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Appendix B

Sherwin Iron (NT) Pty Ltd

Sherwin Creek Iron Ore Project

Supplementary Environmental Impact Statement

2014

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Water Management Plan: Sherwin Creek Iron Ore Project

Prepared for: Sherwin Iron (NT) Pty Ltd

Prepared by: EcOz Environmental Services



2014

EcOz Environmental Services

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1 Current Conditions

1.1 Surface water

1.1.1 Regional catchments context

The Sherwin Creek Iron Ore Project Area (Project Area) is located within the middle reaches of the Roper River catchment, which is 81 794 km^2 in extent and the largest river entering the Gulf of Carpentaria. From its headwaters, the Roper River catchment drains in an easterly direction for a total length of approximately 500 km, where it enters the Gulf of Carpentaria. The tidal limit of the river is Roper Bar, a natural rock bar extending across the river, approximately 200 km east of Mataranka and 20 km downstream of the proposed mine site (Figure 1-1).

The Roper River is a losing system, with flows decreasing with distance downstream, except for areas of groundwater interaction (Knapton 2009). Only the upper reaches of the Roper River maintain flows greater than 0.1 m^3/s (100 L/s) by the end of the dry season, due to groundwater input. The middle and lower reaches of the river usually have flows less than 0.1 m^3/s by the end of the Dry season, and flow records show that cease to flow conditions can often occur at Roper Bar. In some very dry periods, such as the 1950s and 1960s, cease to flow events occurred up to 65 km upstream of Roper Bar at Judy Crossing.

Under the *NT Water Act (2004)*, the entire Roper River catchment falls within the Daly Roper Water Control District, in which there is considered a need for close management of water resources in order to avoid stressing groundwater reserves, river flows or wetlands. Legislation in Water Control Districts covers all aspects of sustainable water resource management including the investigation, use, control, protection and allocation.

There are no listed significant wetlands in the vicinity of the Project Area. Although not considered to be within the potential zone of impact, it is noted that the lower estuarine reaches of the Roper River, together with its associated tidal flats and coastal dunes, are contained within the Limmen Bight and associated coastal floodplains Site of Conservation Significance (NT). Covering an area of 185,000 ha, this area is also listed in the Directory of Important Wetlands in Australia as the Limmen Bight (Port Roper) Tidal Wetlands System (Environment Australia, 2001). The area is significant because it is the second largest area of saline coastal flats in the NT. The Mataranka thermal pools in the upper Roper River catchment are also outside of the potential zone of impact and listed as a Site of Conservation Significance (NT).

Several cattle stations and communities (e.g. Ngukurr) extract water from the Roper River at points downstream of the Project Area, and the river is widely used for stock watering purposes. The Roper River is a very popular destination for local and visiting anglers.

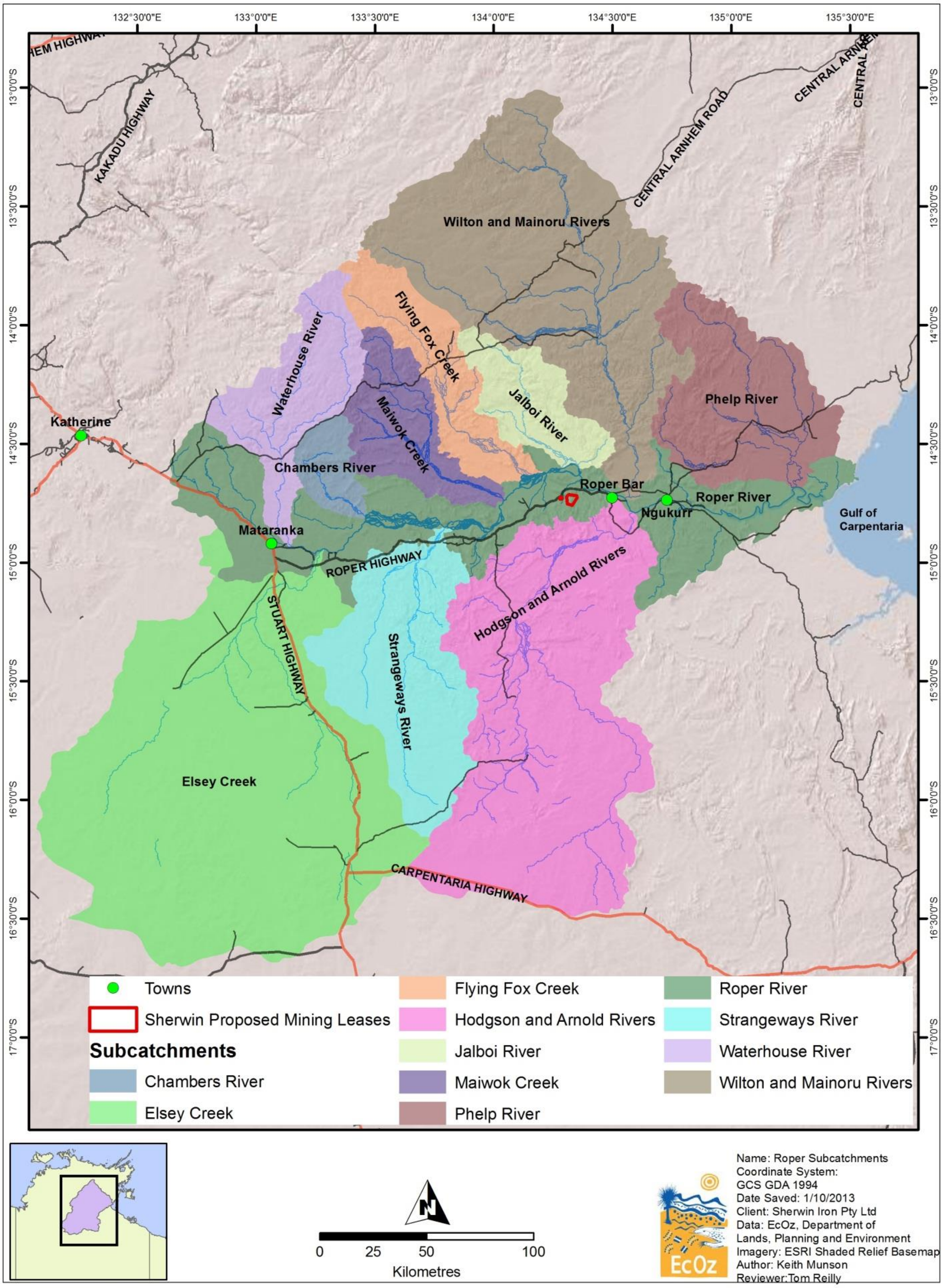

Figure 1-1. Map showing Sherwin Creek Iron Ore Project and river catchments

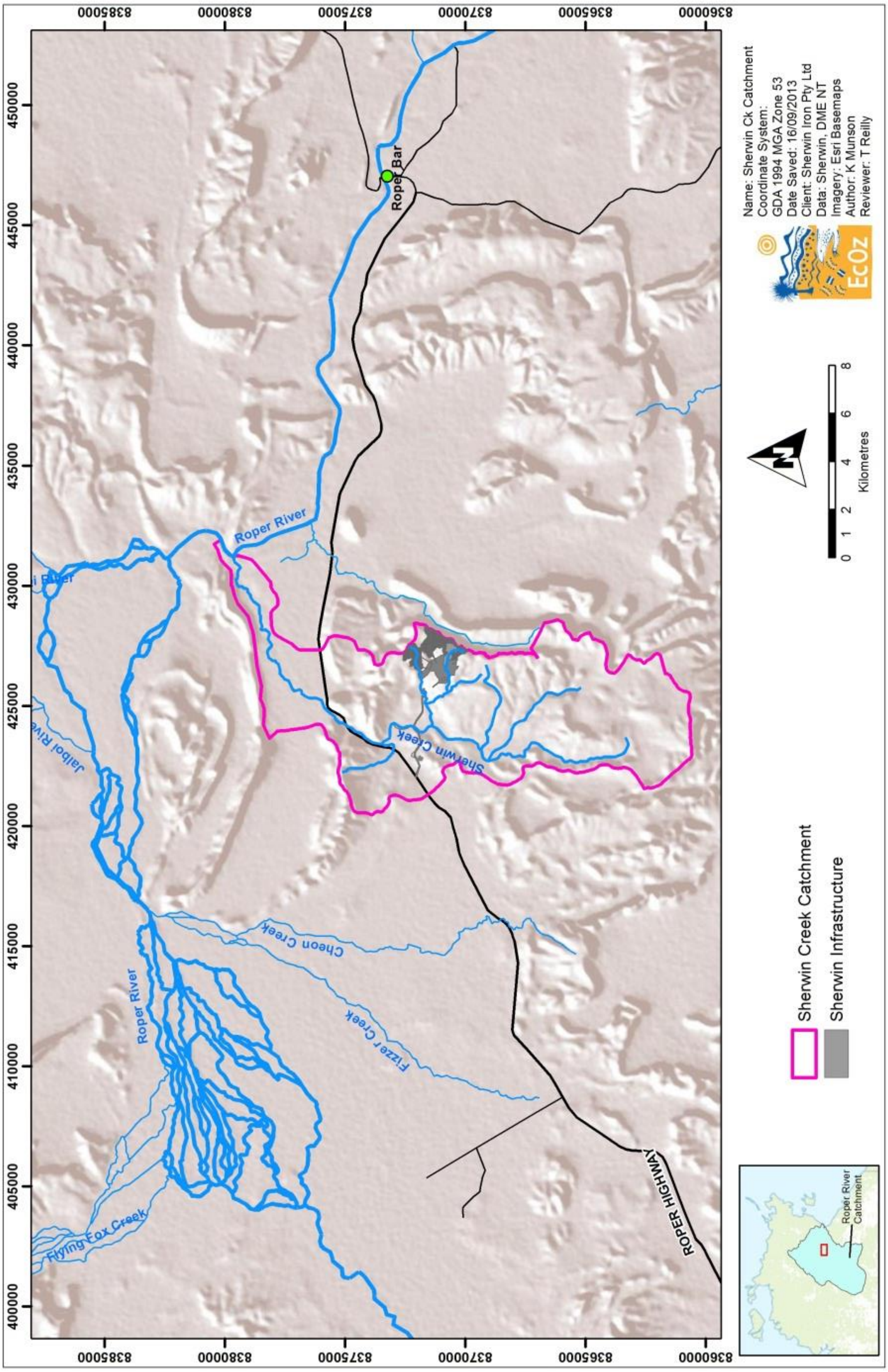

Figure 1-2. Map showing Sherwin Creek catchment.

Figure 1-3. Image showing typical character of Sherwin Creek
(taken from monitoring site SISW04)

1.1.2 Local catchments

The Project Area is located in the middle reaches of Sherwin Creek, a small intermittent 1st order tributary of the Roper River, whose catchment is approximately 100 km^2 in area (Figure 1-2). Over its 30 km length, the total fall in elevation of Sherwin Creek is approximately 140 m. In the vicinity of the proposed mine site, Sherwin Creek has a rocky bed with average channel dimensions of 25m (wide) x 3m (deep) (Figure 1-3). The mine site drains predominantly to the west whilst Sherwin Creek drains from south to north into the Roper River some 8km north-east of the mine. The Access/Haul Road crosses Sherwin Creek some 2 km downstream of the mine site.

Although there is no measured hydrological data available, given the relatively small size of the catchment it is assumed that stream flows are highly responsive to rainfall events and anecdotal observations suggest that the stream ceases to flow in the early dry season (i.e. May/June), with some permanent/semi-permanent pools located downstream of the proposed mine site.

Adjacent minor catchments include Cheon and Fizzer Creeks to the west and a small un-named tributary to the east of the Sherwin Creek catchment (Figure 1-2).

1.1.3 Sherwin Creek hydrology

Sherwin Creek displays a slight sinuous and meandering form with a well-defined active channel. The floodplain is relatively small along most of the channel. Most of the unnamed tributaries draining the mine site are relatively straight with steep hydraulic gradients. Critical parameters necessary for hydraulic estimations (Manning's n) were visually assessed and based on photographs, observations made and professional hydrological judgment, it was concluded that an n-value of 0.035 (dimensionless) for the channel and overbanks should be adopted.

The Rational Method (Australian Rainfall and Runoff, AR&R, Institution of Engineers Australia 1998) has been employed for flood estimation, which provides recommended run-off coefficients for the entire Northern Territory (Table 1-1). Since Sherwin Creek is relatively steep the higher coefficients were used. Whilst there is only limited design information available in the Northern Territory, which translates to a greater uncertainty than for other regions in Australia, the Rational Method provides useful order-of-magnitude design flood estimates. The method was used to estimate flood peak discharges from the main catchments for the 5, 10 and 100 year average recurrence interval (ARI) rainfall events. The Rational Method is based on following formula, as follows:

$Q_p = 0.278 \times C \times i \times A$

where:

Q_p = peak flow (m^3/s)

C = coefficient of runoff

i = intensity of rainfall in time t_c (mm/hr)

A = area of catchment (km^2)

For the purposes of this assessment, only the portion of the Sherwin Creek catchment upstream of the Access/Haul Road (i.e. 12.5 km long and some 64 km^2 in extent) was considered.

Table 1-1. Runoff coefficients for Northern Territory (AR&R).

ARI	Runoff Coefficient
1:2 year	0.5 - 0.7
1:5 year	0.6 - 0.8
1:10 year	0.7 - 0.9
1:100 year (adopted value)	0.9

The final step in the hydrological estimation is to determine the time of concentration (t_c). This is the time required for rain falling at the farthest point of the catchment to flow to the catchment outlet. After time t_c, the whole catchment area is contributing to the flow in the river (Shaw 1994). The Bransby-Williams formula was adopted to estimate t_c (Institution of Engineers Australia 1998), as follows:

$t_c = 58 \times L /(A^{0.1} \times S_e^{0.2})$

where:

t_c = time of concentration (min)

L = mainstream length (km)

A = area of catchment (km^2)

S_e = average slope of catchment (m/km)

The mainstream length and the average slope of the catchment were calculated using a contour data (2 m) of the area. Rainfall at t_c was determined using the online computer program (BoM, 2013) which calculates IFD curves (Intensity-Frequency-Duration). For this assessment, rainfall intensity values were determined for the three rainfall events (5, 10 and 100 year ARIs) using the time of concentration as the rainfall duration. The IFDs for Sherwin Creek are presented in Figure 1-4.

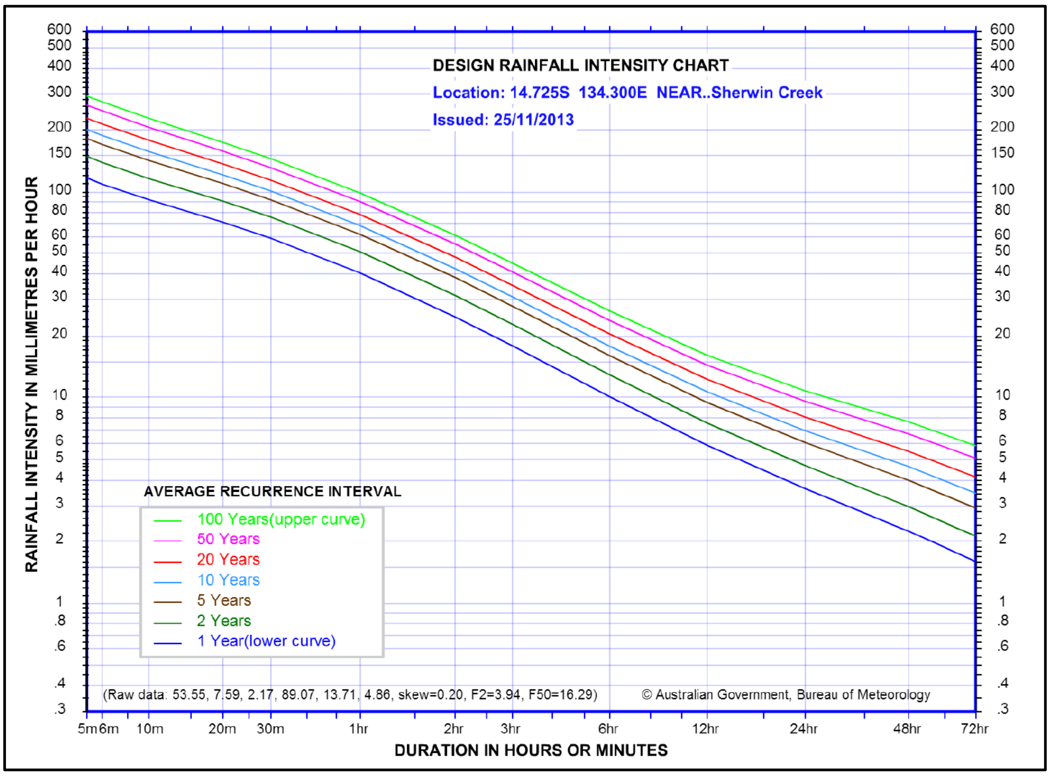

Figure 1-4. Adopted IFDs for the Sherwin Iron ore Project.

Estimated rainfall intensity values (i), flow (Q) and depths for the times of concentration and ARI rainfall events and the estimated peak flood discharges are provided in Table 1-2.

Table 1-2. Estimated rainfall intensities and flood peak discharges.

ARI	5 year	10 year	100 year
i (mm/hr)	16	18	26
Q (m^3/s)	228	288	416
Estimated Flow Depth (m)	4.3	4.8	5.5

This preliminary assessment indicates that the main active channel of Sherwin Creek may accommodate only smaller flows and larger flood events will overtop the stream banks, with flood water inundating the floodplain.

Depths of water across the floodplain could be approximately 2.5 m for the 100-yr ARI flood event at the crossing of the site access road on Sherwin Creek. Estimated flow velocities, both within the channel and in the overbank regions, are relatively low, which this is to be expected given the gradient along the course of the Sherwin Creek.

The mean annual runoff from the catchment above the Access/Haul Road is estimated at 34.5 ML/a.

1.1.4 Surface water quality

There is limited available baseline surface water quality data for Sherwin Creek, which includes two samples at adjacent (1 km apart) sites within the Project Area and one sample from a site on the lower reaches of Sherwin Creek, about 2 km upstream of the Roper River confluence (Table 1-3, Figure 1-5).

Available water quality data indicate that the upper to middle reaches of Sherwin Creek is rainfall-dominated, being characterised by circum-neutral pH, moderate electrical conductivity (EC) and low ionic composition. In contrast, it appears that the lower reaches of Sherwin Creek are groundwater-fed, as indicated by relatively high pH, EC, alkalinity and ionic composition. Concentrations of dissolved heavy metals are generally below laboratory detection limits, with the exception of manganese and iron. Nutrient concentrations are slightly elevated in comparison to default ANZECC (2000) guidelines for 95 % protection of aquatic ecosystem health (Table 1-3).

Table 1-3. Baseline water quality data for Sherwin Creek

Site	Date	In-situ pH	In-situ DO	In-situ EC	In-situ Turbidity	Total Dissolved Solids	Total Suspended Solids	Hydroxide $CaCO_3$	Carbonate $CaCO_3$	Bicarbonate $CaCO_3$	Total Alkalinity $CaCO_3$	Total hardness CaCO3	SO_4^{2-}	Cl	Ca	Mg	Na	K
		units	%	uS/cm	FTU	g/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
ANZECC 95%		*6 - 8*		*250*	*2 - 15*													
SISW05	17/05/2012	6.65	1.1		12		6	<1	<1	21	21		<1	29	2	6	14	1
SISW04	17/05/2012	6.55	73	147	5.8	0.094	<5	<1	<1	11	11		3	22	1	5	12	1
G9035112	20/06/1986	8.5		925		0.545			6	259	222	280	82	120	48	39	89	10

Site	Date	As	Cd	Cr	Cu	Mn	Ni	Pb	Zn	Fe	Ammonia	Nitrite	Nitrate	Nitrite + Nitrate	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus
		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
ANZECC 95%		*0.024*	*0.0002*	*0.001*	*0.0014*	*1.9*	*0.011*	*0.0034*	*0.008*		*0.01*		*0.16*	*0.005*		*0.3*	*0.01*
SISW05	17/05/2012	<0.001	<0.0001	<0.001	0.001	0.036	<0.001	<0.001	<0.005	0.13	0.02	<0.01	0.01	0.01	2.8	2.8	0.02
SISW04	17/05/2012	<0.001	<0.0001	<0.001	<0.001	0.03	<0.001	<0.001	<0.005	<0.05	0.01	<0.01	<0.01	<0.01	0.1	0.1	0.02
G9035112	20/06/1986												1				

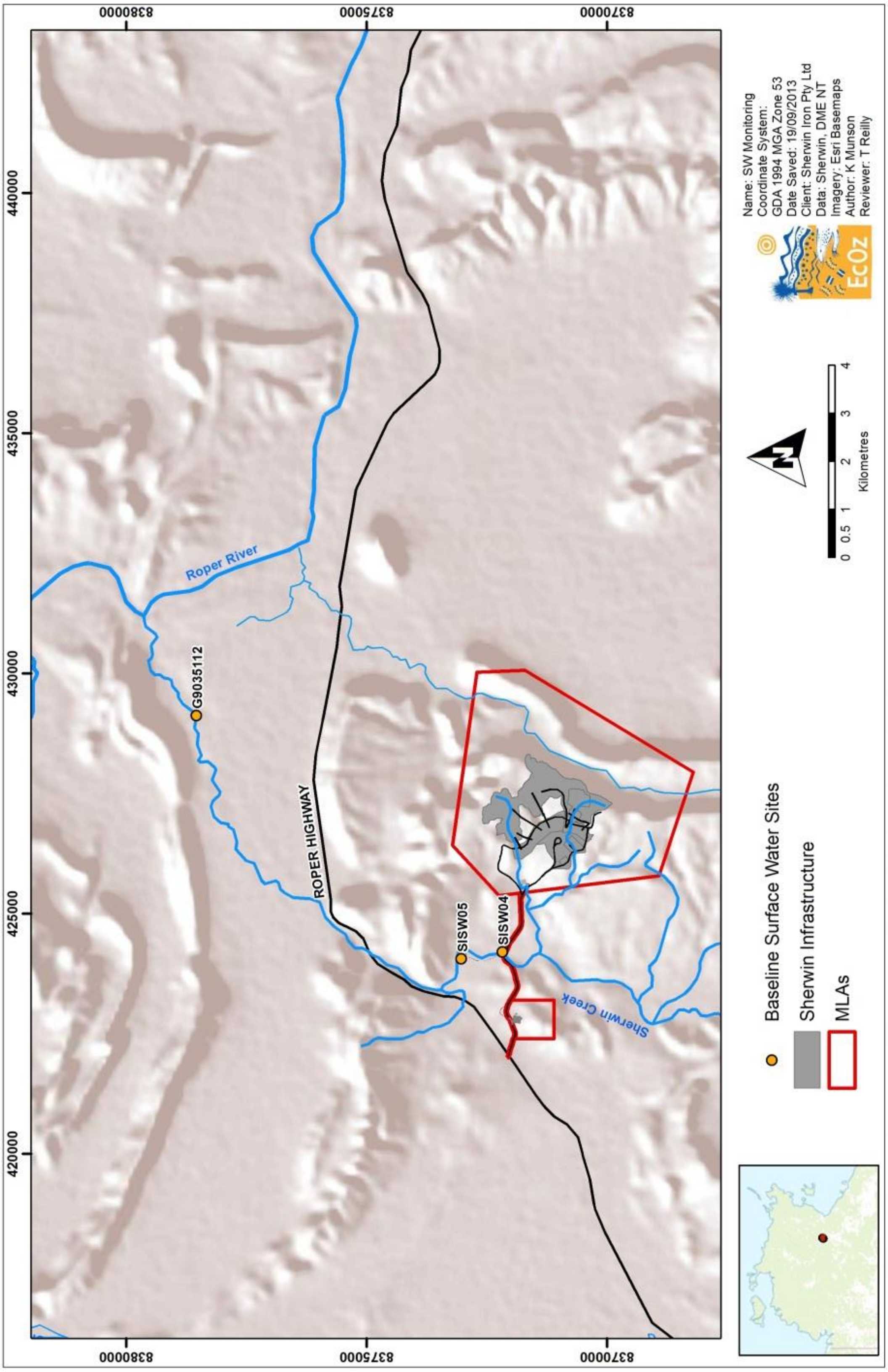

Figure 1-5. Map showing location of baseline surface water monitoring sites

1.2 Groundwater

1.2.1 Regional groundwater resources

The project area is located within the Daly-Roper Water Control District (WCD), where a water extraction licence is generally required for any extraction. Exceptions apply to mining operations, domestic purposes, drinking water, grazing stock and irrigation of a domestic garden not exceeding 0.5 ha.

The Daly-Roper WCD comprises the combined Daly and Roper River catchments, each with major river systems including the Katherine, Flora, Douglas, and tributaries of the Daly and Roper Rivers (i.e. Waterhouse, Mainoru, Wilton and Phelp). The Oolloo, Jinduckin and Tindall aquifers are also included in the WCD as these aquifers discharge into the rivers. The WCD also includes the Katherine, Oolloo and Mataranka Water Allocation Plan (WAP) areas.

Under section 57 of the NT *Water Act,* any bore drilled within the WCD requires a bore construction permit, except for mining operations. A bore located outside a WCD does not require a construction permit, noting that under the same Act, a Northern Territory licensed driller must be used to drill the bore.

1.2.2 Local groundwater resources

The project area terrain is predominantly flat to undulating and blanketed with thin Quaternary soils. The cyclic sandstone and mudstone shallow marine sequence is up to 2,000 m thick in the area and has been intruded by dolerite sills, up to 50 m thick, prior to regional deformation (Alarcon-Leon 2013a – EIS Appendix F2).

MLA29584 (Deposit C) contains the Maiwok Sub Group, comprising a sequence of mud/siltstones at the bottom, sandstone with silt/mudstones and at the top, interbedded fine grained sandstone, siltstone and mudstone, with distinct pisolitic ironstone units at several stratigraphic horizons near the surface. The Upper, Middle and Lower Ironstone beds are well represented at Sherwin Creek. Dolerite sills, up to 50 m or more in thickness, have intruded between the Lower Ironstone and the overlying basal oolitic hematite of the Middle Ironstone.

The local aquifers may be described as weathered strata overlying hard fractured bed rock and comprise:

- A permeable and ephemeral shallow system. The pedological column, particularly at the north-western end of Deposit C, contains some lenses of fresh ground water trapped locally in silty-clays, overlying extremely weathered sandstone (~6 m thick). These conditions do not extend across the footprint of the proposed open pit and are highly localised, within the alluvial-debris fans located at the outlets of numerous small creek channels and gullies.

- The shallow system is underlain by a sequence of interlayered weathered and fractured siltstones, sandstones, shales and localised mudstones, in which groundwater is encountered between about 20 m below surface (lower lying terrain) and 70 m below surface (across higher lying terrain and the open pit). Below this, there is a thick sequence of siltstones overlying a very hard bluish dolerite that acts as the lower boundary of the confining system.

Groundwater strikes were generally small and resultant groundwater levels below the depth of mining (Table 1-4). The hydraulic parameters of the aquifers are low, indicative of the relative impermeability of the terrain. Baseline EIS groundwater investigations (Alarcon-Leon 2013a) indicated that mining to about 40 m below surface would not interfere with the deeper fractured aquifers and groundwater influx will not take place.

Current groundwater sources are detailed in Table 1-4 and Figure 1-6.

Table 1-4. Groundwater sources (source: Alarcon-Leon 2013a - EIS Appendix F2)

Bore ID	Depth	Water Strikes	GWL	Airlift Yield	Medium Term Sustain ability	Long Term Sustainable Yield	Aquifer
	mbgl	mbgl	mbgl	L/s	(L/s)	(L/s)	
SEMB1	50	47	50.1	<0.01	-	not calculated	Shale underlying clay.
SEMB2	50	37	36.6	0.20	0.10	not calculated	Fracture zone in siltstones.
SEMB3	55	16, 23	4.3	1.33	0.90	0.81	Sherwin Ironstones.
SEMB4	40	23	22.9	0.01	-	not calculated	
SEMB5	50	43	45.8	<0.01	-	not calculated	Clay.
SEMB6	55	25	16.3	0.10	0.10	not calculated	Weathered sandstone.
SPB01	27	13 to 18	9.6	0.45	0.40	not calculated	Alluvial conglomerates, grey siltstone and quartz.
SPB02	100	26, 34, 37, 51	2.3	0.50	0.10	not calculated	Fractured iron rich sandstones, siltstones and shales.
SPB03	75	34, 48, 51, 67	0.5	<0.01	-	not calculated	
SPB06	75	25, 26, 40, 43, 53, 61, 67	3.5	0.22	0.20	not calculated	
SPB07	75	9, 15	6.5	1.0	0.65	0.11	Alluvial conglomerates overlying highly weathered and fractured sandstones. Bore is the same system as per SPB01.

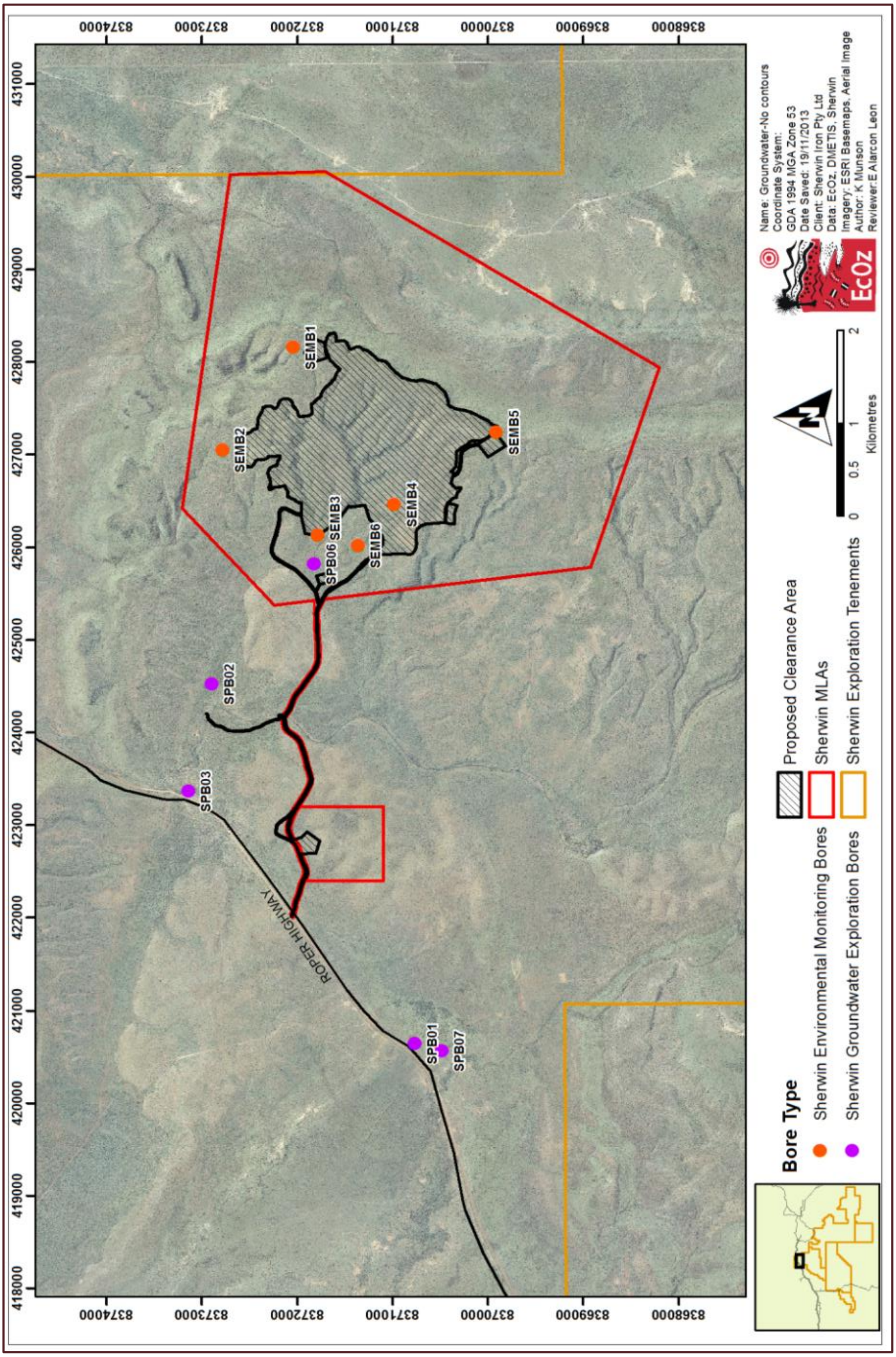

Figure 1-6. Map showing groundwater extraction and monitoring bore locations

1.2.3 Groundwater quality

Groundwater qualities (Table 1-5) are deemed suitable for most uses/users:

- Circum-neutral to slightly alkaline pH, ranging from 5.84 to 8.99.
- Electrical conductivities (EC) range from 98 to 1,110 µS/cm, averaging 464 µS/cm.
- Most groundwaters have relatively small concentrations of major ions, with only one sample (bore SPB03) having elevated chloride (108 mg/L) and sodium (178 mg/L).
- The trace elements are generally well below their assessment levels.
- Hydro-geochemical assessments indicate the presence of three types of ground water: the first is a $Ca(HCO_3)_2$ type, indicating recently recharged waters which occur across the low lying ground to the west and south-west of the proposed open pit. The second is a $NaHCO_3$ type which indicates ion-exchange waters to the north and north-west of the proposed open pit (i.e. between bores SPB02 and SPB03). The third group is a NaCl type, which indicates end-point (saline/brackish) waters across high lying ground and below the proposed mine pit. These waters have lower pH values than elsewhere and slight salinity, indicating slow and little recharge, if any.

Table 1-5. Groundwater quality

Sherwin Mine Ground Water Quality			Assessment Levels		Sample Type: Ground Water										
			NHMRC/NRMMC	ANZECC	Sampling Date: Year 2013										
			(2011)[1]	(2000)[2]	6-Sep	30-Aug	27-Oct	27-Oct	27-Oct	12-Sep	9-Nov	15-Oct	7-Nov	12-Oct	25-Oct
Analyte	**Unit**	**LOR**		**95%**[3]	SEMB02	SEMB03a	SEMB03b	SEMB03c	SEMB03d	SEMB06	SPB01	SPB02	SPB03	SPB06	SPB07
Field Measurement															
pH Value	pH Unit				5.84	7.39				6.74	8.25	8.99	8.58	8.32	6.5
Electrical Conductivity	µS/cm				98	311.2				220.6		446	1880	339.1	
Total Dissolved Solids	mg/L				63.8	202.3				141.8					
Salinity	ppt				0.1	0.1				0.1	0.54	0.2	0.94	0.23	0.3
Dissolved Oxygen	%				98.5	87				65		72.9		76.1	
Temperature	°C				27.8	30.2				30.2		33.5		30.5	
Laboratory Measurement															
pH Value	pH Unit	0.01		6.0-8.5	5.84	7.39	7.02	6.97	7.01	6.74	8.27	8.02	9.12	8.1	7.66
Electrical Conductivity @ 25°C	µS/cm	1		10000	98	311.2	387	342	347	220.6	1110	336	896	339	714
Total Dissolved Solids (Calc.)	mg/L	1		100	638	223	252	222	226	141.8	722	218	582	220	464
Total Hardness as $CaCO_3$	mg/L	1			4	133	115	114	113	87	386	50	<1	105	204
Alkalinity															
Hydroxide Alkalinity as $CaCO_3$	mg/L	1			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$	mg/L	1			<1	<1	<1	<1	<1	<1	<1	<1	57	<1	<1
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1			1	105	142	116	117	85	459	107	173	112	298
Total Alkalinity as $CaCO_3$	mg/L	1			1	105	142	116	117	85	459	107	230	112	298
Aions															
Acidity as $CaCO_3$	mg/L	1					79	52	54		11	5	<1	<1	31
Sulfate as SO_4 - Turbidimetric	mg/L	1		400	4	7	5	6	6	3	4	9	7	3	3
Chloride	mg/L	1	250	400	21	24	27	28	28	13	52	24	108	29	38
Cations															

Sherwin Mine Ground Water Quality			Assessment Levels		Sample Type: Ground Water										
			NHMRC/NRMMC	ANZECC	Sampling Date: Year 2013										
			(2011)[1]	(2000)[2]	6-Sep	30-Aug	27-Oct	27-Oct	27-Oct	12-Sep	9-Nov	15-Oct	7-Nov	12-Oct	25-Oct
Analyte	**Unit**	**LOR**		**95%**[3]	SEMB02	SEMB03a	SEMB03b	SEMB03c	SEMB03d	SEMB06	SPB01	SPB02	SPB03	SPB06	SPB07
Calcium	mg/L	1			<1	2	5	3	4	2	54	5	<1	4	34
Magnesium	mg/L	1			1	31	25	26	25	20	61	9	<1	23	29
Sodium	mg/L	1		300	16	15	14	15	15	10	82	49	178	17	64
Potassium	mg/L	1			2	2	1	1	1	7	4	6	3	4	3
Dissolved Metals															
Arsenic	mg/L	0.001			<0.001	0.001	0.002	0.001	0.002	0.002	<0.001	<0.001	0.001	<0.001	<0.001
Boron	mg/L	0.05			<0.05	0.09	0.11	0.11	0.11	<0.05	0.13	0.12	0.5	0.09	0.09
Barium	mg/L	0.001			0.004	0.006	0.01	0.008	0.008	0.018	0.012	0.007	0.002	0.008	0.013
Beryllium	mg/L	0.001			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001			<0.0001	<0.0001	0.0004	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Cobalt	mg/L	0.001			0.003	0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001
Chromium	mg/L	0.001			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.006	<0.001	0.002	<0.001
Manganese	mg/L	0.001			0.18	0.099	0.153	0.129	0.135	0.457	0.137	0.099	0.013	0.089	0.462
Nickel	mg/L	0.001			0.001	<0.001	0.001	<0.001	<0.001	0.002	0.007	0.004	<0.001	0.002	<0.001
Lead	mg/L	0.001			<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	mg/L	0.01			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	0.01			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005			<0.005	<0.005	10.5	0.475	1.34	<0.005	0.009	<0.005	0.005	<0.005	0.252
Total Metals[4]															
Arsenic	mg/L	0.001	0.01	0.024	0.001	0.002	0.003	0.002	0.002	0.027	0.002	0.021	0.005	0.009	<0.001
Boron	mg/L	0.05	4	0.37	<0.05	0.08	0.1	0.12	0.1	0.05	0.16	0.13	0.59	0.1	0.1
Barium	mg/L	0.001	2	-	0.017	0.01	0.018	0.009	0.013	0.131	0.061	0.133	0.07	0.162	0.017
Beryllium	mg/L	0.001	0.06	-	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	0.002	<0.001	0.003	<0.001

Sherwin Mine Ground Water Quality			Assessment Levels		Sample Type: Ground Water										
			NHMRC/NRMMC	ANZECC	Sampling Date: Year 2013										
			(2011)[1]	(2000)[2]	6-Sep	30-Aug	27-Oct	27-Oct	27-Oct	12-Sep	9-Nov	15-Oct	7-Nov	12-Oct	25-Oct
Analyte	**Unit**	**LOR**		**95%[3]**	SEMB02	SEMB03a	SEMB03b	SEMB03c	SEMB03d	SEMB06	SPB01	SPB02	SPB03	SPB06	SPB07
Cadmium	mg/L	0.0001	0.002	0.0002	<0.0001	<0.0001	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0006
Cobalt	mg/L	0.001	-	-	0.005	0.003	<0.001	<0.001	<0.001	0.048	0.014	0.033	0.005	0.024	<0.001
Chromium	mg/L	0.001	0.05	0.001	0.001	<0.001	0.012	<0.001	<0.001	0.02	0.008	0.027	0.007	0.031	0.001
Copper	mg/L	0.001	2	0.0014	<0.001	<0.001	0.014	0.001	0.003	0.009	0.019	0.274	0.006	0.037	0.008
Manganese	mg/L	0.001	0.1	1.9	0.346	0.156	0.197	0.142	0.146	3.7	2.28	2.43	1.12	0.809	0.412
Nickel	mg/L	0.001	0.02	0.011	0.002	<0.001	0.004	<0.001	<0.001	0.012	0.014	0.079	0.007	0.035	0.002
Lead	mg/L	0.001	0.01	0.0034	<0.001	<0.001	0.01	<0.001	0.002	0.006	0.008	0.014	0.005	0.009	0.016
Selenium	mg/L	0.01	0.01	0.011	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	0.01	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	0.11	0.04	0.01	0.03	0.02
Zinc	mg/L	0.005	3	0.008	<0.005	0.01	13.5	1.39	1.37	0.045	1.65	0.69	0.127	0.103	3.52
Dissolved Mercury	mg/L	0.0001					<0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Total Recoverable Mercury	mg/L	0.0001	0.001				<0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Others															
Fluoride	mg/L	0.1					0.2	0.2	0.2		1.4	1.2	0.5	0.3	0.6
Ammonia as N	mg/L	0.01					0.03	0.04	0.04		0.04	0.4	0.23	0.16	0.36
Nitrite as N	mg/L	0.01					<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	0.02
Nitrate as N	mg/L	0.01					<0.01	<0.01	<0.01		0.12	0.08	0.02	<0.01	0.4
Nitrite + Nitrate as N	mg/L	0.01		11	0.24	<0.01	<0.01	<0.01	<0.01	0.01	0.12	0.08	0.02	<0.01	0.42
Total Kjeldahl Nitrogen as N	mg/L	0.1			<0.1	<0.1	0.1	0.1	0.1	0.7	0.1	1.1	0.2	0.4	0.7
Total Nitrogen as N	mg/L	0.1			0.2	<0.1	0.1	0.1	0.1	0.7	0.2	1.2	0.2	0.4	1.1
Total Phosphorus as P	mg/L	0.01			<0.01	0.02	0.01	0.02	0.03	0.07	0.08	0.33	0.03	0.05	0.01
Reactive Phosphorus as P	mg/L	0.01					<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01
Ionic Balance															
Total Anions	meq/L	0.01			0.7	2.92	3.7	3.23	3.25	2.13	10.7	3.15	7.79	3.12	7.09

Sherwin Mine Ground Water Quality			Assessment Levels		Sample Type: Ground Water										
			NHMRC/NRMMC	ANZECC	Sampling Date: Year 2013										
			(2011)[1]	(2000)[2]	6-Sep	30-Aug	27-Oct	27-Oct	27-Oct	12-Sep	9-Nov	15-Oct	7-Nov	12-Oct	25-Oct
Analyte	**Unit**	**LOR**		**95%[3]**	SEMB02	SEMB03a	SEMB03b	SEMB03c	SEMB03d	SEMB06	SPB01	SPB02	SPB03	SPB06	SPB07
Total Cations	meq/L	0.01			0.83	3.35	3.82	3.34	3.36	2.36	11.4	3.28	7.82	2.95	6.94
Ionic Balance	%	0.01					1.57	1.55	1.63		2.98	1.92	0.15		1.05

Note:

1. NHMRC and ARMCANZ (2011). Australian Drinking Water Guidelines.
2. ANZECC and ARMCANZ (2000). Australian Water Quality Guidelines for Fresh and Marine Water Quality.
3. Values are 'triggers' for slightly moderately disturbed ecosystems. Values applicable to high conservation/ecological value systems and highly disturbed ecosystems are available in ANZECC and ARMCANZ (2000).
4. All values above the Australian Drinking Water Guidelines are highlighted in yellow colour.

2 Water Management System

2.1 Water demand

An estimate of the water demand for potable use and mining operations is provided in Table 2-1 below, with the rationale and details provided for the water demand in the following sub-sections.

Table 2-1. Estimated potable and mining operational water requirements

Water Demand/Requirement DSO Mining 3Mt/a	ML/a	L/s
Camp Site (100 occupants)	7.3	0.46
Mine Offices/Workshop/Site (65 personnel)	0.1	0.01
Total Potable Water Requirement	**7.4**	**0.9**
Mine Water Requirement (non-potable)		
Crushing and Screening (dust suppression)	3.5	0.20
Workshop/Wash Bays	1.5	0.09
Haul Road/Open Pit Mining/ROM (dust suppression)	75.0	4.34
Total Mine Operational Water Requirement	**87.5**	**5.10**
The total water requirement is estimated at 5.10L/s over 24 hours. For the purposes of long-term sustainability bores should not be pumped for longer than 12 hours per day and thus the water demand has been estimated at 12L/s over 12 hours per day.		

The potable and mine water demand will be met solely from groundwater sources. As such potential sources of water such as treated waste water and rain falling into the open pits have been excluded from the water balance (but are included in the water account which presents a summary of all water inputs and losses or outputs). The primary users of water at the site are dust suppression at the screening plant and along the haul roads.

The above estimates of the water demand were based on a combination of current measurements and estimates for consumption during bulk sampling at the site and from figures obtained from industry and using several water saving strategies, extrapolated for mining, including:

- Water-saving devices and worker awareness training at the camp and mine ablutions.
- The latest technology in crushing and screening.
- Polymers on all roads requiring dust suppression.

The commercially-available polymer 'ISB9000' by Dust-A-Side (or similar) is to be applied to haul roads for sealing purposes and dust control of road and hardstand pavements. The polymer proposed is not classified as a dangerous good under the Australian Dangerous Goods Code.

2.1.1 Potable water requirement

The potable water requirement has been estimated as follows:

Camp: 100 persons, 200 L/d for 365 d = 7.3 ML/a or 0.46 L/s – this is justified as Sherwin recognises the importance/value of water and will implement water saving devises such as: AAA showerheads, taps and low pressure fittings. The allowance of 200 L/p/d is in line with water consumption at several camps at iron ore mines across northern WA.

Mine: 65 persons, 5 L/d for 365 d = 0.1 ML/a or 0.01 L/s. Sherwin intends providing chilled water dispensers at the offices and workshops.

2.1.2 Mine water requirement

Crushing and screening

Crushing and Screening: 3.5 ML/a or 0.20 L/s – based upon information provided by the mine's contractor Screen Masters (the screening equipment uses 12 nozzles at a rate of 1 L/min for 16 hours/day and 300 work days).

For the mine water requirement, it has been assumed that operations will take place for 300 days to account for stoppages, shutdowns, maintenance, etc.

Sherwin aims at transporting ore with a moisture content less than 7 % and will add moisture prior to ship-loading, if and when required.

Administration and workshop

Workshop/Wash Bays: 1.5 ML/a: non-potable uses: toilets, basins, high pressure cleaners and dust suppression.

Sherwin will install a 20 kL tank and will filter/recycle water at the Workshop; it is estimated that make-up water will approximate 5 kL/day:

- Toilets/basins, but no showers: possibly around 1,000L /day, treated and recycled for dust suppression.
- Washing parts, trucks, etc.: water to be collected, filtrated and recycled similar to a car wash.

Dust suppression haul road/open pit mining/ROM

Dust-A-Side indicated that the water requirement to install/establish a polymer (bitumen – refer Attachment 1) is estimated at 17 ML/a, assuming the use of a premium mix-in solution at approximately 75 mm depth (~6 L/m^2 for establishment = 636 kL for a 20 m x 5.3 km site access/haul road and ~153 L/m^2/a for maintenance = 16,218 kL totalling 17ML/a (naturally palliative treatments (spray applied) use high amounts of water during establishment before decreasing by about 70 – 80 % for maintenance).

Sherwin, based upon current measurements and extrapolations and including applying polymers/bitumen to the haul roads, currently estimates the dust suppression water requirements at 75 ML/a = 4.34L/s = 250 kL/day.

2.1.3 Total water demand

The total water demand for the DSO project, based on the above assumptions and data, is thus estimated at 87.4 ML/a, which is approximately 5.10L/s for 24-hr days. In terms of a sustainable ground water supply, this approximates to an extraction rate of about 12 L/s.

2.2 Water management infrastructure and operation

The water management system for the Sherwin Creek Iron Ore Project is illustrated in Figure 2-1.

Fire water storage tanks will be located at the plant and accommodation camp for use in the case of an emergency. The camp will have a dedicated pressurised fire water system. The fire water storage tank reserve capacity in each location will be located in the lower portion of the respective raw water tanks, with all other water consumption being drawn from above the fire water reserve capacity. The fire water pumps will be a conventional system, utilising an electric duty and standby pump, with a diesel back-up pump.

Water required for human consumption (drinking or washing) will be treated via ultra-violet treatment and reverse osmosis prior to use. Raw water will be stored at the mine camp in three 45 kL and two 35 kL tanks prior to treatment.

A modular 'OSMOMBR' wastewater treatment plant (max. capacity 500 kL/day) will be installed at the mine camp. The wastewater effluent after treatment will be reticulated onto landscaped areas and the surplus will be stored in a turkey's nest dam for use in dust suppression. All products resulting from the wastewater treatment plant will be managed in accordance with relevant legislation and guidance material for minimum quality of water to be used in irrigation.

Erosion control measures are detailed in the Erosion and Sediment Control Plan (ADG 2013 - EIS Appendix E), which involves the re-routing of clean, upstream catchment run-off around disturbed areas through a system of diversion channels and level spreaders. Uncontaminated run-off from disturbed areas will be collected in catch drains and channelled into sediment basins. Sediment basins will be constructed using the IECA Best Practice Erosion and Sediment Control guidelines with a minimum storage depth of 0.6 m. Implementation of these measures will ensure the integrity of receiving waters.

As outlined in the baseline Acidic/metalliferous Drainage (AMD) Assessment Report (Alarcon-Leon 2013b – EIS Appendix G), the risk of AMD is considered to be low and coupled with the absence of groundwater influx into the open pit, there is unlikely to be a requirement to manage contaminated water on site. The ore extraction process is also benign (i.e. no chemicals added), so there is no risk of contamination associated with chemical extraction. Although the risks are considered minimal, sedimentation ponds located downstream of potential sources of contamination from mined materials (i.e. waste dumps, stockpiles) and stored hazardous materials (i.e. workshops, fuel storages etc.) will be monitored to confirm that water quality is suitable for discharge and if an issue is identified, specific changes in management and/or infrastructure may need to be made.

The mined out pits will be used to store rain falling into the open pit, with diversions to direct water away from current work areas/faces. If required, mining during the wet season will retract to higher-lying ground and will then continue once the lower lying areas have dried out and/or the water level receded. This water will be the preferred first source of water for dust suppression and is currently not included as a source of water to meet the water demand/requirements. Discharge from the open pit has not been allowed for and is unlikely to be necessary, since there is sufficient capacity to retain all rain falling directly into the open pit.

The groundwater investigation (Alarcon-Leon 2013a – EIS Appendix F2) confirmed the absence of groundwater within the depth of mining. Thus, there will be no flux of groundwater into the open pit. Rain falling directly into the open pit will be collected in sumps, fitted with submersible pumps; at the downstream end (western side) of the open pit mining will take place in a sequence to facilitate pit mine water management in such a fashion that higher elevations are mined during the wet season. This pit rain and runoff water will be the primary source for dust suppression water.

Groundwater sources will be pumped and piped to several turkey's nests (nominally designed to be 75 x 75 m and at least 3 m deep (Figure 2-2):

- North of the magazine area but more than 500 m away near the new haul road access (to be supplied by bores located between the magazine and sub-grade stockpile area).
- Along the existing access road (to be supplied by bores located near Sherwin Creek, south of the Restricted Work Area).
- West of the proposed camp (to be supplied by bores located further west of the proposed camp).

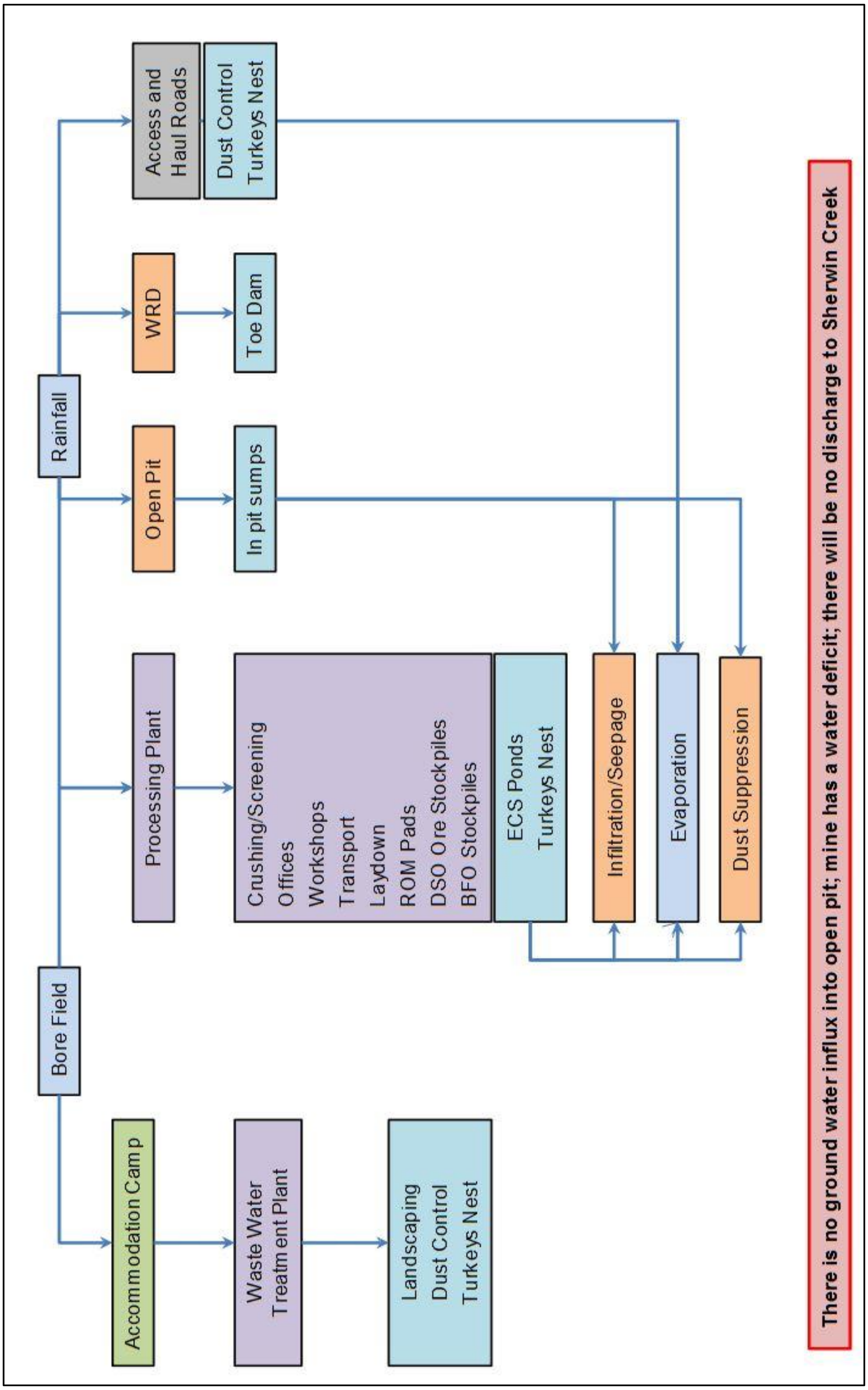

Figure 2-1. Diagram showing water management system for year 1 operations

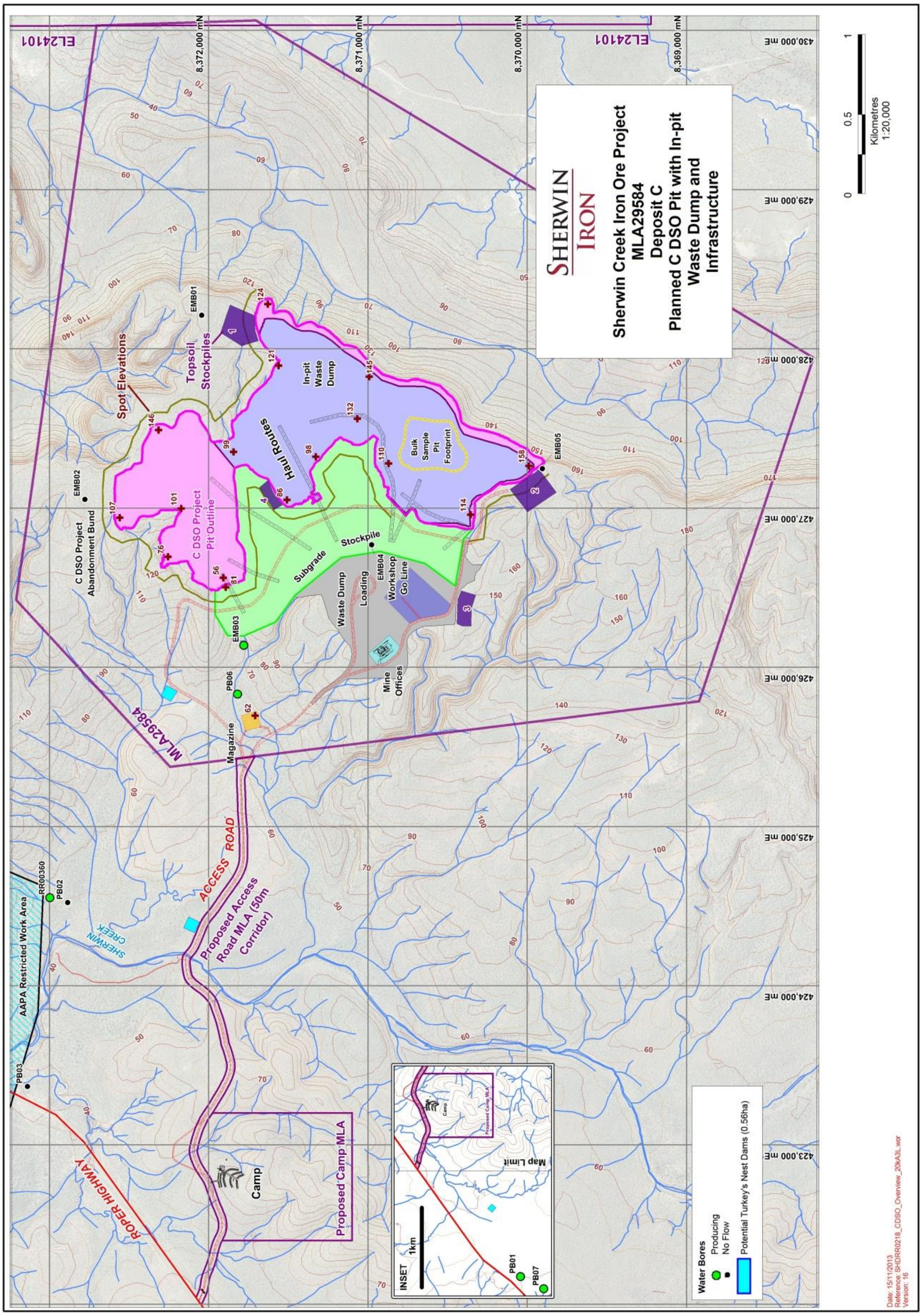

Figure 2-2. Map showing mine layout and locations of turkey's nest dams.

2.3 Water account

The average water account for the DSO project is based upon all inputs and outputs as per the definitions included in Attachment 2.

However, the water balance for the projects is based upon:

- Bores (ground water) being the sole source of water.
- Potential sources of water, primarily for dust suppression, and indicated as a first (preferred) source of water when available include treated water from WWTP's at the camp and mine site, sedimentation pond at the Plant/Workshop and sumps in the open pit.

It is anticipated that by using rain-runoff at the Plant/Workshop during the wet season when available, will allow bores to fully recover following recharge from rain before the dry season commences. This operational measure will enhance the sustainability of the ground water resources.

Detailed monthly (low, average and high rainfall) water balances are provided in Attachment 3 for the open pit and summarised in Table 2-2 below, which indicate that there will be no discharge from the open pit and that all rain falling inside the perimeters of the pit will be contained.

Table 2-2. Pit water balances

Pit Water Balance - Annual Summaries					
	Cumulative Area	Approximate Cumulative Volume	Cumulative Low Rain	Cumulative Average Rain	Cumulative High Rain
	-	-	517mm/a	816mm/a	1,449mm/a
	(m^2)	(m^3)	(m^3)	(m^3)	(m^3)
Year 1	184,447	2,250,000	66,730	105,292	187,033
Year 2	628,028	5,760,000	227,211	358,510	636,833
Year 3	851,115	10,260,000	309,729	488,713	868,118
Year 4	1,356,373	13,860,000	490,715	774,288	1,375,389
Year 5	1,811,700	17,100,000	655,445	1,034,209	1,837,100
Year 6	1,981,173	19,740,000	716,758	1,130,953	2,008,949
Volumes calculated to 30m pit depth; assume 70% rain-runoff inside pit perimeters.					

Rain falling in the open pits will be available up to between May (low and average rain) and June (high rainfall), before evaporation and infiltration through the floor of the pit depletes the available water. There is the potential to withdraw water from the pit during this period at the rates indicated in Table 2-3 below.

Table 2-3. Pit water availability

	Pit Water Availability: January to May
	(ML/a)
Year 1	12
Year 2	40
Year 3	55
Year 4	88
Year 5	117
Year 6	128

3 Knowledge Gaps

3.1 Identification of knowledge gaps

The most critical knowledge gap in relation to water management for Sherwin identified in the baseline groundwater assessment (Alarcon-Leon 2013a – EIS Appendix F2) is addressing the current deficiency in water supply to meet the DSO project demand (i.e. 87.4 ML/a demand versus 12 ML/a sustainable extraction from currently identified groundwater resources).

Another key knowledge gap is the deficiency in the amount of available baseline water quality data. It is generally considered that at least two years of baseline data covering a range of seasonal conditions is an ideal baseline, upon which the potential impacts of mining operations can be assessed.

3.2 Filling knowledge gaps

Sherwin recognises the strategic value and importance of water resources and remains committed to identifying sufficient groundwater sources for the DSO project.

Sherwin has initiated geophysical and hydrogeological assessments to identify suitable target areas for drilling within a 20 km radius from the mine - there appears to be promising targets to the north, south-west, south and east of the mine and in some of these areas there are existing bores with yields exceeding 1L/s. Once this work is completed, ground geophysical surveys will follow (including the areas drilled last year for calibration purposes) followed by bore drilling, testing and water quality sampling programs. Current estimates indicate that 12 bores yielding 1 L/s each will suffice to meet the water demand and the risk to locate adequate and sustainable ground water resources for the project is considered low. Bore testing procedures and modelling will be used to ensure that bores are allocated long term sustainable abstraction rates that will ensure that there is no detrimental impact on the resource and/or the surrounding environment

As substantial disturbance associated with the bulk sample mining activities have already commenced within the Project Area, it is not possible to address the issue of inadequate baseline water quality data. However, the proposed water quality monitoring program (Section 5.1) includes a surface water monitoring site on Sherwin Creek that is upstream of mining operations, which can be used as a reference site to assess potential future impacts.

4 Risk Management

4.1 Assessment methods

Risk is defined as the chance of something happening that will have an impact on objectives. The first step in the risk assessment process involved identifying the hazards associated with hydrology and water quality. Each hazard was analysed for likelihood and consequence and a risk ranking was developed for the inherent value. Mitigation measures were considered for each hazard and a new likelihood, consequence and risk ranking (now the residual risk) was defined.

The ranking for event consequence is shown in Table 4-1. The likelihood of an event occurring provides a measure of the known or anticipated frequency of occurrences (see Table 4-2). Combining likelihood with consequence (see Table 4-3) provides guidance on risk levels of each aspect and enables ranking of priorities.

Identified hazards, associated risks, mitigation measures and residual risks to hydrology and water quality associated with the project are summarised in Table 4-4 and discussed in further detail in Section 4.2 below.

Table 4-1. Consequence ranking

Consequence		
1	Insignificant	No measurable impact on the environment. No injuries. Low-nil financial loss.
2	Minor	Minor, temporary environmental impact. No publicity likely and no stakeholder concerns. First aid treatment required. Medium-low financial loss.
3	Moderate	Substantial temporary or permanent minor, localised environmental damage. Stakeholder enquires (this may include government, unions or public). Medical attention required. High-medium financial loss.
4	Major	Substantial or permanent environmental damage. Prosecution possible. Loss of company credibility and high stakeholder interest. Permanent injuries. High financial loss.
5	Catastrophic	Widespread severe and permanent environmental damage. Major stakeholder and media interest. Prosecution likely. Permanent injury or death. Extreme financial loss.

Table 4-2. Qualitative measures of likelihood

Probability/likelihood			Likelihood criteria
A	Rare:	Practically impossible, will only occur in exceptional circumstances. Has never occurred in the industry.	0-1%
B	Unlikely:	Could occur at some time but highly unlikely. Has occurred in the industry previously.	1-10%
C	Moderate:	Might occur at some time. Has occurred in associated companies previously.	11-50%
D	Likely:	Known to occur or will probably occur in most circumstances. Has occurred several times/year in associated companies.	51-90%
E	Almost certain:	Common or repeating occurrence. Is expected to occur several times/year in any associated business.	91-100%

Table 4-3. Risk rankings used by combining consequence with likelihood levels for each aspect identified

		Consequence				
		1	2	3	4	5
Likelihood	A	1	3	6	10	15
	B	2	5	9	14	19
	C	4	8	13	18	22
	D	7	12	17	21	24
	E	11	16	20	23	25

Where;

Red =	extreme risk	intolerable
Purple =	high risk	intolerable or tolerable
Yellow =	medium risk	tolerable or acceptable
Green =	low risk	acceptable

4.2 Actions and strategies in response to identified risks

4.2.1 Surface water hydrology

The main potential risks to surface water hydrology are the alteration to surface water flows associated with:

i. Road crossing of Sherwin Creek

ii. Modification of natural drainage flow paths associated with mining infrastructure.

Hydrology inherent risk profile

The proposed road between the mine site and Roper Highway crosses Sherwin Creek and in the absence of appropriate design and construction, stream crossings (e.g. bridges, culverts, causeways) could lead to a localised alteration of stream hydrology (e.g. increased velocities associated with constriction of flows); which may affect upstream movement of aquatic fauna (e.g. fish) and lead to increased localised erosion. While there are no recorded or expected threatened species within the local waterbodies, this may have an effect on accessible wet season habitat for some species. This is considered to be of minor consequence with a moderate likelihood, resulting in a medium inherent risk.

There will be some modification and removal of the upper sections of several drainage lines in the catchment of a minor tributary of Sherwin Creek associated with construction of the mine site, with potential impacts on flows to downstream areas. However, as these drainage lines are located at the top of their respective catchments, this is considered to be a minor consequence (i.e. minor, temporary environmental impact) and in the absence of any mitigation measures is moderately (i.e. might occur at some time) likely to occur. This results in a low inherent risk of impact to downstream aquatic environments.

Hydrology risk mitigation

To minimise the potential risks of alteration to surface water flows associated with the road crossing of Sherwin Creek and other minor drainage lines, their design and construction will incorporate appropriate engineering principles and natural flows will be maintained at all times. Construction will be cognisant of fish passage principles (e.g. Fairfull and Witheridge 2003).

Natural surface water flows will be maintained within the mine site area as far as practicable and where minor drainage diversions are required (e.g. around waste dumps/stockpiles), consideration will be given to ensuring that water flows resume their natural flow paths as close as possible downstream of disturbed areas.

Hydrology residual risk

The above mitigation measures reduce the risk of hydrological impacts associated with both the construction of haul road stream crossings and modification of natural drainage flow paths to a low level.

4.2.2 Surface water quality

Surface water systems are particularly susceptible to changes in water quality associated with mining activities that may lead to inputs of contaminants from:

- Acid/metalliferous drainage (AMD) from ore and/or waste rock
- Suspended solids and turbidity in run-off from disturbed areas
- Spills/leaks of hazardous chemicals
- Sewage and other wastes

Surface water quality inherent risk profile

The transfer of rock materials from underground to the ground surface may result in the mobilisation of solutes (e.g. metals, salts), which may in turn lead to degradation in quality of downstream surface and/or groundwaters. The risk of contaminant mobilisation is increased significantly with the occurrence of potentially acid forming (PAF) materials and as outlined in the AMD/PAF Report (Alarcon-Leon 2013b – EIS Appendix G). Detailed investigations indicate that there are small quantities of PAF materials located in the north-western section of the proposed pit shell. In the absence of appropriate management, acid/metalliferous drainage has the potential to impact water quality and subsequently, aquatic ecosystem health for a considerable distance downstream. Given the relatively small quantities of PAF likely to be encountered in this project, the fact that these small quantities are ore and will be shipped off site and the absence of groundwater influx to the mine pit (Alarcon-Leon 2013a – EIS Appendix F2), in the absence of appropriate management and/or mitigation measures, both the consequence and likelihood of this impact are considered to be moderate, resulting in a high inherent risk of impact to downstream surface water quality.

Within the project area, there are some soil types that pose an inherently high risk of erosion and clearing for mining and ancillary activities (e.g. pits, stockpiles, waste dumps, roads, processing areas, etc.) involves the removal of vegetation and in many cases, the soil surface cover. This may lead to erosion of soils/subsoils and subsequent transport of sediments into downstream aquatic environments in surface run-off. Increased sedimentation and turbidity can affect the functioning of aquatic environments in a number of ways, such as smothering of habitats, inhibition of photosynthetic activity and ecological effects (e.g. changes in visibility affecting predatory species). In the absence of appropriate mitigation measures, there are likely to be major consequences (i.e. substantial or permanent environmental damage) with a moderate likelihood (i.e. might occur at some time), resulting in a high risk of impact to downstream aquatic environments.

There are to be no chemicals used in the ore extraction process, with the storage and handling of hazardous materials being primarily associated with hydrocarbons (i.e. fuel for mining equipment). Potential impacts associated with spills or leaks of hazardous materials include contamination of downstream surface quality. In the absence of appropriate mitigation measures, there are likely to be ‘major’ consequences (i.e. substantial or permanent environmental damage) with a ‘moderate’ likelihood (i.e. might occur at some time), resulting in a ‘high’ risk of impact to downstream aquatic environments.

Treated sewage water will be used for dust suppression. If the disposal location has a connection to a drainage line, there is a risk of impacts on downstream surface water quality associated with elevated nutrient concentrations, which may in turn cause nuisance/toxic algal blooms. Irrigation of water in a small area could also lead to waterlogging of the soil and potentially a localised effect on vegetation (e.g. change in species composition). If not located or managed appropriately, domestic waste disposal may also pose a risk to surface water quality. Remaining non-hazardous (inert and putrescible) solid wastes will be disposed of in an on-site, trench type landfill. If the disposal trench location has a connection to a drainage line, there is a moderate consequence (i.e. substantial temporary or permanent minor environmental damage) and moderate likelihood (i.e. might occur at some time), resulting in a medium risk of impacts on downstream surface water quality associated with elevated nutrient concentrations.

Surface water quality risk mitigation

Proposed measures to manage any PAF materials that are encountered are summarised below and details provided in the AMD/PAF Report (Alarcon-Leon 2013b – EIS Appendix G):

- Demarcation, progressive excavation and immediate implementation of measures such as burial, sealing and compaction to contain/encapsulate/cover and prevent oxidisation of any PAF materials.
- Benching were possible will be excavated in lengths that permit easy extraction, remediation and closure.
- Where PAF is exposed, sealing and compaction of the sides and base of the excavation will be undertaken before backfilling.

- Implementation of construction methods to prevent long-term PAF exposure to oxygen (e.g. sheet piling) will be considered.
- Any generated AMD will be monitored, managed and treated using appropriate methodologies.

To mitigate potential impacts of increased turbidity and suspended solids associated with construction and mining works, monitoring and management of runoff will be undertaken in accordance with the Erosion and Sediment Control Plan (ADG 2013 – EIS Appendix E) and this WMP. This will include the construction of sediment basins in key areas, to enable adequate settling of suspended materials prior to use or discharge. Wherever possible, any discharge points will be located so that water flows into relatively flat, vegetated areas rather than directly into drainage lines.

Hazardous materials and wastes will be stored in appropriately labelled containers within purpose-built dangerous goods and chemical storage containers. These will be self-bunded, ventilated and compliant with AS1940-2004 Storage and Handling of Flammable and Combustible Liquids. These containers are suitable for the storage of paint, thinners, oils, diesel, chemicals, Class 3 flammables substances (as classified in the *UN Recommendations for the Transport of Dangerous Goods – Model Regulations*) and other potentially dangerous liquids. In the event that a spill or leak is detected, steps will be undertaken immediately to contain the leak/spill and if required, remediation measures will be implemented (e.g. recovery and appropriate disposal of contaminated soil).

All sewage wastewater generated from the mine site and camp will be treated to a high quality and recycled. The recycled water will be used for irrigation within the camp area and dust suppression around the mine site. Irrigation of recycled water will be in accordance with the *Guidelines for Management of Recycled Water Systems* (Department of Health 2011a) and *Environmental Health Factsheet No. 513 Recycled Water Irrigation: Information Guide for Applicants* (Department of Health 2011b). The trench landfill will be located at least 150 m away from any surface water pathways.

A comprehensive surface water monitoring program will be undertaken at the mine site, which will include sampling of both potential sources of contamination (e.g. sediment basins) and natural surface waterbodies upstream and downstream of mining infrastructure. Details of the proposed monitoring program are provided in Section 5.1. Data will be stored in an appropriate database and reviewed at regular intervals (i.e. as data become available), to assess whether mining activities are impacting on surface water quality or if there are any trends in water quality that provide early warning of potential impacts.

Surface water quality residual risk

The mitigation measures outlined above will reduce high risks to surface water quality to moderate or low risks.

4.2.3 Groundwater levels

The main potential risk to groundwater levels is from abstraction for potable and operational mine water supplies (i.e. primarily dust suppression), in the absence of other users.

Groundwater levels inherent risk profile

It was concluded in the baseline groundwater assessment (Alarcon-Leon 2013a – EIS Appendix F2) that influx of groundwater to the mine pit and hydraulic connectivity of ground water to surface water resources in the vicinity of the mine (including GDEs) are not considered risks and will not be impacted by mining and processing. Dewatering to facilitate open pit mining will not be required and therefore no safeguards or management measures in relation to groundwater levels are required. However, the groundwater resources identified to date in the vicinity of the mine site (i.e. long-term sustainable yield = 12 ML/a) are inadequate to meet the estimated total operational requirements of the mine (i.e. 87.4 ML/a).

Although the operational risk associated with depletion of local groundwater resources is relatively high, there is considered to be a ‘minor’ environmental consequence (i.e. minor, temporary environmental impact) and ‘unlikely’ likelihood (i.e. could occur at some time but highly unlikely), resulting in a ‘low’ inherent risk of environmental impacts.

Groundwater levels risk mitigation

To minimise water use and therefore the risk of lowering of groundwater levels, Sherwin will implement of water saving strategies, including (but not limited to) the following:

- Minimise use (e.g. education of workers in camp, use of polymers on roads to reduce requirements for dust suppression)
- Recycling of wastewater for dust suppression (i.e. sewage treatment plant)
- Re-use of rainfall/run-off captured in disturbed areas of the mine site for dust suppression.

In order to identify additional groundwater resources to meet mining operational requirements, Sherwin will undertake geophysical exploration, bore drilling, testing and sampling. Sherwin will assess potential impacts of extraction and sustainable yields from these additional groundwater resources (i.e. potential GDE’s, other users, etc).

In order to minimise the operational and environmental risks (if any) associated with depletion of groundwater resources, Sherwin will ascertain/set operational controls for ground water exploitation (i.e. sustainable safe yield, allowable drawdown and distance to zero drawdown) and monitor bore yields, groundwater level behaviour and water quality, in accordance with this WMP.

Groundwater levels residual risk

The above mitigation measures further reduce the ‘low’ risk of impacts associated with changes to groundwater levels associated with extraction for mining operations.

4.2.4 Groundwater quality

Existing groundwater quality within the project area is variable but relatively good and there are no major regional aquifers in the immediate area (Alarcon-Leon 2013a – EIS Appendix F2). The main potential risks to groundwater quality are localised and associated with inputs of contaminants from:

i. Acid/metaliferous (AMD) drainage from ore and/or waste rock; and
ii. Spills/leaks of hazardous chemicals.

Groundwater quality inherent risk profile

The baseline AMD assessment (Alarcon-Leon 2013b – EIS Appendix G) indicated that potentially acid forming (PAF) bodies are relatively small, isolated and largely confined to the north-west of the proposed open pit. The volumes of PAF requiring disposal will be relatively low, with the primary risk associated with AMD for this project being infiltration of rain water from a partially backfilled open pit during mining and post-closure, which may leach through PAF materials located below or downstream of the pit and therefore impact on downstream groundwater quality. In the absence of appropriate mitigation measures, there is a ‘moderate’ consequence (i.e. substantial temporary or permanent minor, localised environmental damage) and ‘moderate’ likelihood (i.e. might occur at some time), resulting in a ‘high’ inherent risk of impact to groundwater quality.

The storage and handling of hazardous materials is primarily associated with hydrocarbons. Potential impacts associated with spills or leaks of hazardous materials include contamination of downstream groundwater quality and, in the absence of appropriate management/mitigation measures, there is a ‘high’ risk of this occurring.

Groundwater quality risk mitigation

Proposed measures to manage any PAF materials that are encountered are summarised below and details provided in the AMD/PAF Report (Alarcon-Leon 2013b – EIS Appendix G):

- Demarcation, progressive excavation and immediate implementation of measures such as burial, sealing and compaction to contain/encapsulate/cover and prevent oxidisation of any PAF materials.
- Benching were possible will be excavated in lengths that permit easy extraction, remediation and closure.
- Where PAF is exposed, sealing and compaction of the sides and base of the excavation will be undertaken before backfilling.
- Implementation of construction methods to prevent long-term PAF exposure to oxygen (e.g. sheet piling) will be considered.
- Any generated AMD will be monitored, managed and treated using appropriate methodologies.

In order to mitigate the potential risk of groundwater contamination from spills/leaks of hazardous materials and wastes, these will be stored in appropriately labelled containers within purpose built dangerous goods and chemical storage containers. These are self-bunded, ventilated and are compliant with AS1940-2004 Storage and Handling of Flammable and Combustible Liquids. These containers are suitable for the storage of paint, thinners, oils, diesel, chemicals, Class 3 flammables substances (as classified in the UN Recommendations for the Transport of Dangerous Goods – Model Regulations) and other potentially dangerous liquids. In the event that a spill or leak is detected, steps will be undertaken immediately to contain the leak/spill and if required, remediation measures will be implemented (e.g. recovery of contaminated soil).

Groundwater quality residual risk

The mitigation measures outlined above will reduce high risks to groundwater quality to low risks.

Table 4-4. Risks to surface and groundwater

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Surface water hydrology	Change in hydrology due road crossings from mine site to Roper Highway.	• Impeded fish migration • Increased erosion	2	C	M 8	• Ensuring that creek crossing design (culverts) will have limited influence on flows.	2	B	L 5
Surface water hydrology	Change in hydrology due to modification of upper parts of catchment.	• Reduced stream flow into Sherwin Creek	2	C	M 8	• Natural surface water flows will be maintained within the mine site area and where minor drainage diversions are required. • Consideration will be given to ensuring that water flows resume their natural flow paths as far as possible.	2	B	L 5
Surface & ground-water quality	Storage of ore and/or waste rock	• Contamination of downstream surface and/or groundwaters associated with acid mine drainage (i.e. acid and/or heavy metal contamination).	3	C	H 13	• Ongoing characterisation of materials and storage and management methods. • Demarcation and progressive excavation and implementation of immediate remediation measures such as burial, sealing and compaction to prevent PAF materials to oxidise. • Where PAF is exposed, sealing and compaction of the sides and base of the excavation will be undertaken before backfilling. • Implementation of construction methods to prevent long-term PAF exposure to oxygen (e.g. sheetpiling)	2	B	L 5

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
						will be considered.			
Surface water quality	Land disturbance	• Erosion leading to transport of sediments in run-off, resulting in impact on downstream surface water quality (e.g. increased suspended solids, turbidity).	4	C	H 18	• Management of runoff in accordance with Erosion and Sediment Control Plan and this WMP.	3	B	M 9
Surface & ground-water quality	Storage & handling of hazardous materials (e.g. hydrocarbons)	• Spill or leak to environment with potential to contaminate downstream surface and/or groundwaters.	4	C	H 18	• Appropriate storage of hazardous materials and monitoring of storage facilities, in accordance with Standard Operating Procedures, Environmental Management Plan and relevant standards/guidelines. • Adequate training (e.g. inductions).	3	B	M 9
Surface & ground-water quality	Disposal of sewage & other waste	• Contamination of downstream surface and/or groundwaters.	3	C	H 13	• Appropriate design, location and operation of waste facilities, in accordance with operational procedures and Environmental Management Plans.	2	B	L 5

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Ground-water levels	Groundwater abstraction (e.g. water supply, pit dewatering)	• Alteration to local or regional groundwater levels and availability	2	B	L 5	• Implementation of water saving strategies (i.e. minimise use, recycling of wastewater, use of polymers on roads to reduce requirements for dust suppression) • Undertake geophysical exploration, bore drilling, testing and sampling to identify additional nearby groundwater resources. • Assess potential impacts on additional nearby groundwater resources (i.e. potential GDE's, other users, etc). • Ascertain/set operational controls for ground water exploitation (i.e. sustainable safe yield, allowable drawdown and distance to zero drawdown). • Monitor bore yields, ground water level behaviour and water quality in accordance with this WMP.	2	B	L 5

5 Monitoring

5.1 Monitoring program

5.1.1 Surface water monitoring

Details and site locations for the proposed surface water monitoring program are provided in Table 5-1 and Figure 5-1 below. In order to assess potential impacts of mining on water quality, monitoring sites have been selected on Sherwin Creek, both upstream and several locations downstream of mining activities, as well as a reference site at a similar location in an adjacent catchment.

Table 5-1. Proposed surface water monitoring program

Monitoring Sites	Frequency/Type	Measurements/Analytes
Stream Monitoring Sites: SISW01 – SISW08 **Sediment Basins and Turkeys Nest Dams** (specific locations to be determined prior to commencement of mining)	**Weekly field measurements** (during periods of flow) **Event-based field measurements/laboratory analyses**[1] (i.e. following >25mm of rainfall on site and/or when Sherwin Creek flows following heavy rainfall). **Monthly laboratory analyses** (during periods of flow) **Quarterly laboratory analyses** (during periods of no flow)	**Field measurements:** Rainfall Flows (visual observations, estimations using average flow widths, depths and velocities, and/or calibrated v-notches). Records should reflect whether flowing or standing water is sampled. Temperature, pH, oxidation-reduction potential (ORP), electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO) and turbidity. **Laboratory analyses:** Total suspended solids (TSS), hardness, acidity and alkalinity. Major anions (Cl, SO_4, CO_3/HCO_3, NO_3) and cations (Ca, Mg, Na and K). Dissolved metals[2]: Al, As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Zn, Fe. Ammonia and nutrients (NO_2, NO_3, TKN, Total N and Total P).

1. **For event-based sampling, samples for laboratory analysis will be collected if field parameters exceed trigger values.**
2. **A full metal scan analysis will be undertaken for at least 3 sampling events and then periodically (e.g. annual) to confirm the proposed metal suite is appropriate for ongoing monitoring. Total metals analyses will also be undertaken at key monitoring sites as a quality control measure and to assess the proportion of metals bound in particulate matter.**

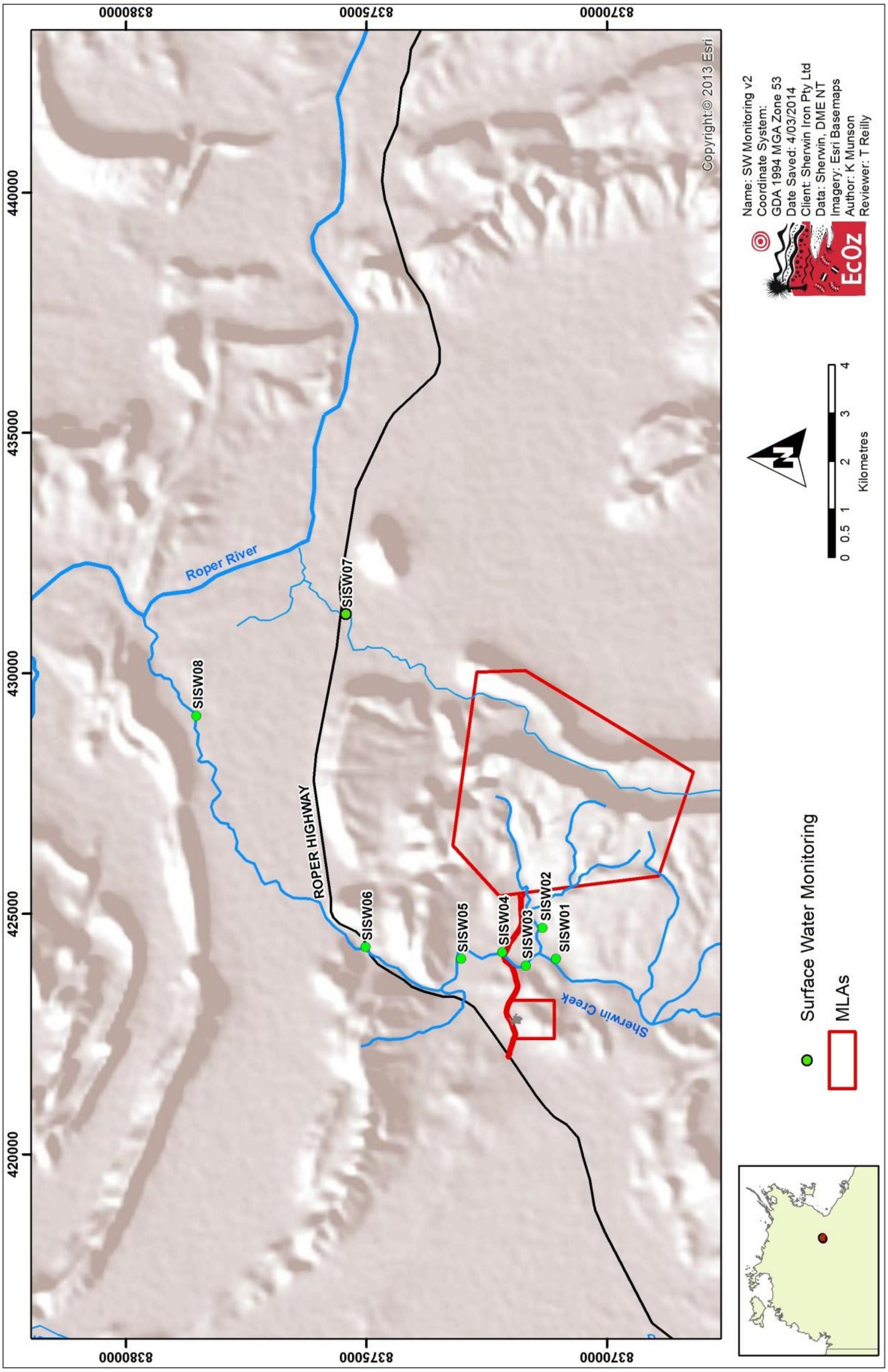

Figure 5-1. Map showing locations of stream surface water monitoring sites

5.1.2 Groundwater monitoring

Details and site locations for the proposed surface water monitoring program are provided in Table 5-2 and Figure 1-6. In order to assess potential impacts of open pit mining on the groundwater regime, six baseline environmental monitoring bores have been installed around mine site infrastructure. It is likely that additional monitoring bores will be required to adequately monitor potential effects of specific infrastructure and locations and these will be determined upon completion of detailed design and provided prior to commencement of mining.

Table 5-2. Proposed groundwater monitoring program

Monitoring Sites	Frequency	Measurements/Analytes
Groundwater Monitoring Sites: Figure 1-6. Open Pit: SEMB01 to SEMB06 Borefields: SPB01 to SPB07	**Quarterly**	**Field measurements:** Rainfall. Depth to ground water level. Abstraction from bores. General field *in situ* (field) water quality measurements: pH, EC, TDS, Salinity, Temperature, Dissolved Oxygen, Oxidation Reduction Potential including observations such as odour, colour, etc.) **For samples collected for lab analysis:** Total Alkalinity (Talk, mg/L). Total Acidity (TAc, mg/L). Major anions (Cl, SO_4, CO_3/HCO_3, NO_3-N; mg/L). Major cations (Ca, Mg, Na and K; mg/L). Dissolved metals (Al, As, B, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn, Fe; µg/L).
*** Note: A full metal scan analysis will be undertaken for at least 3 sampling events and then periodically (e.g. annual) to confirm the proposed metal suite is appropriate for ongoing monitoring. Total metals analyses will also be undertaken at one monitoring site per sampling event as a quality control measure.**		

5.1.3 Biological monitoring

Annual surveys of freshwater macroinvertebrates will be undertaken in Sherwin Creek at several locations upstream (Site SISW01 - reference) and downstream (SISW05 and SISW08 - potential impact) of the mine site. An additional reference site (SISW07) will also be monitored in an adjacent catchment to the north that will not be impacted by mining activities. Macroinvertebrate monitoring sites will be located as close as possible to regular surface water monitoring sites (Figure 5-1).

Specific monitoring locations will selected in accordance with the NT 'AUSRIVAS' (Australian Rivers Assessment Scheme) User Manual (Lamche 2007) for sampling of macroinvertebrates, which specifies that a suitable stream bank 'edge' habitat should be selected for sampling. A sampling locality for this habitat is chosen where the edge is as close to vertical as possible, ideally contains abundant trailing root material and is in an area with low flow velocity (but importantly, must be flowing). The timing of macroinvertebrate sampling will coincide with the late wet season/ early dry season recessional flow period (i.e. 4-6 weeks after last storm event), which is considered the optimal time as specified in the NT AUSRIVAS User Manual (Lamche 2007).

It was observed during baseline environmental sampling that due to its location high in the catchment, the Sherwin Creek upstream site (i.e. SISW01) may only flow for relatively short periods during the wet season and would cease to flow much earlier than the other sites downstream, making it difficult to conduct biological sampling at upstream and downstream sites at the same time. It was also noted during the baseline macro-invertebrate sampling that the Sherwin Creek upstream site may have different habitat to other sites (i.e. sparse riparian vegetation, lack of stream banks containing suitable 'edge' habitat), which may make future upstream-downstream comparisons difficult.

5.2 Data review and interpretation

Water quality data will be entered into an appropriate database as soon as it is collected and comparisons made with water quality trigger values (see below); in order to immediately identify any potential impacts of mining operations. Further investigation and (if required) remedial action(s) will be undertaken promptly to address any potential water quality issues.

5.2.1 Water quality trigger values

It is proposed that for surface water, the default ANZECC (2000) guidelines for 95 % aquatic ecosystem protection (hardness-modified) will initially be adopted as maximum trigger values for surface water monitoring. It is envisaged that site-specific trigger values will be developed when there is sufficient data available from baseline monitoring and/or upstream reference sites and will be developed from data representing flowing waters.

It is proposed that for groundwater, the default Ground Water Investigation Levels (GILs) Schedule B1 National Environment Protection (Assessment of Site Contamination) Measure 2011 which combines the Australian Drinking Water Guidelines (NHMRC and NRMMC 2011) and the guidelines for 95 % species protection levels (hardness modified) (ANZECC and ARMCANZ 2000) be adopted as trigger values for ground water quality. Site-specific (and possibly individual monitoring location-specific) trigger values are to be developed when there is sufficient data available from baseline monitoring and reference sites.

In addition to the above, water discharged shall have no visible surface films, oils and greases, Total Petroleum Hydrocarbons, litter or suspended matter.

Monitoring data will be reported on and raw data provided to Regulatory Authorities (e.g. DME, EPA) at required intervals and in agreed formats. At a minimum, this will include trend analysis and comparison with water quality trigger values.

6 Acronyms and References

6.1 Acronyms

AMD	Acid/metalliferous drainage
ANZECC	Australian and New Zealand Environment & Conservation Council
EC	Electrical conductivity
DO	Dissolved oxygen
DSO	Direct shipping ore
GDE	Groundwater dependent ecosystem
Mtpa	Million tonnes per annum
NT	Northern Territory
PAF	Potentially acid-forming
ROM	Run of mine (i.e. ore material)

6.2 References

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Attachment 1: Dust Suppression Polymer Product Details

DUST-A-SIDE®

DUST-FREE

ALL-WEATHER

SAFER

LOWER OPERATING COSTS

IMPROVED TYRE PERFORMANCE

PROVEN FUEL REDUCTIONS

ABOUT DUST-A-SIDE

Practice makes perfect… and over 30 years of research and refinement has gone into making the Dust-A-Side haul road and dust control management system a global leader in the industry, and Dust-A-Side the partner of choice at over 70 open-cut and underground mine sites across four continents.

Our environmentally-friendly products – coupled with our unique haul road stabilisation process and total management system – keeps roads dust and mud free, functional in all weather conditions and safer to use, and will significantly lower your operating costs.

Dust-A-Side Australia is the only Australian company that provides a complete range of dust control products and services truly capable of delivering **Total Dust Control Management** across any operation.

WESTERN AUSTRALIA | QUEENSLAND | NEW SOUTH WALES | VICTORIA | SOUTH AUSTRALIA | TASMANIA | NORTHERN TERRITORY

ROAD ESTABLISHMENT

Proper preparation of any untreated surface ensures a functional, safe, efficient, dust-free surface. Following profiling to specification, the prepared surface is ripped and mixed with Dust-A-Side product to provide a stabilised wearing course. The surface is then sealed to deter any water ingress, and the roads bladed and compacted to shape. Heavy-duty haul trucks can be used as part of the compaction process, with newly established roads opened to normal traffic immediately after establishment. The product does not leach out once bonding and stabilisation have occurred.

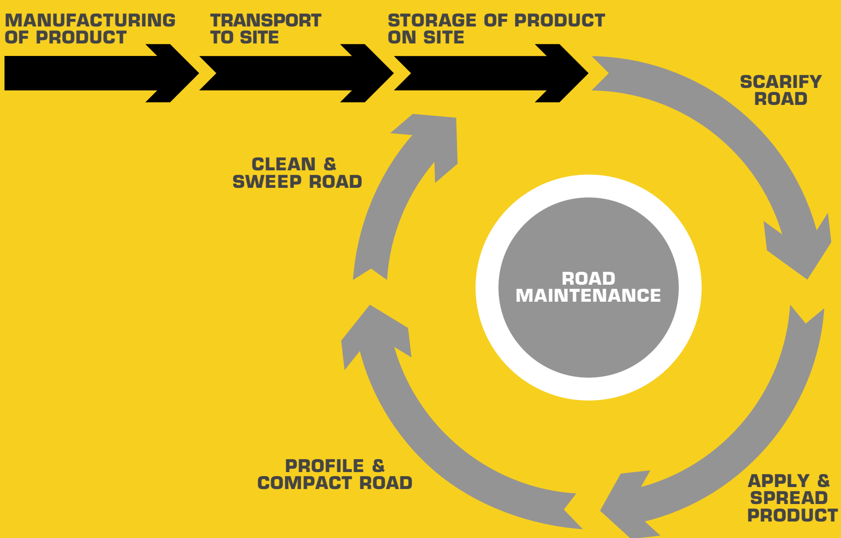
Once the Dust-A-Side road has been established, the maintenance system ensures a sustainable dust-free haul road under Dust-A-Side's supervision.

ROAD MAINTENANCE

Following the establishment of the Dust-A-Side haul road, we provide a continuous maintenance service to ensure that the high standards are maintained and that the mine maximises the available benefits.

Maintenance comprises:

- Sweeping to control dust and spillage, and increase the effectiveness of subsequent maintenance sprays
- Maintenance sprays of Dust-A-Side emulsion to control water ingress into the surface
- Re-scarifying of the running surface to maintain the integrity of the seal layer
- Pothole repair
- Repair of failed sections of road
- Repair of damaged sections of road.



SUSTAINABILITY AND COST BENEFITS

Use of the Dust-A-Side system can significantly enhance the sustainability of your mining operation. Its extensive list of benefits includes:

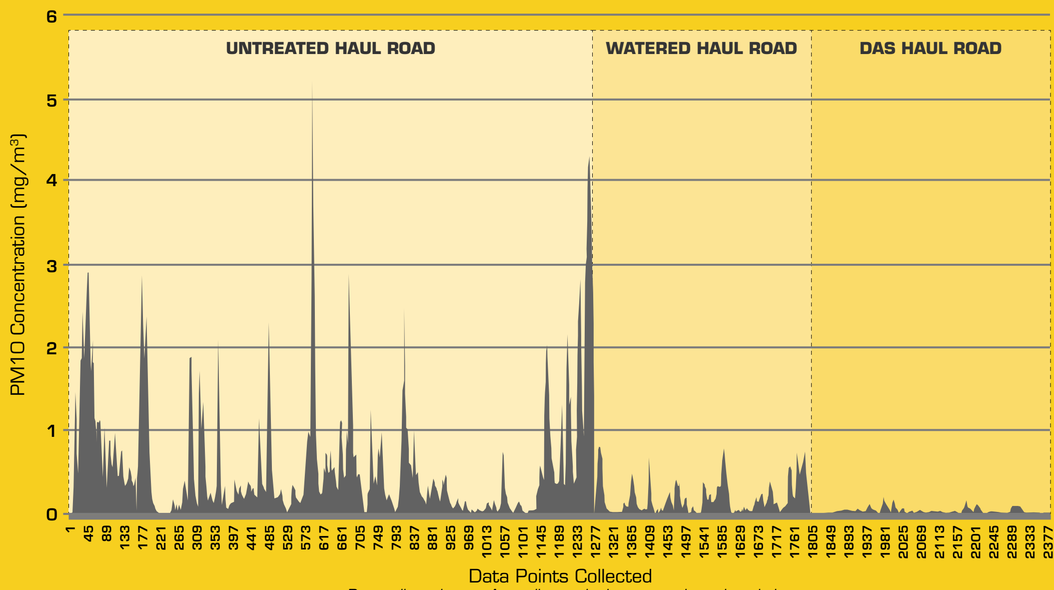
- Safer hauling conditions, due to excellent visibility and a much-improved running surface
- Increased productivity, through less wet-weather stand-downs
- Reduction in direct operating costs through fewer water cart and grader requirements, as well as ongoing road maintenance costs
- Lower fuel usage due to improved rolling resistance of haul roads and less support machinery required
- Extended tyre life and reduced machinery fatigue
- Water savings, a reduced carbon footprint and employee health benefits.

DUST MONITORING

Dust-A-Side measures the effectiveness of its system by comparing dust generation on both Dust-A-Side-treated roads and ‘conventional’ untreated ones, using its unique, proprietary dust-monitoring trailer.

The trailer has a real-time, light-scatter Aerosol Monitor, powered by solar panels, which can measure dust levels while in motion or stationary. An on-board weather station records wind direction, wind speed, ambient temperature and humidity, ensuring that the results take into account different climatic conditions.

MOBILE DUST MONITORING TRIALS

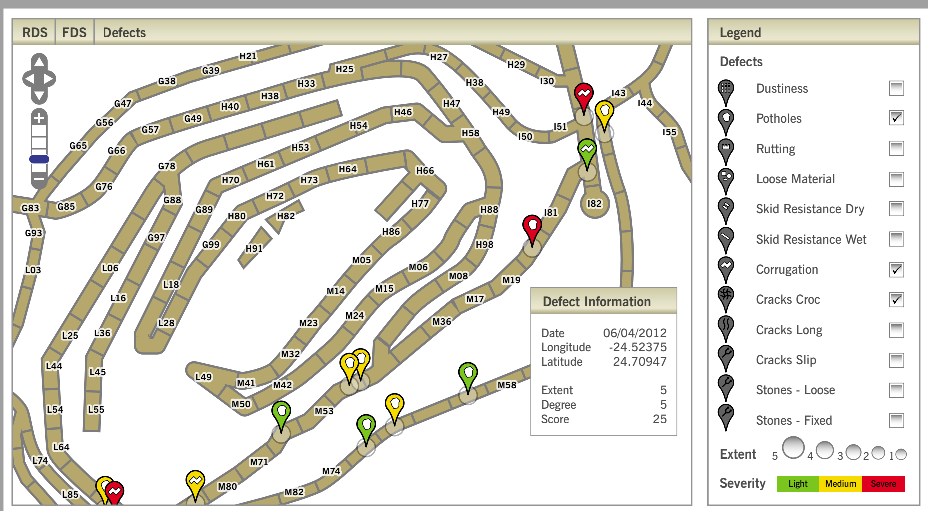


Data collected on an Australian coal mine over a six-week period

DAS METRICS

DASMetrics is an innovative software solution designed to enable effective road condition monitoring and management. A live visualisation of the road network, via an intuitive, visually interactive and easy-to-use dashboard, provides a unified gateway to access timely and relevant road conditions, audit and repair information, and scheduled maintenance works.

DASMetrics also incorporates a unique Road Defect Score system, which estimates the impact of road conditions based on fuel usage and CO_2 emissions using validated algorithms and calculations. By using this scientifically-measured and validated information, we are able to offer further value and savings to our clients as a direct result of continuous incremental improvements in the overall condition of the road network.



LABORATORY TESTING

Dust-A-Side provides a complete material and water-testing service in a NATA-accredited laboratory. This ensures that material selection is optimised for each operating environment, and the results of the Dust-A-Side system maximised through site-specific processes and techniques.

DUST-A-SIDE®

Celebrating 21 Years Of Excellence

COMPANY OVERVIEW - AUSTRALIA

DUST CONTROL MANAGEMENT SPECIALISTS

Dust-A-Side Background

- More than 30 years experience in Haulroad & Dust Control Management

- > 500 employees

- Operating on 4 continents at 70+ sites
  - South Africa
  - Botswana
  - Namibia
  - Zambia
  - Congo
  - Chile
  - Australia
  - USA
  - New Caledonia

Total Dust Control Management

Dust-A-Side is a <u>Total Haulroad & Dust Control Management</u> solutions provider

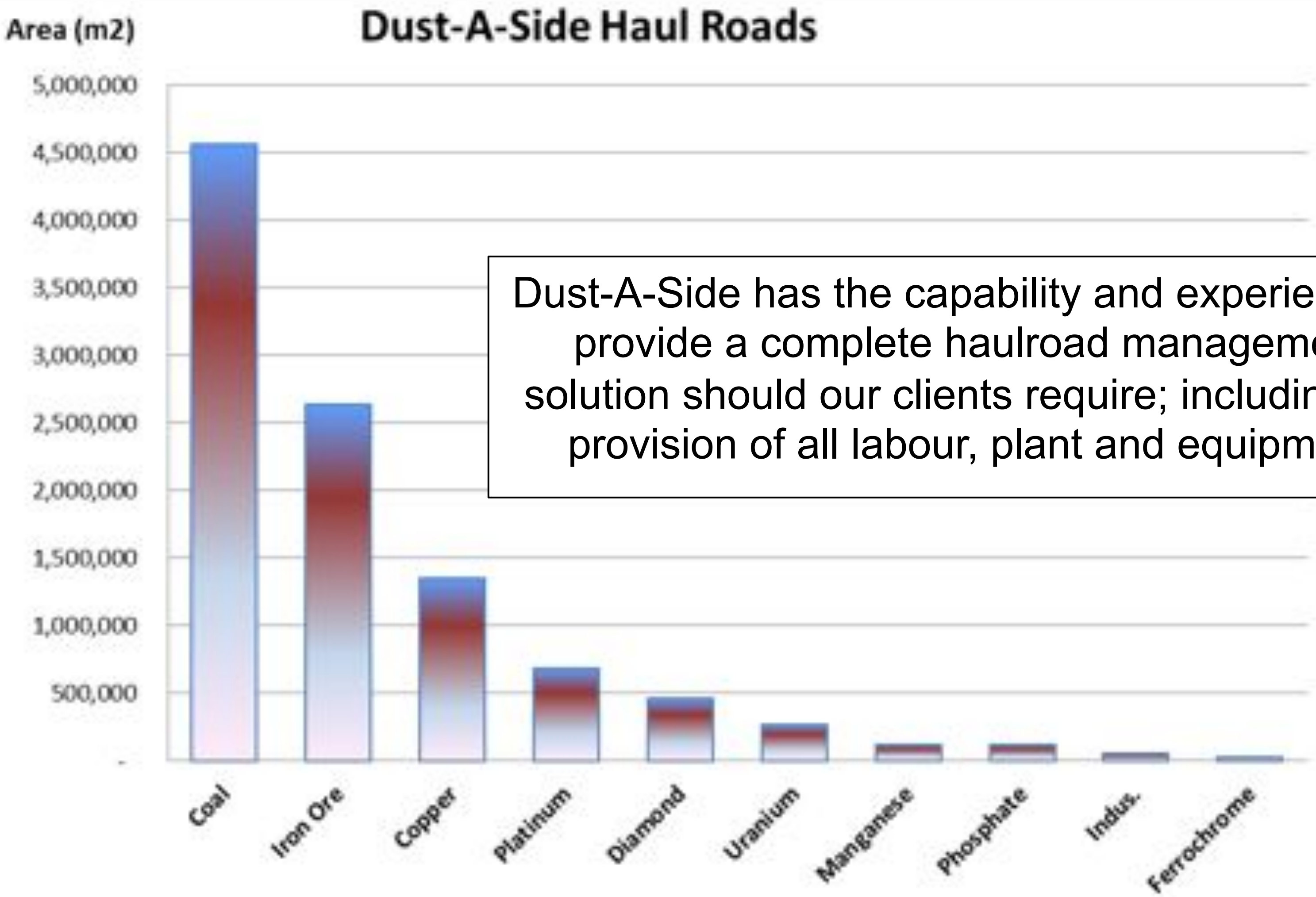
Total Dust Control Management

- **Permanent Road Solutions;**
  - **DAS Product (Establish into wearing course)**
- **Non-Permanent Road Solutions;**
  - **DAS Product (Spray-On only)**
  - **Hydrosperse**
  - **Hydrotac**
  - **Hydrowet**
- **Materials Handling;**
  - **Aquatarp (Stockpiles and Train Load Out)**
  - **High Pressure Mist Systems (Design, Construct, Maintain)**
  - **Hydroplus**
- **Additional Services;**
  - **Dust Monitoring**
  - **Haulroad Construction (via strategic partnerships)**

Mining Customer Base

- Anglo American
- BHP Billiton
- Rio Tinto
- Xstrata
- Peabody
- De Beers
- Exxaro
- Debswana
- Assmang
- ARM
- Foskor
- Sasol Coal
- Arcelor Mittal
- Downer EDi Mining

Complete Haulroad Management



Dust-A-Side has the capability and experience to provide a complete haulroad management solution should our clients require; including the provision of all labour, plant and equipment.

Key Dust-A-Side Partners

- **Local Expertise –** Otraco International Pty Ltd (a wholly owned subsidiary of Downer EDi) is a 50% shareholder of the business in Australia.
    - Leading Global Provider of Tyre Management Services to the Mining Industry
    - Local Knowledge
    - Mining Expertise
    - Plant & Equipment
- **Global Support –** Colas is a 50% shareholder of the business globally.
    - Global Leader in Road Construction
    - Global Supply Chain & Logistics
    - Manufacturing Expertise
    - Research & Development

COLAS
The road forward

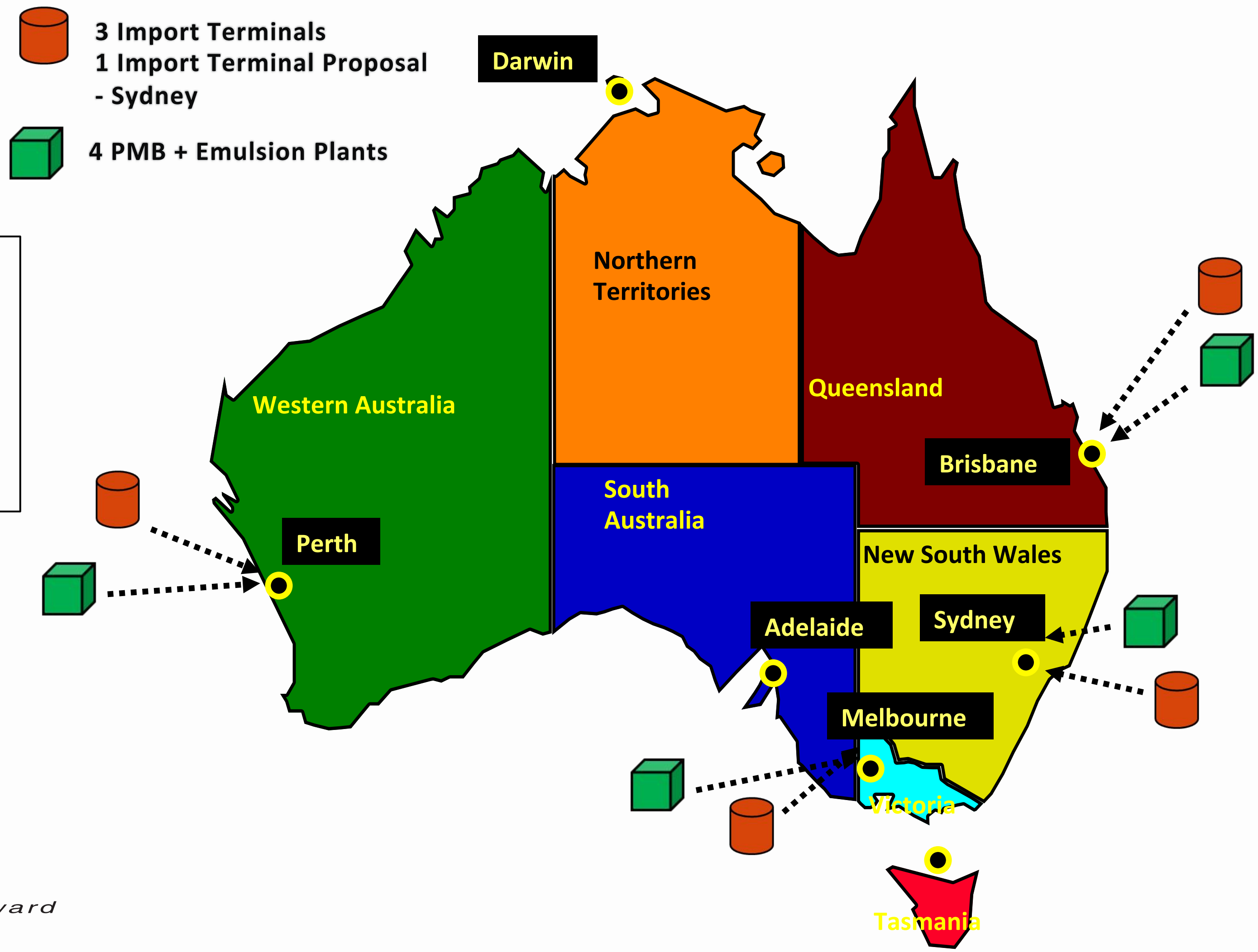
OTRACO

Downer EDi Mining

DUST-A-SIDE

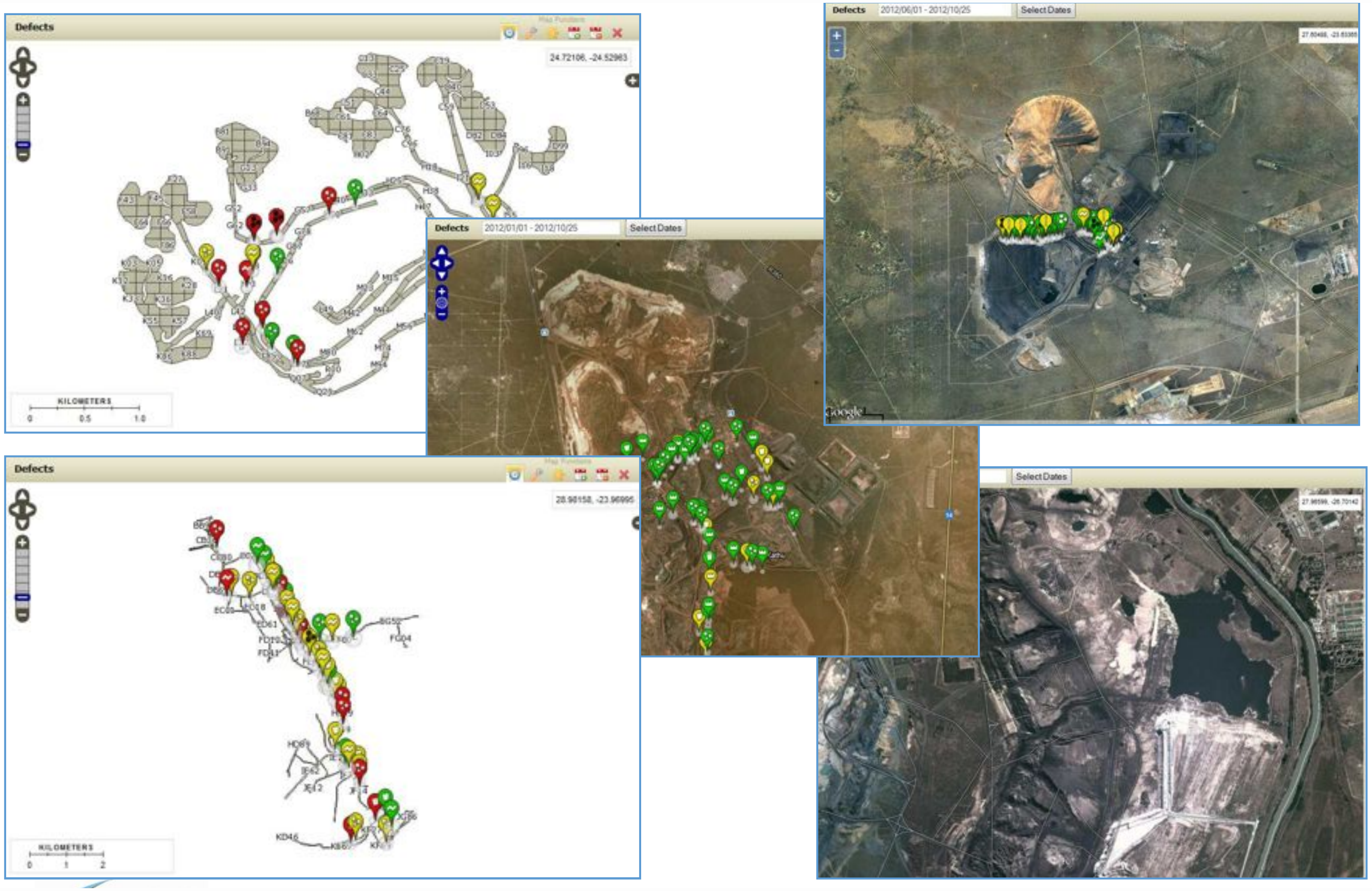
Manufacturing Capability

- Import 170,000+ tons of bitumen pa
- Manufacture 70m+ litres of specialty emulsions pa



The road forward

Haulroad Management Systems



- **<u>DAS Metrics</u> – A Haulroad management software solution for road defect tracking, works scheduling & benefits reporting**

Safety Management Systems

- **Dust-A-Side's Safety Management System is a Structured Process**

DAS Product Properties

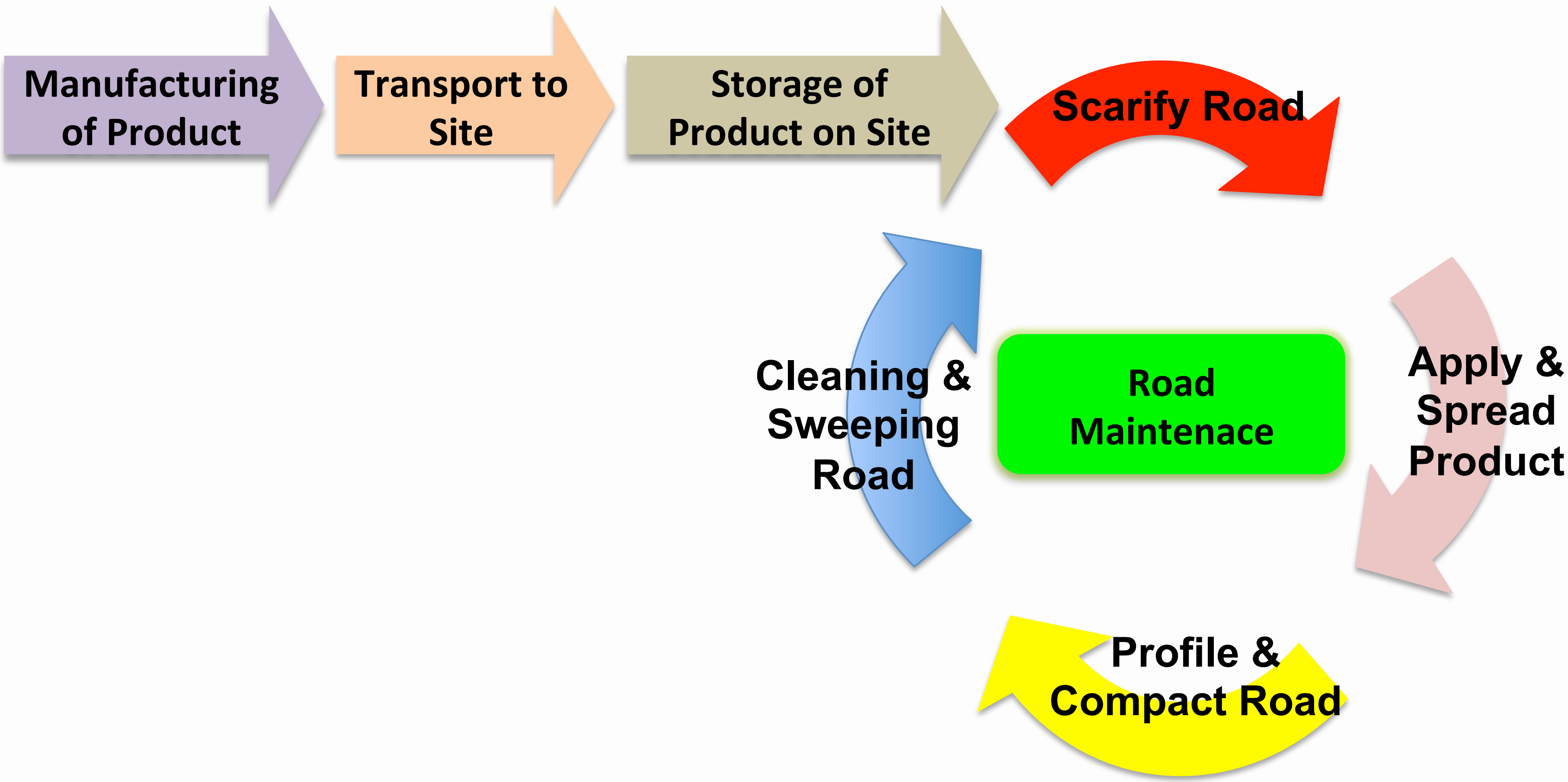
- Extremely good dilution properties
- High resistance to total dissolved solids
- Ability to mix with very fine aggregate
- Good transport and storage stability
- Little skin formation upon storage
- Capability to withstand extreme conditions

Dust-A-Side Haulroads

DUST-A-SIDE

Haul Road Establishment

Haul Road Maintenance



Haul Road Maintenance

Proven Results

The Benefits

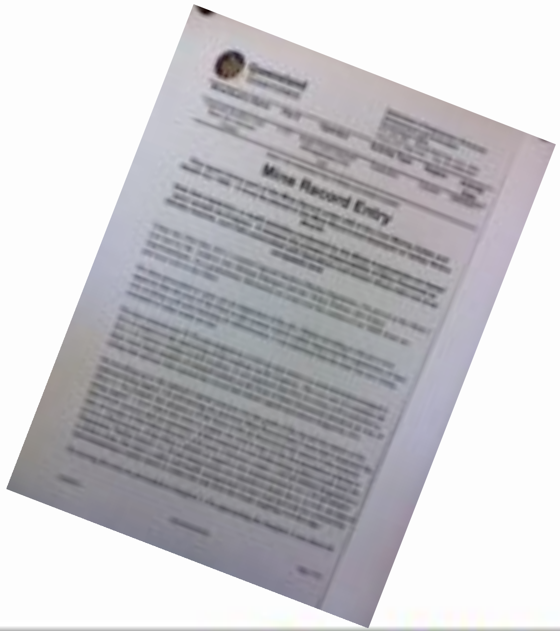
Dust Control

- “Largest source of PM_{10} is haul trucks travelling on unpaved mine roads (40%).”
- “Best practice was found to be the application of suppressant on haul roads.”

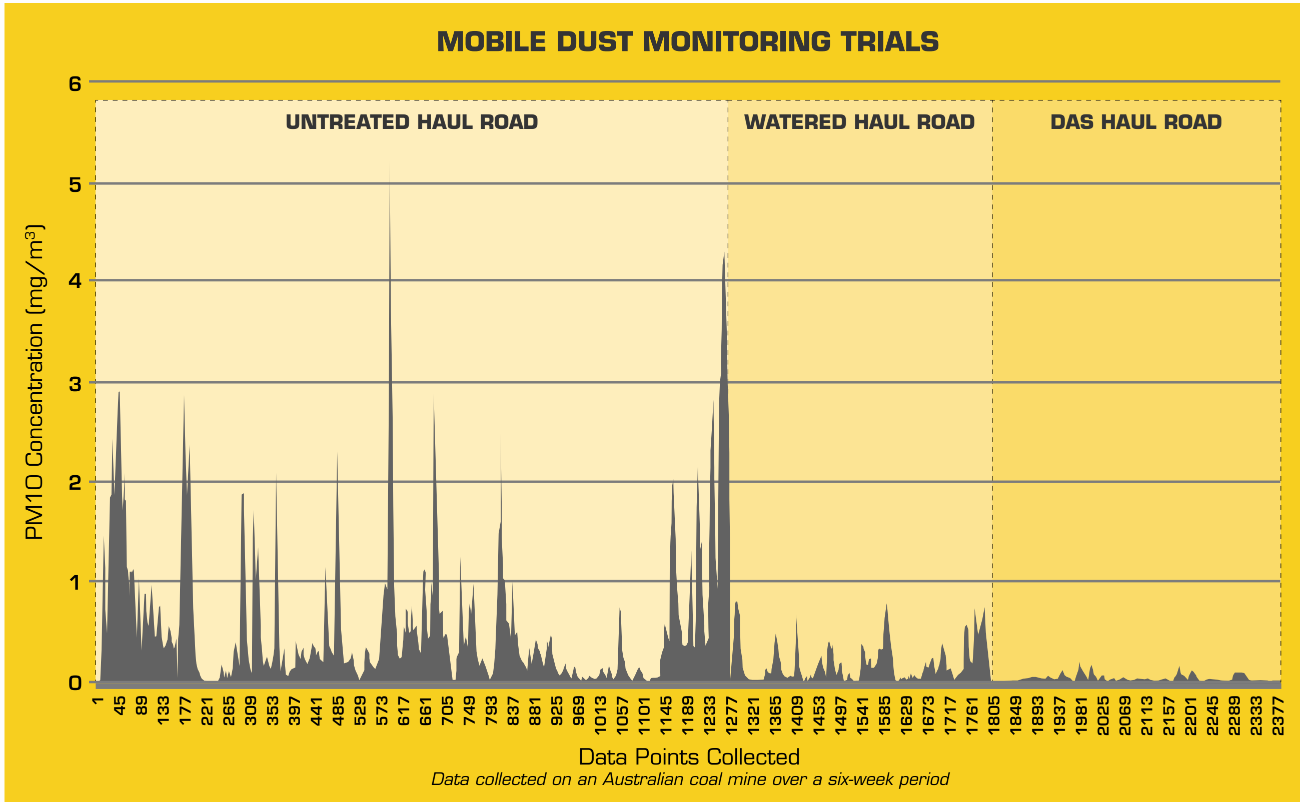
Findings of Independent Study commissioned by NSW Department of Environment, Climate Change and Water, December 2010

- “…It was apparent that the trial of the Dust-A-Side system which visibly improved the suppression of dust was working well and retaining its effectiveness.”

Queensland Inspector of Mines, 26th May 2011



Dust Control



Safety: Increased Visibility

Operational Safety

- **"Haultruck friction levels on DAS roads are very stable with increased watering and light rainfall events, even increasing as contaminants are diluted. This reduces risk to haultruck operators when compared with untreated roads, since the low yet stable friction levels provide a consistent operating environment."**

- **"Watering of untreated roads is the root-cause of 59% of reported uncontrolled vehicle movements (*Safety bulletin no. 99 (Version 1) 23 August 2010*). It follows that eliminating the need to water Dust-A-Side roads substantially reduces the risk of uncontrolled movements."**

- **"After rain events, Dust-A-Side surfaces dry faster than untreated surfaces providing a higher level of surface friction more quickly."**

Environmental Benefits

- 90%+ water saving
- Reduced carbon emission

Reduced Wet-Weather Impacts

- *“Main haulroad now trafficable after rain events, cutting recovery in the pits by up to 12 hours and getting equipment to work areas immediately.”*
- *“After a 9mm rain event, recovery in ‘A ramp’ was 12 hours ahead of the rest of the mine because of the Dust-A-Side ramp installed.”*

Direct Operational Savings

- <u>Smaller Watercart</u> from 75,000l to 20,000l
- Reduction in Watercart <u>fleet numbers</u>

Direct Operational Savings

- 75% Reduction in Grader Fleet numbers required for haul roads

Fuel Savings

- 7% saving in fuel at Thabazimbi Mine
- 5.1 % saving measured by ECS and BP Energy Plus at Jwaneng Mine
- 3.8% saving measured by ECS at Mogalakwena Mine

		RDS_{DAS} ACTUAL	RDS_{DAS} BASELINE	Total Haul Truck Fuel Used	Haul Truck Fuel Used on DAS Roads	Fuel Avoided	Fuel Avoided	Saving per litre	Value
				litre	litre	litre	%	CPL	Rand
Quarter 1	Jan 12	18.94	40.797998	1,622,803	1,379,383	71,735	5.20%	45.33	R 735,548
	Feb 12	18.94	40.797998	1,511,032	1,284,377	66,794	5.20%	45.28	R 684,219
	Mar 12	26.4	40.797998	1,692,072	1,438,261	49,054	3.41%	30.02	R 507,919
Quarter 1	**Sum:**			**4,825,906**	**4,102,020**	**187,583**	**4.57%**	**39.94**	**R 1,927,686**
	Apr 12	32.394	40.797998	2,123,771	1,805,205	35,900	1.99%	18.49	R 392,762
	May 12	26.443	40.797998	1,631,409	1,386,698	47,267	3.41%	31.97	R 521,568
	Jun 12	29.248	40.797998	1,278,682	1,086,879	29,766	2.74%	25.11	R 321,069
Quarter 2	**Sum:**			**5,033,861**	**4,278,782**	**112,933**	**2.64%**	**24.54**	**R 1,235,399**
	Jul 12	26.500	40.797998	1,592,278	1,353,436	45,950	3.40%	29.32	R 466,871
	Aug 12	20.000	40.797998	1,289,778	1,096,311	54,249	4.95%	43.35	R 559,127
	Sep 12	23.012	40.797998	1,648,373	1,401,117	59,251	4.23%	39.53	R 651,568
Quarter 3	**Sum:**			**4,530,428**	**3,850,863**	**159,450**	**4.14%**	**37.03**	**R 1,677,566**
Total Value Delivered				**14,390,195**	**12,231,665**	**459,966**	**3.76%**	**33.64**	**R 4,840,651**

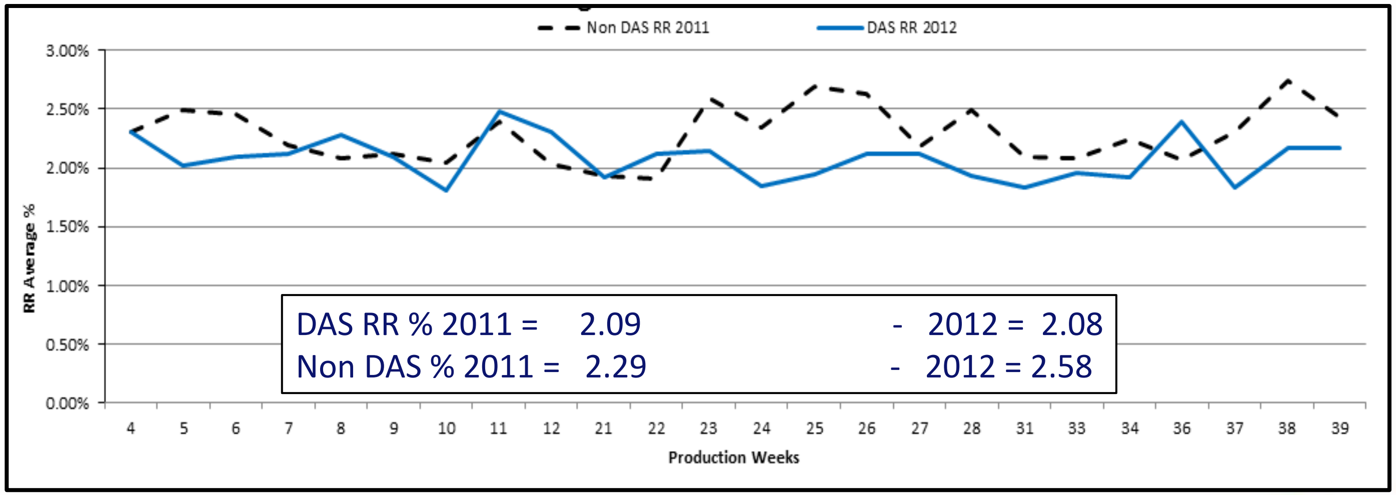
Fuel Value	**R 4,840,651**
CO2 Reduction Value	**R 252,316**
Total Value Delivered	**R 5,092,967**

Rolling Resistance

- **"A Dust-A-Side treated sealed surface improved rolling resistance compared with unsealed surfaces; potentially in the order of 20-30% compared with a competent unsealed haul road."**

- **"Dust-A-Side treated haul roads reduce measured road roughness compared with untreated roads, this is likely to reduce maintenance costs for haul trucks and provide Workplace Health & Safety benefits for operators."**

ROADSAFETY
TRAINING SERVICES



Tyre Savings

Increase in tyre life at Thabazimbi
5,500hrs to 6,900hrs

Financial Payback

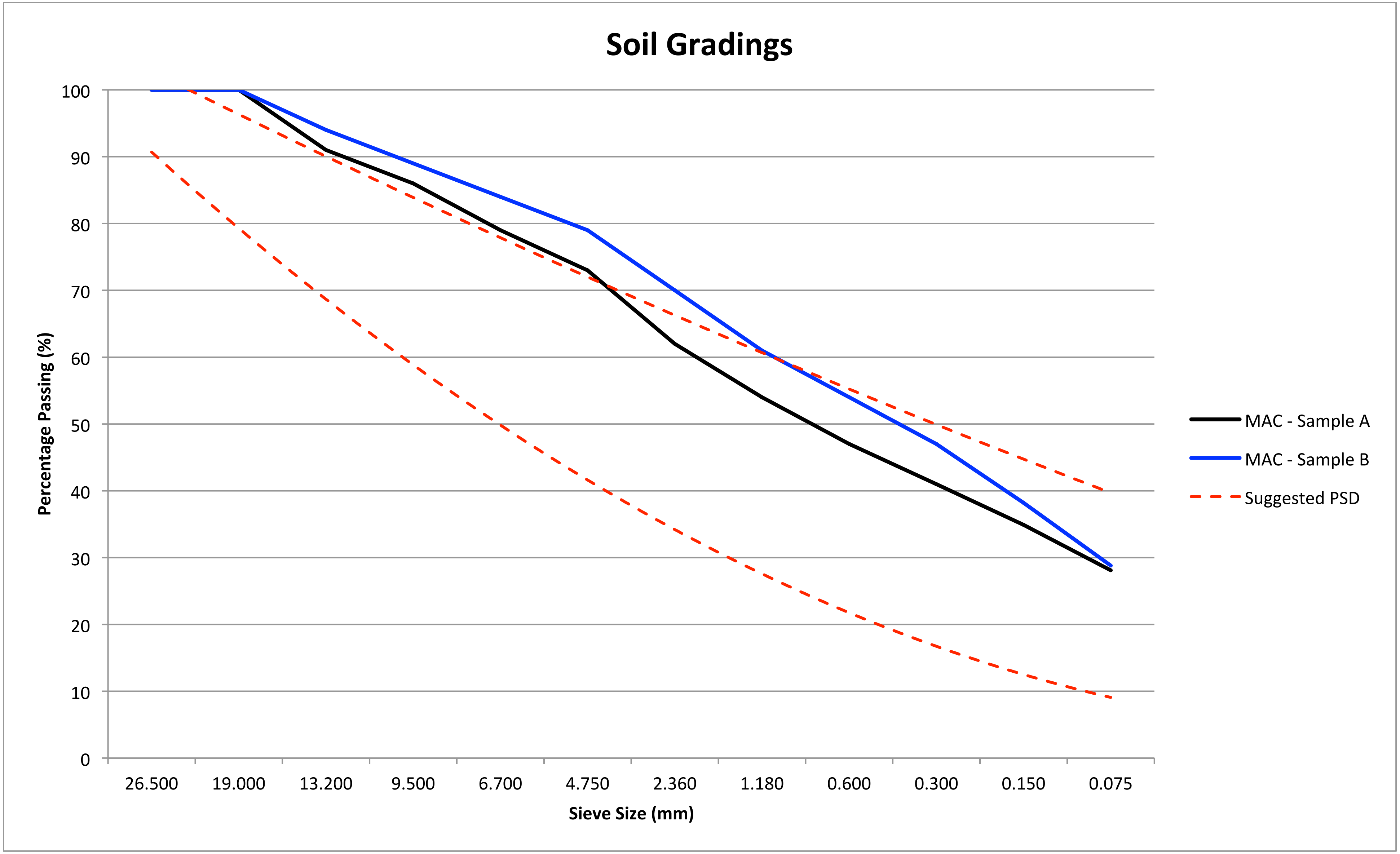
- **Payback period ~ 18 months**
  - **Watercart savings – number, size and labour**
  - **Grader savings – number, size and labour**
  - **Fuel savings ≥ 5%**
  - **Tyre life increase ≥ 7%**
  - **Reduced wet-weather stand-downs**
  - **Water savings ≥ 90%**
  - **Improved production cycle time**
  - **Reduced maintenance cost**
  - **Increased component life**
  - **Reduced road re-sheeting**

Dust-A-Side

Better Roads = Enhanced Sustainability & Improved Productivity

Contact Details:

- Brisbane Office (07) 3117 3790
- Perth Office (08) 9473 7544



Soil Gradings
Percentage Passing (%)
100
90
80
70
60
50
40
30
20
10
0
26.500
19.000
13.200
9.500
6.700
4.750
2.360
1.180
0.600
0.300
0.150
0.075
Sieve Size (mm)
MAC - Sample A
MAC - Sample B
Suggested PSD

Cardno Bowler
Shaping the Future

Cardno Bowler Pty Ltd
ABN: 74 128 806 735
Address:
1 Fox Road,
Acacia Ridge QLD 4110

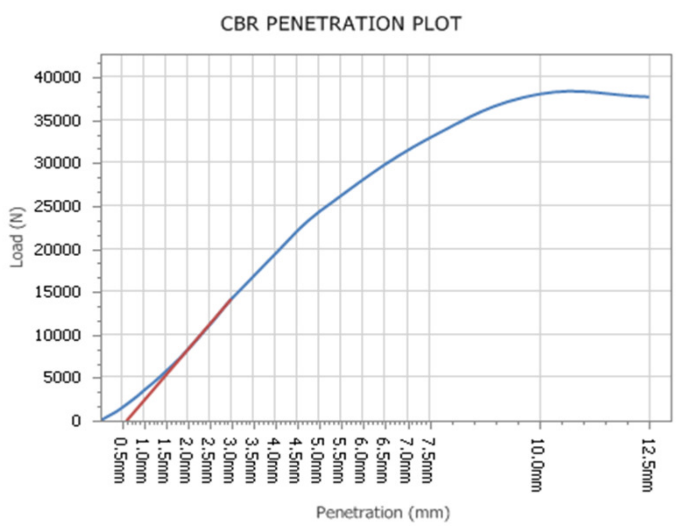
Laboratory: Acacia Ridge
Phone: 3320 8500 Fax: 3320 8599
Email: cardnobowlerlab@cardno.com.au
Website: www.cardno.com.au

CALIFORNIA BEARING RATIO REPORT

Client:	Zenith Civil Infrastructure Pty Ltd	Report Number:	1986/R/6329-1
Client Address:	PO Box 9377, GCMC,	Project Number:	1986/P/372
Project:	Roper River Haul Road	Lot Number:	
Location:	Subgrade	Report Date:	23/07/2013
Component:		Client Reference/s:	
Area Description:	Subgrade	Page Number:	Page 1 of 1

Test Procedures	AS1289.6.1.1, AS1289.2.1.1		
Sample Number	1986/S/13124		Sample Location
Sampling Method	Sampled by client	LOCATION	Roper River Haul Road
Date Sampled	10/07/2013		Subgrade
Sampled By	Client		CH: 21,900 KM
Date Tested	22/07/2013		
Material Source	Insitu	Material Limit Start	-
Material Type	Subgrade	Material Limit End	-
Client Reference	2% Polymer Additive	Compactive Effort	Unknown
Material Description	-		

Maximum Dry Density (t/m³):	N/A
Optimum Moisture Content (%):	N/A
Field Moisture Content (%):	N/A
Sample Percent Oversize (%)	N/A
Oversize Included / Excluded	Excluded
Target Density Ratio (%):	N/A
Target Moisture Ratio (%):	N/A
Placement Dry Density (t/m³):	N/A
Placement Dry Density Ratio (%):	N/A
Placement Moisture Content (%):	N/A
Placement Moisture Ratio (%):	N/A
Test Condition / Soaking Period:	Soaked 4 days
CBR Surcharge (kg)	4.5
Dry Density After Soak (t/m³):	-
Moisture (top 30mm) After Soak (%)	5.6
Moisture (remainder) After Soak (%)	-
CBR Swell (%):	0
Minimum CBR Specification (%):	-
CBR Value @ 5.0mm (%):	**130**



Remarks	Sampled & moulded by client. Tested as received.

NATA

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025

Laboratory Accreditation No.: 1986

Approved Signatory: Andrew Lenkeit
Form ID: W7Rep Rev 1

Cardno Bowler
Shaping the Future

Address:
1 Fox Rd
Acacia Ridge, QLD, 4110

Telephone: (07) 3320 8500
Facsimile: (07) 3320 8599

Geotechnical Engineering Consultants
Soil Laboratory Services
Environmental Consultants
ABN: 74 128 806 735

Email: cardnobowlerlab@cardno.com.au
Web: www.cardno.com.au

REPORT ON Q115-1978 UNCONFINED COMPRESSIVE STRENGTH

CLIENT:	**Zenith Civil Infrastructure Pty Ltd**	*JOB No.:*	**1986/P/372**
ADDRESS:	**PO Box 9377, GCMC QLD 9726**	*REPORT No:*	**2**
PROJECT:	**Roper River Haul Road**		

MATERIAL TYPE:	**Insitu Subgrade**	*SAMPLE NO:*	**1986/S/13124**
ADDITIVE:	**Polymer**	*SAMPLED BY:*	**Client**
CLIENT REFERENCE NO:	**Roper River Rd, CH: 21,900 km, Subgrade**	*DATE SAMPLED:*	**10.07.2013**
ADDITIVE CONTENT:	**2.0%**	*TEST BY:*	**KT**
		DATE TESTED:	**12.07.2013**
		REPORTED BY:	**MH**
		DATE ISSUED:	**12.07.2013**

Location:	**Roper River Rd, CH: 21,900 km, Subgrade**
OFFSET (m)	**n/s**
TEST LEVEL (m) (RL)	**Subgrade**

TEST RESULTS

AVERAGE MPA (3 DAY CURING) **2.5**

Remarks: 1) Sampled & moulded by client. Tested as received. 2)Variation Q115: Cured for 3 days
3)Variation Q115: 1 test specimen only

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory
Number: 1986

This document is issued in accordance with NATA accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved by ....
A Lenkeit Approved Signatory

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Acacia Ridge, QLD, 4110

Telephone: (07) 3320 8500
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Web: www.cardno.com.au

REPORT ON Q115-1978 UNCONFINED COMPRESSIVE STRENGTH

CLIENT: **Zenith Civil Infrastructure Pty Ltd**
ADDRESS: **PO Box 9377, GCMC QLD 9726**
PROJECT: **Roper River Haul Road**

JOB No.: **1986/P/372**
REPORT No: **1**

MATERIAL TYPE: **Insitu Subgrade**
ADDITIVE: **Polymer**
CLIENT REFERENCE NO: **Roper River Rd, CH: 21,900 km, Subgrade**
ADDITIVE CONTENT: **2.0%**

SAMPLE NO: **1986/S/12744**
SAMPLED BY: **Client**
DATE SAMPLED: **30.06.2013**
TEST BY: **KT**
DATE TESTED: **02.07.2013**
REPORTED BY: **AL**
DATE ISSUED: **03.07.2013**

Location: **Roper River Rd, CH: 21,900 km, Subgrade**
OFFSET (m) **n/s**
TEST LEVEL (m) (RL) **Subgrade**

TEST RESULTS

AVERAGE MPA (3 DAY CURING) **2.5**

Remarks: 1) Sampled & moulded by client. Tested as received. 2)Variation Q115: Cured for 3 days
3)Variation Q115: 3 test specimen only

NATA Accredited Laboratory Number: 1986

This document is issued in accordance with NATA accreditation requirements. Accredited for compliance with ISO/IEC 17025

WORLD RECOGNISED ACCREDITATION

Approved by ....
A Lenkeit Approved Signatory

FORM: 282 REV: 2 23.03.12

Attachment 2: MCA Water Account Summary

INPUT - OUTPUT STATEMENT DATA ENTRY

Site Details:	Sherwin Creek Iron Ore Project

Quick Reference Guide on Adjacent page

Reporting Period Details	Date (dd/mm/yyyy)	Storage (ML)
Start	01-July-2014	0
Finish	30-June-2014	0

INPUTS-OUTPUTS

Input-Output	Source/Destination	Inputs/Outputs	Water Quality			Sub-Element Total (ML)	Accuracy (high, medium, low)			Notes (1,2..)
			Category 1 (ML)	Category 2 (ML)	Category 3 (ML)		Measured	Estimated	Simulated	
Inputs	Surface Water	*Precipitation and Runoff*	317			317		Medium		1
		Rivers and Streams				0				
		External Surface Water Storages				0				
	Groundwater	*Aquifer Interception*				0				2
		Bore Fields		50		50		Medium		
		Entrainment		94		94		Medium		3
	Sea Water	*Estuary*				0				
		Sea/Ocean				0				
	Third Party Water	*Contract/Municipal*				0				
		Waste Water				0				
	TOTAL INPUTS		317	144	0	461				
Outputs	Surface Water	*Discharge*				0				
		Environmental Flows				0				
	Groundwater	*Seepage*		5		5		Medium		
		Reinjection				0				
	Sea Water	*Discharge to Estuary*				0				
		Discharge to Sea/Ocean				0				
	Supply to Third Party					0				
	Other	*Evaporation*		386		386		Medium		
		Entrainment		70		70				
		Other (define)				0				
	TOTAL OUTPUTS		0	461	0	461				
DIVERSIONS*										
Inputs	Surface Water	*Precipitation and Runoff*				0				
		Rivers & Streams				0				
	Groundwater	*Aquifer Interception*				0				
	TOTAL DIVERSION INPUTS		0	0	0	0				
Outputs	Surface Water	*Discharge*				0				
	Groundwater	*Reinjection*				0				
	Supply to Third Party					0				
	Other	*Other (define)*				0				
	TOTAL DIVERSION OUTPUTS		0	0	0	0				

* Only commonly used Diversion Source and Destination categories visible. Remaining categories (Sea Water, Third Party inputs and sea water output) rows 'hidden'.

Accuracy Summary - Input (ML)

Confidence	High	Medium	Low
Measured	0	0	0
Estimated	0	461	0
Simulated	0	0	0

Accuracy Summary - Output (ML)

Confidence	High	Medium	Low
Measured	0	0	0
Estimated	0	391	0
Simulated	0	0	0

Diversions Accuracy Summary - Input (ML)

Confidence	High	Medium	Low
Measured	0	0	0
Estimated	0	0	0
Simulated	0	0	0

Diversions Accuracy Summary - Output (ML)

Confidence	High	Medium	Low
Measured	0	0	0
Estimated	0	0	0
Simulated	0	0	0

Notes (user defined):

1 *Average Rainfall at Ngukurr.*
2 *No mine influx - ground water level below floor of open pit.*
3 *Rock moisture.*

Input-Output Data Entry Usage Notes:

Modification of the Input-Output Model
Companies/operations may include new Sub-elements within the input-Output model as required by individual circumstances.
However, the Primary Elements (Sources and Destinations) must remain the same.
The worksheet can be unlocked by right mouse clicking the worksheet tab and clicking unprotect sheet (no password required).

Data Entry
Data is only to be entered into unshaded cells
Only one accuracy parameter is to be entered for each element.

Data Sources
Data Sources may include but not be limited to:
- Direct Measurement (storage and flow)
- Water Allocation
- Water Sharing Plans
- Site Water Balance Models
- Publicly Available Water Information
- Water User Charges

Diversions
Diversions include water that is diverted away from the operational facility, and is not involved in any of the tasks within the operational facility. It is water which is actively managed by the minerals operation, but is not used in a traditional 'consumptive' sense. **Diverted water is not included in the reporting of inputs-outputs for the operational facility.**
Source and Destination Categories for Diversions are consistent with those for the Operational Facility. Note, only commonly used categories are visible in the input-out data entry table. The remaining categories (Sea Water, Third Party inputs and sea water output) can be viewed by right clicking and unhiding the rows along the left side of the worksheet.

Water Quality
Water Quality category can be company defined. For Preliminary Water Quality Categorisation Worksheet (No.5) for full definitions and water quality decision tree

Accuracy (High, Medium, Low)
High, Medium and Low values are a qualitative measure of confidence assigned by site operators. These levels can be based upon the level of available data, assessed reliability of data, past performance of measurement/estimation tools and/or operator experience.

Attachment 3: Water Balance

Average Rain								
Cumulative Area at Year End	Year 1	184,447	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	182.8	23,602	23,602	5.90	13,925	6,118	3,559
	Feb	176.5	22,788	46,390	6.10	16,072	6,829	3,446
	Mar	174.8	22,569	68,959	5.60	14,569	6,743	4,704
	Apr	55.9	7,217	76,177	6.10	7,272	3,090	1,559
	May	10.7	1,382	77,558	5.60	1,647	762	532
	Jun	5.1	658	78,217	5.30	631	308	251
	Jul	1.1	142	78,359	5.50	216	102	75
	Aug	0.7	90	78,449	6.70	111	43	12
	Sep	1.8	232	78,681	7.70	188	63	-7
	Oct	13.5	1,743	80,424	8.80	1,528	450	-242
	Nov	42.4	5,474	85,899	8.50	4,448	1,356	-571
	Dec	131.6	16,991	102,890	7.30	11,986	4,256	177
	Annual	**815.5**	**105,292**		**6.60**			
Cumulative Area at Year End	Year 2	628,028	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	182.8	80,362	80,362	5.90	47,414	20,830	12,119
	Feb	176.5	77,593	157,955	6.10	54,724	23,253	11,734
	Mar	174.8	76,845	234,801	5.60	49,605	22,960	16,015
	Apr	55.9	24,575	259,375	6.10	24,760	10,521	5,309
	May	10.7	4,704	264,079	5.60	5,607	2,595	1,810
	Jun	5.1	2,242	266,321	5.30	2,148	1,050	854
	Jul	1.1	484	266,805	5.50	736	347	255
	Aug	0.7	308	267,113	6.70	377	146	40
	Sep	1.8	791	267,904	7.70	640	215	-24
	Oct	13.5	5,935	273,839	8.80	5,201	1,532	-823
	Nov	42.4	18,640	292,479	8.50	15,145	4,618	-1,946
	Dec	131.6	57,854	350,333	7.30	40,813	14,491	604
	Annual	**815.5**	**358,510**		**6.60**			
Cumulative Area at Year End	Year 3	856,115	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	182.8	109,548	109,548	5.90	64,634	28,395	16,520
	Feb	176.5	105,773	215,321	6.10	74,599	31,698	15,996
	Mar	174.8	104,754	320,076	5.60	67,620	31,298	21,832
	Apr	55.9	33,500	353,575	6.10	33,752	14,342	7,237
	May	10.7	6,412	359,988	5.60	7,644	3,538	2,468
	Jun	5.1	3,056	363,044	5.30	2,928	1,432	1,164
	Jul	1.1	659	363,703	5.50	1,003	473	348
	Aug	0.7	419	364,123	6.70	514	199	54
	Sep	1.8	1,079	365,202	7.70	872	294	-33
	Oct	13.5	8,090	373,292	8.80	7,090	2,088	-1,122
	Nov	42.4	25,409	398,701	8.50	20,645	6,295	-2,652
	Dec	131.6	78,865	477,567	7.30	55,636	19,754	823
	Annual	**815.5**	**488,713**		**6.60**			

Cumulative Area at Year End	Year 4	1,356,373	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	182.8	173,561	173,561	5.90	102,401	44,987	26,173
	Feb	176.5	167,580	341,141	6.10	118,189	50,221	25,343
	Mar	174.8	165,966	507,107	5.60	107,133	49,587	34,589
	Apr	55.9	53,075	560,182	6.10	53,475	22,722	11,466
	May	10.7	10,159	570,341	5.60	12,110	5,605	3,910
	Jun	5.1	4,842	575,183	5.30	4,639	2,269	1,845
	Jul	1.1	1,044	576,228	5.50	1,589	749	551
	Aug	0.7	665	576,892	6.70	815	315	86
	Sep	1.8	1,709	578,601	7.70	1,382	465	-52
	Oct	13.5	12,818	591,419	8.80	11,233	3,309	-1,777
	Nov	42.4	40,257	631,676	8.50	32,708	9,974	-4,202
	Dec	131.6	124,949	756,625	7.30	88,145	31,298	1,304
	Annual	815.5	774,285		6.60			

Cumulative Area at Year End	Year 5	1,811,700	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	182.8	231,825	231,825	5.90	136,777	60,089	34,959
	Feb	176.5	223,836	455,661	6.10	157,865	67,080	33,850
	Mar	174.8	221,680	677,340	5.60	143,097	66,233	46,200
	Apr	55.9	70,892	748,232	6.10	71,426	30,350	15,316
	May	10.7	13,570	761,802	5.60	16,176	7,487	5,222
	Jun	5.1	6,468	768,269	5.30	6,196	3,030	2,464
	Jul	1.1	1,395	769,664	5.50	2,123	1,000	736
	Aug	0.7	888	770,552	6.70	1,088	421	115
	Sep	1.8	2,283	772,835	7.70	1,846	621	-70
	Oct	13.5	17,121	789,956	8.80	15,004	4,420	-2,373
	Nov	42.4	53,771	843,727	8.50	43,688	13,322	-5,613
	Dec	131.6	166,894	1,010,621	7.30	117,735	41,804	1,742
	Annual	815.5	1,034,209		6.60			

Cumulative Area at Year End	Year 6	1,981,173	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	182.8	253,511	253,511	5.90	149,571	65,710	38,229
	Feb	176.5	244,774	498,285	6.10	172,632	73,354	37,017
	Mar	174.8	242,416	740,701	5.60	156,483	72,429	50,522
	Apr	55.9	77,523	818,225	6.10	78,107	33,189	16,748
	May	10.7	14,839	833,064	5.60	17,689	8,187	5,711
	Jun	5.1	7,073	840,136	5.30	6,775	3,314	2,695
	Jul	1.1	1,526	841,662	5.50	2,321	1,094	805
	Aug	0.7	971	842,633	6.70	1,190	460	126
	Sep	1.8	2,496	845,129	7.70	2,019	680	-77
	Oct	13.5	18,722	863,851	8.80	16,408	4,833	-2,595
	Nov	42.4	58,801	922,652	8.50	47,775	14,569	-6,138
	Dec	131.6	182,506	1,105,158	7.30	128,749	45,715	1,905
	Annual	815.5	1,130,953		6.60			

Low Rain

Cumulative Area at Year End	Year 1	184,447	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	118.8	15,341	15,341	5.90	9,051	3,976	2,313
	Feb	114.7	14,812	30,154	6.10	10,447	4,439	2,240
	Mar	122.4	15,798	45,952	5.60	10,101	4,676	3,261
	Apr	39.1	5,052	51,004	6.10	5,071	2,155	1,087
	May	0.0	0	51,004	5.60	609	282	197
	Jun	0.0	0	51,004	5.30	104	51	41
	Jul	0.0	0	51,004	5.50	23	11	8
	Aug	0.0	0	51,004	6.70	5	2	1
	Sep	0.0	0	51,004	7.70	0	0	0
	Oct	0.0	0	51,004	8.80	0	0	0
	Nov	29.7	3,832	54,836	8.50	3,257	993	-418
	Dec	92.1	11,894	66,730	7.30	8,377	2,974	124
	Annual	**516.8**	**66,730**		**6.60**			
Cumulative Area at Year End	**Year 2**	**628,028**	**Rain**	**Cumulative Rain**	**Daily Evaporation**	**Potential Evaporation**	**Potential Infiltration**	**Surplus or Deficit**
	Rain (mm)	**(m2)**	**(m3)**	**(m3)**	**(mm)**	**(m3)**	**(m3)**	**(m3)**
	Jan	118.8	52,236	52,236	5.90	30,819	13,539	7,877
	Feb	114.7	50,435	102,671	6.10	35,571	15,115	7,627
	Mar	122.4	53,792	156,463	5.60	34,395	15,920	11,105
	Apr	39.1	17,202	173,665	6.10	17,267	7,337	3,703
	May	0.0	0	173,665	5.60	2,073	960	669
	Jun	0.0	0	173,665	5.30	355	174	141
	Jul	0.0	0	173,665	5.50	78	37	27
	Aug	0.0	0	173,665	6.70	18	7	2
	Sep	0.0	0	173,665	7.70	1	0	0
	Oct	0.0	0	173,665	8.80	0	0	0
	Nov	29.7	13,048	186,713	8.50	11,091	3,382	-1,425
	Dec	92.1	40,498	227,211	7.30	28,523	10,128	422
	Annual	**516.8**	**227,211**		**6.60**			
Cumulative Area at Year End	**Year 3**	**856,115**	**Rain**	**Cumulative Rain**	**Daily Evaporation**	**Potential Evaporation**	**Potential Infiltration**	**Surplus or Deficit**
	Rain (mm)	**(m2)**	**(m3)**	**(m3)**	**(mm)**	**(m3)**	**(m3)**	**(m3)**
	Jan	118.8	71,207	71,207	5.90	42,012	18,457	10,738
	Feb	114.7	68,752	139,959	6.10	48,489	20,604	10,397
	Mar	122.4	73,328	213,287	5.60	46,886	21,702	15,138
	Apr	39.1	23,450	236,737	6.10	23,538	10,002	5,047
	May	0.0	0	236,737	5.60	2,826	1,308	913
	Jun	0.0	0	236,737	5.30	484	237	192
	Jul	0.0	0	236,737	5.50	106	50	37
	Aug	0.0	0	236,737	6.70	25	10	3
	Sep	0.0	0	236,737	7.70	2	1	0
	Oct	0.0	0	236,737	8.80	0	0	0
	Nov	29.7	17,787	254,523	8.50	15,119	4,610	-1,942
	Dec	92.1	55,206	309,729	7.30	38,882	13,806	575
	Annual	**516.8**	**309,729**		**6.60**			

Cumulative Area at Year End	Year 4	1,356,373	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	118.8	112,815	112,815	5.90	66,561	29,242	17,012
	Feb	114.7	108,927	221,742	6.10	76,823	32,643	16,473
	Mar	122.4	116,176	337,918	5.60	74,283	34,383	23,983
	Apr	39.1	37,152	375,070	6.10	37,293	15,846	7,997
	May	0.0	0	375,070	5.60	4,478	2,073	1,446
	Jun	0.0	0	375,070	5.30	766	375	305
	Jul	0.0	0	375,070	5.50	168	79	58
	Aug	0.0	0	375,070	6.70	39	15	4
	Sep	0.0	0	375,070	7.70	3	1	0
	Oct	0.0	0	375,070	8.80	0	0	0
	Nov	29.7	28,180	403,250	8.50	23,953	7,304	-3,077
	Dec	92.1	87,464	490,715	7.30	61,603	21,873	911
	Annual	516.8	490,715		6.60			

Cumulative Area at Year End	Year 5	1,811,700	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	118.8	150,686	150,686	5.90	88,905	39,058	22,723
	Feb	114.7	145,493	296,179	6.10	102,612	43,602	22,003
	Mar	122.4	155,176	451,355	5.60	99,220	45,925	32,034
	Apr	39.1	49,624	500,979	6.10	49,811	21,166	10,681
	May	0.0	0	500,979	5.60	5,981	2,768	1,931
	Jun	0.0	0	500,979	5.30	1,023	501	407
	Jul	0.0	0	500,979	5.50	224	106	78
	Aug	0.0	0	500,979	6.70	52	20	5
	Sep	0.0	0	500,979	7.70	4	1	0
	Oct	0.0	0	500,979	8.80	0	0	0
	Nov	29.7	37,640	538,619	8.50	31,994	9,756	-4,110
	Dec	92.1	116,826	655,445	7.30	82,282	29,216	1,217
	Annual	516.8	655,445		6.60			

Cumulative Area at Year End	Year 6	1,981,173	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	118.8	164,782	164,782	5.90	97,221	42,712	24,849
	Feb	114.7	159,103	323,885	6.10	112,211	47,680	24,061
	Mar	122.4	169,691	493,577	5.60	108,501	50,221	35,030
	Apr	39.1	54,266	547,843	6.10	54,471	23,146	11,680
	May	0.0	0	547,843	5.60	6,541	3,027	2,112
	Jun	0.0	0	547,843	5.30	1,119	547	445
	Jul	0.0	0	547,843	5.50	245	115	85
	Aug	0.0	0	547,843	6.70	57	22	6
	Sep	0.0	0	547,843	7.70	5	2	0
	Oct	0.0	0	547,843	8.80	0	0	0
	Nov	29.7	41,161	589,004	8.50	34,987	10,669	-4,495
	Dec	92.1	127,754	716,758	7.30	89,979	31,949	1,331
	Annual	516.8	716,758		6.60			

High Rain								
Cumulative Area at Year End	Year 1	184,447	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	684.2	88,339	88,339	5.90	52,120	22,897	13,322
	Feb	636.1	82,129	170,468	6.10	58,225	24,741	12,485
	Mar	610.0	78,759	249,227	5.60	51,097	23,650	16,497
	Apr	531.7	68,649	317,876	6.10	51,939	22,070	11,137
	May	132.0	17,043	334,919	5.60	15,781	7,304	5,095
	Jun	94.0	12,137	347,055	5.30	9,133	4,466	3,632
	Jul	19.5	2,518	349,573	5.50	3,383	1,594	1,173
	Aug	20.4	2,634	352,207	6.70	2,551	987	270
	Sep	30.0	3,873	356,080	7.70	3,190	1,074	-121
	Oct	126.5	16,333	372,413	8.80	14,266	4,202	-2,257
	Nov	168.0	21,691	394,104	8.50	16,519	5,037	-2,122
	Dec	561.4	72,484	466,588	7.30	51,364	18,238	760
	Annual	**1,448.6**	**187,033**		**6.60**			
Cumulative Area at Year End	Year 2	628,028	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	684.2	300,788	300,788	5.90	177,465	77,964	45,359
	Feb	636.1	279,642	580,430	6.10	198,250	84,240	42,510
	Mar	610.0	268,168	848,597	5.60	173,980	80,528	56,171
	Apr	531.7	233,746	1,082,343	6.10	176,849	75,146	37,921
	May	132.0	58,030	1,140,373	5.60	53,732	24,870	17,348
	Jun	94.0	41,324	1,181,697	5.30	31,096	15,208	12,368
	Jul	19.5	8,573	1,190,270	5.50	11,517	5,428	3,995
	Aug	20.4	8,968	1,199,238	6.70	8,686	3,360	918
	Sep	30.0	13,189	1,212,427	7.70	10,862	3,656	-412
	Oct	126.5	55,612	1,268,038	8.80	48,576	14,308	-7,684
	Nov	168.0	73,856	1,341,895	8.50	56,246	17,152	-7,226
	Dec	561.4	246,802	1,588,697	7.30	174,891	62,098	2,587
	Annual	**1,448.6**	**636,833**		**6.60**			
Cumulative Area at Year End	Year 3	856,115	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	684.2	410,028	410,028	5.90	241,916	106,279	61,832
	Feb	636.1	381,202	791,230	6.10	270,251	114,835	57,949
	Mar	610.0	365,561	1,156,791	5.60	237,166	109,774	76,571
	Apr	531.7	318,637	1,475,429	6.10	241,077	102,438	51,693
	May	132.0	79,105	1,554,534	5.60	73,247	33,903	23,648
	Jun	94.0	56,332	1,610,866	5.30	42,390	20,731	16,860
	Jul	19.5	11,686	1,622,552	5.50	15,700	7,399	5,447
	Aug	20.4	12,225	1,634,777	6.70	11,840	4,581	1,251
	Sep	30.0	17,978	1,652,756	7.70	14,807	4,984	-562
	Oct	126.5	75,809	1,728,565	8.80	66,218	19,504	-10,474
	Nov	168.0	100,679	1,829,244	8.50	76,674	23,381	-9,850
	Dec	561.4	336,436	2,165,680	7.30	238,408	84,651	3,527
	Annual	**1,448.6**	**868,118**		**6.60**			

Cumulative Area at Year End	Year 4	1,356,373	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	684.2	649,621	649,621	5.90	383,276	168,382	97,963
	Feb	636.1	603,952	1,253,573	6.10	428,168	181,936	91,810
	Mar	610.0	579,171	1,832,744	5.60	375,750	173,918	121,313
	Apr	531.7	504,828	2,337,573	6.10	381,946	162,296	81,899
	May	132.0	125,329	2,462,901	5.60	116,048	53,714	37,467
	Jun	94.0	89,249	2,552,151	5.30	67,160	32,845	26,712
	Jul	19.5	18,514	2,570,665	5.50	24,874	11,723	8,629
	Aug	20.4	19,369	2,590,034	6.70	18,759	7,257	1,982
	Sep	30.0	28,484	2,618,518	7.70	23,459	7,897	-890
	Oct	126.5	120,107	2,738,625	8.80	104,911	30,901	-16,595
	Nov	168.0	159,509	2,898,134	8.50	121,477	37,043	-15,606
	Dec	561.4	533,027	3,431,162	7.30	377,717	134,116	5,588
	Annual	1,448.6	1,375,389		6.60			

Cumulative Area at Year End	Year 5	1,811,700	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	684.2	867,696	867,696	5.90	511,940	224,907	130,848
	Feb	636.1	806,696	1,674,391	6.10	571,902	243,011	122,631
	Mar	610.0	773,596	2,447,987	5.60	501,887	232,302	162,038
	Apr	531.7	674,297	3,122,284	6.10	510,164	216,778	109,393
	May	132.0	167,401	3,289,685	5.60	155,004	71,745	50,044
	Jun	94.0	119,210	3,408,895	5.30	89,705	43,871	35,679
	Jul	19.5	24,730	3,433,624	5.50	33,225	15,658	11,526
	Aug	20.4	25,871	3,459,495	6.70	25,056	9,693	2,648
	Sep	30.0	38,046	3,497,541	7.70	31,334	10,548	-1,188
	Oct	126.5	160,426	3,657,967	8.80	140,129	41,274	-22,166
	Nov	168.0	213,056	3,871,023	8.50	162,257	49,479	-20,845
	Dec	561.4	711,962	4,582,985	7.30	504,515	179,137	7,464
	Annual	1,448.6	1,837,100		6.60			

Cumulative Area at Year End	Year 6	1,981,173	Rain	Cumulative Rain	Daily Evaporation	Potential Evaporation	Potential Infiltration	Surplus or Deficit
	Rain (mm)	(m2)	(m3)	(m3)	(mm)	(m3)	(m3)	(m3)
	Jan	684.2	948,863	948,863	5.90	559,829	245,945	143,089
	Feb	636.1	882,157	1,831,020	6.10	625,400	265,744	134,102
	Mar	610.0	845,961	2,676,981	5.60	548,835	254,032	177,195
	Apr	531.7	737,373	3,414,354	6.10	557,887	237,056	119,626
	May	132.0	183,060	3,597,414	5.60	169,504	78,456	54,726
	Jun	94.0	130,361	3,727,775	5.30	98,096	47,975	39,016
	Jul	19.5	27,043	3,754,818	5.50	36,333	17,123	12,604
	Aug	20.4	28,291	3,783,110	6.70	27,400	10,600	2,895
	Sep	30.0	41,605	3,824,714	7.70	34,265	11,534	-1,299
	Oct	126.5	175,433	4,000,147	8.80	153,237	45,135	-24,239
	Nov	168.0	232,986	4,233,133	8.50	177,435	54,107	-22,795
	Dec	561.4	778,561	5,011,694	7.30	551,709	195,895	8,162
	Annual	1,448.6	2,008,949		6.60			