APPENDIX J

Surface Water Assessment and Monitoring

CLIENTS | PEOPLE | PERFORMANCE

Vista Gold Australia Pty Ltd

Mt Todd Gold Project - Mine Site

Surface Water Assessment and Monitoring Program

May 2013

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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- *Water quality data provided by Vista Gold Australia Pty Ltd had been checked for quality*
- *Treated water discharged from RP3 will in the future replace the discharge from RP1 into Edith River.*
- *During mining operations all water leaving the site will be treated.*

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Glossary	
%ile	Percentile
µg	Microgram
µS/cm	Microsiemens/centimetre
ANFO	Ammonium Nitrate Fuel Oil
ANZECC & ARMCANZ	Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand
AMD	Acid and Metalliferous Drainage
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DME	Department of Mines and Energy
EL	Exploration Lease
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPHC	Environment Protection and Heritage Council
ERDS	Edith River Downstream
ERISS	Environmental Research Institute of the Supervising Scientist
ERSW4	Edith River SW4
ERUS	Edith River Upstream
FRDS	Fergusson River Downstream
FRUS	Fergusson River Upstream
HLP	Heap Leach Pad
ITV	Interim trigger value
kg	Kilogram
km^2	Square Kilometre
L	Litre
LGO	Low Grade Ore
m	Metre
m^3	Cubic Metres (1000L)
ML	Megalitres
mg	Milligram
NEPC	National Environmental Protection Council
NEPM	National Environment Protection Measures
NES	National Environmental Significance
NRETAS	The Department of Natural Resources, Environment, the Arts and Sport
NT	Northern Territory
NTEPA	Northern Territory Environment Protection Authority
RP	Retention Pond
t	Tonnes
TOC	Total Organic Carbon
TSF	Tailing Storage Facility
TV	Trigger Value
WDL	Waste Discharge Licence

Executive Summary

This report discusses the current and future water quality on-site, identifies any potential impacts from discharging mine water to the Edith River as permitted in Waste Discharge Licence (WDL) 178-2 and documents necessary measures to manage identified potential impacts. Issues relating to surface water hydrology, flood risk and mine water management are addressed in GHD (2013b).

Surface water quality has been monitored at several locations in the Edith River and on the Mt Todd mine site for many years. These data show that the water quality of the retention ponds (RPs) on-site has improved dramatically since 2005. However, pH, sulphate and the metals copper, cadmium and zinc remain at levels that have the potential to cause adverse effects on receiving ecosystems downstream of the mine site. The Northern Territory Department of Natural Resource Environment the Arts and Sport (NRETAS) issued a Waste Discharge Licence (WDL) 178 to Vista Gold Australia in January 2011 requiring that any discharge from RP1 is to be diluted to 20,000:1 and discharges to the Edith River are only to occur when river depth is 0.81m or more. This level of dilution was derived to maintain downstream ecosystem health based on ecotoxicity testing performed by the Environment Research Institute of Supervising Scientist (ERISS) (2005).

Investigations into the flow of Edith River at the SW4 sampling site show that the dilution attained at the 0.81m River level can be as low as 50:1, depending on the siphon release at RP1. These investigations showed that the WDL's dilution of 20,000:1 from RP1 has never been met. The NT EPA (formerly NRETAS) addressed this issue in WDL 178-1 in March 2012. WDL 178-1 required Vista Gold to determine site specific trigger values (SSTVs). These were based on background water quality and the Australian and New Zealand Environment Conservation Council (ANZECC) and Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) default 95% species protection trigger values. The site specific trigger values were to be met at the edge of the mixing zone.

A macroinvertebrate sampling program has been undertaken for many years to assess downstream impacts of the mine's discharge. The results of the program indicate that macroinvertebrate populations at site SW4, downstream of the confluence of Burrell Creek (receptor of the RP1 discharge) and Edith River to date show no adverse impacts from low pH and high metal, electrical conductivity and sulphate levels at this site. The discharges from the Mt Todd mine site, in particular from RP1, have not adversely impacted macroinvertebrate populations downstream of the mine site. However, habitats sampled for macroinvertebrates were shallow gravel river edges, and did not take into account the ecosystems in large pools where there is potential for metals from the discharge to settle in benthic sediments. The sediments in the deep pools were sampled and tested for metal accumulation in the 2012 sampling program. The sediments downstream of SW4 contained elevated metals compared to reference and upstream sites, however, all metal concentrations were below the ANZECC & ARMCANZ (2000) guidelines for ecosystem protection.

Vista Gold has received a WDL 178-2 to discharge treated mine water from RP3 into Edith River. To date untreated water has been discharged from RP1. Metal levels of the treated water are substantially reduced compared to levels in untreated RP1 water. Dilution factors have been calculated for RP1, RP7 and treated RP3 mine waters from a suite of bioassays representative of species living in the Edith River to obtain an 80% species protection level at SW4.

A sampling program has been developed for the mine site. The proposed analytes will detect anthropogenic chemicals such as hydrocarbons from fuel sources, nitrous oxides from the use of ANFO (Ammonium Nitrate Fuel Oil), and elevated metals and sulphate from the mine site. An increase in sampling sites at the Mt Todd mine site has been included and will help to differentiate between potential contaminant point sources. The selection of the proposed additional sites has been based on the locations of potential point source influences from the mine to the Edith River. Results from all sampling will be assessed against the Monitoring Values determined following the methodology in Vista Gold's Discharge Plan (GHD 2013) to ensure ecosystem health.

During operations, Vista Gold proposes to discharge water only after treatment by the water treatment plant. The treated water quality discharged will be of higher quality than that discharged during the dewatering process. Vista Gold proposes to meet the water quality for ecosystem protection to meet the requirements of any future WDL.

1. Introduction

Vista Gold Australia Pty Ltd (Vista Gold) proposes to re-establish and operate the Mt Todd Gold Mine, located 55km north of Katherine and 250km south of Darwin. The mine site is accessed via Jatbula Road (restricted mine access road), approximately 10km east of the Stuart Highway (the main highway between Darwin and Adelaide).

Mining and associated operations will occur on mineral leases MLN 1070, MLN 1071 and MLN 1127 covering 5,365ha. Vista Gold also controls exploration leases EL 25668, EL 25669, EL 25670 covering 117,632ha.

The Project area is in an historical mining district. The Mt Todd Gold Mine site is a brownfield/disturbed site. The site was most recently mined for gold in the 1990s. Mining operations ceased in the early 2000s. Mining infrastructure such as tailings dams, waste rock dumps and remains of processing facilities remain on-site. The site has many surface water bodies. Some of these contain water with high metal and low pH levels and have the potential to overflow during the wet season.

The primary concerns regarding water quality from the Mt Todd mining area are related to acid and metalliferous drainage (AMD) in several of the retention pond areas. Exposure of the mine's waste rock to air and water results in sulphide minerals liberating heavy metal ions such as zinc and copper, as well as sulphates, into the retention ponds. The liberated sulphate ions can mix with free hydrogen ions in solution leading to the formation of sulphuric acid, which in turn is responsible for lowering the overall pH of the ponds. Excesses of heavy metal ions and low pH may have deleterious effects on the aquatic ecosystems of the Edith River.

This report discusses the current and future water quality on-site, identifies any potential impacts from discharging mine water to the Edith River as permitted in Waste Discharge Licence (WDL) 178-2 and documents necessary measures to manage identified potential impacts. Issues relating to surface water hydrology, flood risk and mine water management are addressed in GHD (2013b).

1.1 Previous Disturbance and Mining History

The Mt Todd area is the location of numerous Aboriginal archaeological sites, including a large (at least 2 by 2.5km) quarry site occupying the *Eucalyptus tintinnans* woodland habitat to the west and south of the Batman Pit. The Overland Telegraph Line traversed the site in 1872, and was soon followed by mining for gold. From then until the 1980s the study area was the site for intermittent mining for gold, tin and wolfram. Much of this early disturbance was overgrown by the early 1990s.

The Project area was again mined for gold in the 1990s, but underperformance and higher than anticipated operating costs led to the mine being closed and placed in care and maintenance in 1997. Design capacity was never achieved because inadequacies in the crushing circuit reduced recoveries of gold. Cyanide soluble copper minerals resulted in high reagent consumption, further hindering efforts to reach designed production levels.

General Gold formed a joint venture with Multiplex Resources and Pegasus Gold to own, operate and explore the mine in 1999. Operations ceased in July 2000, with administrators appointed. Mining infrastructure such as tailing dams, waste rock dumps and remains of processing facilities remain on site. The mine has been in care and maintenance for the past 10 years.

This Project takes the opportunity to renew mining of the gold resource whilst simultaneously securing rehabilitation for the site.

1.2 Project Description

The current mine development and operation plans involve an open pit mine with conventional open pit mining methods. Ore will be processed on site prior to disposal of the tailings in one of two tailings storage facilities. The current plans are to process approximately 17.8 million tonnes of ore per annum for a design mine life of 13 years. Approximately 62 million tonnes of thickened process tailings will be stored within the proposed expansion of the existing TSF1 during production years one through four. An additional 161 million tonnes of thickened tailings will be stored in the proposed new Tailings Storage Facility (TSF2), commencing during production years four (Tetra Tech 2012).

2. Legislative and Licence Requirements

2.1 Commonwealth Legislation

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act), any development requires assessment if it has the potential to affect one or more of eight matters of National Environmental Significance (NES). The matters of NES that may be of relevance to surface water at Mt Todd include:

- wetlands of international importance (listed under the Ramsar Convention);
- listed threatened species and ecological communities; and
- migratory species protected under international agreements.

The EPBC Protected Matters Search Tool indicates that at Kakadu Stages 1 & 3 (a Ramsar listed wetland), ten threatened species and fourteen migratory species are likely to, may or are known to occur in the search area (Project area plus a 10km buffer). Sightings have been made in the water storage of one migratory species, the freshwater crocodile (*Crocodylus johnstoni*). This species was not recorded by Lane *et al.,* (1990), however there are seven records from the Yinberrie Hills in the NT Fauna Atlas. The other species identified are upstream of the mine and will not be impacted by mining activities.

2.1.2 National Environment Protection Measures (Implementation) Act 1998

Under the *National Environment Protection Measures (Implementation) Act* 1998, the National Environmental Protection Council (NEPC) was established to set national environmental goals and standards for Australia through the development of National Environment Protection Measures (NEPMs). The NEPC is part of the Environment Protection and Heritage Council (EPHC).

Section 14(1) of the NEPC Act prescribes that NEPMs may relate to any one or more of the following:

- ambient marine, estuarine and fresh water quality;
- general guidelines for the assessment of site contamination; and
- environmental impacts associated with hazardous wastes.

2.2 Northern Territory Legislation

2.2.1 Mining Management Act 2001

The *Mining Management Act* 2001 ensures the development of the Territory's mineral resources in accordance with environmental standards consistent with best practice in the mining industry. The Act is administered by Department of Mines and Energy (DME). The objectives of the act that relate to surface water at Mt Todd are:

- Protect the environment by:
  - the authorisation and monitoring of mining activities;
  - requiring appropriate management of mining sites;

- facilitating consultation and cooperation between management and workers in implementing environment protection management systems;
- implementing audits, inspections, investigations, monitoring and reporting to ensure compliance with agreed standards and criteria; and
- specifying the obligations of all persons on mining sites with respect to protection of the environment.

- Assist the mining industry to introduce programs of continuous improvement to achieve best practice environmental management.

2.2.2 Water Act 1992

The *Water Act* 1992 covers allocation, use, control, protection and management of Northern Territory water resources.

Pollution under the Act includes directly or indirectly altering the physical, thermal, chemical, biological or radioactive properties of the water so as to render it less fit for a prescribed beneficial use for which it is or may reasonably be used, or to cause a condition which is hazardous or potentially hazardous to:

- public health, safety or welfare;
- animals, birds, fish or aquatic life or other organisms; and
- plants.

The Waste Discharge Licence (WDL 178-2) for the Mt Todd site is applicable under this Act (See Section 2.4 below).

2.2.3 Waste Management and Pollution Control Act 2009

The purpose of the *Waste Management and Pollution Control Act* 2009 is to protect the environment through objectives and approvals, encouraging effective and responsible waste management and reduction and response to pollution. This Act facilitates the implementation of national environment protection measures made under the *National Environment Protection Council (Northern Territory) Act 1999*, and incorporates environmental compliance plans and audits.

Section 14 of the Act establishes a process for notifying the Environmental Protection Agency (the administrating agency for the Act) about incidents causing, or threatening to cause pollution. Schedule 2 of the Act requires environment protection/licensing for certain activities.

2.3 Guidelines

The following Guidelines may be applicable to surface water quality in the NT:

- Australian and New Zealand guidelines for Fresh and Marine Water Quality ANZECC & ARMCANZ (2000);
- Erosion and Sediment Control Plan Content, NRETAS, 2006; and
- NT Health and Families: Requirements for Mining, Construction and Bush Camps (Environmental Health Information Fact Sheet No. 700).

2.4 Waste Discharge Licence

The Northern Territory Government has provided Vista Gold Australia with a Waste Discharge License (WDL) under Section 74 of the *Water Act* 1992. The WDL permits the discharge of waste water into the Edith River from the Mt Todd mine site for a period of two years (until 30 September 2014). The requirements of the license are:

"The Licensee must, for each wastewater source or each combination of wastewater sources, determine the Dilution Factor and Monitoring Value(s) required to achieve an 80% species level of protection at monitoring point SW4

The Dilution Factor and Monitoring Value(s) must be:
14.1. determined in accordance with the Discharge Plan using Direct Toxicity Assessment;
14.2. determined prior to the first discharge for each Wet season covered by this Licence;
14.3. provided to the NT EPA prior to the first discharge for each Wet season of this Licence; and
14.4. made available on the Licensee's Australian website within 10 Business days of being provided to the NT EPA under condition 14.3

The Licensee must apply, in accordance with the Discharge Plan, the Dilution Factor and Monitoring Value(s) provided to the NT EPA under condition 14 at monitoring point SW4"

3. Existing Environment

3.1 Surrounding Land Uses

The mine is surrounded by Exploration Lease 25576 and 25670, controlled by Vista Gold. Land uses immediately adjacent to the mine site include:

- north – Horseshoe Tin Field;
- east – Nitmiluk National Park;
- south – Edith River and Edith Falls Road; and
- west – Yinberrie Hills (supporting a population of Gouldian finches (*Erythrura gouldiae*).

3.2 Surface Hydrology

The Mt Todd mine is located in the Daly River Catchment (NRETAS, 2011) to the north of the Edith River. The Edith River flows from the east to the west into the Fergusson River, which enters the Daly River. Catchment areas and flows are shown in Table 1.

Table 1 Summary of River Flow Information

Gauging Station Number	Tributary	Catchment Area (km^2)	Mean Annual Flow Volume (m^3)	Mean Annual Discharge (m^3/sec)
G8140040	Daly River	47,100	5,750,000,000	213.90
G8140001	Katherine River	8,640	1,922,000,000	87.17
G8140044	Flora River	5,900	762,300,000	30.80
G8140008	Fergusson River	1,490	415,600,000	23.49
G8140068	King River	11,000	207,800,000	7.64
G8140063	Douglas River	842	148,800,000	6.07

Several surface water bodies including retention ponds are present on-site (Figure 1), being the:

- Raw Water Dam;
- Waste Rock Dump Pond (RP1);
- Low-Grade Ore Dump Pond (RP2);
- Batman Pit Lake (RP3);
- Plant Runoff Pond (RP5);
- Tailings Storage Facility Pond (RP7);
- Heap Leach Pond (HLP); and
- Decant/Polishing Pond.

On-site water storage facilities and the capacity of each facility are listed in Table 2.

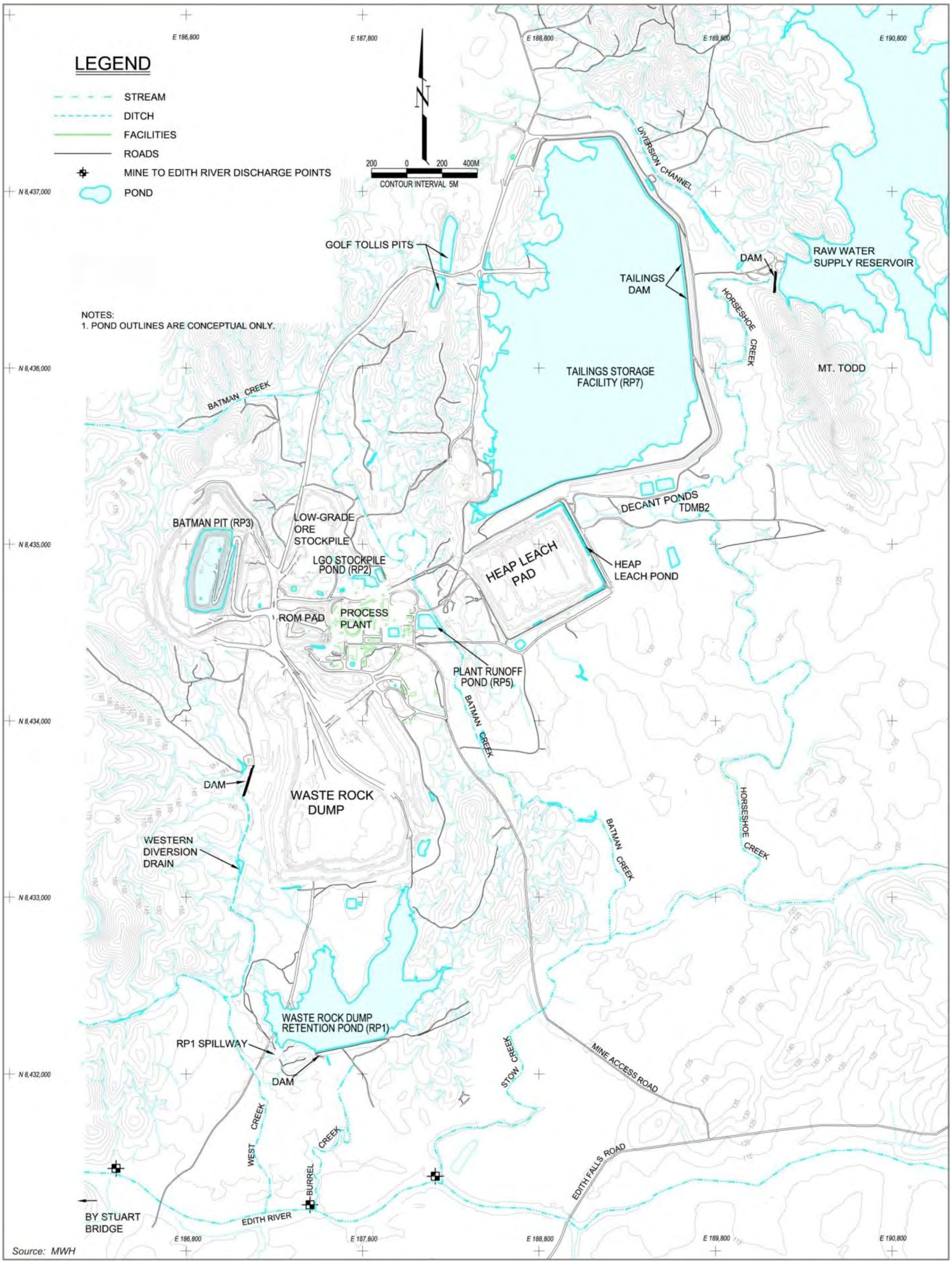

Figure 1 Surface Water Locations

Table 2 On-site Water Storage Facilities (Vista Gold 2010)

Retention Pond Number	Details	Current Storage Capacity (m^3)	Current Storage Capacity (ML)
Raw Water Supply Reservoir	Water Supply	4,500,000	4,500
RP1	Waste Rock Dump Retention Pond	1,040,000*	1,040*
RP2	Low-grade Ore Stockpile Pond	5,000	5
RP3	Batman Pit	10,600,000	10,600
RP5	Plant Run-off Pond	20,000	20
RP7	Tailing Impoundment Facility	5,070,000	5,070
n/a	Decant / Polishing Ponds	30,000	30
n/a	Barren Solution Pond	6,600	6.6
n/a	Heap Leach Pad Moat	17,000	17

**The actual volume of RP1 has since changed due to remodeling and earthworks. Vista Gold proposes to further modify RP1 as the waste rock dump increases in size during operations.*

A gauging station is located on the Edith River downstream of the mine. The catchment area for the gauge is 671km^2. The maximum recorded river height at this station is 6.44m (NRETAS 2011a). This height was exceeded on the 27th December 2011 when a height of approximately 9.4m was recorded.

A description of the individual tributary catchments of the Edith River from the Mt Todd Water Management Plan 2010/2011 (Vista Gold 2010) is summarised below:

- Horseshoe Creek is fed naturally by its catchment area, including the raw water supply reservoir and a drainage diversion channel around the tailings storage facility. Horseshoe Creek may receive any potential seepage from RP7. It flows into Stow Creek, which in turn discharges into the Edith River. The Horseshoe Creek riparian zone east of RP7 contains wetland species and may be classified as a seasonal wetland as it is ephemeral (Vista Gold 2010);
- Batman Creek is fed naturally by its catchment area upstream of the mine site during the wet season. It captures discharges and runoff from RP5, RP2 and the Heap Leach Pad during the wet season and discharges to Stow Creek;
- Stow Creek is fed by Batman Creek and Horseshoe Creek and discharges to the Edith River;
- a large majority of Burrell Creek is essentially covered by the waste rock dump. It receives water from the RP1 siphons during planned discharges. Burrell Creek contains wetland-type vegetation species and during the wet season would be classified as a seasonal wetland (Vista Gold 2010); and
- West Creek is located to the west of the waste rock dump and discharges directly to the Edith River. It is constantly fed by the western diversion drain. It also receives water from the waste rock dump retention pond (RP1) spillway during periods of uncontrolled discharge.

3.2.1 Environmental Values and Beneficial Uses

The Edith River is not listed as a wetland of international importance (Ramsar Wetland). Nor is it listed as one of Australia's Nationally Important Wetlands.

The Edith River and its catchment (including the mine site) have a declared Beneficial Use under the *Water Act* 1992 (NRETAS 2011d). Beneficial Use is a legislated process that assists in the protection and management of water. The community decides how a particular water body should be used by choosing on one or more Beneficial Use categories. Specific categories of uses have been defined in the Water Act to provide the context in which decisions relating to water management, planning and the issuance of licences and approvals are made.

The Edith River declared beneficial use is the protection of aquatic ecosystems. (NRETAS 2011d)Groundwater in the region is referred to as the Katherine Area groundwater and also has declared beneficial uses under the *Water Act* 1992. These are for use of raw water for drinking, for agricultural or industrial purposes (NRETAS 2011a).

Edith River

The Edith River is a 69km tributary of the Fergusson River. The nearest sensitive receptor (in this case a residential area) is the Werenbun Community, approximately 8km east (upstream of the Edith River and to the immediate south of the mine site).

Edith Falls

Leliyn/Edith Falls is located on the western side of Nitmiluk National Park (Katherine Gorge), 42 kilometres north of Katherine along the Stuart Highway. The site is a popular tourist attraction and important sacred site for the Werenbun Community. Tourist visitation is controlled in a limited area around and above the plunge pool, leaving the downstream sections of the river available for free access by members of Werenbun community and other Aboriginal people visiting the area. It is a favoured area for turtles and is regarded as a safe place for children due to the relative absence of saltwater crocodiles (CSIRO 2009).

The environmental values at this site include:

- water quality for swimming;
- water quality for ecosystem protection; and
- flora and fauna for bushwalking.

Impacts on these values may arise from camping and bushwalking activities.

Downstream Users

Cropping occurs downstream of the mine site, close to the confluence of the Edith River with the Fergusson River. Edith River water may be used for irrigation. Surface water (which is potentially dependent, in part, on locally discharging groundwater) from the Edith River is used in the Edith Farms area for stock and domestic purposes as well as for irrigation (surface water extraction licences, 360ML and 110ML on portions 4725 and 2351 respectively).

3.3 Surface Water / Groundwater Interactions

3.3.1 Mt Todd Mine Site

Regional groundwater flow at the Mt Todd mine site is generally westwards, mimicking the surface water flow of the Edith River. The regional flow is likely to be interrupted by local groundwater highs and lows associated with groundwater sources and sinks. Local topography is likely to provide localised groundwater high points beneath elevated features such as the Yinberrie Hills and Mt Todd, or low points where groundwater may discharge as springs in surface water courses.

Groundwater is likely to be recharged from infiltration of direct rainfall, leakage from the ephemeral surface water courses that flow after wet season rainfall events, and leakage from the perennial Edith River where river levels are above the surrounding groundwater level. High rainfall in the wet season, combined with thin alluvial cover and extensive areas of outcrop in surface drainages, are likely to result in high rates of aquifer recharge.

The key potential anthropogenic sources of groundwater infiltration are the raw water dam, the tailing storage facility (TSF), heap leach pad, low grade ore (LGO) stockpile, process plant, unlined earthen surface water diversion drains, pits, waste rock dumps, the waste rock dump retention pond and the proposed new TSF.

3.3.2 Anthropogenic Groundwater Sinks at Mt Todd

The currently flooded Batman Pit (RP3) is an example of a groundwater sink when evaporation during the dry season (or pumping) exceeds inflow, resulting in a regional (or local) groundwater low point. During this scenario groundwater flows into the pit and makes contact with the mine workings. Batman Pit is also expected to act as a groundwater sink during mining. During future non-operational periods, the source/sink scenario will be a function of rainfall, evaporation, pumping and infiltration (in or out).

3.4 Discharge Currently Entering the Edith River

A conceptual water model for the site is provided in Figure 2.

Water discharged from the mine site currently enters the Edith River during the Wet season from:

- treated RP3 water via Batman Creek;
- RP7 via Horseshoe Creek;
- Stow Creek into the Edith River;
- controlled siphon discharge from RP1 via Burrell Creek; and
- overflow from RP1 via a spillway to West Creek.

No surface flow of mine water currently enters the Edith River during the dry season from May to December (MHW 2006), because Horseshoe, Batman, Burrell and West Creeks are ephemeral. Groundwater has the potential to discharge to surface water throughout the year (Tetra Tech 2013).

Stow Creek receives water intermittently during the wet season from two ephemeral creeks that run through the mine site: Batman Creek and Horseshoe Creek. These creeks have received overflow and seepage during heavy rainfall. Flows come from several mine site sources, including the mine’s tailings dam (RP7), retention ponds and a heap leach pad (HLP).

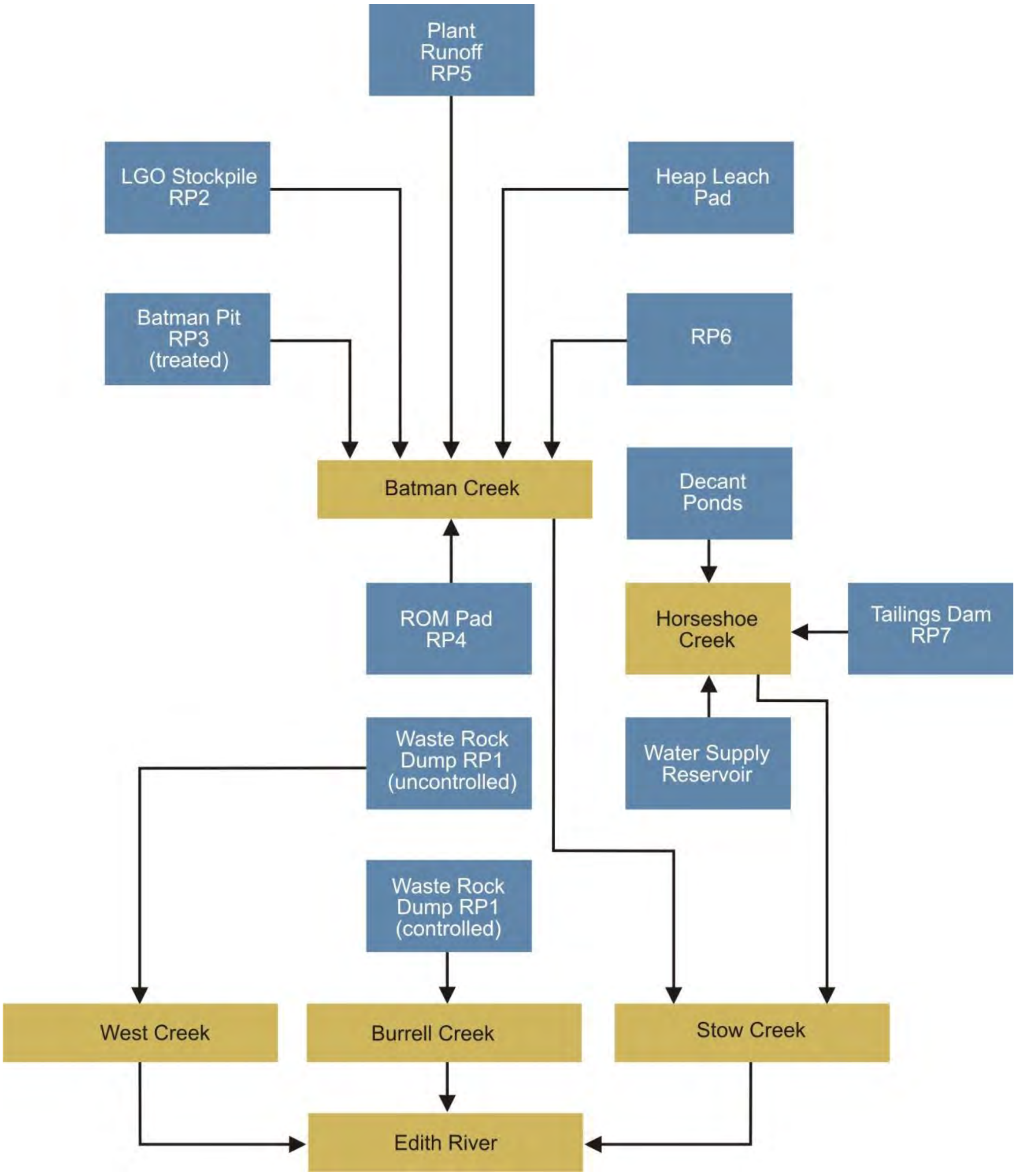

Figure 2 Site Conceptual Model

Controlled discharge from RP1 has been the largest contributor of mine water to Edith River to date. Water has been released to the Edith River in order to increase the holding capacity of RP1 during the wet season. Uncontrolled discharge from RP1 (via the spillway) to West Creek has occurred during heavy rainfall events, the most recent being 27th December 2011.

Uncontrolled discharge from Stow Creek into the Edith River may occur during periods of wet season base flow (approximately January to May). Mine water may make up part of this discharge and potentially originates from a number of sources on-site. Seepage from the low grade ore (LGO) stockpile, the Process Plant and the HLP is flushed to Batman Creek and then Stow Creek. Tailings Dam seepage and underflow as well as some seepage from the HLP are flushed into Horseshoe Creek and then Stow Creek. Some seepage from the Tailings Dam (RP7) may also occur directly into Horseshoe Creek along the eastern Tailings Dam wall.

The other locations of mine water discharge to the Edith River are the RP1 discharge point and a minor drainage, West Creek. The RP1 discharge point is where controlled siphon pumping from RP1 enters the Edith River. West Creek delivers diverted water from the western side of the Waste Rock Dump via the Western Diversion Drain, and overflow from the RP1 spillway. It is reported that West Creek only delivers mine water to the Edith River when substantial rainfall events cause RP1 to overflow, as was the case in December 2011.

Treated RP3 mine water will be discharged during mine dewatering 2012/2013 and 2013/2014 wet seasons only via Batman Creek into Stow Creek where it then enters Edith River. The volumes discharged from RP3 will be determined by the requirements of WDL 178-2.

3.5 Sources of Impact and Sensitive Receptors

3.5.1 Sources of Impact

Water quality may cause impacts associated with:

- leachate containing metals and acids from ore and waste rock pile contaminating surface water runoff and/or discharges;
- enhanced loads of suspended sediment; and
- hydrocarbon and other chemical spills, leaks or disposals contaminating surface water runoff and/or discharges.

Mine Water Contamination

The retention ponds at the Mt Todd mine site contain waters of varying quality. Some contain elevated levels of metals such as copper and zinc as a result of oxidation of the native rock (e.g. waste rock) in the area. Periodically, water from the waste rock dump retention pond (site RP1) reaches a level where discharge to the nearby Edith River is necessary to maintain control of the water levels throughout the mine site.

RP3 is currently being treated in order to reduce the concentrations of metals. Discharge from RP3 is regulated by WDL 178-2 and the Vista Gold Discharge Plan (GHD 2013).

Chemicals to be Stored on Site

An assessment of chemicals to be stored on-site has been undertaken to provide a list of potential contaminants that may enter surface waters in the case of an accidental spill or from routine mine operations.

All chemicals, fuels and oils will be or are currently stored and contained according to Australian Standards and Regulations for the protection of surface water from impacts of spills. Lubricating oil will be stored in bulk containers inside a bunded area with spill protection and recovery.

Waste oil will be stored in a tank within a bunded area and held for collection by a contractor for reprocessing and recycling.

To prevent adverse environmental impacts from exposure to flocculants Vista Gold proposes to use non-hazardous, low toxicity non-ionic or anionic flocculants.

To assess if any chemicals stored on-site (current and future) are entering the surface waters additional analytes have been included into the current surface water monitoring program. Nitrate and nitrite have been included on the list of analytes to assess if ANFO is entering the waterways from blasting. Total petroleum hydrocarbons have also been included on the list of analytes to assess if diesel is entering the surface waters. Weak Acid Dissociable (WAD) cyanide has been included in the proposed monitoring program to identify if this contaminant is entering the waterways.

3.5.2 Sensitive Receptors

Sensitive receptors that may be impacted by the mine's activities include:

- the morphology of streams and land surfaces;
- aquatic and terrestrial biodiversity including;
  - aquatic phytoplankton;
  - aquatic macrophytes;
  - terrestrial plants;
  - zooplankton;
  - benthic and other aquatic macroinvetebrates including biting insects;
  - terrestrial invertebrates;
  - fish;
  - frogs;
  - reptiles;
  - birds and;
  - mammals; and
- downstream users of water.

Contaminated surface water from the mine may have the following impacts on sensitive receptors:

- direct effects of metals contaminating the gills of fish and other aquatic animals;
- bioaccumulation of heavy metals up the food chain;
- direct effects of low pH on plants and animals and prokaryotes;
- mortality of macroinvertebrates leading to disruption of food sources and food webs;

- mortality from drinking contaminated water;
- indirect and direct toxicity;
- settling of precipitates on stream substrates, which can clog interstitial spaces in river bed sediments and restrict availability of habitat to aquatic organisms; and
- loss of potable, irrigation and stock water supplies.

Risks to biodiversity are assessed in Chapter 13, Flora and Vegetation and Chapter 14, Fauna.

3.6 Current Surface Water Quality

3.6.1 Water Quality Data – Mt Todd Mine Site

Acid and metalliferous drainage (AMD) in several of the retention pond areas are the main water quality concerns from the Mt Todd site. Exposure of sulphide minerals associated with the mine's waste rock to air and water results in the liberation of heavy metal ions such as zinc and copper as well as sulphates into the retention ponds. The liberated sulphate ions can mix with free hydrogen ions in solution leading to the formation of sulphuric acid, lowering the overall pH of the pond. Excesses of heavy metal ions and low pH can have deleterious effects on the aquatic ecosystems of receiving environments, in this case, the Edith River.

A monitoring program is in place to assess the quality of surface waters upstream and downstream of the mine site. In the past, surface water had been analysed for pH, EC, SO_4, Al, Cd, Cu and Zn. The current sampling program has increased the number of analytes to capture any anthropogenic chemicals used on-site (Section 6).

The surface waters at Mt Todd mine are sampled on a daily basis during mine discharge from the start of the wet season through to April or May at the end of the wet season at the locations specified in the WDL. This sampling period is intended to capture metal levels that will indicate if any discharges (controlled or uncontrolled) from the mine site occur. Surface waters are also sampled year round on a monthly basis to obtain annual variations in water quality.

The surface water chemistry data provided by Vista Gold in Appendix A covers sampling periods in wet seasons from 2008 to 2011 for the retention ponds and surface waters. Summaries of each sampling location are provided in Appendix A. To provide an indication of the decrease in metal concentration through the wet season the maximum and minimum results are also shown in Appendix A. Summaries of the median results for major analytes for each surface water site are shown in Figure 3.

The samples from the start of the wet season show high metal concentrations for the first week of sampling due to evaporation of the RPs during the dry season increasing the concentrations of metals in the ponds. The metal concentrations in the RPs continually decrease during the wet season and at the end of the wet season are approximately half that observed at the start of the season.

Mean monthly water quality parameters from the three Edith River sites (SW2, SW4 and SW10) and single Stow Creek (SW3) monitoring site over the 2011-2012 wet season is provided to demonstrate the general temporal patterns of variation among the sites (Figure 3). Data are presented as the mean with 95% confidence intervals indicated by the error bars. Patterns for 2010-2011 were analysed and are referred to where results differ from what happened in 2011-2012. As would be anticipated, the monitoring site above the influence of discharges from the mine site (SW2) had relatively stable close to neutral pH, and low levels of sulphate, copper and zinc over both wet seasons.

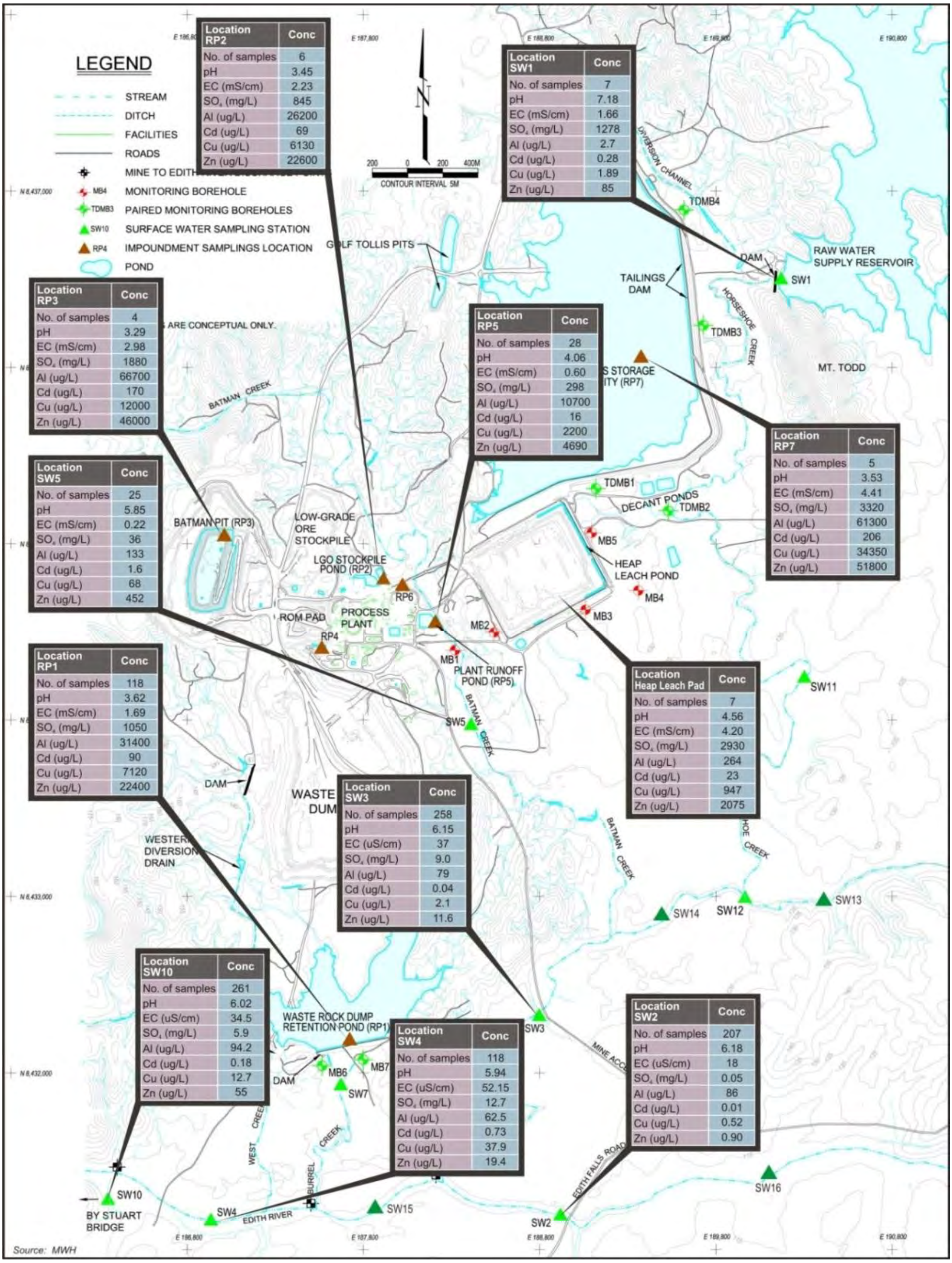

Figure 3 Summary of Mt Todd Surface Water Data

3.6.2 Retention Ponds – RP7

RP7 in the past and currently contains water with high EC, low pH and high metal levels (Figure 4). RP7 currently contains the poorest water quality on site. The water displays the distinct chemical signature of acidic drainage from sulfidic scat stockpiled in the south-western part of the RP7 catchment (Earth Systems 2012).

There is evidence that water is migrating from RP7 via the previous alignment of Horseshoe Creek where backfilling occurred. There are two key seepages observed in the field where the RP7 embankment crosses the original creek line. This surface seepage is the main source of water migration from RP7. Water from the seeps has been observed to pond for several hundred meters both upstream and downstream in Horseshoe Creek (Earth Systems 2012). Seepage rates from the north-eastern embankment were estimated to be up to 5 – 10 L/s and 1 L/s from the eastern embankment (Earth Systems 2012).

Earth Systems (2012) also suggest that RP7 water is present in groundwater down gradient of the embankment. This indicates that another key mechanism for water migration from RP7 is direct percolation of the RP water from the ponded water to the groundwater system via fractured bedrock, along the western margin of the RP. However Earth Systems (2012) state that the seepage of acidic water from the tailings material is not expected to be a significant risk to water quality, provided current management practices are maintained (ie. maintaining saturation of tailings to minimise acid generation).

Vista Gold is proposing to raise RP7 to accommodate an additional 62Mt of tailings via a 16m tailings lift. Provided the tailings remain saturated the additional material will not increase sulfide oxidation and acid generation. Further, Earth Systems (2012) state that the rate of seepage from the uplifted TSF is expected to be comparable, if not lower, than the seepage rates currently observed. This is due to the deposition of tailings material with relatively low hydraulic conductivity across the entire footprint of the existing TFS, which will limit the rate of seepage via the backfilled Horseshoe Creek line, as well as seepage from the ponds into the groundwater via fractured bedrock pathways.

To prevent waste rock from generating acid in the future, following mine closure and TFS rehabilitation; Vista Gold proposes to cap any waste rock with acid generating potential with a clay liner then cover with non-acid generating rock from the mining process. This proposed process will prevent water movement through the TSF and consequent leaching of acid water.

3.6.3 Retention Ponds – RP1

Retention Pond (RP) 1 collects run-off water from the waste rock dump, which in the past had the potential for significant acid generation. Water quality in RP1 has improved significantly since the ERISS (2005) direct toxicity assessment (DTA) conducted on a water sample from the RP. Metal levels in the RP have reduced by approximately 3 – 5 times those measured by ERISS in 2005, with the toxicity reducing by approximately 20 times (Dilution factor 2005: 1:20,000, Dilution factor 2013: 1:1,000). Prior to the 2012/2013 wet season RP1 was the main source of mine water into the Edith River. RP1 discharged untreated mine water to meet 95% species protection site specific trigger values at SW10.

The DME undertook significant earthworks to divert stormwater runoff from the retention pond prior to the 2012/2013 wet season. Together with additional pumping from RP1 to RP3, the free board in RP1 has reduced and the likelihood of an uncontrolled discharge from RP1 due to a storm event is now less likely.

Prior to the commencement of mining operations Vista Gold propose to only discharge untreated water from RP1 if it is required to lower the freeboard to eliminate the chance of an uncontrolled discharge.

Upon commencement of operations all water to be discharged from RP1 will be treated through the water treatment plant.

3.6.4 Batman Pit – RP3

Batman Pit is the mine void remaining from the previous mining operations. Since 2005 the pit has filled with water which has become acidic with high EC and metal concentrations. Before the mine can commence operations the pit must be dewatered. Currently, Vista Gold are treating the water in-situ in order to raise the pH and remove metals. This treated water will be discharged into the Edith River, via Batman Creek and Stow Creek at a dilution determined by a DTA to meet an 80% species protection level at SW4 to meet WDL 178-2. This is discussed in detail Section 4.

3.6.5 Stow Creek SW3

Results from the Stow Creek site (SW3) were clearly influenced by intermittent flows of contaminants from the tailings dam (RP7), retention ponds and the heap leach pad (HLP), and likely variation in the pattern of rainfall between years. There was little decrease in pH during December to February in 2011-2012, although there was significant decrease during December to February 2010-2011. Sulphate levels in 2011-2012 were high in December, and declined in January although remaining higher than at the other sites. Sulphate levels in 2010-2011 were lower than those observed in 2011-2012 with a pattern of gradual increase during the wet season. Copper and zinc levels remained statistically similar to levels at SW2 throughout the 2011-2012 wet season. Levels of copper and zinc peaked above SW2 levels during January 2010-2011.

3.6.6 Edith River SW4

Water quality at the site immediately downstream from the mine (SW4) was strongly influenced by discharges from the RP1 discharge point, and to a lesser extent from Stow Creek discharge . pH was significantly lower relative to the upstream site (SW2) through December to February, with recovery in March. The pH was even lower in December 2010-2011, although the general pattern, including recovery in March and April, was similar to 2011-2012. Sulphate levels relative to upstream values were elevated in all months except March. Levels were also elevated in 2010-2011, with recovery delayed until April. Levels were consistently lower than those recorded at SW3 during December to February 2011-2012 with the reverse occurring during December to March 2010-2011. These patterns seem to reflect the intermittent flow from Stow Creek. Copper and zinc levels were very significantly elevated above upstream levels during all months other than March. The patterns in 2010-2011 were similar to those in 2011-2012, other than recovery to upstream levels not occurring until April 2011.

3.6.7 Edith River SW10

Water at the downstream site (SW10) could be expected to be of higher quality than occur at SW4 near the discharge point. Any improvement is likely to have resulted from dilution caused by rainfall, surface runoff, and inflow from creeks between SW4 and SW10. pH was lower relative to upstream (SW2) of the mine during December to January, and did not differ significantly from that near the discharge point (SW4). During 2010-2011 the pH was higher than at SW4 during December to February and similar to SW4 in March to April when the pH at SW4 increased. Levels of sulphate were elevated relative to upstream of the mine during December to March, with levels less than SW4 only during December. Levels of sulphate during 2010-2011 were elevated and significantly lower than at SW4 during December to March. The elevation in sulphate continued through to April. Levels of copper and zinc remained lower or the same as at SW4 during all months. Elevated copper levels upstream of the mine site were highest during January and February, with high zinc levels persisting to March. Levels of copper and zinc during 2010-2011 were consistently much lower than at SW4 in all months other than April when levels of elevation at both site decline to that of SW2.

3.6.8 Patterns of Contamination

The patterns of contamination described above are based on a consistent annual cycle of rainfall in the wet season. These patterns are determined by elevated levels occurring in Stow Creek (at times that are difficult to predict due to rainfall and upstream impacts) entering the Edith River. The elevated levels of contamination in the early wet season months at sites downstream of the mine are considerably lower as the wet season continues, and the dilution of contamination between SW4 and SW10 plays an important part in returning metal levels to background at SW10. This cycle varies between years according to patterns and levels of rainfall and river flows. The levels of contamination in the controlled discharges and the volumes of discharge released also act on the patterns of contamination within the Edith River at SW4 and SW10.

3.7 Fate and Effects of Contaminants

3.7.1 Fate and Effects of Discharge Entering the Edith River

Sites on the Edith River that receive discharges of mine water with elevated metals and depressed pH still retain significant benthic macroinvertebrate community. Any potential impacts that have been observed in the past have been very short-term or transient, and the results do not indicate a long-term adverse effect. This is supported by the sediment chemistry sampled in May 2011 (Table 3).

Sediments in the Edith River (SW15 and SW4) below SW2 and in Stow Creek (USSC, SW13, SW12, SW14 and SW3) have large particle sizes and minimal clay content (fines <63µm).This configuration of particle sizes and low total organic carbon (TOC) provides limited binding sites (usually organic particles such as humic acids) for metals to adsorb to the sediments. Metals are therefore unlikely to remain in the system (Simpson et al., 2005). There is some influence of mine discharge on zinc, cooper and manganese levels in the sediments. Sediments at SW4 have higher levels than at SW2. These differences are not large, with all metal concentrations at all sites tested coming in below the interim sediment quality guideline low trigger values (ANZECC & ARMCANZ 2000). Sample sites are shown in Figure 3.

The sediments sampled at the macroinvertebrate sampling sites are representative of shallow river habitat and show a slight increase in copper, manganese and zinc levels downstream of the mine discharge (Table 3). These sediment samples may not be representative of the sediments found in the large pools. Deposition of fine particles may increase as water flow decreases on entering large pools. Deposition of fine particles has the potential to increase the TOC of the sediment and increase the ability of the sediments to bind metals from the mine discharge. High levels of metals in benthic sediments can enter food chains and ultimately increase metal levels in recreational fish (Welch 2009).

Sediments sampled in 2012 from deep pools (Envirotech Monitoring 2012) showed that metals were elevated compared to those sampled at SW2; however all metals were below ANZECC & ARMCANZ (2000) sediment quality guidelines for environmental protection.

Table 3 Sediment Quality Data (Metals – Weak Acid Digest)

	USSC	SW13	SW12	SW14	SW3	SW4	SW15	SW2	ANZECC ISQG - low
% Moisture	20	19	19	15	18	22	22	24	
pH	5.9	6.3	6.2	6.3	6.1	6.7	6.8	5.9	
%TOC	0.19	0.094	0.28	0.046	0.043	0.12	0.16	< 0.005	
Metals mg/kg									
Aluminium	2200	1500	1000	760	1000	1200	940	990	25519*
Cadmium	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.5
Chromium	< 5	< 5	< 5	8.7	< 5	< 5	5.4	< 5	80
Cobalt	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	-
Copper	< 5	< 5	< 5	< 5	< 5	26	< 5	< 5	65
Iron	14000	9000	6100	9700	6400	7200	8500	12000	-
Lead	6.7	< 5	< 5	< 5	13	< 5	< 5	< 5	50
Manganese	41	36	18	44	18	79	130	20	460**
Mercury	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.15
Nickel	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	21
Silver	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	1
Zinc	6.4	< 5	< 5	6.9	9.8	24	9.2	< 5	200
Particle Size %									
>2000µm	2.7	2.1	0.1	30	13	0.3	1.1	0.3	
1000-2000µm	2	4	0.7	12	3.6	2.1	8.8	0.8	
500-1000µm	9.8	14	38	33	30	8.3	38	21	
250-500µm	32	30	39	14	23	37	20	28	
125-250µm	38	42	16	8.3	24	24	5.8	14	
63-125µm	6.5	2.5	3.7	2.7	1.5	2.3	3	4.9	
<63µm	9.3	6.2	2.4	< 0.1	5.7	26	24	31	

**Ingersoll et al. 1996 **Persaud et al 1992*

Welch (2009) stated that metal levels in recreational fish species sampled downstream of the mine discharge were elevated when compared to upstream fish samples. This was attributed to an increase in metals uptake from contaminated sediments. Different species of fish were sampled at each site. The metal levels cannot be compared between sites because differences in species, age, stage of maturation and sex of fish influence metal uptake and deposition.

3.7.2 Macroinvertebrate Data

Aquatic macroinvertebrate communities were sampled to assess the impact of the mine discharge on populations downstream from the RP1 discharge site. The populations downstream are compared with populations from reference sites. Macroinvertebrate sampling commenced in 2003 at the following locations (Figure 3):

- Edith River Upstream of Stow Creek Confluence (ERUS);
- Edith River Downstream of Stow Creek Confluence (ERDS);
- Edith River Downstream of Site SW4 (ERSW4);
- Fergusson River Upstream (FRUS); and
- Fergusson River Downstream (FRDS).

The five sites were sampled using standard NT AUSRIVAS survey methodology. The macroinvertebrates were generally identified to family level and the actual macroinvertebrate abundances were extrapolated from the percentage identified. A Bray-Curtis similarity matrix was generated after transforming the data using a 4^{th} root transformation for the 2003–2008 data (Vista Gold 2008). The matrices compared percentage similarity pair-wise between the three Edith River sites and the two Fergusson River sites. The reference site was subsequently compared with the Edith River similarities and a decision made as to whether an impact was detectable.

The mine site discharge had no detectable impact on macroinvertebrate populations in the Edith River during the years 2003, 2005, 2006, 2007 or 2008 (Vista Gold 2008). This was based on the reference sites being less similar to one another than were the Edith River sites to each other. Based on the statistical methodology of the historical sampling program, an impact was detected only once, in 2004 (GHD 2011a).

Based on these historical data, the mine discharge does not have an adverse impact on macroinvertebrate populations in the Edith River. Sampling undertaken in 2011 and 2012 supports these findings. The water quality at sites SW3, SW4 and SW10 is not creating an adverse impact on the macroinvertebrate populations sampled. The major reason for the lack of impact would be the lack of TOC in the sediments and the large particle size, both of which limit the ability of the sediment to retain metals.

3.7.3 Edith River Flow and RP1 Dilutions

Water quality data from the beginning of several wet seasons shows that there are high metal concentrations entering Edith River during the first week of discharge which decrease as the season progresses. The increased concentrations have not caused any long-term impacts on aquatic populations in the Edith River as evidenced by several years of macroinvertebrate sampling demonstrating that the Edith River populations at SW4 are similar to those from the reference sites.

The sample site SW4, below the RP1 discharge site at Burrell Creek, shows the highest concentrations of metals of any site on the Edith River (excluding aluminium which has naturally high background levels in the Edith River). These results show that the discharge from RP1 is being diluted with Edith River water, although not to the level required to meet the interim trigger values of WDL 178-1.

The previous WDLs required a 20,000:1 dilution of the RP1 mine water to Edith Creek for 95% species protection WDL 178 stated that the dilution rate of 20,000:1 is achieved when the Edith River height at the SW4 gauge station is at an estimated minimum of 0.81m. Investigations into the flow of the Edith

River have shown that NRETAS may have overestimated the flow of the Edith River at SW4. This may be related to extrapolation of data obtained by NRETAS in 1999 and 2000 (Envirotech Monitoring 2011). Envirotech Monitoring (2011) calculated that the 20,000:1 dilution rate will be attained when there are flows of 4,800m^3/s in the Edith River with the siphons fully open at 0.24m^3/s. This flow rate has never been reached in the Edith River. A maximum flow rate in the Edith River of 1,503m^3/s was recorded at the gauge station G8140152 in 2000 (Envirotech Monitoring 2011). This would have been exceeded during December 2011 when the height at the gauging station was above 9 metres.

NRETAS calculated a flow rate of 12m^3/s at SW4 when the river height was 0.81m (Envirotech Monitoring 2011). The minimum dilution rate obtained for the discharge of RP1 based on this flow rate would be 50:1. The maximum dilution for RP1 discharge to the Edith River as measured at gauge station G8140152 in 2000 would be 6,262:1. Therefore the previous WDL's required dilution rate for RP1 was never met. Even so, the elevated metal levels at SW4 from the RP1 discharge did not have adverse impacts on macroinvertebrate populations.

The failure to achieve a 20,000:1 dilution factor caused NRETAS to issue a revised licence, WDL 178-1 requiring development of site specific trigger values (SSTVs) to be met at the downstream edge of a yet to be identified mixing zone. The SSTVs will be based on ANZECC & ARMCANZ (2000) 95% species protection default trigger values and assessment of the mixing zone, ecotoxicity of RP1 and macroinvertebrate studies.

Sample site SW10, further downstream on the Edith River, shows lower EC, SO_4 and metal concentrations than SW4 (with the exception of aluminium which is returning to levels similar to the reference site). This indicates that complete mixing of mine water and Edith River water is occurring with additional inflows from creeks entering Edith River downstream of SW4. The decrease in metals between SW4 and SW10 may involve metals settling out in the deep pools of Edith River. Further investigation to determine the sediment composition in the deep pools showed that metals were elevated when compared to concentrations at SW2, however all concentrations were below ANZECC & ARMCANZ (2000) sediment quality guidelines.

The elevated metal levels and SO_4 observed at sample sites SW3, SW4 and SW10 during the wet season can be attributed to source rock from mine activities and discharges from the retention ponds on the mine site.

3.7.4 Impacts of Current Surface Water Discharges to Edith River

Macroinvertebrate populations at SW4 site show no adverse impacts from exposure to elevated metal, sulphate and EC from the mine water even though water quality does not meet previous WDL requirements. Metal deposition in deep pool sediments do not have the potential to adversely impact resident fish populations and related ecosystems (Envirotech Monitoring 2012).

4. Mine Discharge Plan

4.1 Introduction

Vista Gold received an updated Waste Discharge Licence (WDL 178-2) from the NT EPA in February 2013. The licence outlined environmental requirements for the discharge of treated wastewater from RP3 into the Edith River, and discharge from the RP7 and RP1 siphons. RP1 by volume has been the largest contributor of mine water to the receiving environment to date with no adverse impacts detected.

4.2 Dilution Factors

A Discharge Plan (GHD 2013) has been developed by Vista Gold to address the requirements of Waste Discharge Licence (WDL) 178-2. The Discharge Plan describes the investigations that have been, and are proposed to be, conducted in a weight of evidence approach (using multiple lines of evidence) to derive dilution factors for mine waste water discharge from site. The dilution factors were calculated for ecosystem protection in the Edith River at the 80% species protection level near the point of discharge (SW4) and were derived from ecotoxicity testing using appropriate species following ANZECC & ARMCANZ (2000) guidelines. Investigations used to derive the 2012/2013 dilution factors and provide additional information on the health of the Edith River downstream from the discharge point include:

- Investigations into the toxicity of Retention Pond (RP) 7 mine water;
- Investigations into the toxicity of treated RP3 mine water (pilot trial and in-situ samples);
- Investigations into the toxicity of RP1 mine water;
- Risk assessment for the discharge of treated RP3 mine water at SW4;
- Risk assessment for the discharge of untreated RP1 and RP7 mine waters at SW10 and SW4;
- Investigations into the determination of a mixing zone for the Mt Todd discharge;
- Macroinvertebrate and sediment studies to assess downstream impacts from the mine discharge;
- Investigations into the speciation of metals due to water chemistry at the site.

This Discharge Plan provides results to date for the investigations listed above to address the requirements of WDL178-2.

The Discharge Plan provides information that will be used by Vista Gold for guidance on ecosystem protection within the Edith River including:

- An 80% species protection dilution factor obtained from a suite of site specific bioassays for treated RP3; and
- Untreated RP1 and RP7 mine water discharges to be met at SW4 for the following discharge scenarios using:
  - Controlled discharge of treated mine water from RP3 at a dilution factor to meet requirements for 80% species protection at SW4;
  - Controlled discharge of untreated mine water from RP1 at a dilution factor of 1:1,000 for 2012/2013 wet season;
  - Controlled discharge of untreated mine water from RP7 at a dilution factor of 1:4,545 for 2012/2013 wet season.

The Discharge Plan provides the outcomes of three risk assessments on water quality of untreated discharges on the Edith River. A risk assessment conducted on the water quality for discharges from RP1 and RP7 using the interim site specific trigger values (ISSTVs) (GHD 2012) (based on 95% species protection trigger values) showed that a medium risk was calculated for copper and zinc, with a low risk calculated for aluminium, cadmium and pH to the indigenous aquatic populations at SW10. The risk assessments conducted on untreated water from RP1 and RP7 at SW4 using the 80% species protection dilution factor resulted in a low risk for copper, zinc and pH for populations living in the Edith River at SW4 and no risk for aluminium and cadmium.

5. Future Water Quality

5.1 Mine Site

In addition to care and maintenance for the Mt Todd Mine Site, Vista Gold has been conducting studies towards resumption of mining operations including pit development, processing plant and operational facility design and construction. Virtually all operational facilities on-site used to store contaminated water are close to their maximum capacity following an unprecedented wet season in 2010/11. Of particular interest are the Tailing Storage Facility (RP7), the Batman Pit (RP3) and RP1. Vista Gold initiated a number of investigations for the treatment of contaminated water on-site as a proactive approach to ensure the protection of the offsite receiving environments in the event of an uncontrolled discharge occur during future wet seasons. The updated GoldSIM water balance model for the site indicates that if a significant volume (in excess of multiple Gigalitres) of water are not removed from the system, whether through evaporation or discharge during the dry seasons, there is a high probabilityof uncontrolled discharges in future wet seasons.

To minimise this risk Vista Gold is currently treating the water *in-situ* prior to discharge from RP3 into the Edith River upstream of the SW4 sampling point. The two stage process includes use of very finely ground calcium carbonate ($CaCO_3$) and quick lime (CaO). Laboratory results in trials and to date *in-situ* have shown that the treatment results in considerable reduction in metal concentrations and increases in pH. The chemical analytical results of the treated water are shown in Table 4.

Vista Gold is proposing to build a water treatment plant before the commencement of mining in order to to treat future mine waste water. All water to be discharged off site will be treated once the water treatment plant is constructed and commissioned. In the interim, the Department of Mines and Energy and Vista Gold have conducted earthworks designed to prevent uncontrolled discharges by diverting stormwater away from retention ponds.

Following treatment, discharged water will be of a better quality than that discharged to date. Further, discharge volumes will decrease compared to those discharge during the pit dewatering process as treated water will be used on site during plant operations.

5.2 Impacts of Future Surface Water Discharges

The treatment process will alter the chemistry of future discharges of water from the Mt Todd mine site. As mentioned in section 3.7.2 the previous discharge regime (from RP1) has not adversely impacted the macroinvertebrate population downstream of the mine's discharge point, even though the 20,000:1 dilution factor required by the initial WDL was never met. Due to the increase in pH and reduction in metal concentration, the quality of the water discharged from RP3 after treatment will not adversely impact on the macroinvertebrate populations of Edith River.

Vista Gold intends to dewater over a period of two wet seasons (2012/2013 and 2013/2014), NT EPA has permitted the 80% species protection level of dilution to be applied at SW4 to allow this to occur.

Wastewater treatment prior to discharge will significantly reduce the metal load entering the Edith River. Aluminium, cadmium, cobalt, copper, nickel and zinc will be reduced between 70 – 99%. Water quality entering the Edith River will be significantly improved compared to that previously discharged. This will benefit the receiving aquatic ecosystems by reducing the metal content of the river water and reducing the size of the mine's mixing zone.

Upon commencement of operations Vista Gold propose to treat all water in the water treatment plant. All treated water will be used in plant process. Any water leaving site will be treated and Vista Gold will apply for an appropriate water discharge license prior to operations commencing. As future discharge water quality will be of a high standard it is unlikely that any adverse impacts will be detected in downstream populations in the Edith River.

Table 4 Chemistry of RP3 Treated Water (Trial 2011)

Analytes (metals 0.45 µm)	RP3 Untreated Water	RP3 Treated Water 18/08/11
pH		
DO (mg/L)		
Conductivity (uS/cm)	2,800	2,600
Mg (mg/L)	220	200
SO_4 (mg/L)	1,800	1,400
Al (µg/L)	62,000	10
Cd (µg/L)	160	48
Co (µg/L)	1,600	460
Cr (µg/L)	2	<1
Cu (µg/L)	11,000	13
Mn (µg/L)	21,000	17,000
Ni (µg/L)	1,600	290
Pb (µg/L)	1	<1
Fe (µg/L)	<50	<10
Hg (µg/L)	<1	<0.1
Zn (µg/L)	46,000	3,400

5.3 Tailings Storage Facility (TSF2)

A new tailings storage facility (TSF2) is proposed for the Mt Todd site as the current TSF1 will be insufficient to contain future tailings from the mine. The site chosen for TSF2 is located southeast of the existing TSF and south of the existing raw water supply reservoir. The site is bounded to the west by Horseshoe Creek, to the south by Stow Creek, to the east by a small mountain range, and to the northwest by Mt. Todd. In general, the ground slopes from north to south. (Vista Gold 2011).

The TSF2 impoundment is designed to operate as a zero-discharge facility with a linear low-density polyethylene (LLDPE) textured (double sided) geomembrane bottom liner for tailings containment.

5.3.1 Dewatering

Supernatant process water from the tailings impoundment will be dewatered and returned to the process plant using a pair of skid mounted electric pumps. The tailings delivery pipelines and the return water pipelines shall be installed within specially excavated HDPE lined ditches to provide effective containment of process fluids in case of accidental spills resulting from a breach in the pipelines (Tetra Tech 2012).

5.3.2 Seepage Control

The seepage collection system for the TSF2 tailings impoundment will consist of a network of underdrains and overdrains for collecting subsurface seepage in the TSF footprint and tailings pore water drain down respectively (Tetra Tech 2012). Additionally, toe drains will be installed at the upstream and downstream toes of the stage 1 embankment.

5.3.3 Surface Water Management

A surface water diversion channel will be constructed to the southwest of the facility during Stage 1 construction to divert the existing Horseshoe Creek away from the toe of the embankment to prevent erosion of the facility. Rip-rap will be used to line the diversion channel to prevent erosion (Tetra Tech 2012). The channel has been designed to accommodate a peak flow of approximately 182m^3/s comprising 100m^3/s of runoff from a 100 year, 24h storm event in the Horseshoe Creek catchment and 82m^3/s of overflow from the existing raw water supply dam.

A surface water diversion along the south-eastern edge of TSF2 will direct Stow Creek away from the TSF2 footprint. The channel will have a width and length of approximately 60m and 850m respectively and a nominal depth of 4.2m. Rip-rap will be used to line the channel. The channel has been designed to accommodate a peak flow of approximately 656 m^3/sec from a 100 year, 24h storm event in the Stow Creek catchment.

5.3.4 Impacts of the Proposed TSF2 on Surface Water Quality

The proposed TSF2 will operate as a zero discharge facility with many contingency management techniques incorporated into the design in case of mechanical failure and other causes of system overflows or excess drainage. The Horseshoe Creek and Stow Creek diversion channels have been designed to minimise erosion during flows with the use of a liner and an “S” shaped channel.

Construction of the TSF2 is proposed to occur in stages. It is recommended that construction be conducted during the dry season to minimise erosion due to construction activities. Horseshoe Creek is ephemeral, and does not have a resident aquatic life year round. Upstream of the proposed Horseshoe Creek diversion is a modified rocky base with minimal aquatic life that dries out completely during the dry season. Similarly, Stow Creek recedes during the dry season and water quality deteriorates until pools dry out. The proposed diversions will not adversely impact on aquatic populations in Horseshoe Creek or Stow Creek during construction in the dry season and the diversion drains will be integrated with Horseshoe Creek and Stow Creek during the next wet season.

5.3.5 Impact Mitigation for TSF2

To provide protection from potential erosion from construction of the TSF2, Horseshoe Creek and Stow Creek diversion drains, a sediment and erosion minimisation plan is required following the Erosion and Sediment Control Plan Content (NRETA 2006).

It is recommended that construction of the diversion channels be conducted in the dry season when the ephemeral creeks do not contain water. To avoid adverse impacts on aquatic populations that may be resident in Horseshoe Creek and Stow Creek during the wet season.

5.4 Passive / Semi-Passive Water Treatment

Vista Gold intends to install passive or semi-passive water treatment on the site. This will treat seepage and runoff from facilities that generate AMD (e.g. RP1) or alkaline but metal laden water (TSF1 and TSF2). It will become operational after closure of the mine and once flow rates are reduced to levels that make passive treatment viable.

The goals of the passive / semi-passive water treatment are to:

- eliminate or drastically curtail the costs and continual inputs (e.g. reagents, power, staff) required to operate and maintain the new WTP;
- eliminate sludge disposal cell operations and maintenance;
- enable year-round collection, containment and treatment of all AMD prior to release; and
- ensure that treated AMD complies with the WDL water quality standards.

Passive and semi-passive water treatment systems typically include one or more of constructed anaerobic and aerobic wetlands, successive alkalinity producing systems (SAPS), oxic limestone drains (OLD), anaerobic limestone drains (ALD), sulphate-reducing bacteria bioreactors, aeration and settling basins, waterfalls, permeable reactive barriers as well as other passive treatment methods.

Passive and semi-passive water treatment systems are generally appropriate for AMD with a discharge of between approximately $24m^3$/h and $48m^3$/h and low levels of mineral acidity. Passive water treatment systems have successfully treated AMD flows of up to $120m^3$/h. It is estimated that three passive treatment systems (most likely anaerobic wetlands or SAPS) will be required covering a total area of approximately 11ha. During the operations, AMD flow from the reclaimed TSF1 and HLP will be treated in Passive Treatment System 1. Immediately following closure, AMD flow from the reclaimed WRD will be treated in Passive Treatment System 2. In the post-closure phase, AMD flows from TSF2 will be treated in Passive Treatment System 3. The location and final form of these systems is yet to be determined.

5.4.1 Conceptual Anaerobic Wetland Treatment System

As mentioned above, the most likely passive treatment system is an anaerobic wetland system as these are commonly used for treatment of mining impacted waters. Subsurface wetlands, when properly constructed, create an oxygen deficient environment which enables the growth of sulphate-reducing bacteria (SRB). Growth of the SRB is encouraged by the presence of the desired electron acceptor (sulphate) and electron donors (organic carbon substrates), while minimising the population of other bacteria that would compete for the electron donors. Maintaining an oxygen deficient system is critical in minimising the population of bacteria that may scavenge the electron donors from the SRB and thereby minimise the growth of the SRB populations.

The presence of the electron acceptor, sulphate, is provided in the source water. The electron donors in the form of organic carbon substrates must be supplied in the constructed wetland. Common electron donors used in subsurface constructed wetlands include manure (e.g. horse, cow, or sheep), woodchips, straw, or other organic matter. Substrate selection is often based on the availability of materials near the project site, and a wide variety of combinations of substrates have proven effective for treatment.

The key mechanisms for treatment within a subsurface constructed wetland include:

- sulphate reducing bacteria respire sulphate and transform the sulphate to soluble sulphides (H_2S, HS^- and S^{2-}); and

- the soluble sulphides react with cationic metal ions (i.e. Me^{2+} such as Fe, Ni, Cu, Zn) to form highly insoluble metal sulphides.

The reaction can be simplified as follows:

$$2CH_2O + SO_4^{2-} \rightarrow 2HCO_3^{-} + H_2S$$ where CH_2O is a simple organic carbon source.

In addition, sorption of dissolved metals to negatively charged substrates may result in short-term or long-term immobilisation (Halverson, 2004).

5.4.2 Impacts of Proposed Passive Water Treatment on Surface Water Quality

As the location and final form of the passive / semi-passive treatment has not yet been determined it is difficult to assess the impacts of the treated water on discharge to surface water in detail. It is anticipated that the treatment systems will be designed to substantially reduce contaminants in the AMD (sulphate in particular), and allow the discharge to meet the site specific trigger values prescribed in the WDL. Further, the use of the passive / semi-passive systems will minimise any adverse impacts caused by AMD entering the Edith River by removing contaminants and raising pH.

5.5 Chemical, Fuel and Oil Storage

Chemicals stored and used on site have the potential to enter waterways in the event of accidents or spills. Chemicals stored and used on site are listed below:

- Diesel will be stored on-site for mining equipment and owners' vehicles. It is planned to have a single diesel storage area close to the heavy equipment workshop. Refuelling facilities will be provided in the heavy vehicle workshop area for the vehicles belonging to the operation. It is anticipated that approximately 60,000 – 70,000L of diesel will be used daily. Storage capacity of up to 600,000L will be maintained on-site; and
- The drillers' storage yard also contains 260L of waste oil in 20L drums and 16 x 25L of EP Bit drilling fluid.

The Ore Processing Plant will use various reagents including:

- sodium cyanide will be delivered as a solid in a vendor bulk sparging unit in 22t packages. Cyanide will be recovered by dissolving it in water for storage in a $494m^3$ tank. There will be storage for up to seven days consumption - 16,153 tonnes per annum (tpa);
- caustic soda will be delivered in 1t bags with a 50% solution stored in a $43m^3$ tank – 710 tpa;
- flocculent will be delivered as a powder in 1t bulk bags and stored in a 15t dry storage silo. A flocculent solution will be made by dissolving the powder in raw water and stored in two $1027m^3$ tanks – 266 tpa;
- sodium metabisulfite will be delivered as a powder in 1.2t bulk bags with a 20% solution stored in a $73m^3$ tank - 12,958 tpa;
- hydrochloric acid will be delivered as a liquid by 20t road tankers. Storage tank capacity will be 14 days – 1,441 tpa;
- activated carbon will be delivered to site in 500kg bulk bags - 355 tpa;
- fluxes will be delivered to site as bagged solids via bulk truck delivery (borax, silica, soda ash, potassium nitrate and litharge) – 3.6 tpa;

- lead nitrate will be delivered as a powder in 1t bulk bags with a 20% solution stored in a 102m^3 tank – 1,775 tpa; and
- quicklime will be delivered to site in 1.25t bulk bags - 16,153 tpa.

5.5.1 Explosives Magazines/Depot

Packaged explosives will be stored in Ammonium Nitrate Fuel Oil (ANFO) Emulsion storage bins, powder magazines and a cap magazine to be built and operated in accordance with the Dangerous Goods regulations.

6. Surface Water Monitoring Program

6.1 WDL 178-2 Surface Water Monitoring

The surface water monitoring program is a requirement of WDL 178-2 (commencing 05/02/2013 and expiring 30/09/2014). The requirement is outlined in Sections 19, 20, 21 and Appendix 1 of the licence.

The following sections 6.1.1, 6.1.2 and 6.3 outline the requirements of the water monitoring program as described in WDL 178-2.

Vista Gold have developed a Standard Operating Procedure (SOP) for daily surface water monitoring required by the WDL and the monthly surface water monitoring program for extended sample locations.

6.1.1 Monitoring Sites

The authorised monitoring points for the Surface Water Monitoring Program are listed in Table 5. The points are illustrated in the map presented in Figure 4. The source of the discharge must also be sampled on a daily basis during discharge.

Table 5 Authorised Monitoring Points

Authorised Monitoring Point	Description	Location
SW 2	Edith River at Bridge on Edith Falls Road	Easting: 0189088 Northing: 8431347
SW 4	Gauge station on Edith River downstream of RP1 siphons (Burrell Creek) and RP1 Spillway (West Creek), near boundary of mine property	Easting: 0186745 Northing: 8431490
SW 10	Edith River at old Stuart Highway Causeway	Easting: 0179781 Northing: 8430015
RP1	Waste rock wastewater source	Easting: 0187843 Northing: 8432432
RP3	Batman Pit	Easting: 0187055 Northing: 8434993
RP7	Tailings storage area	Easting: 0189211 Northing: 8436326

6.1.2 Parameters

Parameters to be monitored from WDL 178-2 are listed in Table 6.

Table 6 Parameters to Measure at Sample Locations (WDL 178-2Daily when discharging)

Parameter	Units	Methodology
River Height at SW4	m	Gauging Station
River Flow	L/s	
Pumping Rate	L/s	Rating table or flow meter if available
Dissolved Oxygen	ppm	In-situ field measurement
Temperature	°C	In-situ field measurement
Electrical Conductivity	µS/cm	In-situ field measurement
pH		In-situ field measurement
Aluminium[1,2]	µg/L	Lab
Cadmium[1,2]	µg/L	Lab
Cobalt[1,2]	µg/L	Lab
Copper[1,2]	µg/L	Lab
Chromium III[1,2]	µg/L	Lab
Chromium VI[1,2]	µg/L	Lab
Iron [1,2]	µg/L	Lab
Lead[1,2]	µg/L	Lab
Magnesium[1,2]	mg/L	Lab
Manganese[1,2]	µg/L	Lab
Mercury[1,2]	µg/L	Lab
Nickel[1,2]	µg/L	Lab
Zinc[1,2]	µg/L	Lab
Sulfate	mg/L	Lab
Bicarbonate	mg/L	Lab
Unfiltered Alkalinity	mg/L	Lab
Hardness	mg/L	Lab
Total Dissolved Solids	mg/L	Lab
Total Suspended Solids	mg/L	Lab
Total Solids	mg/L	Lab
Sodium	mg/L	Lab
Chloride	mg/L	Lab
Calcium	mg/L	Lab
WAD Cyanide	mg/L	Lab

[1]Total specific metal analysis [2]Dissolved metal analysis filtered through a 0.45 micrometre (µm) filter

6.1.3 Methods

All samples will be analysed using a National Association of Testing Authorities (NATA) accredited laboratory.

Surface water samples will be collected in accordance with the Australian Standard Surface Water Sampling Guidelines by trained environmental scientists. The Australian Standards used include:

- Australian/New Zealand Standard, Water Quality – Sampling Part 4: Guidance on sampling from lakes, natural and man-made AS/NZ 5667.4, 1998; and
- Australian/New Zealand Standard, Water Quality – Sampling Part 6: Guidance on sampling from rivers and streams AS/NZ 5667.6, 1998.

6.1.4 Quality Assurance / Quality Control

Sample Quality Assurance / Quality Control applied during sample collection and analysis include:

- field notes including *in situ* water quality parameters;
- field duplicates;
- sample holding times;
- NATA accredited laboratory; and
- Chain of Custody (CoC) documentation. A CoC form includes label data (customer and Project, location, operator, and sample date). The completed form must accompany the samples from the field to the laboratory.

6.1.5 Reporting

As specified in Section 30 of WDL 178-2, surface water monitoring reports are to be submitted to the Executive Director on a monthly basis during discharge. These monthly submissions will present tabulated data from the surface water monitoring program, including river heights at time and point of discharge and results from *in situ* and laboratory water quality parameters.

6.1.6 Timing

The frequency and timing of sample events required by site and by parameter are presented in Table 7.

Table 7 Timing of Sampling Events for Sample Types (WDL 178-1)

Sampling Point	Field Parameters (pH, EC, Temp, Flow, DO)	Total, filtered metals and metalloids	Other major cations/anions	WAD CN
SW 2	A	A	A	B
SW 4	A	A	A	B
SW 10	A	A	A	B

A Daily (when discharging); and 1 week after the cessation of discharge; and once during the period of first flush

B Monthly

6.2 Surface Water Monitoring for EIA

Vista Gold has developed a Surface Water Monitoring Plan for assessing water quality of water bodies with the potential to be impacted by discharges from the mine site. The water quality data will be used in addition to the results from the macroinvertebrate and sediment monitoring programs and ecotoxicological assessments conducted routinely to provide a weight of evidence approach for assessing the impacts of the Mt Todd mine discharge on aquatic populations in the Edith River.

One of the lines of evidence suggested to be incorporated is the use of physical and chemical assessments of surface waters. Presented below is the surface water monitoring program to feed into the multiple lines of evidence required for environmental assessment.

In the past the main concerns regarding water quality from the Mt Todd mining area are related to acid and metalliferous drainage in several of the retention pond areas. Exposure of sulphide minerals associated with the mine’s waste rock to air and water results in the liberation of heavy metal ions such as zinc and copper as well as sulphates into the retention ponds. The liberated sulphate ions can mix with free hydrogen ions in solution leading to the formation of sulphuric acid, lowering the overall pH of the pond. Excesses of heavy metal ions and low pH can have deleterious effects on the aquatic ecosystems of receiving environments, in this case, the Edith River. Aquatic ecosystem effects have not been observed in the Edith River but can include:

- direct effects to fish through gill exposure to heavy metals, including copper and bioaccumulation through the food chain;
- direct effects to macroinvertebrate populations, which could result in the loss of available prey items for fish species; and
- settling of precipitates on stream substrates, which can clog interstitial spaces in river bed sediments and restrict availability of habitat to aquatic organisms.

Treating the mine water by raising the pH and lowering the metal concentrations will reduce the potential impacts listed above.

Measuring the effects of mine water on populations in the receiving environment requires sufficient data to interpret the chemical processes in the catchment area. This includes testing for several parameters that interact physico-chemically.

The following water quality monitoring program has been developed with the above mentioned in mind, with a suite of parameters chosen to detect the presence and potential effects of AMD and mine associated contaminants on the aquatic ecosystem of Edith River. The data from this monitoring program will be analysed in conjunction with biological and ecotoxicological studies concurrently performed. This analysis will aid in ecosystem protection in the Edith River, and will take the historical background of the site into consideration.

6.2.1 Site Selection

Rationale

The specific authorised monitoring points mentioned in Appendix 1 of WDL 178-2 will be incorporated into this monitoring program. Several additional sampling points are proposed throughout the catchment area. These sites will help to differentiate between potential contaminant point sources. Selection of the proposed additional sites was based on the locations of potential point source influences from the mine to the Edith River.

The three main discharge sites reporting to the Edith River and the potential surface water sources contributing to the discharges are characterised below.

Source of Contamination

Differentiation of the contributions of pollutants from the three potential input sources is an essential aid in management decisions regarding the integrity and capacity of the upstream sources (ponds). There are several sources of possible contamination on-site:

- RP1, RP2 and RP5;
- RP3 treated mine water;
- Tailings Dam (RP7); and
- Heap Leach Pad Moat.

Several additional sites along Horseshoe Creek, West Creek and Stow Creek have been integrated into this sampling program; and are identified in Section 6.2.2.

Critical Waterways Sections

Confluence of Stow Creek and Edith River (CSE)

This waterway is a tributary of the Edith River receiving water sporadically from the ephemeral Batman and Horseshoe Creeks, which run through the Mt Todd mine area. According to the 2010/11 Water Management Plan (WMP) (Vista Gold Australia 2010), overflow is possible during large rainfall events from the RP2 and RP5 catchments into Batman Creek, and also from the mine's RP7 tailings dam into Horseshoe Creek. A third potential input source outlined in the WMP is from the Heap Leach Pad (HLP) moat. This spills during heavy rainfall and eventually drains into Stow Creek via Batman Creek. However, due to earthworks completed at the site in 2011 and 2012 to divert stormwater runoff overflowing of these sites is unlikely.

Confluence of RP1 and Edith River (RP1E)

This is the discharge location for the controlled release of mine water from the waste rock retention pond (RP1). According to the WDL 178-2 requirements, water from this pond can only be released at the dilution factor to meet the 80% species protection level calculated by DTA prior to discharging.

Confluence of West Creek and Edith River (WCER)

This creek discharges directly into the Edith River. It is the direct receiving environment for the RP1 site spillway, which can spill in an uncontrolled manner during the heavy wet season rainfall events. However, earthworks conducted by Vista Gold and DME should reduce the likelihood of this occurring.

6.2.2 Current Sampling Sites

The authorised surface water monitoring points listed in Appendix 1 of WDL 178-2 are outlined below. The sites are monitoring requirements of WDL 178-2:

- SW2 (Edith River at bridge on Edith Falls Road);
- SW4 (Gauge station on Edith River downstream of RP1 siphons (Burrell Creek) and RP1 Spillway (West Creek), near boundary of mine property); and
- SW10 (Edith River at old Stuart Highway causeway).

With the potential for inputs of mine influenced water from Section 6.2.1 in mind, the following sample sites have been identified to provide additional data for WDL 178-2, with the following provisions:

- permission can be obtained from the landowners;
- determination of a requirement to establish roadways to the sampling sites; and
- the sites are safely accessible in wet weather.

The following sites have been selected in addition to the SW2, SW4 and SW10:

- one site on Horseshoe Creek (SW11): This site will be used to indicate ambient water quality in Horseshoe Creek prior to its confluence with Stow Creek;
- one site on Batman Creek (SW5): This site will be used to indicate ambient water quality in Batman Creek prior to its confluence with Stow Creek;
- one site upstream of SW14 and the confluence of Stow Creek and Horseshoe Creek (SW13): This site will be used as an upstream reference for the two sites further downstream;
- one site downstream of the confluence of Stow Creek and Horseshoe Creek (SW14): This site will be used to indicate the degree of change to the ambient chemistry of the Stow Creek upstream water following influx from Horseshoe Creek; and
- one site downstream of the Stow Creek confluence on the Edith River (SW15): This site will be used in conjunction with the upstream Edith River site to detect change as a result of discharge from Stow Creek.

The following storage ponds will be sampled to identify additional source concentrations:

- Tailings Storage Facility (RP7);
- Waste Rock Dump Retention Pond (RP1); and
- Batman Pit (RP3).

The proposed monitoring sites are illustrated in Figure 4 and summarised in Table 8.

6.2.3 Methods

Surface water samples will be collected by trained environmental scientists in accordance with the Australian Standard Surface Water Sampling Guidelines. The Australian Standards used include:

- Australian/New Zealand Standard, Water Quality – Sampling Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples. AS/NZ 5667.1:1998;
- Australian/New Zealand Standard, Water Quality – Sampling Part 4: Guidance on sampling from lakes, natural and man-made AS/NZ 5667.4, 1998; and
- Australian/New Zealand Standard, Water Quality – Sampling Part 6: Guidance on sampling from rivers and streams AS/NZ 5667.6, 1998.

All laboratory samples other will be analysed at a NATA accredited laboratory.

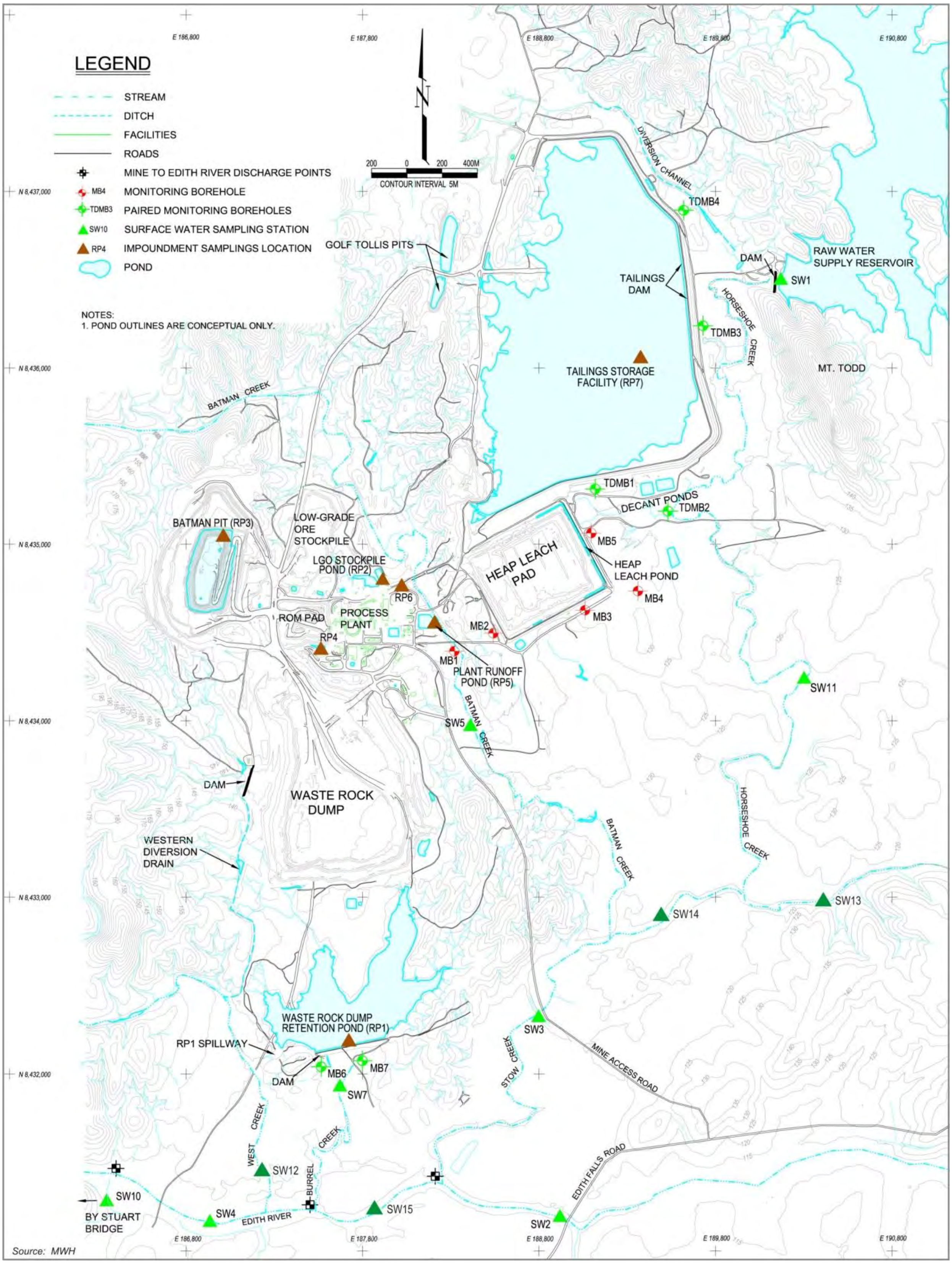

Figure 4 Location of Surface Water Sampling Sites

Table 8 Summary of Water Sampling Sites for Mt Todd Mine

Site	Water body
SW1	Raw Water Supply
SW11	Horseshoe Creek
SW5	Batman Creek
SW3	Stow Creek
SW13	
SW14	
SW7	Burrell Creek
SW2	Edith River
SW15	
SW 4	
SW 10	
SW12	West Creek
RP 7	Tailings storage area
RP3	Batman Pit
RP 1	Waste rock retention pond
Heap Leach Pad Moat	Heap leach pad

6.2.4 Quality Assurance / Quality Control

Sample quality assurance / quality control practices applied during sample collection and analysis include:

- field notes including *in situ* water quality parameters;
- field duplicates;
- sample holding times;
- NATA accredited laboratory; and
- CoC documentation.

6.2.5 Reporting

As specified in WDL 178-2, an annual report including interpretation of all monitoring data is required as a condition of the license. The report will include all surface water, biological and sediment monitoring results and interpretation.

6.2.6 Water Quality Parameters and Sampling Regime

Table 9 outlines the parameters to be monitored for each site mentioned above.

Sampling will be undertaken prior to the start of the wet season and during the wet season. The limited time available to sample surface water each year requires a higher frequency of sampling than is usual for monitoring programs of this type (mines). A monthly sampling event is proposed. Previous data show that water quality improves over the wet season. The large volumes of diesel proposed to be stored and used on-site necessitate the inclusion TPH in the monitoring suite. NO_x has been included in the sampling program to assess if ANFO has the ability to enter waterways. This program will run in conjunction with sampling for the WDL. Many of the sampling sites are the same.

Table 9 Parameters to be Monitored Monthly

	Parameter
In situ	Flow
	Dissolved Oxygen
	Temperature
	Electrical Conductivity
	pH
Laboratory	Total Suspended Solids
	Total Dissolved Solids at 180^{o} C
	Total Dissolved Salts
	Unfiltered Alkalinity, bicarbonate, carbonate
	Major cations: Na, K, Ca, Mg
	Major anions: Cl, SO_4
	Nitrate and Nitrite
	Hardness
	Cyanide-WAD
	TPH
	Dissolved Metals (45µm) (Al, As (III & V), Cd, Co, Cu, Cr (III & VI), Iron (II&III), Pb, Mg, Mn, Hg, Ni, U, Zn)
	Total Metals (Al, As, Cd, Co, Cu, Cr, Iron, Pb, Mg, Mn, Hg, Ni, U, Zn)

6.3 Review of Monitoring Programs

Data from the monitoring program will be reviewed on a monthly basis and the requirements for modification of the sampling program assessed. There is potential to reduce the number of sampling sites if monitoring demonstrates that the mine is not increasing levels of analytes. There is also potential to reduce the number of analytes if analytes are consistently below detection limits. Results may allow for a reduced sampling intensity.

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Appendix A
Surface Water Quality Summary

Mine Surface Water

Retention Ponds

Table 10 Statistics for RP1 Weir 1

2008 - 2011	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
RP1 Wier 1							
Average	3.46	3.05	2165	66823	181	13883	45454
20th%	3.34						
50th %	3.44	3.06	2250	70050	194	14400	47850
80th%	3.60	3.51	2560	80160	226	16640	56520
St Deviation	0.15	0.53	451	19375	57	3906	13959
Minimum	3.13	1.30	716	4800	36	3880	8780
Maximum	3.97	4.01	2980	123000	296	23900	70300
Count	101	101	97	98	98	98	98

Table 11 Statistics for RP1 Weir 2

2008 - 2011	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
RP1 Wier 2							
Average	3.49	2.81	1975	65859	175	14754	41120
20th%	3.35						
50th %	3.45	2.86	1955	66600	175	14900	41500
80th%	3.65	3.47	2606	91160	236	18840	55620
St Deviation	0.17	0.73	600	25417	57	4187	13987
Minimum	3.19	1.43	687	39	58	3130	14500
Maximum	4.10	4.39	3110	120000	296	23600	67000
Count	99	99	96	97	97	97	96

Table 12 Statistics for RP1 Weir 3

2008 - 2011	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
RP1 Wier 3							
Average	3.60	2.35	1466	24841	100	4809	30463
20th%	3.47						
50th %	3.59	2.26	1275	23100	91	4500	28200
80th%	3.71	3.03	2016	31360	126	5942	39000
St Deviation	0.15	0.78	671	10377	40	1712	11902
Minimum	3.24	0.90	432	10	32	1640	9910
Maximum	4.14	4.66	3390	53900	219	11700	61800
Count	86	86	82	83	83	83	83

Table 13 Statistics for RP1 Siphon A

2008 - 2011	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
RP1 Siphon A							
Average	3.60	1.73	1023	30978	89	6831	21328
20th%	3.53						
50th %	3.60	1.68	954	29100	84	6410	20400
80th%	3.73	2.11	1312	40520	112	8454	27460
St Deviation	0.14	0.30	243	7911	22	1535	5128
Minimum	3.05	1.30	668	20400	63	4890	14600
Maximum	3.90	2.26	1490	47600	139	10100	31000
Count	82	82	83	83	83	83	83

Table 14 Statistics for RP1 Siphon B

2008 - 2011	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
RP1 Siphon B							
Average	3.61	1.73	1086	33026	94	7348	22709
20th%	3.54						
50th %	3.62	1.69	1050	31400	90	7120	22400
80th%	3.70	2.10	1340	41420	116	8920	28500
St Deviation	0.12	0.30	276	9208	25	1870	6196
Minimum	3.05	1.30	669	20200	62	4840	1690
Maximum	3.90	2.25	1970	62000	193	15000	41100
Count	118	81	119	118	119	119	119

Table 15 Statistics for RP2

2008 - 2009	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
RP2							
Average	3.50	2.22	896	28333	69	6133	22086
20th%	3.43						
50th %	3.45	2.23	845	26200	69	6130	22600
80th%	3.61	2.81	1019	32600	78	6674	25560
St Deviation	0.09	0.53	170	3305	11	677	4348
Minimum	3.41	1.72	805	26200	58	5460	17100
Maximum	3.61	3.19	1280	32600	92	7490	30000
Count	6	6	7	6	7	7	7

Table 16 Statistics for RO2 Spillway

2008 - 2009	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
RP2							
Average	3.50	0.81	622	26825	55	5285	15233
20th%	3.40		500	18400	41	4224	
50th %	3.50	0.81	634	28000	54	5595	16900
80th%	3.60		718	32900	69	5946	
St Deviation	0.08		104	6433	13	835	3602
Minimum	3.40	0.81	436	18400	35	3780	11100
Maximum	3.60	0.81	726	32900	75	6030	17700
Count	4	1	6	4	6	6	3

Table 17 Statistics for RP3

2008 - 2011	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
RP3							
Average	3.27	3.12	1925	69800	165	11925	46167
20th%							
50th %	3.29	2.98	1880	66700	170	12000	46000
80th%							
St Deviation	0.07	0.42	150	9728	14	772	2954
Minimum	3.19	2.80	1800	62000	150	11000	43300
Maximum	3.32	3.73	2140	80700	176	12700	49200
Count	3	4	4	3	3	4	3

Table 18 Statistics for RP5

2008 - 2009	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
RP5							
Average	3.87	1.82	611	17500	38	4527	10633
20th%							
50th %	3.80	1.29	619	15800	38	4160	10700
80th%							
St Deviation	0.17	0.94	17	3477	4	1068	1701
Minimum	3.75	1.27	592	15200	34	3690	8900
Maximum	4.07	2.90	623	21500	42	5730	12300
Count	3	3	3	3	3	3	3

Table 19 Statistics for RP5 Spillway

2008 - 2009	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
RP5 Spillway							
Average	4.07	0.60	297	10457	17	2166	4775
20th%	3.98						
50th %	4.06	0.60	298	10700	16	2200	4690
80th%	4.14	0.72	351	13020	20	2530	5580
St Deviation	0.10	0.12	58	2871	4	512	1179
Minimum	3.91	0.41	186	5960	10	1370	2730
Maximum	4.37	0.73	428	16700	28	3540	8090
Count	28	8	29	23	29	29	29

Table 20 Statistics for RP7

2008 - 2009	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
RP7							
Average	3.49	4.85	3270	65100	199	33150	50200
20th%	3.07						
50th %	3.53	4.41	3320	61300	206	34350	51800
80th%	3.73	6.48	3980		232	40000	59400
St Deviation	0.31	1.19	629	9771	34	6783	9023
Minimum	2.97	4.11	2460	57800	151	23900	37800
Maximum	3.74	6.96	3980	76200	232	40000	59400
Count	5	5	4	3	4	4	4

Table 21 Heap Leach Pad

2008 - 2011	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
Heap Leach							
Average	5.10	2.98	2645	272	32	917	1995
20th%	3.50						
50th %	4.56	4.20	2930	264	23	947	2075
80th%	6.95	4.93	3330	418	60	1360	2630
St Deviation	1.70	2.08	868	131	19	488	596
Minimum	3.50	0.78	1390	142	21	415	1200
Maximum	7.92	5.45	3330	418	60	1360	2630
Count	7	7	4	4	4	4	4

Table 22 Statistics for SW1 (Raw Water Supply Reservoir)

1999 -2008	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
SW 1							
Average	7.02	1.36	1161	33.4	0.28	2.27	85.2
20th%	6.48		765				
50th %	7.18	1.66	1278	2.7	0.28	1.89	85.2
80th%	7.45	2.55	1321	91.4		4.37	
St Deviation	0.46	1.23	266	47.8	0.34	1.56	
Minimum	6.18	0.03	765	2.0	0.04	0.97	85.2
Maximum	7.52	2.64	1321	126.3	0.52	4.82	85.2
Count	7	7	4	7	2	7	1

Surface Waters

Table 23 Edith River Average 2008 – 2011

2008 -2011	pH (pH Units)	EC (µS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
SW2							
Average	6.20	18.4	0.11	108	0.01	0.57	1.49
20th%	6.07						
50th %	6.18	18.0	0.05	86	0.01	0.52	0.90
80th%	6.36	21.1	0.20	149	0.02	0.68	1.60
St Deviation	0.17	4.8	0.13	90	0.01	0.36	3.24
Minimum	5.71	8.4	0.05	10	0.01	0.13	0.20
Maximum	6.70	50.5	1.20	528	0.10	2.78	39.30
Count	207	206	194	194	220	193	193
2008 -2011	**pH (pH Units)**	**EC (µS/cm)**	**SO_4 (mg/L)**	**Al (µg/L)**	**Cd (µg/L)**	**Cu (µg/L)**	**Zn (µg/L)**
SW4							
Average	5.83	60.8	18.1	130.5	1.02	57.6	254.5
20th%	5.61	41.6					
50th %	5.94	52.2	12.7	62.5	0.73	37.9	194
80th%	6.12	72.6	21.4	118	1.28	61.5	328.8
St Dev	0.45	42.9	21.7	189.9	1.00	67.2	239.7
Minimum	4.22	13.6	0.7	11.9	0.02	1.1	6.7
Maximum	6.73	423.8	196	1110	5.36	386	1400
Count	118	118	101	101	100	100	100
2008 -2011	**pH (pH Units)**	**EC (µS/cm)**	**SO_4 (mg/L)**	**Al (µg/L)**	**Cd (µg/L)**	**Cu (µg/L)**	**Zn (µg/L)**
SW10							
Average	6.06	34.95	6.4	118.2	0.23	11.7	64
20th%	5.86						
50th %	6.02	34.50	5.9	94.2	0.18	12.7	55
80th%	6.28	44.16	9.7	178.0	0.38	18.2	108
St Dev	0.26	11.47	4.0	89.3	0.20	7.2	55
Minimum	5.08	11.20	0.5	1.4	0.01	1.5	3
Maximum	6.85	66.00	25.3	552.0	0.98	37.6	260
Count	261	243	246	246	242	247	246

Table 24 Stow Creek

2008 -2011	pH (pH Units)	EC (µS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
SW3							
Average	6.34	47	12.2	110	0.41	5.7	26.6
20th%	5.92						
50th %	6.15	37	9.0	79	0.04	2.1	11.6
80th%	6.43	64	17.0	153	0.18	4.6	28.0
St Dev	2.81	43	15.5	99	3.97	14.5	42.3
Minimum	4.75	11	0.1	9	0.01	0.3	0.3
Maximum	51.00	418	141	650	53.00	187.0	233.0
Count	258	241	207	219	178	227	230

Table 25 Stow Creek

15 April 2011	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
SW13	6.68	No Data	2.61*	4.2	<0.2	1.19	12.8
SW14	6.65	No Data	2.57*	5.8	<0.2	2.48	14.2

Assumption that data has been incorrectly entered into spread sheet supplied by Vista (data entered as mg/L instead of µg/L)

Table 26 Batman Creek

2008 -2011	pH (pH Units)	EC (mS/cm)	SO_4 (mg/L)	Al (µg/L)	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
SW5							
Average	5.62	0.27	69	208	3.33	326	729
20th%	4.84						
50th %	5.85	0.22	36	133	1.64	68	452
80th%	6.31	0.41	132	389	6.45	290	1460
St Dev	0.70	0.18	64	209	3.79	641	632
Minimum	4.33	0.07	13	18	0.36	26	123
Maximum	6.41	0.71	218	844	14.80	2450	2080
Count	25	24	21	20	21	21	21

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