7.1 Existing conditions

7.1.1 Andranangoo Catchment

The Andranangoo mine site is part of the Andranangoo Creek catchment. The catchment is an undeveloped tropical rural catchment with a total area of 55,400 ha (554 km^2) (TLC 2004). The catchment is shown in Figure 7.1. The catchment includes fresh and estuarine areas at the downstream end prior to discharge to the Timor Sea. The minesite is at the downstream of the catchment. The creek extends approximately 45 km south of the minesite. The disturbance required for the mine site, haul road and camp areas is approximately 65 ha (0.65 km^2) representing approximately 0.12% of the Andranangoo Creek catchment. Land units from Hollingsworth (2003) are presented in Table 7.1.

Overland stream flows in Andranangoo Creek are greatest during the monsoonal wet season. Spring flows from groundwater are expected to stop by the end of the dry season, however spot flow measurements from Andranangoo Creek in the dry seasons of 2000 and 2001 indicate flows of 32-347 L/s (Haig *et al* 2003).

A perennial spring is located directly south of the proposed mining area. This spring flows into a low lying area within the proposed mining area, and then splits into two streams to the ocean and an adjoining clay pan and estuary.

The volume of surface water flow in the catchment has been estimated on an annual basis. This has been estimated to be 241 GL based on an annual rainfall of 1,620 mm, a catchment area of 554 km^2 and an estimated annual run-off coefficient of 0.27. This runoff coefficient was estimated based on a review of data for the Tiwi Islands from the Australian Tropical Rivers Data Audit (Bathurst and Melville Islands).

Monthly flows have been calculated for the Andranangoo Creek catchment based on a desktop review of catchment areas, monthly rainfall and monthly evapotranspiration figures (refer to climate data in Section 3). The estimated monthly flows are presented in Table 7.2.

Estimated peak flows have been calculated for the Andranangoo Creek catchment based on a desktop review of the catchment areas, design rainfall intensities from published information (Institute of Engineers Australia, 2001) and estimated run-off coefficients. The estimated peak flows are presented in Table 7.3.

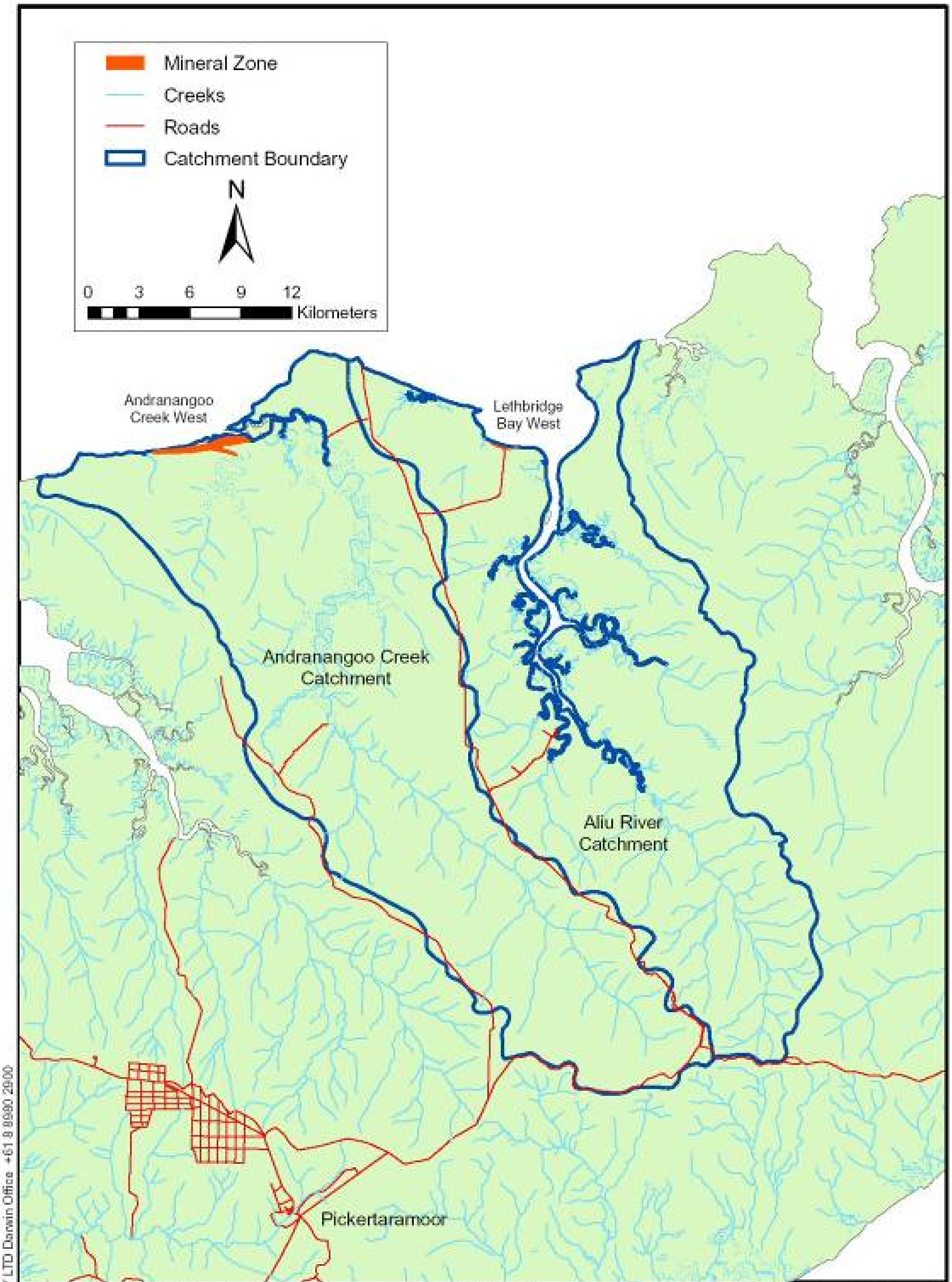

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Table 7.1: Andranangoo Catchment Summary

Land Units Hollingsworth (2003)	Area (ha)	% of Catchment Area
Laq105	13542	24.63
Lfc093	9054	16.47
Uec088	7990	14.53
Gfo109	5428	9.87
Udf085	4984	9.07
Gaq086	3511	6.39
Gec091	3292	5.99
Lrm099	2454	4.46
Gfc085	924	1.68
Gec090	786	1.43
Ueo107	558	1.02
Laq086	529	0.96
Lfo095	529	0.96
Gfo095	438	0.80
Gec088	282	0.51
Lfo109	241	0.44
Uaf100	197	0.36
Lff112	179	0.32
Lfl098	48	0.09
z	9	0.02
Total	**54,975**	**100**

Table 7.2: Estimated Andranangoo Creek Monthly Flows

Andranangoo, Evapotranspiration Method													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Mean monthly rainfall (mm)	308	322	346	102	67	6	1	5	6	53	118	286	1620
Estimated monthly volume (GL)	57.3	67.6	62.6	0.70	0	0	0	0	0	0	2.5	50.5	241
Estimated average flow (kL/s)	21.4	27.9	23.4	0.27	0	0	0	0	0	0	0.95	18.9	-

Table 7.3: Estimated Andranangoo Creek Peak Flows

Catchment	Area (km^2)	Area (ha)	Length of Stream (km)	Approx. Change in Elevation (m)	Average Slope (m/km)	Time of Concentration (hrs)	ARR Peak Flow Duration (hrs)
Andranangoo	554	55400	45	60	1.3	21.8	22
ARI (years)	**1**	**2**	**5**	**10**	**20**	**50**	**100**
Design rainfall intensity (mm/hr)	91	114	134	145	163	186	204
Estimated run-off coefficient	0.3	0.5	0.6	0.7	0.7	0.7	0.7
Estimated flows (ML/s)	4.2	8.8	12.4	15.6	17.6	20.0	22.0

Time of concentration calculated using the Bransby-Williams method $Tc = 58L / (A^{0.1} * S^{0.2})$

Cross section information is not currently available to estimate the flooding depths at the sites during extreme rainfall events.

Site area

The mining activities are located predominantly within a natural drainage line north of a scarp, at an elevation of between approximately 2 to 3 m AHD. Drainage migrates westward towards wetlands/damplands and tidal mangroves associated with the Andranangoo Creek, which is located approximately 500 m from the eastern most mining block. A ridge of coastal dunes at an elevation of about 4 to 5 m AHD inhibits drainage northward towards the coast.

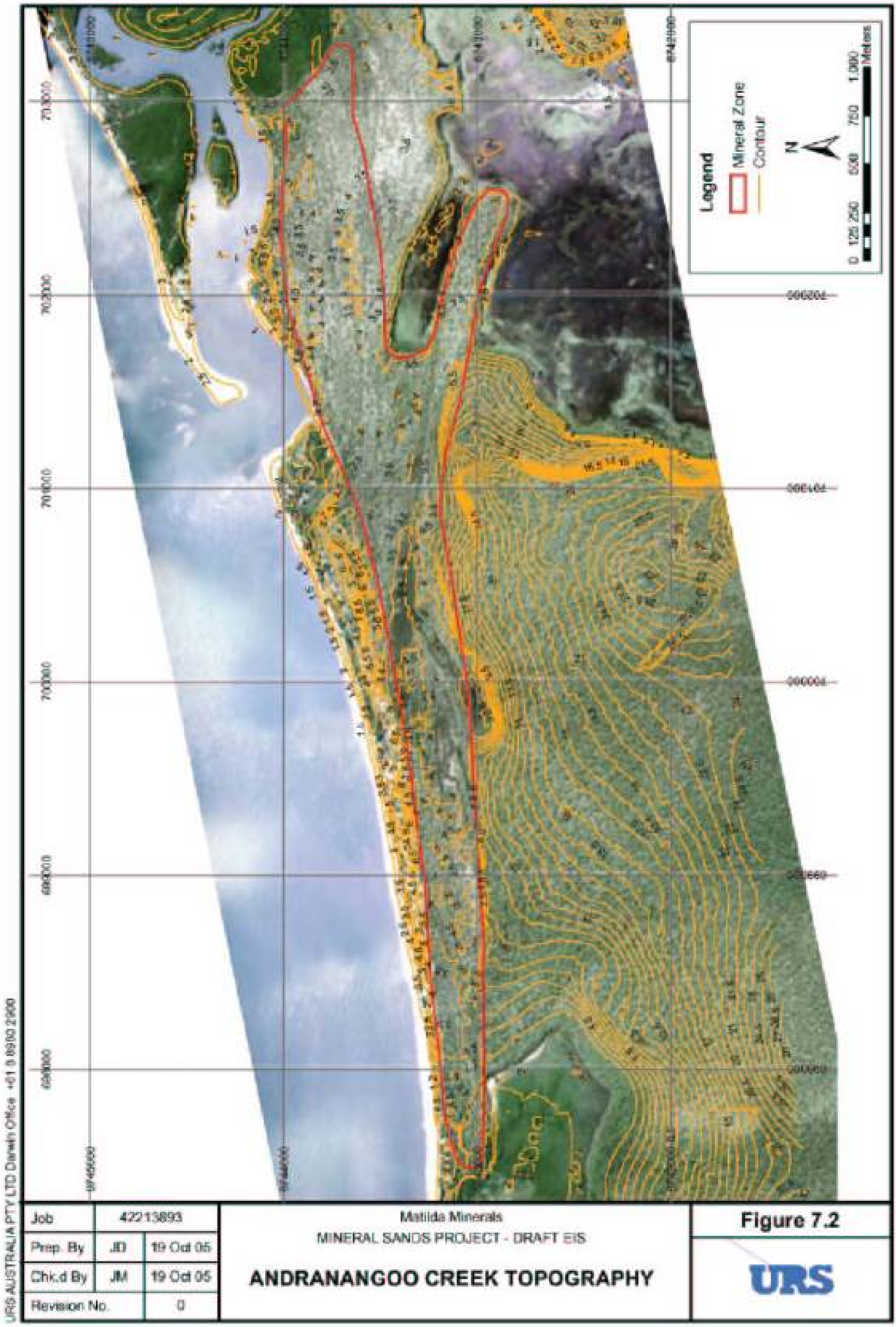
A permanent spring is located directly upstream of the Andranangoo deposit. This flows a short distance to the north-east to a low lying area within the site. This area appears to pond and discharge north through the existing sand dunes to the Timor Sea and also east to existing wetlands/damplands and mangroves that discharge to the Andranangoo Creek.

The stream distance from the spring sites to the Timor Sea is approximately 1.5 km, with approximately 1.3 km of this stream within the Andranangoo site. The stream distance from the spring to the wetlands/damplands within the Andranangoo site is approximately 2.0 km; from the wetlands/damplands adjacent to the eastern portion of the Andranangoo site to the mangroves east of the Andranangoo site is approximately 2.0 km; and from the mangroves to the Andranangoo creek is approximately 2.5 km.

The topography and mineral deposit are presented in Figure 7.2.

Significance of surface water

Consultation with the local Aboriginal communities is discussed in Section 22. This consultation identified that the Andranangoo site area is used occasionally for fishing and hunting by the Aboriginal community. There is no Aboriginal cultural significance identified with the existing spring near the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Andranangoo site. Surface water or groundwater is not currently used by the Aboriginal community near the site.

It is understood that Andranangoo Creek is used regularly for fishing by a fishing charter business (Top End Sportfishing Safaris) and occasionally by recreational users. It is expected that these businesses and recreational users will continue to wish to access Andranangoo Creek. The mineral sands mining operations will not restrict access to the creek for these users. Surface water or groundwater is not currently used by either business, however there are recreational ‘shacks’ in the catchment.

The ecological significance for surface water near the site for flora and fauna is described in Sections 9 and 10. *Melaleuca* woodland is associated with drainage lines and minor depressions and is also known to fringe the brackish swamp area. The *Melaleuca* have been identified as a species that could potentially be impacted by changes to the surface water regime, as they require seasonal inundation with fresh water.

There are several receiving environments for surface water from the site and floodwaters passing through the sites including:

- Andranangoo Creek;
- mangrove creeks associated with Andranangoo Creek in the north eastern edge and western edges of the deposit;
- wetlands/damplands located in the eastern edge of the deposit; and
- the Timor Sea to the north of the site.

The Timor Sea is the ultimate receptor for surface water from the catchment.

Water quality

There is little existing data available regarding water quality and stream flows in the Andranangoo Creek. It is expected that turbidity and salinity will fluctuate during the year due to the larger flows expected during the monsoonal wet season and the tidal fluctuations throughout the year. Salinity would be lower and turbidity would be higher during the monsoonal wet season.

7.1.2 Aliu (Jessie) Creek catchment

Catchment

The Lethbridge mine site is part of the Aliu (Jessie) Creek catchment. The catchment is an undeveloped tropical rural catchment with a total area of approximately 49,200 ha (492 km^2) (TLC 2004). The catchment is shown in Figure 7.1. The site is at the downstream end of the catchment. The creek extends approximately 42 km south of the site. The site area is approximately 35 ha (0.35km^2), representing approximately 0.07 % of the Aliu Creek catchment. Land units from Hollingsworth (2003) are presented in Table 7.4.

Table 7.4: Aliu (Jessie) Creek Catchment Summary

Land Units Hollingsworth (2003)	Area (ha)	% of Catchment Area
Laq105	10313	21.37
Lrm099	8481	17.57
Udf085	7352	15.23
Gec091	5239	10.85
Lfc093	5010	10.38
Gfo109	3744	7.76
Uec088	3121	6.47
Gfc085	1114	2.31
Gec088	847	1.76
Ueo107	683	1.41
Gfo095	588	1.22
Gaq085	486	1.01
Lff112	379	0.78
Lfo109	322	0.67
Gaq086	190	0.39
Gec090	181	0.37
Laq086	108	0.22
Lfl098	73	0.15
Lfo095	33	0.07
Z	2	0.00
Total	48,266	100.00

Overland stream flows in Aliu are greatest during the monsoonal wet season. Spring flows from groundwater are expected to stop by the end of the dry season, however spot flow measurements from Aliu Creek in the dry season of 2000 indicated a flow of 43 L/s (Haig *et al* 2003).

Springs are known to exist in the catchments and it is expected these would feed the shallow aquifer system downstream, Van Diemen Sandstone (Haig *et al* 2003).

The volume of surface water flow in the catchment has been estimated annually to be 215 GL, based on an annual rainfall of 1,620 mm, a catchment area of 492 km^2 and an estimated annual run-off coefficient of 0.27. This runoff coefficient was estimated based on a review of data for the Tiwi Islands from the Australian Tropical Rivers Data Audit (Bathurst and Melville Islands).

Estimated monthly flows have been calculated for the Aliu creek catchment based on a desktop review of catchment areas, monthly rainfall and monthly evapotranspiration figures (refer to climate data in Section 3). The estimated monthly flows are presented in Table 7.5.

Table 7.5: Estimated Aliu Creek Monthly Flows

Aliu, Evapotranspiration Method													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Mean monthly rainfall (mm)	308	322	346	102	67	6	1	5	6	53	118	286	1620
Estimated monthly volume (GL)	50.9	60.0	55.6	0.6	0	0	0	0	0	0	2.2	44.9	214
Estimated average flow (kL/s)	19.0	24.8	20.8	0.24	0	0	0	0	0	0	0.85	16.8	-

Estimated peak flows have been calculated for the Aliu creek catchments based on a rational method from a desktop review of the catchment areas, design rainfall intensities from published information (Australian Rainfall and Runoff, IE Aust 2001) and estimated run-off coefficients. The estimated peak flows are presented in Table 7.6.

Table 7.6: Estimated Aliu (Jessie) Creek Peak Flows

Catchment	Area (km^2)	Area (ha)	Length of Stream (km)	Approx. Change in Elevation (m)	Average Slope (m/km)	Time of Concentration (hrs)	ARR Peak Flow Duration (hrs)
Aliu (Jessie)	492	49200	42	60	1.4	20.3	20
ARI (years)	**1**	**2**	**5**	**10**	**20**	**50**	**100**
Design rainfall intensity (mm/hr)	96	120	140	152	170	194	213
Estimated run-off coefficient	0.3	0.5	0.6	0.7	0.7	0.7	0.7
Estimated flows (ML/s)	3.9	8.2	11.5	14.5	16.3	18.6	20.4

Time of concentration calculated using the Bransby-Williams method $Tc = 58L / (A^{0.1} * S^{0.2})$

Cross section information is not currently available to estimate the flooding depths at the sites during extreme rainfall events.

Site Area

The mining activities are located on a level plateau at approximately 3 m AHD. The western portion of the deposits drains southward towards wetlands/damplands and similarly in the eastern extent of the deposit.

A 1.5 km long section of the western portion of the Lethbridge deposit is approximately 50 m north of wetlands/damplands, and the western most point is 50 m east of a small area of tidal mangroves.

The eastern boundary of the Lethbridge site is approximately 2.0 km west of the Aliu creek. The northern boundary of the Lethbridge site is approximately 0.5 km south of Lethbridge Bay (Timor Sea).

The topography and mineral deposit is presented in Figure 7.3.

Significance of Surface Water

Consultation with the local Aboriginal communities is discussed in Section 22. This consultation identified that the Lethbridge site area is used occasionally for fishing and hunting by the Aboriginal community. There is no Aboriginal cultural significance identified with the existing spring near the Lethbridge site. Surface water or groundwater is not currently used by the Aboriginal community near the site.

It is understood that Aliu Creek is used for fishing regularly by fishing charter businesses (Barra Base and Tiwi Lodge) and occasionally by recreational users. It is expected that these businesses and recreational users will continue to wish to access Aliu Creek. The mineral sands mining operations will not restrict access to the creek for these users. Surface water or groundwater is not currently used by either business, however there are recreational shacks' in the catchment.

The ecological significance for surface water near the site for flora and fauna are described in Sections 9 and 10. The *Melaleuca* woodland that is associated with drainage lines and minor depressions, and is also known to fringe the brackish swamp area, has been identified as a species that could potentially be impacted by changes to the surface water regime as they require seasonal inundation with fresh water.

There are several receiving environments for surface water from site or surface waters or floodwaters passing through the site including:

- Aliu Creek east of the site;
- mangrove creeks associated with the Aliu Creek east of the site;
- wetlands/damplands located in the south-eastern and south-western edges of the deposit; and
- Lethbridge Bay (Timor Sea) to the north of the site.

The Timor Sea is the ultimate receptor for surface water from the catchments.

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Water Quality

There is little existing data available regarding water quality and stream flows in Aliu Creek. It is expected that turbidity and salinity will fluctuate during the year due to the larger flows expected during the monsoonal wet season and the tidal fluctuations throughout the year. It would be expected that salinity would be lower and turbidity would be higher during the monsoonal wet season.

7.2 Objectives and standards

Matilda is committed to manage surface water prior to the commencement, during and following the completion of mining activities at both the Andranangoo and Lethbridge sites. The objectives of this management will be to ensure potential negative impacts to the environment are prevented or minimised. This management will include erosion and drainage control.

Matilda is also committed to conducting surface water monitoring prior to the commencement, during and following the completion of mining activities at both the Andranangoo and Lethbridge sites. The monitoring will be used to ensure that potential negative impacts to the environment are prevented or minimised. The proposed monitoring will include rainfall, landform reconstruction, erosion and drainage, water levels and water quality sampling where possible given appropriate safety considerations.

Matilda will reference the ANZMECC Marine and Freshwater Ecosystem (2000) guidelines to assess the results of water quality sampling programs.

Relevant legislation, standards and policies

- Matilda's Environmental Policy (see Section 1.9.2 of this Draft EIS)
- *Mine Management Act 2001*
- *Soil Conservation and Land Utilisation Act 1985*
- *Waste Management and Pollution Control Act 1998*
- *Water Act 1992*
- *Water Supply and Sewerage Act 1988*
- *ANZECC Guidelines for Fresh and Marine Water Quality 2000.*

7.3 Definition of issues and impacts

7.3.1 General – Andranangoo and Lethbridge

The potential surface water issues and impacts expected from the activities at both the Andranangoo and Lethbridge sites are expected to include:

- Changes to landform in mining areas which could have minor impacts following mining;
- The removal of vegetation, which will result in a very small overall increase in the volume of surface water generated in each catchment, in the period until rehabilitation of the sites are complete;
- Potential erosion in the mining area, stockpile areas and along haul roads, which could have some impact on nearby receiving environments;
- Potential drainage issues in the mining area and haul roads that could have some localised impacts on the nearby waterways; and
- Potential water quality impacts from deposition of eroded sediments into nearby waterways.

These potential issues are discussed below.

Landform

The mining activities are expected to lower the landform in the areas of mining at the site by approximately 150 mm. This could result in more frequent surface water flooding during rainfall events, and a small increase in possibility of tidal inundation during tidal surges at the completion of mining and rehabilitation activities.

The angles of the slopes will be such that the reshaped contours are compatible with the surrounding landform (Section 5.4). The contouring will also ensure that drainage from the site is effective, and that erosion will be minimised and rehabilitation will be successfully achieved. The small increase in possibility of tidal inundation during tidal surges is not considered to be a significant issue.

Increase in surface water volumes

An estimate of the increase in volume of surface water generated at the Andranangoo and Lethbridge sites from the mining areas, haul roads and camps, is presented in Table 7.8.

The estimated increases in the volumes of surface water generated by the minesites are relatively small in comparison to that from the catchment. For the Andranangoo site, an increase of 0.17 GL/year in run-off is estimated, which would increase the annual flow in the Andranangoo Creek catchment (156 GL/year) by 0.11%. For the Lethbridge site, an increase of 0.17 GL/year in run-off is estimated, which would increase the estimated annual flow in the Aliu Creek catchment (138 GL/year) by 0.12%.

The increased volume of surface water run-off was calculated using the area of cleared land that will be present at any one time. This includes 2 ha for the camp and processing areas and 10 ha of disturbed land in the mining area that will be cleared at any one time (land that has not been revegetated or has been cleared ready for excavation) (Matilda pers. comm. 2005).

Table 7.8: Estimated increase in surface water flows at Andranangoo and Lethbridge sites

Andranangoo													
Area = 12ha	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Mean monthly rainfall (mm)	308	322	346	102	67	6	1	5	6	53	118	286	1620
Estimated existing run-off Coefficient	0.2	0.2	0.2	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.2	-
Estimated new run-off Coefficient	0.3	0.3	0.3	0.15	0.1	0.1	0.1	0.1	0.1	0.1	0.15	0.3	-
Estimated increase in run-off Coefficient	0.1	0.1	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	-
Estimated increase in monthly run-off (mm)	31	32	35	5	3	0	0	0	0	3	6	29	144
Estimated increase in monthly volume (GL)	0.04	0.04	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.17
Lethbridge, Rational Method													
Area = 12ha	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Mean monthly rainfall (mm)	308	322	346	102	67	6	1	5	6	53	118	286	1620
Estimated existing run-off Coefficient	0.2	0.2	0.2	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.2	-
Estimated new run-off Coefficient	0.3	0.3	0.3	0.15	0.1	0.1	0.1	0.1	0.1	0.1	0.15	0.3	-
Estimated increase in run-off Coefficient	0.1	0.1	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	-
Estimated increase in monthly run-off (mm)	31	32	35	5	3	0	0	0	0	3	6	29	144
Estimated increase in monthly volume (GL)	0.04	0.04	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.17

Estimate of areas takes progressive rehabilitation program into account.

Erosion and drainage

The clearing of vegetation will be required at the site for the mining areas, haul roads and camps. This is expected to increase volumes of run-off generated at the site and could increase erosion at the site. The impact at the catchment level is expected to be low, as the area being cleared is relatively small in relation to the larger catchments in which the sites are located, and disturbed areas will be continuously rehabilitated. Measures would need to be taken to minimise erosion arising from drainage of the mine sites, haul roads and camps.

It is expected that the tailings pumped and deposited into the mine slot at both sites will be predominantly water, medium and fine-grained sand with minor amounts of silt (refer to Section 2.2). This returned material will be similar to the extracted material, and minimal impact is expected provided that the material is contained within the mine slot.

Surface water from rainfall events generated upstream of the site will be diverted around the mining area, and there is a potential for erosion impacts in the area of the drains around and downstream of the mining area. This could also potentially have impacts in areas downstream including the areas undergoing rehabilitation, and management measures will be implemented to minimise potential erosion impacts.

Haul roads to both sites have the potential for erosion adjacent to the road and will require the installation of a floodway, pipe(s) when crossing existing streams. There is the potential for erosion directly downstream of any new floodways/drains or culverts and for pooling upstream.

The feeder stockpile is expected to move with the mining area. The stockpile has significant potential for erosion and downstream sediment deposition. This potential impact will require management.

The HMC stockpile is expected to remain at one location on the escarpment. It is expected to be roofed and bunded, and therefore not expected to have significant potential for erosion and downstream sediment deposition.

The Port Melville HMC stockpile area is to be an existing roofed and bunded facility. It is not expected that there is a significant risk of erosion at this location.

Water Quality

There is the potential for the acidification of surface water if acid sulphate soils (ASS) or potential acid sulphate soils (PASS) is exposed to air and surface water during excavation (mine slot) or stockpiling activities at the site. Any such soils would require management, to prevent acidification occurring.

There is the potential for the contamination of surface waters with pathogens and nutrient from sewage in septic tanks at the camps if they become flooded with surface waters. The size of these systems will not be large, and the potential impact can be minimised by appropriate design and location of septic systems.

There is a potential for contamination of surface waters with hydrocarbons or chemicals from spills, particularly in the fuel storage area at the camp. The area is not expected to be large and the potential impact can be minimised by appropriate design and location of the facility and appropriate management of its operation.

7.3.2 Andranangoo

Potential site-specific surface water issues and impacts expected from the proposed mining activities at the Andranangoo site include:

- Landform impacts from the haul road alignment, and also on the low lying area downstream of the existing spring.
- Potential flooding of the mining area. The camp area will be elevated on the escarpment and flooding is not expected to occur in this area.

- Potential impacts from erosion and deposition of sediments into nearby waterways.

Landform

Erosion was identified as a potential issue and impact associated with the alignment of the Andranangoo haul road through black soils at CH 47-48 km (Metcalf 2005b). In response Matilda has realigned the road to avoid this area.

Erosion of the small low-lying area in the Andranangoo deposit downstream of the existing spring is a potential issue. This area will be excavated during the mining activities and currently has surface water flows from the existing spring. Flows from the existing spring will be diverted during mining in this area, and will be returned following mining activities. When this area is rehabilitated, specific earthworks and management would be required to restore a similar landform, and to revegetate the area with pre-existing flora species. This would minimise erosion from spring flows in this area.

Flooding

The camp for the Andranangoo site will be located at the top of the escarpment, which is significantly higher than the nearby Andranangoo Creek. There appears to be little potential for flooding of the camp during storm events. One scenario where very large rainfall is expected is in the event of a tropical cyclone. Under a cyclone watch, contingency plans will be implemented, including evacuation of camp personnel to Darwin, and securing machinery and equipment on the escarpment at the minesite.

Erosion and Drainage

The Andranangoo mining area is in close proximity to an existing spring. There are potential impacts to the mine area from flooding from the spring. It is intended to protect the existing spring and stream in areas not proposed for mining, and to provide temporary stream diversion in areas expected to be mined. This diversion will require specific management.

Sediments could be eroded from the site, and deposited via surface water flow into the adjacent tidal dunes to the north or the wetlands/damplands, mangroves and Andranangoo Creek to the east of the Andranangoo deposit. The estimated impact associated with this erosion is low and short term, and the volumes of material deposited on the nearby vegetation in the damplands/mangroves or into the channel of the Andranangoo Creek itself are estimated to be small. Measures would be taken to minimise erosion arising from drainage of the mine sites, haul roads and camps.

7.3.3 Lethbridge

The potential site-specific surface water issues and impacts expected from the proposed mining activities at the Lethbridge site include:

- Potential flooding of the mining area. The camp area will be elevated on the escarpment, and flooding is not expected to occur in this area.
- Potential impacts from erosion and deposition of sediments into nearby waterways.

Flooding

The camp for the Lethbridge site will to be located at the top of the escarpment, which is significantly higher than the nearby Aliu Creek. There appears to be little potential for flooding of the camp during storm events. One scenario where very large rainfall is expected is in the event of a tropical cyclone. Under a cyclone watch, contingency plans will be implemented, including evacuation of camp personnel to Darwin, and securing machinery and equipment on the escarpment at the minesite.

Erosion and Drainage

Sediments could be eroded from the site, and deposited via surface water flow into the adjacent tidal dunes to the north or the wetlands/damplands, mangroves and Aliu Creek to the south-east and south-west of the Lethbridge deposit. The estimated impact associated with this erosion is low and short term, and the volumes of material deposited on the nearby vegetation in the damplands/mangroves or into the channel of the Aliu Creek itself are estimated to be small. Measures would be taken to minimise erosion arising from drainage of the mine sites, haul roads and camps.

7.4 Management

7.4.1 Andranangoo and Lethbridge landform

Landform Measures

The proposed mitigation measures to prevent or minimise the potential impacts on landform at the Andranangoo and Lethbridge sites include:

- Re-alignment of the Andranangoo haul road extension, which has included a deviation around the black soil identified at CH 47-48 km (Metcalf 2005b) to reduce potential erosion along this haul road.
- Construction of drainage channels and low-lying areas with similar geometry (depth and width) as the existing areas in the Andranangoo deposit downstream of the spring.
- Maintaining buffer zones of 200 m from mining activities adjoining the Timor Sea, to prevent additional inundation during tidal surges to the sites.

- Maintaining buffer zones of 50 m from mining activities adjoining mangrove areas, to prevent potential break-out from mining activities and deposition of sediments into either Andranangoo Creek or Aliu Creek.

- Establishing a buffer zone with silt fencing and a small bund around the existing spring near the Andranangoo deposit to prevent soil deposition into the existing spring and stream, and to prevent potential flooding of the mining area from the spring or break-out from the mining slot into the stream.

It is intended to survey and mark the proposed 200 m between the mining area and the Timor Sea and the proposed 50 m buffer around the wetlands/damplands and mangroves at Andranangoo and Lethbridge. It is also proposed to survey areas to be mined prior to clearing, to provide data on which to assess the effectiveness of landform reconstruction and rehabilitation programs.

7.4.2 Andranangoo and Lethbridge erosion and drainage

Buffer zones (measures)

The proposed mitigation measures to prevent or minimise the potential impacts from erosion and drainage at the Andranangoo and Lethbridge sites are described below:

- Maintaining a 50 m wide buffer zone with no intrusive activities around the existing spring near the Andranangoo deposit to minimise potential impacts on water quality and prevent break-out.

- Maintaining a 50 m wide buffer zone with no intrusive activities between the mining areas and the existing wetlands/damplands at the Andranangoo and Lethbridge sites.

- Maintaining a 50 m wide buffer zone with no intrusive activities between the mining areas and the existing mangroves at the Andranangoo and Lethbridge sites.

Mining slot measures

Measures to manage and minimise impacts from drainage and erosion from surface water flows within the mining slot, deposition of tailings into the mine slot and rehabilitation area at Andranangoo and Lethbridge include:

- Minimising the area of open excavation at any one time to minimise the volume of surface water generated in the mining slot and the volume of sediment that can be eroded from disturbed land. It should also be noted that the sand to be mined is coarse (with less than 1% being of size <10 µm) and low clay or sediment content.

- Constructing internal drainage within the mining slot to collect run-off, prevent soil erosion and sediment transport outside the mining slot by tailings. This will be achieved by grading the mining slot to a sump or low point so that run-off and sediment collects within the mining slot to infiltrate, whilst active mining goes on elsewhere. The depth of this sump or low point would be controlled by the depth of groundwater.

- Backfilling the mining slot and compacting the area with earthmoving machinery as soon as practicable after mining ceases. This will reduce the risk of erosion in the re-contoured area during or following rainfall events.
- Backfilling mined areas to surface levels that are similar to the existing levels and providing a stable landform with minimal slopes and levels that are consistent with the existing landform prior to revegetation. This will reduce the volume of sediment mobilised during rainfall.
- Revegetating the backfilled landform as soon as practicable with an appropriate range of species. This will further reduce the volume of sediment mobilised during rainfall. Proposed rehabilitation techniques are described in more detail in Section 21 – Rehabilitation and mine closure.

Mining area diversion measures

Measures to minimise erosion and manage surface water drainage during diversion around and directly downstream of the mining slot at Andranangoo and Lethbridge sites include:

- Constructing a temporary bund and shallow spoon drain on the escarpment side of the road in the mining area to provide flood protection to the active mining area and divert flows around the active mining and rehabilitation areas. The temporary bund and spoon drain will be constructed prior to mining and then removed progressively as revegetation is established in the former mining areas. The diversion of surface waters from upstream of the mining area will reduce the volume of surface water generated in the mining area.
- Spreading surface water flows from spoon drains and diversions into the rehabilitation areas using wide and shallow drains with minimal slopes to minimise erosion in the rehabilitation areas;
- Converting channel flow to sheet flow before it is dispersed into the surrounding environment by controlled widening at the outfall.
- Establishing a buffer zone with a small bund/diversion drain from the existing spring near the Andranangoo deposit to prevent potential flooding of the mining area from the spring.

Haul road measures

Surface water will be managed and erosion minimised along the new sections of the Andranangoo and Lethbridge haul roads by:

- Installing adequately sized spoon drains parallel to the haul roads and adequately sized floodway(s), pipe(s) beneath the haul road. These culverts and/or pipes will be placed at existing streams and otherwise at regular intervals to collect surface water from existing streams and from the haul road spoon drains. These pipes will minimise the impacts from changes in the drainage regime including detention of surface water upstream of the haul roads and erosion of the existing streams downstream of the haul roads.
- Appropriate elevation, material selection and compaction of the haul roads for the proposed traffic volume and weight of trucks/day. This will minimise the potential for washout of the haul roads during large storm events. It is expected that the haul roads will remain following the completion of mining activities at the sites.

Stockpile measures

Measures to manage drainage and minimise the potential impacts from erosion at the feeder and HMC stockpiles at the Andranangoo and Lethbridge sites include:

- Constructing small spoon drains to divert surface water flows around feeder stockpiles and maintaining low silt berms around the perimeter of the feeder stockpile to minimise the transport of sediment. Feeder stockpiles would be constructed and decommissioned at regular intervals as the mining slot moves. The use of diversion spoon drains and low silt berms will reduce the volume of surface water coming into contact with the stockpiles and reduce the volume of material eroded from the feeder stockpiles. Flows of water will be converted from channel flow to sheet flow before being dispersed into the wider environment.
- Constructing a facility with bunding and roofing for the HMC stockpile at the Andranangoo and Lethbridge sites. It is expected that one facility will be constructed at each site and this facility will not move during the mining activities but will be removed following mining activities. The roofing of the stockpile and the use of bunding will prevent rainfall coming into contact with the HMC stockpile, thereby minimising erosion from the HMC stockpile at both sites.
- Keeping the stockpile to a minimum by transporting HMC to Port Melville four times daily.
- Use of the existing bunded and roofed facility at Port Melville to stockpile mineral sands from both Andranangoo and Lethbridge site prior to shipping.

Design criteria

Design criteria for the drainage of the new Andranangoo and Lethbridge haul roads are presented in Table 7.9.

Table 7.9: Andranangoo and Lethbridge Haul Road Drainage Design Parameters

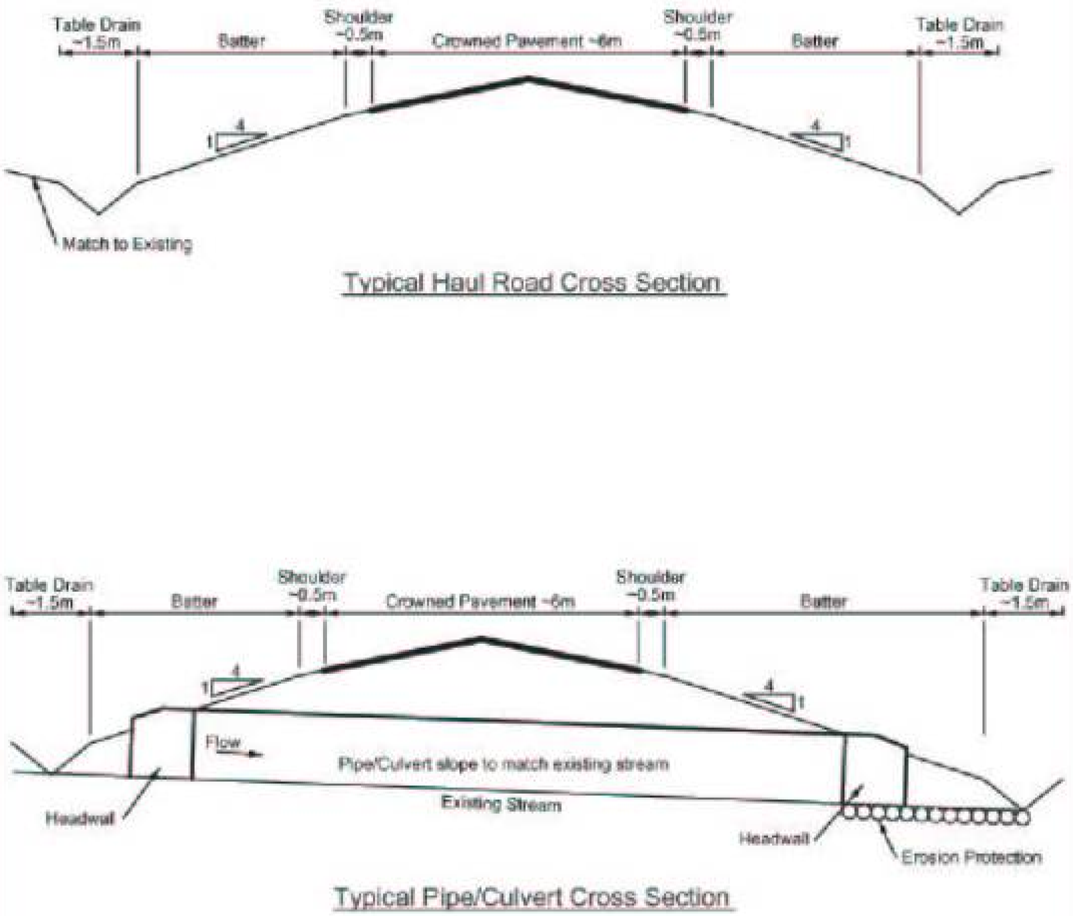
Structure	Design Criteria
Camp Buildings	Located on escarpment, at high points with >0.5m freeboard from surrounding areas
Flood protection of mining area	Protect from 5-year ARI event 0.3 m freeboard
Diversion drains to direct run-off around mining area and feeder stockpiles - channel flow will be converted to sheet flow before dispersed to surrounding environment	Convey a 5-year ARI event 0.3 m freeboard Flow velocity < 1 m/s Appropriate silt fencing
HMC Stockpiles	Impervious base and appropriate roofing and bunding (or walls)
Haul roads Floodways/Pipes	Generally to pass a 5-year ARI event; erosion protection downstream

A typical cross section for haul roads and spoon drains is presented in Figure 7.4.

Soil erosion monitoring

Proposed monitoring for soil erosion at the Andranangoo and Lethbridge sites during mining activities will include:

- Observations and photographs around the perimeter of the feeder and HMC stockpile areas for evidence of soil erosion during wet season and after rainfall events in the dry season. If erosion is identified, eroded material will be cleaned up and repair works will be undertaken as required.
- Observation and photographs of the buffer zones between the sites and Andranangoo Creek and Aliu Creek during wet season and after rainfall events in the dry season for evidence of soil erosion. If erosion is identified, eroded material will be cleaned up and erosion repair works will be undertaken as required.
- Installation of height staffs to record water levels and deposition of sediment with regular observations and photographs to record the extent of pooling upstream of haul roads and the extent of erosion and scour downstream of culverts beneath the haul roads drains during wet season.



Job No.	42213693		Matilda Minerals MINERAL SANDS PROJECT - DRAFT EIS	Figure 7.4
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Chk'd By	CH	25 Oct 05		
Revision No.		0		

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7.4.3 Andranangoo and Lethbridge water quality

Buffer zones (measures)

Measures to manage and minimise water quality impacts in the receiving environments downstream of the Andranangoo and Lethbridge sites include:

- Maintaining a 50-m wide buffer zone with no intrusive activities around the existing spring near the Andranangoo deposit to minimise potential impacts on water quality and prevent break-out.
- Maintaining a 50-m wide buffer zone with no intrusive activities between the mining areas and the existing wetlands/damplands at the Andranangoo and Lethbridge sites.
- Maintaining a 50-m wide buffer zone with no intrusive activities between the mining areas and the existing mangroves at the Andranangoo and Lethbridge sites.

Mining slot measures

Measures to manage and minimise water quality impacts in the mining slots at the Andranangoo and Lethbridge sites include:

- Avoiding excavation into acid sulphate soil areas. This will prevent acidification and resulting metals mobilisation of surface water by PASS and ASS. Results of acid sulphate soil analysis are described in Section 8.

Fuel storage and waste disposal measures

Measures to manage and minimise water quality impacts from fuel storage and waste disposal at the Andranangoo and Lethbridge sites include:

- Fuel storage will be in double-skinned isotainers. This double containment storage will ensure that any leakage from the primary container would be contained within the outer isotainer shell. Fuel spills in this area or in other areas will be treated using a spill response kit that will be stored at the site.
- Chemicals will be stored in sealed and bunded facilities. This bunding will contain any potential chemical spills in the facility. Chemical spills in this area or other areas of the site will be treated using a spill response kit that will be stored at the site.
- Hydrocarbon and chemical waste will be transported to Port Melville and shipped to Darwin. Waste of a domestic nature arising from the camp (including kitchen and office waste) would be collected in 205 L drums, and periodically burnt and disposed of in a small sanitary landfill

trench adjacent to the infrastructure area. This will minimise the potential for contamination of surface water from wastes generated at the site.

Water quality monitoring

The proposed surface water monitoring at the Andranangoo and Lethbridge sites comprises the following:

- Regular surface water samples will be collected from the existing Spring near the Andranangoo site, with field analysis for pH, electrical conductivity, temperature, and Redox potential, and laboratory analysis (including radiological analysis with environmental detection limits) for comparison with the ANZECC Marine and Freshwater Ecosystem guidelines. Depending on the initial results of the monitoring program, the analysis being conducted will then be rationalised. If erosion is identified, clean-up of the eroded material and repairs may be required.

- Occasional spot samples (un-filtered) will be collected within the mining slot, in spoon drains upstream and downstream of mining activities with field analysis for pH, electrical conductivity, temperature, and Redox potential, and laboratory analysis for turbidity, suspended solids and selected metals. These samples would be collected during rainfall events in the wet season.

- Observations and photographs of the fuel storage and chemical storage areas will be taken during the wet season and after rainfall events in the dry season. If there is evidence of fuel or chemical spills then clean-up procedures would be implemented. Records would be kept of any clean-up carried out. If spills occur outside bunded areas, soil sampling in the spill area for hydrocarbons or the chemical of concern will be undertaken as required.

7.4.4 Rainfall monitoring

It is proposed to install a rainfall gauge at each site during active mining (Andranangoo first and then Lethbridge), and daily rainfall figures would be recorded.

7.4.5 Flow measurement

It is proposed that monitoring includes flow measurement downstream of the existing spring at the time of sampling. This will include measurement of stream cross-section and stream velocity to estimate stream flow.

7.4.6 Reporting

It is proposed that reporting will include rainfall data, visual monitoring records, photographs, surface water sampling results, water levels, and records of any spills and clean-up measures implemented.

These would be collated by Matilda and stored electronically. A summary of this information will be included in a report for the Andranangoo and Lethbridge sites at the completion of mining activities.

7.5 Commitments

Matilda commits to implement measures to minimise potential erosion arising from drainage of the mine sites, haul roads and camps (Section 7.3).

Matilda commits to managing earthworks so as to minimise disturbance to drainage channels and erosion (Section 7.4).

Matilda commits to continual rehabilitation of the disturbed areas and to minimising the total area of disturbance at any one time to reduce the amount of erosion from surface water flow and to monitor soil erosion (Section 7.2).

Matilda commits to maintaining a 50-m buffer zone around the wetlands/damplands and mangroves to prevent erosion and to reduce deposition of sediment (Section 7.2).

Matilda commits to monitoring surface water quality prior to commencement, during and following the completion of mining activities (Section 7.4).