

FRANCES CREEK PROJECT,
NORTHERN TERRITORY:
WASTE CHARACTERISATION

MAY 2006

PREPARED FOR

TERRITORY IRON LIMITED

BY

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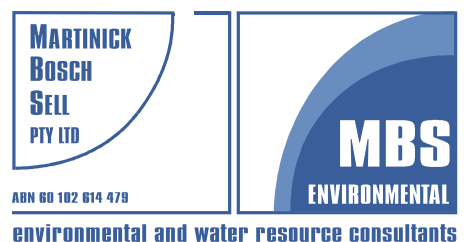


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1. EXECUTIVE SUMMARY

1.1 WASTE ROCK CHARACTERISATION

A waste rock sampling program for the Frances Creek Project was undertaken in January 2006. A total of ten waste rock samples were taken for geochemical characterisation. Sampling covered the Ochre Hill, Helene 5, Helen 6/7, Jasmine East, Thelma Pit 2 and Thelma Rosemary deposits. Eight composite samples were taken from reverse circulation drill chips, one from open pit waste and one from Cretaceous overburden. The sampled waste rock predominantly comprises oxidised siltstone and shales, with some dolerite as well as Cretaceous sediments.

The iron ore deposits are effectively free of sulphur and toxicants, but enclosing carbonaceous waste rocks contain trace amounts of uranium and chalcophile element – bearing sulphides. Sulphur contents are very low (maximum value recorded in ore is 0.025%, and in waste 0.103%) and the chance of acid development at these levels would normally be considered zero. However, the waste rocks are carbonate mineral free with no acid neutralising capacity. A Thelma 2 Pit waste rock sample had the highest sulphur value (0.103%S) with all sulphur already oxidised to sulphuric acid and a pH leachate value of 4.9. Adjacent pit water has a pH value of 3.5, which represents the sum of organic and sulphuric acids developed, then concentrated by 32 years of evaporation since former mining.

All soils tested were sulphur-free, but acidic with a median pH value of 5.2. A moderately dense vegetation cover is present with organic-rich soil development. Dense typical local vegetation growth occurs right to the high water mark indicating the low level of acidity is neither affecting plant growth nor is it likely to affect that growth in the future.

Based on results of analytical work and an understanding of the geology of the Frances Creek area, there is no likelihood of acid rock drainage development. Final open pit voids may develop low pH water within the aluminium hydroxy-sulphate buffer zone of pH 3.2 to 4.9 over a long time frame, but most acidity will be sourced from decomposing vegetation, not sulphides. Soluble organic – chalcophile element compounds derived from rotting vegetation and the enclosing siltstones may accumulate in final pit void waters to levels marginally higher than ANZECC fresh water ecosystem protection trigger values, but still below drinking water guideline values.

The sole problem foreseen is that Wildman Siltstone waste rock appears to have no carbonate minerals and effectively no acid neutralising potential. If total sulphur values in exposed siltstone waste rock in open pits exceed 0.1%S, it is recommended that consideration is given to pit backfilling to minimise contact between in-pit water and siltstone in final pit voids. Otherwise the water may acidify to values in the pH 3.2 to 4.9 range where aluminium hydroxy-sulphate acts as a pH buffer.

1.2 GROUNDWATER CHARACTERISATION

Surface waters and soil leachates both carry high contents of non-filterable colloidal silica suggestive of organic – silicic acid complex molecules. pH values of both groups and also the weathered waste rock from Thelma Pit 2 are acidic despite extremely low to low sulphur

contents. This indicates that organic and silicic acids are controlling the acidity. In comparison, dewatering groundwater and pit waters, excluding that from Thelma Pit 2 water, are weakly alkaline.

Most waters and leachates contain quantities of soluble aluminium that exceed ANZECC fresh water ecosystem protection trigger values by one to three orders of magnitude. With the exclusion of most samples from the Helene area, waters and soils that overlie or drain Wildman Siltstone, contain iron-sulphide related (cobalt, nickel, selenium) and chalcophile elements (copper, lead, thallium and zinc) that approach and occasionally exceed ANZECC fresh water ecosystem protection trigger values.

The relatively high soluble aluminium in Frances Creek waters is likely to be present as hydroxy-sulphate and/or an organic complex. Aluminium in acidic solutions is not considered a toxicant and there is no fresh water trigger value for aluminium at pH less than 6.5.

Thelma 2 Pit has anomalous beryllium, cobalt, copper, manganese, nickel, lead, thallium and zinc including the highest values for most of these metals. Jasmine Pit has slightly anomalous copper, thallium and zinc and Ochre Hill leachates have slightly anomalous cadmium, molybdenum, nickel and zinc. All waters and leachates from the Thelma-Rosemary, Jasmine and Ochre Hill areas, without being significantly anomalous, generally contain higher chalcophile elements than from Helene. This indicates a higher sulphide content in waste rock of the more north-easterly areas than in the Helene area, which is likely to be reflected in groundwater concentrations for these areas.

1.3 LEACHATE CHARACTERISATION

Geochemical leachate data indicates that Helene and Ochre Hill areas will produce alkaline wastes with negligible toxicants. Traces of arsenic, cadmium, nickel and molybdenum may leach from Ochre Hill waste rock, but only very slight dilution plus oxygenation is required to reduce concentrations for all of these elements to below ANZECC fresh water ecosystem protection trigger values. As such, adverse impacts associated with leachate from waste rock are not anticipated and there is no requirement for constructed wetlands. In the Jasmine – Thelma-Rosemary area, small amounts of cobalt, copper, lead, nickel, thallium and zinc are likely to leach but, as for the Ochre Hill area, only slight dilution plus oxygenation will be required to reduce all leachate results to below ANZECC freshwater ecosystem protection trigger values.

1.4 URANIUM AND THORIUM GEOCHEMISTRY

Uranium and thorium are present in the ore and waste rock, but soluble levels are extremely low.

Uranium concentrations at individual sites varies considerably. At Helene, the median value is 10 parts per million, at Thelma-Rosemary 44 parts per million, Jasmine 29 parts per million and Ochre Hill 18 parts per million. These values seem to parallel the variation in chalcophile toxicants for the leachate analyses suggesting a relationship between the sulphide and uranium, but not the thorium mineralisation.

Whilst the uranium median value is three times the expected shale background, these values are not unusual when compared with those in many mineralised areas. Many open pit and underground mines world-wide operate at comparable or higher levels.

2. OBJECTIVES

MBS Environmental was engaged by Territory Iron to undertake waste characterisation investigations for the proposed Francis Creek Iron Ore project. Specifically, the objectives of this investigation were to:

- Determine the potential for generation of acid rock drainage from waste rock to be generated by the project.
- Characterise and provide comment on the qualities of the surface water, soil waters, groundwater and pit waters for the project area
- Determine, based on waste rock geochemical characteristics, the potential for trace element pollution of local groundwater as a result of long-term waste rock disposal and interaction of groundwater with the final pit.
- Provide comments on the uranium and thorium values within the project area.

3. INTRODUCTION

3.1 GEOSTRUCTURAL AND GEOCHEMICAL SETTING

The Early Proterozoic Frances Creek hematite deposits occur as lenses of variable thickness within grey carbonaceous sulphidic pelite overlying shallow water shelf facies marine arenites in the lower member of, and about 100m above the base of the Wildman Siltstone. The deposits appear to form a distinctive stratigraphic unit within the siltstone and commonly overlie a discontinuous dolerite sill. Previous authors have inferred that the ironstone develops into a pyritic carbonaceous shale breccia in depth, and that this breccia is caused by bedding parallel thrust faulting. Geo-stratigraphically, this theory is difficult to support.

At the stratigraphic location of the iron ore deposits, a regional change in lithology is noted in Northern Territory Geological Survey (NTGS) reports and land texture changes (as seen on aerial photographs) are well developed. Lower Wildman Formation sediments appear to be distal regressive fining upwards, shallow water, low current, low to very low percentage clastic sediment, shelf deposits, the iron ore zone itself a close to zero oxygen partial pressure dominantly chemical sedimentation “still-stand” facies. Sediments above the iron ore are also distal and shallow, but transgressive, coarsening upwards into cross bedded fine to coarse sandstone deposits, indicating significant current movement as water depths decreased.

The stratigraphic level of the iron ore appears to have been a period of very fine grained, anoxic, dominantly chemical cherty iron – rich and sulphur – bearing precipitate deposition with negligible associated clastic sedimentation. This suggests the ore model fits the classic world-wide depositional style of late Archaean – Early Proterozoic shallow sub-aqueous stratiform deposits, namely manganese carbonate/oxide deposits, followed by iron/silica ($\pm$ carbonate and/or sulphide) deposits and finally anoxic sulphur-bearing carbonaceous shales / carbonate/silica mudstones, as water depths increase and oxygen fugacity decreases.

Trace metal data from the low grade iron ore and adjacent wastes analysed in this study fully support this model. Many of the base and heavy metal analyses and element ratios suggest a low to moderate sulphide content in the iron protore without any evidence for base metal mineralisation, sedimentary exhalite deposition or hydrothermal alteration.

Following folding and thickening along fold crests, the iron grades were substantially supergene enriched during a prolonged deep weathering period prior to the late Mesozoic. This same pattern within iron deposits is noted world-wide and appears typical of the ores at Frances Creek.

4. METHOD AND RESULTS

4.1 WASTE ROCK CHARACTERISATION

Table 1 provides a summary of the characterisation of the waste rock for the Frances Creek project.

Frances Creek iron ore lenses are hosted in carbonaceous weakly sulphidic siltstone, shale and finely laminated weakly sulphidic carbon-rich phyllite. Additional rock types are rare dolerite sills which generally follow the ore horizon footwall. A prolonged period of surface exposure prior to the Cretaceous period, caused deep supergene iron enrichment of protore to ore grades after which the area was buried beneath Cretaceous continental sediments. Subsequent Cainozoic weathering and lateritisation re-exposed the buried ores and may have leached sulphides from the ores and enclosing rocks above the current water table.

Waste rock, both enclosing and interbedded with ore, is largely iron enriched, leached and free of visible sulphide and carbonate minerals. Some carbon and minor clay minerals are retained and samples show pH ranging from 4.9 to 8.1. Measured sulphur values are insufficient to generate measurable sulphuric acid and the pH generally appears to be due to organic derived acidity. A single sample of carbonate-free waste from the Thelma 2 pit area, with pH = 4.9 and minor sulphate-Sulphur content, will not generate any further acid due to the free carbon present. Measured Net Acid Potential Production (NAPP) on this sample was zero.

4.1.1 Sample Selection

A substantial database of newly completed reverse circulation drill holes provided data for sample selection. A small number of samples had been re-analysed for a suite of trace metals using a “total” four acid digestion. Waste samples were selected, where possible, from this database.

No drill chip samples were available from Thelma 2 Pit area and nothing from the Cretaceous overburden which will constitute a moderate proportion of the total wastes. Rock waste from a stockpile was collected at Thelma 2 Pit and a surface outcrop Cretaceous sample collected at Thelma-Rosemary.

Figure 1 shows the site layout. Ten waste samples, eight of composited reverse circulation drill chips, one sample of open pit waste and one sample of Cretaceous overburden were collected. Samples were:

- Ochre Hill - Two samples of drill chips comprising 12 metres of internal¹ wastes (IW).
- Helene 5 - Two samples of drill chips, one sample comprising five metres of IW, the second sample comprising three metres of footwall² waste (FW).
- Helene 6/7 - Two samples of drill chips, one sample comprising one metre of IW, the second sample comprising two metres of hanging wall³ waste (HW).

¹ Internal waste comprises waste from between ore lenses or infolded hanging wall material.

² Footwall waste comprises waste from stratigraphically below the ore lens.

³ Hanging wall waste comprises waste from stratigraphically above the ore lens.

- Jasmine East - Two samples of drill chips, one sample comprising four metres of marginal ore⁴, the second sample comprising three metres of internal waste.
- Thelma Pit 2 - One sample of carbonaceous siltstone waste rock, believed to be from the HW.
- Thelma Rosemary - One sample of unconformably overlying Cretaceous arenite.

Excluding the final two samples, all wastes are of pulverised material. Sulphur values from the previous analyses were not accepted, new analyses undertaken by LECO gas generation.

All samples were analysed for Acid Neutralising Capacity, Sulphur by LECO and sulphate-Sulphur. Since no LECO sulphur analyses exceeded 0.2% total Sulphur, none were analysed for Net Acid Generation.

4.1.2 ARD Data Interpretation

All samples calculate as having a Net Acid Production Potential (NAPP) of zero or less than zero and all are Non Acid Forming (NAF).

⁴ Ore definition is greater than 60% Fe. The interval sampled is just below this Fe content level.

Table 1: Waste Rock Characterisation Data

ELEMENTS	ANC	Tot C	EC	Final-pH	Fizz-Rate	pH	Tot S	SO ₄ -S	MPA	NAPP	CLASSIFICATION
UNITS	kg H ₂ SO ₄ /t	%	µS/cm	NONE	NONE	NONE	%	%	kg H ₂ SO ₄ /t	kg H ₂ SO ₄ /t	
DETECTION	1	0.01	10	0.01	0	0.1	0.005	0.03	1	1	
METHOD	ANCEx/ VOL	/LECO	W/ MTR	ANCEx/ MTR	ANCEx/ QUAL	W/ MTR	/LECO	ANCEx/ OES	CALC	CALC	
COMMENTS:	282.0/0511033 (23/01/2006) CLIENT O/N: Tlron 01 1/1										
SAMPLE DESCRIPTION											
FC 01 Ochre Hill; OHRC104, 09-14m. IW	2	0.05	51	1.5	0	8.1	<0.005	<0.03	0	-2.0	NAF
FC 02 Ochre Hill; OHRC109, 20-27m. IW	2	0.04	57	1.5	0	7.7	<0.005	<0.03	0	-2.0	NAF
FC 03 Helene 5; FCRC054, 38-40m. FW	0	0.05	46	1.5	0	6.6	<0.005	<0.03	0	0.0	NAF
FC 04 Helene 5; FCRC112, 19-24m. IW	1	0.05	84	1.5	0	7.5	<0.005	<0.03	0	-1.0	NAF
FC 05 Helene 6/7; HERC010, 37-38m. IW	1	0.02	36	1.5	0	7.6	<0.005	<0.03	0	-1.0	NAF
FC 06 Helene 6/7; HERC018, 09-11m. HW	0	0.06	37	1.5	0	7.0	<0.005	<0.03	0	0.0	NAF
FC 07 Jasmine East; JERC008, 26-30m. ORE	1	0.06	56	1.5	0	6.0	<0.005	<0.03	0	-1.0	NAF
FC 08 Jasmine East, JERC006, 35-39m. IW	0	0.08	35	1.5	0	6.4	0.008	<0.03	0	0.0	NAF
FC 09 Thelma-Rosemary, TRRC020, 06-08m. FW	0	0.09	23	1.5	0	5.4	0.008	<0.03	0	0.0	NAF
T2 Thelma 2 Pit - Carbonaceous Siltstone Waste	0	0.68	291	1.5	0	4.9	0.103	0.13	-0.8	-0.8	NAF
TRK Thelma-Rosemary, Cretaceous Overburden	1	0.18	66	1.5	0	6.5	0.012	<0.03	0	-1.0	NAF
	OHRC104,	Drill hole number followed by sample depth information									
	ORE	Marginal grade ore. Interval includes two metres analysing less than 60% Fe.									
	HW, IW, FW HW = Hanging Wall; IW = Internal waste, possibly infolded HW; FW = Footwall waste.										

4.2 CHARACTERISATION OF SURFACE AND GROUND WATERS

Substantial geochemical information on natural waters are available in the Frances Creek district. Data available includes:

- EC and pH data from the main Frances Creek and Helene 9, 11 dams and Helene 6/7 open pit. – sourced from Territory Iron.
- Water quality data collected during dewatering of the Helene 6/7 open pit and the Helene 11 dam. – sourced from Territory Iron. This data is considered optimum for groundwater as samples were collected within the dewatering cycle.
- Water quality data from the Helene 9 dam (unaffected by dewatering). – sourced from Territory Iron. This data is considered optimum as background surface water.
- Water quality data from the Helene 4 (sample F6), Jasmine 1(sample F2) and Thelma 2 (sample F3) open pits (unaffected by dewatering) – sourced through MBS Environmental (MBS).
- Water quality data from the Helene 4 Dam (Sample F6) – sourced through MBS.
- Surface ponds sourcing run-off water from mineralised Wildman siltstone (sample F4), unmineralised Wildman Siltstone (sample F5) and pristine Mundogie Sandstone (sample F1) – sourced through MBS.
- Stream channel flow waters from basically unmineralised ground (samples M2, M3, M5, M6) – sourced by MBS.
- Stream channel flow waters from mineralised ground (samples M4, M7, M8). – sourced by MBS.
- A stagnant pool on an old ore stockpile (sample M1). – sourced by MBS.

Table 2 supplies all geochemical information separated into the following categories:

- Rainfall run-off waters.
- Stream channel flow and standing waters from unmineralised catchment sources.
- Stream channel flow and standing waters from mineralised catchments.
- Open Pit groundwater plus direct rainfall, both subject to evaporation. (Most open pits are on relatively high ground with minimal rainwater inflow from topography). Samples were collected from moderate depth.
- Territory Iron dewatering programme 2005. Helene 6/7 water and Helene 11 Dam water subjected to dewatering; Helene 9 Dam sampled at this time, but is rainwater run-off flow that has been subject to evaporation.

Water sampling locations are shown in Figure 1. All samples have been analysed for EC, pH, nitrate-nitrogen, ammoniacal nitrogen, bi-carbonate as CaCO₃, Chloride, Fluoride, Total Dissolved Solids [TDS] (gravimetric), sulphur as Sulphate, and metals aluminium, arsenic, boron, barium, beryllium, bismuth, calcium, cadmium, cobalt, chromium, copper, iron (water soluble), potassium, lithium, magnesium, manganese, molybdenum, sodium, nickel, phosphorous, lead, antimony, selenium, strontium, silicon, thallium, uranium, vanadium and zinc. Some samples were analysed for thorium. Dewatering samples included low levels of silver, bromine, cerium and rare earth elements, germanium, hafnium, iodine, niobium,

tantalum, platinum group metals, rubidium, scandium, titanium, tungsten and zirconium. These are not reported.

‘FC’ water samples were not filtered, and contain higher beryllium values than ‘M’ samples which were filtered. Beryllium adsorbs on colloidal silica and this is an explanation for high beryllium values. This has a significant effect on the results.

Surface and soil waters vary considerably and contain substantial content of extremely fine colloidal material (data from NTEL) which passes a 0.45 micron filter. This is confirmed from calculated TDS data which is enhanced at lower pH. The colloidal material appears from evaluation of the analytical data to be colloidal silica.

Table 2 Geochemical Data – All Waters

ELEMENTS		EC	pH	NO3 N	NH3 N	HCO3	Cl	F	TDS	Al F	As F	B F	Ba F	Be F
UNITS		µS/cm	None	mg/L	mg/L	mgCaCO3/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	µg/L
DETECTION		0.01	0.1	0.005		1	2	0.1		0.01	0.1	0.01	0.01	0.05
METHOD		ALK1	ALK1	FIA 4	FIA	ALK1	FIA 4	FISE1	TSSTD5	W/1081	W/100M	W/1081	W/1081	W/100M
PROJECT INFORMATION:	Job No's: NTEL 05177 Waters; NTEL 05306 Waters; NTEL 04499 Dewatering 2005. Project: Frances Creek Iron Ore													
ANZECC DRINKING WATER GUIDELINES		--	6.5 - 8.5	50	(50)	None	(250)	1.5	(500)	(0.2)	7	4	0.7	None
ANZECC FRESH WATER TRIGGER VALUES				None	None	None	None	None	--	0.055 M	24 H	0.37 H	None	0.13 ECL
ANZECC LIVESTOCK TRIGGER VALUES				400	(430)	None	None	2	4000	5	500	5	None	None
IDENTIFICATION	SHORT DESCRIPTION													
	Rainfall run-off Water													
F1 14/11/05	Surface pond. Pristine completely undisturbed area, early wet season surface run-off water.	45	6.6	<0.005	1.05	10	2.4	0.1	110	10.20	1.35	0.07	0.075	0.20
F6 14/11/05	Helene 4 Dam. Drains Wildman Siltstone and (mainly) Mundogie Sandstone. Regional background.	34	6.6	0.070	0.20	8	5.6	<0.1	40	0.02	4.25	0.08	0.015	<0.05
F5 14/11/05	Surface Pond. Upstream from F4, early wet season run-off from non-mineralised (Iron) Wildman Siltstone.	306	4.8	0.020	2.61	<1	17.3	0.1	160	0.08	2.45	0.09	0.090	0.35
F4 14/11/05	Surface pond. Helene Tailings Area, early wet season run-off from mineralised area.	121	7.2	<0.005	0.35	30	5.5	0.2	80	0.04	2.40	0.07	0.035	<0.05
	Stream Channel and Standing Waters - basically unmineralised													
M2 13/12/05	Waterfall Gully, Helene Area. Standing water in Waterfall Gully. Unmineralised Wildman Siltstone catchment.	25	5.7	0.005	0.115	7	3.7	<0.1	40	1.3	7.7	0.0235	0.0092	<0.05
M3 13/12/05	Frances Creek. Non mineralised catchment, drains Mundogie Fm. Greyish water.	36	6.0	0.115	0.05	9	6.1	<0.1	20	0.5	1.5	0.0190	0.0091	<0.05
M6 13/12/05	Central Frances Creek. Water hole in Frances Ck, no flow, but creek is flowing further upstream. Dominantly unmineralised.	36	6.9	0.025	0.145	23	1.1	<0.1	30	0.6	1.35	0.0160	0.0106	<0.05
M5 14/12/05	Ochre Hill North. Wide swamp across road, little flow but large water body. Unmineralised catchment area.	45	6.1	<0.005	0.185	19	2.4	<0.1	40	0.5	0.5	0.0350	0.0146	<0.05
	Stream Channel and Standing Water - mineralised													
M7 14/12/05	Jasmine. Creek across road just before Jasmine. Diversion around mine disturbance. Some mineralised Wildman Siltstone catchment.	50	6.4	0.06	0.03	19	3.9	<0.1	30	0.3	0.4	0.0180	0.0158	<0.05
M8 14/12/05	Southern Frances Creek. Frances Creek, upstream of ford, red colour, flowing. Equal proportions mineralised and unmineralised	132	6.9	0.1	0.05	37	3.7	<0.1	80	0.3	1.2	0.0155	0.0184	<0.05
M4 13/12/05	Tributary. Mineralised catchment downstream of Helene 11 Dam. Drains old stockpiles. Flowing, slight greyish coloured water.	596	7.5	0.075	0.035	120	13.4	0.2	360	0.1	1.6	0.0175	0.0840	<0.05
	Open Pit Groundwater plus Rainwater.													
M1 13/12/05	Stagnant Stockpile Pool. Pool within old ore stockpile. Possibly largely rainwater. Bright red colour but may be reflecting soil colour.	17	5.9	0.29	0.075	7	1.0	<0.1	60	0.3	1.55	0.0095	0.0041	<0.05
F7 14/11/05	Helene 4 Open Pit. Standing water in mine pit within low grade mineralisation.	43	7.4	0.005	0.37	16	2.5	0.1	20	0.62	2.40	0.07	0.020	<0.05
F2 14/11/05	Jasmine 1 Open Pit. Standing water in mine pit. Red-brown colour.	40	6.9	<0.005	0.06	9	3.3	<0.1	30	0.06	1.55	0.07	0.010	<0.05
F3 14/11/05	Thelma 2 Open Pit. Clear standing water, dark grey Wildman Siltstone footwall. Blue colour recorded.	279	3.5	0.035	0.04	--	3.0	0.4	100	6.72	0.40	0.06	0.045	1.65
	Territory Iron Data - Dewatering 2005													
HELENE PIT 6/7 15/4/05	Helene Pit 6/7. Analysis undertaken during 2005 dewatering. Effectively totally Groundwater.	106	7.9	<0.005	0.005	51	4.9	0.4	60	6.80	1.05	0.02	0.012	<0.05
DAM 11 20/04/05	Helene 11 Dam. Analysis undertaken during 2005 dewatering. Effectively totally Groundwater.	198	7.4	<0.005	0.015	86	6.2	0.2	120	15.40	3.35	0.02	0.013	<0.05
DAM 9 21/04/05	Helene 9 Dam. Analysis unaffected by 2005 dewatering. Mainly rainwater run-off near surface + minor deep groundwater component.	26	6.7	<0.005	0.005	13	1.6	<0.1	40	21.80	1.75	0.01	0.011	<0.05

Table 2 Geochemical Data – All Waters

ELEMENTS		Bi F	Ca F	Cd F	Co F	Cr F	Cu F	Fe-Sol	K F	Li F	Mg F	Mn F	Mo F	Na F
UNITS		µg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	µg/L	mg/L
DETECTION		0.005	0.01	0.02	0.0050	0.01	0.01	0.01	0.1	0.01	0.01	0.01	0.05	0.1
METHOD		W/100M	W/108I	W/100M	W/108I	Various	W/108I	W/108I	W/108I	W/100M	W/108I	W/108I	W/100M	W/108I
PROJECT INFORMATION:	Job No's: NTEL 05177 Waters; NTEL 05306 Waters; NTEL 04499 Dewatering 2005. Project: Frances Creek Iron Ore													
ANZECC DRINKING WATER GUIDELINES		None	None	2	None	0.05	2	(0.3)	None	None	None	0.5	50	(180)
ANZECC FRESH WATER TRIGGER VALUES		0.7 ECL	None	0.2	0.0014 L	0.0033 L	0.0014 H	0.3 (Can)	None	None	None	1.7 M	3.4 L	None
ANZECC LIVESTOCK TRIGGER VALUES		None	1000	10	1.0000	1	0.5	None	None	None	None	None	150	None
IDENTIFICATION	SHORT DESCRIPTION													
	Rainfall run-off Water													
F1 14/11/05	Surface pond. Pristine completely undisturbed area, early wet season surface run-off water.	<0.05	1.3	0.08	0.0050	<0.02	0.015	4.15	5.5	2.15	1.2	0.110	0.25	2.7
F6 14/11/05	Helene 4 Dam. Drains Wildman Siltstone and (mainly) Mundogie Sandstone. Regional background.	<0.05	0.7	<0.02	<0.005	<0.02	<0.005	0.50	1.3	0.25	0.5	0.035	0.10	4.5
F5 14/11/05	Surface Pond. Upstream from F4, early wet season run-off from non-mineralised (Iron) Wildman Siltstone.	<0.05	7.3	0.12	0.0450	<0.02	<0.005	1.80	7.6	3.65	12.9	0.870	0.05	19.9
F4 14/11/05	Surface pond. Helene Tailings Area, early wet season run-off from mineralised area.	<0.05	4.0	0.06	<0.005	<0.02	<0.005	0.80	3.2	8.45	7.3	0.050	0.50	6.7
	Stream Channel and Standing Waters - basically unmineralised													
M2 13/12/05	Waterfall Gully, Helene Area. Standing water in Waterfall Gully. Unmineralised Wildman Siltstone catchment.	<0.05	0.1	<0.02	0.0002	0.0016	0.003	0.62	2.8	0.35	0.3	0.004	0.25	3.0
M3 13/12/05	Frances Creek. Non mineralised catchment, drains Mundogie Fm. Greyish water.	<0.05	0.3	<0.02	0.0001	0.0005	0.002	0.34	2.3	0.50	0.9	0.007	0.1	3.8
M6 13/12/05	Central Frances Creek. Water hole in Frances Ck, no flow, but creek is flowing further upstream. Dominantly unmineralised.	<0.05	2.3	<0.02	0.0004	0.0007	0.003	0.6	3.4	0.45	1.4	0.027	0.25	0.9
M5 14/12/05	Ochre Hill North. Wide swamp across road, little flow but large water body. Unmineralised catchment area.	<0.05	0.8	<0.02	0.0012	0.0009	0.004	0.4	10.1	0.65	0.8	0.291	0.3	1.3
	Stream Channel and Standing Water - mineralised													
M7 14/12/05	Jasmine. Creek across road just before Jasmine. Diversion around mine disturbance. Some mineralised Wildman Siltstone catchment.	<0.05	1.7	<0.02	0.0000	0.0002	0.001	0.2	1.2	0.40	2.2	0.001	0.1	3.3
M8 14/12/05	Southern Frances Creek. Frances Creek, upstream of ford, red colour, flowing. Equal proportions mineralised and unmineralised	<0.05	7.0	<0.02	0.0001	0.0005	0.001	0.26	1.9	0.65	6.8	0.004	0.25	7.1
M4 13/12/05	Tributary. Mineralised catchment downstream of Helene 11 Dam. Drains old stockpiles. Flowing, slight greyish coloured water.	<0.05	37.6	<0.02	0.0002	0.0002	0.002	0.08	3.5	0.85	35.5	0.002	0.85	30.6
	Open Pit Groundwater plus Rainwater.													
M1 13/12/05	Stagnant Stockpile Pool. Pool within old ore stockpile. Possibly largely rainwater. Bright red colour but may be reflecting soil colour.	<0.05	<0.1	<0.02	0.0005	0.0004	0.002	0.52	3.9	1.15	<0.1	0.018	0.25	1.2
F7 14/11/05	Helene 4 Open Pit. Standing water in mine pit within low grade mineralisation.	<0.05	0.5	0.02	<0.005	<0.02	<0.005	0.50	1.4	2.40	2.9	0.040	0.15	3.0
F2 14/11/05	Jasmine 1 Open Pit. Standing water in mine pit. Red-brown colour.	<0.05	0.9	0.10	<0.005	<0.02	0.005	0.20	1.8	2.05	1.0	0.015	0.05	3.6
F3 14/11/05	Thelma 2 Open Pit. Clear standing water, dark grey Wildman Siltstone footwall. Blue colour recorded.	<0.05	1.1	0.16	0.0450	<0.02	0.035	0.35	4.1	9.00	2.2	0.510	<0.05	3.9
	Territory Iron Data - Dewatering 2005													
HELENE PIT 6/7 15/4/05	Helene Pit 6/7. Analysis undertaken during 2005 dewatering. Effectively totally Groundwater.	<0.05	1.0	<0.02	0.0001	0.0002	0.001	0.06	2.5	17.00	9.2	0.011	0.20	7.5
DAM 11 20/04/05	Helene 11 Dam. Analysis undertaken during 2005 dewatering. Effectively totally Groundwater.	<0.05	9.4	<0.02	0.0001	0.0003	0.001	0.44	1.6	1.80	13.0	0.069	0.15	15.6
DAM 9 21/04/05	Helene 9 Dam. Analysis unaffected by 2005 dewatering. Mainly rainwater run-off near surface + minor deep groundwater component.	<0.05	0.8	<0.02	0.0002	0.0002	0.001	0.30	1.0	0.20	1.0	0.031	0.10	2.6

Table 2 Geochemical Data – All Waters

ELEMENTS		Ni F	P F	Pb F	SO4	Sb F	Se F	Sr F	Si F	Th F	Tl F	U F	V F	Zn F
UNITS		mg/L	mg/L	µg/L	mg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	mg/L	mg/L
DETECTION		0.01	0.1	0.5	0.3	0.01	0.5	0.005	0.05	0.01	0.01	0.005	0.01	0.01
METHOD		W/108I	Various	W/100M	Calc	W/100M	W/100M	W/108I	W/108I	W100M	W/100M	W/100M	W/108I	W/108I
PROJECT INFORMATION:	Job No's: NTEL 05177 Waters; NTEL 05306 Waters; NTEL 04499 Dewatering 2005. Project: Frances Creek Iron Ore													
ANZECC DRINKING WATER GUIDELINES		0.02	None	10	500	None	10	None	None	None	None	20	None	(3)
ANZECC FRESH WATER TRIGGER VALUES		0.011 H	None	3.4 H		9 L	11 H	None	None	None	0.03 L	0.5 L	0.006 L	0.008 H
ANZECC LIVESTOCK TRIGGER VALUES		1	None	100	1000	None	20	None	None	None	None	200	None	20
IDENTIFICATION	SHORT DESCRIPTION													
	Rainfall run-off Water													
F1 14/11/05	Surface pond. Pristine completely undisturbed area, early wet season surface run-off water.	<0.01	<0.1	7.00	1.5	0.10	0.4	0.005	14.7	nd	0.09	0.76	0.02	0.030
F6 14/11/05	Helene 4 Dam. Drains Wildman Siltstone and (mainly) Mundogie Sandstone. Regional background.	<0.01	<0.1	0.29	0.6	0.15	0.2	0.005	3.7	nd	0.02	0.05	<0.01	<0.005
F5 14/11/05	Surface Pond. Upstream from F4, early wet season run-off from non-mineralised (Iron) Wildman Siltstone.	0.05	<0.1	0.22	105	<0.05	0.2	0.055	7.0	nd	0.02	0.03	<0.01	0.195
F4 14/11/05	Surface pond. Helene Tailings Area, early wet season run-off from mineralised area.	<0.01	<0.1	0.53	18.0	0.20	0.4	0.015	6.1	nd	0.02	0.17	<0.01	0.030
	Stream Channel and Standing Waters - basically unmineralised													
M2 13/12/05	Waterfall Gully, Helene Area. Standing water in Waterfall Gully. Unmineralised Wildman Siltstone catchment.	0.00111	0.003	0.96	0.4	0.1	0.2	0.002	4.8	0.28	<0.01	0.133	0.0018	0.004
M3 13/12/05	Frances Creek. Non mineralised catchment, drains Mundogie Fm. Greyish water.	0.00049	<0.1	0.52	1.4	<0.05	<0.2	0.004	3.0	0.10	<0.01	0.059	0.0006	0.002
M6 13/12/05	Central Frances Creek. Water hole in Frances Ck, no flow, but creek is flowing further upstream. Dominantly unmineralised.	0.00176	<0.002	0.35	1.4	<0.05	<0.2	0.008	0.4	0.08	<0.01	0.085	0.0010	0.002
M5 14/12/05	Ochre Hill North. Wide swamp across road, little flow but large water body. Unmineralised catchment area.	0.00217	0.08	0.32	0.8	<0.05	<0.2	0.005	2.0	0.12	0.03	0.112	0.0017	0.005
	Stream Channel and Standing Water - mineralised													
M7 14/12/05	Jasmine. Creek across road just before Jasmine. Diversion around mine disturbance. Some mineralised Wildman Siltstone catchment.	0.00061	<0.002	0.2	4.9	<0.05	<0.2	0.013	4.5	0.06	<0.01	0.066	0.0005	0.001
M8 14/12/05	Southern Frances Creek. Frances Creek, upstream of ford, red colour, flowing. Equal proportions mineralised and unmineralised	0.00144	0.002	0.09	20.2	<0.05	0.8	0.022	3.5	0.05	<0.01	0.074	0.0007	0.002
M4 13/12/05	Tributary. Mineralised catchment downstream of Helene 11 Dam. Drains old stockpiles. Flowing, slight greyish coloured water.	0.00148	<0.1	0.03	172.0	<0.05	4.8	0.100	4.4	0.02	<0.01	0.659	0.0004	0.000
	Open Pit Groundwater plus Rainwater.													
M1 13/12/05	Stagnant Stockpile Pool. Pool within old ore stockpile. Possibly largely rainwater. Bright red colour but may be reflecting soil colour.	0.00406	0.028	0.3	0.9	0.05	<0.2	0.004	0.6	0.06	0.02	0.248	0.5000	0.006
F7 14/11/05	Helene 4 Open Pit. Standing water in mine pit within low grade mineralisation.	<0.01	<0.1	0.21	0.3	0.15	<0.2	<0.005	5.7	nd	0.01	0.13	<0.01	0.015
F2 14/11/05	Jasmine 1 Open Pit. Standing water in mine pit. Red-brown colour.	<0.01	<0.1	0.20	3.6	0.20	<0.2	<0.005	10.6	nd	0.01	0.03	<0.01	0.010
F3 14/11/05	Thelma 2 Open Pit. Clear standing water, dark grey Wildman Siltstone footwall. Blue colour recorded.	0.11	<0.1	0.33	75.0	<0.05	0.4	0.010	14.2	nd	0.47	3.11	<0.01	0.110
	Territory Iron Data - Dewatering 2005													
HELENE PIT 6/7 15/4/05	Helene Pit 6/7. Analysis undertaken during 2005 dewatering. Effectively totally Groundwater.	0.00177	0.01	0.06	1.2	<0.05	<0.2	0.005	8	nd	<0.01	0.05	0.0005	0.007
DAM 11 20/04/05	Helene 11 Dam. Analysis undertaken during 2005 dewatering. Effectively totally Groundwater.	0.00132	0.00001	0.19	12.6	<0.05	0.2	0.030	9	nd	<0.01	0.06	0.0002	0.010
DAM 9 21/04/05	Helene 9 Dam. Analysis unaffected by 2005 dewatering. Mainly rainwater run-off near surface + minor deep groundwater component.	0.00036	5E-06	0.05	0.4	<0.05	<0.2	0.006	9.2	nd	0.01	0.01	0.0002	0.001

Table 2 Geochemical Data – All Waters – Page 4

50 (250)	Guideline Health Value in units defined. Value in brackets is aesthetic, not a health value.
0.0034 H, M, L	Value in units shown. High, Moderate and Low reliability Trigger Values for metals and radicals. These are largely based on non-arid area data and do not take into account geographic conditions. They are also commonly based on organisms not endemic to the Frances Creek locality. For arid areas many (most) of these trigger values are probably inappropriate.
ECL	Environmental Concern Level. Insufficient data to define trigger values. Warrants investigation for cause and effects.
	Values that exceed Guideline or Freshwater Trigger values, but not considered anomalous in the Frances Creek environmental setting.
	Values considered possibly Geochemically and/or Environmentally anomalous for the Frances Creek environmental setting.

4.2.1 Rainfall Run-off Water

The Helene 4 Dam is situated to the east of the Helene iron mineralisation and the catchment includes the lower un-mineralised portion of the Wildman Siltstone, the underlying Mundogie Sandstone and with some contribution from the overlying Cretaceous Petrel Formation. It will be subject to some evaporation during the dry season. It is an ideal “background” sample for comparative purposes with other water types. The Helene 9 Dam could also be used, but is inferior as it drains only Wildman Formation and Zamu Dolerite.

Apart from the Helene 4 Dam, the other three samples are immediate rainfall run-off, likely to dissolve transpiration salts formed by capillary rise to the soil surface.

Sample F1 is from a pristine area northerly from the Ochre Hill minesite. It is positioned on footwall Wildman Siltstone, but may have some contribution from the Mundogie Sandstone. This sample has circum-neutral pH, significantly enhanced soluble aluminium, beryllium, cobalt, copper, soluble iron, lead, thallium, uranium, vanadium and zinc when compared against Fresh Water Trigger Values. The lead value is extremely anomalous for the area and with the enhanced copper, zinc and thallium values suggests a chalcophile sulphide source in the lower Wildman Siltstone. The enhanced beryllium probably reflects a granitoid source for the arkosic Mundogie Sandstone. This sample gives a measure of the naturally occurring toxicants in the area.

Samples F4, F5. These are representative of run-off from mineralised (F4) and un-mineralised (F5) Wildman Siltstone, respectively. The (F5) un-mineralised catchment apart from minor input from embankments of the old Helene 6/7 waste rock dumps, has an acidic pH, significantly enhanced beryllium, cobalt, soluble iron, nickel and particularly zinc when compared against Fresh Water Trigger Values, plus relatively high sulphate. The cobalt, nickel and sulphate contents suggest an iron sulphide source in the Wildman Siltstone. However, enhanced sodium and chloride (three to four times background) suggest that the sample area for sample F5 (Helene 6 Dam) may have been an evaporation area in the dry season. Beryllium is *ca.* twenty times the Environmental Concern Level (ECL) in sample F5.

The F4 mineralised catchment sample (from a surface pond on the old tailings storage facility surface) has neutral pH and is not anomalous apart from a trace of zinc. These samples give a measure of the naturally occurring toxicants in the area.

Helene 4 Dam has circum-neutral pH and no elements exceed Fresh Water Trigger Values or ANZECC Drinking Water Guideline Values. This is the regional background sample.

4.2.2 Stream Channel flow and Pools from Un-mineralised Catchments

Sample M2. Waterfall gully – Helene Area. Weakly acidic pH 5.7 with slightly enhanced soluble aluminium and reduced iron when compared against Fresh Water Trigger Values. Trace of arsenic present. There is insufficient sulphate for the pH control to come from sulphuric acid. The acidity has to be derived from organic acids. No likely environmental problems.

Sample M3 Frances Creek. Very weakly acidic pH 6.0. On axis of main anticline, sourced 100% from Mundogie Sandstone. Has very slightly enhanced aluminium and reduced iron.

Sulphate content too low for sulphuric acid to be the cause of the acidity. No likely environmental problems.

Sample M6 Waterhole in bed of Frances Creek. Neutral pH. Positioned ca. 900 metres north of Thelma 1 Pit in alluvium overlying upper Wildman Siltstone. Very slightly enhanced aluminium and iron compared against Fresh Water Trigger Values. No likely environmental problems.

Sample M5 Ochre Hill North Large water body, little flow. Slightly acidic, pH 6.1. Has very slightly enhanced aluminium and reduced iron compared against Fresh Water Trigger Values. Sulphate content too low for sulphuric acid to be the cause of the acidity. No likely environmental problems.

4.2.3 Stream Channel flow and Pools from Mineralised Catchments.

Sample M7 Jasmine Area. Creek across road just west of Jasmine. Slightly acidic, pH 6.4. No enhanced elements but trace of reduced iron. Sulphate content is almost sufficient to be the cause of the acidity. No likely environmental problems.

Sample M8 Southern Frances Creek. Upstream of Ford. Neutral pH. Red colour. No enhanced elements. No likely environmental problems.

Sample M4 Frances Creek Downstream of Main Dam. Alkaline pH 7.5. Flowing grey water draining mineralisation; high in nitrates and highest in both calcium and sulphate. Exceeds Uranium Trigger Value (0.66 vs 0.50 micrograms per litre). Otherwise no toxicants. No likely environmental problems.

4.2.4 Open Pit Groundwaters plus Rainwater Accumulations.

Sample M1 Stagnant Iron Ore Stockpile Pool. Acidic pH 5.9. Red colour, shallow water. Has slightly enhanced reduced iron but no toxicants. Extremely low chloride and sodium indicate the water is totally direct rainfall run-off. No likely environmental problems.

Sample F7 Helene 4 Open Pit. Water body within Low Grade Ore. Alkaline pH 7.4. Slightly enhanced soluble aluminium and reduced iron, and traces of lead (0.21 micrograms per litre, antimony (0.15 micrograms per litre) and zinc (15 milligrams per litre). No likely environmental problems.

Sample F2 Jasmine 1 Open Pit. Water body within Low Grade Ore. Neutral pH 6.9. Red-brown colour. Slightly enhanced soluble aluminium and reduced iron, and traces of copper (5 milligrams per litre), lead (0.20 micrograms per litre), antimony (0.20 micrograms per litre) and zinc (10 milligrams per litre). Environmental problems unlikely. There are no plans to undertake further mining at this site, but in the event of future mining, minor acidification appears likely and will need to be monitored.

Sample F3 Thelma 2 Open Pit. Water body with exposed carbonaceous siltstone beneath the water level. Acidic pH 3.5. Anomalous fluoride (0.4 milligrams per litre), enhanced aluminium and reduced iron content, high beryllium (1.65 micrograms per litre, 12.5 times the ECL), enhanced cadmium though below trigger values, enhanced cobalt (45 micrograms per litre), low copper (35 micrograms per litre), enhanced nickel (110 micrograms per litre),

slightly enhanced lead (0.33 micrograms per litre), high thallium (0.47 micrograms per litre), high uranium (3.1 micrograms per litre) and moderate zinc (110 milligrams per litre). The sulphate content (75 milligrams per litre) is sufficient to supply most of the acid required for the pH value, taking into consideration the extremely low contents of calcium and magnesium, and the aluminium and silicon contents are sufficient to buffer that pH. Minor acid will be present as organic acids.

The overall analyses support a low content of reactive chalcophile element bearing sulphides in the wall rock of the pit. The solitary waste rock analysis had 0.103% S $\equiv$ 3.76 kilograms H₂SO₄/tonne or 0.20% pyrite, supporting this figure. The sulphate-Sulphur analysis supports total conversion to sulphuric acid as there is insufficient acid soluble calcium (<0.05 milligrams per kilogram) and magnesium (0.48 milligrams per kilogram) to convert the sulphuric acid to alkaline earth sulphates.

If the average iron sulphide content of the Thelma wastes exceeds 0.20%, there is potential for additional acidification. It appears unlikely, but the relatively high content of thallium, beryllium, uranium and zinc plus minor copper in this water and the high acid soluble bismuth content (435 milligram per kilogram) recorded in the ANCEX leachate from the waste, suggest that this specific pit water is unfit for human consumption, potentially dangerous to indigenous life forms and should not be used for any mining purpose.

There are currently no plans to undertake further mining at the Thelma 2 site.

4.2.5 Territory Iron Dewatering Program 2005

The Helene 6/7 pit and Helene 11 Dam were subjected to dewatering. The Helene 9 Dam was simultaneously sampled. No water from the dewatering program reached this dam. Helene 9 is therefore an additional rainwater run-off flow that has been subject to evaporation.

Helene 6/7 Pit Water. This can realistically be described as groundwater. The pit is relatively deep and the percentage of rainwater input small. The water is alkaline with pH 7.9 and contains minor (51 milligrams per litre calculated as CaCO₃) bicarbonate. Soluble aluminium is relatively high but reduced iron extremely low. Values for all toxicants are well below ANZECC drinking water guidelines and fresh water trigger values. Sulphate content (1.2 milligrams per litre) is exceptionally low. Overall the water does not differ significantly from rainwater and is entirely suitable for all mining purposes and if necessary, as drinking water.

Helene 11 Dam. A small shallow dam sourced largely from rainwater and which probably dries up during an extended dry period. The water is weakly alkaline with pH 7.4.

As expected from a dominantly rainwater source in this district, soluble aluminium is high with some reduced iron. Traces of arsenic, cobalt, selenium and zinc are recorded but all well within trigger value specification. Sodium and chloride are high for the district showing 20 times concentration above rainwater concentrations and the sulphate content appears to have also been concentrated (12.6 vs 1.2 milligrams per litre) compared with the nearby Helene 6/7 open pit. Overall the water appears to have a significant groundwater component, but is entirely suitable for all mining purposes. It is not recommended for use as drinking water.

Helene 9 Dam. A large dam sourced from Wildman siltstone plus minor Zamu dolerite in the upper catchment. This differs from the other tested waters in that there is no known iron-ore bearing rock within the catchment. The water has a weakly acidic reaction with pH 6.7. Like other rainfall sourced waters, it has significant dissolved aluminium, little reduced iron, extremely low sulphate and negligible contents of toxicants. The slight acidity is probably due to organic acids. Overall the water does not differ significantly from rainwater and is entirely suitable for all mining purposes and if necessary, as drinking water.

4.3 LEACHATE CHARACTERISATION

The proposed locations for the waste dumps are very closely adjacent to the open pits with a maximum height of 25 metres. Where possible wastes will be used to partially backfill pits to minimise the mining footprint. The waste dumps will therefore overlie low grade iron mineralisation, weathered carbonaceous siltstone bedrock, or dolerite bedrock. No samples of the weathered siltstone or dolerite have been tested, but a sample of carbonaceous siltstone waste from the Thelma 2 Pit has been tested and additional “total” analyses of weathered siltstones are available from the drill hole database. The wastes were also leached with 1.0M acid to test for weak acid soluble metals. Finally, six samples of surface soils and all eleven waste samples have been water leached for comparative soluble metals data.

The samples were analysed for:

- Water soluble radicals via analysis by instrumental and chemical methods for EC, pH, Nitrate and ammoniacal Nitrogen, HCO_3 , Chloride and Fluoride
- A 1:5 sample to water leach followed by micropore filtration using ICP-OES and ICP-MS analysis, for Aluminium, Arsenic, Boron, Barium, Bismuth, Calcium, Cadmium, Cobalt, Copper, Iron, Potassium, Magnesium, Manganese, Molybdenum, Sodium, Lead, Phosphorous, Sulphur, Selenium, Silicon, Thallium, Thorium, Uranium, Vanadium and Zinc.
- An analysis for weak acid soluble compounds via a 25:1 excess of simmering dilute HCl leach adjusted to pH = 1.5 for two hours, followed by micropore filtration and analysis using ICP-OES and ICP-MS for the same elements as above.
- Sulphate-sulphur.

4.3.1 Total’ Analysis Data

Analytical data using a combination of X-Ray Fluorescence (XRF) and a hydrofluoric – nitric – hydrochloric – perchloric acid digest have been undertaken by Territory Iron on eight of the waste samples. XRF analysis has been undertaken on one of the remaining samples. No ‘total’ data is available on the remaining samples. ‘Total’ analyses are presented in Table 3.

This data indicates anomalous arsenic, molybdenum, nickel, antimony and uranium with marginally anomalous mercury, lead, thorium and zinc when compared with average shale. Excluding the uranium and thorium, the other elements are all typically chalcophile (sulphide – related) elements. Sulphur and manganese values are all extremely low. There is a clear suggestion in the data that the chalcophile metal contents show a regional increase to the north.

Table 3: 'Total' Analyses

ELEMENTS	Al ₂ O ₃	As	Ba	Bi	CaO	Co	Cu	Fe	Hg	K ₂ O	MgO	Mn
UNITS	%	mg/Kg	mg/Kg	mg/Kg	%	mg/Kg	mg/Kg	%	µg/Kg	%	%	%
DETECTION		1	1	0.1	0.01	1	1	0.01	10	0.01	0.01	0.01
METHOD	XRF	HF-HClO ₄ -HCl-HNO ₃	HF-HClO ₄ -HCl-HNO ₃	HF-HClO ₄ -HCl-HNO ₃	XRF	HF-HClO ₄ -HCl-HNO ₃	HF-HClO ₄ -HCl-HNO ₃	XRF	HCl-HNO ₃	XRF	XRF	XRF
FRANCES CREEK SURFACE WATER	8.6	1.75	0.02	<0.5	0.002	0.01	0.01	0.3	<0.02	0.00	5	0.11
WORLD AVERAGE SHALE	--	15	700	0.18	--	50	50	--	0.5		--	850
SAMPLE NUMBERS												
FC 01 Ochre Hill; OHRC104, 09-14m. IW	8.3	36	278	0.38	0.01	8	18	40.5	10	2.42	0.65	0.02
FC 02 Ochre Hill; OHRC109, 20-27m. FW	2.8	48	646	0.13	<0.01	175	65	13.5	23	0.81	0.22	0.01
FC 03 Helene 5; FCRC054, 38-40m. FW	8.8	610	250	0.10	0.03	7	26	37.1	<10	2.06	0.60	0.04
FC 04 Helene 5; FCRC112, 19-24m. IW	8.9	149	269	1.32	0.08	9	11	38.7	<10	2.40	0.66	0.03
FC 05 Helene 6/7; HERC010, 37-38m. IW	8.9	115	236	<0.1	0.03	8	8	42.4	<10	2.03	0.91	0.02
FC 06 Helene 6/7; HERC018, 09-11m. HW	11.6	122	291	0.05	0.02	7	7	42.3	<10	1.70	0.46	0.02
FC 07 Jasmine East; JERC008, 26-30m. ORE	6.0	117	303	0.40	0.02	17	50	59.6	<10	1.64	0.46	0.12
FC 08 Jasmine East; JERC006, 35-39m. IW	11.7	na	na	na	0.03	na	na	24.2	na	2.49	0.66	<0.01
FC 09 Thelma-Rosemary, TRRC020, 06-08m. FW	13.4	104	295	0.45	<0.01	6	85	9.0	<10	3.08	<0.01	<0.01
T2 Thelma 2 Pit - Carbonaceous Siltstone Waste	na	na	na	na	na	na	na	na	na	na	na	na
TRK Thelma-Rosemary, Cretaceous Overburden	na	na	na	na	na	na	na	na	na	na	na	na

ELEMENTS	Mo	Ni	P	Pb	S	Sb	SiO ₂	Th	TiO ₂	U	V	Zn
UNITS	mg/Kg	mg/Kg	mg/Kg	mg/Kg	%	mg/Kg	%	mg/Kg	%	mg/Kg	mg/Kg	mg/Kg
DETECTION	0.1	1	10	2	0.001	0.1	0.01	0.01	0.01	0.01	0.05	1
METHOD	HF-HClO ₄ - HCl-HNO ₃	HF-HClO ₄ - HCl-HNO ₃	HF-HClO ₄ - HCl-HNO ₃	HF-HClO ₄ - HCl-HNO ₃	HF-HClO ₄ - HCl-HNO ₃	HF-HClO ₄ - HCl-HNO ₃	XRF	HF-HClO ₄ - HCl-HNO ₃	XRF	HF-HClO ₄ - HCl-HNO ₃	HF-HClO ₄ - HCl-HNO ₃	HF-HClO ₄ - HCl-HNO ₃
FRANCES CREEK SURFACE WATER	0.13	0.02	0.003	0.17	5.17	0.2	0.01	0.01	<0.00002	0.10	0.0002	0.03
WORLD AVERAGE SHALE	3	70	--	20	--	1.0	--	12	4600	4	130	160
SAMPLE NUMBERS												
FC 01 Ochre Hill; OHRC104, 09-14m. IW	6.2	146	0.03	19	0.003	5.4	28.5	8.0	0.32	13.2	114.8	34.2
FC 02 Ochre Hill; OHRC109, 20-27m. FW	6.2	217	0.01	19	0.001	6.5	9.5	8.4	0.11	25.1	148.7	87.3
FC 03 Helene 5; FCRC054, 38-40m. FW	9.8	69	0.17	37	0.008	12.4	32.0	10.3	0.36	16.1	126.0	181.0
FC 04 Helene 5; FCRC112, 19-24m. IW	6.2	67	0.06	13	0.009	7.8	29.9	9.6	0.36	9.5	131.0	145.5
FC 05 Helene 6/7; HERC010, 37-38m. IW	12.0	83	0.05	13	0.001	10.6	24.8	10.2	0.33	9.7	138.0	167.0
FC 06 Helene 6/7; HERC018, 09-11m. HW	10.8	105	0.07	20	0.001	9.8	21.1	12.1	0.49	16.1	114.0	181.0
FC 07 Jasmine East; JERC008, 26-30m. ORE	29.0	326	0.07	38	0.009	13.4	18.9	6.7	0.26	26.3	70.0	135.5
FC 08 Jasmine East, JERC006, 35-39m. IW	na	na	0.05	na	0.012	na	46.9	na	0.42	na	na	na
FC 09 Thelma-Rosemary, TRRC020, 06-08m. FW	5.3	73	0.08	53	0.013	5.6	64.8	14.4	0.51	9.2	164.0	149.5
T2 Thelma 2 Pit - Carbonaceous Siltstone Waste	na	na	na	na	na	na	na	na	na	na	na	na
TRK Thelma-Rosemary, Cretaceous Overburden	na	na	na	na	na	na	na	na	na	na	na	na
		Anomalous values relative to Guidelines or Trigger Values.							na	Not analysed		
	ORE	Marginal grade ore. Interval includes two metres analysing less than 60% Fe.										
	HW, IW, FW	HW = Hanging Wall; IW = Internal waste, possibly infolded HW; FW = Footwall waste.										

4.3.2 'Weak Acid' pH = 1.5 Analysis Data

The Acid Neutralising Capacity (ANC) determination was undertaken with two hours simmering at 90°C in 1.0 molar hydrochloric acid. This is a weakly oxidising environment comparable with, but an order of magnitude more acidic than the likely situation in waste rock dumps. The digest effectively dissolves all carbonate and oxy-hydroxy minerals, extracts all adsorbed metals from manganese hydroxides and extracts most adsorbed metals from clay minerals and non-crystalline iron oxides. The digest does not extract significant metals from crystalline iron oxides, hematite and magnetite. The effective pH of the digestion is pH 1.5, a lower figure than ever likely to occur in the waste rock dumps.

The extract from this determination (ANCEx) has been analysed for the same metals as the water digests, and includes all metals analysed by the 'total' digest. Results are presented in Table 4. These indicate that traces of copper, nickel, lead, thorium, thallium, uranium and zinc are extracted with higher barium, cobalt and copper extracted at Ochre Hill / Jasmine and higher zinc at Helene. Moderate values of aluminium and iron indicate solubilisation of a minor content of sesquioxide minerals.

Overall, this digest indicates there is very little soluble material other than some sesquioxide minerals. The quantities of soluble chalcophile elements are not of environmental significance.

Table 4 Weak Acid ANCEX Digestion Results at pH = 1.5

ELEMENTS	Al	As	B	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	Mg	Mn
UNITS	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
DETECTION	1	1	1	1	0.1	0.01	1	0.1	1	1	1	1	1	1
METHOD	ANCEX/ OES	ANCEX/ MS	ANCEX/ OES	ANCEX/ OES	ANCEX/ MS	ANCEX/ MS	ANCEX/ OES	ANCEX/ MS	ANCEX/ OES	ANCEX/ OES	ANCEX/ OES	ANCEX/ OES	ANCEX/ OES	ANCEX/ OES
COMMENTS:	282.0/0511033 (23/01/2006) CLIENT O/N: Tron 01 1/1													
ANZECC DRINKING WATER GUIDELINES	0.2	0.007	4	0.7	None	None		2	None	0.05	2	0.3	None	0.1
ANZECC STOCK WATER TRIGGER VALUES	5	500	5	None	None	None	1000	10	1	1	0.5	None	None	None
FRANCES CREEK AVERAGE SURFACE	8.6	1.75	0.04	0.02	0.28	<0.5	2.3	0.05	0.01	0.23	0.01	0.3	5	0.11
WORLD AVERAGE SHALE	--	15	100	700	3	0.18	--	0.2	50	100	50	--	--	850
SAMPLE NUMBERS														
FC 01 Ochre Hill; OHRC104, 09-14m. IW	1870	<1	3	27	0.1	<0.1	38	<0.1	<1	3	1	292	193	49
FC 02 Ochre Hill; OHRC109, 20-27m. IW	2353	<1	3	57	0.3	<0.1	55	<0.1	18	2	7	253	195	333
FC 03 Helene 5; FCRC054, 38-40m. FW	1001	<1	1	12	0.2	<0.1	38	<0.1	<1	1	2	350	62	75
FC 04 Helene 5; FCRC112, 19-24m. IW	1047	<1	4	15	0.1	<0.1	240	<0.1	<1	1	1	250	126	101
FC 05 Helene 6/7; HERC010, 37-38m. IW	485	<1	<1	7	0.2	<0.1	56	<0.1	<1	<1	1	231	167	22
FC 06 Helene 6/7; HERC018, 09-11m. HW	569	<1	<1	4	0.2	<0.1	44	<0.1	<1	<1	<1	200	100	33
FC 07 Jasmine East; JERC008, 26-30m. ORE	360	<1	<1	32	<0.1	<0.1	34	<0.1	2	2	4	299	34	269
FC 08 Jasmine East; JERC006, 35-39m. IW	875	<1	<1	6	<0.1	<0.1	47	<0.1	<1	2	1	604	45	10
FC 09 Thelma-Rosemary, TRRC020, 06-08m. FW	593	<1	<1	4	<0.1	<0.1	17	<0.1	<1	9	1	698	27	3
T2 Thelma 2 Pit - Carbonaceous Siltstone Waste	1809	<1	2	17	<0.1	<0.1	28	<0.1	<1	<1	2	607	104	5
TRK Thelma-Rosemary, Cretaceous Overburden	2418	<1	<1	12	<0.1	<0.1	104	<0.1	1	2	6	359	126	45

ELEMENTS	Mo	Na	Ni	P	Pb	S	Sb	Se	Si	Th	Tl	U	V	Zn
UNITS	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
DETECTION	0.1	10	1	10	2	10	0.05	2	5	0.01	0.02	0.01	0.05	1
METHOD	ANCEX/ MS	ANCEX/ OES	ANCEX/ OES	ANCEX/ OES	ANCEX/ MS	ANCEX/ OES	ANCEX/ MS	ANCEX/ MS	ANCEX/ OES	ANCEX/ MS	ANCEX/ MS	ANCEX/ MS	ANCEX/ OES	ANCEX/ OES
COMMENTS:														
ANZECC DRINKING WATER GUIDELINES	0.05	(180)	0.02	None	0.01	--	None	0.01	None	None	None	0.02	None	(3)
ANZECC STOCK WATER TRIGGER VALUES	0.15	None	1	None	0.1	--	None	0.02	None	None	None	0.2	None	20
FRANCES CREEK AVERAGE SURFACE WATER	0.13	6	0.02	0.003	0.17	5.17	0.18	0.10	0.01	0.01	<0.01	0.10	0.0002	0.03
WORLD AVERAGE SHALE	3	--	70	--	20	--	1	0.6	--	12	0.3	4	130	160
SAMPLE NUMBERS														
FC 01 Ochre Hill; OHRC104, 09-14m. IW	<0.1	57	2	13	<2	<10	<0.05	<2	1230	0.16	0.04	0.85	<0.05	3
FC 02 Ochre Hill; OHRC109, 20-27m. IW	<0.1	28	11	<10	<2	<10	<0.05	<2	1465	0.03	0.14	3.72	<0.05	6
FC 03 Helene 5; FCRC054, 38-40m. FW	<0.1	26	2	<10	<2	<10	<0.05	<2	742	0.04	<0.02	0.74	<0.05	7
FC 04 Helene 5; FCRC112, 19-24m. IW	<0.1	24	3	<10	<2	<10	<0.05	<2	732	0.04	0.03	0.91	0.09	5
FC 05 Helene 6/7; HERC010, 37-38m. IW	<0.1	20	6	<10	<2	<10	<0.05	<2	359	0.04	<0.02	0.62	0.20	39
FC 06 Helene 6/7; HERC018, 09-11m. HW	<0.1	22	3	<10	<2	<10	<0.05	<2	363	0.02	<0.02	1.39	0.21	31
FC 07 Jasmine East; JERC008, 26-30m. ORE	<0.1	26	1	<10	<2	<10	<0.05	<2	302	0.06	0.05	1.23	<0.05	4
FC 08 Jasmine East; JERC006, 35-39m. IW	<0.1	13	<1	<10	2	<10	<0.05	<2	445	0.03	<0.02	0.62	0.12	1
FC 09 Thelma-Rosemary, TRRC020, 06-08m. FW	<0.1	12	2	<10	3	<10	<0.05	<2	396	0.04	<0.02	0.27	0.49	3
T2 Thelma 2 Pit - Carbonaceous Siltstone Waste	<0.1	31	2	<10	<2	435	<0.05	<2	1060	0.03	0.03	0.55	0.48	3
TRK Thelma-Rosemary, Cretaceous Overburden	<0.1	21	2	<10	3	<10	<0.05	<2	1315	<0.01	<0.02	0.70	0.14	5
	Anomalous values relative to Guidelines or Trigger Values.													
	ORE Marginal grade ore. Interval includes two metres analysing less than 60% Fe.													
	HW = Hanging Wall; IW = Internal waste, possibly infolded HW; FW = Footwall waste.													

4.3.3 Water Digests

Soil and waste rock samples have been analysed following a 1:5 sample to demineralised water ratio, 15-16 hour oxygenated bottle roll procedure which simulates the amount of leaching likely over an extended period of years. These were conducted in compliance with Australian Standard Leach Procedure 4439.1 Class 1.

4.3.3.1 Time Equivalence and Composition of Sample Leachates

The sample water leach was undertaken in a nominal 15 – 16 hour 1:5 sample / water bottle roll with head air space $\equiv$ >10 times naturally dissolved oxygen. This provided maximum oxygen accessibility to mineral fragments in an abrasive environment that eliminates surface “armouring”. The water to sample ratio exceeded 20 times average soil or waste rock saturation capacity.

Greater than 80% of fragments in crushed sample material have an average grainsize less than 0.005 centimetres (50 microns) compared with waste rock dump material, which has a high percentage of fragments exceeding 1.0 – 10 centimetres and an average size of nominally 1.0 centimetre. The relative surface area exposed to leaching of soil particles in the leach procedure compared to the equivalent situation in a waste rock dump exceeds 2,500 times, more likely 10,000 – 20,000 times. Based on 50 rainfall saturations each of nominally 20-25 millilitres of a waste rock dump per year, with 100% saturation (~30% porosity) averaging 16 to 18 hours per saturation, one soil leach procedure is theoretically equivalent to 50 to 200 years of waste rock dump weathering. These figures assume 1000-1,250 millimetres per year rainfall, equivalent to the historical rainfall records for Pine Creek.

Excluding very easily dissolved substances such as chlorides, nitrates and sulphates, the water leach thus estimates the maximum metals toxicants likely to leach from waste rock over a minimum time frame of nominally 50 to 200 years (say conservatively 20 to 25 years) at saturation capacity with oxygenated rain water. Since proper waste rock management procedures should minimise ingress of rainwater to less than 15% of total precipitation, the water leach values are estimated to indicate 6 to 600 times the worst case short term scenario values for waste rock dump leachate.

From experience, a flush of from 40% to 90% (dependent on substance) of the very easily dissolved substances is likely to occur on the first saturation occasion due to the presence of highly oxidised material and initial high positive oxygen fugacity (Eh saturation). After the first flush, further dissolved substance release will be dependent on positive oxygen fugacity (if any) within the waste rock dumps.

4.3.3.2 Composition of Leachates

For samples FC-01, FC-02 from Ochre Hill, sample leachates have noticeable soluble content of arsenic, cadmium, thallium and uranium and Helene 6/7 has some soluble arsenic, cadmium and traces of uranium. Other soluble metals include manganese, nickel and antimony, but these apart from nickel are below ANZECC fresh water ecosystem protection trigger value guidelines. Whilst the arsenic and nickel values are significant, arsenic being

more than double the drinking water guidelines and ANZECC fresh water ecosystem protection trigger values, only minor dilution is required to lower the leachates below statutory values. No effect is likely on groundwater.

For the Frances Creek iron mines of the 1966 – 1974 period, modern waste rock management procedures were not in use. Considering the 30 to 40 year period of weathering and substance solution since that time, which approximately corresponds to the conservative period nominated above, current pit water analyses are still well below the leachate analyses for all elements excluding selenium, lead, phosphorous and chromium. Whilst higher than the current pit water average analysis, the “high” trace elements represent:

- Selenium Less than 3% of the ANZECC drinking water guideline value.
- Lead Less than 0.6% of the ANZECC drinking water guideline value.
- Phosphorous Low. There is no set guideline value.
- Chromium Less than 0.35% of the ANZECC drinking water guideline value.
- Thallium No set ANZECC drinking water guideline value. Environmental Concern Level (ECL) for fresh waters is significantly exceeded. See discussion below.
- Copper Incorrect interpretation has previously been made for copper values for Thelma 2 Pit water. See discussion below.

Based on these figures, it is clear that the wastes leachates are extremely unlikely to affect the groundwater.

Values for uranium and other metals (excluding thallium) in leachates are well below statutory drinking water guidelines, but rare individual results are at or slightly exceed fresh water trigger values. Since the rate of metal leaching in the analytical procedure is orders of magnitude faster than in the natural state, no effect is likely on groundwater.

Thallium is anomalous, from 17 times to more than 100 times the fresh water Environmental Concern Level in Ochre Hill, Jasmine, Helene 5 and Thelma 2 Pit waste leachates. Other waste rock samples are recorded as below detection limit, but that detection limit is itself, 15 times the Environmental Concern Level value. Thus it appears probable that the area has a high anomalous background content of thallium, a factor previously recorded by the author in another Early Proterozoic location within this geographic region. There is a definite relationship to the uranium plus thorium contents and the total thallium values are similar to the amount of thallium that would form by radio-active decay from U + Th since the Early Proterozoic. Thus the problem is endemic and non-correctable.

There is no drinking water guideline value established for thallium. Thallium does occur in surface water in this district, though at lower values than those recorded in this report (Table 2). With the exception of water from the Thelma 2 Pit and the pristine drainage from the Mundogie Sandstone, all values are at, or below the Fresh Water Environmental Concern Level. Data in the ANZECC Guidelines for thallium toxicity does not include species endemic to the district. It is suggested that the thallium situation be reported to statutory authorities and that thallium be included in all further testwork and monitoring.

Copper in water from the Thelma 2 Pit. The leachate value determined in this investigation was less than 50µg/kg. In Thelma 2 Pit water, copper content was 35µg/L. In a previous determination by Australian Groundwater Technologies, the copper value determined was also 35µg/L. This is just 1.4% of the ANZECC Drinking Water Guideline, but like thallium, exceeds the Fresh Water ecosystem protection trigger value. This is insufficient copper to colour the water blue.

Taking into consideration the ‘total’ values (Table 3), the leachates (Table 5) indicate there is a greater content of soluble chalcophile elements in the Ochre Hill, Jasmine and Thelma-Rosemary areas compared with the Helene area and it is probable that protore and associated wastes in these areas will have a higher proportion of sulphides. When fresh waste is intersected below the natural water table, additional oxygen access to trace sulphides in the rocks may cause contaminant values to increase.

4.3.3.3 Effect of Waste Rock Dump Leachates on Groundwater

The contaminant metal values in the leachates are sufficiently low to indicate negligible effect on groundwater. In the case of arsenic, the leachates contained moderate amounts of soluble iron, indicating low oxygen content despite the vigorous agitation in the leach procedure. Some arsenic may be present as As^{3+} , in which case it will precipitate in an insoluble form along with the iron when the iron is oxidised. This is supported by all surface water and groundwater values where the highest values recorded are less than half the ANZECC Drinking Water Guideline and only 15% of the Fresh Water ecosystem protection trigger value (Table 2).

Some leachates have weakly acidic pH values. The pH of 4.9 in the leachate from the carbonaceous siltstone sample collected at Thelma Pit 2, where the highest thallium value is recorded, is also slightly acidic, but most of the sulphur appears to have already oxidised. However the adjacent pit water has even lower pH suggesting sulphides are present in the pit wall rocks. A low pH of 5.4 is recorded from near to surface oxidised siltstone at the nearby Thelma-Rosemary area where thallium is below the analytical detection limit. Both samples have insufficient residual non-sulphate sulphur to generate further sulphuric acid and both have sufficient carbon present for the acidic reaction to be sourced from organic acids.

Soils in this area have substantial organic carbon content with no neutralising carbonate mineral content. This results in a natural acidic pH reaction related to naturally occurring organic acids. The acidic pH bears no relationship to either acid – sulphate soils or acid rock drainage.

Table 5 1:5 Waste Rock Sample / Water Digest Results

ELEMENTS	EC	pH	N-NO ₃	HCO ₃	Cl	F	TDS	Al	As	B	Ba	Be
UNITS	µS/cm	NONE	mg/Kg	mg CaCO ₃ /kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	µg/kg	mg/Kg	mg/Kg	µg/kg
DETECTION	10	0.1	1	5	5	0.5	10	0.05	5	0.05	0.05	5
METHOD	W/MTR	W/MTR	W/COL	W/VOL	W/COL	W/SIE	CALC	W/OES	W/MS	W/OES	W/OES	W/MS
COMMENTS:	282.0/0511033 (23/01/2006) CLIENT O/N: Thron 01 1/1											
ANZECC DRINKING WATER GUIDELINES	--	6.5 - 8.5	50	None	(250)	1.5	(500)	(0.2)	7	4	0.7	None
ANZECC FRESH WATER TRIGGER VALUES			None	None	None	None	--	0.055 M	24 H	0.37 H	None	0.13 ECL
ANZECC LIVESTOCK TRIGGER VALUES			400	None	None	2	4000	5	500	5	None	None
FRANCES CREEK AVERAGE SURFACE WATER	110	7.4	nd	50	4.2	0.2	73	8.6	1.75	0.04	0.02	0.28
SAMPLE NUMBERS												
FC 01 Ochre Hill; OHRC104, 09-14m. IW	51	8.1	<1	61	25	<0.1	33	7.39	37	0.22	0.10	<5
FC 02 Ochre Hill; OHRC109, 20-27m. IW	57	7.7	<1	50	25	<0.1	37	2.81	27	0.42	0.15	<5
FC 03 Helene 5; FCRC054, 38-40m. FW	46	6.6	<1	35	14	<0.1	30	0.10	<5	0.30	<0.05	<5
FC 04 Helene 5; FCRC112, 19-24m. IW	84	7.5	<1	91	17	<0.1	55	0.29	<5	0.16	<0.05	<5
FC 05 Helene 6/7; HERC010, 37-38m. IW	36	7.6	<1	35	15	<0.1	23	1.77	11	0.17	<0.05	<5
FC 06 Helene 6/7; HERC018, 09-11m. HW	37	7.0	<1	35	13	<0.1	24	0.21	<5	0.20	<0.05	<5
FC 07 Jasmine East; JERC008, 26-30m. ORE	56	6.0	<1	36	17	<0.1	36	0.16	<5	0.21	<0.05	<5
FC 08 Jasmine East; JERC006, 35-39m. IW	35	6.4	<1	35	10	<0.1	23	0.29	<5	0.16	<0.05	<5
FC 09 Thelma-Rosemary, TRRC020, 06-08m. FW	23	5.4	<1	25	11	<0.1	15	0.27	<5	<0.05	<0.05	<5
T2 Thelma 2 Pit - Carbonaceous Siltstone Waste	291	4.9	<1	15	9	<0.1	189	0.76	<5	0.15	0.16	<5
TRK Thelma-Rosemary, Cretaceous Overburden	66	6.5	2	45	25	1	43	3.45	21	<0.05	<0.05	<5

ELEMENTS	Bi	Ca	Cd	Co	Cr	Cu	Fe	Mg	Mn	Mo	Na	Ni
UNITS	µg/kg	mg/Kg	µg/kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	µg/kg	mg/Kg	mg/Kg
DETECTION	0.3	0.05	1	0.05	0.05	0.05	0.05	0.05	0.05	3	0.5	0.05
METHOD	W/MS	W/OES	W/MS	W/OES	W/OES	W/OES	W/OES	W/OES	W/OES	W/MS	W/OES	W/OES
COMMENTS:												
ANZECC DRINKING WATER GUIDELINES	None	None	2	None	0.05	2	(0.3)	None	0.5	50	(180)	0.02
ANZECC FRESH WATER TRIGGER VALUES	0.7 ECL	None	0.2	0.0014 L	0.0033 L	0.0014 H	0.3 (Can)	None	1.7 M	3.4 L	None	0.011 H
ANZECC LIVESTOCK TRIGGER VALUES	None	1000	10	1	1	0.5	None	None	None	150	None	1
FRANCES CREEK AVERAGE SURFACE WATER	<0.5	2.3	0.05	0.01	0.23	0.01	0.3	5	0.11	0.13	6	0.02
SAMPLE NUMBERS												
FC 01 Ochre Hill; OHRC104, 09-14m. IW	0.5	5.66	<1	<0.05	<0.05	<0.05	3.07	0.80	0.11	11	25	0.05
FC 02 Ochre Hill; OHRC109, 20-27m. IW	<0.3	1.34	4	<0.05	<0.05	<0.05	5.57	0.24	0.75	8	14	0.06
FC 03 Helene 5; FCRC054, 38-40m. FW	<0.3	<0.05	<1	<0.05	<0.05	<0.05	0.17	0.15	<0.05	<3	10	<0.05
FC 04 Helene 5; FCRC112, 19-24m. IW	<0.3	6.33	<1	<0.05	<0.05	<0.05	0.17	3.38	0.08	4	5	<0.05
FC 05 Helene 6/7; HERC010, 37-38m. IW	<0.3	0.33	<1	<0.05	<0.05	<0.05	1.32	2.02	<0.05	3	9	<0.05
FC 06 Helene 6/7; HERC018, 09-11m. HW	<0.3	0.59	7	<0.05	<0.05	<0.05	0.07	3.83	<0.05	<3	12	<0.05
FC 07 Jasmine East; JERC008, 26-30m. ORE	<0.3	0.74	<1	<0.05	<0.05	<0.05	0.63	0.80	0.38	<3	10	<0.05
FC 08 Jasmine East; JERC006, 35-39m. IW	<0.3	0.11	<1	<0.05	<0.05	<0.05	0.12	0.16	<0.05	<3	4	<0.05
FC 09 Thelma-Rosemary, TRRC020, 06-08m. FW	<0.3	<0.05	<1	<0.05	<0.05	<0.05	<0.05	0.15	<0.05	<3	6	<0.05
T2 Thelma 2 Pit - Carbonaceous Siltstone Waste	<0.3	4.63	<1	<0.05	<0.05	<0.05	<0.05	17.42	0.71	<3	10	<0.05
TRK Thelma-Rosemary, Cretaceous Overburden	<0.3	5.65	<1	<0.05	<0.05	<0.05	1.14	2.15	0.11	<3	23	<0.05

Table 5 1:5 Waste Rock Sample / Water Digest Results

ELEMENTS		P	Pb	S	SO ₄	Sb	Se	Si	Th	Tl	U	V	Zn
UNITS		mg/Kg	µg/kg	mg/Kg	mg/Kg	µg/kg	mg/Kg	mg/Kg	µg/kg	µg/kg	µg/kg	mg/Kg	mg/Kg
DETECTION		0.5	0.03	0.5		0.5	0.03	0.3	0.3	0.5	0.3	0.05	0.05
METHOD		W/OES	W/MS	W/OES	CALC	W/MS	W/MS	W/OES	W/MS	W/MS	W/MS	W/OES	W/OES
COMMENTS:													
ANZECC DRINKING WATER GUIDELINES		None	10	--	(500)	None	10	None	None	None	20	None	(3)
ANZECC FRESH WATER TRIGGER VALUES		None	3.4 H	--	--	9 L	11 H	None	None	0.03 L*	0.5 L	0.006 L	0.008 H
ANZECC LIVESTOCK TRIGGER VALUES		None	100	--	1000	None	20	None	None	None	200	None	20
FRANCES CREEK AVERAGE SURFACE WATER		0.003	0.17	5.17	15.5	0.18	0.10	0.01	0.01	<0.01	0.10	0.0002	0.03
SAMPLE NUMBERS													
FC 01 Ochre Hill;	OHRC104, 09-14m. IW	0.6	0.04	6.8	20	2.8	<0.03	20	9.4	0.6	6.1	<0.05	0.42
FC 02 Ochre Hill;	OHRC109, 20-27m. IW	1.4	<0.03	9.4	28	2.4	<0.03	22	1.4	<0.5	4.8	<0.05	0.12
FC 03 Helene 5;	FCRC054, 38-40m. FW	<0.5	<0.03	3.1	9	<0.5	<0.03	15	<0.3	<0.5	<0.3	<0.05	<0.05
FC 04 Helene 5;	FCRC112, 19-24m. IW	<0.5	<0.03	16.0	48	<0.5	<0.03	8	<0.3	0.8	0.3	<0.05	<0.05
FC 05 Helene 6/7;	HERC010, 37-38m. IW	<0.5	<0.03	3.8	11	1.0	<0.03	9	2.7	<0.5	2.8	<0.05	0.06
FC 06 Helene 6/7;	HERC018, 09-11m. HW	<0.5	<0.03	3.0	9	0.7	<0.03	9	<0.3	<0.5	<0.3	<0.05	<0.05
FC 07 Jasmine East;	JERC008, 26-30m. ORE	<0.5	<0.03	9.0	27	<0.5	<0.03	11	<0.3	0.5	<0.3	<0.05	0.05
FC 08 Jasmine East;	JERC006, 35-39m. IW	<0.5	<0.03	3.6	11	<0.5	<0.03	14	<0.3	<0.5	<0.3	<0.05	<0.05
FC 09 Thelma-Rosemary;	TRRC020, 06-08m. FW	0.6	<0.03	2.6	8	<0.5	<0.03	13	<0.3	<0.5	<0.3	<0.05	<0.05
T2 Thelma 2 Pit - Carbonaceous Siltstone Waste		<0.5	<0.03	171.2	514	<0.5	<0.03	31	<0.3	3.5	<0.3	<0.05	<0.05
TRK Thelma-Rosemary, Cretaceous Overburden		<0.5	<0.03	12.1	36	0.6	<0.03	31	<0.3	<0.5	1.5	<0.05	0.07
			Anomalous values in the context of the Frances Creek area environmental situation.										
			Anomalous values relative to Guidelines or Trigger Values. Discussed in text.										
		ORE	Marginal grade ore. Interval includes two metres analysing less than 60% Fe.										
		HW, IW, FW	HW = Hanging Wall; IW = Internal waste, possibly infolded HW; FW = Footwall waste.										

4.4 SURFACE SOIL DATA

Six samples of surface soils were collected during a fauna and flora investigation and do not cover all soil types expected in the area. The samples were subjected to an ASLP 4439.1 Class 1 water leach as described in Section 4.3.3 and 4.3.3.1. Results are summarised in Table 6. The samples are:

- Sample FS1 Top of Jasmine Ridge. The sample has been collected in an area of Cretaceous arkosic sediment that stratigraphically overlies iron ore in the Thelma – Rosemary area and contributes to water run-off in the Helene 5, 6/7 and Jasmine areas. The sample has an acidic reaction with pH 5.1, moderate soluble aluminium and reduced iron, moderately high lead content (3.0 micrograms per kilogram), very low sulphate and minor (40 micrograms per kilogram) zinc but otherwise no toxicants. Most of the acidity comes from organic acids.
- Sample FS2 North of Ochre Hill. Situated on the iron ore formation within Wildman Siltstone. The sample has an acidic reaction with pH 5.3, moderate soluble aluminium and reduced iron, very low sulphate and minor (40 micrograms per kilogram) zinc but otherwise no toxicants. Most of the acidity comes from organic acids.
- Sample FS3 Wildman Siltstone Hanging Wall. A red-brown clayey soil collected near the inlet drain of the former tailings facility. The sample has an acidic reaction with pH 5.1, has no soluble aluminium or reduced iron, insufficient sulphate to support the acidity, a trace of lead well below guideline values and minor (40 micrograms per kilogram) zinc but otherwise no toxicants. The unusual chemistry suggests that this soil is either introduced or is developed over an unmapped occurrence of Zamu Dolerite.
- Sample FS4 Wildman Siltstone Footwall. A clay-rich soil which is bleached and white in depth, upstream from the former tailings facility. Moderately acidic with pH 4.6. Anomalous geochemistry with soluble aluminium, but no reduced iron, relatively high potassium and manganese, moderate (2.8 micrograms per kilogram) lead, relatively high sulphate (56 milligrams per kilogram), the highest soil uranium (0.7 micrograms per kilogram) and 200 micrograms per kilogram zinc. The sulphate value appears too low to support the relatively strong acidity and some acidity must come from organic acids.
- Sample FS5 Between Ochre Hill and Millers. Described as pristine, unaffected by human activity. Weakly acidic with pH 6.0. Contains soluble aluminium, 3.1 micrograms per kilogram of lead and a trace of zinc, otherwise no toxicants. The acidity comes from organic acids.
- Sample FS6 Undisturbed area Upslope from Helene 4 Waste Dump. On footwall Wildman Siltstone / Mundogie Sandstone contact zone. Weakly acidic with pH 6.0. Apart from minor soluble aluminium, is free of all toxicants. The acidity comes from organic acids.

Table 6 Leachate Results from Soil Samples

ELEMENTS	EC	pH	NO3 N	NH3 N	HCO3	Cl	F	TDS	Al F	As F	B F	Ba F	Be F
UNITS	µS/cm	units	mg/kg	mg/kg	mgCaCO3/L	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg	mg/kg	mg/kg	µg/kg
DETECTION	1	0.1	0.005	0.02	1	1	0.1	0.1	0.1	2	0.05	0.02	2
METHOD	EA	EA	FIA 4	FIA	EA	FIA 4	FISE P	TDS P	G905I	G905M	G905I	G905I	G905M
PROJECT INFORMATION:	Job No's: NTEL 05224 Soils. Project: Frances Creek Iron Ore												
ANZECC DRINKING WATER GUIDELINES	--	6.5 - 8.5	50	(50)	None	(250)	1.5	(500)	(0.2)	7	4	0.7	None
ANZECC FRESH WATER TRIGGER VALUES			None	None	None	None	None	--	0.055 M	24 H	0.37 H	None	0.13 ECL
ANZECC LIVESTOCK TRIGGER VALUES			400	(430)	None	None	2	4000	5	500	5	None	None
FRANCES CREEK AVERAGE GROUNDWATER	110	7.4	nd		50	4.2	0.2	73	8.6	1.75	0.04	0.02	0.28
SHORT DESCRIPTION													
FS1 14/11/05	<u>Top of Jasmin Ridge</u> - above the old pit and waste dumps. In Cretaceous overburden overlying Wildman Siltstone.	29	5.1	0.56	0.82	12	18.0	<0.5	400	0.7	<2	<0.05	<0.02
FS2 14/11/05	<u>North of Ochre Hill</u> - on ore zone and footwall. Some ironstone present. Clay soil overlying Wildman Siltstone.	46	5.3	8.80	<0.02	14	7.5	<0.5	250	0.9	<2	<0.05	<0.02
FS3 14/11/05	<u>Wildman Siltstone HW</u> . Dark red-brown clayey material near inlet drain of Tailings Dam area, non-mineralised.	37	5.1	3.64	0.06	8	14.5	<0.5	300	<0.1	<2	<0.05	0.04
FS4 14/11/05	<u>Wildman Siltstone FW</u> . Clay-rich soil upstream from old tailings area. Bleached and low in carbon at shallow depth.	200	4.6	1.10	10.8	<1	99.5	0.5	600	0.6	<2	<0.05	0.06
FS5 14/11/05	<u>Between Ochre Hill and Millers</u> . Pristine area not disturbed by human activity. Wildman Siltstone. West of road.	44	6.0	9.64	1.96	20	15.0	<0.5	150	6.0	<2	<0.05	0.02
FS6 14/11/05	<u>Helene 4 Waste Dump area</u> . Area up-slope from dump. Adjacent Wildman Siltstone / Mundogie Sandstone contact.	9	6.0	0.22	0.38	16	4.5	<0.5	100	0.6	2	<0.05	<0.02

ELEMENTS	Bi F	Ca F	Cd F	Co F	Cr F	Cu F	Fe-Sol	K F	Li F	Mg F	Mn F	Mo F	Na F
UNITS	µg/kg	mg/kg	µg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg	mg/kg	mg/kg	µg/kg	mg/kg
DETECTION	0.5	1	1	0.02	0.05	0.02	0.2	1	2	0.5	0.02	0.5	1
METHOD	G905M	G905I	G905M	G905I	G905I	G905I	G905I	G905I	G905M	G905I	G905I	G905M	G905I
PROJECT INFORMATION:	Job No's: NTEL 05224 Soils. Project: Frances Creek Iron Ore												
ANZECC DRINKING WATER GUIDELINES	None	None	2	None	0.05	2	(0.3)	None	None	None	0.5	50	(180)
ANZECC FRESH WATER TRIGGER VALUES	0.7 ECL	None	0.2	0.0014 L	0.0033 L	0.0014 H	0.3 (Can)	None	None	--	1.7 M	3.4 L	--
ANZECC LIVESTOCK TRIGGER VALUES	None	1000	10	1.0	1.0	0.5	None	None	None	None	150	None	None
FRANCES CREEK AVERAGE GROUNDWATER	<0.5	2.3	0.05	0.01	0.23	0.01	0.3			5	0.11	0.13	6
SHORT DESCRIPTION													
FS1 14/11/05	<u>Top of Jasmin Ridge</u> - above the old pit and waste dumps. In Cretaceous overburden overlying Wildman Siltstone.	<0.5	1.0	<1	<0.02	<0.05	<0.02	0.4	2.0	<2	0.5	0.04	<0.5
FS2 14/11/05	<u>North of Ochre Hill</u> - on ore zone and footwall. Some ironstone present. Clay soil overlying Wildman Siltstone.	<0.5	1.0	<1	<0.02	<0.05	<0.02	0.4	3.0	<2	1.5	0.10	<0.5
FS3 14/11/05	<u>Wildman Siltstone HW</u> . Dark red-brown clayey material near inlet drain of Tailings Dam area, non-mineralised.	<0.5	1.0	<1	<0.02	<0.05	<0.02	0.5	<2	1.5	0.02	<0.5	3.0
FS4 14/11/05	<u>Wildman Siltstone FW</u> . Clay-rich soil upstream from old tailings area. Bleached and low in carbon at shallow depth.	<0.5	2.5	<1	<0.02	<0.05	<0.02	<0.2	13.5	<2	6.0	0.48	<0.5
FS5 14/11/05	<u>Between Ochre Hill and Millers</u> . Pristine area not disturbed by human activity. Wildman Siltstone. West of road.	<0.5	0.5	<1	<0.02	<0.05	<0.02	1.6	2.5	2	0.5	0.06	<0.5
FS6 14/11/05	<u>Helene 4 Waste Dump area</u> . Area up-slope from dump. Adjacent Wildman Siltstone / Mundogie Sandstone contact.	<0.5	<0.5	<1	<0.02	<0.05	<0.02	0.4	1.0	<2	<0.5	<0.02	<0.5

Table 6 Leachate Results from Soil Sample

ELEMENTS	Ni F	P F	Pb F	S F	SO4	Sb F	Se F	Sr F	Si F	Tl F	U F	V F	Zn F
UNITS	mg/kg	mg/kg	µg/kg	mg/kg	mg/kg	µg/kg	µg/kg	mg/kg	mg/kg	µg/kg	µg/kg	mg/kg	mg/kg
DETECTION	0.05	0.5	0.5	0.1	0.3	0.5	10	0.02	0.05	0.5	0.05	0.05	0.02
METHOD	G905I	G905I	G905M	G905I	Calc	G905M	G905M	G905I	G905I	G905M	G905M	G905I	G905I
PROJECT INFORMATION:													
ANZECC DRINKING WATER GUIDELINES	0.02	None	10	--	500	None	10	None	None	None	20	None	(3)
ANZECC FRESH WATER TRIGGER VALUES	0.011 H	None	3.4 H	--	--	9 L	11 H	None	None	0.03 L	0.5 L	0.006 L	0.008 H
ANZECC LIVESTOCK TRIGGER VALUES	1	None	100	--	1000	None	20	None	None	None	200	None	20
FRANCES CREEK AVERAGE GROUNDWATER	0.02	0.003	0.17	5.17	15.5	0.18	0.10	0.014	0.01	<0.01	0.10	0.0002	0.03
	SHORT DESCRIPTION												
FS1 14/11/05	<u>Top of Jasmin Ridge</u> - above the old pit and waste dumps. In Cretaceous overburden overlying Wildman Siltstone.												
	<0.05	<0.5	3.0	0.7	2.1	<0.5	<10	<0.02	1.5	<0.5	0.5	<0.05	0.04
FS2 14/11/05	<u>North of Ochre Hill</u> - on ore zone and footwall. Some ironstone present. Clay soil overlying Wildman Siltstone.												
	<0.05	<0.5	1.6	0.8	2.4	<0.5	<10	<0.02	1.5	<0.5	0.5	<0.05	0.04
FS3 14/11/05	<u>Wildman Siltstone HW</u> . Dark red-brown clayey material near inlet drain of Tailings Dam area, non-mineralised.												
	<0.05	<0.5	0.7	2.9	8.7	<0.5	<10	<0.02	1.5	<0.5	0.1	<0.05	0.04
FS4 14/11/05	<u>Wildman Siltstone FW</u> . Clay-rich soil upstream from old tailings area. Bleached and low in carbon at shallow depth.												
	<0.05	<0.5	2.8	18.6	56	<0.5	<10	0.04	1.0	<0.5	0.7	<0.05	0.20
FS5 14/11/05	<u>Between Ochre Hill and Millers</u> . Pristine area not disturbed by human activity. Wildman Siltstone. West of road.												
	<0.05	<0.5	3.1	2.1	6.3	<0.5	<10	<0.02	9.0	<0.5	0.3	<0.05	0.02
FS6 14/11/05	<u>Helene 4 Waste Dump area</u> . Area up-slope from dump. Adjacent Wildman Siltstone / Mundogie Sandstone contact.												
	<0.05	<0.5	0.5	0.5	1.5	<0.5	<10	<0.02	1.5	<0.5	0.2	<0.05	<0.02
50 (250) Guideline Health Value in units defined. Value in brackets is an aesthetic, not a health value.													
0.0034 Value in units shown. High, Moderate and Low reliability Trigger Values for metals / radicals.													
H, M, L Largely based on non-arid area data and do not take into account geographic conditions.													
ECL Environmental Concern Level. Insufficient data to define trigger values. Warrants investigation for cause and effects.													
Values that exceed Guideline or Freshwater Trigger values, but not considered anomalous in the Frances Creek environmental setting.													
Values considered possibly Geochemically and/or Environmentally anomalous in the Frances Creek setting.													

4.5 URANIUM AND THORIUM GEOCHEMISTRY

A batch of 131 samples plus duplicates and standards were analysed by Territory Iron for various trace elements including Uranium and Thorium. Where possible, waste samples for this investigation were selected from that batch of samples. Total value trace element data for the waste samples analysed in this investigation are included in Table 4.

A brief analysis of the uranium and thorium data was requested and low resolution view of the uranium radioactivity supplied. Since no additional analyses have been undertaken, the full data will not be presented in this report.

There is a generalised correlation between the main uranium anomaly and that portion of the siltstone unit that hosts the iron ore. This is logical as the same sedimentary facies conditions are suitable for precipitation of both iron-rich and uranium-rich protore. There are sufficient differences to indicate that the two metal types were not subject to synchronous deposition. Thus the iron ore is not a guide to uranium mineralisation or vice versa.

4.5.1 Statistical Data

A total of 131 samples were analysed. For uranium, values in iron ore range from 5.3 parts per million to 74.8 parts per million with a median of 12.3 parts per million. In waste rock samples, the values were 6.2 parts per million to 65.2 parts per million with a median of 13.9 parts per million. Thorium values in iron ore range from 0.1 parts per million to 4.8 parts per million, with a median of 1.5 parts per million, and in waste rock ranges from 2.0 parts per million to 15.2 parts per million with a median of 5.2 parts per million. There is no correlation between the uranium and thorium values.

The median values compare with average values for shale of uranium four parts per million and thorium 12 parts per million. The uranium is enhanced and the thorium values noticeably depressed. It appears that there is no geochemical correlation between the uranium and thorium.

Whilst the uranium median value is three times the expected shale background, these values are not unusual when compared with those in many mineralised areas. Many open pit and underground mines world-wide operate at comparable or higher levels.

Uranium data at individual sites varies considerably. At Helene, the median value is 10 parts per million, at Thelma-Rosemary 44 parts per million, Jasmine 29 parts per million and Ochre Hill 18 parts per million. Since a minimum of one and maximum of four drill holes have been analysed at each location, the relative values at different sites have little meaning.

5. CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

Results of waste characterisation have indicated that neither the iron ore nor the surrounding Wildman Siltstone waste contain any capacity for acid neutralisation. The likely low Eh (dissolved oxygen content) anoxic conditions under which carbonaceous siltstone deposits form are such that minor iron sulphides deposit immediately prior to ferrous iron and silica reaching super saturation within the geochemical system. The sulphur deposition results in an increase in Eh causing deposition of the iron protore which, in turn may result in a further rise in Eh and subsequent deposition of uranium if that metal reaches super saturation levels.

Traces of the chalcophile elements copper, lead, zinc and antimony plus arsenic, thallium and molybdenum will be largely concentrated in extremely carbonaceous footwall to the iron mineralisation and are likely to be at very low levels in the hanging wall rocks. It is essential that exposure of highly carbonaceous footwall that will subsequently be exposed below ground water level be minimised in open pit developments.

5.1 THELMA 2 PIT AREA

At the Thelma 2 pit, previous mining has exposed a large amount of highly carbonaceous footwall material which is now below water level in the pit. This has resulted in chalcophile metals being leached and retained in solution in pit water. All sulphur in footwall waste rock has totally oxidised and current acidity in pit waters is dominated by organic acids from plant decomposition. The current values should be stable after 32 years and no further acidification is considered likely. The current level of sulphuric acid in Thelma 2 pit is extremely low at less than 0.03% H₂SO₄.

Further mining at this site will increase the chalcophile element concentrations. Further mining should be possible in the vicinity of Thelma 2 pit, but should ensure that no footwall shale is exposed below natural groundwater levels. If such mining does occur, it is recommended that waste rock material be used for backfilling Thelma 2 pit to 2.5 metres above the natural water table.

5.2 EASTERN AND NORTHERN AREAS

Chalcophile element contents plus barium and manganese in the waste rock show an increase with distance from the Helene area, though Jasmine East values do not fit the general pattern. There is also a general slight increase in uranium content. On a geochemical basis, this reflects that these areas were relatively more remote from the source area or at differing water depth at the time of mineral deposition. No waste rock data has been collected, but relatively high manganese content iron ore occurs to the north-west of Ochre Hill.

Most of the manganese content will be directly linked to the iron and barium always shows a geochemical link with manganese in this environment. However, the chalcophile elements are

purely sulphide related and indicate a higher sulphide content in the siltstone host at these sites compared with Helene. Waste rock values for sulphur are still very low where data is available for review.

It is recommended that open pits at all sites apart from those in the Helene area be designed so that the footwall of the pit below the natural water table never accesses waste rock with an iron content of less than 20%Fe. In that situation, it is unlikely that chalcophile bearing sulphide minerals will be exposed to oxygenated water in water filled open pits after mine closure. This will prevent recurrence of the situation at Thelma Pit 2.

5.3 URANIUM

The proposed mining areas are immediately adjacent to and in places coincident with a regional stratiform zone of uranium enhancement within the Wildman Siltstone. Median uranium content of iron ore are considerably more than an order of magnitude below levels where workers might receive the maximum recommended dosage rate of 1.0 milliSieverts per annum of gamma radiation. Additional gamma exposure from thorium and/or potassium will be insignificant as these elements are at, or in the case of potassium, well below normal background values.

5.3.1 Proposed Gamma Data Collection and Monitoring

Existing data suggests a median uranium content increase in a general northerly direction within the proposed mining area, which will increase the risk to workers as work progresses in that direction. However the available data is sparse and being entirely from drill hole information is unsuitable for risk prediction. It is essential to undertake a regional survey of gamma radiation levels within all areas where workers may spend time during the mining operations to establish base data for risk assessment, prior to commencement of any mining operations.

Surface gamma values should be below those in the open pits or ore piles, but this needs to be verified. Surface data must be acquired, collated, interpreted by an appropriate consultant and results lodged with regulatory authorities. It is generally accepted that, for normal exposure situations, activity of materials to which personnel are exposed should be less than 1.0 Becquerels per gram. The highest uranium value so far detected on the property is 74.8 milligrams per kilogram uranium for which the calculated activity exclusive of the trace content of associated thorium is 0.93 Becquerels per gram.

It is recommended that background data be collected to present to the relevant authority as evidence to support an application for exemption in accordance with the National Directory for Radiation Protection - Protocol for Application of Exemption Provisions for Radioactive Materials.

5.3.2 Transport and Export of Iron Ore

The Northern Territory Government may require a plan for transport plus port storage be presented prior to approvals being completed. The uranium content of the ore is less than the recognised uranium ore grade of 200 parts per million. Under the provisions of the National Directory for Radiation Protection, radionuclides of natural decay chains, can be present at up to 10 Bequerels per gram and are exempt under the Transport Code.

No special handling facilities are required, but ore should be stored in the open where possible. Under cover storage is not recommended. Provision should be made for automatic sprinkler dust suppression controls at the port.

The concentrations of uranium in the ore are such that it may be prudent to apply for exemption from the requirements of the Code of Practice for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing.

6. GLOSSARY OF GEOLOGICAL AND TECHNICAL TERMS

ANC	Acid Neutralising Capacity A process where a sample is reacted with excess 1.0M HCl at a pH of about 1.5, for 2-3 hours at 80-90°C followed by back-titration to pH=7 with sodium hydroxide. This determines the acid consumed by soluble materials in the sample.
adsorption	The process of metals attaching themselves to mineral particles, normally clays or metal oxy-hydroxides.
anticline	A fold in rock strata that is convex upward with a core of older rocks.
antiformal	A complex structure which is generally anticlinal.
assay	The value of elements or radicals as measured by laboratory techniques.
azimuth	The horizontal direction of a drill hole or rock stratum.
banded iron formation	A banded rock composed of layers of an iron-rich mineral such as magnetite, pyrite, pyrrhotite or iron carbonate, and silica such as quartz, chert or iron silicates.
basalt	Dark coloured fine grained volcanic rock composed mainly of plagioclase feldspar and pyroxene.
basement	Term used to describe the geological rock unit underlying all other units in the described area.
Cainozoic era	A period of geological time covering the past 65 million years.
chlorite	A hydrated magnesium alumino-silicate mineral formed by low grade metamorphism.
chloritic banded iron formation	A banded rock composed of layers of chlorite mineral in banded iron formation
colluvial, colluvium	Weathered material transported by gravity slip on gently sloping surfaces.
desorption	Process whereby metals detach themselves from clays and go into solution.
dextral (fault)	A right lateral strike-slip fault. Viewed from one side, the block on the other side appears to have moved to the right.
diamond drilling	Method used to obtain a core of rock using a diamond impregnated bit.
dip	The angle at which a stratum is inclined from the horizontal.
ECL	Environmental Concern Level. An undefined term relating to a concentration of an element above which investigation should be conducted to prevent environmental damage.
facies	An assemblage or association of mineral, rock or fossil features reflecting the environment and conditions of origin of the sedimentary rock type.
fault	A fracture in the rock along which there has been an observable amount of displacement.
feldspar	A group of abundant rock forming minerals.
felsic	A generalised term to describe igneous and metamorphic rocks composed dominantly of quartz and alkali feldspar.
foliated	Parallel orientation of platy minerals or mineral banding in rocks.
fugacity (oxygen)	The partial pressure of oxygen within the fluid at the site at the specified geological time.

granite	A coarse-grained igneous rock consisting essentially of quartz (20-40%), alkali feldspar and very commonly a biotite and/or muscovite and sometimes hornblende.
gossan	A surface capping of hydrated oxides of iron formed by weathering of metallic sulphides.
hematite	an oxide of iron, Fe_2O_3 , very common in iron ores.
horizon	A time-plane recognisable in rocks by some characteristic feature such as flora, fauna or lithology.
intrusion	A body of igneous rock which invades older rocks.
laterite	A strongly leached iron and aluminium-rich rock formed close to the surface by weathering in alternating hot, wet and cooler, dry conditions.
mafic	Descriptive of rocks composed dominantly of magnesium and iron forming silicates.
magnetite	An important iron ore mineral, Fe_3O_4 .
metallurgical	Referring to treatment of ores to extract concentrates or the metals within them.
mineralisation	The concentration of metals and their chemical compounds within a body of rock.
MPA	Maximum Potential Acidity A calculation where the total sulphur in the sample is assumed to all be present as pyrite. This value is multiplied by 30.6 to produce a value known as the Maximum Potential Acidity. Correctly, the MPA should multiply only the non-sulphate sulphur by 30.6 but sulphate-sulphur is often not determined.
NAG	Net Acid Generation A process where a sample is reacted with 15% hydrogen peroxide solution at pH=4.5 to oxidise all sulphides and then time allowed for the solution to react with acid soluble materials. This is a direct measure of the acid generating capacity of the sample but can be affected by the presence of organic materials.
NAPP	Net Acid Producing Potential (MPA-ANC) A calculation where the total sulphur minus the sulphur present as sulphate is assumed to all be present as pyrite. The non-sulphate sulphur value is multiplied by 30.6 to produce a value. The ANC value is now deducted from this to produce the NAPP. NAPP is a very conservative (excessive acid content) figure as sulphides which do not contain iron are assumed to produce acid which is incorrect.
ore	Mineral bearing rock which can be mined and treated at a profit.
overburden	Any loose unconsolidated material which rests upon solid rock; useless material which overlies a bed of useful material.
oxidation	Near surface decomposition by exposure to the atmosphere and ground water.
oxide zone	The weathered portion of the regolith.
phyllite	A foliated rock formed from a very fine grained argillaceous rock
plunge	Inclination of a fold axis or other structure.
quartz	A mineral composed of silicon dioxide (silica).
Quaternary	Recent geological period less than 1.8 million years old.
RAB drilling	Rotary airblast drilling. A shallow drilling method where rock chips are recovered at the surface by air pressure.
reverse circulation drilling	A percussion drilling technique in which the cuttings are recovered through the drill rods thus minimising losses.

regolith	The portion of the earth's crust which has been affected by mechanical and chemical weathering of unaltered bedrock.
resource	In the context of this report, mineralisation to which conceptual tonnage and grade figures are assigned, but for which exploration data are inadequate to calculate geological reserves.
schist	A metamorphic rock with a platy or foliated texture.
sediment	Rocks formed by the deposition of solids from water.
siltstone	a very fine grained rock composed mainly of very fine sediment between 4 and 60 micrometres in average diameter.
sinistral (fault)	A left lateral strike-slip fault. Viewed from one side, the block on the other side appears to have moved to the left.
strike	The course or bearing of a bed, a vein or a layer of rock.
stringers	Very thin commonly irregular veins, usually of quartz, cutting through other rock types.
strip-ratio	The amount of overburden that has to be removed to produce a tonne of ore.
sub-crop	Rubble or poor outcrops which barely protrude through surface soil.
supergene	Processes involving water, with or without dissolved material, percolating down from the surface.
syncline	A fold in rock strata that is convex downward with a core of younger rocks.
transitional zone	The section of the regolith normally where water table fluctuation occurs and where there has been incomplete oxidation. Fresh, partially altered and totally altered sulphide and silicate minerals co-exist. Supergene precipitation of heavy metals and precious metals often occurs in this zone.
ultramafic	Descriptive of igneous rock containing virtually no quartz or feldspar and composed essentially of ferromagnesian silicates, mainly olivine, pyroxene and derived minerals.
vein	A thin sheet-like intrusion into a fissure or crack, commonly bearing quartz.
volcanic	Descriptive of rocks originating from volcanic activity.

FIGURES

