Tropicana Gold Project
Preliminary Assessment of Contamination Potential

July 2009

Tropicana Joint Venture

360 environmental

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Prepared for: Tropicana Joint Venture

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Executive Summary

360 Environmental Pty Ltd (360 Environmental) was commissioned by Tropicana Joint Venture (TJV) to undertake a preliminary assessment of potential contamination risks associated with the operation of TJV's proposed Tropicana Gold Project (TGP). The TGP is a proposed gold mine with supporting infrastructure planned to develop the Tropicana and Havana deposits. The deposits are located approximately 330 km east-northeast of Kalgoorlie and 200 km east of Laverton. The proposed open pit mining of the Tropicana and Havana deposits is envisaged to result in development of a 75.3 Mt resource if the TGP reaches its maximum expected potential.

The Environmental Protection Authority has recognised that mining and associated processing activities have the potential to generate a contaminated site as defined under the *Contaminated Sites Act 2003* and thus require an assessment of the potential contamination risk to the local and surrounding environment associated with the proposed TGP. This report presents the results of the preliminary contamination assessment for inclusion in the project's Public Environmental Review document (TJV, 2009).

The scope of work undertaken during this investigation has included the following:

- A review of baseline soil and water quality data provided by the TJV to better understand the occurrence and distribution of potential elements of concern in the natural environment, their likely occurrence and risk to the surrounding environment following closure of the mine.
- Development of site specific trigger levels (SSTLs) on the basis of existing soil and water quality for future assessment on the impact of the proposed TGP operations on the surrounding environment.
- Development of a Conceptual Site Model detailing potential contaminant sources, pathways and receptors.
- A review of the proposed construction specifications for the Tailings Storage Facility (TSF) and the Waste Material Landform (WML).
- Assessment and reporting of contamination potential associated with the TGP.

The contamination assessment has identified a number of potential contamination issues relating to the proposed open pit mine, the majority resulting from potentially contaminating activities such as the use of cyanide and heavy machinery across the site. Other potential issues relate to site specific factors, such as heavy metal concentrations in regolith and rock beneath the TGP above soil site specific trigger levels derived from surface soil concentrations, and the presence of small quantities of potentially acid forming (PAF) material and fibrous minerals within the deposit.

However, TJV is committed to best practicable environmental management and continuous improvement of its environmental performance. Primary considerations for the project to date have been the avoidance significant impacts on the surrounding environment, the reduction of the ecological footprint of the project and the

development of the project that meet current and future requirement. In order to address the potential contaminating activities and contaminants of concern identified, TJV has nominated to adopt a number of strategies throughout the life of the mine to minimise the risk of any potential contamination generated from the proposed operations impacting on the surrounding environment. These strategies focus on removing or reducing the source where possible, or where this is not feasible, removing the pathway between the identified sources and potential receptors.

In recognition that the environment of the TGP Operational Area is unlike that of other existing gold operations within Western Australia, Site Specific Trigger Levels (SSTLs) have been developed for both mining waste and groundwater from the review of existing data. It is proposed that these SSTLs are used for comparative purposes in future assessments of the impact the proposed TGP operations are having on the surrounding environment. Should future monitoring programs report concentrations of analytes of concern above the SSTLs, the need for further assessment and/or management shall be triggered. Revision of these trigger levels may be appropriate if additional groundwater or surface soil analysis data for the site is obtained prior to the commencement of construction works at the site.

The contamination assessment has also identified some areas where the collection of further data is desirable to assist in determining best management strategies. Although the presence of heavy metals in soils and rocks beneath the site at concentrations above nominated guideline levels has been relatively well investigated, only limited data on metal leach rates and weathering/oxidising potential of the metals in the TGP environment is currently available. This information is important to determine whether waste material containing metal concentrations above SSTLs pose a potential risk to the surrounding environment through leaching and oxidation. Additionally the level to which these metals are bioavailable is not yet known. This feature is important in determining the actual impact the metals will have on the surrounding environment.

Furthermore, only limited groundwater analysis data has been collected across the site. Accordingly, over the life of the project, further data collection and assessment is recommended, including the following:

- Completing the current leach /kinetic testing program for waste material and other indicators of natural attenuation over a broad range of sample types.
- Assessment of the bio-availability of metals in the site soils and wastes.
- Periodically conducting a complete chemical analysis of the tailings.
- Review existing monitoring bore locations to identify those that should be used to monitor potential changes in groundwater quality and expand the monitoring bore network if required.
- Periodically review PAF and Non-acid forming potential of the major rock types

Using the preliminary assessment and the additional data collected over the life of the project, periodic review of the contamination potential of the TGP must be undertaken and new management strategies formalised and adopted as required.

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1 Introduction

1.1 Background

360 Environmental Pty Ltd (360 Environmental) was commissioned by Tropicana Joint Venture (TJV) to undertake a preliminary assessment of potential contamination risks associated with the operation of the proposed Tropicana Gold Project (TGP). The TGP is a proposed gold mine with supporting infrastructure planned to develop the Tropicana and Havana deposits. The deposits are located approximately 330 km east-northeast of Kalgoorlie and 200 km east of Laverton (Figure 1). The proposed open pit mining of the Tropicana and Havana deposits is envisaged to result in development of a 75.3 Mt resource if the TGP reaches its maximum expected potential. The TJV is between AngloGold Ashanti Australia Ltd (70% stake, Manager) and Independence Group (30% stake).

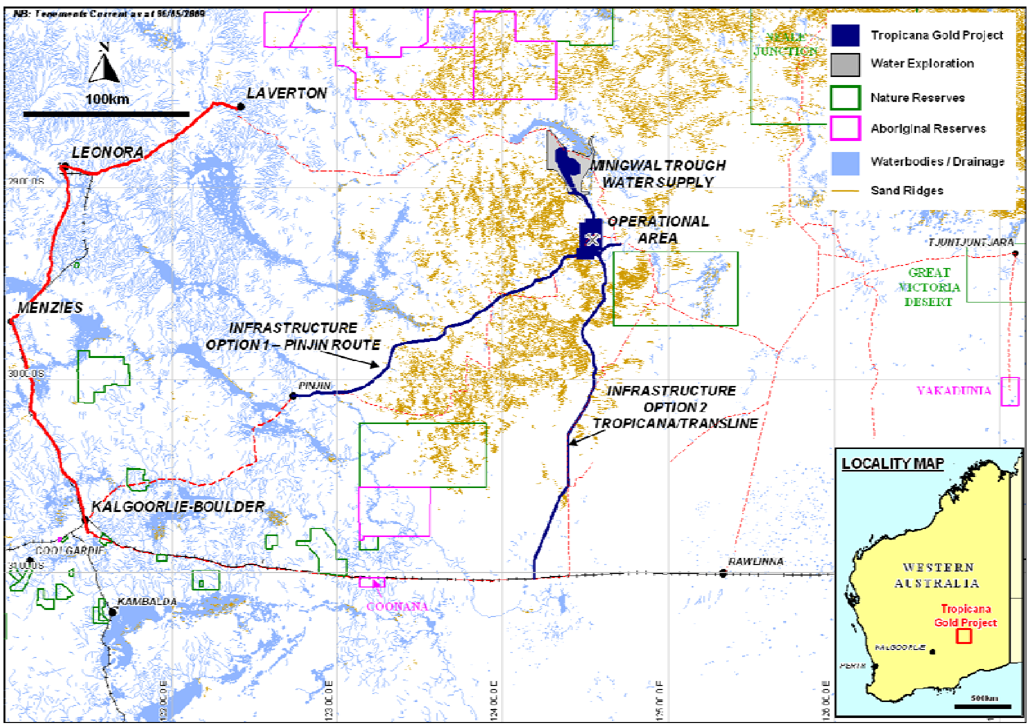

Figure 1. Tropicana Gold Project General Location

The Environmental Protection Authority (EPA) has recognised that mining and associated processing activities have the potential to generate a contaminated site, as defined under the *Contaminated Sites Act* 2003, and thus require an assessment of the potential contamination risk to the local and surrounding environment associated with the proposed operation. This report presents the results of the preliminary contamination assessment for inclusion in the project's Public Environmental Review (PER) (TJV, 2009) document.

1.2 Scope of Work

The scope of work undertaken for this investigation included the following:

- A review of baseline soil and water quality data provided by the TVJ to better understand the occurrence and distribution of potential elements of concern in the natural environment, their likely occurrence and risk to the surrounding environment following closure of the mine. Data reviewed included:
    - Baseline characterisation data of soils collected at surface from over the regional area and regolith from Reverse Circulation (RC) drilling undertaken across the Operational Area.
    - Static and kinetic test data from across the Operational Area.
    - Water quality results from groundwater monitoring bores located across the Operational Area, and incidental groundwater intercepted during drilling programs.
- Development of site specific trigger levels (SSTLs) on the basis of the baseline soil and water quality data, for future assessment on the potential impact of the proposed TGP operations on the surrounding environment.
- Assessment and reporting with reference to the *Department of Environment (DoE) (2003) Assessment of Soil, Sediment and Water* (2003) guideline document, the United States Environmental Protection Agency (US EPA) Ecotoxicity Ecological Soil Screening Levels (Eco—SSLs) and the SSTLs, including a summary of risks to the TJV from the proposed operations, and recommendations for additional assessment or testing, if required.
- A review of other relevant available information relating to site characteristics including topography, geology, climate data, soil profiles, surface hydrology and groundwater.
- A review of the proposed construction specifications for the Tailings Storage Facility (TSF) and the Waste Material Landform (WML).
- Development of a Conceptual Site Model, detailing potential contaminant sources, pathways and receptors.

2 Site Description and Physical Environment

2.1 Site Location and Proposed Features

The focus of the TGP is the Tropicana and Havana deposits, which are located 330 km east-northeast of Kalgoorlie and 230 km east of Laverton. The key statistics of the proposed open cut gold mine are shown in Table 1. It is currently expected that the TGP would operate for up to 15 years to develop the potential of the resource.

Table 1: Estimated Project Statistics

Element	Description
Current Resource:	
Resource tones	75.3 Mt
Resource grade	2.07 g/t
Estimated gold resource	5.01 Moz
Proposed Utilisation of Resource:	
Construction period	Approximately 30 months, commencing Q2 2010
Mining rate (ore and waste)	Up to 75 Mtpa
Stripping ratio	8:1
Open pit void/s	Up to 400 ha
Pit depth	up to 400 m
Overburden Volume	~ 800 Mt
Processing Plant and Rate	'CIL' plant with processing rate of up to 7 Mtpa
Life of Mine:	
Project life	Up to 15 years of mining; total project duration up to 25 years (including post closure monitoring)
Maximum Area of Disturbance	3,440 ha

2.2 Proposed Infrastructure and Features

The TGP will be composed of the following main areas of infrastructure and disturbance:

- Operational Area – The proposed gold mine, including the mining areas, waste rock landforms, stockpiles, tailings storage facility, processing plant, water storage dams, power station, internal roads, administration buildings, aerodrome, village and other supporting infrastructure;
- Water Supply Area –The Minigwal Trough, located north-northwest of the Operational Area, has been nominated as a viable source of water for the proposed TGP;

- Infrastructure Corridor – Two main options were considered during the scoping and pre-feasibility stage of the TGP (Pinjin and Tropicana-Transline options). The Pinjin Road option has been determined to be the preferred option as the infrastructure corridor for TJV, where as the Tropicana-Transline is the only available option for the communication corridor.

2.2.1 Processing Plant

The processing plant consists of two stage crushing, high pressure grinding roll (HPGR), communication circuit and a carbon-in-leach (CIL) circuit. If practicable, direct dumping will be used to feed the primary crusher to minimise ore rehandling on the ROM pad. The processing plant has been designed to maximise process efficiencies and reduce energy consumption (e.g. HPGR inclusion in the circuit to maximise power consumption efficiencies).

2.2.2 Tailings Storage Facility

The tailings storage facility (TSF) proposed for the TGP has been designed around the following requirements:

- permanent and secure containment of all solid waste materials;
- maximisation of tailings density;
- removal and reuse of free water;
- minimisation of seepage;
- excess storage capacity to retain a 1 in 100 year Average Recurrence Interval (ARI);
- rapid and effective rehabilitation; and
- ease of operation.

The proposed TSF design is a two-cell paddock storage facility, incorporated into the northwestern waste dump, with the waste dump adjacent to the northern and eastern sides of the TSF (see Figure 2). Initially, the TSF will be constructed to store one year of tailings production. As the TGP progresses, the TSF embankments will be raised in annual stages over the operational phase of the project.

The basin surrounding the decant tower of the TSF will be lined with High-Density Polyethylene (HDPE) to minimise seepage to the underlying substrate and groundwater. The remaining area will be lined with a clay liner. The basin liner and underdrainage system for the facility have been optimised to make best use of naturally occurring materials on the site.

The thickened tailings disposal method has been selected, as it is has a more efficient use of power and substantial water recycling.

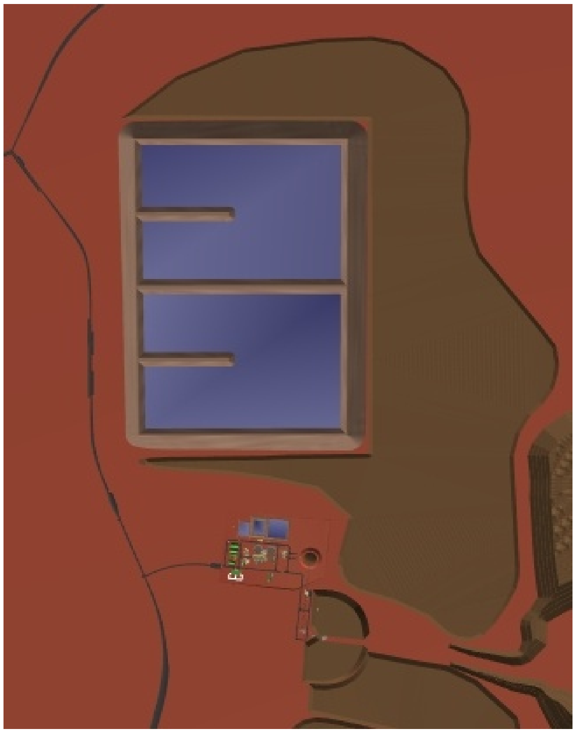

Figure 2: WML/TSF Combined Facility

2.2.3 Waste Material Landform (WML)

The waste material landforms (WML), containing non-gold bearing overburden, will ultimately be up to 40 m high and collectively cover up to 1,200 ha. However, the final landform will not project above the surrounding environment and hence, will blend into the landscape at closure (TJV, 2009).

The WMLs will surround the pit void and the northern landform will incorporate the TSF. They will have a maximum slope angle of 15° and will form a continual slope (rather than be benched). During the operational phase, the slopes of the WML will be progressively battered down to their final profiles for environmental closure conditions.

Modelling and waste/substrate stability analysis have demonstrated that traditional berms will not be necessary to produce a stable landform. Thus, the final shape of the WML will be a gently sloped, artificial sand hill with a gravel top for stability. The surface of the WMLs will be covered with at least 1 m of growing medium and vegetated with local plant species (TJV, 2009).

2.2.4 Power Supply

A power station with an installed capacity of up to 40 MW is required to service the TGP. The average electrical load for the TGP is estimated at 27 MW.

Several options are been considered by the TGP; however, a final decision is yet to be made. Based on the current infrastructure and market constraints, on-site power generation with diesel is the only option that can be confidently implemented.

2.2.5 Supporting Infrastructure and Facilities

Village

A 700-bed accommodation village with associated amenities will be required to support the Construction and Operational phases of the TGP. The village will be located approximately 4 km northwest of the mine site.

Sewage from the plant ablutions, administration buildings and accommodation village will be processed through a packaged sewage treatment plant. Reuse options for treated water will be investigated.

Aerodrome

An aerodrome will be constructed to accommodate commercial aircraft up to the standard of a BAE-146 eighty seat jet aircraft. The current preferred site of the aerodrome is north of the processing plant; however, this has not been confirmed. Associated buildings/ infrastructure, including a check-in building with a covered outdoor area and fuel storage facility, will be required at the aerodrome. The TGP aerodrome will be fenced and appropriately monitored and maintained to prevent facility-fauna interactions.

2.2.6 Topography and Surface Hydrology

The Great Victoria Desert (GVD) is dominated by longitudinal sand dunes with a predominant east-west orientation and ring dunes separated by interdune corridors (or swales) and sand plains. The local landscape at the Operational Area consists predominantly of sand plains, with a series of sand dune area forming east-west ridges as they do in the majority of the remainder of the GVD. The Resource Area lies on a low ridge inside a broad valley between a local dunefield and a local high-point.

The drainage catchments upstream of the TGP Operational Area and Infrastructure Corridors are generally characterised by low relief, poorly defined drainage lines and areas with strongly linear sand dunes and internal drainage. The regional geology is predominantly aeolian sands with high infiltration capacity, interspersed with areas of colluvial soils with lower infiltration capacity. As a result, stormwater runoff rates and volumes are generally low.

The region's climate is hot and persistently dry, with potential evaporation greatly exceeding rainfall. Rainfall and flood events are highly variable in size and timing, and are often influenced by tropical cyclones. Accordingly, stormwater flows are usually infrequent and of short duration, resulting from periods of intense rainfall. However, local drainage from less permeable soils has the potential to produce runoff that could impact on TGP infrastructure, operations and the surrounding environment.

2.2.7 Geology and Soils

Locally, the bedrock geology consists predominantly of quartzo-feldspathic and garnet-bearing gneisses, with minor garnet bearing amphibolite. Sericite-, biotite-, and chlorite- dominant schists intersect the gneissic units. Fresh bedrock is overlain by 1 to 20 m of transported cover and a weathered profile that varies in thickness from 10 to 55 m. The thickness of cover over fresh bedrock is largest within the proposed Havana Pit and thins to the northeast along the ridge line.

Soil mapping of Western Australia has been carried out by Tille (2006), who describes the area surrounding the operational area as being located in the Southern Great Victoria Desert Zone of the Sandy Desert Region.

2.2.8 Groundwater

Studies undertaken in the operational area (Pennington Scott, 2009) indicate that the water table is located at approximately 20-30 m below ground level. Groundwater is saline to hyper-saline, with groundwater gradients flowing toward the Rason paleodrainage, several kilometres north of the mine. Groundwater occurs mainly in the fractures and joints in the basement rock, with most porosity and permeability occurring in the lower saprolite, and in faults, shears and joints in the underlying sap rock. The lower saprolite is about 20-30 m thick and occurs at depths from about 20-50 m. Fractures and joints within the sap rock extend to about 70-90 m below ground level. Figure 3 illustrates the main geological and hydrological features present at the TGP (Pennington Scott, 2009).

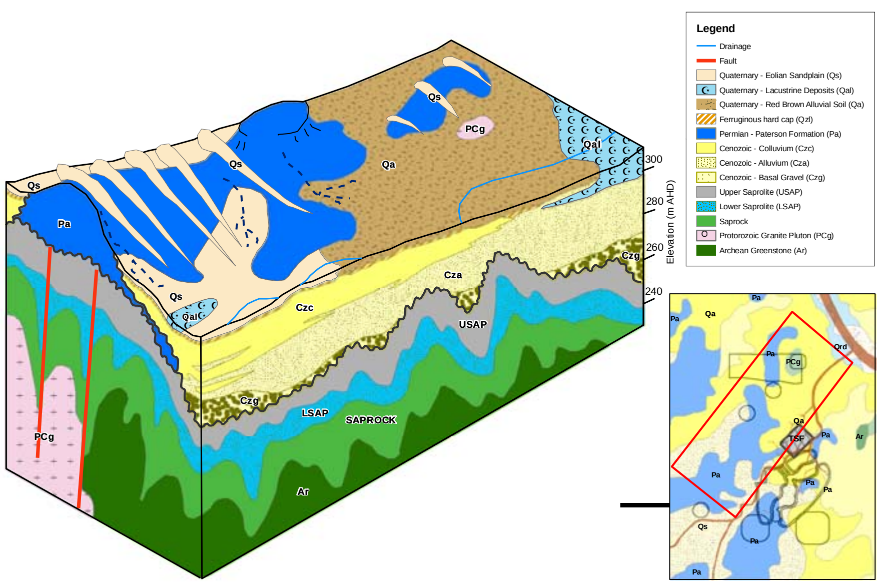

Figure 3: Schematic Block Diagram of Geology and Hydrogeology (from Pennington Scott, 2009)

2.2.9 Climate

Due to the remote location of the TGP there are no Bureau of Meteorology (BOM) weather stations located nearby. To gain understanding of likely weather conditions, data has been obtained from the Laverton Airport and Balgair weather stations which are located approximately 230 km northwest and 250 km southeast of the TGP operational area, respectively. This information suggests that the surrounding area has a semi-arid to arid climate with daily temperature ranges of approximately 5 to 48 °C in summer and -5 to 35 °C during winter (Bureau of Meteorology 2008a; 2008b). Rainfall generally comprises seasonal thunderstorms and cyclone-related rain events during the summer months, to scattered showers during the winter months. Annual rainfall averages for Laverton and Balgair are approximately 275 – 290 mm, with lowest rainfall in spring (Bureau of Meteorology, 2008a; 2008b). Summer rainfall is generally associated with cyclonic activity extending into the interior, and this may result in heavy rains between January and April (Laverton Airport received over 200 mm in February 2004).

As desert rainfall is often sporadic and localised, these average rainfall figures are indicative only, as rainfall at the Operational Area may differ significantly from Balgair and Laverton on a daily/annual basis. Daily temperatures can also vary significantly from Balgair and Laverton; however, these monitoring sites do give an indication of potential conditions at the Operational Area. The TJV has installed weather-monitoring equipment, which will provide site-specific weather information for the area. During 2008, TJV weather station near the resource area received 144 mm of rainfall.

3 Preliminary Site Assessment Criteria

3.1 Soil Investigation Criteria

Assessment of site contamination in Western Australia is based on the *Contaminated Sites Act* 2003 and the DEC (2001-2006) *Contaminated Sites Management Guideline Series*. The guidelines include Health Based Soil Guidelines (Human Health Investigation Levels (HILs)) for various exposure settings and Ecological Investigation Levels (EILs), as presented in the Department of Environment (DoE) (2003) *Assessment Levels for Soil, Sediment and Water* guideline document.

Additionally, relevant soil quality data may be compared with the United States Environmental Protection Agency (US EPA) Ecotoxicity Ecological Soil Screening Levels (Eco-SSLs), in recognition that the DoE (2003) EIL and HIL soil investigation criteria are more applicable to urban environments. Eco-SSLs are concentrations of contaminants in soil that are protective of ecological receptors that commonly come into contact with and/or consume biota that live in or on soil, and have been derived separately for four groups of ecological receptors, these being plants, soil invertebrates, birds, and mammals (U.S. EPA, 1997, 1998, and 1999).

In recognition that the local environment associated with the TGP Operational Area is unlike that of other existing gold operations within Western Australia, Site Specific Trigger Levels (SSTLs) for metals in soils have been developed using analysis data for surface soil samples collected by TJV and Outback Ecology Services across the TGP Operational Area in 2008. This data provides a baseline for naturally occurring metal concentrations in surface soils. These trigger levels have been used in this investigation to assess metal concentrations in samples collected at depth beneath the TGP Operational Area. It is anticipated that these trigger levels would be used in future assessments to determine the impact, if any, activities associated with the TGP are having on the surrounding environment where the baseline local area concentrations are higher than the EIL or the US EPA levels. Exceedences of these SSTLs would trigger the need for further assessment and appropriate management to be undertaken. The nominated soil investigation criteria for metals are presented in Table 2.

With regards to future assessment of hydrocarbon levels in soils at the TGP site, the DoE (2003) EILs for Total Petroleum Hydrocarbons (TPH) and benzene, toluene, ethylbenzene and xylene (BTEX) have been nominated as the most appropriate assessment criteria. These criteria are presented in Table 3.

3.2 Groundwater Investigation Criteria

It is typical when assessing potential groundwater impact to use the *ANZECC/ARMCANZ 2000 Australian and New Zealand Guidelines for Fresh and Marine Water Quality*; however, it is recognised that this is not appropriate for the TGP because the groundwater in the region is saline to hyper saline. These guidelines will thus only be used for assessing potential surface water contamination issue.

Table 2: Adopted Soil Assessment Criteria - Metals

Analyte	Ecological Investigation Levels (EIL) (mg/kg)	US EPA Ecological Soil Screening Levels (mg/kg)				Site Specific Trigger Levels (mg/kg)
		Plants	Soil Invertebrates	Wildlife		
				Avian	Mammalian	
Antimony	20	-	78	-	0.27	20
Arsenic	20	18	-	43	46	20
Barium	400	-	330	-	2000	400
Beryllium	-	-	40	-	21	12*
Cadmium	3	32	140	0.77	0.36	3
Chromium (total)	50	-	-	-	-	317*
Chromium (III)	-	-	-	26	34	-
Chromium (VI)	-	-	-	-	130	-
Cobalt		13	-	120	130	20.5*
Copper	60	70	80	28	49	134*
Lead	300	120	1,700	11	56	300
Manganese	500	220	450	4,300	4,000	500
Mercury	1	-	-	-	-	1
Molybdenum	40	-	-	-	-	40
Nickel	60	38	280	210	130	106*
Selenium	-	0.52	4.1	1.2	0.63	-
Silver	-	560	NG	4.2	14	-
Vanadium	-	-	-	7.8	280	318*
Zinc	200	160	120	46	79	200

Notes:
- No guideline available
* Derived from background data

Table 3: Adopted Soil Assessment Criteria - Hydrocarbons

Analyte	Ecological Investigation Levels (EIL) (mg/kg)
Total Petroleum Hydrocarbons	
C6-C9	100
C10-C14	500
C15-C28	1000
>C16-C35 (aromatic)	-
>C16-C35 (aliphatic)	-
>C35 (aliphatic)	-
Monocyclic Aromatic Hydrocarbons (MAHs)	
Benzene	1
Toluene	3
Ethylbenzene	5
Xylenes	5
Polycyclic Aromatic Hydrocarbons (PAHs)	
Total PAHs	20
Anthracene	10
Benzo(a)pyrene	1
Fluoranthene	10
Naphthalene	5
Phenanthrene	10
Pyrene	10
Notes: - No guideline available	

The preliminary groundwater investigation criteria are presented in Tables 4 and 5. As these triggers where derived from a small data set they should be reviewed as new information becomes available.

The DoE (2003) Fresh Water Guideline levels are nominated as the most appropriate assessment criteria for future assessment of hydrocarbon levels in groundwater at the TGP. As petroleum hydrocarbons are not anticipated to occur naturally in groundwater beneath the TGP site, where no Fresh Water guideline levels are available, such as for TPHs, all detections above the laboratory limit of reporting shall be treated as a trigger for further assessment and/or management. Hydrocarbon assessment levels are shown in Table 5.

Table 4: Preliminary Groundwater Assessment Criteria - Metals

Analyte	DoE (2003) Fresh Water (mg/L)	Site Specific Trigger Levels (mg/L)
Aluminium	0.055 (pH >6.5)	0.055
Arsenic	0.024 (as AsIII); 0.013 (as AsV)	-
Barium	-	0.064
Beryllium	0.004	0.004
Cadmium	0.0002	0.05
Chromium (total)	0.01	0.01
Chromium (VI)	0.001	-
Cobalt	-	0.049
Copper	0.0014	0.019
Lead	0.0034	0.11
Manganese	1.9	1.9
Mercury	0.00006	-
Molybdenum	0.05	0.05
Nickel	0.011	0.038
Selenium (Total)	0.005	-
Vanadium	-	0.003
Zinc	0.008	-

Table 5: Adopted Groundwater Assessment Criteria - Hydrocarbons

Analyte	DoE (2003) Fresh Water (µg/L)
Monocylic Aromatic Hydrocarbons (MAHs)	
Benzene	950
Toluene	300
Xylenes	350 (as o-xylene)
	200 (as p-xylene)
Polycylic Aromatic Hydrocarbons (PAHs)	
Naphthalene	16
Total PAHs	3.0

3.3 Relevant Legislation and Hierarchy of Responsibility for Remediation

The *Environmental Protection Act (EPA)* 1986 was introduced in Western Australia to create an Environmental Protection Authority, for the prevention, control and abatement of environmental pollution and environmental harm, and for the conservation, preservation, protection, enhancement and management of the environment. At that time, the Act (Part IV – Environmental Impact Assessment), along with conditions imposed on approvals under planning law, were the only mechanisms available to require possible contamination to be investigated and remediated. If a scheme amendment or an approval to subdivide or develop land was not being sought, the State had no specific or very limited power to address contamination through the EPA 1986, even if there was a potential risk to human health and the environment. In order to address these limitations, and in response to increasing public concern regarding the health risks associated with the redevelopment of land formerly used for waste disposal, industrial or commercial purposes, the *Contaminated Sites Act* 2003 came into effect on 1 December 2006 to provide a comprehensive framework for the management of contaminated sites in Western Australia.

One of the main features of the *Contaminated Sites Act* 2003 is to permit DEC to develop a database of contaminated sites in the state. The Act imposes wide reporting obligations by requiring the following people to make initial reports of known or suspected contaminated sites to the DEC:

- any person who knows or suspects they have (at any time in the past) caused or contributed to contamination on a site (even if they no longer own or occupy the site).
- owners (including mortgagees in possession) who know or suspect contamination of their site, and
- occupiers of (or people in control of) sites which they know or suspect are contaminated.

For contamination caused after 1 June 2007, if a person knows that they have caused the contamination, they must report the site to DEC within 21 days of knowing. If they merely suspect a site is contaminated, they must report the site as soon as is reasonably practicable. Memorials are lodged on the titles to all land that is subject to these classifications. No authorities are able to issue subdivision or development approvals for these sites without considering DEC's advice about the contamination.

The Department of Environment and Conservation's (DEC) *Contaminated Sites Management Series* (2001-2006) are administrative and technical guidelines published by the DEC to assist in the assessment, management and remediation of contaminated sites in Western Australia. Advice on whether a site may be contaminated is presented in the DEC (2004) *Potentially Contaminating Activities, Industries and Land uses guideline*. The DEC (2006) *Reporting of Known or Suspected Contaminated Sites* provides advice on the reporting process.

Once a report of contamination is made, the site will be "classified" by the DEC. There are seven potential classifications as follows:

- Report not substantiated
- Possibly contaminated – investigation required
- Not contaminated – restricted use
- Contaminated - restricted use
- Contaminated - remediation required
- Remediated for restricted used
- Decontaminated

Further details on the classification process are provided in the DEC's (2006) *Site Classification Scheme* guideline.

If a site is classified as "possibly contaminated – investigation required", and an assessment is to be undertaken, guidelines on the development of a suitable sampling and analysis program can be found in DEC (2001) *Development of Sampling and Analysis Program*. This guideline details the appropriate staging of the assessment, suitable sampling methodology for soil, sediment and groundwater, sample identification, preservation, transportation and storage, quality assurance and quality control and sampling frequency. Information on the potential contaminants of concern associated with specific landuse or industries are listed in the DEC (2003) *Potentially Contaminating Activities, Industries and Land Uses* guideline. In accordance with the *Contaminated Sites Act* 2003, a sampling and analysis plan needs to be signed off by an appointed site auditor prior to any field investigations being undertaken.

Resulting soil, sediment or groundwater sampling data are compared to the DEC (2003) Soil, Sediment and Water Levels which provide criteria for assessing site contamination and determining the requirements for further investigation, or assessment of risk to determine if any further action is required. If a site is classified as "contamination -remediation required" or an earlier contamination assessment has indicated the site is contaminated, a site will need to be remediated.

The *Contaminated Sites Act* 2003 sets out a basic "hierarchy of responsibility" for remediation of contaminated sites. The hierarchy can be summarised as follows:

- A person who caused or contributed to the contamination after the commencement of the Act (with or without lawful authority).

- A person who caused or contributed to the contamination of a site before the commencement of the Act is responsible for remediation only to the extent that the person caused the contamination without lawful authority.
- A person who is a landowner or occupier and wishes to change the use of the land.
- A person who became an owner of the Site is responsible to the extent that they knew or suspected that the site was contaminated at the time of becoming owner.
- A person who became an owner of the site either before or after the commencement of the Act (or was the owner at the time when the contamination occurred and continues to own the site).

The timeframe for action will depend upon the risk the contamination poses to both human health and ecological receptors. Some contamination may be able to be managed in accordance with normal operations, while other sites will need to be remediated. The DEC (2006) *The Use of Risk Assessment in Contaminated Site Classification* guideline assists in determining the risks to human health and the environment by establishing a risk based process for identifying, characterising and remediating contaminated sites.

4 Field Data Assessment

A number of field investigations have been undertaken across the TGP Operational Area and surrounding region that provide useful information pertaining to material characterisation, baseline environmental values and potential contamination issues associated with the TGP. These investigations have included the following:

- Surface soil sampling by TJV across the Operational Area and analysis for a range of major and minor elements
- Outback Ecology Services, Tropicana JV Gold Project - Characterisation of soils and regolith material from RC drilling, 2008
- SRK Consulting, Geochemical Characterisation of Waste Rock and Low Grade Ore Static and Kinetic Testing, 2009
- Outback Ecology Services, Tropicana JV Gold Project - Characterisation of soils and regolith material from RC drilling, 2008
- Groundwater monitoring program (September 2007 to December 2008)
- Pennington Scott, Operational Area Groundwater Assessment, 2009

The investigations are summarised in the following sections with respect to potential contamination issues

4.1 Surface Soils Sampling and Analysis

A program of geochemical characterisation of surface samples collected from across the TGP Operational Area was undertaken by TJV in 2008. A total of 132 samples were collected and submitted for analysis for a range of parameters, including metals, nutrients and major cations and anions. Analytical results are presented in Appendix A. Summary information, including minimum, maximum and average concentrations are presented in Table 6 and are assessed against the Australian Institute of Mining and Metallurgy (AIMM) average crustal abundance values (AIMM, 2001) and nominated guideline levels (as detailed in Section 3 of this report).

The analytical results indicate:

- Analyte concentrations in surface soils are moderately to highly variable across the Operational Area. Calcium, magnesium, sodium, % sulfur and silica concentrations are shown to be the most variable.
- Average concentrations for the majority of elements fall below average crustal abundance levels, with the exception of arsenic, mercury, phosphorus, % sulfur, strontium, silica and tellurium, although individual concentrations of a number of other elements also exceed respective average crustal abundance levels.

Table 6: Summary of Surface Soils Sampling and Analysis Results

Element	As	Ba	Be	Co	Cr	Cu	Fe	Hg	Mn	Mo	Ni	Pb	Sn	V	Zn
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Minimum	2	8.8	0.1	0.9	9	2	0.36	0.01	34	0.2	5	3	0.4	7	9
Maximum	23	*351.6*	1.2	20.5	317	*134*	17.05	0.19	363	3.8	106	28	2.6	318	88
Average	5	58.0	0.3	2.4	64	12	2.86	0.10	94	1.2	13	8	0.8	56	22
Nominated Guidelines															
Average Crustal Abundance	1.5	500	2.6	20	100	50	4.1	0.05	950	1.5	80?	14	2.2	160	75
EIL	20	400	-	-	50	60	-	1	500	40	60	300	50	-	200
Plants	18	-	-	13	-	70	-	-	220	-	38	-	-	-	160
Soil Invertebrates	-	*330*	*40*	-	-	*80*	-	-	*450*	-	*280*	-	-	-	*120*
Wildlife - Avian	43	NG	-	120	26	28	-	-	4300	-	210	-	-	7.8	46
Wildlife - Mammalian	46	2000	21	130	34	49	-	-	4000	-	130	-	-	280	79

- Although concentrations of a number of individual samples are above respective guideline levels, average concentrations are generally in compliance. Exceptions include:
  - An average chromium concentration of 64 mg/kg above the EIL of 50 mg/kg and Eco-SSL values of 26 mg/kg and 34 mg/kg for avian and mammalian wildlife.
  - An average vanadium concentration of 56 mg/kg above the Eco-SSL of 7.8 mg/kg for avian wildlife.

4.2 Outback Ecology Services

An investigation of the soil and regolith at the TGP site was completed by Outback Ecology Services (2008). The objective of the study was to develop a good understanding of soils / regolith and their properties in the project area, in order to facilitate the optimisation of future rehabilitation strategies.

RC drilling samples from 45 location within the study area were selected to include a range of regolith depths between 0 and 7 m from the drill samples provided, with 'upper profile' samples representative of the 0 – 2 m depth range and 'lower profile' samples representative of the 3 – 7 m depth range. The selected samples were analysed for a range of physical and chemical parameters, including pH and total metals. Analytical results are presented in Appendix B. Summary information, including minimum, maximum and average concentrations, is presented in Table 7 and is assessed against average crustal abundance values (AIMM, 2001), the results from surface samples collected by TJV, and nominated guideline levels, as applicable. The results indicated the following:

- Nearly all concentrations for all metals were below respective SSTLs and EILs (see Section 4.1). The one exception was a mercury concentration of 0.2 mg/kg, which was marginally above the maximum level of 0.19 mg/kg measured in the samples collected by TJV. However, this may only be a function of a rounding up factor.
- Maximum chromium, lead and mercury concentrations were above respective average crustal abundance values (AIMM, 2001) of 100 mg/kg, 0.05 mg/kg and 14 mg/kg respectively. Outback Ecology (2008) indicate the elevated chromium and lead concentrations occur in the geological strata 'quaternary sand over laterite' and 'sandstone or ferricrete', whilst the elevated mercury occurs the geological strata 'arenite/sand over arenite/arenite over conglomerate'.
- All average metal concentrations were below average crustal abundance values.

Table 7: Summary of Surface Soil Analysis Results - Outback Ecology Services (2008)

Sample ID	As	Cd	Cr	Cu	Hg	Ni	Pb	Zinc
	mg/kg							
2-001	<5	<1	47	5	<0.1	3	5	<5
2-003	<5	<1	35	7	<0.1	6	5	<5
74-000	<5	<1	44	5	<0.1	3	5	<5
74-001	<5	<1	43	5	<0.1	3	5	<5
145-000	<5	<1	36	5	<0.1	3	5	5
145-003	<5	<1	18	5	<0.1	6	5	5
192-001	<5	<1	36	5	<0.1	2	5	<5
192-002	<5	<1	17	12	<0.1	8	5	5
301-001	<5	<1	15	5	0.2	5	5	5
301-003	<5	<1	16	5	<0.1	2	5	5
380-001	<5	<1	50	5	<0.1	5	5	5
380-003	<5	<1	43	5	<0.1	22	5	5
404-001	<5	<1	114	8	<0.1	9	17	5
404-003	<5	<1	44	6	<0.1	4	6	5
416-001	<5	<1	88	12	<0.1	8	16	5
416-003	<5	<1	17	5	<0.1	3	5	5
427-001	<5	<1	44	5	<0.1	3	5	6
427-003	<5	<1	24	6	<0.1	4	6	5
447-001	<5	<1	55	<5	<0.1	2	5	5
447-004	<5	<1	52	7	<0.1	16	9	5
450-000	<5	<1	53	<5	<0.1	2	5	5
450-002	<5	<1	28	9	<0.1	9	6	5
454-000	<5	<1	43	<5	<0.1	3	5	5
454-001	<5	<1	10	12	<0.1	5	5	5
454-002	<5	<1	12	5	<0.1	2	5	5
470-000	<5	<1	48	<5	<0.1	4	6	5
470-002	<5	<1	103	23	<0.1	20	25	<5
538-000	<5	<1	45	<5	<0.1	2	5	<5
538-001	<5	<1	55	<5	<0.1	3	8	<5
538-003	<5	<1	72	7	<0.1	5	12	<5
Minimum	<5	<1	10	<5	<0.1	2	5	5
Maximum	<5	<1	114	23	0.2	22	25	6
Average	<5	<1	44	7	0.1	6	7	5
Average Crustal Abundance (AIMM, 2001)	1.5	-	100?	50	0.05	80?	14	75
Nominated Guidelines								
EIL	20	3	50	60	1	60	300	200
Plants	**18**	**32**	-	**70**	-	**38**	**120**	**160**
Soil Invertebrates	-	*140*	-	*80*	-	*280*	*1700*	*120*
Wildlife - Avian	43	0.77	26	28	-	210	11	46
Wildlife - Mammalian	46	0.36	34	49	-	130	56	79

- Chromium concentrations in 7% of all samples exceeded the DoE (2003) EIL of 50 mg/kg. Although Outback Ecology (2008) indicates that average chromium concentrations of 56.3 mg/kg and 79 mg/kg for geological strata 'quaternary sand over laterite' and 'sandstone or ferricrete' respectively exceed the EIL, the overall average chromium concentration of 44 mg/kg was below the criterion.
- Chromium concentrations in a number of individual samples and the average chromium level of 44 mg/kg, exceeded both the US EPA (2005) Eco-SSLs of 34 mg/kg for mammalian wildlife and 26 mg/kg for avian wildlife.
- Thirteen percent of lead concentrations exceeded the US EPA (2005) Eco-SSL of 11 mg/kg for avian wildlife, but all samples were below the remaining nominated guidelines.
- A broad range of soil pH results were found for all samples, reflecting the variation and complexity of the soils and regolith materials sampled. Soil pH generally increased slightly with sampling depth through the regolith profile. Most results fell between pH 6 and 8, which can be rated as slightly acidic to slightly alkaline for pH measured in 1:5 soil:water (Hazelton and Murphy 2007). Samples between pH 4 and 6 are classed as strongly to moderately acid, whilst samples above pH 8 are classed as moderately to strongly alkaline.
- Electrical conductivity increased with depth in most samples analysed and the majority of samples were classified as non-saline.

4.3 Geochemical Characterisation of Mining Waste

A program of geochemical characterisation of samples from the TGP area was undertaken by SRK Consulting in 2007 - 2009 (SRK, 2008a; 2008b, 2009) to establish the acid generating and metal leaching potential of selected diamond drill (DD) core and RC samples from the Resource Area. The objective was to select sample material from a range of rock types occurring across the resource areas, with approximately 97.2% of identified waste material types represented in the sampling program. Drill holes were selected to provide a broad spatial coverage, both laterally and vertically. Sample depths ranged from one metre below surface to a depth of 323.0 m down the borehole.

The samples were analysed for a range of parameters, including paste pH and electrical conductivity, total sulfur, sulfate sulfur content, total carbon/total inorganic carbon, acid neutralising capacity (ANC), net acid generation (NAG), whole rock chemical assay, acid buffering characteristic curves (ABCC), kinetic NAG and sequential NAG. In addition, modified AMIRA type column kinetic testing was carried out on a limited number of samples.

4.3.1 Acid Generating Potential

Geochemical characterisation of samples from the TGP area undertaken by SRK Consulting to investigate the acid generating potential of materials in this area showed that the majority of the waste material (70% - 75%) can be expected to be non acid forming (NAF). Approximately eight percent of the waste material could be expected to be potentially acid form, although this could be as high as 15%. This material is associated with a small number of rock types including:

- Ferruginous cherts (ANC_{RT})
- Feldspathic Gneiss (undifferentiated) (ANFF)
- Sulfide rich sediments (AX)
- Schists
- Pegmatites

A further 10% to 22% of the waste material is classified as uncertain (UC). However, it should be noted that assessment of the relative abundance of each lithological unit selected for the geochemical analysis program showed a sampling bias towards sulfide mineralisation and as such, acid generation potential may be overestimated.

4.3.2 Acid Neutralising Capacity

Geochemical analysis indicated that the contribution to the acid neutralising capacity or potential (NP) appears to be a combination of reactive carbonates (predominantly calcium and magnesium carbonates) and less reactive aluminosilicates (which typically neutralise acid at slower rates and lower pH values). However, during high rates of acid generation, only carbonate minerals react sufficiently rapidly to neutralise the acidity and maintain neutral pH conditions, whilst silicate minerals will remain unreactive. Accordingly, the results of acid buffering characteristic curve testing, sequential NAG testing and kinetic NAG testing suggest that the available neutralisation potential is best indicated by the carbonate equivalent NP (CarbNP) calculated from the inorganic carbon content and should be used for material classification.

The results of CarbNP calculated for each sample indicate that some units, including saprolite (ALCY), Archaean gneiss (AN?), Permian sediments (MS) and the Quaternary sediments (QLSD) have little or no neutralisation potential and therefore would not be expected to provide any buffering capacity. Conversely, waste material, comprising the Archaean amphibolitic gneiss (ANA), Garnet gneiss (undifferentiated) (ANG), biotite-schists (AZB), and sericite schists (AZS), contain elevated CarbNP concentrations and low sulfide sulfur levels, and thus are considered key sources of neutralisation capacity. Tertiary cover, although having a lower neutralization capacity, could also be used to neutralise acid generating waste material, but might be best utilised as a cover material.

Overall, SRK Consulting (2009) have concluded that the waste material is likely to contain sufficient neutralisation capacity to neutralise all the acid that may be generated, provided the waste material is fully mixed and that the CarbNP is available to neutralise the acid generated.

4.3.3 Elemental Analysis Results

Geochemical Abundance Indices (GAI) values were used to identify elements that exceed average crustal abundances (AIMM, 2001) and may potentially be leached from the waste material. Table 8 presents a summary of the calculated GAI values for the lithological units (based on average elemental contents). The findings of this assessment included the following:

- The majority of elements did not differ significantly from their mean crustal abundances.
- Ferruginous chert (ANC_{RT}) and the sulfide rich rock (AX) are the most mineralised and contain the highest levels of arsenic, cadmium, lead, sulfur, selenium and zinc. Of these, arsenic, cadmium and zinc would be expected to be leached more readily under oxidizing conditions.
- Although low in sulfur, the Archaean gneiss (AN) appears to be slightly elevated in arsenic.
- Although concentrations of boron are elevated in most of the lithological units, generally this element it is not expected to leach readily from the waste material.
- Selenium is relatively elevated in most units; however, it is readily sorbed and may not be mobile within the waste material.

A summary of the multi-element analysis results for all samples against average crustal abundance values (AIMM, 2001) and the SSTLs derived from the surface soils analysis results (see Section 3.1) is presented in Table 9. These results indicate the following:

- Nearly all average metal concentrations increased with depth by up to an order of magnitude. Of particular note were increases in average barium, cobalt and copper levels, from 58.0 to 987 ppm, 2.4 to 26 ppm and 12 to 76 ppm, respectively. A decline in average mercury concentrations, from 0.10 to 0.03 ppm, was the only exception. Accordingly, the majority of average metal concentrations exceeded average crustal abundance levels (AIMM, 2001) and a number also exceeded respective site specific trigger levels (SSTLs), which have been developed from surface soil data. This variability with depth is associated with the weathering profile.
- Average concentrations for barium, cobalt and manganese exceeded respective SSTLs.

Table 8: Summary of Significant Geochemical Abundance Indices (SRK, 2009)

Description	As	B	Cd	Co	Cu	Mo	Pb	S	Se	Zn
MCA (ppm)	1.5	10	0.11	20	50	1.5	14	260	0.05	75
ALCY	1	2	0	0	0	0	0	1	2	0
AN?	2	3	0	0	0	0	0	0	0	0
ANA	0	2	0	0	0	0	0	2	1	0
ANC $_{RT}$	4	2	3	0	1	1	2	6	4	1
ANF	0	2	2	0	0	1	1	4	1	0
ANFA	0	1	0	0	0	0	0	2	0	0
ANFF	0	2	1	0	0	1	2	4	2	0
ANFQ	1	2	0	0	0	0	0	3	0	0
ANG	1	2	0	0	0	0	0	2	1	0
ANGA	0	3	0	0	0	0	0	2	1	0
ANGQ	0	1	0	0	0	0	0	1	1	0
APP	0	2	0	0	0	0	0	3	0	0
AX	5	2	2	1	2	1	0	6	5	1
AZ	1	3	1	0	0	0	0	4	2	0
AZB	0	0	0	0	0	0	1	3	1	0
AZC	0	2	0	0	0	0	0	4	1	0
AZS	1	2	0	0	0	1	0	4	2	0
MS	1	2	0	0	0	0	0	1	3	0
PPD	0	2	0	0	0	0	0	2	0	0
QLSD	0	0	0	0	0	0	0	0	1	0
TL	1	2	0	0	0	0	0	0	3	0

Note: MCA – mean crustal abundance; blank cells equate to zero GAI values

- Nearly all maximum concentrations for all metals were above respective average crustal abundance values (AIMM, 2001) and above respective SSTLs (Table 8), with the exception of beryllium and mercury. Concentrations of metals were notably more variable at depth, with levels extending across up to three orders of magnitude. Arsenic concentrations were by far the most variable, ranging from 0.2 ppm to 336 ppm, although barium, lead and zinc levels also showed a notable variance.

Table 9: Summary of Soil Analysis Results (SRK, 2009)

Values	As	Ag	Ba	Be	Cd	Co	Cr	Cu	Hg	Mn	Mo	Ni	Pb	Se	V	Zn
	ppm															
Minimum	0.2	0.2	6	0.1	0.1	1.3	6	3	0.01	36	0.6	6	2	0.02	12	7
Maximum	335.8	2.8	4695	2.5	6.3	91	815	573	0.16	5314	22.5	319	1326	7.36	391	1523
Average	12.0	0.5	987	0.9	0.3	26	114	76	0.02	822	3.8	67	44	0.46	141	135
AIMM Average Crustal Abundance	1.5	0.07	500	2.6	0.11	20	100?	50	0.05	950	1.5	80?	14	0.05	160	75
Site Specific Trigger Level	20	-	400	12	3	20.5	317	134	1	500	40	106	300	-	318	200

4.3.4 Kinetic Test Results

In recognition that elements with averages above the (AIMM, 2001) average crustal abundance levels may indicate a potential for these elements to leach from the waste material if exposed to weathering conditions, modified AMIRA type column tests were carried out on eight soil samples by SRK Consulting (2009) to assess changes in pH, sulfate and metal concentrations in the resulting kinetic test leachate. Preliminary results have been provided at the completion of 32 cycles (weeks) of the kinetic tests. Although the results show steady state conditions have not yet been established for the tests, they do indicate a clear difference in oxidation and solute release rates amongst the different samples.

pH levels

Preliminary pH results are shown on Figure 4 and show that the majority of samples remain in the near neutral pH range, indicating buffered pH conditions. However, one of the sample from the ferruginous chert (SRK003,ANCRT) has rapidly acidified over the 32 weeks, which is consistent with a low CarbNP (<0.8) compared with other samples, ranging from 17.6 to 90.4. In addition, whilst another ferruginous chert sample (SRK075), remained near neutral for approximately 28 weeks, in the subsequent four weeks the pH has declined sharply, suggesting that the sample has entered the early stages of acid generation.

Although sulfate to calcium + magnesium molar ratio remained at or below a value of one, indicating that not all of the carbonate minerals had been depleted from the sample, a calcium to magnesium molar ratio close to one suggested a dolomitic carbonate phase, which is consistent with a slower rate of dissolution of the carbonate minerals and acid neutralisation. Calculation of calcium to magnesium molar ratios for the remainder of the samples indicated that samples with high calcium to magnesium molar ratios were being buffered effectively in the pH 7 range, resulting from the more rapid dissolution of a predominantly calcitic carbonate phase.

Sulfate Concentrations

Preliminary sulfate concentrations in the kinetic test leachates are shown on Figure 5 and show that all the tests underwent an initial "flush" of sulfates, after which the concentrations decreased. SRK (2009) attribute this flush to the removal of oxidation products from the samples that accumulated whilst the samples were in storage. In subsequent weeks, sulfate concentrations, and as such, oxidation rates in the majority of the samples have remained relatively consistent. Notable exceptions have been steady increases in sulfate release rates (and hence oxidation rates) in the ferruginous cherts samples (SRK003 & SRK075) and sulphide rich rock (feldspar + qtz; SRK088) which have not yet reached a maximum value.

Comparison of calculated rates of sulfide depletion against rates of CarbNP consumption indicated that the CarbNP were depleted well in advance of the depletion of the acid generation potential for all but the garnet gneiss (undifferentiated) sample which had the highest CarbNP. These results indicate that the majority of these samples might be expected to eventually become acidic. The results also indicate that the rate of oxidation is related to pH conditions and sulfur content, generally increasing with increasing sulfur content and decreasing pH. However as noted previously, the samples selected as part of the geochemical analysis are biased towards sulfide mineralisation and therefore acid generation potential may be overestimated.

Figure 4: Consecutive Leachate pH Profiles for Kinetic Tests (SRK, 2009)

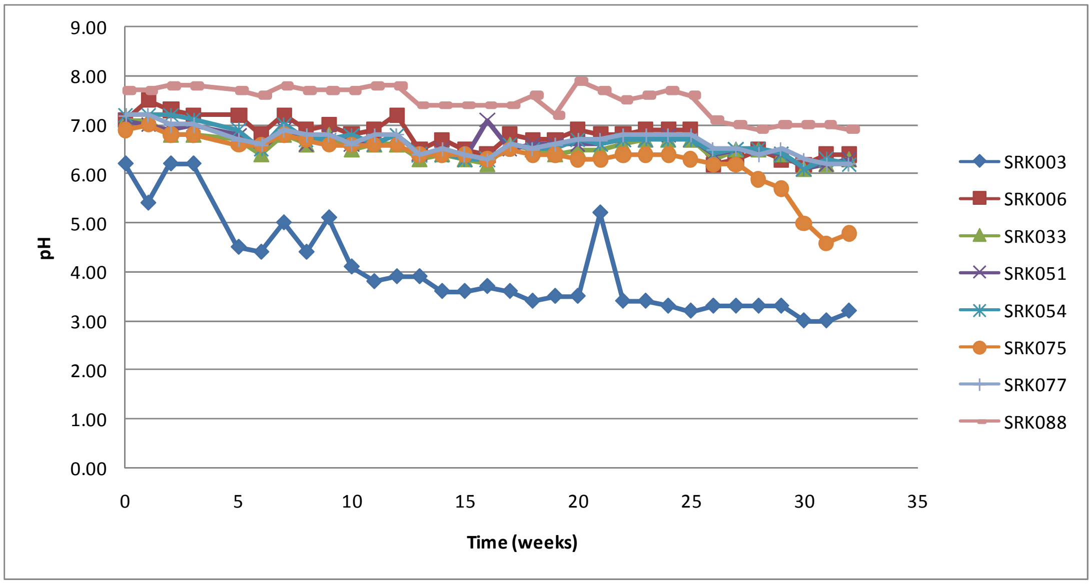

Figure 5: Sulfate Concentrations in Kinetic Test Leachates (SRK, 2009)

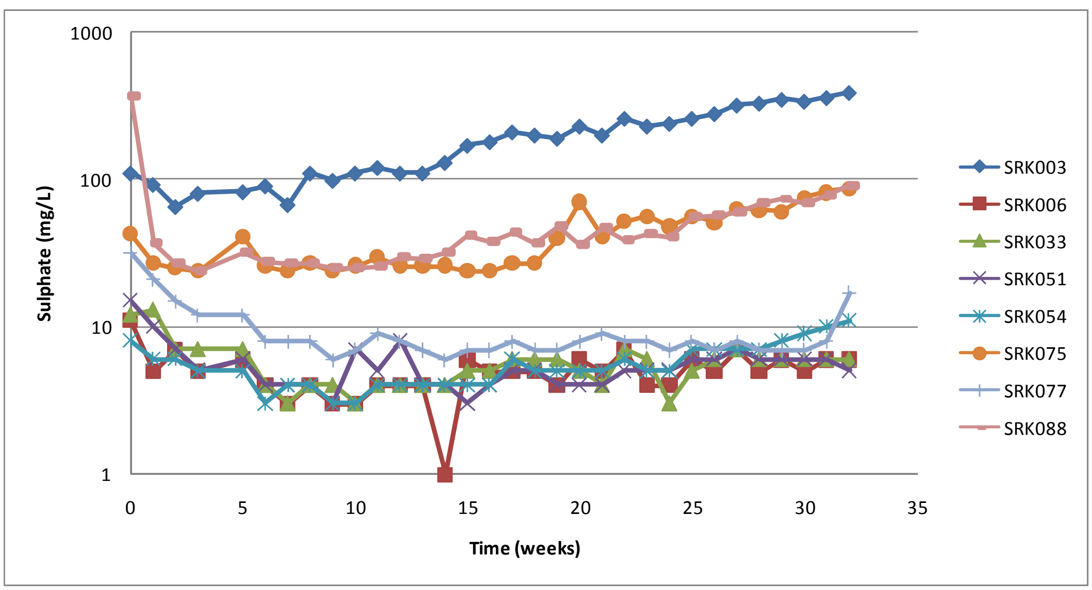

Table 10: Summary of Acid Neutralisation and Generation Rates (SRK, 2009)

Test	Sample	Unit	S(T) (%)	Ca/Mg	CarbNP Depletion		AP Depletion	
					Rate*	Time (yrs)	Rate*	Time (yrs)
1	SRK003	ANC $_{RT}$	3.56	0.34	0.0432	0	0.159	13
2	SRK006	ANG	0.13	6.15	0.00629	276	0.00250	35
3	SRK033	ANFF	1.11	2.36	0.00689	76	0.00263	251
4	SRK051	ANFF	1.60	5.36	0.00354	130	0.00258	363
5	SRK054	ANFQ	1.21	8.69	0.00795	43	0.00417	171
6	SRK075	ANC $_{RT}$	1.83	1.12	0.0643	21	0.0333	33
7	SRK077	ANF	1.70	3.97	0.00392	122	0.00315	320
8	SRK088	AX	1.34	3.07	0.0595	7	0.0262	30

Solute Leachability

Although solute release rates from the kinetic tests have not yet stabilised, the results indicate a clear difference in release rates for some metals amongst the different samples. Key findings from these results included the following:

- Metal concentrations in the leach water fluctuate over the 32-week period. For metals such strontium, a peak concentration was released early but in subsequent weeks, concentrations steadily decreased. By Week 32 the majority of metal release concentrations are continuing to decline or are at a relatively steady state.
- Release rates for a number of metals appear to be pH related and increase with decreasing pH. Not unexpectedly, concentrations of a number of analytes, including aluminium, beryllium, cadmium, cobalt, copper, manganese, nickel, and zinc are notably higher in the kinetic test leachate for the ferruginous chert sample, SRK003, than for any of the other samples, with the majority consistently exceeding respective groundwater SSTLs and DoE (2003) Fresh Water guidelines.
- Conversely arsenic release occurs at near neutral pH conditions and is highest in non acid forming material garnet gneiss (SRK006).
- Concentrations of numerous analytes in the sulfide rich rock sample, (SRK088), including aluminium, arsenic, cadmium, mercury, molybdenum,

selenium and zinc, were above the DoE (2003) Fresh Water guidelines , although only aluminium and molybdenum were above respective SSTLs.

- Aluminium and barium concentrations in nearly all samples were generally above respective SSTLs, whilst cadmium and zinc were generally in exceedence of DoE (2003) Fresh Water guidelines.

Table 11: Summary of Solute Release Rates (SRK, 2009)

Analyte	SRK003	SRK006	SRK033	SRK051	SRK054	SRK075	SRK077	SRK088
	ANC_{RT}	ANG	ANFF	ANFF	ANFQ	ANC	ANF	AX
	mg/kg/wk							
SO4	156	2.4	2.6	2.6	3.9	31	3.0	25
Ca	3.9	2.2	1.1	1.2	1.5	6.5	1.3	11.7
Mg	7.8	0.2	0.3	0.1	0.1	4.4	0.2	1.5
Al	1.5	0.0077	0.0077	0.0079	0.0043	0.0043	0.0042	0.045
Sb	0.000044	0.00072	0.00026	0.00069	0.00018	0.00062	0.00029	0.00064
As	0.0076	0.026	0.0031	0.0027	0.0020	0.0019	0.0028	0.020
Cd	0.014	0.000085	0.00012	0.000088	0.00052	0.00023	0.000084	0.00012
Co	0.37	0.00043	0.00043	0.00044	< DL	0.024	0.00042	0.00046
Cu	0.085	0.0042	0.0043	0.0044	0.0043	0.0043	0.0042	0.0033
Fe	57.2	0.0042	0.0043	0.0044	0.0043	0.074	0.0042	0.019
Pb	0.0062	0.0021	0.0035	0.0033	0.0028	0.0023	0.002	0.0016
Mo	0.00040	0.00023	0.010	0.00086	0.00029	0.00021	0.0012	0.012
Ni	0.087	0.0042	0.0043	0.0044	0.0043	0.0060	0.0042	0.0033
Se	0.0053	0.0021	0.0022	0.0022	0.0022	0.0023	0.0021	0.0037
Zn	0.46	0.0060	0.0086	0.0088	0.0086	0.14	0.0093	0.0079

Utilising these results, SRK Consulting (2009) calculated average solute release rates for the balance of the rock types comprising the waste material to determine potential impacts on the surrounding environment, including the underlying groundwater. From this data, the overall mass weighted solute release rates for the waste material land form as a whole were calculated. These are summarised in Table 12.

4.3.5 Estimated Percolation Rates and Quality

On the basis of the oxidation and solute release rates, SRK Consulting (2009) calculated preliminary estimates of the potential range of solute concentrations that may result in the percolate from the waste material landform in order to assess potential impacts on the local groundwater. Based on published waste material landform net infiltration rates, SRK Consulting (2009) estimated that the infiltration would be less than 6% of mean annual rainfall, although in the longer term the net infiltration rate could be reduced to close to regional recharge rates (in the order of 1 % or less of mean annual precipitation) through active waste material management that may including the blending of NAF and PAF within the waste material landform, combined with trafficking. However, due to preferential flow paths, seepage events could occur occasionally.

Seepage quality from the landform was estimated for an upper bound and a lower bound case. The mass weighted average solute release rates given in Table 12 were used to estimate potential concentrations in percolate from the waste material to give an upper bound estimate based on the assumption that about 3 m of waste rock would be in the oxidation zone. Considering a 1 m^2 column of waste material, about 16 L of water would pass through the waste material and contact about 30 % of the rock (i.e. 0.3 x 1.8 tonne/m^3 x 3 m^3 = 1.62 tonnes of waste material). Then correcting for the surface area, only about 30 % of the material would be reactive (i.e. 0.3 x 1.62 = 0.486 tonnes).

The lower bound estimate was calculated assuming that the reactive PAF and UC materials could be isolated by several meters of NAF materials (i.e. they were excluded from the mass weighting calculations). In that event only the NAF materials would be reacting over time and the low end of the oxidation and solute release rates would apply. Overall the waste material has a net excess of neutralisation capacity which suggests that, if managed appropriately, neutral pH conditions could be maintained as a whole. It is possible however that localised some areas of acid conditions could exist. The water quality estimates using the kinetic test solute release rates are shown in Table 12.

In the case of the lower bound estimate it is almost certain that neutral conditions could be maintained and the pH would be buffered to about 7, in which case the concentrations of a number of parameters would be lower than estimated as their solubility would be limited by the formation of secondary minerals.

Table 12: Summary of Assumed Solute Release Rates (SRK, 2009)

Major Unit	Class	Wt Distrib. %	Solute Release Rate (mg/kg/wk)							
			SO4	Al	Sb	As	Cd	Co	Cu	Fe
ALCY	UC	13.80	28.2	0.024	0.00063	0.011	0.00017	0.012	0.0038	0.046
AN?	UC	1.70	28.2	0.024	0.00063	0.011	0.00017	0.012	0.0038	0.046
ANA	NAF	1.20	2.9	0.0064	0.00043	0.0073	0.00018	0.00034	0.0043	0.0043
ANC_{RT}	PAF	1.80	155.8	1.5	0.00004	0.0076	0.014	0.37	0.084	57
ANF	UC	7.50	28.2	0.024	0.00063	0.011	0.00017	0.012	0.0038	0.046
ANFA	NAF	6.60	2.9	0.0064	0.00043	0.0073	0.00018	0.00034	0.0043	0.0043
ANFF	PAF	6.20	155.8	1.5	0.00004	0.0076	0.014	0.37	0.084	57
ANFQ	UC	8.10	28.2	0.024	0.00063	0.011	0.00017	0.012	0.0038	0.046
ANG	NAF	11.20	2.9	0.0064	0.00043	0.0073	0.00018	0.00034	0.0043	0.0043
ANGA	NAF	18.30	2.9	0.0064	0.00043	0.0073	0.00018	0.00034	0.0043	0.0043
ANGQ	NAF	-	2.9	0.0064	0.00043	0.0073	0.00018	0.00034	0.0043	0.0043
APP	PAF	0.20	155.8	1.5	0.00004	0.0076	0.014	0.37	0.084	57
AX	PAF	0.05	155.8	1.5	0.00004	0.0076	0.014	0.37	0.084	57
AZ	UC	2.70	28.2	0.024	0.00063	0.011	0.00017	0.012	0.0038	0.046
AZB	NAF	-	2.9	0.0064	0.00043	0.0073	0.00018	0.00034	0.0043	0.0043
AZC	PAF	-	155.8	1.5	0.00004	0.0076	0.014	0.37	0.084	57
AZS	UC	-	28.2	0.024	0.00063	0.011	0.00017	0.012	0.0038	0.046
MS	UC	2.50	28.2	0.024	0.00063	0.011	0.00017	0.012	0.0038	0.046
PPB	NAF	0.80	2.9	0.0064	0.00043	0.0073	0.00018	0.00034	0.0043	0.0043
PPD	NAF	0.90	2.9	0.0064	0.00043	0.0073	0.00018	0.00034	0.0043	0.0043
QLSD	NAF	4.80	2.9	0.0064	0.00043	0.0073	0.00018	0.00034	0.0043	0.0043
TL	NAF	8.10	2.9	0.0064	0.00043	0.0073	0.00018	0.00034	0.0043	0.0043
Mass weighted release rates			24.6	0.14	0.00045	0.14	0.00045	0.0083	0.0013	0.035

Table 12 cont.: Summary of Assumed Solute Release Rates

Major Unit	Class	Wt Distrib. %	Solute Release Rate (mg/kg/wk)						
			Pb	Mo	Ni	Se	Zn	Ca	Mg
ALCY	UC	13.80	0.002	0.0061	0.0046	0.003	0.072	9.1	3
AN?	UC	1.70	0.002	0.0061	0.0046	0.003	0.072	9.1	3
ANA	NAF	1.20	0.0028	0.0025	0.0043	0.0021	0.0082	1.5	0.19
ANC_{RT}	PAF	1.80	0.0062	0.0004	0.087	0.0053	0.46	3.9	7.8
ANF	UC	7.50	0.002	0.0061	0.0046	0.003	0.072	9.1	3
ANFA	NAF	6.60	0.0028	0.0025	0.0043	0.0021	0.0082	1.5	0.19
ANFF	PAF	6.20	0.0062	0.0004	0.087	0.0053	0.46	3.9	7.8
ANFQ	UC	8.10	0.002	0.0061	0.0046	0.003	0.072	9.1	3
ANG	NAF	11.20	0.0028	0.0025	0.0043	0.0021	0.0082	1.5	0.19
ANGA	NAF	18.30	0.0028	0.0025	0.0043	0.0021	0.0082	1.5	0.19
ANGQ	NAF	-	0.0028	0.0025	0.0043	0.0021	0.0082	1.5	0.19
APP	PAF	0.20	0.0062	0.0004	0.087	0.0053	0.46	3.9	7.8
AX	PAF	0.05	0.0062	0.0004	0.087	0.0053	0.46	3.9	7.8
AZ	UC	2.70	0.002	0.0061	0.0046	0.003	0.072	9.1	3
AZB	NAF	-	0.0028	0.0025	0.0043	0.0021	0.0082	1.5	0.19
AZC	PAF	-	0.0062	0.0004	0.087	0.0053	0.46	3.9	7.8
AZS	UC	-	0.002	0.0061	0.0046	0.003	0.072	9.1	3
MS	UC	2.50	0.002	0.0061	0.0046	0.003	0.072	9.1	3
PPB	NAF	0.80	0.0028	0.0025	0.0043	0.0021	0.0082	1.5	0.19
PPD	NAF	0.90	0.0028	0.0025	0.0043	0.0021	0.0082	1.5	0.19
QLSD	NAF	4.80	0.0028	0.0025	0.0043	0.0021	0.0082	1.5	0.19
TL	NAF	8.10	0.0028	0.0025	0.0043	0.0021	0.0082	1.5	0.19
Mass weighted release			0.011	4.7	0.0027	0.0036	0.011	0.0026	0.069

The preliminary upper and lower bound concentration estimates may be used to assess potential impacts on groundwater quality. Since non-reactive materials will be used to place the proposed cover over the waste material landform, surface run-off water quality should not be impacted.

Table 13: Summary of Estimated Percolate Quality (SRK, 2009)

Parameter	Concentration (mg/L)	
	Upper Bound	Lower Bound
SO4	42618	2523
Al	238	11
Sb	0.79	0.076
As	14	13
Cd	2.3	0.30
Co	61	0.59
Cu	18	6.6
Fe	8210	7.4
Pb	4.6	3.4
Mo	6.2	0.69
Ni	19	7.4
Se	4.6	3.7
Zn	119	14
Ca	450	500
Mg	3153	326

4.4 Groundwater Analysis

Baseline groundwater quality data was obtained from four existing abstraction bores within the proposed operational footprint (Havana Bore, Tropicana Bore, Laydown Bore No. 1 and Laydown Bore No. 2). This data was obtained on a monthly to quarterly basis, and from three exploration drill holes at which groundwater was intercepted during the drilling program. Groundwater monitoring results are presented in Tables 14 and 15. The results indicated the following:

- pH of groundwater was generally slightly acidic to slightly alkaline across all four monitoring bores, with levels ranging from 6.6 to 8.05.

- Groundwater across the region is generally saline to hyper-saline with EC levels generally ranging from 45,000 to 50,000 µS/cm. EC levels at the Havana Bore are notably lower than in the Tropicana or Laydown Area bores, ranging from 20,000 to 27,000 µS/cm. Even lower EC measurements were detected in groundwater intercepted in the drillholes (KMA121, BDRC004, BDRC005), ranging from 15,00 to 4,500 µS/cm.
- The majority of groundwater analysis results conformed to respective FWG. Several exceptions included the following:
  - Nickel concentrations in groundwater at KMA121, BDRC004 and BDRC005 ranged from <0.005 mg/L to 0.038 mg/L, which are at or below the SSTL.
  - The majority of cadmium and copper concentrations were below laboratory limits of reporting (LOR) of 0.001 mg/L and 0.005 mg/L.
  - Similarly, although the majority of lead concentrations were below laboratory LOR of 0.001 to 0.02 mg/L; the majority of LORs were above the DoE (2003) Fresh Water guideline level of 0.0034 mg/L.
- No appropriate trigger levels were available for barium, cobalt, molybdenum and vanadium.

This data provides a baseline for groundwater quality across the site, against which water quality data collected during the operational and post-operational phases of the mine can be assessed, to ensure the quality of the underlying groundwater is not being impacted.

Table 14: Groundwater Analysis Results – Metals

Date Sampled	Location	Al	B	Ba	Be	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Sr	Sn	V
01/10/06	Havana Bore																
01/09/07										<0.01		0.008					
18/12/07						0.001			<0.005	<0.01	<0.001	0.084					
05/02/08						<0.001			<0.005	<0.01	<0.005	0.008					
14/02/08						<0.001			<0.005	<0.01	<0.01	0.012					
27/03/08						<0.001			<0.005	<0.01	0.01	0.009					
15/05/08						0.001			0.009	0.09	<0.010	0.01					
26/06/08						<0.001			<0.005	<0.01	<0.01	0.008					
01/09/07	Tropicana Bore									<0.01		0.051					
01/11/07										<0.01		0.046					
18/12/07						0.002			0.019	<0.01	<0.001	0.091					
05/02/08						0.003			<0.005	<0.01	<0.010	0.041					
14/02/08						0.003			<0.005	<0.01	<0.01	0.039					
28/02/08						0.003			<0.005	0.04	<0.001	0.012					
27/03/08						0.003			0.006	<0.01	0.01	0.041					
29/04/08						0.003			0.005	<0.01	<0.02	0.044					
15/05/08						0.003			0.01	0.03	<0.010	0.043					
29/07/08						0.005			<0.005	0.06	<0.001	0.041					
27/08/08						0.003			<0.005	<0.01		0.042					
10/09/08						0.003			<0.005	<0.01	<0.001	0.038	<0.005	<0.005			
07/11/08						0.005			<0.005	<0.01	<0.02	0.041					
02/12/08						0.003			<0.005	0.04	<0.001	0.89					
01/10/06	Laydown Bore 1																
01/11/07										<0.01		0.37					
18/12/07						<0.001			0.009	<0.01	0.001	0.36					
29/01/08						<0.001			<0.005	0.01	0.07	0.42					

Table 14 cont. Groundwater Analysis Results - Metals

Date Sampled	Location	Al	B	Ba	Be	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Sr	Sn	V
14/02/08	Laydown Bore 1					<0.001			<0.005	<0.01	<0.01	0.41					
28/02/08						<0.001			<0.005	0.26	<0.001	0.37					
27/03/08						<0.001			<0.005	<0.01	<0.01	0.39					
27/03/08						<0.001			<0.005	<0.01	0.01	0.38					
26/06/08						<0.001			0.012	1.2	<0.01	0.43					
29/07/08						0.001			<0.005	0.12	<0.001	0.39					
07/11/08						<0.001			<0.005	<0.01	<0.02	0.27					
02/12/08						0.003			<0.005	0.05	<0.001	0.42					
01/11/07	Laydown Bore 2									<0.01		0.4					
18/12/07						<0.001			<0.005	<0.01	0.001	0.38					
29/01/08						<0.001			<0.005	0.01	0.11	0.4					
14/02/08						<0.001			<0.005	<0.01	<0.01	0.41					
28/02/08						0.002			<0.005	0.38	<0.001	0.38					
29/04/08						<0.001			<0.005	<0.01	<0.02	0.38					
15/05/08						<0.001			0.016	3	<0.010	0.35					
26/06/08						<0.001			0.016	1.6	<0.01	0.41					
29/07/08						0.001			<0.005	0.21	<0.001	0.38					
27/08/08						0.001			<0.005	<0.01		0.43					
10/09/08						<0.001			<0.005	<0.01	<0.001	0.39	<0.005	<0.005			
07/11/08						<0.001			<0.005	<0.01	<0.02	0.32					
02/12/08						<0.001			<0.005	1.3	<0.001	0.4					
Groundwater Intercepted During Drilling Programs																	
05/11/08	KMA121	<0.005	1.6	0.064	<0.0005	<0.001	<0.001	0.049	0.014	<0.01		0.98	0.026	0.038	<0.05	1.5	0.003
05/11/08	BDRC004	<0.005	1.5	0.042	<0.0005	<0.001	<0.001	<0.005	0.013	<0.01		0.87	0.028	<0.005	<0.05	0.28	<0.002
05/11/08	BDRC005	<0.005	1.2	0.039	<0.0005	<0.001	<0.001	<0.005	0.015	<0.01		1.2	0.022	<0.005	<0.05	0.29	<0.002
	Min	<0.005	1.2	0.039	<0.005	<0.001	<0.001	<0.005	0.005	<0.01	0.001	0.008	0.005	<0.005	0.05	0.28	0.002
	Max	<0.005	1.6	0.064	<0.005	0.005	<0.001	0.049	0.019	3.00	0.11	1.20	0.028	0.038	0.05	1.5	0.003
	Average	<0.005	1.4	0.048	<0.005	0.002	<0.001	0.020	0.007	0.18	0.012	0.289	0.017	0.012	0.05	0.69	0.002
	DoE (2003) FWG	0.055	NG	0.7	0.004	2E-04	0.001	NG	0.001	NG	0.003	1.9		0.011			0.008

Table 15: Groundwater Analysis Results – Field Parameters and Nutrients

Date Sampled	Location	EC	pH	TDS	CO3	HCO3	OH	Hardness	CL	SO4	NO3	Na	K	Ca	Mg	Si	TP	TN	TKN
1/10/06	Havana Bore		7.95	14000	<1	280	<1	4500	6500	1900	32	3000	140	530	760				
1/9/07		20000	7.55	16000	<1	230	<1	4500	6200	590	29	3100	140	470	790	36			
18/12/07		27000	7.35	21000	<1	210	<1	6100	9700	3200	22	4000	190	580	1100				
5/2/08		20000	7.05	16000	<1	230	<1	4300	6100	2100	22	2700	130	470	760				
14/2/08		21000	7.15	15000	<1	250	<1	4400	6600	2300	23	3000	140	470	790				
27/3/08		20000	6.95	15000	<1	210	<1	4000	6500	1700	29	2700	120	430	710				
15/5/08		20000	7.3	17000	<1	210	<1	4200	6800	1900	31	3900	150	420	760				
26/6/08		22000	7.2	16000	<1	240	<1	4600	6300	1700	29	3200	160	520	810				
1/9/07	Tropicana Bore	50000	6.8	39000	<1	240	<1	9300	17000	5000	4.7	9100	610	550	1900	34			
1/11/07		49000	6.75	37000	<1	240	<1	9000	17000	5000	1.6	8300	550	550	1900	35			
18/12/07		50000	7.25	39000	<1	240	<1	9000	19000	5600	1.8	8500	570	520	1900				
5/2/08		49000	7.55	38000	<1	240	<1	8800	17000	5100	1.9	8500	460	560	1800				
14/2/08		50000	7.25	38000	<1	12	<1	9200	18000	5500	<0.1	9100	560	570	1900				
28/2/08		48000	7	41000	<1	140	<1	7600	18000	4200	3.6	8000	400	490	1600				
27/3/08		49000	6.95	40000	<1	250	<1	8200	18000	4400	2	7900	500	500	1700				
29/4/08		49000	7.25	39000	<1	240	<1	9300	17000	3500	<1	8600	570	580	1900				
15/5/08		49000	6.95	42000	<1	240	<1	8800	18000	4500	3.4	11000	660	480	1800				
29/7/08		50000	6.85	40000	<1	260	<1	8800	18000	4400	8.2	8600	350	560	1800				
27/8/08		45000	7.95	35000	<1	200	<1	9000	14000	3500	<0.1	9300	510	550	1800				
10/9/08		49000	7.7	38000	<1	210	<1	8800	18000	4900	<4	8800	560	520	1800		0.05	1.2	0.37
7/11/08		48000	6.80	37000	<1	200	<1	8500	17000	3900	3.4	8300	500	540	1700				
02/12/08		2300	6.85	56000	<1	240	<1	14000	25000	5800	1.8	12000	510	850	2800				
01/10/06	Laydown Bore 1		7.15	34000	<1	240	<1	7900	17000	5600	<4	8800	660	530	1600				
01/11/07		45000	6.9	34000	<1	240	<1	7300	15000	5000	<0.1	7900	590	430	1500	30			
18/12/07		46000	7.3	35000	<1	280	<1	6800	17000	5700	0.6	8800	550	400	1400				
29/01/08		46000	7.2	35000	<1	270	<1	7900	17000	5600	<4	8900	630	470	1600				
14/02/08		47000	7.5	35000	<1	290	<1	7200	16000	5100	<0.1	8400	590	450	1500				

Table 15 cont.: Groundwater Analysis Results – Field Parameters and Nutrients

Date Sampled	Location	EC	pH	TDS	CO3	HCO3	OH	Hardness	CL	SO4	NO3	Na	K	Ca	Mg	Si	TP	TN	TKN
28/2/08	Laydown Bore 1	46000	7.2	37000	<1	130	<1	6400	17000	4700	2.1	8200	390	390	1300				
27/3/08		46000	6.6	34000	<1	250	<1	6700	17000	4600	<1	7900	570	410	1400				
27/3/08		45000	7.7	33000	<1	280	<1	6700	16000	4700	<1	7700	560	400	1400				
26/6/08		49000	7.8	37000	<1	300	<1	7700	17000	4500	<0.1	10000	530	510	1600				
29/7/08		46000	6.9	35000	<1	270	<1	7100	16000	4300	4.4	8200	400	400	1500				
7/11/08		46000	7.20	34000	<1	230	<1	7400	16000	4300	1.3	8500	590	460	1500				
2/12/08		46000	6.9	34000	<1	270	<1	6900	16000	3400	<0.1	8600	440	400	1400				
1/11/07	Laydown Bore 2	47000	7.15	35000	<1	250	<1	7800	17000	5800	0.1	8300	630	460	1600	32			
18/12/7		47000	7.35	36000	<1	270	<1	7100	18000	5800	0.2	8700	580	410	1500				
29/1/08		45000	7.6	35000	<1	280	<1	7400	15000	4700	<4	8200	620	440	1500				
14/2/08		48000	7.45	35000	<1	280	<1	7500	16000	5300	<0.1	8600	620	450	1600				
28/2/08		47000	7.5	37000	<1	120	<1	6600	17000	5000	<0.1	8100	410	390	1400				
29/4/08		45000	7.35	34000	<1	270	<1	7500	15000	3500	<1	8200	620	460	1600				
15/5/08		46000	7.15	37000	<1	260	<1	7000	17000	4500	<0.1	10000	710	350	1500				
26/6/08		50000	7.55	37000	<1	300	<1	7800	17000	4600	<0.1	10000	520	500	1600				
29/7/08		47000	7.2	35000	<1	260	<1	7000	16000	4300	4.5	8200	410	390	1500				
27/8/08		47000	7.45	36000	<1	230	<1	8400	16000	4300	<0.1	9400	620	500	1700				
10/9/08		46000	7.9	34000	<1	280	<1	7300	16000	5100	<4	8500	640	420	1500		<0.01	<0.05	<0.05
7/11/08		45000	7.30	34000	<1	260	<1	7100	5000	5200	<0.1	8000	570	430	1500				
2/12/08		46000	7.5	36000	<1	260	<1	7300	16000	4400	<0.1	8500	460	460	1500				
Groundwater Intercepted During Drilling Program																			
5/11/08	KMA121	5300	7.35	3700	<1	120	<1	690	1600	470	<0.1	940	68	64	130	9.8			
5/11/08	BDRC004	1500	8.05	970	<1	230	<1	140	470	270	1.2	480	23	16	23	5.4			
5/11/08	BDRC005	1500	7.35	960	<1	240	<1	120	290	150	<0.1	310	19	18	18	11			
	Min	1500	6.60	960	1	12	1	120	290	150	0.1	310	19	16	18	5.4	0.01	0.05	0.05
	Max	50000	8.05	56000	1	300	1	14000	25000	5800	32	12000	710	850	2800	36	0.05	1.2	0.37
	Average	39783	7.28	31453	1	235	1	6907	14321	4032	5.8	7359	450	454	1413	24	0.03	0.625	0.21

4.5 Fibrous Minerals

Following the detection of possible fibrous minerals in limited diamond drilling cores, a number of samples were submitted for Scanning Electron Microscopy (SEM) analysis to determine fibre type and morphology. The assessment indicated that the dominant fibrous mineral present was Actinolite, with the presence of a few other fibrous minerals as well. Some fibres that could not be accurately classified were designated "amphibole". The minerals were found to be long and thin, typically less than 1 micron in width and longer than 10 microns in length, with a very high length to width aspect ratio.

All fibres identified in these samples met the criteria for a respirable fibre, that is, small enough to reach the lungs. The criteria is usually defined as is less than 3 microns in width, greater than 5 microns in length, and a length to width aspect ratio of more than 3:1. Accordingly, these results indicate that some fibrous minerals present at the TGP site may be potentially hazardous. Studies completed suggest that only a relatively small quantity of material meets this criteria although it is acknowledged that the material may be wide spread. The TJV believes that this issue can be effectively managed by adopting appropriate dust management measure as required under the *Mine Safety and Inspection Act* 1978.

4.6 Discussion

Multi-element analysis of surface soil samples and near surface soil samples carried out by TJV and Outback Ecology Services (2008) respectively over the TGP Operational Area has provided a baseline for metal concentrations occurring naturally in the TGP environment. Similarly, ongoing groundwater sampling and analysis results carried out by TJV has provided a baseline for metal concentrations in groundwater at the TGP site. As such, it is considered appropriate that the resulting data are used as site specific trigger levels for the purpose of future assessment on the impact of the proposed TGP operations on the surrounding environment. These trigger levels are presented in Tables 2 and 4. Should future monitoring programs report concentrations of these analytes above the SSTLs, the need for further assessment and/or management will be triggered.

The results of the field investigations and laboratory analysis have indicated that concentrations of a number of metals in samples collected at depth, including barium, cobalt, lead, manganese and nickel occur at levels above SSTLs. These concentrations rise with increasing depth from the surface. In addition, tests for acid generation have shown that up to 15% of the total volume of waste material generated could be PAF (SRK, 2009). In the event that an acidic environment is created, the potential for greater concentrations of metals to be released is increased. Nonetheless, geochemical characterisation has indicated that the waste material has a net excess of neutralisation capacity which suggests that, if managed appropriately, neutral pH conditions could be maintained as a whole, although some localised areas of acid conditions could still exist.

Preliminary results from the kinetic leach test indicate that individual levels and cumulative metal release concentrations generally conformed to the SSTLs for groundwater and soils respectively, indicating that despite elevated metal concentrations in the underlying regolith, the metals generally do not readily leach out. One sample, of ferruginous chert was the exception, with a number of analytes exceeding respective SSTLs. However, this material is a relatively small proportion of the predicted waste volume (~2%).

The presence of fibrous minerals, which were initially observed in diamond drilling cores, and have been confirmed through SEM analysis, may create health issues if not appropriately managed.

5 Site Conceptual Model

The purpose of a conceptual site model (CSM) is to illustrate the three fundamental components of contaminated land, source, pathway and receptor. For contaminants to pose of risk to human or ecological health, all three components have to be in place. The CSM below outlines the various sources of contamination, pathways receptors associated with the TGP.

5.1 Potential Sources

Potential sources of contamination at the TGP site were identified as including the following:

- The Tailings Storage Facility (TSF). If there is a breach in the underling HDPE geomembrane /clay liner, cyanide and heavy metals in the tailings may seep into the underlying substrata and groundwater. It is noted that the TJV is committed to maintaining a cyanide concentration of 50 mg/L in the total standing bleed water at the TSF, to meet the requirements of the International Cyanide Management Code (ICMC), of which TJV is a signatory. However, this concentration is orders of magnitude higher than the DoE (2003) Fresh Water guideline level of 7 µg/L. No SSTL is available for this potential contaminant.
- Waste Material Landform (WML). Heavy metals in the waste material maybe leached by infiltrating rainwater and seep through to the underlying substrata and groundwater. In addition, the small quantity of PAF present in mine waste may increase acidity of soils and thus increase leaching of metals in soils. Surface run-off generated by major storm or cyclonic events may carry eroded particulate bound metals across the immediate vicinity of the waste dump and surrounding land. Resulting increases in concentrations of these metals across this area may impact on flora and fauna.
- It is recognised that potential seepage from the TSF and the surface run-off from the WML will be limited due to low rainfall and high evaporation rates. However, in the event of a major storm or cyclonic event, the TSF may overflow and cyanide and heavy metal-rich water spread across the adjoining waste dump and surrounding land. A portion of the cyanide and heavy metals may adsorb to soil particles, elevating concentrations in surface soils in this area, potentially impacting flora and fauna. The remainder of heavy metals and cyanide may infiltrate through the substrata to the underlying groundwater.
- Hydrocarbons and Dangerous Goods Spills. Spills of fuel and other chemicals may occur across the operational area during the construction and operational phases. Potential contaminants of concern include a wide variety of compounds such as total petroleum hydrocarbons, benzene, toluene, ethylbenzene and xylenes, polycyclic aromatic hydrocarbons, phenols, volatile and semi-volatile organic compounds, explosives and di-iso butyl-ketone.

Possible sources of hydrocarbon contamination are from refuelling spills, hydraulic equipment failure and spills, poor housekeeping and waste management in workshops and chemical storage areas and general plant and equipment leaks and spills.

- Putrescible and Industrial Waste. The TGP will generate waste including putrescibles waste, industrial waste and recyclables, some of which will have the potential to cause contamination to both the soils and underlying groundwater. The potential contaminants of concern depend on the type of waste disposed; however, as a minimum, nutrients, metals and hydrocarbon may be potential contaminants of concern.
- Fibrous Minerals. Fibrous minerals have been observed in limited diamond drilling cores, and may impact human health of workers onsite if not appropriately managed.
- Sewage Ponds The village and associated amenities will be required to house up to 700 personnel at any one time during the Construction and Operational phase of the TGP. If not managed appropriately, sewage could be a major health and environmental issue.

5.2 Chemicals of Concern and Areas of Association at the Site

Chemicals of potential concern identified at the site and the areas they are associated with are summarised in Table 16 below.

Table 16: Analytes of Potential Concern and the Areas of Association Within the Site.

Areas of Association within the Site	Analyte of Concern	Rationale
Tailings Storage Facility	Heavy metals (arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, nickel, selenium, vanadium, zinc) Cyanide	Heavy metals and cyanide from the tailings.
Waste Material Landform	Heavy metals (arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, nickel, selenium, vanadium, zinc) Potentially Acid Forming Rocks	Heavy metals leaching from the waste rock material May acidify surrounding soils and promote leaching of metals from these soils

Areas of Association within the Site	Analyte of Concern	Rationale
	Fibrous minerals	Weathered rock or crushed fibrous containing rock may release fibrils
Workshops and Laydown Areas	Hydrocarbons, degreasers, solvents	Associated with the use and maintenance of vehicle and plant
Vehicular Activities	Hydrocarbons	Associated with potential spills from the use of vehicles and plant across the site
Rubbish Tip	Nutrients (nitrate as N, nitrite as N, nitrite and nitrate as N, Total Kjeldahl Nitrogen (TKN) as N, total phosphorus)	Associated with the decomposition and leaching of putrescibles waste
	Heavy Metals (arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, zinc)	Associated with the weathering and leaching of scrap metal
	Hydrocarbons Solvents	Leaks from discarded containers for products used in vehicle and plant maintenance
Mining and Crushing	Fibrous minerals	Crushed fibrous-containing rock may release fibrils especially undertaking high risk activities such as drilling, loading, transport and crushing
Sewerage ponds	Metals (e.g. aluminium, arsenic, cadmium, chromium, cobalt, lead, nickel, zinc) Nutrients (phosphorus, potassium, nitrogen) Phenols Microbes (e-coli, enterococci, faecal coliforms and thermotolerant coliforms)	Associated with waste material from sewerage ponds

5.3 Sources, Pathways and Receptors

Table 17 summarises the sources of potential environmental concern, pathways, receptors and risks. Risks for a number of receptors is low to moderate, in recognition that under normal weather and operating conditions, there is very little risk of the majority of the potential sources of contamination identified impacting on potential receptors. However, during large storms or cyclonic events that may result in extensive flooding, the risk of contaminants entering the surrounding environment and migrating towards a sensitive receptor increases significantly.

Table 17: Sources of Potential Environmental Concern, Pathways and Receptors.

Source	Pathway	Receptor	Risk
Tailings Storage Facility	Direct contact, ingestion of soil and tailings, inhalation of particulates.	Birds and animals	Low for animals (TSF to be fenced off)
			Moderate for birds
		Operational phase workers during any site works.	Low/Moderate
	Surface runoff with elevated metal concentrations from tailings storage facility	Flora and Fauna	Low/Moderate
		Surface water bodies	Low/Moderate
	Seepage from TSF	Groundwater	Low/Moderate
		Subterranean species	Low/Moderate

Table 17 (cont.): Sources of Potential Environmental Concern, Pathways and Receptors.

Source	Pathway	Receptor	Risk
Waste Material Landforms	Leaching from unsaturated zone into groundwater	Groundwater	Low/Moderate
		Subterranean species	Low/Moderate
	Surface runoff with elevated metal concentrations	Flora and Fauna	Low/Moderate
		Surface water bodies	Low/Moderate
	Inhalation of fibrous material	Operational phase workers during any site works.	Moderate
Hydrocarbons and other chemicals	Direct contact, ingestion of soil	Onsite workers	Low
Hydrocarbons and other chemicals	Direct contact, ingestion of soil	Fauna	Low (assuming most spills occur in workshops or in active operational areas where fauna are not so likely to roam)
Hydrocarbons and other chemicals	Inhalation of particulates/vapours	Onsite workers	Moderate
		Fauna	Low
	Spill leaching from unsaturated zone into groundwater	Groundwater	Low due to depth of groundwater (lighter hydrocarbons may volatilise off before reaching groundwater; heavier hydrocarbons more likely to adsorb to soil particles).
		Subterranean species	Moderate

Source	Pathway	Receptor	Risk
Rubbish Tip	Direct contact, ingestion of soil, inhalation of particulates/vapours	On-site workers	Low/Moderate
		Flora	Low
		Fauna	Moderate
	Surface runoff with elevated concentrations of a range of potential contaminants	Flora and Fauna	Moderate
		Surface water bodies	Low/Moderate
	Leaching from unsaturated zone down to groundwater	Groundwater	Moderate
		Subterranean species	Low/Moderate
Open Pit Face	Inhalation of fibrils	Operational phase workers	Low
		Fauna	Low
Sewerage ponds	Direct contact and ingestion	Onsite workers	Low (assume access restricted to key personnel)
		Fauna	Low (assume Sewerage ponds appropriately fenced off).
	Leaching from unsaturated zone into groundwater	Groundwater	Low/Moderate
		Subterranean	Low/Moderate

5.4 Contaminant Management and Minimisation Strategies

TJV is committed to best practice environmental management and continuous improvement of the TJV environmental performance. Primary considerations in the preliminary design process have been the avoidance of potential impacts on the surrounding environment, the reduction of the ecological footprint of the project and the development of a future-proof design. Documented management strategies have been drafted and will be finalised, maintained and incorporated in to the TGP's Integrated Management System for environmental aspects that require documented controls to ensure the desired environmental outcomes are achieved.

In order to address the potential contaminants of concern identified in Section 5.2, TJV has nominated to adopt a number of strategies throughout the life of the mine to minimise the risk of any potential contamination generated from the proposed operations impacting on the surrounding environment. These strategies focus on removing or reducing the source where possible, or where this is not feasible, alternatively removing the pathway between identified sources and potential receptors. Key strategies are summarised in the sections below.

5.4.1 Tailings Storage Facility

As discussed in Section 2.2.2, the basin of the TSF will be lined with a combination of HDPE and low permeability clay to minimise seepage to the underlying substrate and groundwater. The basin liner and underdrainage system for the facility have been optimised to make best use of naturally occurring materials on the site. On this basis, the basin area will consist of the following components:

- Subgrade (300mm depth) over the TSF basin, consisting predominantly of reworked in-situ material.
- 1.5mm HDPE smooth geomembrane liner over the subgrade beneath the supernatant pond of each cell (textured liner will be used below causeways). The total area covered by the geomembrane is equivalent to approximately 20% of the basin area for each cell.
- The rest of the basin area (approximately 80% of the basin) will be covered with a 300 mm thick clay soil liner (material sourced from the open pit pre-strip) covered with 300 mm of sand (to reduce drying and cracking of the soil liner).
- A basin underdrainage system will be constructed through the basin area and is designed to reduce the phreatic surface on the basin liner, and to reduce seepage through the basin and embankment. The underdrainage system will drain by gravity to a collection sump located at the lowest in the TSF basin for each cell, with the water then pumped back into the supernatant pond for reuse.
- Seepage modelling carried out by Knight Piesold for the TGP indicate that seepage rates for the proposed TSF under normal operation conditions and extreme wet conditions would both remain below the Department of Water (2006) of 1 kL/ha/day.

In addition, fencing will be erected initially around the tailings storage facility to keep animals out, and water birds will be monitored and discouraged to enter or remain in the area. The fencing will either be adjusted or removed as the waste material landform expands to surround the TSF.

A comprehensive monitoring program will be developed to monitor for potential problems during the operation of the mine. The monitoring will include survey pins to check embankment movements, piezometers in the embankment and monitoring bores downstream of the embankment. The piezometers and bores will be monitored monthly for water levels and quarterly for water quality parameters.

Cyanide Management

The TSF will be managed to meet the requirement of the International Cyanide Management Code (ICMC). As part of the code, the TSF will be monitored for levels of Weak Acid Dissociable Cyanide (WADCN) to ensure that wildlife is protected. The Tailings Storage Facility Environmental Management Plan incorporates cyanide monitoring procedures and management strategies to meet the requirements of the ICMC. The preferred management option is to actively control cyanide levels at the CIL circuit to maintain residual WADCN in tailings bleed water at an acceptable level (in accordance with the requirements of the ICMC). However, should monitoring in the first year of operation demonstrate that this is not possible, then alternative methods will be evaluated and implemented to meet the required standards.

If required, the cyanide control or destruction facility will be designed to reduce WADCN in the tailings bleed water. The intention would be to treat only sufficient bleed water to ensure that the total standing bleed water at the TSF is below the target of 50 mg/L.

When the Tropicana/Havana pit is ultimately decommissioned, the TSF will be rehabilitated. The exact rehabilitation strategy is yet to be determined but the facility will be covered with a capillary break and growth medium. The thickness of the capillary break will be at least 1 m, along with 1 m of growth medium. The outer western slope of the facility will be battered down to 15° to blend into the adjacent waste landform.

5.4.2 Waste Material Landform

The WML will be managed to ensure that no PAF material is placed within the outer 10 m of the waste dump. During operation, surface water run-off from the landforms will be managed via the site internal drainage system that directs potentially contaminated surface run-off to central points for recovery or evaporation. Run-off in the collection point will be tested following significant rain events to determine if management strategies are working. Monitoring bores will be installed across site to determine if the operation is affecting the local groundwater supply.

At closure, a toe drain will be installed to contain any run-off generated from the facility. This drain will be diverted in the pit void.

5.4.3 Hydrocarbon and Chemical Spills

In order to address the issue of hydrocarbon spills, the TJV has proposed to design, construct and implement hydrocarbon and chemical storage facilities that will contain any spills that may occur within the storage and refuelling area (AS1940; AS3780; AS4452). The facilities will be designed to meet the Australian Standards and WA DEC requirements. In the event that a spill occurs outside a containment area, the TJV will establish an on-site hydrocarbon remediation facility (HRF) for the TGP. The HRF is to be utilised for the remediation of hydrocarbon contaminated soils generated during operations. The detailed design of the facility has not been completed; however, the facility will be designed and constructed in accordance with relevant legislation including the *Bioremediation of hydrocarbon-contaminated soils in Western Australia – Contaminated Sites Management Series* (DoE 2004). In addition, the following procedures will be implemented:

- All chemicals utilised on site will be stored in accordance with the appropriate Australian Standards and other relevant regulations
- Compulsory spill reporting
- Spill emergency response procedure
- Revegetation of any areas damaged by a spill or leak following decontamination.

5.4.4 Waste Management

In order to minimise the impact of putrescibles and industrial waste generated from the operation of TGP, TJV have proposed the following management strategies:

- Implement a site recycling program to support ZeroWasteWA policy
- Manage industrial waste in accordance with the Environmental Protection (Controlled Waste) Regulations 2004
- Manage the site landfill in accordance with the Environmental Protection (Rural Landfill) Regulations 2002.

5.4.5 Fibrous Minerals

Health risks from airborne dust containing fibrous materials will be managed in accordance with the Mine Safety and Inspection Act 1994. Management will focus predominantly on silica and fibrous minerals.

Management of human health risks from airborne dust containing fibrous materials originating from the waste material may include avoidance or reduction strategies such as capping, restriction of access, wet crushing, remote operation and sealed cabins. In the event that it cannot be managed to an acceptable level, personnel protective equipment requirements will be adopted. This program will be incorporated into the TGP's Dust Management Plan, which also includes the development of a monitoring program to assess impact of dust on sensitive vegetation.

6 Conclusions and Recommendations

The contamination assessment has identified a number of potential contamination sources that are typical for a mining operation, such as the use of cyanide in ore processing and large quantities of hydrocarbons. Other potential sources relate to site-specific factors, such as the presence of heavy metals in the waste that area either at or above the EIL or SSTLs, the presence of small quantities of PAF and low level fibrous minerals.

TJV is committed to best practice environmental management and continuous improvement of the TJV environmental performance. Primary considerations in the preliminary design process have been the avoidance of potential impacts on the surrounding environment, the reduction of the ecological footprint of the project and the development of a future-proof ????. Documented management strategies have been drafted and will be finalised, maintained and incorporated in to the TGP's Integrated Management System for environmental aspects that require documented controls to ensure the desired environmental outcomes are achieved. In order to address the potential contaminants of concern identified at the TGP site, TJV has nominated to adopt a number of strategies throughout the life of the mine to minimise the risk of any potential contamination generated from the proposed operations impacting on the surrounding environment. These strategies focus on removing or reducing the source where possible, or where this is not feasible, alternatively removing the pathway between identified sources and potential receptors.

In recognition that the local environment associated with the TGP Operational Area is unlike that of other existing gold mine operations within WA, preliminary SSTLs have been developed for both mining waste materials and groundwater on the basis of existing data. These SSTLs may be used for comparative purposes in future assessments of the impact the proposed TGP operations are having on the surrounding environment. Should future monitoring programs report levels of these analytes above the SSTLs, the need for further assessment and/or management will be triggered. Revision of these trigger levels will be appropriate as additional data becomes available over the life of the project.

The contamination assessment has identified some areas where the collection of further data is desirable to assist in determining best management strategies. Although the presence of concentrations of heavy metals in soils and rock above nominated guidelines has been relatively well investigated, it is based on a preliminary data that will need to be periodically reviewed over the life of the project or as new information becomes available . In addition, the bio-availability of metals in the TGP Operational Area is not yet understood which is typical of a project at this stage. This information is important to determine whether the naturally occurring elevated metals in the underlying rocks within the Operational Area pose a risk to the surrounding environment through leaching and oxidation, once they are brought to surface. In addition, only limited groundwater analysis data has been collected across the site.

Accordingly, further data assessment is recommended once the project has commenced operation, including the following:

- Completing the current leach /kinetic testing program for water material and other indicators of natural attenuation over a broad range of sample types
- Assessment of bio-availability of metals in the site soils and wastes.
- Periodically conducting a complete chemical analysis of the tailings.
- Review existing monitoring bore location to identify those that should be used to monitor potential changes in groundwater quality and expand if required.
- Periodically review PAF and Non-acid forming potential of the major rock types.

7 Limitations

This report is produced strictly in accordance with the scope of services set out in the contract or otherwise agreed in accordance with the contract. 360 Environmental makes no representations or warranties in relation to the nature and quality of soil and water other than the visual observation and analytical data in this report.

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Aspects of this report, including the opinions, conclusions and recommendations it contains, are based on the results of the investigation, sampling and testing set out in the contract and otherwise in accordance with normal practices and standards. The investigation, sampling and testing are designed to produce results that represent a reasonable interpretation of the general conditions of the site that is the subject of this report. However, due to the characteristics of the site, including natural variations in site conditions, the results of the investigation, sampling and testing may not accurately represent the actual state of the whole site at all points.

It is important to recognise that site conditions, including the extent and concentration of contaminants, can change with time. This is particularly relevant if this report, including the data, opinions, conclusions and recommendations it contains, are to be used a considerable time after it was prepared. In these circumstances, further investigation of the site may be necessary.

This report has been prepared for the sole use and benefit of Tropicana Joint Venture. Any reliance placed on the whole or any part of this report by any person or organisation other than Tropicana Joint Venture shall be at the sole risk of that person or organisation.

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APPENDICES

Appendix A
TJV Surface Soils
Analysis Data

Sample ID	Sample Location		As	Ba	Be	Bi	C	Ca	Ca	Co	Cr	Cu
	Eastings	Northings	ppm	ppm	ppm	ppm	%	ppm	mg/Kg	ppm	ppm	ppm
SA004	651459	6763083	2	33.2	-	0.1	0.25	2379	86	1.5	41	6
SA005	649788	6762155	5	41.7	0.2	0.26	0.17	292	113	2.5	115	14
SA009	649788	6762155	-	19.4	-	0.08	0.3	363	183	1.3	43	2
SA023	646726	6757690	10	49.6	0.3	0.36	0.5	313	181	2.9	131	16
SA026	646899	6757105	16	42.7	0.2	0.52	0.38	287	78	1.9	122	12
SA027	645781	6757458	4	36.3	0.1	0.18	0.21	265	56	3.3	85	12
SA029	645297	6756215	4	37.1	0.3	0.19	0.26	312	61	2.4	68	10
SA034	648402	6756019	8	72.2	0.3	0.2	0.44	452	183	2.7	73	12
SA051	655105.74	6770892.16	-	21.6	-	0.02	1.05	161659	38020	1.1	9	4
SA052	657734.67	6770427	-	124	0.2	0.1	0.07	561	183	2.8	49	134
SA056A	658727	6767701	8	279.4	1.2	0.38	0.6	2763	1188	20.5	196	42
SA056B	658733.9	6767685.96	6	231.2	0.8	0.33	0.36	3712	2498	13.5	204	32
SA057	654593.73	6769203.66	2	62.3	0.2	0.14	0.31	321	132	2.9	64	33
SA059	652424	6765945	5	52.9	0.3	0.25	0.25	232	-	2.5	187	17
SA060	652115	6765173	5	27.1	0.2	0.2	0.25	246	-	1.8	84	8
SA064	664956	6757672	2	235	0.7	0.15	0.23	3139	791	9.1	66	14
SA064A			-	234.3	0.7	0.13	0.26	3797	724	8.4	63	22
SA066	662760.1	6762440.9	-	126.3	0.3	0.13	0.13	437	232	2.9	59	12
SA073	666259	6756503	2	129.3	0.4	0.13	0.34	1186	584	4.4	64	10
SA076	660760	6757253	11	339	0.6	0.24	0.37	410	79	2	59	114
SA077	659813	6758588	4	115.5	0.3	0.2	0.47	605	190	2.2	61	11
SA078	659073	6757575	3	119.9	0.2	0.11	1.69	2349	1627	1.9	38	8
SA079	657026	6756879	2	149.6	0.4	0.13	0.27	841	621	3.1	45	14
SA085	648831	6747928	-	38.4	0.1	0.09	0.25	833	201	2	49	6
SA092	661606	6769897	2	124.8	0.3	0.1	0.17	1780	1191	3.9	45	12
SA104	646662	6762363	2	30.2	0.2	0.1	0.18	476	171	1.7	34	6
SA112	647629	6766746	7	58.1	0.3	0.23	0.51	388	206	2.7	87	15
SA113	647800	6766758	14	110.2	0.3	0.32	0.34	529	192	2.5	197	16
SA114	647884	6766727	10	139.4	0.2	0.37	0.49	481	136	2.2	123	12
SA120	663688	6763544	3	339.4	0.6	0.16	0.21	2162	99	4.9	58	15
SA127	663517	6770396	2	119.3	0.4	0.12	0.26	92096	37500	13.2	39	18
SA130	648049	6761110	3	25.6	0.2	0.14	0.2	243	79	1.4	49	6
SA138	647285	6746644	14	52.2	0.2	0.45	0.28	303	68	2.9	176	21
SA148	645163	6746667	3	30.4	0.1	0.14	0.27	323	-	2	74	11
SA153	639484	6751200	4	29.9	0.2	0.18	0.24	501	246	2.6	79	8
SA155	637680	6750837	6	54.2	0.3	0.2	0.31	495	114	2.9	90	28
SA156	637782	6752329	2	15.5	-	0.12	0.19	313	76	1.2	61	6
SA157	634656	6751710	2	14.1	-	0.09	0.23	384	143	1.3	44	6
SA159	634656	6751710	14	46.2	0.2	0.37	0.38	999	-	2.5	151	11
SA163	635547	6753627	-	9.2	-	0.06	0.13	291	60	1.3	37	11
SA166A	643274	6747061	2	12.5	-	0.06	0.39	314	114	0.9	34	4
SA170	650503	6750731	4	55.4	0.4	0.18	0.51	663	412	3.4	78	10
SA174	630465	6746488	13	34.8	0.4	0.63	0.19	279	-	2.9	317	17
SA175	641581	6743757	-	15.1	-	0.07	0.14	304	81	1.1	36	5
SA176	642780	6744641	-	15.7	-	0.1	0.38	416	222	1.1	24	4
SA181	656901	6774145	3	351.6	0.6	0.21	0.24	3751	658	8.4	92	22
SA186	655627	6772691	-	158.1	0.3	0.12	0.62	12921	4677	4.4	51	17
SA187	655833	6772447	3	141.3	0.4	0.12	0.61	11355	4434	3	32	10
SA189	657964	6770839	-	89.6	0.1	0.08	0.26	3331	194	1.7	32	9
SA190	666456	6772412	3	66.9	0.2	0.13	0.26	321	92	2.3	42	8
SA191	667574	6772594	2	185.7	0.3	0.11	0.22	800	285	2.8	48	8
SA197	662957	6754886	2	166.1	0.6	0.14	0.2	2742	515	8.6	75	16
SA199	661801	6753849	5	135.1	0.7	0.18	0.27	1087	730	5.5	66	15
SA20			2	18.1	-	0.09	0.3	192	112	1	47	7
SA208	650840	6746452	2	23.1	-	0.12	0.2	263	-	1.2	51	53
SA217	647590	6767205	-	33	0.1	0.11	0.17	299	113	2	59	4
SA219	659416	6776276	9	89.3	0.3	0.22	1.15	1431	326	1.9	53	11
SA222	658566	6777221	6	92.7	0.5	0.15	0.94	3450	545	4.9	60	12
SA229	657086	6771084	-	146.3	-	0.06	0.82	49789	36683	1.7	26	6
SA230	657596	6779476	23	71.3	0.4	0.26	0.29	599	226	2.3	89	11
SA231	654204	6775986	4	111.3	0.5	0.16	0.28	1030	665	4.9	43	15
SA235	656348	6774330	-	159.7	0.4	0.15	1.03	27128	1370	5	90	15
SB000			-	13.5	-	0.08	0.18	224	-	1	39	5
SB001	648269.96	6756359.99	-	12.5	-	0.08	0.32	8047	317	0.9	37	5
SB002	650107.04	6763722.02	4	24.3	0.2	0.18	0.17	367	130	1.7	87	8
SB003	647826.97	6756305.02	2	16.3	-	0.09	0.3	334	145	1.1	48	4
SB004	647424.98	6755568.98	-	16.1	-	0.1	0.26	322	100	1.3	53	19
SB006	650303.02	6765551.99	4	54.5	0.4	0.19	0.67	567	273	2.9	80	15
SB007	648985	6763765.01	3	32	0.2	0.14	0.35	388	130	1.8	70	28
SB008	649810.97	6763079.97	4	32.1	0.1	0.16	0.14	313	73	2	78	9
SB009	648139.04	6764176.04	-	18.7	-	0.09	0.18	278	66	1.1	45	5
SB011	645543.99	6756627.99	6	42.2	0.3	0.33	0.37	306	113	2.4	90	16
SB013	647615.98	6756184.96	2	10.6	-	0.08	0.27	359	106	0.9	39	11
SB018	645997.98	6754501	3	26.4	0.1	0.15	0.5	464	244	1.9	59	8

Sample ID	Sample Location		As	Ba	Be	Bi	C	Ca	Ca	Co	Cr	Cu
	Eastings	Northings	ppm	ppm	ppm	ppm	%	ppm	mg/Kg	ppm	ppm	ppm
SB019	647378.02	6753919.02	2	30.8	0.1	0.11	0.62	468	298	1.7	**59**	17
SB023	645308.05	6756940.02	4	41.5	0.2	0.22	0.26	362	185	2.7	**63**	9
SB027	647426.97	6764796.98	14	42.9	0.2	0.46	0.39	367	104	2.4	**163**	10
SB028	647942.95	6765851.97	-	20.1	-	0.08	0.48	558	358	1.1	31	10
SB029	649813.97	6763411.99	4	38.2	0.2	0.15	0.25	599	336	2.1	**72**	11
SB030	646199.95	6760910.98	-	107.2	0.3	0.09	0.64	11321	4920	3	**55**	9
SB031	646081.04	6760671	-	66.6	0.2	0.09	0.9	15761	5206	2.4	39	9
SB032	646525.96	6759913.04	3	26.5	-	0.11	0.13	280	100	1.5	43	5
SB033	647355.97	6757348.01	-	18.2	-	0.09	0.33	321	93	1	50	5
SB035	646294.03	6763150.94	-	12.9	-	0.07	0.14	272	84	1	22	4
SB036	647018.97	6764804.01	2	11.5	-	0.08	0.1	206	-	0.9	28	4
SB057	634656	6751709.95	3	14.4	0.1	0.1	0.17	286	88	1.4	31	5
SB078	644562.02	6763251.97	-	20.6	0.1	0.15	0.29	278	139	1.6	41	9
SB079	648646	6764409.96	2	23.1	-	0.11	0.28	340	109	1.4	**56**	12
SB083	646931.98	6764549	-	22.9	0.1	0.1	0.25	356	128	1.5	**56**	6
SB084	640513.03	6745999.04	3	27	0.2	0.12	0.31	274	60	1.7	**63**	7
SB092	644266.03	6763241.98	-	20.8	0.1	0.08	0.29	304	75	1.4	42	5
SB094	646930.98	6757350.96	-	18.6	-	0.08	0.79	660	342	1	46	5
SB095	645387.96	6745721.01	3	27.6	0.1	0.08	0.35	399	176	0.9	41	6
SB096	648424.48	6756401.98	2	19.9	0.1	0.09	0.27	303	199	1.5	48	8
SB097	648768.23	6759161.95	2	16.1	-	0.08	0.31	482	290	1	46	5
SB098	649849.39	6763348.01	4	45.6	0.3	0.16	0.25	541	312	2.5	**72**	9
SB099	647065.61	6760776.02	-	44	0.2	0.12	0.22	708	380	2.1	43	7
SB100	649369.1	6762094.01	-	17.8	-	0.09	0.33	790	393	1	49	4
SB101	647222.57	6766283.24	3	12.1	-	0.08	0.11	285	126	1	47	5
SB102	647219.88	6766277.4	-	16.3	-	0.08	0.13	404	101	1.2	45	6
SB104	647224.96	6766272.24	2	16.4	-	0.08	0.46	481	227	1.1	43	6
SB107	647242.56	6766264.92	-	22	-	0.09	0.55	647	367	1.3	45	5
SB108	647244.94	6766275.97	2	18.2	0.1	0.09	0.28	453	226	1.2	49	38
SB113	645211.49	6765426.24	-	14.1	-	0.09	0.26	305	119	1.1	45	5
SB114	646534.56	6765234.31	-	13.1	-	0.08	0.14	238	80	0.9	26	4
SB115	646537.96	6765226.84	-	14.6	-	0.08	0.28	478	175	1	31	5
SB120	645533.04	6765385.24	-	14.7	-	0.08	0.48	517	238	1.1	48	5
SB126	646716.86	6765183.97	4	14.7	-	0.11	0.1	419	114	1.3	**65**	6
SB127	646722.8	6765176.58	2	13.5	-	0.06	0.4	417	184	1	40	5
SB128	646718.22	6765175.53	3	16.2	-	0.08	0.35	440	199	1.1	49	5
SB130	646707.39	6765187.86	-	12.7	-	0.09	0.14	377	146	1.2	**54**	7
SB131	646672.3	6765128.02	-	12.7	-	0.07	0.17	283	96	1.1	41	23
SB132	646652.94	6765134.36	-	8.8	-	0.07	0.25	242	78	0.9	38	4
SB133	646650.21	6765140.61	-	17.4	0.1	0.08	0.17	1611	294	1.1	31	4
SB134	646667.79	6765154.67	-	12.9	-	0.06	0.37	468	202	1.1	44	5
SB140	645411.78	6764582.13	-	13.9	-	0.07	0.59	530	265	1	39	5
SB142	645426.04	6764588.05	-	13.4	-	0.08	0.16	307	135	1.1	31	4
SB143	645451.94	6764598.8	-	11.8	-	0.07	0.76	516	243	0.9	29	4
SB145	645440.79	6764623.32	-	11.5	-	0.08	0.21	364	137	1	38	4
SB148	645416.4	6764632.06	-	19.7	-	0.07	0.14	953	118	1.1	25	4
SB159	645583.4	6764571.18	-	13.4	-	0.09	0.17	340	111	1	48	6
SB189	631388	6756360	-	29	0.1	0.12	0.15	264	81	1.8	**59**	8
SB190	647727	6744718	2	22.4	-	0.14	0.31	691	131	1.5	**64**	7
SB191	631508	6746499	5	37.2	0.2	0.24	0.13	433	176	2.4	**131**	11
SB192	645652	6757549	3	28.1	-	0.12	0.41	347	137	1.5	**66**	10
SB193	647392	6757265	3	18.2	-	0.11	0.18	241	52	1.2	**60**	12
SB194	647467	6754088	4	39.1	0.2	0.17	0.5	457	212	2	**81**	10
SB195	647480	6754099	6	36.9	0.2	0.18	0.68	954	441	1.8	**92**	9
SB200			3	24.9	0.1	0.11	0.14	351	134	1.8	40	7
SBV060	643098.97	6749456.95	-	12.8	-	0.08	0.28	379	163	1	41	5
SBV063	635547	6753627.01	-	12.4	-	0.08	0.39	520	263	1.1	43	4
SBV066	641633.04	6749676.96	3	32.8	0.1	0.12	0.31	493	250	2.2	**65**	8
UNITS			ppm	ppm	ppm	ppm	%	ppm	mg/Kg	ppm	ppm	ppm
		Minimum	4.68	57.96	0.29	0.14	0.34	3609.04	1313.22	2.43	63.95	12.24
		Maximum	**23**	351.6	1.2	0.63	1.69	161659	38020	20.5	317	134
		Average	2	8.8	0.1	0.02	0.07	192	52	0.9	9	2

Sample ID	EC	Fe	Hg	K	K	K	Li	Mg	Mg	Mn	Mo	N-Kjel	N-NO3
	uS/cm	%	ppm	ppm	mg/Kg	mg/Kg	ppm	ppm	mg/Kg	ppm	ppm	mg/l	mg/Kg
SA004	-	1.94	-	933	-	-	4.6	318	-	80	1	30	2
SA005	12	5.18	-	1288	-	43	7.6	257	23	141	1.2	80	3
SA009	23	1.51	-	595	-	-	4.4	160	24	61	0.9	95	3
SA023	45	6.41	-	1675	100	99	9.5	357	20	73	1.2	100	9
SA026	42	10.4	0.19	1389	-	48	6.2	347	-	53	1.3	55	12
SA027	11	3.35	-	1197	-	-	6.5	254	-	63	1.2	45	2
SA029	15	3.62	-	1312	-	34	8.6	379	-	61	1	50	3
SA034	46	5.62	-	2405	-	57	7.6	450	32	85	1.1	70	1
SA051	2307	0.36	-	400	-	79	1.5	163	-	35	0.2	200	-
SA052	96	1.98	-	3741	127	118	8.4	739	67	185	0.9	35	3
SA056A	407	7.2	0.01	11296	991	901	33.2	6963	540	322	1.5	90	1
SA056B	201	4.89	-	10137	659	639	33.2	7585	980	307	0.9	80	2
SA057	21	2.74	-	1965	-	49	9.2	345	-	75	1.2	120	1
SA059	12	8.34	-	1676	-	26	6	318	-	88	1.3	130	-
SA060	14	3.86	-	834	-	-	7.9	217	-	44	1.2	50	2
SA064	131	3.41	-	7961	292	261	14.7	2611	178	363	1.3	65	2
SA064A	125	3.08	-	7881	278	270	14	2568	165	337	0.9	160	2
SA066	10	2.64	-	3253	-	42	7.3	476	30	136	1	100	2
SA073	118	2.36	-	4720	233	205	8.4	1076	108	226	0.9	60	6
SA076	44	5.07	-	5101	-	47	5.9	884	54	85	3.8	75	3
SA077	28	2.36	-	3274	-	133	8.1	608	38	104	1.3	25	3
SA078	247	2.14	-	2635	100	54	7.6	533	153	129	1	110	2
SA079	176	2.14	-	4238	234	207	8	1068	155	155	1.2	85	1
SA085	44	1.72	-	1271	-	24	6.7	424	37	76	1.2	120	2
SA092	110	1.86	-	3629	177	158	11.3	1281	55	167	1	55	1
SA104	13	1.68	-	1003	-	-	7.1	268	39	76	1.4	40	2
SA112	16	4.31	-	1763	-	90	8.9	428	46	81	1.4	65	-
SA113	22	12.95	-	1952	-	97	8	602	58	77	1.6	80	1
SA114	21	6.53	-	2044	-	106	8.3	527	39	67	2.1	175	-
SA120	15	3.53	-	8331	122	124	11.1	1520	28	222	1.1	20	4
SA127	12870	1.82	-	4518	463	504	23.9	5822	1092	290	0.7	160	2
SA130	-	2.62	-	760	-	-	5.6	172	-	51	1	25	2
SA138	11	8.61	-	1564	-	46	10	350	-	65	1.9	90	1
SA148	15	2.66	-	1050	-	33	6.7	294	-	44	1.1	65	3
SA153	19	3.85	-	997	-	27	9.3	342	50	81	1.2	50	4
SA155	18	4.15	-	1684	-	73	9.6	416	-	74	1.1	65	6
SA156	11	2.38	-	458	-	30	4.6	137	-	60	1.3	45	2
SA157	11	1.49	-	391	-	36	5.1	132	-	47	0.9	90	2
SA159	16	8.39	-	1488	-	49	7.1	386	-	59	1.3	65	2
SA163	11	1.25	-	277	-	-	4.7	114	-	34	1	50	-
SA166A	17	1.23	-	351	-	-	4.5	98	-	46	1.2	40	5
SA170	28	3.6	-	2107	144	144	12.4	640	71	135	1.2	85	4
SA174	13	17.05	-	1071	-	-	7.1	387	-	91	2.1	45	3
SA175	11	1.28	-	437	-	29	4.8	139	-	44	0.9	35	2
SA176	39	1.25	-	433	-	-	4.6	127	24	46	0.9	45	3
SA181	74	3.76	-	6588	253	245	12.9	2125	115	358	1.1	75	3
SA186	202	2.11	-	4115	154	206	11.9	1675	75	206	1	70	2
SA187	137	2.04	-	3867	202	134	10.3	1591	82	147	0.9	60	2
SA189	27	1.47	-	1927	-	34	6.1	383	54	82	1	115	3
SA190	-	2.27	-	2586	-	-	8.3	294	-	86	1.1	45	1
SA191	27	1.84	-	5119	-	111	9.5	517	50	155	1	55	4
SA197	113	2.98	-	6144	282	250	13.4	1753	112	321	1	140	18
SA199	148	3.15	-	4427	303	264	13.7	1493	244	289	1.2	90	3
SA20	12	1.72	-	550	-	20	4.6	128	-	53	1	45	4
SA208	-	1.92	-	727	-	21	5	178	-	53	1.1	50	4
SA217	14	2.07	-	1030	-	38	6	209	-	76	1.2	95	2
SA219	100	3.75	-	2218	231	164	8.2	527	51	83	1.8	85	1
SA222	121	3.67	0.02	2378	113	152	9.5	695	73	217	1.4	215	2
SA229	2380	1.23	-	1339	-	73	4.5	655	26	85	0.9	175	-
SA230	43	7.1	-	1814	138	127	11.2	475	60	100	1.2	70	2
SA231	63	2.69	-	3676	302	320	15.9	1095	125	185	1.1	70	1
SA235	153	2.97	-	4372	310	222	9.8	2479	109	213	0.9	75	5
SB000	12	1.45	-	362	-	30	4.4	115	-	48	1.2	95	3
SB001	115	1.29	-	346	-	-	4.1	114	20	59	1.1	120	3
SB002	15	3.97	-	735	-	23	6.6	237	32	74	1	60	1
SB003	20	1.59	-	447	-	34	4.3	116	-	54	1	50	5
SB004	19	1.8	-	487	-	-	4.6	119	-	64	1.1	115	4
SB006	59	3.76	-	1930	149	137	10.3	471	36	86	1.2	75	-
SB007	14	2.78	-	1035	-	38	6.1	257	-	66	1.2	65	4
SB008	10	3.39	-	1088	-	-	6.2	248	-	69	1.2	70	2
SB009	15	1.35	-	468	-	-	4.8	114	-	56	1.1	75	3
SB011	16	4.8	-	1401	103	60	8.1	349	20	67	1.3	160	3
SB013	22	1.29	-	297	-	48	3.7	106	23	52	1.1	35	-
SB018	26	2.74	-	872	-	34	7.6	204	-	76	1.3	150	3

Sample ID	EC	Fe	Hg	K	K	K	Li	Mg	Mg	Mn	Mo	N-Kjel	N-NO3
	uS/cm	%	ppm	ppm	mg/Kg	mg/Kg	ppm	ppm	mg/Kg	ppm	ppm	mg/l	mg/Kg
SB019	27	2.18	-	1063	-	48	6.7	229	-	70	1.1	155	-
SB023	19	3.33	-	1279	107	72	8.7	300	39	101	1.3	115	-
SB027	13	9.25	-	1166	-	36	8.5	310	-	60	1.7	155	2
SB028	74	1.88	-	539	-	67	4.2	173	51	59	1.1	90	4
SB029	28	3.1	0.17	1284	-	88	7.5	365	52	90	1.1	50	3
SB030	174	1.74	-	2575	144	110	14.2	1957	109	98	1	140	3
SB031	237	1.43	-	2179	160	128	11.9	1437	66	90	0.9	40	1
SB032	-	2.28	-	825	-	31	6.6	216	-	61	1	65	1
SB033	28	1.62	-	482	-	64	4.2	126	-	56	1.2	50	2
SB035	-	1.18	-	370	-	-	4.4	97	-	45	0.9	15	1
SB036	-	1.32	-	271	-	35	3.8	75	-	49	1.7	55	-
SB057	11	1.68	-	415	-	-	5.3	136	-	50	1	70	3
SB078	15	1.41	-	665	-	44	5.4	153	-	66	1.1	45	5
SB079	14	2.02	-	681	-	37	5.3	163	-	60	1.1	45	4
SB083	23	1.66	-	781	-	25	6.3	169	-	55	1.1	120	5
SB084	15	2.49	-	908	-	-	6.8	214	-	50	1.1	55	1
SB092	-	1.35	-	647	-	47	5.4	149	-	55	1	35	2
SB094	109	1.65	-	565	-	39	4.2	192	68	76	1.6	160	-
SB095	42	1.55	-	533	-	32	4.3	154	20	53	1.4	45	-
SB096	30	1.67	-	600	-	46	4.9	157	-	53	0.9	40	5
SB097	43	1.52	-	401	-	21	4.5	129	28	58	1	90	4
SB098	20	2.99	-	1559	-	56	9.4	409	45	105	0.9	100	3
SB099	44	2.32	-	1449	-	25	10.8	473	60	140	1.2	100	-
SB100	140	1.69	-	428	-	-	4.4	126	-	71	1.1	95	4
SB101	22	1.49	-	324	-	40	3.9	101	-	65	1.4	35	5
SB102	19	1.43	-	485	-	-	4.4	176	-	63	1.4	30	1
SB104	72	1.38	-	444	-	46	4	122	-	64	1.1	95	2
SB107	189	1.47	-	679	-	61	4.8	223	44	78	1.2	65	-
SB108	55	1.49	-	518	-	28	4.6	139	20	75	1.1	55	2
SB113	18	1.36	-	370	-	-	4.2	105	-	58	1.3	80	3
SB114	12	1.22	-	354	-	-	4	90	-	47	0.9	20	3
SB115	30	1.48	-	427	-	-	4.2	106	-	70	1.7	35	6
SB120	54	1.52	-	420	-	26	4.1	125	35	68	1.3	55	1
SB126	32	2.13	-	422	-	-	4.6	123	-	63	1.2	40	3
SB127	30	1.31	-	379	-	22	4.1	112	-	64	1.3	140	3
SB128	49	1.51	-	455	-	20	4.3	122	-	72	1.5	135	-
SB130	33	1.52	-	369	-	21	4.4	133	20	64	0.9	105	6
SB131	19	1.29	-	378	-	42	4.3	92	-	57	1.2	75	3
SB132	15	1.12	-	252	-	-	3.5	76	-	43	0.9	85	3
SB133	-	1.37	-	528	-	25	4.8	211	-	58	1.2	70	1
SB134	101	1.42	-	400	-	33	4.2	129	41	70	1.4	35	24
SB140	48	1.15	-	406	-	-	4.3	114	24	52	1.1	120	1
SB142	18	1.39	-	354	-	-	4.3	100	-	60	1.3	70	3
SB143	42	1.26	-	332	-	51	4.1	118	20	55	1.2	130	1
SB145	24	1.26	-	341	-	-	4	101	-	54	1.1	85	3
SB148	11	1.26	-	542	-	-	4.8	195	-	56	1	25	2
SB159	24	1.31	-	377	-	30	4.1	117	-	51	1.1	75	4
SB189	11	2.17	-	803	-	25	7.4	203	-	55	1.2	105	3
SB190	23	1.81	-	717	-	25	4.8	207	20	73	1.3	45	5
SB191	14	5.73	-	1175	-	57	8.2	520	84	83	1.3	30	3
SB192	22	2.42	-	918	-	60	5.8	196	-	70	1.2	120	6
SB193	12	2.02	-	530	-	44	4.7	129	-	59	1.1	40	2
SB194	25	3.77	-	1355	-	67	8	301	-	80	1.5	65	3
SB195	45	5.23	-	1082	-	40	6.7	253	-	101	1.6	180	1
SB200	14	1.94	-	826	-	21	6.8	246	25	61	1.2	100	2
SBV060	38	1.31	-	363	-	54	4.5	120	23	48	1.2	35	6
SBV063	39	1.41	-	355	-	31	4.9	248	-	53	1.1	125	4
SBV066	27	2.24	-	1009	-	47	7.5	247	36	87	1.1	100	2
UNITS	uS/cm	%	ppm	ppm	mg/Kg	mg/Kg	ppm	ppm	mg/Kg	ppm	ppm	mg/l	mg/Kg
	192.78	2.86	0.1	1668.06	245.39	93.53	7.32	572.07	96.11	94.46	1.19	79.96	3.22
	12870	17.05	0.19	11296	991	901	33.2	7585	1092	363	3.8	215	24
	10	0.36	0.01	252	100	20	1.5	75	20	34	0.2	15	1

Sample ID	Na	Na	Nb	Ni	P	P	Pb	pH	Rb	S	S	Sb	Si
	ppm	mg/Kg	ppm	ppm	ppm	mg/Kg	ppm	NONE	ppm	mg/Kg	%	ppm	%
SA004	200	-	3.7	10	-	-	6	5.7	6.64	-	0.013	0.15	43.7
SA005	150	26	4.68	16	80	-	12	5.6	10.46	-	0.008	0.36	39.1
SA009	91	31	2.83	10	-	-	4	5.9	4.56	-	0.009	0.13	41.3
SA023	179	21	6.76	27	112	-	13	4.9	14.47	-	0.012	0.41	36.8
SA026	167	21	6.12	13	86	-	16	4.8	11.3	-	0.013	0.48	33.6
SA027	129	29	4.6	30	72	-	9	5.1	10.74	-	0.02	0.28	37.5
SA029	131	-	4.63	15	72	-	10	5	12.31	-	0.008	0.28	39.5
SA034	309	22	6.63	14	160	-	12	5.3	16.74	-	0.017	0.32	38.5
SA051	151	53	1.43	5	-	-	3	7	2.8	154	16.009	-	4.3
SA052	848	69	4.02	13	68	-	10	6.7	17.16	-	0.009	0.15	43
SA056A	2761	662	12.9	106	1117	145	27	6.3	59.27	-	0.028	0.43	27.5
SA056B	1417	96	11.8	82	477	-	19	7.2	39.5	-	0.018	0.31	25.9
SA057	268	25	5.47	15	93	-	9	5	16	-	0.03	0.19	35.6
SA059	175	27	4.88	15	122	-	16	4.9	13.21	-	0.007	0.41	37.6
SA060	88	-	5.07	13	59	-	10	5	7.93	-	0.013	0.27	37.1
SA064	3424	29	5.32	27	197	54	10	6.8	37	-	0.03	0.18	37.9
SA064A	3427	25	4.89	19	193	-	12	6.8	36.42	-	0.022	0.19	38.1
SA066	1284	23	4.21	15	106	-	8	5.8	17.83	-	0.006	0.18	38.2
SA073	1396	22	4.39	16	142	-	9	6.7	22.86	-	0.03	0.14	39
SA076	498	59	5.97	8	355	-	13	5.3	20.02	-	0.03	0.15	39.8
SA077	670	29	5.97	13	547	95	17	5.5	20.49	-	0.028	0.2	38.5
SA078	619	22	3.6	11	87	-	8	6.8	13.36	-	0.018	0.15	38.8
SA079	1043	45	5.13	12	104	-	8	6.4	23.77	-	0.007	0.18	38.8
SA085	249	-	3.76	10	61	-	7	6	8.98	-	0.012	0.17	41.4
SA092	749	20	3.99	15	82	-	9	7.3	21.56	-	0.011	0.16	41.9
SA104	129	-	4	10	53	-	7	5.8	8.25	-	0.012	0.16	41.6
SA112	260	22	7.01	18	125	-	13	5.4	13.43	-	0.023	0.37	37.6
SA113	300	36	7.31	14	245	-	18	5.5	14.74	-	0.036	0.44	30.1
SA114	325	31	8.46	12	240	-	15	5.2	13.84	-	0.019	0.48	28.9
SA120	3692	25	5.01	21	155	-	13	5.3	44.04	-	0.02	0.18	38.6
SA127	9704	8372	4.23	19	174	-	8	7.4	29.32	294	8.449	0.16	17.1
SA130	89	-	3.98	10	55	-	8	5.5	6.93	-	0.019	0.21	44.2
SA138	166	27	6.98	17	111	-	19	5.3	13.62	-	0.016	0.52	35
SA148	106	23	4.64	15	65	-	7	4.9	9.73	-	0.01	0.22	38.8
SA153	112	-	4.88	15	66	-	10	5.9	9.62	-	-	0.31	39.9
SA155	273	30	5.89	16	172	-	10	5.3	14.49	-	0.01	0.29	38.2
SA156	59	24	3.48	10	-	-	7	5.4	4.26	-	0.008	0.21	42
SA157	48	-	3.4	8	-	-	5	5.9	4.35	-	0.018	0.15	42
SA159	138	21	6.73	19	100	-	16	5.2	13.36	-	0.014	0.46	34.9
SA163	39	26	2.97	12	-	-	4	5.6	3.56	-	0.009	0.11	34
SA166A	43	-	3.17	7	-	-	4	5.5	3.6	-	0.011	0.11	43.8
SA170	214	26	4.87	17	95	-	12	5.8	21.18	-	0.016	0.28	41.6
SA174	108	-	9.42	18	140	-	28	5	10.47	-	0.009	1.08	30.6
SA175	73	25	2.92	8	-	-	4	6	4.29	-	0.017	0.11	45
SA176	50	-	3.15	7	-	-	5	6.1	4.31	-	0.013	0.14	44.7
SA181	3851	29	5.62	29	245	-	10	6.6	28.78	-	0.012	0.2	38.6
SA186	708	31	4.46	25	171	-	8	8	22.93	-	0.019	0.16	37.1
SA187	651	-	4.12	14	125	-	9	8.1	21.13	-	0.011	0.17	41.4
SA189	385	24	2.91	9	-	-	6	5.9	10.57	-	0.22	0.11	41
SA190	276	-	4.27	12	61	-	9	5.5	18.51	-	0.016	0.19	42.1
SA191	1195	23	4.15	11	114	-	8	6.1	27.61	-	0.008	0.14	30.7
SA197	1594	50	6.18	21	165	-	12	6.1	36.2	-	0.016	0.2	36.7
SA199	644	48	7.81	19	219	-	14	6.6	28.97	-	0.046	0.26	38.1
SA20	82	22	2.56	10	63	-	5	5.3	5.16	-	0.005	0.15	43.9
SA208	82	-	3.46	9	50	-	8	5.2	6.89	-	0.012	0.19	41.7
SA217	128	28	3.76	11	55	-	6	5.6	8.55	-	0.011	0.17	43.4
SA219	338	39	7.79	11	375	128	11	5.3	14.02	-	0.025	0.24	37.7
SA222	473	34	7.48	13	210	-	16	5.9	15.89	-	0.221	0.18	36.4
SA229	422	144	2.48	7	-	-	6	6.9	7.47	99	3.676	0.09	26.7
SA230	233	28	8.35	13	319	-	13	6.1	11.92	-	0.016	0.3	35.9
SA231	496	32	5.56	21	131	-	11	6.6	28.63	-	0.017	0.22	37.6
SA235	2010	-	4.97	23	173	-	10	7.6	20.19	-	0.011	0.2	36.8
SB000	46	26	3.17	8	-	-	5	5.2	4.01	-	0.006	0.12	44.2
SB001	67	21	2.53	6	-	-	4	6.7	3.48	-	0.713	0.14	41
SB002	106	-	3.47	12	61	-	10	6	6.05	-	0.011	0.26	41.6
SB003	74	20	2.98	8	-	-	4	5.8	3.93	-	0.012	0.14	44.6
SB004	65	-	3.7	9	56	-	5	5.6	4.21	-	0.007	0.17	43
SB006	226	22	4.91	17	104	-	12	5.6	16.32	-	0.008	0.25	40.1
SB007	133	22	3.94	12	72	-	8	5.3	8.74	-	-	0.2	43.7
SB008	143	25	3.97	12	65	-	9	5.5	8.46	-	0.008	0.24	37.5
SB009	66	-	3.33	8	-	-	5	5.3	4.3	-	-	0.13	44.9
SB011	147	-	5.64	16	99	-	12	5.2	12.98	-	0.011	0.34	38.8
SB013	53	23	2.57	7	-	-	5	5.8	2.78	-	0.01	0.13	43.2
SB018	101	-	3.85	13	80	-	11	6.8	8.36	-	0.011	0.26	40.6

Sample ID	Na	Na	Nb	Ni	P	P	Pb	pH	Rb	S	S	Sb	Si
	ppm	mg/Kg	ppm	ppm	ppm	mg/Kg	ppm	NONE	ppm	mg/Kg	%	ppm	%
SB019	112	25	4.21	13	76	-	7	5.7	10.05	-	0.016	0.19	37.5
SB023	127	21	4.77	13	73	-	9	5.5	11.76	-	0.007	0.28	41.1
SB027	162	25	5.46	14	95	-	20	5.1	9.91	-	0.008	0.56	36.1
SB028	89	31	3.36	8	-	-	6	6	4.27	-	0.013	0.15	43.6
SB029	180	23	3.68	16	86	-	9	6.5	9.53	-	0.008	0.22	43.6
SB030	311	29	3.94	14	66	-	8	8.1	19.48	-	0.021	0.16	41.5
SB031	313	28	3.73	11	75	-	7	7.7	16.12	-	0.016	0.15	36.8
SB032	101	23	3.48	10	55	-	7	5.7	7.68	-	0.006	0.19	45
SB033	70	-	3.23	7	-	-	5	5.6	4.06	-	0.009	0.14	43.8
SB035	57	-	3.12	8	-	-	5	6	3.82	-	0.019	0.13	46.5
SB036	44	22	3.05	7	-	-	23	5.2	3.11	-	0.006	0.26	46.2
SB057	49	20	3.59	9	-	-	5	5.5	4.84	-	0.007	0.16	43.6
SB078	81	22	3.25	19	55	-	5	5.6	6.18	-	0.012	0.13	43.9
SB079	91	22	3.29	10	61	-	6	5.5	6.46	-	0.007	0.17	39.1
SB083	93	21	3.78	9	61	-	6	5.3	6.83	-	0.007	0.16	43.2
SB084	95	25	3.72	11	66	-	7	5.1	8.94	-	-	0.22	43.7
SB092	83	-	3.49	9	-	-	5	5.2	6.17	-	0.007	0.14	44.9
SB094	96	30	3.36	7	68	-	5	7.1	4.4	-	0.02	0.15	40.8
SB095	69	24	3.43	6	56	-	5	6.1	4.01	-	0.017	0.14	44.4
SB096	92	-	2.89	15	52	-	6	6.1	4.97	-	0.013	0.14	44.1
SB097	72	26	2.61	7	52	-	5	6.4	3.45	-	0.007	0.16	41.1
SB098	207	-	4.18	14	65	-	10	6.1	12.15	-	0.006	0.23	40.8
SB099	186	-	3.7	13	55	-	8	6.5	11.65	-	0.008	0.19	41.8
SB100	69	-	3.11	8	-	-	5	6.9	3.57	-	0.011	0.17	43.6
SB101	55	26	3.36	7	-	-	5	6.2	3.04	-	0.006	0.13	41.9
SB102	82	22	3.23	8	-	-	5	6.6	3.9	-	0.005	0.14	45.3
SB104	68	24	3.39	9	-	-	4	6.1	3.56	-	0.02	0.13	43.8
SB107	105	25	3.32	8	-	-	5	6.2	5.43	-	0.014	0.14	38.9
SB108	77	22	3.51	8	-	-	5	6.5	4.19	-	0.009	0.14	45.3
SB113	57	28	3.08	8	-	-	5	5.6	3.36	-	0.015	0.13	37.1
SB114	51	-	3.06	7	-	-	5	5.7	3.47	-	0.006	0.12	41.9
SB115	138	-	3.17	7	-	-	5	6.2	3.64	-	0.006	0.17	41.8
SB120	79	28	3.41	8	-	-	5	6.1	3.63	-	0.009	0.13	43.5
SB126	70	28	3.74	9	-	-	6	6.4	4.22	-	0.007	0.2	42.6
SB127	60	23	3.05	7	-	-	4	6	3.34	-	0.007	0.13	40.4
SB128	69	23	3.4	7	-	-	5	6.1	3.88	-	0.012	0.14	43
SB130	62	27	3.88	8	-	-	5	6.1	3.68	-	0.01	0.15	42.2
SB131	58	32	3.18	8	-	-	5	6.2	3.9	-	0.052	0.14	43
SB132	38	23	2.51	7	-	-	4	5.8	2.56	-	0.011	0.12	42.8
SB133	66	24	3.41	8	-	-	4	5.5	4.59	-	0.018	0.13	43.7
SB134	65	29	3.26	8	-	-	4	5.9	3.69	-	0.011	0.14	44.6
SB140	59	33	2.73	8	-	-	4	6.1	3.71	-	0.01	0.12	46.4
SB142	55	23	3.27	7	-	-	4	6.1	3.56	-	0.006	0.15	44.7
SB143	51	27	2.61	6	50	-	4	5.9	3.32	-	0.011	0.12	46.2
SB145	48	-	2.94	7	-	-	5	6	3.22	-	0.005	0.13	44.3
SB148	69	-	2.91	8	-	-	5	6	4.7	-	0.007	0.12	45.1
SB159	59	27	3.4	8	-	-	5	5.9	3.68	-	0.008	0.16	44.6
SB189	85	28	5.23	12	64	-	7	5.3	8.04	-	0.008	0.21	40
SB190	124	23	3.36	16	-	-	5	5.8	5.48	-	0.016	0.16	43.1
SB191	116	21	5.12	16	89	-	16	5.9	11.8	-	0.007	0.4	37.7
SB192	104	36	4.2	10	61	-	7	5.2	8.35	-	0.015	0.19	42.6
SB193	70	-	3.53	10	-	-	6	5.7	4.77	-	0.008	0.17	42.8
SB194	140	-	4.54	13	117	-	10	5.6	13.36	-	0.006	0.26	40.5
SB195	120	21	4.13	11	128	-	11	6.3	9.74	-	0.037	0.32	41.7
SB200	101	23	3.94	10	-	-	7	5.8	6.91	-	0.007	0.18	43.6
SBV060	53	-	3	8	-	-	5	6	3.86	-	0.006	0.13	44.1
SBV063	54	25	3.22	9	-	-	4	6.1	3.63	-	0.008	0.13	43.8
SBV066	99	-	4.12	11	51	-	7	6.1	9.41	-	0.016	0.2	39.6
UNITS	ppm	mg/Kg	ppm	ppm	ppm	mg/Kg	ppm	NONE	ppm	mg/Kg	%	ppm	%
	428.8	121.89	4.32	13.25	132.66	105.5	8.48	5.94	11.1	182.33	0.24	0.21	40
	9704	8372	12.9	106	1117	145	28	8.1	59.27	294	16.009	1.08	46.5
	38	20	1.43	5	50	54	3	4.8	2.56	99	0.005	0.09	4.3

Sample ID	Sn	Sr	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr
	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SA004	0.7	8.69	-	3.15	0.18	0.05	0.28	35	0.4	1.56	21	35.7
SA005	1	8.74	-	9.2	0.24	0.08	0.61	117	0.6	2.71	20	59.2
SA009	0.5	5.22	-	2.31	0.16	0.04	0.23	26	0.3	1.09	11	27
SA023	1.4	12.47	-	13.87	0.31	0.1	0.85	172	0.7	3.65	21	86.8
SA026	1.3	9.61	-	12.64	0.28	0.08	0.85	258	0.8	3.18	16	85.4
SA027	0.9	6.92	-	6.25	0.21	0.08	0.55	66	0.5	2.57	28	56.1
SA029	1	7.73	-	7.35	0.2	0.08	0.62	74	0.6	3.27	18	59
SA034	1.2	13.46	-	7.93	0.28	0.11	0.72	88	0.6	6.51	24	81.1
SA051	0.5	597.82	-	1.02	0.04	0.02	0.16	7	0.1	1.14	10	14.4
SA052	0.8	22.72	-	4.39	0.22	0.1	0.41	37	0.4	3.39	63	42.5
SA056A	2.6	72.29	-	14.27	0.58	0.34	1.64	163	1.6	17.1	88	145
SA056B	2.3	53.46	-	10.81	0.61	0.27	1.36	148	1.4	11.1	67	136
SA057	1.1	10.79	-	5.36	0.26	0.12	0.66	57	0.6	4.11	30	64.8
SA059	1	9.84	0.1	9.6	0.28	0.09	0.61	167	0.7	2.88	22	62.7
SA060	1.1	5.65	-	12.33	0.21	0.06	0.63	75	0.7	2.54	14	65.1
SA064	0.9	59.91	-	5.31	0.41	0.2	0.58	69	0.6	9.77	35	52.7
SA064A	0.9	58.21	-	5	0.39	0.2	0.57	63	0.6	9.35	53	48
SA066	0.8	19.78	-	4.69	0.23	0.1	0.47	48	0.4	3.27	19	52.1
SA073	0.8	31.12	-	5.13	0.26	0.13	0.56	49	0.5	7.16	29	40.9
SA076	1	42.46	-	11.55	0.36	0.11	1.55	90	1.2	5.76	29	109
SA077	1.1	24.76	-	6.88	0.27	0.12	0.8	51	0.7	5.1	30	72.3
SA078	0.7	29.66	-	3.73	0.21	0.09	0.44	36	0.4	2.38	22	36.1
SA079	0.9	22.15	-	5.56	0.22	0.13	0.74	38	0.6	4.97	24	65.1
SA085	0.7	8.93	-	3.23	0.16	0.06	0.37	30	0.4	2.26	55	43.9
SA092	0.8	21.88	-	4.49	0.22	0.12	0.43	37	0.4	4.64	38	42
SA104	0.8	6.88	-	3.44	0.17	0.06	0.37	28	0.4	2.29	15	42.2
SA112	1.3	14.98	-	11.4	0.29	0.11	0.81	105	0.6	3.81	24	110
SA113	1.7	34.48	0.1	13.26	0.3	0.1	0.77	163	0.7	3.81	31	103
SA114	1.9	21.95	-	12.23	0.29	0.11	0.85	153	0.8	5.53	24	114
SA120	1.1	66.08	-	7.78	0.24	0.23	1.03	69	0.5	5.83	34	55.4
SA127	1	661.69	-	4.83	0.17	0.13	0.54	33	0.5	8.93	39	43.8
SA130	0.7	5.1	-	4.95	0.18	0.05	0.41	51	0.4	2.03	14	48.4
SA138	1.5	10.3	0.1	20.79	0.31	0.1	0.93	240	0.9	3.43	18	103
SA148	0.9	5.78	-	5.83	0.19	0.06	0.48	55	0.6	2.2	17	57.1
SA153	1.1	7.39	-	9.82	0.2	0.07	0.58	73	0.6	2.89	16	58.8
SA155	1.2	13.48	-	11.7	0.23	0.1	0.7	83	0.6	3.75	19	67.2
SA156	0.7	3.58	-	4.24	0.13	0.04	0.29	39	0.4	1.34	22	34.4
SA157	0.6	4	-	2.8	0.13	0.03	0.28	24	0.3	1.1	14	28.2
SA159	1.5	12.74	0.1	21.72	0.28	0.09	0.78	194	0.7	3.04	16	93.6
SA163	0.7	2.59	-	2.27	0.11	0.03	0.25	21	0.3	0.92	10	27.8
SA166A	0.6	3.07	-	2.17	0.12	0.03	0.26	19	0.3	0.94	11	28
SA170	1	13.65	-	7.16	0.21	0.13	0.67	68	0.5	4.02	28	52
SA174	2.2	8.62	0.2	46.42	0.35	0.08	1.43	318	1.1	3.75	15	142
SA175	0.5	4.1	-	2.44	0.12	0.03	0.24	22	0.3	1.12	11	37.7
SA176	0.6	3.62	-	2.34	0.13	0.03	0.25	22	0.3	1.07	11	30
SA181	1	114.6	-	5.34	0.32	0.17	0.55	76	0.7	8.01	42	51.9
SA186	0.8	31.45	-	4.7	0.23	0.14	0.4	44	0.5	4.9	30	47.2
SA187	0.9	32.44	-	4.75	0.21	0.14	0.43	41	0.4	4.22	26	51.8
SA189	0.6	21.5	-	2.74	0.15	0.07	0.28	27	0.3	1.88	19	30.4
SA190	1.1	10.73	-	5.49	0.21	0.12	0.53	46	0.5	3.62	17	57.8
SA191	0.8	36.41	-	4.74	0.19	0.14	0.6	33	0.5	3.73	29	52.2
SA197	1.2	31.54	-	6.14	0.32	0.21	0.69	61	0.7	8.09	33	72.4
SA199	1.4	34.95	-	7.66	0.34	0.19	0.95	70	0.8	8.69	36	82.2
SA20	0.5	3.88	-	2.5	0.11	0.03	0.23	30	0.3	0.99	13	22.3
SA208	1.1	4.69	-	3.36	0.15	0.05	0.35	35	0.4	1.54	11	37.2
SA217	0.7	7.75	-	3.22	0.18	0.06	0.35	36	0.4	1.97	27	38.6
SA219	1.5	16.46	-	13.14	0.32	0.11	1.12	76	0.6	5.41	26	205
SA222	1.2	36.77	-	14.09	0.31	0.14	1.34	59	0.6	7.54	33	189
SA229	0.4	137.19	-	2.34	0.14	0.05	0.28	25	0.2	1.79	13	25.3
SA230	1.6	13.73	-	12.25	0.37	0.1	1.07	111	0.7	5.6	31	169
SA231	1.2	22.77	-	6.6	0.25	0.19	0.63	54	0.7	5.74	36	61.7
SA235	0.9	70.73	-	5.97	0.25	0.13	0.43	54	0.4	5.5	32	49.8
SB000	0.5	2.83	-	2.69	0.13	0.03	0.29	22	0.3	1.11	11	30.8
SB001	0.5	30.44	-	1.78	0.11	0.03	0.2	20	0.3	0.86	9	21.6
SB002	0.8	7.1	-	6.21	0.17	0.05	0.34	80	0.4	1.7	19	38.7
SB003	0.5	3.78	-	2.36	0.14	0.03	0.23	27	0.3	0.93	11	33.1
SB004	0.7	3.9	-	3	0.16	0.03	0.27	31	0.4	1.26	13	39.6
SB006	1.1	12.85	-	6.47	0.23	0.11	0.51	75	0.5	3.66	26	51.2
SB007	0.8	6.79	-	4.76	0.19	0.06	0.41	54	0.4	2.19	22	44.9
SB008	0.7	7.72	-	5.42	0.2	0.07	0.36	68	0.5	2.18	16	43.4
SB009	0.6	3.5	-	2.23	0.16	0.03	0.24	23	0.4	1.17	14	26.8
SB011	1.2	8.62	-	10.22	0.23	0.09	0.68	112	0.7	3.17	22	71.9
SB013	0.6	2.86	-	1.83	0.1	0.02	0.21	20	0.6	0.83	22	21.9
SB018	0.8	6.65	-	5.43	0.17	0.05	0.41	55	0.4	1.98	15	41.6

Appendix B Outback Ecology Services (2008) Soil and Regolith Data

Sample ID	As	Cd	Cr	Cu	Hg	Ni	Pb	Zinc
	mg/kg							
2-001	<5	<1	47	5	<0.1	3	5	<5
2-003	<5	<1	35	7	<0.1	6	5	<5
74-000	<5	<1	44	5	<0.1	3	5	<5
74-001	<5	<1	43	5	<0.1	3	5	<5
145-000	<5	<1	36	5	<0.1	3	5	5
145-003	<5	<1	18	5	<0.1	6	5	5
192-001	<5	<1	36	5	<0.1	2	5	<5
192-002	<5	<1	17	12	<0.1	8	5	5
301-001	<5	<1	15	5	0.2	5	5	5
301-003	<5	<1	16	5	<0.1	2	5	5
380-001	<5	<1	50	5	<0.1	5	5	5
380-003	<5	<1	43	5	<0.1	22	5	5
404-001	<5	<1	114	8	<0.1	9	17	5
404-003	<5	<1	44	6	<0.1	4	6	5
416-001	<5	<1	88	12	<0.1	8	16	5
416-003	<5	<1	17	5	<0.1	3	5	5
427-001	<5	<1	44	5	<0.1	3	5	6
427-003	<5	<1	24	6	<0.1	4	6	5
447-001	<5	<1	55	<5	<0.1	2	5	5
447-004	<5	<1	52	7	<0.1	16	9	5
450-000	<5	<1	53	<5	<0.1	2	5	5
450-002	<5	<1	28	9	<0.1	9	6	5
454-000	<5	<1	43	<5	<0.1	3	5	5
454-001	<5	<1	10	12	<0.1	5	5	5
454-002	<5	<1	12	5	<0.1	2	5	5
470-000	<5	<1	48	<5	<0.1	4	6	5
470-002	<5	<1	103	23	<0.1	20	25	<5
538-000	<5	<1	45	<5	<0.1	2	5	<5
538-001	<5	<1	55	<5	<0.1	3	8	<5
538-003	<5	<1	72	7	<0.1	5	12	<5
Minimum	<5	<1	10	<5	<0.1	2	5	5
Maximum	<5	<1	114	23	0.2	22	25	6
Average	<5	<1	44	7	0.1	6	7	5
Average Crustal Abundance (AIMM, 2001)	1.5	-	100?	50	0.05	80?	14	75
Nominated Guidelines								
EIL	20	3	50	60	1	60	300	200
Plants	**18**	**32**	-	**70**	-	**38**	**120**	**160**
Soil Invertebrates	-	*140*	-	*80*	-	*280*	*1700*	*120*
Wildlife - Avian	43	0.77	26	28	-	210	11	46
Wildlife - Mammalian	46	0.36	34	49	-	130	56	79