sea level rise by 2030 (see above) are at the lower end of the values discussed by Wasson (1992). Therefore, the immediate effects of sea level rise are likely to be small in magnitude.

A fall in sea level is predicted within the next 5 ka as the next glacial starts (Wasson 1992). It will cause incision of the freshwater, transition and estuarine sediments of the lower Magela floodplain and the sand fill of the current anastomosing sand-bed channel on the western side of the valley near ERARM. This will, in turn, rejuvenate the mine site tributaries and erode the backflow billabongs. The tributaries will become fully integrated with the main stream and supply more sediment than is currently the case. Clearly, any mine-site generated sediment would be extensively reworked out of the mine site tributaries as a result of a substantial fall in sea level. Oxidation of the lower Magela estuarine sediments will generate acid and high iron contents by the oxidation of pyrite and organic matter. If tailings were stored with these sediments, heavy metals would also be mobilised.

8 Conclusions

As outlined in section 1, the purpose of this report was threefold:

1. To collate and review all of the existing data relevant to the discharge of solutes and particulate material from the rehabilitated mine site and from nearby tributaries of Magela Creek;
2. To determine the fate of particulates in the off-site system; and
3. To collate and review all of the existing material relevant to an understanding of the long-term behaviour of Magela Creek and its tributaries.

Although natural solute and sediment yields in the Alligator Rivers Region are low by world standards, mine sites can produce significantly higher yields. Disturbed sites generate sediment yields that are an order of magnitude higher than those from natural catchments. Large storms dominate soil erosion and sediment transport in the Alligator Rivers Region. Up to 7 m of erosion and 20.4×10^6 t of sediment will be eroded from the rehabilitated mine site over the 1000 years structural life. Assuming sediment delivery ratios of between 0.24 and 0.50, up to 15.5×10^6 t will be stored on site and up to 10.2×10^6 t will be transported off the mine site (table 5). Vegetation, the installation of convexo-concave slope profiles and the use of surficial gravel lags will all reduce the soil erosion rate on the rehabilitated mine site and should be incorporated in the final rehabilitated mine design.

The mine site tributaries and the backflow billabongs will be the most significant sediment storage sites downstream of the mine site. The backflow billabongs will be completely infilled with mine-derived sediment over the 1000 years structural life of ERARM rehabilitated mine site. Relatively little sediment storage will occur in the anastomosing sand zone of Magela Creek but the lower floodplain will trap and store essentially all of the mine-derived sediment supplied to it, if sufficient sediment is generated from the rehabilitated mine site.

Sea level rise will re-establish tidal connection with the old tidal channels and cause extensive salinisation of the most downstream wetlands on Magela Creek. This will cause the remobilisation of stored sediments but a large proportion should be redeposited elsewhere on the floodplain.

A substantial fall in sea level will result in incision of Magela Creek downstream of ERARM and the remobilisation of massive amounts of stored sediments and the oxidisation of the remaining sediments. Mine site tributaries will be rejuvenated and any mine site generated sediment will be flushed into Magela Creek.

While a disproportionately large effort has been directed at understanding the evolution and behaviour of the sand anastomosing reach and lower floodplain of Magela Creek, these sections will not be the initial repositories for mine-derived sediment. The mine site tributaries are not as well understood but are certainly more important sediment stores and sediment pathways. The reason for this discrepancy in research effort is that the lower Magela wetlands are internationally significant and have, therefore, been perceived as being the most important ecosystem likely to be impacted by mining. Under the most likely post-rehabilitation scenario (scenario 4 in table 5) no mine site generated particulates will reach the lower Magela wetlands.

9 Recommendations

The above review has highlighted the following two areas where additional research is essential to improve the assessment and prediction of the off-site geomorphic impacts of uranium mining on Magela Creek. Each of these additional research projects is briefly outlined below.

9.1 Mine site tributaries

Little is currently known of channel stability, the probability of gullying, and sediment movement and storage, on the mine site tributaries, particularly Gulungul Creek. The work of Nanson et al (1993) and East et al (1993) does not address the issue of their contemporary activity only their Quaternary evolution and geological stability. Cull et al (1992) applied regional relationships to estimate their sediment budget. These tributaries will be the first to receive sediment generated from the rehabilitated mine site and should store large amounts of the supplied sediment for a relatively long period of time. Therefore, they should be investigated to the extent recommended by Pickup et al (1983, 1987). A geomorphic and hydrologic monitoring program should be implemented. Monitoring should include discharge, sediment transport and water quality at gauging stations located upstream *and* downstream of the mine site. In addition, geomorphic characterisation of the channel and floodplain in homogeneous reaches, the installation and periodic resurvey of permanently marked channel and floodplain cross sections, characterisation of channel and floodplain sediments, and the seasonal and inter-annular variation in the geomorphic, hydrologic and limnological behaviour of the backflow billabongs should be assessed. Datalogging of selected water quality parameters (pH, electrical conductivity, dissolved oxygen, redox potential, temperature, turbidity) at least near the surface and near the bottom of Gulungul and Georgetown Billabongs should be carried out over at least daily periods each month to assess whether thermal and oxygen stratification develop and persist. Furthermore, the same datalogging of water quality parameters must be carried out over a longer time period during the first flush of the Wet season to understand the development of acid stratification documented by Hart and McGregor (1980). Historical channel changes based on the complete coverage of vertical air photographs should also be determined to identify sites of stability, erosion and deposition. The probability of gully initiation on unchannelled reaches and the sediment yields produced by such gullying also require quantification.

9.2 Extreme events

It is essential that the probability and magnitude of extreme storms and floods are more accurately defined because of their potential significance for soil erosion, sediment transport, channel changes and avulsions, and landform evolution modeling by SIBERIA. This can be

achieved by extending the only previous palaeoflood analyses on the Katherine Gorge by Baker and Pickup (1987). The Australia Day flood of 1998 on the Katherine River provides a rare opportunity to carry out detailed investigations of contemporary SWDs, to check the accuracy of the discharges reconstructed by the SWD technique and to determine appropriate correction factors. Peter Sandercock may have already undertaken this work as part of his honours thesis at the Department of Geography, University of Western Australia. To date, we have not been able to view a copy of his thesis.

Preliminary aerial reconnaissance of the East Alligator River upstream of the area mapped in detail by Pickup et al (1983, 1987) and investigated by Murray et al (1992) and Wohl (1988, Wohl et al 1994a), for this project revealed better sites and higher level SWDs than those previously investigated (Saynor & Erskine 1998). These sites should be analysed for their SWDs and palaeoflood record. Furthermore, the investigations of Magela Creek recommended by Pickup et al (1983, 1987) have still not been undertaken (E Wohl 1997, pers comm). This work should also be completed, particularly as aerial inspections for this project revealed that the gorge below Magela Falls is an excellent site for the preservation and analysis of SWDs. The role of catastrophic floods in causing the two avulsions on the East Alligator River floodplain at Cahills Crossing needs to be determined to assess the potential for avulsions on Magela Creek next to ERARM. The model of channel avulsions on floodplains in south-eastern Australia proposed by Erskine et al (1990) and Schumm et al (1996) should be evaluated for its relevance to rivers in the seasonally wet tropics. While Nanson et al (1990, 1993) did not record any Holocene avulsions on the anastomosing sand section of Magela Creek next to ERARM, this does not mean that avulsions will not occur as the anastomosing channels continue to aggrade, as predicted by Nanson et al (1993). Late Holocene avulsions of Magela Creek may have occurred immediately downstream of the upper bedrock gorge. It is *recommended* that the following three projects should be undertaken:

1. Assessment of the contemporary SWDs laid down by the January 1998 flood in the Katherine Gorge and their reliability for estimating the peak flood discharge of the formative flood. This work may have already been completed by Peter Sandercock;
2. Detailed analyses of the SWDs and palaeofloods in the true sandstone gorges on the East Alligator River upstream of the area mapped by Pickup et al (1983, 1987) and on Magela Creek between Magela Falls and Bowerbird Waterhole to determine whether any catastrophic floods have occurred in the Alligator Rivers Region during the mid- to late-Holocene; and
3. Determination of the cause of Holocene avulsions on the East Alligator River at Cahills Crossing so as to assess the sensitivity of Magela Creek near ERARM to future avulsions. Magela Creek upstream of ERARM should also be covered by the investigation. In particular, the association between avulsions and the palaeofloods identified immediately upstream in the true East Alligator River gorge needs evaluation.