9.7.3 Blasting Noise and Vibration (2, 7)

DPIFM has noted that it is proposed that if blasting noise does disturb camp residents then one of the control options that may be investigated is "only blasting when winds are from the SW quadrant". As the information provided in Figure 8.1 in the EIS suggests wind from the SW occurs less than 5% of the year, how effective would this control measure be.

The on-site weather station contains an anemometer that records wind speed and direction. Should complaints about blasting noise be received from camp residents, the wind direction as indicated by the anemometer will be checked prior to blasting.

ECNT has asked what are the possible impacts of blasting and mine operations on surrounding wildlife and will 40dB have an impact on birds and other animals.

Noise impacts on wildlife will be minor and localised. Experience at other mine sites has shown that fauna species quickly adapt to mine site noise if there is no associated or perceived threat.

10.5 Erosion (5, 7)

MAGNT has stated that there is no mention of erosion relating to bund.

The flood protection bund will be designed, constructed, and maintained with full protection against erosion. This is required not only to minimise the generation of sediment loads for environmental protection but also to protect its stability for flood protection of the mine. The design for erosion protection will include all foreseeable forms of erosion including direct rainfall impact onto the bund surface, sheet flow and gully/rill erosion from runoff, and flood flows from large floods in the McArthur River. Hydraulic modelling to date has shown that flood flow velocities at and adjacent to the bund will be low enough to minimise the potential for erosion. For added protection, rock armouring will be placed on the outer batter of the bund in all areas vulnerable to erosion. Erosion resistance will be monitored throughout the mine life with date and geo-referenced photographic surveys undertaken annually. Assessment of erosion resistance monitoring, with implications and strategies for maintenance of erosion protection (if necessary), will be documented in annual reporting.

For mine closure, the erosion hazards and consequences (combined to define risk) of the bund will be identified from monitoring data during the mine life. At this stage, the detailed mine pit closure works will be defined and necessary modifications for the degree of erosion protection required for permanent mine closure will be determined, implemented, and confirmed with mine closure monitoring.

ECNT has raised concerns about the increased potential for soil erosion during the duration of the proposed open cut project. ECNT believes it is inevitable, despite the mitigation measures outlined in the draft EIS, that this large-scale disruption of the soil layer will lead to an unacceptable increase in sediment loads in the McArthur River and affected creeks.

During operation of the open cut project, the potential for soil erosion impacting on receiving waters (e.g. excessive sediment laden discharge) will be minimal and will be actively managed. The sediment discharge mitigation will include the following elements:

- TSF fully contained runoff – all runoff and associated sediment will be captured within the water management system, and the outer embankments will be constructed of coarse materials and maintained not to erode.
- Open cut – all runoff and associated sediment in the mine pit will be captured within the water management system. The bund wall runoff pond will remove sediment prior to its discharge via decant overflow.
- OEF PAF zone – all runoff and associated sediment will be captured within the water management system (PAF Pond).
- OEF NAF zone – all runoff passes through adequately sized and maintained sediment ponds prior to discharge via decant overflow.

- New McArthur River and Barney Creek channels – designed to minimise erosion, expected to have similar sediment dynamics as original watercourses, and will not generate excessive sediment when rehabilitation becomes established.
- Overflow of water management system (PAF pond or TSF water management dam) in extreme rainfall will not produce sediment loads in discharge that would be distinguishable from the natural flood sediment load occurring in such extreme conditions.
- Progressive rehabilitation of exposed areas once they are no longer required by stabilising and revegetating the surface to minimise erosion.

11.2.1 Alluvium (5)

The EIS states that the exact location of the palaeochannel is not known, and that further testing will be carried out to determine the extent of the aquifer. MAGNT has asked why the EIS release wasn't delayed until this information was obtained and included.

A detailed groundwater investigation of the mine area was undertaken as part of the EIS investigation. The results of this investigation are presented in detail in Appendix C of the draft EIS and in URS (2005) *MRM Expansion EIS – Groundwater Investigation to Determine the Potential Impacts of Dewatering*.

Since then an additional groundwater drilling and testing program has been completed to better identify the palaeochannel characteristics and to obtain further information abut the waterhole/groundwater interaction. The results of this investigation are summarized below and a report on the investigation is given in Appendix E.

11.2.4 Further Field Investigations (1, 7)

EPA notes that additional hydrogeological work has been completed to improve the groundwater modelling accuracy. EPA has asked that interpretation of the results of this work and further modelling iterations should be included in the Supplement.

Introduction

As noted by the EPA, MRM has undertaken additional groundwater drilling since the preparation of the draft EIS. The objective of this additional investigation was to better define the location of the palaeochannel so that a more accurate estimate can be obtained of the pit inflow rates and the drawdown effects. A summary of the investigation and its results is given below. The full report on the investigation is given in Appendix E.

Drilling Program

The groundwater drilling program was undertaken during September and October 2005. The main elements of the program included:

- One test production bore was installed to enable a pumping test to be carried out.
- Fifteen bores were installed to confirm the relationship between the palaeochannel and the open cut. Of these ten were located along the eastern edge of maximum extent of the open cut, three were located along its southern extent, and two were drilled to determine the location of the palaeochannel between Djirrinmini Waterhole and the proposed open pit.
- Four bores were installed adjacent to Djirrinmini Waterhole to better determine the hydrogeology near the river pool.

Refined Conceptual Hydrogeology Model

Based on the interpreted geology and the additional information from the groundwater investigation program, the conceptual hydrogeological model of the area presented in the draft EIS has been refined. The changes from the previous conceptual hydrogeology model as outlined in the draft EIS include:

- The thickness and width of the palaoechannel conceptually are similar to that previously interpreted, however the channel bifurcates south of the proposed open cut, separated by an area of shallow bedrock (Figure 4).
- The location of the palaeochannel has laterally moved closer to the McArthur River compared with the previous conceptual model.

Groundwater Flow Model

Compared to the previous model, the groundwater model code and model domain, boundary conditions, distribution of hydraulic properties and layering have remained the same. However, the geometry of the palaeochannel has been modified to reflect its revised location. Modelling assumptions and limitations are similar to those applied to the previous model.

Previous calibration of the groundwater model was undertaken from the aquifer test conducted on bores within the palaeochannel and bedrock aquifers. Due to the limited drawdown in observation bores during the aquifer testing of the new test production bore, the previous aquifer test results were used to re-calibrate the model. The steady state model calibration results are shown in the following table and indicate an acceptable correlation of modelled versus measured conditions.

Observation Bore	Observed Drawdown (m)	Simulated Drawdown (m)
MAC2	0.57	0.59
GWM103	0.76	0.77

Open Cut Inflow Rates

The groundwater inflow to the open cut estimated by the revised model is 1,350 kL/day after 6 months increasing to 1,990 kL/day after 1 year. After Year 4 of mining, the estimated inflow increases to 4,190 kL/day. Estimated inflows progressively increase to about 6,780 at year 17 and slightly decrease to 6,650 kL/day at year 25.

The estimated groundwater inflows from the weathered bedrock and alluvium are smaller than from the bedrock. After 25 years, estimated inflows from the alluvium and weathered bedrock are about 2,820 kL/day and 3,830 kL/day from the bedrock.

These inflow estimates from the refined groundwater model indicated an increase of approximately 600 kL/day compared to the previous estimates as presented in the draft EIS. This increase in inflows will be accommodated by the water management system implemented in the vicinity of the open cut area.

URS

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McARTHUR RIVER MINE
OPEN CUT PROJECT
ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT

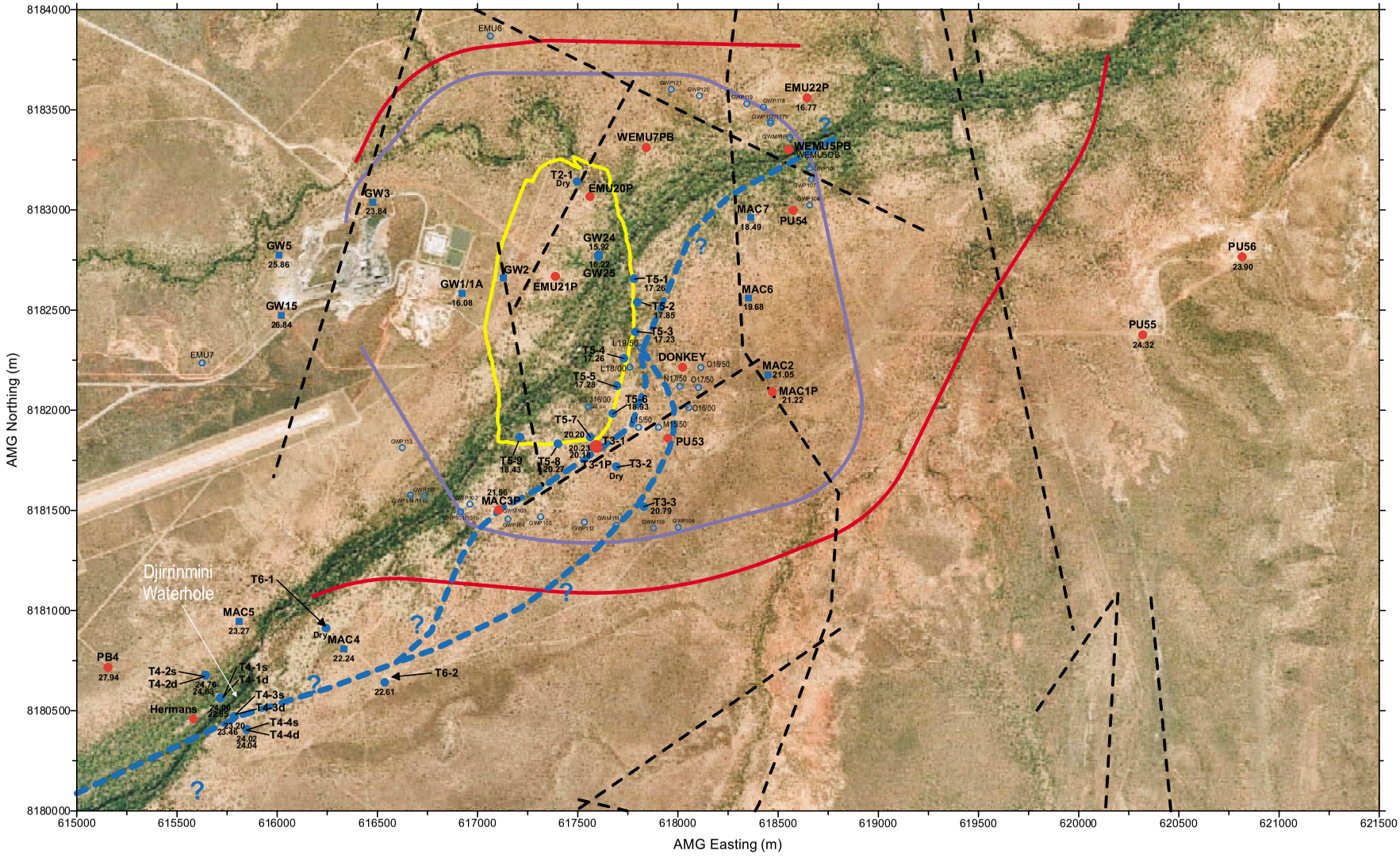
Job No.: 42625552 | Drawn: LL | Approved: CMP | Date: 28-11-05

File No. 42625552-g-158.cdr

Figure: 4

PALAEOCHANNEL LOCATION

A4 | Rev. A



Groundwater Drawdown

As was the case with the previous model, bedrock/fault groundwater levels will be lowered significantly in the immediate area of the open cut because of the groundwater abstraction required for mine dewatering. Most of this abstraction will occur from: (i) faults in both the fresh and weathered bedrock; and (ii) the permeable sections of the weathered bedrock.

Figures 5 and 6 show the modeled drawdown effects from the pit dewatering based on the refined conceptual hydrogeological model. The drawdown pattern is similar to that given in the draft EIS which was based on the initial conceptual model. Figure 5 shows the drawdown in Year 10 from both the alluvial and weathered bedrock aquifers and Figure 6 shows the effects in Year 25.

Effects on Djirrinmini Waterhole

Based on the refined conceptual hydrogeological model, the estimated drawdown at Djirrinmini Waterhole after 25 years of mining is about 0.35 m in the weathered bedrock and alluvium. This compares with an estimated 0.5 m drawdown based on the initial model.

The downstream end of the waterhole is located on low permeability weathered bedrock but its banks at the upstream end are in the alluvium, underlain partially by the palaeochannel. The low permeability bedrock and lateral seepage from the alluvium will assist in reducing any potential drawdown under the waterhole caused by lowering of groundwater levels in the fresh bedrock/faults. The waterhole is located far enough from the pit to be on the edge of the cone of depression developed in both the palaeochannel and the weathered bedrock.

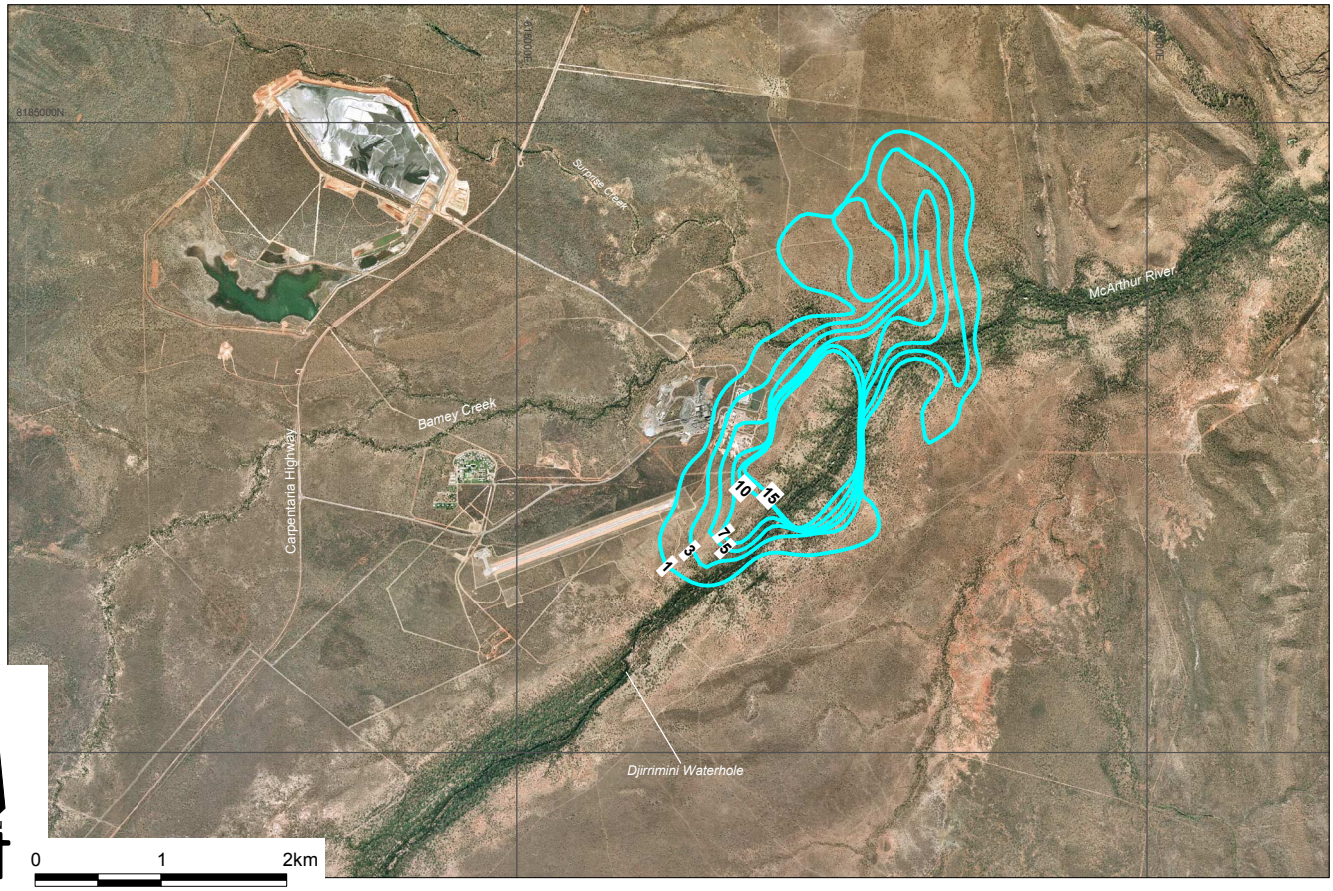
The reduction in groundwater level in both the weathered bedrock and alluvial aquifers can be expected to result in a reduced lateral flow into the waterhole. As discussed in the draft EIS, this is likely to result in a decrease in the depth and extent of the waterhole at the end of the dry season prior to it being replenished in the following wet season. Given the predicted maximum drawdown of 0.35 m, the magnitude of the reduction in the depth and extent of the waterhole will be less than what was previously anticipated with a drawdown of 0.5 m.

It should be noted that the predicted drawdown of 0.35 m is a maximum which will not occur until after 25 years of mining. Prior to that, the drawdown will be less. A program for monitoring groundwater levels in both the weathered bedrock and the alluvial aquifers at the waterhole has been implemented to provide baseline groundwater levels near the pool. This will allow for the confirmation of the accuracy of the predicted effects on the commencement of mining. This program will continue throughout the life of the mine and mitigation measures such as sustaining upstream river flows from suitable bores will be implemented should the drawdown effects be detected.

Effects on River Flows

Due to the hydraulic connection between the river and the underlying aquifers, there is potential for a reduction in river flows due to groundwater drawdown.

PALAEOCHANNEL GRAVEL (LAYER 3)



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Scale 1:60 000 (A3)

Horizontal Datum: AGD84, Zone 53

WEATHERED BEDROCK (LAYER 4)

1 Groundwater Drawdown Contour (m)

xstrata

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McARTHUR RIVER MINE
OPEN CUT PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT

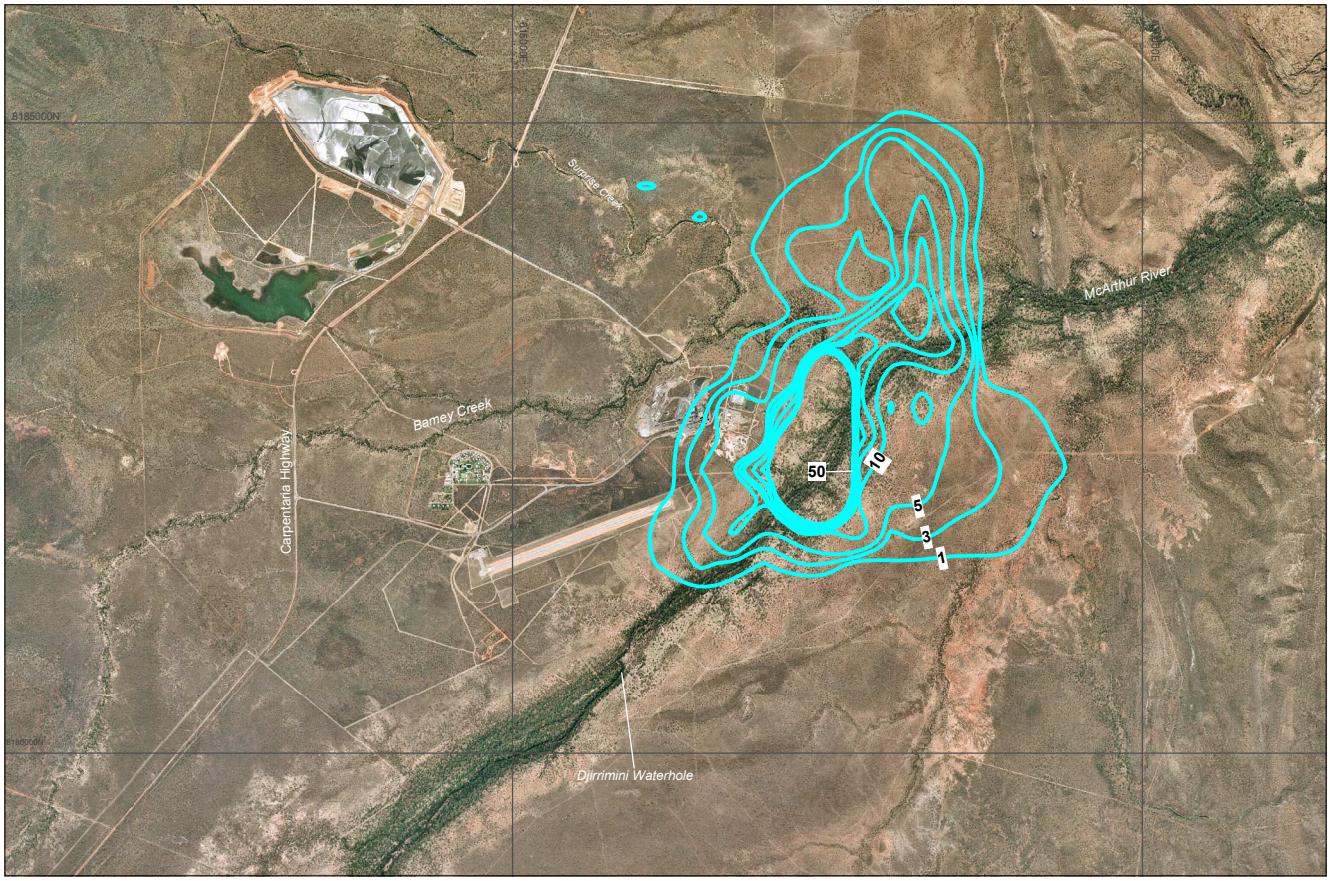
REFINED SIMULATED GROUNDWATER DRAWDOWN YEAR 10

Drawn: LL	Approved: CMP	Date: 12-12-05
Job No: **42625552**	File No: 42625552-g-159b.wor	

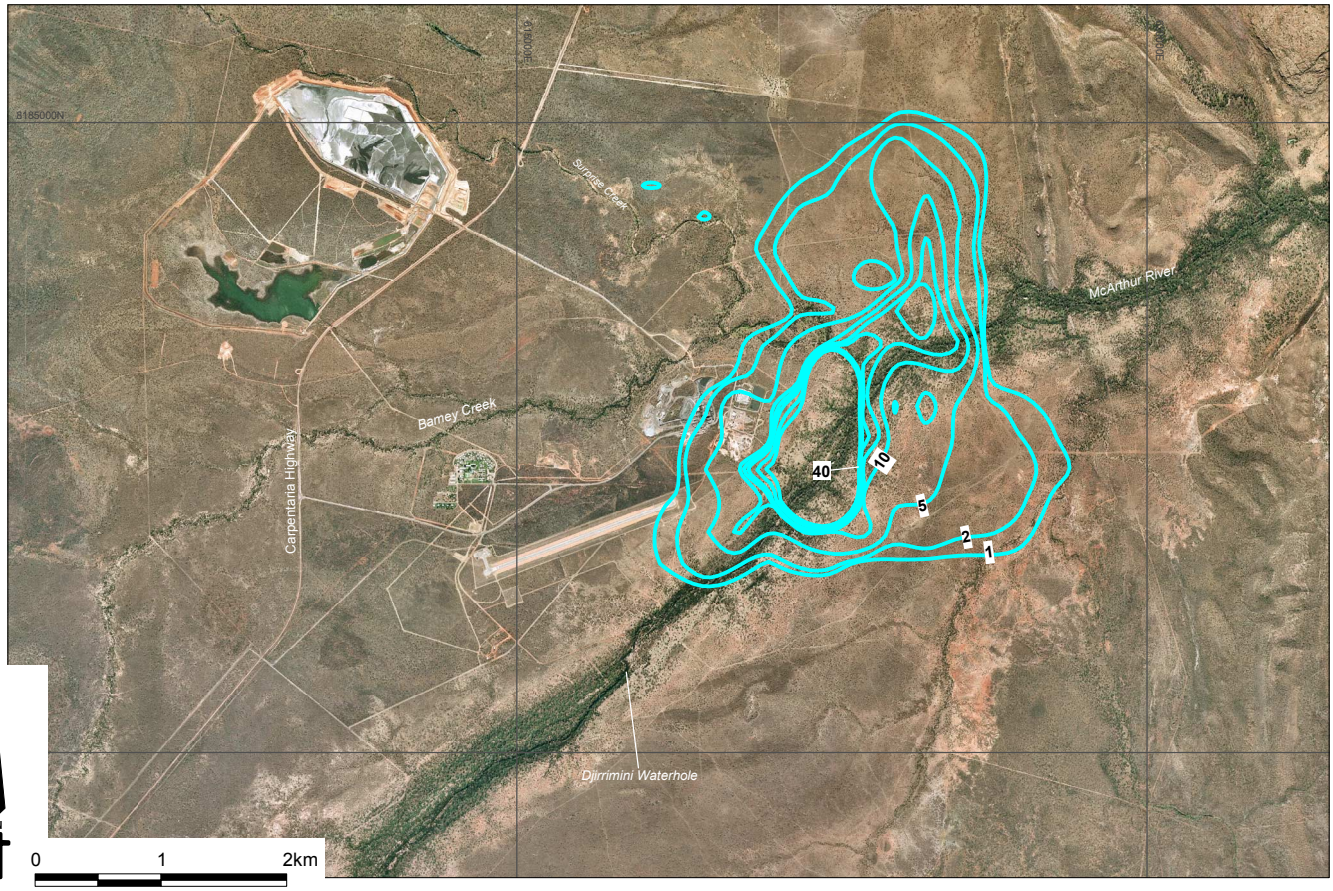
Figure: **5**

Rev: B

A4



PALAEOCHANNEL GRAVEL (LAYER 3)



0 1 2km

Scale 1:60 000 (A3)

Horizontal Datum: AGD84, Zone 53

BEDROCK (LAYER 4)

1 Groundwater Drawdown Contour (m)

xstrata

URS

McARTHUR RIVER MINE
OPEN CUT PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT

REFINED SIMULATED GROUNDWATER DRAWDOWN YEAR 25

Drawn: LL	Approved: CMP	Date: 12-12-05
Job No: **42625552**	File No: 42625552-g-160b.wor	

Figure: **6**

Rev: B

A4

Groundwater drawdown has the potential to reduce the inflow of groundwater into the river in instances where the groundwater table is above the river bed. Based on stream gauging measurements, approximately 375kL/day of groundwater is discharged into the river in the reach upstream of the start of the realigned channel that will be affected by drawdown at Year 25. This flow is the maximum likely reduction in stream flow that can be attributed to drawdown.

Data from the MRM gauging station indicates that since 1970 the river has ceased to flow for up to five months during dry years. Based on these data, groundwater drawdown could extend the 5 months by approximately 15 days at the end of the mine life which is the time during those dry years that the average daily flow is less that 375 kL/day. Prior to Year 25, the number of additional days of no flow would be less than 15.

ECNT has stated that no environmental approvals should be considered until the additional groundwater drilling program is completed and independently reviewed.

As discussed above, the additional groundwater drilling program has been completed and the results are included in this EIS Supplement (Appendix E) for submission to the Northern Territory Government for review.

11.6.1 Groundwater Chemistry – Mining Area (7)

ECNT has concerns about the chemistry of the groundwater and notes that large concentrations of SO_4 in the groundwater in the upper weathered rock area are due to sulphide materials being common in the area and that in both the bedrock and alluvial groundwaters, lead and zinc are elevated.

The groundwater samples referred to represent baseline conditions near the minesite. Due to mineralisation being present in the area, elevated levels of sulfate, lead and zinc are representative of natural groundwater conditions.

11.7 Stream Flow (5, 7, 13)

MAGNT has stated that the EIS did not study the possible upstream effects from aquifer changes until June 2005. It considers that this is not a lot of data on which to base assumptions and requires further work.

River gauging of the McArthur River has been undertaken since 1970. The additional work undertaken in June 2005 was as a consequence of the results of the groundwater model predictions of the effect on Djirrimini Waterhole. The modeling could not be undertaken sooner as the final pit configuration had to be developed and the results of the groundwater drilling program undertaken in late 2004 assessed.

ECNT has asked that more information be provided on the groundwater/ surface water relationship upstream and downstream of the mine. It considers that the language used in the draft EIS to describe the impacts on the waterhole is unconvincing.

Further to the groundwater investigation undertaken during the preparation of the draft EIS, an additional groundwater drilling and testing program has been completed to better identify the palaeochannel characteristics and to obtain further information abut the waterhole/groundwater interaction. The results of this investigation are given in Appendix E.

NLC has stated that the draft EIS when dealing with environmental flows makes no account of groundwater flow in the palaeochannel on the local region of the river.

As shown on Figure 4, the palaeochannel is generally offset from the river and is overlaid by it at only two locations. It does not contribute any significant flow to the river as is evidenced by the fact that river flow typically ceases at the end of the dry season.

The effect of drawdown of groundwater levels on river flows is discussed in the response to the EPA comment in Section 11.2.4 above.

NLC considers that the proposed pit void will intercept sub-surface flows creating a major sink for groundwater with impacts on river pools and river flows.

The effects of groundwater drawdown on river flows and river pools are discussed in response to the comment from the EPA under Section 11.2.4 above.

11.8.1 Conceptual Model (5, 12)

The present McArthur River is assumed to be in direct contact with groundwater. MAGNT has asked about the significance of the fact that the same groundwater can make contact with the open pit and exchange water with the pit.

The hydraulic connection between surface flows in the McArthur River and the groundwater that will flow into the open cut is a significant component of the groundwater model. Most of this water is connected via the palaeochannel. The significance of the palaeochannel with respect to pit dewatering is discussed in Section 11.9.1 of the draft EIS.

Subsequent to the preparation of the draft EIS, additional groundwater investigations have been undertaken to better define the location of the palaeochannel in relation to the open cut. Based on the additional information obtained, the conceptual hydrogeological model has been refined and confirmed based on the new inputs and assumptions.

The groundwater inflow to the open cut estimated by the revised model is 1,350 kL/day after 6 months increasing to 1,990 kL/day after 1 year. After Year 4 of mining, the estimated inflow increases to 4,190 kL/day. Estimated inflows progressively increase to about 6,780 at year 17 and slightly decrease to 6,650 kL/day at year 25.

The estimated groundwater inflows from the weathered bedrock and alluvium are smaller than from the bedrock. After 25 years, estimated inflows from the alluvium and weathered bedrock are about 2,820 kL/day and 3,830 kL/day from the bedrock.

These inflow estimates from the refined groundwater model indicated an increase of approximately 600 kL/day compared to the previous estimates as presented in the draft EIS.

MARA notes that the effects of the groundwater drawdown contained in the EIS are largely from modeling and that because of the lack of regional groundwater data, the groundwater model is only approximate.

As with most computer models, the results can only be considered as approximate. However, as the groundwater model has been developed from data gathered during two extensive on-site drilling programs, an acceptable level of confidence can be placed on the model results. Once open cut operations begin, the results of ongoing monitoring will be used to update the model and to re-estimate pit inflow and drawdown predictions.

It is worth noting that the measured average inflow into the Test Pit as of November 2005 was 570 kL/day compared with the model predictions of 666 kL/day. This is considered to be an acceptable result and provides confidence about the predictions of the open cut.

11.9.1 Pit Dewatering Rates (2)

DPIFM has asked what alternatives to a cut off trench have been investigated to control groundwater inflows to the pit from the palaeochannel.

Dewatering of open pits with the use of pit sumps, dewatering bores or horizontal drain-holes in the side of the pit are the industry standard in controlling groundwater inflows into open pits. A comparison was made between these conventional methods and a cut-off trench to determine the effectiveness in reducing groundwater inflows to the proposed open pit. As the cut-off trench does not stop groundwater from entering the pit from bedrock it's limited in effectiveness. As a result, dewatering bores, pit sumps and horizontal drain-holes will be used to dewater the pit.

11.10 Effect of Water Storage in Voids (1)

EPA has noted that minimisation of acid generation in the underground voids in the long term is dependent on breaching the flood protection bund so that the voids fill with water. It has asked what alternatives are available to minimise groundwater impacts from contaminated groundwater inflows if the bund wall breach is not an option or floods fail to fill the void.

Once mining is completed, the mine dewatering will cease. Once this happens, groundwater will flow into the underground voids even if the bund wall is not breached or floods do not fill the void.

The time it takes to fill the voids will depend on how full they are at the end of mining. As discussed in Section 12.9.1 of the draft EIS, the underground voids will be used as a water storage facility during operations so there is likely to be water in them when mining ceases. However, assuming that the underground void is completely empty (contains no water) and based on a dewatering rate from the groundwater modelling of 6,000 kL/day at the end of mining, it would take approximately one year to

completely fill the void. In practice, the underground void would be partially full initially and therefore would take less than a year to fill.

11.11.1 Magnitude of Groundwater Drawdown (7)

ECNT has asked how far away from the pit area will the drawdown cone migrate, and what impacts will this have.

Figures 5 and 6 of this EIS Supplement show the extent of drawdown in alluvium and bedrock aquifers after 10 and 25 years of mining. These figures update the figures given in the draft EIS and are based on the refined hydrogeological model developed from the results of the additional groundwater investigations undertaken since the draft EIS was prepared.

The revised drawdown pattern is similar to that given in the draft EIS which was based on the initial conceptual model

11.11.4 Potential McArthur River Impacts (1, 5, 7, 10, 13)

EPA has stated that there is no explanation as to why the predicted vertical leakage will not significantly extend the no-flow period during dry years. It has asked for a definition of 'significant' in this context.

Due to the hydraulic connection between the river and the underlying aquifers, there is potential for a reduction in river flows due to groundwater drawdown.

Groundwater drawdown has the potential to reduce the inflow of groundwater into the river in instances where the groundwater table is above the river bed. Based on stream gauging measurements, approximately 375kL/day of groundwater is discharged into the river in the reach upstream of the start of the realigned channel that will be affected by drawdown at Year 25. This flow is the maximum likely reduction in stream flow that can be attributed to drawdown.

Data from the MRM gauging station indicates that since 1970 the river has ceased to flow for up to five months during dry years. Based on these data, groundwater drawdown could extend the 5 months by approximately 15 days at the end of the mine life which is the time during those dry years that the average daily flow is less that 375 kL/day. Prior to Year 25, the number of additional days of no flow would be less than 15.

MAGNT has stated that as the pit is in the (real) riverbed, the alluvial channel will be connected with the groundwater, so that river flows may be reduced if groundwater levels are lowered very far, and groundwater recharge may not occur.

The pit will not be the real river bed but there will be an hydraulic connection between the river and the groundwater which will be pumped out of the pit.

The effect of lowering the groundwater levels on river flows is discussed above.

MAGNT comments as follows. "Dry season loss (evaporation) will be 60-170 kl/day, or 10% of river flow. The EIS says this is insignificant, but is it? The EIS says that the loss "will not significantly extend the non-flow period", but no data is presented. There's no reference to Appendix C, which contains the data – exactly two days' gauging during June 2005 - and which states that "Any impact on groundwater inflow rates to these pools [i.e. two permanent pools just upstream of the open cut pit] is likely to have a negative effect on pool water levels and salinities during the dry season". This would appear to be NOT an 'insignificant' impact."

Due to the hydraulic connection between the river and the underlying aquifers, there is potential for a reduction in river flows due to groundwater drawdown. This loss is not due to evaporation.

Groundwater drawdown has the potential to reduce the inflow of groundwater into the river in instances where the groundwater table is above the river bed. Based on stream gauging measurements and the refined groundwater modelling, approximately 375kL/day of groundwater is estimated to be discharged into the river in the reach upstream of the start of the realigned channel that will be affected by drawdown at Year 25. This flow is the maximum likely reduction in stream flow that can be attributed to drawdown.

Data from the MRM gauging station indicates that since 1970 the river has ceased to flow for up to five months during dry years. Based on these data, groundwater drawdown could extend the 5 months by approximately 15 days at the end of the mine life which is the time during those dry years that the average daily flow is less that 375 kL/day. Prior to Year 25, the number of additional days of no flow would be less than 15.

ECNT considers that a 0.5 m reduction in the levels of both the weathered bedrock and alluvial aquifers after 25 years at Djirrinmini Waterhole to be a minimum expected decrease in water levels, not a maximum as stated in the Draft EIS.

Further to the groundwater investigation undertaken during the preparation of the draft EIS, an additional groundwater drilling and testing program has been completed to better identify the paelochannel characteristics and to obtain further information abut the waterhole/groundwater interaction. The results of this investigation are given in Appendix E and provide a more accurate quantification of groundwater drawdown at the waterhole.

Based on the refined conceptual hydrogeological model developed from the additional drilling, the estimated drawdown at Djirrinmini Waterhole after 25 years of mining is about 0.35 m in the weathered bedrock and alluvium. This compares with an estimated 0.5 m drawdown based on the initial model.

The reduction in groundwater level in both the weathered bedrock and alluvial aquifers can be expected to result in a reduced lateral flow into the waterhole. As discussed in the draft EIS, this is likely to result in a decrease in the depth and extent of the waterhole at the end of the dry season prior to it being replenished in the following wet season. Given the predicted maximum drawdown of 0.35 m, the magnitude of the reduction in the depth and extent of the waterhole will be less than what was previously anticipated with a drawdown of 0.5 m.

It should be noted that the predicted drawdown of 0.35 m is a maximum which will not occur until after 25 years of mining. Prior to that, the drawdown will be less. A program for monitoring groundwater levels in both the weathered bedrock and the alluvial aquifers at the waterhole has been implemented to provide baseline groundwater levels near the pool. This will allow for the confirmation of the accuracy of the predicted effects on the commencement of mining. This program will continue throughout the life of the mine and mitigation measures such as sustaining upstream river flows from suitable bores will be implemented should the drawdown effects be detected.

DEH has raised concerns about the impact of the groundwater drawdown on the Djirrinmini Waterhole and how that might affect the sawfish habitat. It has asked that remedial measures be prescribed and implemented if monitoring to identify the increase in drawdown of the water level over time identifies a threat to the viability of the waterhole.

As discussed in the draft EIS, the lowering of the groundwater table at the Djirrinmini Waterhole towards the end of the mine life will reduce the depth and extent of the waterhole towards the end of the dry season. This is a natural phenomenon which occurs now at the end of each dry season and the aquatic fauna and flora will have already adapted to it. However the groundwater drawdown will exacerbate the effect.

It is difficult to provide details of the impacts that will be likely in 25 years time. Consequently, as discussed in Section 13.5.6 of the draft EIS, a comprehensive monitoring program of the waterhole's aquatic biology will be implemented during the initial years of the open cut project before any drawdown effects occur. As the drawdown effects will occur gradually and only towards the end of the mine life there will be adequate time to identify the extent of any effects that might be occurring to the aquatic biology and to develop mitigation measures. Such measures could include sustaining dry season flows upstream of the waterhole from groundwater resources.

NLC is concerned that the removal of large quantities of groundwater for operational purposes will result in a net loss to the environment which may have significant impacts on downstream groundwater flow at crucial times for fish, reptiles and invertebrates trying to survive in downstream pools during the dry season.

There are no river pools downstream of the mine that are within the sphere of influence of groundwater drawdown induced by pit dewatering.

As discussed in the responses to comments given above, groundwater drawdown has the potential to increase the period of no flow in the river at the end of the dry season by a maximum of 15 days at the end of the mine life. Prior to that, the additional no-flow days would be less.

11.11.5 Seepage from Tailings Storage Facility (13)

Groundwater seepage from beneath the Tailings Storage Facility into Surprise Creek as surface water runoff has already been observed and NLC considers that it is reasonable to assume that this will continue into the future, increasing in volume as the height of the facility increases.

As discussed in Section 7.3.4 of the draft EIS, the existing seepage from the TSF is being controlled by the installation of a geopolymer barrier wall around the perimeter of Cell 1 fronting Surprise Creek. To control seepage from the expanded TSF it is proposed to install a network of monitoring and recovery bores around the perimeter of the TSF to intercept any seepage that does occur. Any seepage that is intercepted will be pumped back to the water management dam. Hence, even with increasing the volume of tailings in the TSF in the future, seepage will be mitigated from flowing to Surprise Creek.

NLC states that, given the lack of information on the connectivity of aquifers and the palaeochannel, it is not possible to confidently assess where seepage from the TSF will travel and how much of this water will flow into the pit void.

Further to the groundwater drilling program described in the draft EIS, a further drilling investigation has been undertaken to better define the geometry and location of the palaeochannel near the proposed open cut. Additional groundwater monitoring bores have also been installed near the TSF. This investigation has not identified any preferential groundwater flow paths from the TSF to the open cut.

11.11.6 Seepage from the Overburden Emplacement Facility (13)

NLC considers that the OEF has the potential to disrupt normal groundwater flow through sub-surface aquifer and has the potential to generate a significant hydraulic head, resulting in downward pressure and seepage of contaminated water.

The OEF is not expected to have any significant effect on the underlying groundwater system. This is because it has been designed to minimise seepage (and hence any hydraulic head) by the "multiple lines of defence" strategy to protect the PAF cell which include:

- Profiling the base of the OEF to drain seepage to the perimeter drains;
- Compaction of the base of the OEF to a permeability of 10^{-8} m/sec to minimise seepage into the underlying groundwater system;
- Provision of a compacted layer of fine-grained lower permeability material on the top (wearing) surface of each 10 m lift to direct any seepage to the perimeter drains; and
- Rehabilitating the surface of the OEF to shed water rather than to pond it and create additional seepage potential.

NLC states that it is not possible to confidently assess where seepage from the OEF will travel and how much of this water will flow into the pit void.

As discussed above there will be no significant seepage from the OEF. Any seepage that does occur will be through NAF/AC material only and will not have any deleterious effect on groundwater quality.

The extensive groundwater drilling investigations undertaken on site have not identified any preferential groundwater flow paths from the OEF to the open cut.

12.2 Regional Surface Water Systems and Catchment Context (12)

MARA considers that in Section 12.2 the draft EIS makes a gross understatement in saying 'The exclusion of the very small mine footprint (less than 10 km²) (of total catchment area)…will have no significant effect on the river flows.'

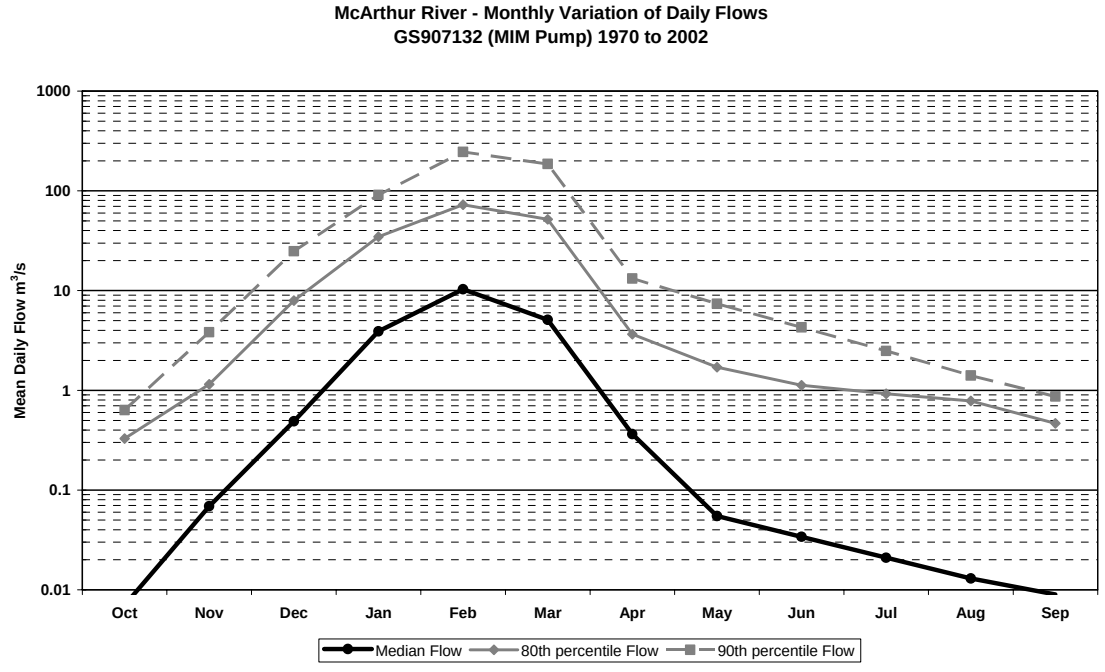
This statement in the draft EIS was made in the context of the contribution of catchment runoff to river flows. The exclusion of 10 km^2 from a catchment of 10,000 km^2 (0.1%) will have no significant effect.

12.3.3 Flood Hydrology of McArthur River (5, 6)

Table 12.4 in the EIS presents average daily wet season flows, related to fish movements during the wet season. MAGNT has stated that there is no comparable discussion as to what happens during the dry season, a time when fish and other aquatic organisms are likely to be most stressed by changes in water levels, chemistry, temperature etc. MAGNT has asked for some water quality data from May to October.

During the dry season, upstream surface flows recede and can often cease to sustain in-stream pools for typically 1 to 2 months. Groundwater in surrounding or adjacent alluvial aquifers assists in sustaining the permanent pools (albeit with natural variability) during these dry periods. The open cut project will not affect dry season surface water flows from the upstream catchment. Seasonal surface flow statistics for dry season conditions are shown (expanded from EIS Figure 12.3 to include dry season months).

Opportunistic fish passage during the dry season when there is sufficient continuous surface flow along the river will not be impacted because the mine will not significantly affect surface flows from upstream and the new channels will be constructed with no physical obstructions and will not produce a hydraulic obstruction for all flow up to at least 100 m^3/s.



The following table summarises recent (2003-2004) water quality data for the McArthur River during the dry season (July-October).

Dry Season (July to October) Statistics of Surface Water Quality in McArthur River (January 2003 to January 2005)

Parameter	SW7 (Upstream)	SW6 (Downstream)
pH	**8.2**[1] (8.1 – 8.3)[2] 45 samples	**8.1** (8.0 – 8.2) 44 samples
Electrical Conductivity (µS/cm)	**674** (664 - 778) 45 samples	**698** (637 - 992) 44 samples
Sulfate (SO_4) (mg/L)	**11.7** (10.3 – 14.3) 45 samples	**15.5** (12.7 – 35.0) 44 samples
Total Cadmium (µg/L)	**0.01** (0.01 – 0.02) 45 samples	**0.01** (0.01 – 0.03) 44 samples
Total Copper (µg/L)	**0.59** (0.47 – 0.87) 45 samples	**0.65** (0.49 – 0.97) 44 samples
Total Lead (µg/L)	**0.28** (0.08 – 1.18) 45 samples	**0.44** (0.15 – 1.53) 44 samples
Total Zinc (µg/L)	**2.2** (1.0 – 5.3) 45 samples	**2.8** (1.4 – 9.4) 44 samples

[1] Median values shown in **bold**
[2] 20th to 80th percentile range shown in brackets

MAGNT has asked why does the DIPE gauge apparently only show 75% of the data.

The DIPE stream gauge data from 1970 to 2002 has wet season daily flow data missing for approximately 20% to 30% of this period due to a range of factors. Most stream gauges in Australia operate in dynamic river environments that are harsh for electronic equipment. This makes data capture vulnerable to many influences such as debris, sedimentation, floods, power failure and other risks. In relative terms across Australia, the 75% wet season daily data capture achieved at the DIPE gauge is a reasonable to good expectation for stream flow monitoring in a remote tropical environment.

AFANT has stated that given the lack of information on fish migration correlated to river flows, the increase in flood levels above the mine site are a potential risk to fish migration. Consideration needs to be given to either limiting the increase in flood levels or clearly determining that they will not have an adverse impact.

Generally, fish do not migrate during periods of flood and the increase in flood levels stated in the EIS is for peak flood levels which only occur for less than 6 hours within the 24 to 72 hour period of a typical flood hydrograph. Increases in the peak flood levels would not affect fish migration.

12.6 McArthur River Geomorphology (5)

MAGNT has states that the draft EIS provides a brief description of the original condition of the river but much is left out. It has asked what percentage of woody debris, submerged and emergent plants, overhanging vegetation, gravel and different particle-sized sands are present in the existing river (all the standard things noted when characterising a river habitat)? What microhabitats are available for fish and invertebrates? What is the water chemistry? What will the chemistry of the water in the channel be like (running over fresh substrate – will this change anything)? What are the ranges of water quality during wet and dry seasons?

Key habitat and substrate features of the new river channel (such as woody debris density/distribution aquatic plants, riparian cover, and bed/bank foundations) will replicate the existing river. Biological design of the new channel will be undertaken interactively with designers, fish biologists and rehabilitation specialists using the existing channel substrate characteristics described in Appendix J.2 in the draft EIS and supported with additional surveys during the 2006 wet season. The biological rehabilitation design of the new channel will include intentional habitat restoration balanced with allowance for the river to restore itself through natural sedimentation, morphology, and natural debris accumulation and vegetation colonisation. This strategy recognises that excessive human intervention to "control" the river evolution can be more damaging to the environment than a more moderate approach that synergises with natural river morphology. For example, attempting to fully recreate/install extensive woody debris and sandbars before passing flow through the new channel, would likely wash away and pose substantial risk of a concentrated "wave" of debris and sand flow during the first few floods of operation with a consequent risk to downstream environments.

It will be important to allow natural evolution of river morphology to supplement strategic interventionist revegetation and rehabilitation initiatives. The initial rehabilitation will include placement of woody debris and clean sand on the bed of the channel with an informal flow path for low flows that allows micro-scale meandering to develop in response to natural flows and flow obstructions (snags, sand and rock bars). The spacing, arrangement, and density of placed "woody debris" will be determined interactively between biologists and river engineers.

On-going minor erosion and sedimentation along the realigned channels is expected to occur throughout the mine life and be consistent with natural cycles of erosion and sedimentation along upstream and downstream reaches of the river. These processes are natural and are not considered to be adverse environmental impacts. Erosion of the realigned channel is likely to generate mainly relatively coarse sediment (sand and silt) and should not cause excessive turbidity. Natural turbidity in the upstream river is generally from runoff from the catchment into the river rather than erosion of the river channel itself.

Mitigation measures will be introduced to reduce the generation of turbid waters from the exposed dispersive clay soils along the realigned river channel. These are likely to include covering areas of dispersive soils with a protective cover (e.g. the coarse rock capping with topsoil filled into the voids) and may also require a local 'laying back' of the realignment channel batters, or increasing the density of revegetation particularly with respect to ground cover species.

MAGNT has stated that the EIS does not mention Bishop et al. (2001), which gives comprehensive water quality data for fish in the Alligator Rivers region, and is directly relevant here (data includes a range of seasons and conditions). MAGNT considers that the EIS should also include relevant information in Pusey et al (2004).

The two references noted have been reviewed as part of the EIS process. The ecology of many of the fish species (or allospecies) found at McArthur River is described in Bishop et al (2001) and Pusey et al (2004). These data will contribute to establishing baseline conditions as part of the proposed marine monitoring program in the McArthur River estuary.

Four sections of the McArthur River have exposed bedrock on the river bed or banks. MGANT has asked if this and the anabranchs will be duplicated in the channel.

As shown in Figure 12.13 of the draft EIS, the realigned river channel will pass through sections of alluvial and sections of bedrock. Approximately 65% of the channel will be in either fresh rock or weathered rock. There will be no anabranches constructed as part of the realigned channel as they will not be required for any hydraulic purpose.

The EIS indicates that river sinuosity will increase, as the new channel will be 400 m longer than the river. MGANT considers that sinuosity appears to be an engineering/mathematical concept, because the new channel does not appear to be very sinuous at all.

River sinuosity can be considered at the following two scales:

- at the broader main-channel scale (which is influenced by flood conditions); and
- at the "micro" scale for frequent flow as "seasonal flows" across the bed of the main channel.

The draft EIS has demonstrated that at the broader main-channel scale, new channel sinuosity will be consistent with the very low existing sinuosity of local, upstream, and downstream reaches (refer also draft EIS Figures 12.4, 12.5, 12.7, and 12.12 which show the minimal meandering at the scale of the existing river channel). At the micro scale, the natural bed of the river channel is moderately sinuous with flows meandering around and between log jams, sediment deposits, exposed bedrock, and riparian vegetation (as shown in the photograph below). The low-flow meandering influences will be replicated in the bed of the new river and creek channels with designed features to replicate the "foundations" of the channel substrate such as strategic woody debris replacement, sand deposits, and revegetation. Natural processes which create, sustain, adapt, and occasionally damage such features will not be impacted. There will be no change to upstream hydrology (including extreme floods), or upstream sediment supply caused by the project, and new channel hydraulics are designed to replicate existing conditions.

Existing McArthur River at Low Flow

12.7.1 McArthur River Water Quality Monitoring (1, 5, 7, 12, 13)

EPA considers that there appears to be relatively few points both upstream and downstream of the proposed open cut mine that have been monitored for physico-chemical parameters and changes in river morphology. More statistical power is needed in the design, particularly with respect to baseline data collection for a future monitoring program.

MRM will adapt the water quality monitoring program with additional upstream and downstream sites and extension of parameters to include broader physico-chemical parameters (pH, TSS, turbidity, temperature, dissolved oxygen, supplemented with nitrogen, phosphorus and chlorophyll 'a' concentration). The sites will be agreed with the EPA to achieve more statistical power related to evaluating influences of spatial scale (catchment), land-use (catchment) and temporal variations (rainfall and flows).

The EIS states that seepage from the tailings facility shows up in waters below the mine. Surprise and Barney Creeks have high levels of lead and sulphate, while Barney Creek also has high zinc levels downstream. MAGNT considers that this needs to be remedied. It has asked what monitoring is the mine undertaking to manage this pollution correctly. It also considers that the statement that there is

no ANZECC trigger level for sulphates and the impact of these levels on aquatic organisms needs to be addressed

Historical seepage impacts on Barney Creek and Surprise Creeks will continue to be remedied with seepage cut-off / interception, and risk minimisation with new TSF areas to be placed at a greater distance from local water courses and the installation of monitoring and recovery bores.

The performance of existing seepage control strategies (and additional mitigation as required) will continue to be monitored and reported in annual monitoring reports. MRM will implement changes and improvements to seepage monitoring as required and agreed with regulatory authorities.

The lack of firm sulfate concentration water quality trigger levels in ANZECC guidelines is not significant. In the absence of ANZECC criteria specifically for sulfate concentrations, the potential for excess sulfate would be limited by ANZECC water quality criteria for electrical conductivity (or salinity).

MAGNT considers that the declared beneficial uses for the McArthur River and its catchment of 'Aquatic Ecosystem Protection' and 'Recreational water quality and aesthetics' be used rather than stock water standards. It suggests that special criteria should be nominated for this project for any parameter that 'naturally' exceeds ANZECC (2000a), so that there is an explicit threshold (trigger value) above which a discharge will be recorded as an incident or a failure-to-comply.

ANZECC 'aquatic ecosystem protection' and 'recreational water quality and aesthetics' criteria are more applicable as receiving water quality criteria rather than discharge criteria. These criteria have not been used to assess seepage and runoff water from the OEF and TSF as this water will not be discharged to receiving waters. Water from the OEF and TSF will be retained within the site's water management system and reused in the processing plant. Consequently use of receiving water criteria for such waters is not appropriate.

However, water quality of the McArthur River/Surprise Creek/Barney Creek system is compared to aquatic ecosystem guidelines. As stated in the surface water management plan in the EIS, ambient water quality monitoring will be assessed in accordance with ANZECC guidelines for fresh and marine water quality until site-specific trigger levels are developed by MRM and agreed to by the EPA.

ECNT notes that downstream median sulfate concentrations are approximately 60 percent higher than upstream median concentrations.

Although downstream sulfate concentrations are higher in statistical results of monitoring data, the corresponding effect on electrical conductivity and salinity is less than 15%. Electrical conductivity is within the range occurring in the variability of upstream and downstream salinity and in many freshwater systems subject to extremes of dry and wet seasons.

ECNT notes that downstream zinc concentrations are already almost 3 times the ANZECC trigger values while upstream concentrations are closer to the guidelines.

As described in the draft EIS, ANZECC trigger values in terms of concentrations for some metals exceed the natural concentration of metals in the McArthur River upstream of the mine, and are not particularly suitable for water quality assessment or to support decision making. Median zinc concentrations are slightly higher at downstream monitoring sites in the historical monitoring data which reflects the period and historical influences of seepage from the Cell 1 of the TSF which has been addressed with remedial and impact mitigation works and is the subject of ongoing monitoring. The current downstream median quality is below the 80th percentile of the reference (upstream) site water quality and variability of zinc concentrations between the sites is comparable (refer draft EIS Table 12.7).

ECNT disputes the adoption of the 80th percentile reading at the upstream site and the conclusions reached by MRM. The water quality monitoring program has already accumulated almost 10 years of data, so ECNT has asked why it has taken so long to develop more ecologically appropriate trigger values. It considers that any new site-specific trigger values currently being negotiated with DPIFM are independently reviewed and based on the precautionary principle.

Appropriate procedures for development of ecologically appropriate water quality trigger values have been adopted in the use and application of monitoring data to date. The "*80th percentile reference site*" method is based on ANZECC recommendations and is conservative with the embodied philosophy of the precautionary principle. The derivation of new site-specific trigger values can be independently reviewed relative to reasonable requirements of stakeholders as required.

ECNT has asked what are the ecological impacts of the late dry season/ early wet season increases in concentrations of metals downstream of the mine?

Variations in concentrations of metals (and other natural "contaminants") in the late dry season and early wet season is a common natural occurrence in rivers in catchments subject to extremes of dry and wet seasons across tropical areas of Australia. The late dry season increase in concentration is consistent with evapo-concentration influences and groundwater influences which have higher concentration of metals and salinity in local alluvial aquifers. These are natural influences and the aquatic ecology has adapted to these conditions.

MARA has noted that there are two sites for monitoring river water quality on the McArthur River with no other monitoring undertaken along the entire 120 km from the mine to the coast.

Surface water monitoring is conducted at three sampling sites in the McArthur River; SW7 (upstream of the mine), SW6 (downstream of the mine) and SW8 (Burketown Crossing) near Borroloola.

However, the water quality results at SW8 are affected by many factors including vehicular and boat traffic, runoff from the town area, the sewage treatment works and tidal influence. Consideration was given to relocating this sampling point. However, it was determined that moving it further upstream would make it inaccessible for all but the driest months of the year.

It is for these reasons that the results for SW8 were not included in the draft EIS. The most accurate way to determine water quality effects from the mine is to assess the data from monitoring that are

immediately upstream and downstream. In this way the influences of other land uses in the catchment can be eliminated.

Furthermore, Charles Darwin University was commissioned by MRM in 2003 to determine the heavy metal status of marine sediment from Borroloola to the mouth of the McArthur River. Whilst water samples can provide a snap shot view, analysis of sediments can provide a longer term view of changes that may have occurred over time. This survey indicated that no changes due to mining operations could be detected.

MARA has asked that in the absence of comprehensive monitoring of heavy metals in the downstream areas of this river, how can the EIS state that 'Throughout the McArthur River system, concentrations of copper, lead and zinc frequently exceed ANZECC (2000a) trigger values'.

This statement refers to the presence of naturally high concentrations of heavy metals in the McArthur River that have been measured upstream as well as downstream of the mine. The presence of metal concentrations that exceed ANZECC trigger values upstream of the mine and unaffected by the mining operations is a reflection of the natural mineralisation of the region.

MARA has stated that the EIS does not acknowledge the extent of heavy metals entering the drainage area of the McArthur River via Barney and Surprise Creeks.

While seepage from the TSF and a discharge to Surprise Creek have occurred in the past, impacts on water quality have not persisted. Works to cut-off seepage from the TSF have been installed and will continue to be monitored. There is no evidence to suggest permanent impact on downstream water quality from historical problems that have been remedied. With the proposed open cut project, the water management system will be upgraded and regular risk assessments will be undertaken to determine when additional upgrades are required.

MARA has stated that the EIS does not undertake to provide data on, or acknowledge relevance of, not only the downstream stretch of the McArthur River, but also the extensive coastal and offshore areas adjacent to the Sir Edward Pellew Islands.

The water quality data in the table above demonstrate that there is no detrimental effect on the water quality of the McArthur River downstream of the mine.

The Charles Darwin University was commissioned by MRM in 2003 to determine the heavy metal status of marine sediment at the mouth of the McArthur River. The report summarising this study found that:

- At the McArthur River mouth, metal levels in sediments were found to be similar to other river estuaries in the south eastern Gulf. Lead isotope data indicate that MRM ore-derived lead does not contribute to the lead inventory of these sediments.
- Lead isotope ratios in sea grass at McArthur River mouth indicate that MRM ore-derived lead makes little or no contribution to lead levels in sea grass.

- Metal concentrations in oysters at McArthur River mouth are all well below food standards (AFS A12). Lead concentrations in oysters were too low to determine lead isotope ratios.

MRM has committed to maintaining and expanding its monitoring program in the lower reaches of the McArthur River. The key elements of this program include the following:

- Quarterly water quality sampling in the area from Borroloola to the mouth of the McArthur River. These samples will be taken at the start of the wet (during first flush), towards the end of the wet and two dry season sampling events.
- Water sampling will continue at the mouth of the McArthur River.
- Further analysis of sediments in the McArthur River from Borroloola to the mouth of the McArthur River and the delta will be conducted on an annual basis. Sampling points utilised in the 2002 study would again be used in addition to a transect across the delta at the mouth of the McArthur River which would extend in three parallel lines out to Port McArthur. If the sampling within the river and the additional transects show no impact over two years, the transect sampling will cease and will focus on the river.
- MRM will include a monitoring program for heavy metals in food sources by seeking assistance from local professional fishermen to collect samples of species of fish and mud crabs which are frequently collected by people in the area.
- Seagrass will be collected from areas around Port McArthur and analysed for heavy metals. Seagrass is a useful bioindicator as it will uptake heavy metals if they are present in the sediment and water.

NLC has stated that the failure to provide information for any chemical species monitored beyond 2001 and 2002 is a major concern, as the extent of environmental impact from this mine for the past three years has not been made a matter for public consideration. It also raised concerns about the lack of any analytical data for Cd compounds the matter given that it is one of the water quality parameters required under terms of the company's Water Discharge Licence.

The assessment of existing water quality presented in the draft EIS has been updated to include water quality data from the last two years (January 2003 to January 2005) to evaluate current conditions and eliminate the masking effect of historical problems which have now been remedied. The updated water quality statistics in the table below show no demonstrable effect on river water quality.

Updated Statistics of Surface Water Quality in McArthur River (January 2003 to January 2005)

Parameter	SW7 (Upstream)	SW6 (Downstream)
pH	**8.3**[1] (8.0 – 8.3)[2] 125 samples	**8.1** (7.9 – 8.3) 121 samples

Parameter	SW7 (Upstream)	SW6 (Downstream)
Electrical Conductivity (µS/cm)	**670** (499 - 747) 125 samples	**683** (519 - 958) 121 samples
Sulfate (SO_4) (mg/L)	**10.1** (6.4 – 13.7) 127 samples	**12.9** (8.3 – 25.2) 121 samples
Total Cadmium (µg/L)	**0.01** (0.01 – 0.04) 124 samples	**0.02** (0.01 – 0.04) 125 samples
Total Copper (µg/L)	**0.85** (0.56 – 2.99) 129 samples	**0.93** (0.60 – 2.32) 125 samples
Total Lead (µg/L)	**0.60** (0.14 – 4.22) 129 samples	**0.79** (0.22 – 3.63) 125 samples
Total Zinc (µg/L)	**3.8** (1.5 – 21.0) 129 samples	**5.4** (2.0 – 19.4) 125 samples

[1] Median values shown in **bold**

[2] 20th to 80th percentile range shown in brackets

NLC expressed alarm that water quality information from 2003-2005 was not available in the public domain, making public scrutiny impossible at the time comment for the draft EIS is due.

The requested data are provided above and show reduced metal concentrations compared to the data provided in the draft EIS.

NLC has made the following comments on the surface water quality monitoring program:

- ***Inclusion of trigger values for other chemical species of concern such as arsenic and cadmium.***

  Updated water quality data are presented in the table above and includes cadmium concentrations. These data show no impact from the mine. MRM will expand the monitoring program to include arsenic concentrations to the monitoring programme (arsenic is currently monitored annually in natural surface waters).

- ***The frequency of monitoring needs to be increased and consideration needs to be given to the use of on-line and continuous monitoring systems for gross chemical parameters such as pH and electrical conductivity.***

  MRM has installed two automatic sampling stations – upstream and downstream on the McArthur River. These automatic samplers are activated by river flow to enable first flush samples to be collected and subsequent samples at varying river depths.

  Continuous monitoring of pH is not necessary as there has been minimal variation in pH values to date. Continuous pH monitoring is not practical in rivers that dry up as pH sensors need to be

permanently wet to maintain reliable readings and calibration drift is a common problem. Manual pH measurement currently remains the most reliable method to obtain sound pH monitoring data.

- ***Existing sampling site S6 is in a position that will be bypassed by run-off from the spillways at the eastern edge of the Northern Overburden Emplacement Facility. Its current location would also preclude capture of impacts emanating from seepage at its northern edge that may transport into the un-named creek system to the north.***

  MRM will investigate the need for another water quality sampling site. This will assessed on the basis of the availability of suitable access and in consultation with DPIFM. Furthermore, monitoring will be conducted in the OEF sediment ponds before they discharge to the natural creek system.

- ***The total number of sampling points used (SW6 and SW7) and the frequency at which samples are collected (monthly when there is flow) cannot be considered to be representative of the full extent of impact from existing operations, let alone operations under the planned expansion.***

  Additional water quality monitoring locations will be established downstream of the mine so that all potential impacts of the mine will be measured. Since 2003, MRM has sampled water quality at weekly intervals. Furthermore MRM has installed two automatic sampling stations – upstream and downstream of the mine. This will enable samples to be taken at varying river flows including first flush events.

NLC has noted that the water quality data in Figures 12.8 and 12.9 of the draft EIS contain data up to 2002 thus precluding a comprehensive appraisal of existing environmental impacts in the period 2002 to 2005.

The above table includes updated water quality data for 2003 and 2004.

NLC states that while chemical species emanating from the process include arsenic, cadmium and Xanthate flotation chemicals, these species are not routinely monitored.

Cadmium is currently being monitored. Arsenic will be included in the future monitoring program. Xanthate is difficult to monitor as it rapidly breaks down.

NLC considers that the draft EIS does not define acceptable environmental discharge limits and notes that site-specific trigger values for water quality in the McArthur River are yet to be determined in conjunction with DPIFM. It notes that the draft EIS does not detail the rationale being used to develop values for these triggers.

The open cut project will not require controlled discharge from the water management system and discharge limits for such a discharge are not required. However, MRM does have a licensed emergency discharge procedure. This procedure has been adopted because although the site's water management system provides acceptable containment capacity for the majority of moderate and large rainfall events, it must also ensure that extreme rainfall events or particular event sequences do not unnecessarily contribute

to excessive accumulation of mine waters. This principle is particularly important for mines such as MRM operating in tropical climates where complete containment of every conceivable rainfall event is not practical, and could otherwise cause adverse environmental impact in the event of catastrophic release of excessive quantities of mine water.

The emergency discharge procedure allows for variable flow discharges via pumps and siphons at a rate that must be limited to ensure that the zinc concentration monitored at the downstream McArthur River surface water monitoring site (SW6) does not exceed the concentration at the upstream monitoring site (SW7) by more than 50 µg/L. Specific monitoring and reporting procedures are invoked for the emergency discharge procedure. Discharge is not permitted when river flows at the existing DIPE stream gauge are below the 4 m gauge level (flow of approximately 100 m^3/s). This procedure will continue to apply for the open cut project.

MRM will negotiate with the DPIFM to agree on site-specific receiving water quality criteria because ANZECC trigger values are shown to be not appropriate. This will involve analysing monitoring data collected by DPIFM and MRM to determine appropriate trigger levels for the McArthur River in the vicinity of the mine (i.e. at SW6 and the downstream automatic sampling station). Other guidelines which have been referred to in the past (ANZECC freshwater) will also be used for reference, however analysing background data will provide appropriate trigger levels for the area within the monitoring program.

MRM will develop a trigger action response plan whereby if an agreed trigger level is exceeded at the downstream monitoring site, a response plan will be implemented. The plan would include more intensive sampling to confirm any exceedence and/or an investigation into the possible cause of the exceedence and, if necessary, the development of a remedial strategy. The proposed Community Reference Group will be consulted during the preparation of the trigger action response plan.

Additional trigger levels will also be set for the area from Borroloola to the mouth of the McArthur River. It is logical to identify the trigger levels for this area as the tidal influences may change the composition of metals within the water. This area has been the focus of a study in 2002 which was mainly aimed at the collection and analysis of sediment samples. Water samples were also taken at the same time as the sediment study. These sites will continue to be used to obtain quarterly water samples to determine appropriate trigger levels for this area. These samples should ideally be taken at the start of the wet (during first flush), towards the end of the wet and 2 dry season sampling events. Quarterly data will continue to be collected until sufficient information is obtained to define agreed trigger levels with DPIFM.

NLC has suggested that high reliability freshwater and marine guidelines have been determined by ANZECC for species such as arsenic, cadmium, lead and zinc.

The above guidelines have not been derived for tropical aquatic ecosystems and are not appropriate for the a tropical marine environment such as the Gulf of Carpentaria.

NLC notes that no data relating to metal concentrations in flora and fauna downstream of the mine are offered and no aquatic ecology survey sites downstream of the planned expansion are identified and results from external studies performed (Xstrata, 2003) are yet to be published. It considers that the absence of benchmarks or baselines relating to metal concentrations in riverine aquatic biota, either near the minesite or in the downstream wetlands ecosystems leaves Xstrata potentially exposed to corporate risk. NLC considers that the lack of a well designed metals monitoring system in river fauna and flora means that distribution of metals in the river system due to any accident or release cannot be reasonably assessed in terms of potential impact. NLC considers that there is little evidence of plans to deploy this scientific capacity to deal with the issues discussed within the draft EIS.

A survey of mangrove, molluscs and other invertebrates in tidal creeks in the McArthur River Region, Gulf of Carpentaria was prepared by Dr Russel Hanley, Northern Territory Museum, Darwin November 1993. A total of 30 transects were recorded on the 5 creeks adjacent to Bing Bong and the Carrington Channel in the McArthur River estuary. Mollusc species of the areas of each transect were described.

Heavy metal status of sediment in the McArthur River downstream of the MRM site was conducted in February 2003. Four main sections of the river were sampled including:

- The sinuous/cuspate meandering section from Borroloola to Batten Point; and
- The three main deltaic channels from Batten Point to the Gulf of Carpentaria (the Davies, Carrington and McArthur Channels).

The study concluded that the "average concentration in surface sediment from the three deltaic channels of the McArthur River are similar but sediment from the upstream river section from Borroloola to Batten Point has higher manganese, cobalt, zinc and cadmium levels than the deltaic sediments. Most metal levels in McArthur River surface sediments are similar to those in sediments from several other rivers entering the Gulf of Carpentaria. There is no evidence that increased zinc and lead levels in McArthur River sediments is related to the presence or mining of zinc/lead ore-bodies in its catchment. Cored sediment samples from up to 1 m depth (likely to be equivalent to several hundred years of deposition) from floodplain and mangrove sites in the deltaic section of the McArthur River show no trends of higher zinc or lead concentrates or lead isotope ratios towards the top of the cores. This indicates that there has been no recent discernable addition of zinc or lead attributable to the McArthur River Mine."

In addition, MRM will implement a monitoring program for metals in biota in the McArthur River in the immediate vicinity of the mine. Prior to commencement of river diversion works, surveys will be conducted upstream and downstream of the river realignment to identify appropriate sentinel species that can be used in future monitoring programs to provide information on ecosystem health. These surveys will be conducted in May – June 2006. Species selected will need to be available throughout the various seasons to allow monitoring to be conducted in both the dry and wet season for the first 2 – 3 years of the program. The program will then be reviewed in conjunction with DPIFM to determine the appropriate frequency of any ongoing monitoring.

MRM has also committed to undertake further analysis of sediments in the McArthur River from Borroloola to the river mouth, on an annual basis. Sampling points utilised in the 2002 study would again be used in addition to transect across the delta of the mouth of the McArthur River which would extend in

three parallel lines out to Port McArthur. If the sampling within the river and the additional transects show no impact over two years, the transect sampling will cease and will focus on the river. There is no scientific reason to continue sampling the transect area if there are no recorded impacts in the river.

MRM is also working with Charles Darwin University to broaden the marine monitoring program over the next few years. This will include regular sampling of fish and other marine life from the McArthur River mouth and at Port McArthur. AFANT is also involved in this work.

NLC has stated that, even though it may not be an acute risk, resultant increased metal contamination in aquatic foods due to contamination from the planned expansion has not been considered in the draft EIS. Given these foods may be caught and consumed by the local population, NLC considers that MRM should develop a strategic approach to this issue and to make an informed assessment of the potential risk to public health from the project.

Studies into the health of marine flora and fauna commenced in 1992 prior to the commencement of mining and port operations. These studies are conducted annually by the Environment Analytical Chemistry Unit of Charles Darwin University. They include assessments of the sea water, oysters, shellfish and seagrass to check levels of cadmium, copper, lead or zinc.

An additional study was conducted in 2003 to specifically test for heavy metal concentrations. Under this study, oysters sampled at the mouth of the McArthur River were found to have levels of zinc and lead were well below the AFS A12 food standards. Lead concentrations in the oysters were too low for lead isotopes ratios to be determined.

Furthermore sampling and analysis of other aquatic food types will be included in the MRM environmental monitoring program. Information will be obtained from community members to determine the species which are most utilised as a food source and the appropriate approvals obtained to sample them for analysis. Examples of possible species include barramundi and mud crabs. The results of the analysis will be made available to community members.

NLC considers that the risk of impact related to site release of surface water is not properly addressed because the existing ecosystems of the McArthur River wetlands and freshwater reaches remain virtually undescribed – in direct contrast to the requirements of section 6 of the Guidelines.

As discussed in the draft EIS, the environmental management strategies to be implemented at the mine have been designed to ensure that there will be no downstream impacts in the McArthur River wetlands and freshwater reaches. The risk of impacts related to the release of surface water has been carefully considered in the design of the TSF, the OEF and the site water management system. All potentially contaminated water will be retained and reused on site and the flood immunity of all potentially contaminated areas has been set within the range of 1 in 100 year ARI to 1 in 500 year ARI on the basis of the risk they pose to the environment.

The ecology of the McArthur Rive wetlands and freshwater reaches has been described in the studies discussed in the responses to the above comments. This has enabled baseline conditions to be established

for downstream ecosystems. Ongoing monitoring is proposed to be undertaken in these areas once the open cut operations commence to confirm that mining activities will not be have any measurable downstream impacts.

12.7.2 Surprise and Barney Creeks (7, 12)

ECNT is disturbed that there is not a clearer picture about the cause of elevated lead and sulfate concentrations in Barney and Surprise Creeks.

Elevated concentrations of metals and sulfates in Barney and Surprise Creeks are due to historical (now remedied and monitored) seepage from the TSF, and natural geology/contaminant sources from the catchment. The greater variability of flow in Barney Creek (i.e. less receding base-flow than the river) exacerbates the natural influence of evaporation (concentration of contaminants) and the relative significance of seepage. Works have been undertaken to remedy seepage from the TSF and its effectiveness is being confirmed with monitoring. Additional remedial options (e.g. installation of dewatering bores) will be implemented as an additional safeguard contingency if necessary. The concentrations of lead and sulfate in Surprise and Barney Creeks attributable to TSF seepage are expected to decrease over time (due to seepage cut-off/recovery works) however naturally elevated and variable concentration of metal concentrations will likely persist due to natural hydro-geochemisty of the catchment.

MARA has commented on an apparent contradiction in the draft EIS in that one section of the Executive Summary states that "Water in the creek (Surprise Creek) was found to contain some sulfate (positive indication of tailings origin) but only background levels of lead and zinc", while another states that "Water in Surprise and Barney Creeks is showing signs of elevated lead and sulfate concentrations".

Elevated levels of sulfates have been identified in Surprise Creek. Lead and zinc concentrations in this creek were also elevated relative to ANZECC guideline values (which have been identified as not appropriate) but are comparable (not elevated) relative to background levels measured at upstream monitoring points.

12.7.3 Water Quality Influences Downstream (7)

ECNT has asked for studies or monitoring reports to prove the claim in the draft EIS that the concentration of sediment and metals tends to decline downstream of the mine to Borroloola as a result of dilution with cleaner water and that in the estuarine reaches, the concentration of suspended sediment decreases rapidly due to flocculation caused by increasing salinity and pH from tidal waters.

Flocculation of suspended sediment always occurs due to increased salinity and pH as freshwater flow mixes with estuarine waters (downstream of Borroloola).

The Charles Darwin University was commissioned by MRM in 2003 to determine the heavy metal status of marine sediment at the mouth of the McArthur River. The report summarising this study found that:

- At McArthur River mouth, metal levels in sediments were found to be similar to other river estuaries in the south eastern Gulf. Lead isotope data indicate that MRM ore-derived lead does not contribute to the lead inventory of these sediments.
- Lead isotope ratios in sea grass at McArthur River mouth indicate that MRM ore-derived lead makes little or no contribution to lead levels in sea grass.
- Metal concentrations in oysters at McArthur River mouth are all well below food standards (AFS A12). Lead concentrations in oysters were too low to determine lead isotope ratios.

12.8.1 Existing Mine Site Water Management (5)

The EIS states that a management principle is to 'maintain a non-release system for 'dirty' mine waters, except under extreme conditions, as approved.' MAGNT has asked for 'extreme conditions' to be defined (threshold values specified), and the terms and procedures of the agency that approves this to be explicitly set out.

No new or additional controlled discharges are required for the open cut project (i.e. there is no requirement for the approval of any new controlled discharges). The proposed water management system (as defined in the draft EIS) maintains the existing no-discharge operating philosophy in all but extreme rainfall conditions.

Risk-based "system" performance criteria for uncontrolled discharge are required recognising that it is not possible and practical to estimate and design, guaranteed containment of implausible, but possible, probable maximum rainfall intensities and rainfall sequences that could cause uncontrolled discharge (i.e. system overflow). The proposed water management performance objective is based on acceptable minimisation of the risk of overflow. The risk of overflow may not necessarily be the result of a single rainfall event or season. The definition of "extreme conditions" is therefore defined as a "system response" criteria in terms of the probability of an uncontrolled overflow, rather than a specific extreme rainfall event (which may not be the worst case "loading" of the system).

The proposed criteria are based on an acceptable and quantifiable low risk of an uncontrolled discharge (overflow probability) in relation to the hazard of contaminants in various areas of the water management system (i.e. 1 in 500 years for TSF area – high hazard, and 1 in 100 years for OEF-PAF moderate hazard – refer Table 12.11 of the draft EIS). These proposed criteria are more stringent than equivalent ANCOLD Tailings Guidelines risk criteria for containment.

During plausible, but extreme rainfall conditions (1 in 100 to 1 in 500 years average recurrence interval), the dilution of uncontrolled system discharge from concurrent receiving stream flows would be in the order of 1,000 times in Barney Creek. Further dilution in the order of 10 to 1,000 times in McArthur River (simply based on relative catchment areas) would make the impact on downstream water quality immeasurable.

The proposed objectives of water management system performance (Table 12.11in the draft EIS) for uncontrolled discharge risk, provide appropriate conservatism and would be suitable as "license criteria for uncontrolled discharge".

The risk-based uncontrolled-discharge criteria do not permit MRM to deliberately or actively release contaminated mine waters during flood conditions.

Should it become necessary to establish new controlled discharge criteria, MRM will use the planned development and calibration of the OPSIM modelling of the water management system's contaminant mass balance to evaluate the mine-water and clean water quantity and quality in order to define rainfall (or other) conditions requiring controlled discharge and the estimated quantity and quality of release. This information will be supplemented with estimates of the likely concurrent river flows (quantity and quality) and net effect on receiving water quality to define and agree controlled discharge criteria with the EPA.

MAGNT considers that any discharge of 'dirty' water, is a serious matter as it shows that the design capacity of the system has been breached or exceeded, and every discharge made under licence should have to be reported immediately to NRETA. MAGNT states that there is nothing explicit under Section 22 of the EIS to indicate that this is already a licence condition, and they consider that merely listing discharge events as part of an annual report is unsatisfactory.

As described above, uncontrolled discharges will be very rare (i.e. only in extreme conditions) and sufficiently diluted by natural creek and river flows in extreme wet seasons. With appropriate implementation of the water management system (including monitoring and seepage control), there will be no cause for measurable or persistent impact on receiving waters due to contaminant discharge.

Any uncontrolled discharge will be reported to the EPA.

12.8.2 Test Pit Project (4, 5, 6)

DHCS has stated that the bund runoff pond between the pit and the flood protection bund should be constructed in accordance with Section 1 of the Medical Entomology Branch guideline 'Guidelines for Preventing Mosquito Breeding Sites associated with Mining Sites'.

All water collection ponds will be designed in accordance with the *'Guidelines for Preventing Mosquito Breeding Sites associated with Mining Sites'* within the constraints of priority for prevention of discharge to receiving waters.

It is mentioned that the existing anti-pollution pond and concentrator runoff pond will be increased in size for the new development. DCHS has requested that the new internal margins should be steep sided (e.g. 1:1 slope), to discourage marginal vegetation growth.

Where practicable the slope of the ponds will be made steep subject to the constraints of engineering integrity of pond margins (e.g. vulnerability to wave attack) and safety hazards associated with maintenance and monitoring activities of personnel working around the ponds.

MAGNT considers that there is a high likelihood of overflow into Barney Creek with the test pit project. It states that this should be continually managed, not just "… in the event of a 1 in 3 year event".

Risk of overflow into Barney Creek will be continually managed during the Test Pit project with 3-monthly reviews of the 12-month outlook of overflow probability and taking account of the consequences of overflow using pond water quality monitoring data. Furthermore the anti-pollution pond at the plant site has been increased in size and can be utilised as a storage area for water if required. This would further reduce the risk of overflow to Barney Creek.

AFANT considers that the Test Pit pond system should be protected from flooding and down river run off, preferably to a 1 in 500 flood level.

Protection of the test pit pond system to 1 in 500 year flood levels is not practical (e.g. height and length of flood protection bund required to reach 500 year flood levels) in the short time frame of the test pit project leading up to the open cut project. The test pit project at less than 10 times the scale of the open cut project will produce much less quantity of dirty mine water (less than 10% of the open cut project) and does not intercept paleo-channel groundwater. The test pit has less potential to accumulate excessive mine water and poses less of a risk to the environment.

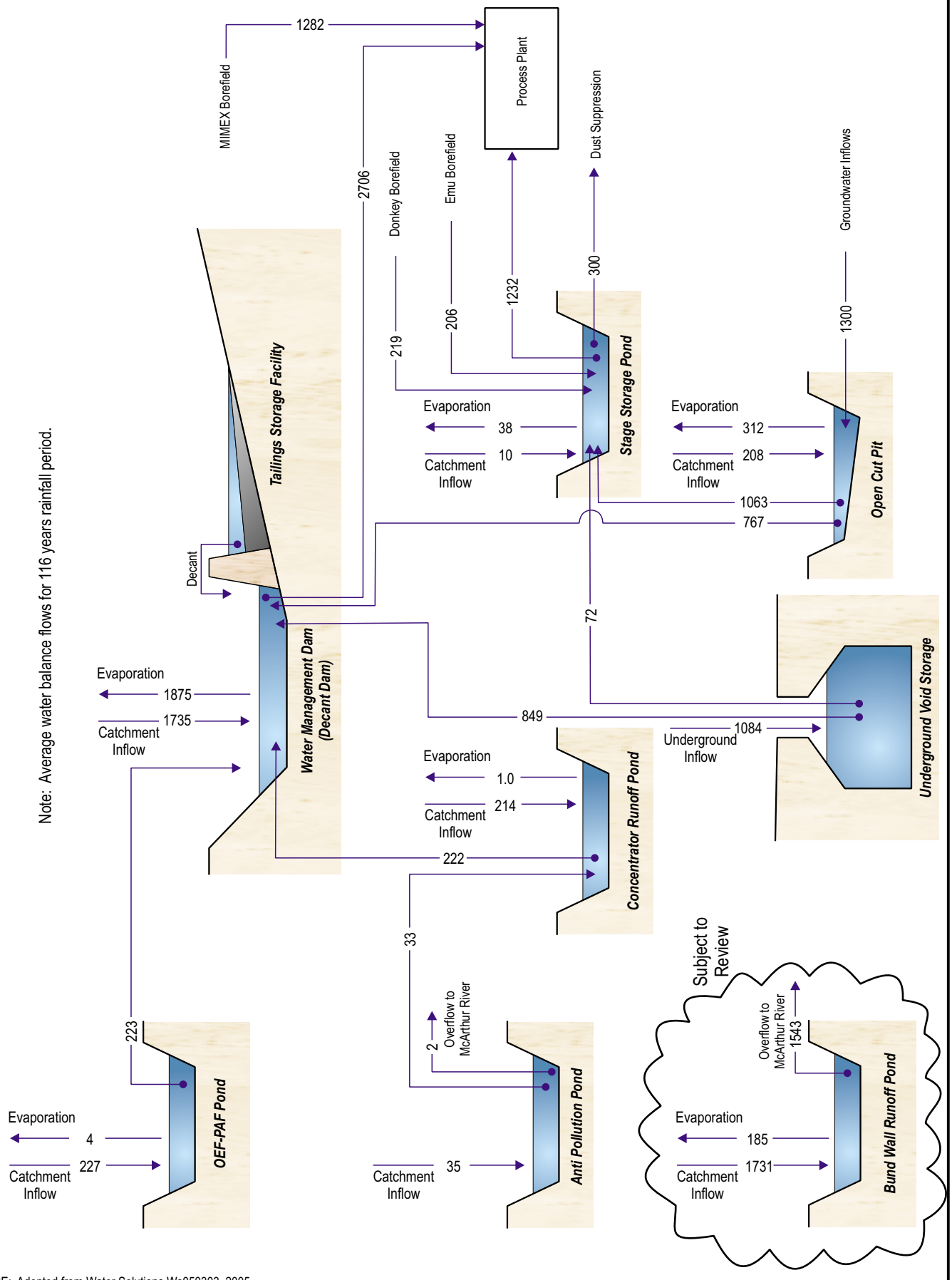
12.9.1 Proposed Water Management Strategy (1, 2, 4, 5, 6, 7, 13)

EPA has asked that Figures 12.11 and 12.10 in the draft EIS be updated to incorporate design volumes and median annual flow rates between each component of the water management system.

Annotated updates of Figure 12.11 (from the draft EIS) are provided showing mean annual water volumes between various components of the water management system. These are based on OPSIM modelling undertaken for mine water planning with 116 years of rainfall data to account for a wide range of possible climate conditions (particularly sequential rainfall events and wet seasons which often prove to be the most severe case). Two diagrams (Figures 2 and 3) are shown representing Years 1 to 3 and Years 4 to 17. The water balance for Years 18 to 25 will be evaluated during Years 2 to 5 taking into account the actual groundwater inflow monitoring data.

EPA has asked of runoff/seepage from the NAF pond be discharged to Barney Creek. They note that this is not shown in Figure 12.11 in the draft EIS. EPA asked what is the predicted volume coming from the NAF storage and is this volume included in the water balance calculations for the site. It also asked about the predicted water quality of the NAF seepage.

Runoff from the NAF pond will overflow to Barney Creek. This overflow was not shown on Fig 12.11 because it is not linked into the 'closed' Mine Water Management System. Water in the NAF pond will be 'clean' water as it will not contain metal contamination although it will contain sediment from the operating surface of the NAF section of the OEF. This water will be of a quality which is satisfactory for discharge into receiving waters after passing through sediment ponds. It will be similar to runoff from



SOURCE: Adopted from Water Solutions Ws050303, 2005.

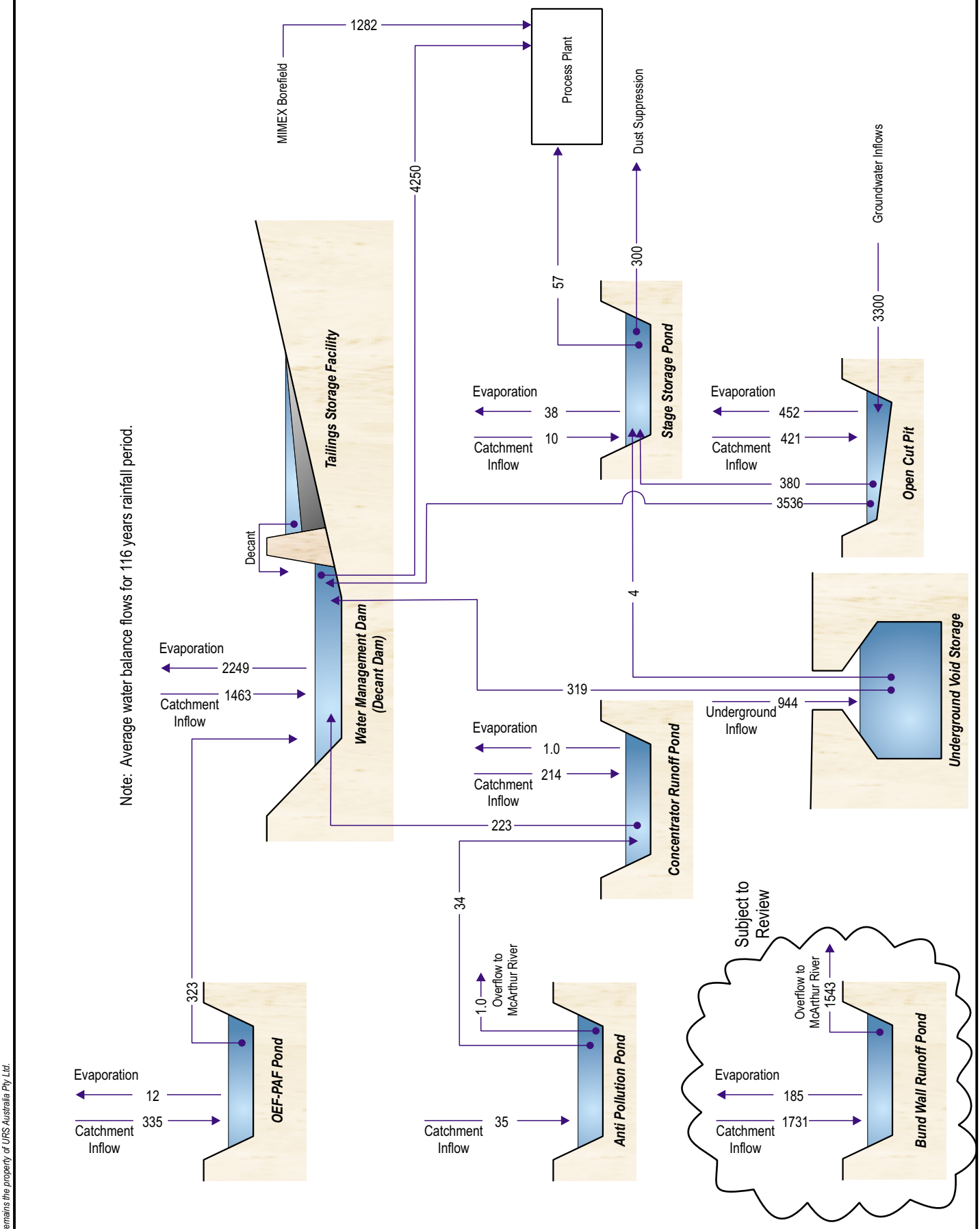
xstrata

URS

McARTHUR RIVER MINE
OPEN CUT PROJECT
ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT

AVERAGE DAILY WATER TRANSFER (kL/d)
SCENARIO 1 - Years 1 - 3

Drawn: VH	Approved: CMP	Date: 21-11-05	Figure: **2**	Rev. A
Job No.: **42625552**	File No. 42625552-g-156.cdr			A4



SOURCE: Adopted from Water Solutions Ws050303, 2005.

xstrata

URS

McARTHUR RIVER MINE
OPEN CUT PROJECT
ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT

AVERAGE DAILY WATER TRANSFER (kL/d)
SCENARIO 2 - Years 4 - 17

Drawn: VH	Approved: CMP	Date: 21-11-05	Figure: 3	Rev. A
Job No.: **42625552**	File No. 42625552-g-157.cdr			A4

other disturbed but uncontaminated areas on the site which will discharge into receiving waters after passing through sediment ponds.

Because NAF pond overflow is not part of the site's Water Management System it has not been included in the site's water balance.

The volume of water overflowing the NAF pond will depend on the intensity of the rain event generating the runoff. It will function as a normal sediment pond which will contain water for a period of time to enable suspended sediment to settle and then it will then overflow.

EPA has stated that if a discharge is planned from the NAF pond, then minimum dilution requirements in Barney Creek for all toxicants being emitted from the pond and details of the proposed discharge regime to achieve water quality objectives should be included in the Supplement.

Overflow from the NAF ponds will have a similar temporal variability as flows in Barney Creek. There will be no need for active discharge. The discharge will be passive as the ponds will overflow when moderate to heavy rainfall occurs. As the NAF pond water will not contain toxicants and as there will be flow in Barney Creek when the NAF pond is overflowing, there will be no need for specific dilution requirements or a managed discharge regime.

EPA has asked if seepage from the TSF has been incorporated in the water budget

The OPSIM modelling is based on the assumption of no seepage from containment ponds in accordance with the objectives to remedy existing seepage and design to minimise seepage from new facilities. This ensures conservatism with respect to OPSIM modelling estimates of overflow probability.

EPA has asked what impacts will the TSF seepage have on groundwater quality if there is no clay liner and where will this seepage ultimately drain.

Based on monitoring results since 1995, the groundwater (mainly in shallow weathered bedrock) around and under the TSF is hard and is a (Na-Mg-Ca)-(SO_4-Cl) type with a TDS content of 2,000 to 3,000 mg/L. Groundwater quality in other monitoring bores around the TSF is similar although the combination of cations and anions varies and the TDS content shows a considerable variation. Since 1995, EC and SO_4 content have both increased as a result of the seepage that has occurred. Any seepage from the expanded TSF will be of similar quality to the existing seepage and the same effects on groundwater quality are expected. Quantitative results of recent groundwater quality monitoring are given in Table 11.1 of the draft EIS.

Modelling has indicated that any seepage from the expanded TSF is likely to move downgradient in a southerly direction. It is proposed to install a network of recovery bores around the southern perimeter of the expanded TSF. Any seepage which reaches the underlying groundwater will be collected in the recovery bores and returned to the TSF water management dam.

EPA has stated that the draft EIS fails to consider the potential impacts of climate change on the proposal. At the very least, potential impacts should be considered over the 25 year life of the open cut operations. For example, what are the implications of climate change to water management if cyclone frequencies and intensities increase? Can the OPSIM model be used to run simulations of various scenarios?

The OPSIM modelling can be used to evaluate various scenarios reflecting the impact of climate change. As described in the draft EIS (Section 12.9.1 – page 12-26) the scenario evaluation would require a full range of climate change variables including intensity of rainfall events, effects on rainfall event sequences (both inter-seasonal and inter-annual), changes to overall wet season rainfall, and similar estimates for evaporation at short, seasonal, and inter-annual time scales. Such estimates for future climate change are not yet available. The OPSIM modeling will be revised and the water management system upgraded (as necessary to maintain the defined uncontrolled discharge risk objectives) when climate change estimates become available.

The recent report "*Climate Change in the Northern Territory*" prepared for NT Department of Infrastructure, Planning and Environment (Hennessay et al), provides some indication of future climate change based on current best available climate modeling predictions. Although the predictions in this report are not sufficient at this stage to evaluate water management system performance for future climate change, some report findings suggest that climate change will likely produce a beneficial effect for water management required for the open cut project. The report suggests that average rainfall is likely to decrease by up to 20% and average evaporation is likely to increase by up to 100 mm/year (3%). Both these factors would reduce the potential to accumulate excessive mine water and reduce the probability of overflow from the proposed water management system.

Figure 12.11 show the proposed water management schematic but does not indicate how inflows to the water management dam including underground storage transfer will occur. DPIFM has asked for this to be shown.

Inflows from catchment runoff to the containment dams will occur by gravity drainage. Inflows to all storages sourced from transfers from other storages will all occur by pumping via pipelines and be monitored with electronic flow meters. The transfer flow capacity is one of several key parameters for the water management system and performance evaluation to be determined by the OPSIM modelling.

DHCA has asked that all new water holding features be constructed in accordance with Section 1 of the Medical Entomology Branch guideline 'Guidelines for Preventing Mosquito Breeding Sites associated with Mining Sites'.

All water collection ponds will be designed in accordance with the *'Guidelines for Preventing Mosquito Breeding Sites associated with Mining Sites'* within the constraints of priority for prevention of discharge to receiving waters and management of safety hazards for routine operations at the storages.

DHCS has asked that erosion prevention structures be provided at the bund wall runoff pond overflow point/s, to prevent the formation of eroded pools and downstream siltation of the McArthur River, both

of which could lead to mosquito breeding. It is not mentioned how the Bund Wall Runoff Pond overflow is to be conveyed to the McArthur River (i.e. formalised channel, sheet flow).

The bund wall runoff pond and all other water management ponds will be designed and constructed with engineered spillway structures to prevent erosion of downstream watercourses. The discharge from this pond will be pumped over the flood protection bund to a formalised channel discharging to the McArthur River.

DHCS has asked that any pond likely to overflow be provided with erosion protection structures at the water overflow points, to prevent the creation of eroded pools and downstream siltation of water features, both of which could lead to mosquito breeding.

All water management ponds will be designed and constructed with engineered spillway structures to prevent erosion of downstream watercourses.

MAGNT has asked for clarification of the role of the bund wall runoff pond. Figure 12.11 shows the overflow going into the McArthur River. Further explanation or a better diagram is needed here including exactly what is entering the river.

The bund wall runoff pond will not collect contaminated mine water. The pond collects runoff from the perimeter areas around the pit (between the flood protection bund and pit edge – generally to the north and east). The runoff collected in the pond is likely to contain elevated sediment and the pond is required to remove sediment prior to discharge from the site. It will function in a similar manner to the proposed OEF eastern sediment ponds. The discharge from this pond will be pumped over the flood protection bund to the McArthur River. The quality of this discharge will be monitored.

MAGNT has asked what are the changes in surface water runoff and effects on Barney Creek catchment caused by the presence of the flood protection bund.

All of the "flood management" works (i.e. flood protection bund, and new channels) together with the OEF footprint have been designed interactively with flood modelling of all works to ensure that there are no impacts on Barney Creek channel. The works will have insignificant impact on Barney Creek hydrology because the area of the effected catchment is less than 1% of the total Barney Creek catchment.

MAGNT has asked that the proposed realigned river channel be provided with some bends and twists to reflect a natural river.

Bends, twists, general meandering will occur for low flows over the bed of the new channel similar to the natural river (see the photograph in the responses to comments on Section 12.6). Meandering of the main channel at a broader scale would not be consistent with the existing natural river channel which has minimal sinuosity at this scale.

The EIS has nominated 2,100 ML of underground void storage as the threshold at which water will begin to be pumped to the TSF, and 2,300 ML as the threshold at which it will begin to take steps to upgrade its TSF capacity. MGANT considers that the two thresholds seem fairly close and may not provide ample lead time for expanding the TSF.

The underground void storage capacity is planned to be 3,500ML for years 1 to 12, and 2,500ML for years 13 to 25. The nominated 2,300 ML storage trigger level for implementation of works to upgrade water management system storage capacity is from OPSIM modelling for a range of climatic scenarios (as credibly evidenced from historical data) such that there is sufficient lead time (1 to 2 years with greater than 90% confidence) to implement upgrade works. The 2,100ML trigger level for pumping to the TSF is also based on OPSIM modelling which has shown that this level will result in less than 50% chance that the void storage would fill within 17 years. The respective trigger levels are not directly related to the same water management issue and do not pose a water management risk.

As part of more detailed performance monitoring obtained in the early years of operation, MRM will undertake additional OPSIM modelling with the benefit of actual (rather than estimated) groundwater inflow data to reassess the appropriateness of respective trigger levels and revise these if necessary. Any proposed changes to the trigger levels will be agreed with the EPA.

MAGNT considers that any substantial upgrade to the TSF should require a supplementary Environmental Impact Statement.

Should any substantial upgrade of the TSF be required, MRM will obtain all the necessary approvals from the NT Government prior to construction.

AFANT considers that the integrity of the OEF-PAF pond should be maintained at levels above a 1 in 100 flood unless it can be clearly demonstrated that any flood run off will be diluted to safe cattle drinking water standards before it enters the main river channel.

The OEF-PAF pond will be designed to contain runoff from the OEF-PAF area such that overflows can only occur for 1 in 100 year rainfall conditions (including the "worst case" from a range of rainfall condition "types" such as single events, sequential events, whole wet season rainfall, and sequential seasons with above average rainfall). The PAF pond will also be designed with its spillway above the 1 in 100 year flood level to avoid potential for cross-contamination between river floodwaters and PAF pond waters.

Designing for a more extreme overflow or flood condition is not necessary because the level of contamination in 1 in 100 year rainfall conditions will be minimal due to extensive dilution from rainfall. Furthermore the water management system is designed and will be operated to keep the PAF pond as empty as possible by pumping the PAF pond waters to the TSF. In an extreme rainfall that could cause overflow of the PAF pond to receiving waters, the small size of the PAF pond catchment relative to the much larger Barney Creek catchment, shows that PAF pond waters would be diluted at least 1,000 times in Barney Creek and a further 100 to 1,000 times in McArthur River.

AFANT considers that the target overflow possibilities of containment storages should be assessed prior to construction and the containments built to the required standards rather than monitoring during mining and then determining the necessary containment levels.

The target overflow probabilities of the water management system containment ponds are defined at the design stage (as per Table 12-11 – page 12-24 of the draft EIS). The overflow probabilities are considered as the key objective for sizing, operation, and maintenance of the water management system and MRM will not change this performance-based objective without approval from NT Government. The only reason for seeking a change to the performance-based objective would be if monitoring data show that mine water quality is persistently less contaminated than predicted and that demonstrable water management or other risk minimisation benefits could be achieved by adopting revised criteria.

A strategic peak wet season release procedure is to be implemented opportunistically to discharge excessive accumulation of cleaner waters in the mine water management system to the McArthur River when it is carrying greater than a pre-determined flow rate). This needs to be clarified as the only release into the McArthur River that ECNT can see in Figure 12.11 is from the bund wall runoff pond.

The reference to strategic release on page 13-43 of the draft EIS was incorrect. A strategic wet season release procedure will not be required for the open cut project. A strategic release procedure was initially considered but subsequent modelling has demonstrated that the site's water can be managed without any reliance on controlled releases.

NLC considers that the potential effect of climate change has not been adequately addressed in the draft EIS. It considers that a 33 year dataset could be considered insufficient to support the assumptions made (particularly as to what constitutes a 1 in 100 year event) and thus conclusions drawn.

The proposed water management system has been tested with 116 years of historical rainfall data which provides robust evaluation of extreme rainfall conditions and a whole range of possible critical rainfall sequences credibly known to be possible. The OPSIM modelling to evaluate the water management system risks can be updated as required at any time in the future as new rainfall and climate estimates become available.

Flood flow estimates have been determined using conventional flood frequency analysis which is widely accepted as best practice for estimating floods with recurrence intervals beyond the period of recorded data. The flood hydrology estimates have been independently peer reviewed.

12.10.1 Description of Works – Realignment (3, 5, 6, 14)

DNRETA has suggested that consideration be given to locating the realigned river channel closer to the flood protection bund to reduce the loss of riparian vegetation along the McArthur River and Bull Creek.

The alignment of the proposed new river channel has been set to ensure minimum possible disturbance to riparian vegetation within the constraints of the design required for best practice river engineering and the need to avoid potential sterilisation of mine ore resources.

DNRETA has suggested that as the existing river channel includes numerous short side-channels that should be included in the design of the river realignment and that levee banks should also be included as they may be important in re-establishing riparian vegetation.

The proposed realignment of the river channel is designed to mimic the shape and geometry of the existing main river channel. The numerous short gullies through the banks of the main channel are not critical for hydraulic or morphological stability.

The existing river channel does not have natural levee banks that need to be replicated in the new channel. The geometry of the proposed channel design takes account of the need to reinstate riparian vegetation.

MAGNT has stated that there is no clear illustration of what the proposed channel will actually look like.

Illustrations of the proposed new channel were shown in the draft EIS on Figures 12.12, 12.13, 12.14. Photos of the existing river shown on Figure 12.5 are the best indication of what the channel is intended to look like when rehabilitated and riparian vegetation is mature. The natural river channel will be replicated because the design and rehabilitation will:

- have no impact on the broad spectrum of river hydrology (flow magnitude, variability, and frequency) which is one key driver for river evolution processes;
- the hydraulics of river flows will maintain a similar erosion and sedimentation regime and geo-morphological influences which preserve the potential for the river to evolve naturally;
- include revegetation with endemic species to restore riparian vegetation;
- include reinstatement of large woody debris and sand bars; and
- monitoring of the above factors to identify and implement remedial works/actions/strategies as required.

MRM proposes to establish a Community Reference Group to facilitate community consultation and involvement in the project. Input from this group will be sought on ecological aspects of the new channel design with respect to the nature and location of micro-habitats along the channel bed and the species selection and planting pattern for the channel revegetation program.

MAGNT has asked if the bedrock present in the bank sections of the existing river will be duplicated.

Exposed bedrock in the bank sections of the existing river channel will be replicated in the new channel.

MAGNT has asked how long will it take the riparian revegetation to grow.

Stating a certain specific time during which revegetation will grow would be misleading. MRM will monitor, maintain and undertaken remedial action as required to ensure successful revegetation of the new channel until it is established. This is expected to occur before the end of the planned mine life (25 years) but cannot be defined exactly. Some factors affecting the time for revegetation include the following:

- The time for revegetation to establish in a riverine environment (as opposed to terrestrial rehabilitation) is vulnerable to the occurrence of floods during the early establishment period – it is not possible to predict what magnitude floods, sequences of floods, or duration of floods will occur in the next 10 years. The revegetation program will account for flood risk and include contingency (remedial actions) in response to potential flood damage during the establishment period.
- Conversely, some aspects of the riverine environment can provide more favourable conditions for revegetation establishment and voluntary colonisation, such as higher moisture levels, enriched growing conditions from organic matter supplied from upstream flows, and natural seed stock supplied from the upstream catchment.
- Revegetation success is more certain with a well planned revegetation program with particular emphasis on substrate preparation and protection, appropriate species mix / density, time of planting, age of plants (i.e. direct seeding and tube-stock establish faster than larger potted specimens), and watering in critically dry periods. MRM's revegetation program will include these measures to maximise success.
- Previous experience on other river diversions has shown that with appropriate design for hydraulic, geomorphologic and substrate conditions, the river systems can be resilient in terms of natural restoration with voluntary colonisation of riparian vegetation even where there is minimal direct implementation of revegetation initiatives (e.g. Isaac River diversion in Queensland). MRM will implement a comprehensive revegetation program which will be supplemented with natural evolution of the river, and there is no reason to expect that revegetation cannot be successful providing adequate monitoring and risk mitigation measures are implemented.

Although it is not possible to define a specific time period during which full revegetation will occur, it can be expected that riparian vegetation should become established (not reliant upon irrigation) within 1 to 5 years, reach full canopy height in 8 to 15 years, and be maturing within 20 to 30 years.

MAGNT has asked what will be the localised protection works to prevent erosion where the realigned channel joins the existing river.

The localised protection works to prevent erosion where the realigned channel joins the existing river will be rock capping (similar to that shown on the banks of the river channel – section type A1 on Figure 12.14 of the draft EIS). The protection works will not include drop structures which could form obstructions to fish passage. The rock capping will be strategically located on the basis of detailed two dimensional hydraulic modelling which can determine velocity direction as well as velocity magnitude to identify where flow could impact on the river banks.

Timber groynes, as shown on the photo below, which have been successfully used for erosion control in tropical river channels may also be considered for alternative erosion protection. If timber groynes are required their use will be discussed with stakeholders before installation.

AFANT has stated that during the mine construction phase, either the existing channel or a realignment completed to its full specifications will need to be in place at all times when wet season flows are possible.

The construction plan will include a key requirement that the existing river channel be left open for wet season flows until the new channel is completed to specification (including a biologist's sign-off that there are no physical barriers to fish movement).

AFANT has asked for more details regarding the realignment of Barney and Surprise Creeks to standards similar to the main river (McArthur River).

Surprise Creek will not be re-aligned. It will intercept Barney Creek at a new location on the new Barney Creek channel. Barney Creek is designed on the basis of similar hydraulic and geomorphological principles and objectives that were used for the McArthur River channel (i.e. velocity and stream-power below erosion thresholds). The realigned Barney Creek channel will intercept alluvial foundations and

the typical section will as shown for type "A1" as shown on Figure 12.14 of the draft EIS. Riparian re-vegetation of the new Barney Creek channel will use species mix/density endemic to the original Barney Creek watercourse.

D Farlam has stated that the new river channel does not truly represent the existing river channel as it needs to consider the local drainage on either side of the channel.

Allowance has been made in the design of the realigned channel to incorporate the tributary flows that discharge into the existing river. These local drainage flows will be accommodated within the capacity of the new channel.

D Farlam states that the flood out area extends up to 2 km either side of the main channel and the surrounding topography gently slopes in towards the main river channel. He sates that this has not been replicated in the modelling.

The extent of the flood plain will not change as a consequence of the river realignment.

Receding flood flows will continue to drain to the river either into the new river channel or into the cut-off section of the old river channel downstream of the flood protection bund. There will be a small volume of flood runoff that will flow into the cut-off section of the old river channel upstream of the flood protection bund. This section of river channel is relatively short and stagnation of water is not expected to be significant as much of the flood water will drain into the realigned river channel as flood levels drop.

12.10.2 Hydraulic Impacts on River Stability (1, 5, 6, 7, 10, 14)

EPA considers that biannual cross-section surveys are not going to determine excessive rates of sedimentation without downstream historical sedimentation data. If has asked if there is baseline data for this reach that gives some indication of regular sedimentation patterns.

There are no permanent pool aquatic habitats downstream of the mine within the zone of potential sedimentation impact from realigned channels. Historical data required to define historical sedimentation regime are not available. Baseline data are limited to historical surveys of the DIPE gauge upstream of the new channel (draft EIS Appendix K).

Bi-annual cross-section surveys will be supplemented with bi-annual aquatic surveys and photographic record of channel conditions (around 200 m spacing downstream to Bukalara Range). Development of the detailed monitoring program will be guided by geomorphologists, river-engineers and biologists and supplemented with mine aerial photography data. Reports and assessments of the need for remedial action will be undertaken in years 1, 3, 5, and 10 and as required and agreed until mine closure.

Sedimentation would also be variable in response to upstream sediment supply which is a catchment scale influence affected by broader catchment stakeholder beyond the scope of the open cut project (the mine represents about 1% of total upstream catchment area).

The plan of sediment monitoring and corrective actions will include adequate safeguards to ensure that remedial actions do not unnecessarily remove sediment deposits (whether attributable to or perceived as an impact from the open cut project), which would otherwise cause adverse or unnecessary impact on riparian vegetation and the broader riverine environment.

EPA has stated that the proposed high resolution aerial photography will need to be taken prior to mine expansion works and following flood events.

MRM will take a baseline set of aerial photographs prior to the river being diverted through the realigned channel. Subsequent photos will be after major flood events at least a five yearly intervals.

MGANT suggested that trees, stumps and other wood debris (e.g. from knocking down riparian vegetation along the real river) be added to the new channel to provide immediate habitat and stream bed stabilisation.

Trees, stumps, and other forms of large woody debris will be "salvaged" from cleared areas during the construction and strategically placed into the new channel to provide immediate habitat and stream bed stabilisation (draft EIS Figure – 12.14)

MAGNT suggested that the largest trees possible be planted along the realigned river channel to speed up the revegetation process. Progress on revegetation must be monitored, e.g. after big storm events, flooding.

Planting larger trees would not necessarily improve or speed up the rehabilitation program. Growth of large potted specimens can be hindered by the effects of root containment due to time since propagation. Appropriately planted tube-stock, with protection and maintenance, should facilitate rapid growth and more cost-effective revegetation when considered over a period of years. Planting by direct seeding has the highest potential for success in conditions where the growing medium and substrate may be vulnerable to erosion or movement in created landforms (excavated or filled). Direct seeding can also be cost effective and adaptable to climate and harsh conditions. MRM's detailed rehabilitation plan will include a combination of direct seeding and tube-stock using revegetation methods appropriate for the geological and substrate conditions and the flood risk (relative to flood flows and depths).

MAGNT has asked that MRM monitors and replaces young planted vegetation swept away by flooding.

MRM will monitor revegetation and restore flood damage to comply with the rehabilitation objectives.

MAGNT has stated that there appears to be little data available as to where the upstream sediment actually comes from. It also requires options as to what could be done to mitigate sediment deposition downstream along the Bukalara Range portion.

The majority of sediment is from diffuse sources from the broader upper catchment which is much larger than the mine area. Sediment from the upper catchment is subject to influences of land use in the

catchment (e.g. grazing, infrastructure corridors), natural factors such as bushfires, and natural erosion of watercourses. The geomorphological landforms along the lower reaches of the McArthur River and at the river mouth are evidence of a sustained long history of sediment transport from the catchment to the coast.

Sediment deposition is not expected to occur downstream to Bukalara Range because the new channels are designed to be stable and minimise the potential to generate excessive or adverse sediment loads and turbidity. A potential sedimentation zone downstream to Buklara range will be monitored. Where sedimentation poses an identified biological or other environmental threat, appropriate remedial actions will be developed and evaluated by biologists and agreed with stakeholders.

AFANT's view is that the erosion risk, at least insofar as it may impact on any permanent waterholes, should be eliminated.

There will always be some natural risk of erosion which is a natural process. It is not appropriate (or possible) to expect complete elimination of erosion. Rather, the focus must be to ensure that the erosion is managed in terms of erosion rates being similar to natural erosion (sustainable), and that erosion vulnerability (banks, bed etc) will not adversely impact on aquatic habitat.

Erosion risk has been eliminated to the best possible degree by appropriate design. With the proposed design there will be no adverse risk of erosion to any permanent waterholes all of which are located upstream of the new channels. Erosion risk will continue to be managed during operations with on-going monitoring and maintenance, particularly to ensure that revegetation of the new channels is successful.

ECNT is concerned that a 5-year ARI flood will lead to wide-scale erosion of the new channel or upstream reaches sufficient to alter river form in the alluvial sections and that there will also be a higher sediment load in the new channel during low flow period.

As stated in the draft EIS, there will be no risk of wide-scale erosion of the new channel or upstream reaches sufficient to alter river form. In low flow periods, the new channel will be in a sedimentation zone for low flow conditions which will benefit promotion of substrate diversity (noting there are no permanent waterholes at risk in the area of the new channel), and there will be minimal risk of increased sediment load to downstream reaches.

ECNT has asked what are the "other factors" other than cattle grazing that will contribute to increased sedimentation in the 2-3 km stretch of the river between the new channel and the Bukalara Range.

The factors that can contribute to increased sedimentation in the 2-3 km reach between the new channel and Bukalara Range include the rate of sediment supply from the upstream catchment which would not be impacted by the mine. The upstream sediment supply can be affected by natural in-stream erosion of upstream channel, diffuse sources of sediment from broad catchment areas (both natural sediment supply and increased sediment supply due to impacts of grazing and other land uses), and influences from bushfires.

DEH is concerned that impacts on the wetlands at the mouth of the McArthur River may result from increased sediment load carried in the wet season. DEH has suggested that monitoring of sediment deposition in the wetlands over time would assist in determining the significance of any impacts.

The assessment undertaken for the draft EIS determined that sedimentation impact at significant distances downstream of the mine would be unlikely, and would be limited to a 2 to 3 km reach between the mine and the Bukalara Range. The potential for sedimentation impact downstream to Bukalara Range will be monitored and an additional water quality monitoring station will be established downstream of the Bukalara Range to confirm no net impact from the project. The risk of sedimentation of wetlands at the mouth of the river which is 120 km downstream of the mine would be far greater from other land uses in the catchment (e.g. grazing and land management practices). Given the large sediment loads that wash down the McArthur River each wet season, it would not be possible to determine the level of sedimentation caused by the mine compared to that caused by all other sources by having a monitoring station at the river mouth. The preferred location is immediately upstream and downstream of the mine where the mine's influence will be more easily discernable.

D Farlam considers that realigning the river will increase sediment load in the river which will deposit downstream below the Burketown Crossing and King Ash Bay.

See response to DEH above.

D Farlam has stated that there will be increased erosion from a 2 year flood event and that there will be ongoing erosion each year there is a higher flood flow.

See response to DEH above.

D Farlam has expressed concern that the new river channel will be rehabilitated with local native plants which will take a minimum of five years to grow before they can stabilise the soil and reduce erosion during a flood event.

Stabilisation of the bank of the realigned river channel will be undertaken by a combination of methods. Revegetation will be one means but others will include rock/topsoil capping or other suitable measures such a timber groynes. Much of the realigned river channel will be cut through natural bedrock which will have naturally stable banks.

Numerous examples exist in river rehabilitation and mine rehabilitation case studies showing direct seeding and tube-stock (with appropriate planting procedures, timing, and substrate conditions / growing medium) can reach more than 3 m height within 2 years of planting.

The assessment undertaken for the draft EIS determined that sedimentation impact at significant distances downstream of the mine would be unlikely, and would be limited to a 2 to 3 km reach between the mine and the Bukalara Range.

12.10.3 Impacts on Flood Levels (3, 5, 6, 7, 12)

DNRETA is concerned about the potential for the pollution of water from the OEF from both rainfall and flooding. It requires that the effects of flooding of the OEF be addressed.

Water from the PAF zone of the OEF will not be discharged because it will be captured in the PAF pond and reused in the processing plant. Runoff from the NAF zone is not expected to contain concentrations of heavy metals which would exceed the relevant guideline values, and sediment will be removed in sediment ponds before pond overflow discharge reaches receiving waters. Rainfall runoff will not have any detrimental downstream water quality effects.

Furthermore, the OEF has been designed with due consideration of flooding and detailed flood modelling has been used to ensure that floods will not erode the OEF. Durable NAF rock will be placed in the outer layer of the OEF which will resist the predicted flood flow velocities. PAF materials will be stored above flood levels (1 in 100 year ARI flood) and there will be no potential for pollution from the OEF caused by river flooding.

MAGNT has stated that it appears possible for floodwaters to enter the mine site by the back of the bund based on a 100 year ARI. It has asked what happens during a 500 year ARI. MAGNT considers that the downstream effects of the site being breached could be catastrophic.

The proposed flood protection bund will exclude all floodwaters from the mine workings and facilities (excluding air-strip) up to 500 year ARI events with an appropriate level of freeboard. MAGNT's comment appears to imply concern that floodwaters could enter the mine from the western (upstream) side near the process plant (where there is no bund shown on the draft EIS Figure 12.17). The landform in this area near the process plant (known as Barney Hill) is naturally elevated above 500 year flood levels, and a flood protection bund is not required to provide flood immunity in this section.

AFANT considers that the increase in flood levels above the mine site resulting from the presence of the main bund wall poses a potential risk to permanent upstream waterholes. It has asked for a study to determine if these higher levels will adversely impact riparian and aquatic vegetation and aquatic fauna in pools like Djirrinmini and the Eight Mile.

The draft EIS statements relating to potential increases in peak flood levels, refer specifically to peak flood level which only occur for periods less than 6 hours within the 24 to 72 hour period of the typical flood hydrograph. The potential increase in peak flood levels is minor relative to scale of peak river flooding depths which are in the order of 15 m deep for 5 year ARI event and over 20 m deep for a 100 year ARI event (refer Appendix K of draft EIS).

In terms of hydrological factors (such as soil moisture, wetting of river banks etc) peak flood conditions are not critical to riparian / aquatic vegetation. Bank and channel vegetation would be more reliant on smaller seasonal channel flows that occur for sustained periods in the order of several days and weeks each wet season (only 5 to 20% of peak flood flows). The open cut project will not impact on upstream surface flow hydrology and will not impact on the frequency of river flooding. The potential increase in

peak flood levels would not cause adverse impact on hydrological requirements of riparian and aquatic vegetation.

In terms of physical factors, it is highly unlikely that there would be adverse physical impact to riparian and aquatic vegetation due to inundation within the short duration of peak flood conditions (noting that such inundation also occurs naturally). The open cut project will not impact on the duration of peak flood conditions. In fact, there may be complimentary beneficial impacts associated with minor increases in peak flood levels due to minor reductions in peak flood velocities upstream of the new channel (as shown in plots in Appendix K of the draft EIS). This would slightly reduce the potential for physical impact (damage) to riparian and aquatic vegetation from exposure to the highest flood velocities that occur in peak flood conditions.

ECNT has asked what are the biological impacts of the increase in flood levels eg. for a 5-year ARI flood, water levels upstream of the mine will increase by 2.3 m.

As discussed above, the increased flood levels described in the EIS refer to the flood peaks which only occur for periods less than 6 hours within the 24 to 72 hour period of the typical flood hydrograph. Inundation of vegetation by infrequent flood events (all floods of less than 1 in 5 year ARI remain in the river channel) for periods of a few hours is unlikely to have any deleterious biological impacts.

MARA considers that the EIS does not clearly address that dramatic weather influences are normal in this region including annual heavy rainfall, periodic floods, cyclone induced rainfall together with the relationship of this open cut mine project proposal located in its entirety in a floodplain.

The draft EIS and supporting hydrological studies have utilised widely accepted best available methods to estimate extreme flood flows up to 1 in 500 year ARI events. All rare and extreme rainfall and flooding conditions have been taken into account for the new channels, flood protection bund, water management system risks, and the OEF. The water management modelling has been based on 35 years of flow measurements in the McArthur River and 116 years of climatic data.

12.10.4 Impacts on Fish Passage (5, 6, 7, 13)

MAGNT has noted that the references cited in the EIS (Cotterell 1998 and Harris 1997) and the fisheries guidelines (NSW Fisheries 1999) are mostly about fishways and weirs on the east coast of Australia which is different country to the monsoonal tropical rivers of northern Australia.

In the absence of available guidelines for the Northern Territory, the references cited for fish passage (including fishways and weirs) provide some guidance on important factors in fish passage and are recognised across Australia as best practice. No fish passage guidelines are available for river diversions with specific technical information on hydrology and hydraulics, and the reference from Harris (1997) relating to bypass channel fishways is an appropriate reference to river diversion works. The fish passage reference of Cotterell (1998) covers conditions in monsoonal tropical rivers that occur in far north Queensland and the Gulf of Carpentaria.

The references were used to identify important physical and hydrological factors for consideration of fish passage. As stated in the draft EIS, information on the site-specific requirements of endemic fish in the McArthur River is not available and hence the assessment and design has primarily focussed on replicating the existing river flow conditions. Key biological design requirements for fish passage will be incorporated with the input of an experienced fish biologist.

MAGNT has asked that the channel design includes input of an experienced fish biologist.

An experienced fish biologist will provide input to the channel design and rehabilitation.

MAGNT has stated that fish need low velocity areas (still spots) and that off-stream pools at end of the channel are not the answer. It has asked how fish are going to use the resting pools and how many there will be.

Numerous small resting areas for fish will be available along the channel in the lee areas behind large woody debris, sandbars and boulders. As an additional measure, fish resting pools will be constructed with deeper areas and uneven bed profiles in the channel (to slow flow velocities) and in constructed off-stream pools at the locations where the realigned channel intersects tributary streams (e.g. chainage 2,400, 3,300 and 4,200 m on the McArthur River realignment, and chainage 600 and 1,600 m on the Barney Creek realignment – refer draft EIS Figure 12.12 for chainage locations) not just at the end of the channel. The off-stream pools will not be permanent pools and will only hold water when the river is flowing (fish do not migrate when the river is not flowing). The pools will be used opportunistically by fish when moving up and down the river and may also be used by fish for opportunistic foraging. Habitat and requirements for protection from predators will be determined with input of an experienced fish biologist.

MAGNT state that microhabitats must be considered when constructing the channel.

Microhabitats will be considered and incorporated into design and rehabilitation of the new channel with input from an experienced fish biologist.

MAGNT has stated that the channel should be built in a sinuous manner, with banks indented, some sloping, some steep, and rocks, boulders and plenty of woody debris installed, and that this may reduce the amount of remediation needed.

The amount of remediation will be minimised by installation of logs, large woody debris, boulders, and sandbars before commissioning of the new channel. The alignment of low and seasonal flows will meander around logs, debris, sandbars, vegetation and other features within the main channel. Banks will be constructed with deliberate irregularity, and further unevenness and diversity of bank types/height will continue to develop as the river evolves.

MAGNT has asked if the channel will be inspected for remedial mitigation during the wet season.

Yes, the channel will be inspected to evaluate performance, rehabilitation progress, and need for remedial action during the wet season. Remedial actions will not be undertaken during the wet season if the works or activities pose unacceptable hazard to the downstream or local riverine environment or to human safety.

AFANT has stated that any physical barriers to fish movement in the realigned river and creek channels should be removed as construction is underway and not left to be dealt with as part of "additional remedial construction works." It states that a monitoring process needs to be implemented to detect any such barriers during construction.

A monitoring process will be implemented to identify and remediate potential physical barriers to fish movement during construction. When the new channels are substantially complete, a complete survey will be undertaken to confirm no barriers are present. In relation to the statement in the draft EIS regarding "*remedial construction works to remove barriers*", this would be undertaken before the new channel is commissioned.

ECNT has suggested that research on fish swimming velocities should be undertaken prior to seeking approvals for the construction of the new channel.

Research on fish swimming ability would only be necessary if the proposed channel increased flow velocities beyond those which currently exist at times when fish migrate. As stated in the draft EIS, a key objective of the new channel design is to ensure that such flow velocities do not increase so that fish migration will not be impacted (i.e. no hydraulic impediment to fish movement). Such research is not necessary and better environmental outcomes would be achieved with expenditure on rehabilitation and biological monitoring.

NLC has suggested that a program to monitor passage of fish using a time-space gradient design be implemented. Measurement should be performed prior to construction, at the end of construction (but prior to diversion of the river) and annually thereafter for a minimum of five years.

As stated in the draft EIS, the realigned channel will be surveyed for the presence of potential physical barriers to fish movement once construction is completed. A second survey will be undertaken once flow is passing through the realigned channel to identify any potential hydraulic barriers to fish movement.

An aquatic monitoring program will be implemented on a regular basis for sites upstream and downstream of the mine site. This will include annual monitoring for sawfish and potentially other fish species of significance. The frequency of the monitoring program will be reviewed annually based on the cumulative results from the previous surveys.

12.10.6 Impacts on Water Quality (1, 4, 5, 6, 7, 9, 12, 13)

EPA has asked for a commitment that the mine surface water quality monitoring program includes the isolated upstream and downstream reaches. It has also asked what actions will be taken if these reaches become stagnant.

MRM will include monitoring of the isolated upstream and downstream reaches of the existing river as part of the receiving waters monitoring program. Stagnation is considered unlikely as the isolated reaches will not hold water when the river dries up in the dry season. In the event that stagnation does occur, remedial action could include flushing of the isolated reaches with river water or enhancing aeration to prevent eutrophication.

DHCS has asked that the isolated reaches of the McArthur River upstream and downstream of the mine be sampled for the presence of mosquito larvae during the post wet season.

MRM will include the isolated reaches of the McArthur River upstream and downstream of the mine in the larval mosquito monitoring program. This program will be developed under the guidance of the Medical Entomology Branch.

MAGNT has asked what will happen in the case of the first part of the channel filling with water after the 2006 wet season.

The first part of the channel will be excluded from filling in the 2006 wet season with temporary cofferdams to at least the 5 year ARI flood level. Protection against larger flood events (with lower chance of occurring in a single season period) would not be practical because floods greater than the 5 year ARI would break the banks of the McArthur River and inundate the floodplain. Any water contained within the new channel would drain back into the existing river channel as flood waters recede.

MAGNT has recommended that there be one downstream water quality monitoring site to show that there is no effect.

Two downstream water quality monitoring sites will be established to assess the effect of the project on downstream water quality. One site will be within the potential low sedimentation impact zone between the downstream end of the new channel and the Glyde River junction at Bukalara Range. The second site will be beyond the potential impact zone downstream of the Glyde River.

Monitoring reports will document water quality and flow data with reference to geomorphological interpretation of site and upstream conditions supported with a photographic record of the monitoring sites and hydrology data to evaluate temporal influences.

MAGNT has asked that there be a monitoring site on Barney Creek or the tailings facility.

The following existing water quality monitoring sites, as shown on Figure 12.7 of the EIS will fulfil the monitoring requirements suggested by MAGNT:

- SW1 (Surprise Creek - upstream of the TSF);

- SW2 (Surprise Creek - downstream of the TSF at Carpentaria Highway);
- SW4 (Barney Creek - upstream of the mine at Carpentaria Highway);
- SW3 (Barney Creek - upstream of Surprise Creek and moved to an equivalent new channel); and
- SW5 (Barney Creek - downstream of Surprise Creek and moved to an equivalent new channel site).

AFANT has asked that steps need to be taken to ensure that the likely level of increased sediment downstream will not pose a threat to riverside or aquatic vegetation or to aquatic animals in any downstream pools.

MRM will take steps to ensure that sedimentation does not pose a threat to the downstream environment.

There are no permanent pools downstream of the new channel to the Bukalara Range within the zone of potential sedimentation impact. This is a natural sedimentation zone caused by backwater hydraulic effects of the river constriction through Bukalara Range. Sedimentation in this area caused by the open cut project is considered unlikely because the new channel has been designed to mitigate the potential for erosion that could generate excessive sediment loads. The most likely potential for sedimentation in this area would be as a result of increased sediment supply from the catchment of the river upstream of the mine. As a safeguard, the extent of sedimentation in the reach downstream to Bukalara Range will be monitored. The threat of sediment risk to downstream riparian vegetation, aquatic vegetation, and aquatic fauna will be evaluated with the input of an experienced biologist.

DLGHS is concerned that the bund wall proposed around the open cut mine will contain material with some lead content. Two overburden (containing lead) emplacement facilities are proposed alongside the bund wall. Material from the test pit is to be used on the bund wall. DLGHS is concerned that the bund could leach or erode from the effects of normal river flows and flood conditions during the 25 year life of the mine and beyond.

Geochemical test work on rock types proposed to be used in the flood protection bund has found that some total metal concentrations in the rock are above ANZECC (1992) guidelines but only lead was marginally above recommended Health Based Investigation Level for “parks, recreational open spaces and playing fields” (NEPM, 1999) guidelines in one sample. Despite this, soluble (dissolved) metal concentrations were non-detectable in all water extract samples. In addition, all rock types to be used in the flood protection bund are non-acid forming (NAF) and will generate leachate with slightly alkaline pH and generally low salinity. Therefore, leachate derived from the flood protection bund will not contain lead or any other metals in concentrations deleterious to the environment as these metals are not mobile under neutral conditions.

The flood protection bund will not be exposed to normal river flows. It will only be exposed to river flows in the event of a flood that is large enough to break the river banks and flow onto the floodplain (approximately a 1 in 5 year event). The outer layer of the bund will be a rockfill zone constructed from durable rock of a type and size that ensures that it will be resistant to rainfall erosion and flood velocities.

ECNT is concerned about the elevated levels of metals in material that will be used for the levee construction.

See response above.

MARA has stated that potential impacts include additional heavy metals entering the river system from the TSF which continues to leak to the present day and erosion of overburden material containing potentially acid forming sulfates from rainfall and river flow.

Seepage from the existing TSF has been identified and a remedial program is currently underway. This program includes the installation of a geopolymer barrier wall around the perimeter of Cell 1 fronting Surprise Creek so that seepage to the creek is prevented. The effectiveness of this program will be confirmed by monitoring. Should further seepage be identified, it is proposed to extract the seepage via a network of recovery bores. A network of recovery bores will be installed around the expanded TSF.

The OEF will be designed to ensure that the overburden material will not erode. Pilot rehabilitation trials will be undertaken when the OEF is sufficiently large and an appropriate mix of materials is available to trial the landform concept (particularly slope length, cover type, and durability) to evaluate erosion stability performance. This approach recognises that erosion stability must be based on site-specific factors including climate, materials, hydrology, and vegetation.

MARA considers that higher sediment loads entering the McArthur River are likely, particularly in the first wet season when the McArthur River is realigned which will pose changes to the health and diversity of habitats found along the McArthur River and increase sediment loads flushed out onto coastal areas during floods which could potentially reduce seagrass areas through smothering.

As previously discussed, considerable planning has been and will be conducted into the design of the new McArthur River channel to mitigate higher than normal erosion and sedimentation levels.

As a result, sedimentation impacts will not be significant and are not expected to extend beyond Bukalara Range. There are no permanent downstream pools in the potential zone of sedimentation between the downstream end of the channel and Bukalara Range.

MARA has noted that the first 1,700 m of the realigned river channel will pass through alluvial materials which it considers to be particularly susceptible to erosion.

Most of the alluvial materials are not considered to be particularly susceptible to erosion but there are areas of dispersive clay soils in various horizons within the alluvial sections which are prone to erosion. Because of this, mitigation measures will be introduced to reduce the generation of turbid waters from the exposed dispersive clay soils.

Proposed mitigation measures will include identifying the locations of dispersive soils during construction and assessing the most appropriate localised protection measures to minimise their potential to erode. These are likely to include covering areas of dispersive soils with a protective cover (e.g.

coarse rock capping with topsoil filled into the voids) and may also require a local 'laying back' of the realignment channel batters (i.e. reducing the bank slope from 1V:2H to around 1V:3H as has been proposed for the higher banks levels) or increasing the density of revegetation particularly with respect to ground cover species.

NLC considers that the EIS does not fully consider any potential impact upon the wetland downstream at the mouth of the river.

The wetlands at the mouth of the McArthur River will not be impacted by the project because:

- Monitoring to date has not indicated any mine-related contamination effects at the mouth of the McArthur River.
- The water management system for the open cut project is designed so that there will be no controlled discharge to the environment. If an emergency discharge is required during a flood event the extensive dilution available would ensure that there would be no significant increase in contaminant concentrations from the discharge.
- The potential, but unlikely impacts of possible sedimentation will not extend beyond Bukalara Range, and monitoring will be undertaken to confirm this.

NLC is concerned that the EIS states that overtopping of the TSF is expected at least once over a 20 year period which could have downstream water quality impacts. It notes that while the mitigation strategies in place appear to be sufficient, their success cannot be fully ascertained until such events occur.

No acid will be release from the mine sufficient to cause change to the pH of the McArthur River.

The reference in the draft EIS to overtopping of the TSF at least once over a 20 year period refers to the existing TSF. This overtopping frequency will be significantly reduced with the expanded TSF. The expanded TSF will be upgraded to contain water in all rainfall conditions up to the extreme rainfall experienced of 1 in 500 year probability.

13.1.1 Introduction – Flora (7)

ECNT considers insufficient flora sampling was undertaken in the areas proposed for the open cut, the TSF and the river realignment and that further sampling is required.

Although Figure 13.1 of the EIS shows few sampling sites in these areas, they have in fact been sampled extensively in previous surveys (Hollingsworth Dames & Moore (1992), Duff and Orr (1992)). These areas were again inspected during the flora surveys for this EIS. Figure 13.1 only shows the sites where quantitative sampling was undertaken. Vegetation mapping techniques, based on aerial photo interpretation and ground truthing, have produced a vegetation map that includes both the open cut and the TSF areas at a scale of 1:50,000 (see Figure 13.3).

13.1.4 Aquatic Plants (7, 13)

ECNT has commented that few aquatic plants were observed within the project area during the flora surveys (just 8 species) and it considers it is likely that more comprehensive sampling will turn up more aquatic plants.

If more sampling is undertaken the probability that more species will be identified would reduce. The highly dynamic nature of the McArthur River channel is not conducive to the development of an extensive aquatic plant community. This is reflected in the observations to date which indicate few aquatic plants are present.

13.1.5 Weeds (2, 3)

DPIFM has asked how weeds will be managed within the newly formed diversions of creeks and rivers.

As discussed in Section 13.2.2 of the draft EIS, a weed management program will be implemented along the realigned channels prior to the start of revegetation to prevent weed establishment. In a riverine system, the management of weeds is more difficult as seed is transported downstream in water flows, as is evidenced by *Xanthium strumarium* which forms dense infestations along the McArthur River. For this reason a weed management plan and weed monitoring program will be developed and maintained within the revegetated area.

Regular monitoring of the realigned channel will be undertaken to allow early detection and eradication of weeds before establishment. The area will be fenced from cattle and other large feral animals to further reduce the likelihood of seed transportation in particular *Xanthium strumarium* (a spiny seed that sticks to the fur of animals) and other weedy species into the revegetation area.

The weed management program along the realigned river and creek channels will be incorporated into the site's existing weed management plan. This plan is prepared and implemented with the assistance of the district weeds officer from DPIFM. The plan is used to strategically manage site weeds by setting long-term (three year) and annual strategies. The weed management plan is required to remain dynamic to manage new issues that may arise, whilst maintaining long-term strategies to facilitate programs which need to be undertaken over successive years. The plan is reviewed annually.

DNRETA has noted some additional high priority weeds that need to be listed.

The following weeds will be included in the list of high priority weeds:

- Devils claw (*Martynia annua*) – Class A weed (to be eradicated)
- Chinee apple (*Ziziphus mauritiana*) - Class A weed (to be eradicated)
- Bellyache bush (*Jatropha gossypifolia*) – Class B weed (growth and spread to be controlled)

13.2.1 Clearing Schedule (7)

ECNT has stated that the total area of native vegetation to be cleared is not specified.

The total area of land to be cleared is summarised in the following table.

Vegetation Community	Area to be Cleared (ha)				
	OEF	Barney Ck Realignment	Area Within Flood Bund	McArthur River Realignment	Total
Hill Woodland	-	-	171	-	171
Inland Boodwood	2	24	24	-	50
Coolibah	243	6	112	24	385
Riverine Woodland	-	1	175	12	188
Riparian Corridor	-	-	38	1	39
Total	245	31	520	37	833

ECNT has stated that the loss of approximately 3.6 km of riparian habitat, to be replaced by a manufactured channel, is unacceptable and will constitute a clear breach of NT land clearing regulations such as the NT Planning Scheme – Clearing of Native Vegetation.

Native vegetation clearing controls require consent from DNRETA for the clearing of freehold land, outside of the existing control plan areas, on land 2 ha or greater in area. Under these controls landholders can only clear 1 ha of native vegetation without approval.

MRM will make an application to DNRETA for approval to clear the proposed development areas for the open cut project.

To compensate for the short-term loss of riparian habitat until it becomes established along the realigned river channel, MRM is proposing to implement a biodiversity offsets program as discussed in Section 21 of the draft EIS.

13.2.2 Realignment of McArthur River (3, 5)

DNRETA considers that the proposed revegetation of the realigned channels is focussed only on bank stabilisation rather than restoration of a functional riparian corridor. It considers that the revegetation should be extended by up to 250 m from the centre of the McArthur River channel and 100 m from the edge of Barney Creek.

The proposed revegetation of the realigned channels will have a dual function of both bank stabilisation and riparian corridor. As discussed in Section 13.4.1 of the draft EIS, the break in the riverine corridor is not expected to be major barrier to the dispersal of riverine forest specialist birds which are relatively mobile. Revegetation of the banks of the McArthur River will create a riverine corridor approximately 60-100 m wide. Once the vegetation becomes established it will function adequately as a riverine corridor. Creating a corridor 500 m wide will not be necessary to reinstate the corridor function along the river.

Barney Creek does not have a significant corridor function. Nevertheless the revegetation of its realigned channel will create a corridor approximately 40 m wide to provide a dispersal route for riverine birds.

DNRETA has stated that the revegetation of riparian areas should proceed as soon as practicable following the realignment of the watercourses. It suggests that species should be planted at higher densities than naturally occur and they should be mulched and irrigated until they become established. Local species should be sourced and both seeds and seedlings used.

An outline of the proposed channel revegetation program is given in Section 13.2.2 of the draft EIS and further details are provided in Appendix K which contains a report prepared by Top End Seeds a specialist revegetation and rehabilitation company. This report provides further details on the:

- Criteria for species selection;
- Basis for species mix;
- Estimated duration and time for harvesting and seeding; and
- Methods of seeding and planting.

Once the revegetation program has been implemented, MRM will implement a monitoring program to regularly identify areas where vegetation has not grown or has been washed away. Based on the results of the monitoring program, additional planting or other maintenance activities will be undertaken as necessary.

MAGNT has asked about an apparent discrepancy in the EIS that states about 4 km of riparian vegetation will be destroyed – but elsewhere there is reference to nearly 6 km of river to be 'moved'.

The new McArthur River channel will be 5.5 km in length. Only 4 km of riparian vegetation will be destroyed. The shorter distance is because riparian vegetation on the banks of the isolated sections of the McArthur River channel (upstream and downstream of the flood protection bund) will be retained.

MAGNT has stated that direct planting of trees is essential, not waiting for years for seeds to grow.

Direct planting of larger potted trees is unlikely to provide a better rehabilitation outcome than direct seeding and tube-stock for several reasons. A much greater number of trees can be established by direct seeding for the equivalent cost of planting one tree, and direct seeding will provide a much greater chance of success with the ability to plant much greater numbers of trees.

Larger potted trees do not grow quickly after planting because their root systems have been constrained in the pot/container since propagation. Conversely, direct seeding and tubestock can grow very rapidly after planting because their roots are not constrained. Numerous examples exist in river rehabilitation and mine rehabilitation case studies showing direct seeding and tube-stock (with appropriate planting procedures, timing, and substrate conditions / growing medium) can reach more than 3 m height within 2 years of planting, and more than 5 m height in 5 years.

Larger potted trees are at greater risk of being damaged or washed away in floods in the period after planting. If large trees are planted, the force from the size of the canopy/foliage cover exposed to river flow is greater than the ability of the smaller root structure to resist being ripped out of the substrate. Furthermore, in newly constructed channels some minor movement and settlement of the substrate inevitably occurs when the ground is initially saturated or inundated in the first few floods. Such movement of the substrate can damage the establishing root structure of recently planted large trees. Conversely, direct seeding is more adaptable and resilient to movement or consolidation of the substrate. For example, seeds in the loose topsoils placed in the void of rock capping will freely move with the topsoil as the soil consolidates. If intense rainfall occurs, some seeds may be mobilised and trapped elsewhere with sediment where they can propagate.

From extensive experience in the mining industry, the best practice rehabilitation method is by direct seeding, particularly in harsh environments where planting trees have been shown to have limited success particularly in terms of vegetation density.

MRM will monitor revegetation and implement remedial actions as required until revegetation reaches full canopy height.

13.2.3 Realignment of Barney Creek (5)

MAGNT has asked if there will there be an increase in sedimentation in the Barney Creek channel and for comment on any remediation or concern for the aquatic fauna of this watercourse.

There will not be an increase in sedimentation patterns in Barney Creek channel. The new channel will naturally accumulate some sediment from upstream supply similar to the existing channel. Barney Creek currently has stony or muddy substrate with sparse fringing vegetation and completely dries up in the dry season. These habitat conditions for aquatic fauna will also exist in the realigned Barney Creek channel and no significant effects on aquatic fauna are expected.

MAGNT notes that while there was no survey of terrestrial invertebrates there are a number of poorly known butterfly species.

Except for biting insects (see Section 13.6 of the draft EIS) terrestrial invertebrate diversity in the area is little known, and obtaining detailed data was beyond the scope of this EIS. However, as described in 13.3.5 of the draft EIS, no significant species (eg. those listed under the *Parks and Wildlife Conservation Act 2000*) are known from the McArthur River area.

13.2.4 Drawdown from Water Extraction (7)

ECNT has asked for additional information about the statement in the Draft EIS that lowering of groundwater levels will not have a significant environmental impact as most flora in the area are likely to rely on soil moisture (rather than the water table) for survival apart from the observation that groundwater levels are already 10-15 m below ground surface over most of the area.

The observation that groundwater levels are 10-15 m below ground level would indicate that vegetation in the area is not reliant on groundwater as a source of nourishment. Most species do not have roots that penetrate to that depth and would not be able to exploit that resource. Therefore, it is considered to be a reasonable assertion that the vegetation is primarily reliant on soil moisture as a water source.

13.2.5 Tailings Storage Facility (13)

NLC notes that the EIS says "the open cut project will not require any expansion of the tailings storage facility (TSF) beyond the footprint area that is currently occupied for underground operations". However Figures 4.1 and 4.2 show an expanded TSF occupying a footprint larger than exists for the existing TSF. It has asked for a definition of what comprises the TSF footprint.

The figure (Figure 7.7) which shows the footprint of the current TSF was inadvertently omitted from the printed version of the EIS. Figure 7.7 is included in this EIS Supplement (Section 7.3.2). The footprint as shown in Figure 7.7 will be the same as the footprint for the expanded TSF.

13.2.7 Effects on Significant Species (7, 13)

ECNT has asked for evidence to demonstrate that the perennial species of Mitchell grass found at a single site on the black soil plain on the eastern side of the McArthur River is not confined to the local region or that the population will not be severely impacted by this project.

Mitchell grass is not a high priority conservation species, as it is classified in the lowest category of "data deficient". It is thought to be a favoured pasture grass, which may have affected its apparent rarity.

ECNT considers that as the Draft EIS says that some species of high conservation significance may remain undetected by flora surveys within the project area that there is a need for additional flora surveys.

Further field surveys will always add to knowledge of biodiversity. However, the current and previous surveys the have been undertaken in the area of the McArthur River mine are sufficient to characterise the flora and fauna of the area and sufficient to facilitate project planning.

NLC considers that a statement made in section 13.2.7 of the draft EIS is inconsistent with data presented in Table 13.4. The report states that "no endangered, vulnerable or near threatened plant species have been recorded from sites affected by the proposed open cut mine". However, Table 13.4 of the EIS lists* ophioglossum gramineum *as a near threatened species.

Ophioglossum gramineum was recorded from a site on the sandstone plateau (Bukalara Range) which is remote from the proposed open cut mine. Habitats where this species occurs will not be disturbed by the proposed project.

13.3.1 Introduction – Fauna (7)

ECNT has stated that there were only four new fauna sampling sites in the project area in 2002/03 and that this is not sufficient.

As discussed in the draft EIS, there have been five separate fauna surveys undertaken at the McArthur River mine site. These were undertaken in 1976, 1992 (two separate surveys in the wet and dry seasons), 2002 and 2003. This is a significant survey effort for one site. Given the extensive survey work that had been undertaken previously, the four new survey sites are considered to be sufficient to characterise the fauna of the areas likely to be affected by the project.

13.3.3 Terrestrial Fauna Species (5)

MAGNT noted a minor discrepancy in the EIS where, under 'trapping results', it is stated that "five species of a small skink were trapped in the program". It is presumed this means "five specimens of a small skink" or "five species of small skink", however appendix I.2 indicates that only three specimens were trapped and these represented three different species.

The sentence should read "Three species of small skink were trapped in the program".

13.3.5 Significant Fauna Species (7, 13)

ECNT notes that the EIS does not mention that the Purple-crowned Fairy-wren was found at sites F4 and F5 in the area of the proposed open cut. Also the EIS notes an example along the Glyde River of where the Fairy wren was not dependent on a continuous riverine habitat corridor for dispersal. ECNT has cited references that show that it is generally confined to riparian vegetation and hence it considers that the loss of the riparian corridor along the McArthur River will almost certainly lead to increased population fragmentation of the Purple-crowned Fairy-wren and the White-browed robin.

Neither the purple-crowned fairy wren (eastern race) or white-browed robin are classified by IUCN (International) or the EPBC Act (Commonwealth) in any threatened category. They are classified under the *Territory Parks and Wildlife Conservation Act 2000* as "near threatened", which is the lowest threat category. Therefore, these two species are not regarded as being of high conservation importance.

Observations on these species (reported in the EIS) at isolated habitat patches in the upper Glyde River are genuine, and are not presented in order to discredit any research studies. However it does indicate that these species can adapt to varying conditions if necessary. Nevertheless, it is recognised that these species are dependent on riverine vegetation and it is for this reason that it is proposed to monitor their populations along the affected portion of the McArthur River as discussed in Section 13.4.6 of the draft EIS.

ECNT have raised concerns about the following threatened or significant species:

- ***Red Goshawk***
- ***Australian Bustard***
- ***Northern Quoll***
- ***Carpentarian Grasswren***
- ***Worrell's turtle***
- ***Gouldian finch***
- ***Carpentarian Rock-rat***
- ***Freshwater sawfish***
- ***Nine migratory bird species listed under the EPBC Act***

ECNT's concern about all of the significant species listed in the draft EIS is noted. Information about these species, including their known distribution in the McArthur River region is provided in Section 13.3.5 of the EIS. The EIS has concluded that none of these species will be significantly affected by the open cut project. None of the ECNT comments offer any new information, such as additional threat mechanisms that have not already been considered, that would change this assessment.

ECNT comments that the draft EIS states that the distribution and ecology of threatened terrestrial invertebrates is poorly known, but these species are not likely to occur in the project area. It notes that no surveys have been conducted.

Except for biting insects (see Section 13.6 of the draft EIS) terrestrial invertebrate diversity in the area is little known, and obtaining detailed data was beyond the scope of this EIS. However, as described in 13.3.5 of the draft EIS, no significant species (eg. those listed under the *Parks and Wildlife Conservation Act 2000*) are known from the McArthur River area.

NLC notes that the draft EIS makes no reference to impacts on several listed species of conservation significance, particularly the migratory species Great knot (*Calidris tenuirostis*), Red knot (*Calidris canutus*), Red-necked stint (*Calidris ruficollis*), Sharp-tailed sandpiper (*Calidris acuminata*) and black-tailed godwit (*Limosa limosa*) as mentioned in the EIS Guidelines.

These species are migratory shorebirds which have never been observed in the vicinity of McArthur River Mine over the course of numerous surveys (see draft EIS Appendix 1.4). There is no suitable habitat in the mine area for these species and they are not expected to regularly occur there. It is possible that individuals or small groups of some species may visit the site occasionally. Development of the project will have no local effects on these species.

These species are known to occur in the wider region. Areas used by large numbers of shorebirds are the mudflats at South West and Centre Islands, and (on the mainland) the McArthur Delta, Sharker Point, and

coastal flats east of McArthur River, North, Centre and West Islands. The coastal flats to the east of the McArthur River delta may be particularly important for some of these species (Jaensch 1993). The lower McArthur tidal wetlands area has already been recognised by Xstrata as being of conservation importance, and the portion contained within McArthur River Station has been presented as a possible biodiversity offset in the draft EIS.

The area of importance for these species is very remote from the mine operations, and no threatening mechanisms have been identified which might impact on their status.

13.4.3 TSF – Fauna Impacts and Management (2, 12)

DPIFM has asked what is the potential for cattle having access to areas affected by tailings dam seepage.

The tailings dam is fenced and MRM has a management program to inspect the integrity of the fence on a regular basis.

MARA stated that referring to the TSF as providing a 'habitat' for 'many species of waterbirds, including listed migratory species' demonstrates MRM's grasping at environmental credibility to the extreme. Because of this AMRA considers that all of MRM's environmental standards become questionable. They also suggest that any wildlife be actively discouraged from any association with the TSF.

Observations over many years indicate that a number of bird species visit open water bodies in the area, including those at the TSF and to this extent it can be considered as a "habitat". On this basis it is expected that birds may utilise the expanded TSF as similar conditions will exist. Birds will only forage where there is an available food source, such as fishes and aquatic invertebrates, or aquatic vegetation. The TSF will not contain any food sources of significance and hence the visits by birds are generally brief as more attractive habitats are available in the region.

The TSF does not pose any threat to the visiting birds. MRM's bird monitoring program has not recorded any bird deaths or any other deleterious effects on birds using the site.

13.4.4 Effects on Significant Species (12)

MARA has expressed concerns that the assessment of significant species is restricted to areas occurring on the mine site with no consideration of downstream areas.

The environmental assessment effort has been concentrated in the areas immediately upstream and downstream of the mine site as these are the areas with potential to be affected by mining operations. Nevertheless monitoring has also been undertaken (2003) at the mouth of the McArthur River of metal levels in sediments, seagrass and oysters.

13.5.2 Aquatic Surveys (5)

MAGNT has asked why there were no aquatic sampling sites downstream of the junction with the Glyde River to get a broad knowledge of the fauna that may inhabit the river.

Data collected from field surveys and previous reports have characterised the diversity of aquatic fauna in the middle and upper sections of the McArthur River. The section of river immediately below the Glyde River junction has only seasonal flow, and no permanent waterholes are known. However, as described in Section 13.5.7 of the draft EIS, an aquatic monitoring program, which will include downstream monitoring sites, will be designed and implemented as part of the open cut project.

MAGNT finds it difficult to agree with the statement that the McArthur River is a "relatively minor" part of the Gulf drainage system. It has a very large and braided estuary, debouching onto the Sir Edward Pellew Islands, and has influence over a complex of interconnected habitats and is considered by MAGNT as a major feature of the Gulf of Carpentaria.

This description is based on the fact that there are a number of river discharging into the Gulf which have significantly larger catchments than the McArthur River. These rivers include the Roper, Leichhardt and the Flinders.

13.5.3 Aquatic Habitats (3, 6)

DNRETA has stated that the impacts of the loss of 4 km of Bull Creek due to the construction of the river realignment need to be assessed.

Bull Creek is a minor ephemeral drainage line which enters McArthur River from the south near Mt. Stubbs. The creek has a catchment size of 74 sq km, and a mean annual stream flow of 3,600 ML/year. In this respect, it is about half the size of Surprise Creek and a tenth the size of Barney Creek (see EIS Table 12.1). This drainage line flows only after rains and offers only temporary habitat for aquatic fauna.

The creek mouth may act as a staging point for aquatic fauna migrating along the McArthur River during and following the wet season. This function will be maintained by the creation of one of the proposed off-river resting pools where the realigned river channel intersects Bull Creek.

AFANT notes that many of the upstream permanent pools are known to hold large numbers of juvenile barramundi and there are also larger fish in many and state that the effect of MRM's operations on these upstream pools must be minimised.

As discussed in the draft EIS, the lowering of the groundwater table at the Djirrinmini Waterhole towards the end of the mine life will reduce the depth and extent of the waterhole towards the end of the dry season. This is a natural phenomenon which occurs now at the end of each dry season and the aquatic fauna and flora will have already adapted to it. However the groundwater drawdown will exacerbate the effect.

It is difficult to provide details of the impacts that will be likely in 25 years time. Consequently, as discussed in Section 13.5.6 of the draft EIS, a comprehensive monitoring program of the waterhole's aquatic biology is proposed to be initiated during the initial years of the open cut project before any drawdown effects occur. As the drawdown effects will occur gradually and only towards the end of the mine life there will be adequate time to identify the extent of any effects that might be occurring to the aquatic biology and to develop mitigation measures. Such measures could include sustaining dry season flows upstream of the waterhole from groundwater resources.

13.5.4 Aquatic Fauna Species (5)

MAGNT has commented that it should be noted that two species of the fish Glossogobius are probably present in the river system.

As noted by MAGNT, these two species are very similar and can be confused. All *Glossogobius* specimens collected during the 2002-03 surveys were keyed to *G. giurus* but it is acknowledged that both species are likely to be present in the system.

MAGNT has stated that poachers and recreational fishers are still a real threat to the freshwater sawfish and that their accidental capture may cause considerable stress or death (there are many unknowns with this species).

This comment is noted. Sawfish do however have a wide distribution within Australia and are not unique to the McArthur River system. There is no risk of sawfish being accidentally captured due to any mining activity.

MAGNT has stated that aquatic invertebrates are largely overlooked despite their ecological importance. The EIS Appendix consists only of a table of species and there is no interpretation or comment.

Macroinvertebrate results are presented as baseline data and are described in Section 13.5.4 of the EIS. Macroinvertebrate communities in ephemeral habitats may be of limited value for monitoring, but monitoring may be feasible in the main McArthur River channel. As noted in Section 13.5.7 of the EIS, options for a macroinvertebrate monitoring program will be evaluated as part of the overall aquatic monitoring program.

13.5.5 Significant Aquatic Fauna (12)

MARA considers that the statement "The only fish of conservation value in the area is the freshwater sawfish" is poorly written. MARA considers that all the fish species in the McArthur River are of conservation value including highly valued recreational and commercial species e.g. barramundi. The aquatic ecology of all downstream areas of this river is relevant to this open cut mine operation – not just the immediate area of operation.

The above sentence, taken from the Executive Summary of the draft EIS actually reads "The only fish of conservation value in the area is the freshwater sawfish (*Pristis microdon*) which is listed as endangered by IUCN and as Vulnerable under the EPBC Act and the Territory Parks and Wildlife Conservation Act 2000". The sentence refers to the fact that no fish species other than the sawfish is listed as threatened under NT or Commonwealth legislation or under the main international threat criteria.

As discussed in 13.5.7 Management and Monitoring below, MRM is committed to undertaking a detailed survey of the freshwater sawfish in the McArthur River upstream and downstream of the mine site. Furthermore, a survey was undertaken in 2003 of the McArthur River estuary in which sediments, seagrass and oysters were analysed for heavy metals. This survey will be repeated annually. Should the survey results indicate metal distributions leading to impacts of concern, relevant management strategies will be considered to reduce potential sources of metal contamination.

13.5.6 Project Effects and Management (5, 6, 7, 12, 13)

The EIS states that initially the changed habitat and flow conditions may deter or limit upstream movements of fish, and that this will change over time. MAGNT has asked what time period is involved. Some fish cannot wait 5-10 years for the channel to stabilise flows and habitats; they don't live that long. MAGNT considers that the channel has the potential to essentially break the river in two and create a barrier to migration.

It is acknowledged in Sections 12.10.4 and 13.5.6 of the draft EIS that realignment of the river may result in some impediments to fish movement in the short term. However, this effect is expected to quickly reduce as the river morphology is subjected to natural wet season flooding, scouring, sediment and debris transport, and as bankside rehabilitation progresses. It is not possible to predict a time frame for this to occur, but if (based on monitoring results) natural fish movements are inhibited in the longer term, then remedial action will be taken. Depending on the nature of the impediment, the remedial action could include removing the impediment or providing additional micro-habitat.

MAGNT has raised a concern that velocities along the entire realigned channel could be constant, at greater than 0.3m/sec, with no relief areas of less speed than this. It suggests that fish need low velocity areas (still spots) and that off-stream pools at end of the channel are not the answer.

To address this issue, off-stream pools will be provided along the realigned channel to act as fish resting areas. In addition to the large pools that will be available at the upstream and downstream ends of the realigned channel three additional resting pools will be created along the realigned channel at the locations where it intersects tributary streams. Additional ecological mitigation strategies will be included around these constructed resting pools such as enhancing substrate/habitat diversity (e.g. placement of snags, creation of deep zones, and silt bars), and ensuring adequate riparian vegetation coverage around the perimeter of the pool. This will assist in recreating the fish flow velocity profile for the existing river which is low velocity zones (less than 0.3 m/s) at regular intervals along the river (typically around 1 to 2 km intervals).

AFANT considers that the emphasis placed on fish welfare during the open cut project is not apparent for the test pit, construction and rehabilitation phases. AFANT's view is that there are significant risks in each of these phases of the mine's life and they require equal management attention.

The Test Pit project does not involve any alteration of or discharge to the McArthur River. Hence there is no need to consider fish welfare issues with the Test Pit project.

AFANT considers that more study of the changed habitat conditions of the realigned channels and upstream pools is necessary to ensure that they do not deter migration of aquatic species.

MRM is committed to a long term aquatic monitoring program at McArthur River aimed at documenting the habitat conditions, biological diversity and movements of aquatic ecosystems upstream and downstream of the mine, within the realigned channel and within the upstream permanent pools. The design, frequency and detail of the program will be agreed following consultation with NT Government specialists.

ECNT and AFANT consider that the lowering of water levels in Djirrinmini Waterhole by 0.5 m after 25 years of mining activity is unacceptable. ECNT considers that inadequate discussion is provided on the likely impacts on aquatic flora and fauna in the waterhole. AFANT considers that groundwater management plans should be adjusted to ensure that the mine does not reduce the level of Djirrinmini or any other permanent waterholes

As discussed in the draft EIS, the lowering of the groundwater table at the Djirrinmini Waterhole towards the end of the mine life will reduce the depth and extent of the waterhole towards the end of the dry season. This is a natural phenomenon which occurs now at the end of each dry season and the aquatic fauna and flora have already adapted to it. However the groundwater drawdown will exacerbate the effect.

It is difficult to provide details of the impacts that will be likely in 25 years time. Consequently, as discussed in Section 13.5.6 of the draft EIS, a comprehensive monitoring program of the waterhole's aquatic biology is proposed for the initial years of the open cut project before any drawdown effects occur. As the drawdown effects will occur gradually and only towards the end of the mine life there will be adequate time to identify the extent of any impacts to the aquatic biology and to develop mitigation measures. Such measures could include sustaining dry season flows upstream of the waterhole from groundwater resources.

ECNT has referred to the statement in the draft EIS that during dry years when river flows cease the predicted vertical leakage through alluvial sections of the new channel will not significantly extend the no-flow period. It has asked what is meant by 'significant'.

Due to the hydraulic connection between the river and the underlying aquifers, there is potential for a reduction in river flows due to groundwater drawdown.

Groundwater drawdown has the potential to reduce the inflow of groundwater into the river in instances where the groundwater table is above the river bed. Based on stream gauging measurements, approximately 375kL/day of groundwater is discharged into the river in the reach upstream of the start of the realigned channel that will be affected by drawdown at Year 25. This flow is the maximum likely reduction in stream flow that can be attributed to drawdown.

Data from the MRM gauging station indicates that since 1970 the river has ceased to flow for up to five months during dry years. Based on these data, groundwater drawdown could extend the 5 months by approximately 15 days at the end of the mine life which is the time during those dry years that the average daily flow is less that 375 kL/day. Prior to Year 25, the number of additional days of no flow would be less than 15.

MARA considers that the EIS contains insufficient data to establish that the 'very large drawdown' of groundwater for the 25 year life of the open cut mine will not affect the diversity of habitats, species and available flow for the downstream areas of the McArthur.

There are no habitat pools in the length of the McArthur River downstream of the mine that could potentially be affected by groundwater drawdown.

Data from the MRM gauging station indicate that since 1970 the river has ceased to flow for up to five months during dry years. Groundwater modelling has shown that at the end of the dry season, groundwater drawdown could extend the no-flow period in the McArthur River by approximately 15 days at the end of the mine life. Prior to Year 25, the number of additional days of no flow in the river would be less than 15. This will not have any significant effect on the diversity of habitats or species downstream of the mine site.

NLC has raised concerns about overfishing of the McArthur River fish stocks by mine employees and recommends that MRM develops a series of control measures. NLC is concerned that where this occurs in remote areas, there is a propensity for highly destructive fishing methods (such as use of explosives, nets or poisons) to be used which could be detrimental to less resilient species of fish and possibly waterfowl.

Experience to date has been that overfishing of the river's fish stocks has not been a problem from mine employees. This is unlikely to be a problem in the future.

Personnel from MRM are advised in their induction that fishing restrictions apply to both Bing Bong and the McArthur River and that they are required to check prior to any fishing activities. No fishing is permitted on the mining leases. In addition employees are not permitted to leave the site unless a release form has been signed by their manager.

In regards to the storage and usage of explosives at the mine site, site regulations prevent any explosive materials leaving the site due to accountabilities that the mine has in regards to the management of these substances.

NLC has stated that drawdown of groundwater in the dry season may affect estuarine areas and river pools, and is thus likely to pose a major threat to survival of sawfish during the dry season.

Drawdown effects from the mine dewatering will have only local impacts within a few kilometres of the mine. Drawdown will have no effects in estuarine areas which are over 100 km downstream.

As discussed in the draft EIS, the lowering of the groundwater table at the Djirrinmini Waterhole towards the end of the mine life will reduce the depth and extent of the waterhole towards the end of the dry season. This is a natural phenomenon which occurs at the end of each dry season and the aquatic fauna and flora have already adapted to it. However the groundwater drawdown will exacerbate the effect.

It is difficult to provide details of the impacts that will be likely in 25 years time. Consequently, as discussed in Section 13.5.6 of the draft EIS, a comprehensive monitoring program of the waterhole's aquatic biology is proposed during the initial years of the open cut project before any drawdown effects occur. As the drawdown effects will occur gradually and only towards the end of the mine life there will be adequate time to identify the extent of any effects on the aquatic biology and to develop mitigation measures. Such measures could include sustaining dry season flows upstream of the waterhole from groundwater resources.

NLC considers that the risk of likely impacts due to groundwater draw-down on water quality and flora and fauna of pools downstream of the operation needs a good deal more consideration.

There are no pools in the McArthur River downstream of the mine site in the area potentially affected by groundwater drawdown.

13.5.7 Monitoring and Management (5, 6, 10, 13, 14)

MAGNT has asked who will undertake that survey for* Pristis microdon *and at what time of year. It notes that accurate data on this species are needed, and any survey work should be carried out by one of several sawfish projects presently being carried out across northern Australia.

See response to DEH comment below.

DEH has raised concerns about the potential impacts on the freshwater sawfish and have asked for further details on the timing, planning and conduct and the subsequent management approach.

As outlined in Section 13.5.7 of the draft EIS, there is currently a lack of data on the distribution, abundance and habits of the freshwater sawfish (*Pristis microdon*) in the McArthur River. MRM has therefore committed to conducting a survey for this species in the river and, based on the results, will provide a detailed management and monitoring plan for this species.

The following methodology for the proposed survey has been developed by Dr. Dean Thorburn, of Murdoch University, Perth. Dr. Thorburn is a leading authority on sawfish, and has recently completed a comprehensive survey of the elasmobranchs of northern Australia, including the McArthur River estuary (Thorburn et al 2004).

Initial Survey

Due to the difficulties in accessing the area during the wet season, an initial survey will be conducted as soon as reasonably practicable in the early dry season and again near the end of the dry season 2006. Each sampling trip will be about three weeks. The sampling team will include a minimum of two specialists (including Dr Thorburn). Sampling will be conducted in accordance with DPIFM licence requirements.

Proposed sampling sites will include the McArthur River main channel, tributary and waterholes in the vicinity of the proposed development, as well as upstream and downstream of the mine site. Sampling sites may include 8 Mile Waterhole, Batten Creek and Emu Creek as well as sites accessible from Balbarrini Station and Top Crossing. Each sampling site will be recorded with GPS and the duration of the netting times recorded.

Despite their large size and apparent robustness, freshwater sawfish are easily injured through inappropriate sampling and handling methods. Sampling equipment will include large meshed sinking monofilament gill nets set perpendicular to the bank. A maximum of three (replicate) nets will be used simultaneously to strengthen the validity and scientific rigor of the program. Sampling for sawfish will be conducted throughout the day and night. Baited set lines may also be utilised at night. Gill nets will be closely monitored, and entangled fish released from the net as soon as reasonably practicable, to minimise the risk of sawfish injury and mortality. Furthermore, gill nets will be regularly checked to minimise bycatch mortality. Sawfish will be measured (total length) and the sex recorded and the data forwarded on to the DPIFM and MAGNT.

While the large mesh size of the gill nets used will preclude the capture of small fish, bycatch of larger species is inevitable. As such, all fish captured will be identified and their length recorded, and the data forwarded on to the DPIFM and MAGNT.

Management Plan

A management plan including the outline of an ongoing monitoring program will be formulated. The plan will include:

- Relevant legislation pertaining to the protection of the freshwater sawfish;
- Ecology and biology of the freshwater sawfish;
- Description of the existing environment;
- Potential impacts from the realignment of the McArthur River, including the effect of upstream migration;
- Actions in the event fish become trapped;
- Management actions to ensure the longevity of the freshwater sawfish population in the McArthur River; and
- Management of habitats and prey species.

Provision will also be made to establish a community awareness and education program for the sawfish monitoring program. This may include signs at popular fishing spots and reading material that can be circulated to communities near the McArthur River. Anecdotal information from local communities is an effective way of collecting sawfish records and identifying possible sampling sites.

Ongoing Monitoring

The transitory nature of the freshwater sawfish and dynamic seasonality of northern Australian rivers (especially the dry season contraction) makes ongoing monitoring of naturally low abundant species difficult. Studies of sawfish in the Fitzroy River, Western Australia, have utilised cattle style tags to monitor sawfish movements. While this method relies on the recapture of the animal to deduce migration, this type of project can be run in conjunction with local community groups and recreational fishers who relay capture information (to, for example, DPIFM and MAGNT) by calling a phone number displayed on the tag. Any tagging program will need to be conducted in accordance with DPIFM regulations/laws. Tagging is an effective method in longer term monitoring programs and, as was the case on the Fitzroy River, can attract a great deal of community and government support. The data collected from tagged individuals may also be used to estimate the size of a population in a region, and additionally avoids the overestimation of a population which can occur when the same individuals are captured on numerous occasions.

During the initial survey a number of localities will be selected as annual sampling sites. Annual monitoring will be conducted as soon as these sites are accessible after the wet season, and when much of the river channel remains connected. During this period sawfish will still be able to move throughout much of the catchment. This subsequently provides the best opportunity to capture freshwater sawfish, and compare the utilisation by the species of the original channel as opposed to the diverted channel.

Annual monitoring sites will be chosen from above and below the mine area, throughout the original channel (prior to realignment) and in the realigned channel (after the first wet season it is in use). A single annual field trip in the early dry season may be sufficient to deduce if the realignment of the river has affected migration habits of the freshwater sawfish, especially if a tagging program is initiated.

NLC considers that the potential impacts on the sawfish were not fully considered in the draft EIS. They consider that the conservation status of the sawfish should be a key factor in driving the design, mitigation strategies and acceptability of the mining operation.

The conservation status of the sawfish has been described in Section 13.5.5 of the draft EIS. Because of its conservation significance, a species-specific monitoring and management program is proposed as described in the above response to the comment from DEH. A key factor in the design of the major project elements including the river realignment, the OEF, and the TSF has been the protection of downstream water quality and the habitat value of the McArthur River. This has included consideration of the sawfish.

NLC considers that not enough information is provided on the monitoring program for the sawfish and that a well-designed and focussed survey, and an assessment and monitoring program be

developed. It suggests that the program includes monitoring the abundance and distribution of the freshwater sawfish throughout upstream, downstream and estuarine reaches of the river, including the diversion channel.

See response above to comment from DEH.

NLC has asked for a redesign of the program for sampling of aquatic biota to ensure that a balance of sampling from upstream and downstream of the diverted river is achieved.

See response above to comment from DEH.

NLC considers that the requirements for assessment and monitoring of the sawfish should be a key driver for the design of the aquatic fauna monitoring system.

See response above to comment from DEH.

NLC has stated that the characteristics of sawfish life, including the breeding habitat, appear largely unknown and thus passage and habitat requirements around the planned mine are unknown.

See response above to comment from DEH.

NLC has suggested that a program be implemented to monitor the abundance and distribution of the freshwater sawfish throughout upstream, downstream and estuarine reaches of the river, including the diversion channel.

See response above to comment from DEH.

NLC has said that the program for sampling of aquatic biota should ensure that a balance of sampling from upstream and downstream of the diverted river is achieved.

See response above to comment from DEH.

NLC has stated that there is a need to take a precautionary approach to mitigation of any possible impacts on both upstream and downstream water quality in dry season pools, and to monitoring the effectiveness of such design and mitigation arrangements. It says this has not been demonstrated in the draft EIS.

There will be no pools affected by the river realignment and only one pool that could be affected by the groundwater drawdown (Djirrinmini Waterhole).

A precautionary approach is proposed to the mitigation of potential effects on the Djirrinmini Waterhole. It is difficult to provide details of the impacts that will be likely in 25 years time. Consequently, as discussed in Section 13.5.6 of the draft EIS, a comprehensive monitoring program of the waterhole's aquatic biology is proposed during the initial years of the open cut project before any drawdown effects

occur. As the drawdown effects will occur gradually and only towards the end of the mine life there will be adequate time to identify the extent of any impacts on the aquatic biology and to develop mitigation measures. Such measures could include sustaining dry season flows upstream of the waterhole from groundwater resources.

NLC has suggested that a monitoring program for sentinel accumulators in the river should be established to assess the availability and potential impacts of metals in the river and estuary that may have been derived from the operation.

MRM has already implemented a monitoring program for the impact of metals in the estuary. The Charles Darwin University was commissioned by MRM in 2003 to determine the heavy metal status of marine sediment at the mouth of the McArthur River. The report summarising this study found that:

- At McArthur River mouth, metal levels in sediments were similar to other river estuaries in the south eastern Gulf. Lead isotope data indicate that MRM ore-derived lead does not contribute to the lead inventory of these sediments.
- Lead isotope ratios in sea grass at McArthur River mouth indicate that MRM ore-derived lead makes little or no contribution to lead levels in sea grass.
- Metal concentrations in oysters at McArthur River mouth are all well below food standards (AFS A12). Lead concentrations in oysters were too low to determine lead isotope ratios.

NLC has suggested that baseline metals in aquatic foods from the river and estuary should be established with respect to established standards for human consumption. The program should include a representative selection of high-risk species to produce a profile of metal exposure to human consumers, and provide assurance that recreational and subsistence harvested foods are maintained within safe health limits.

See response above.

NLC has suggested that a survey of metals contamination near the Bing Bong facility should be developed, followed by a series of seasonal surveys to ensure that metal levels are maintained within key biological indicators and sediments at environmentally acceptable levels. It also suggests that a similar programme for metals contamination near Port McArthur and the wetlands should be developed.

At Bing Bong MRM conducts monthly seawater and marine sediment sampling in the swing basin, the navigation channel and at a control site three kilometres offshore. In addition, an annual monitoring program is undertaken by scientists from Charles Darwin University. This program monitors metal concentrations in:

- Sea water
- Marine sediment

- Oysters
- *Telescopium* & *Terebralia* molluscs
- Sea grass

The 2003 CDU survey of the heavy metal status of marine sediment at the mouth of the McArthur River and at Bing Bong found that:

- At McArthur River mouth, metal levels in sediments were similar to other river estuaries in the south eastern Gulf. Lead isotope data indicate that MRM ore-derived lead does not contribute to the lead inventory of these sediments.
- There were no indications in the Bing Bong offshore trans-shipment area sediments of concentrate spillage onto the sea floor. Lead isotope data for sea floor sediments indicate the MRM ore-derived lead has not contributed to lead levels in the sediment.
- Lead isotope ratios in sea grass at McArthur River mouth indicate that MRM ore-derived lead makes little or no contribution to lead levels in sea grass.
- Metal concentrations in oysters at McArthur River mouth are all well below food standards (AFS A12). Lead concentrations in oysters were too low to determine lead isotope ratios.

In addition MRM has committed to further analysis of sediments in the McArthur River from Borroloola to the river mouth on an annual basis. Sampling points utilised in the 2003 study would again be used in addition to a transect across the delta of the mouth of the McArthur River which would extend in three parallel lines out to Port McArthur. If the sampling within the river and the additional transects shows no impact over two years after the open cut operations begin, the transect sampling will cease and will focus on the river.

AFANT considers that a precautionary approach should be taken whenever an action occurs in the mining operation that could possibly impact on the recreational fishery and that MRM should be prepared to adapt or modify mine design and/or operations to keep pace with any advances in scientific knowledge and to respond to any indicators that suggest fish are being put at risk.

As stated in the draft EIS, an adaptive management approach will be implemented to ensure that there will be no adverse impacts on receiving waters. The site water balance modelling will be reassessed on a regular basis as events change or monitoring data become available. On the basis of the modelling results, design or operational aspects will be modified or upgraded as necessary to minimise the risk of downstream contamination or detrimental impacts to fish.

D Farlam has stated that MRM does not currently monitor for heavy metals in crustaceans or molluscs. He has expressed concern at this as they are indicators of change and are used by Aboriginal people and fishermen.

A survey was undertaken in 2003 of the McArthur River estuary in which sediments, seagrass and oysters were analysed for heavy metals. This survey will be repeated annually. Should the survey results

indicate metal distributions leading to impacts of concern, relevant management strategies will be considered to reduce potential sources of metal contamination.

13.6.2 Mosquito Species (4)

DHCS has noted that there have been some taxonomic changes to mosquito species names and genus. Aedes normanensis and Ae. vigilax are now Ochlerotatus normanensis and Oc. vigilax. Anopheles annulipes and An. farauti are now referred to as An. annulipes s.l. and An. farauti s.l.

These changes are noted.

The mosquito referred to as 'Cx. sittens' in this paragraph has been misspelt, is should be spelt 'Cx. sitiens'.

This correction is noted.

13.6.5 Project Effects and Management Strategies (4)

DHCS has requested that the mosquito management practices for the TSF should also be applied to all other water storage facilities at the McArthur River Mine.

The management practices described for the TSF are generic strategies that will be applied where practical at all new water storage facilities at the site.

DHCS has requested that during construction all drainage channels/spoon drains should have erosion prevention structures at all erosion vulnerable points in the drain, such as bends in drains and drain end points.

MRM will ensure that construction drainage channels/spoon drains will have erosion prevention structures at all erosion vulnerable points.

DHCS has requested that if rock bars are placed in channels to trap sediment they should be made free draining. i.e. do not lead to the upstream impoundment of water in the drain for periods that will enable mosquito breeding.

Any rock bars installed will be made free draining.

DHCS has asked that potential mosquito breeding sites created at Bing Bong Port, as highlighted in the report by Montgomery (1995), that have not been rectified, be rectified to prevent possible mosquito breeding.

MRM will rectify ant potential mosquito breeding sites at Bing Bong that have not already been addressed.

13.7 Marine Biology (13)

NLC states that the draft EIS does not provide sufficient information about the McArthur River wetlands and Bing Bong as required by the EIS Guidelines.

Bing Bong

At Bing Bong, MRM conducts monthly seawater and marine sediment sampling in the swing basin, the navigation channel, and at a control site three kilometres off shore.

An annual monitoring program is undertaken by scientists from the Environmental Analytical Chemistry Unit of Charles Darwin University (CDU). Measurements of lead isotope ratios can provide a signature for the origin of lead found in the environment. The CDU scientists are able to determine whether any lead present is derived from McArthur River Mine.

The following conclusions were made by CDU in its 2004 report:

- Sea water: Metal concentrations at all sites were significantly lower than the water quality guidelines (ANZECC 2000).
- Marine Sediment: Lead isotope ratios in the area immediately west of the loading facility indicate the uptake of some ore-derived lead. No substantial changes in metal concentrations have been observed at the off-shore sites from 1998-2004.
- Oysters: There has been no substantial change in the trends of metal concentrations in oyster tissue in the Bing Bong area from 1998-2004.
- *Telescopium & Terebralia* molluscs: Lead isotope ratios in *telescopium* and *terebralia* from the western beach area indicate the uptake of ore-derived lead dispersed from the load-out facility.
- Sea grass: Three cyclones which occurred near Bing Bong in 2001 resulted in substantial destruction of local sea grass beds and a reduction in fine grained sediment in near shore areas. Lead isotope data indicate that ore-derived lead from the load-out facility is being taken up by sea grass in the vicinity of Bing Bong.

A survey of sea grass in the Bing Bong area was undertaken by WMB Oceanics in December 2004. The following conclusions were drawn from their monitoring program:

- There was evidence of continued sea grass recruitment and recovery at Bing Bong following the major storms and cyclones in 2000 and 2001.
- Seven previously bare sites were identified as having sea grass in December 2004.
- There was recolonisation of sub-tidal areas by the formerly widespread sea grass species *Syringodium isoetifolium*, which was absent from the study area in August 2003.
- Only one site, situated within the inter-tidal dredged material placement area, appears to have lost sea grass which was present in August 2003.

McArthur River Estuary

The Charles Darwin University was commissioned by MRM in 2003 to determine the heavy metal status of marine sediment at the mouth of the McArthur River. The report summarising this study found that:

- At McArthur River mouth, metal levels in sediments were found to be similar to other river estuaries in the south eastern Gulf. Lead isotope data indicate that MRM ore-derived lead does not contribute to the lead inventory of these sediments.
- Lead isotope ratios in sea grass at McArthur River mouth indicate that MRM ore-derived lead makes little or no contribution to lead levels in sea grass.
- Metal concentrations in oysters at McArthur River mouth are all well below food standards (AFS A12). Lead concentrations in oysters were too low to determine lead isotope ratios.

13.7.1 McArthur River Estuary (7, 12)

ECNT comments that while the draft EIS recognises that the Port McArthur tidal wetlands system is ecologically significant there is no discussion of the cultural, spiritual or traditional use significance of these areas for Traditional Owners. ECNT says there are major concerns within local communities in this area about impacts on dugong, fish and turtle from lead concentrations in the water of the McArthur River as a result of discharges from the existing mine.

MRM recognises the significance of the Port McArthur tidal wetlands system to the local Aboriginal people. It is for this reason that MRM has now incorporated these people into its consultation program.

Furthermore, in recognition of the significance of the area, MRM has undertaken environmental monitoring of the McArthur Rive estuary. As discussed above, MRM commissioned Charles Darwin University in 2003 to survey the heavy metal status of sediments and biota at the mouth of the McArthur River. MRM has also committed to further sampling and analysis for heavy metals in the McArthur River from Borroloola to the river mouth on an annual basis. Sampling points utilised in the 2003 study would again be used in addition to a transect across the delta of the mouth of the McArthur River. If the sampling within the river and the additional transects show no impact over two years after the open cut operations begin, the transect sampling will cease and will focus on the river.

MARA states that MRM has not undertaken any consultation with saltwater people nor undertaken any comprehensive baseline studies of this valuable region. It is concerned that there are no benchmarks established to monitor trends or impacts.

An outline of the monitoring program at the McArthur River estuary is given above.

13.7.2 Bing Bong (7, 12, 13)

ECNT has indicated that it is their understanding that there has been no Department of Health involvement in the monitoring of cadmium, copper, lead and zinc in seawater, surface sediment, molluscs and seagrass at Bing Bong.

A summary of the annual monitoring program conducted by Charles Darwin University on the sediments and biots at Bing Bong is provided in the MRM's annual monitoring reports which are submitted to DPIFM. If the report from CDU is received after the submission of the annual report it is provided to DPIFM when received.

The Draft EIS states that the concentration of lead and zinc in surface sediments from the beach immediately west of the channel have shown elevated levels since 1996. ECNT notes that a PhD research study into the rate of metal dissolution from the sediments in the swing basin is not yet completed so it is premature for the Draft EIS to base its environmental health assurances on this one study.

Updated information from Charles Darwin University on the Bing Bong monitoring program is provided above. Based on the results of this work, MRM's report *"Bing Bong Annual Monitoring Program: Metals in Seawater, Sediments and Biota"* reports that "The concentrations of Pb and Zn at the western beach increased until Nov 2000 appear now to be declining. A comparison of the average metal concentrations recorded at all load-out beach sites from 1998 – 2002 also show that Zn and Pb levels have decreased slightly in recent years".

Furthermore, two other studies have been completed for the Bing Bong operations. One titled "Uptake and homeostasis of heavy metals by seagrass species in the Gulf of Carpentaria, Australia" was undertaken by Christy Manala Moir 2003. A further study was completed by Grant Batterham in 1999 was titled "Mobilisation of heavy metals from metal sulphide concentrate in the marine environment, McArthur River Region, Australia".

NLC considers that potential contamination of the coast around Bing Bong is very poorly addressed and the standard of data presented is grossly inadequate and very poor in comparison to other sections of the draft EIS.

In should be noted that the open cut project will not result in any change to the existing operations at Bing Bong. The Bing Bong port facility currently operates under an existing environmental management plan and monitoring results are reported annually to the NT Government. The environmental assessment reported in the draft EIS focussed on the areas to be affected by the open cut project.

Additional information on metal concentrations in the marine environment at Bing Bong is given above.

NLC has stated that contamination at the mouth of the McArthur River and along the coast towards Port McArthur to the east has not been considered.

Information on contamination at the mouth of the McArthur River is given above.

NLC considers that the draft EIS insufficient data and evidence to determine the amount of spillage or level of the risk. It considers that the basic information cited from key scientific references is highly

limited, and that the amount of substantiating evidence does not allow informed judgement on level of risk.

A risk assessment of the Bing Bong operation was undertaken as part of the project's original EIS (Hollingsworth Dames & Moore, 1992). This assessment quantified the risk of spills from barge loading, barge transit, and ship loading. As the open cut project will not result in any changes to the Bing Bong operations, its risk profile will not change and there was no need to undertake any further risk assessment.

NLC considers that the extent and effects of coastal contamination will need to be further assessed with detailed scientific studies aimed specifically at detection of metal contamination in coastal sediments and using evidence from sentinel species of fauna. If this survey identifies spatial metal distributions leading to impacts of concern, NLC considers that specific monitoring procedures will be required for implementation in the EMP.

As previously mentioned, a survey was undertaken in 2003 of the McArthur River estuary and Bing Bong in which sediments, seagrass and oysters were analysed for heavy metals. This survey will be repeated annually. Should the survey results indicate metal distributions leading to impacts of concern, relevant management strategies will be considered to reduce potential sources of metal contamination.

NLC considers that failure to provide public access to scientifically credible data relating to marine impacts at Bing Bong, Port McArthur and the wetlands at the McArthur River mouth and failure to provide access to data related to downstream metal contamination and impacts is suggestive of lack of transparency and accountability. It considers that the use of student projects at the Northern Territory University for environmental studies at Bong Bong suggests a lack of genuine commitment to assessment of risks and issues associated with existing and planned operations.

The results of recent monitoring programs at both Bing Bong and the McArthur River estuary have been discussed in this EIS Supplement. Furthermore, MRM commits to ongoing annual monitoring of sediments and biota at both of these locations for heavy metals. The results of these future monitoring programs will be made available to relevant community members.

Monitoring undertaken to date has not been "student projects" but has been undertaken as consulting projects by qualified university staff.

NLC has stated that fish kills during 2003 have been blamed upon release of contaminated water from the minesite. They state that even though there may be no hard evidence to support these anecdotes, they can create a perception amongst the local community that the company is not responsible with respect to environmental management. It considers that the situation becomes all the more confused when critical information is omitted from the EIS, or when releases from the plant occur without any reference to stakeholders.

As acknowledged by NLC there is no evidence to indicate that the 2003 fish kills were caused by mine activities. Nevertheless, as discussed above, the results of future sediment and biota monitoring in the areas downstream of the mine will be made available to relevant community members.

NLC has suggested that a scientifically robust survey for assessment of metals contamination at Bing Bong and the McArthur River estuary should be developed, followed by a series of seasonal surveys to ensure that metal levels are maintained within key biological indicators and sediments at environmentally acceptable levels.

As discussed above, MRM has committed to ongoing annual monitoring of sediments and biota at both of these locations for heavy metals.

MARA has stated that MRM's "Annual Monitoring Report July 2001-June 2002" stated that the high metal concentrations in the swing basin indicate that there has been some contamination of the marine sediments since McArthur River Mining has been operating at the Bing Bong Loading Facility.

This statement in the report further reads "Monitoring also showed a decrease in the concentration of lead and zinc in the Swing Basin in the past 5 years which indicates the improved handling of concentrate at the loading facility".

MARA notes that MRM's report titled "Bing Bong 2002 Annual Monitoring Program: Metals in Seawater, Sediments and Biota" states the following:

- ***Seawater***
  - ***The TSS (total suspended solids) at most sites (except 8 and 109) were elevated relative to previous years.***

    Comment from same report "elevated TSS levels during November 2002 sampling trip were a result of intense wave action with a low tide causing re suspension of bottom sediments. When normalizing the metal concentration to TSS thereby deriving the concentrations of metals in the suspended sediment it is seen that there has been no increase in metal levels during 1998 – 2002".
  - ***The cadmium concentration recorded for site 107 (174 ng/L) is…without any precedent during 1998-2002.***

    The report states "The cadmium concentration recorded for site 107 (174ng/L) is highly anomalous and without any precedent during 1998 -2002. In the absence of an obvious natural or anthropogenic source of Cd in the Bing Bong area, it is possible that an accidental contamination of the sample has occurred.
  - ***The recorded Cu (Copper) concentrations exceed the guideline level' (ANZECC Water Quality Guidelines 2000).***

    The report further states that "The recorded Cu concentrations exceed the guideline level although the levels recorded from the Bing Bong area clearly are natural background levels".
- ***Sediment***

  The Pb (lead) and Zn (zinc) concentrations in the surface sediments from the beach west of the wharf are elevated compared to the concentrations on the beach east of the channel and all other off shore sites.

The report further states that "The concentrations of Pb and Zn at the western beach increased until Nov 2000 appear now to be declining. A comparison of the average metal concentrations recorded at all load-out beach sites from 1998 – 2002 also show that Zn and Pb levels have decreased slightly in recent years".

- ***Oysters***
  - ***Oysters from sites 107 and 109 have, relatively high concentrations of Cu (Copper) compared to sites 104 and 105. This has been observed in all previous samples from site 107 but the 2002 concentrations are the highest recorded for site 109.***

    The report further states "This phenomenon is unexplained as the concentrations of Cu in seawater (TSS normalized) and sediments from sites 107 and 109 are within background ranges for the area".
  - ***Cd (Cadmium) concentration in oysters (2.124 & 2.328 mg/kg) from site 105 was above the maximum permitted concentration (MPC) for molluscs (2.0 mg/kg – ANZFA, 1996), as have been reported in previous years.***

    This could be reflected as the background levels for this site as there has been little change over time at this site since monitoring commenced.

- ***Telescopium telescopium***

  The concentrations of Cu, Zn and Cd in animals west of the load-out facility were some of the highest recorded since 1998

  The report further states "however, all concentrations were lower than the MPCs for molluscs (ANZFA, 1996)".

- ***Terebralia semistriata***

  Zn concentrations in terebralia were significantly higher west of the load-out facility than east of it.

  The report further states "all analysed metal concentrations were lower than the MPCs for molluscs (ANZFA, 1996). Also the report states "The average concentrations of Zn in animals from 'Beach West' were lower than recorded in Nov 2000 and Nov 2001.

- ***Seagrass***

  There was an increase in leaf and root Cd and Pb concentrations in 2001 compared to the previous three years.

  The report further states "This may be related to the impact of the cyclones in early 2001 and the resulting changes to the sediment substrate".

- ***Conclusions***
  - ***Metal concentrations in unfiltered seawater were the highest recorded during 1998-2001***

    The report further states "However, the high levels were related to a substantial increase in total suspended solids resulting from intense wave action during the sampling trip". The report also

states that "metal concentrations at all sites were significantly lower than the recommended maximum total concentrations of metals in marine waters (ANZECC Water Quality Guidelines 2000)".

- ***There were elevated levels of Zn and Pb in the sediments from the beach west of the load-out facility. The concentrations of Cu, Zn and Cd in animals from the western beach were some of the highest recorded since 1998.***

  All concentrations were lower than the MPCs for molluscs (ANZFA, 1996).