Appendix E-2
Sea turtles report - Part 2

Report to URS on Tiwi Islands Project for Matilda Minerals

Sea Turtles

Part 2

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5 October 2005

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Acknowledgements

This survey of the sea turtle nests and the vegetation analysis of the buffer zone of the shores of the Andranangoo Creek West and Lethbridge Bay West leases on Melville was facilitated by the staff of URS and in particular Julie Marris and James Collins. Operations Manager for Matilda Minerals, Dennis McCamish, and his staff handled onsite logistics. Ms Kiki Dethmers provided assistance in the field. Charles Darwin University provided leave so that the survey could be completed. I am grateful to all of those who helped.

Summary

Flatback and Olive Ridley sea turtles nest in low to medium densities on the beaches of Andranangoo Creek West and Lethbridge Bay West leases on Melville Island.

Collectively 75 sea turtle nests were examined and all were within 10 metres of the Spring High Water Mark. The proposed 200 metre wide buffer zone will be adequate to provide a physical barrier between the proposed mining operations and the sea turtle nesting beach. Tree density above the high water mark reached 1600 trees per hectare. This vegetation provided a strong visual barrier between the beach and the mine site. The integrity of the 200 metre wide buffer zones with their coastal sand dunes, vines, shrubs and woodlands of Melaleucas, Casuarinas and Acacias will need to be maintained during the mining operation.

During this investigation the Operations Manager for Matildas Minerals was trained in sea turtle identification by the width and symmetry of the tracks of the nesting females. Monitoring of the sea turtle nesting numbers on a weekly basis by Matilda Minerals personnel and monthly reporting of nesting numbers along with reports of any sea turtle incidents to the regulating authorities and traditional owners will ensure that data on the numbers of nesting sea turtles will be collated and any negative impacts that may occur will be addressed promptly.

Introduction

The Notice of Intent (NOI) for the proposed mining operations by Matilda Minerals Ltd. at Andranangoo Creek and Lethbridge Bay on Melville Island was presented to the Office of Environment and Heritage in March 2005. In the NOI was a recommendation that a buffer zone of 200 metres be maintained between the Spring High Water Mark and the proposed mining operations. This buffer zone was to provide protection to the shoreline utilised by nesting sea turtles. Within the draft guidelines for preparation of an Environmental Impact Statement provided by the Office of Environment and Heritage were several comments about sea turtles and the possible impact of the proposed mine on the nesting populations of Flatback (*Natator depressus*) and Olive Ridley (*Lepidochelys olivacea*) Sea Turtles. Under the section on Ecology and Baseline studies was the requirement to :

> 4.4.1.e) “Describe the significance of the beaches in the vicinity of the project areas to breeding sea turtles, shorebirds and seabirds as per methodologies agreed with the Biodiversity Conservation Division of the Department of Natural Resources, Environment and the Arts and the Australian Government Department of Environment and Heritage (DEH).
>
> 1. This assessment should include an estimate of the number of breeding turtles (of each species) using the beach at peak breeding season and throughout the year;
> 2. the distance inland from high water mark moved by nesting turtles; and

3. a description (including height, width and density) of any areas of vegetation that are anticipated to buffer nesting beaches from likely disturbances, especially light."

4.4.3.a) "Discuss ecological constraints to the project and describe preventative, management and monitoring strategies which will address the impacts identified in 4.4.2 above including, but not limited to:

1. how the potential for impacts on sea turtles would be minimised, including the impact of artificial light, noise and human disturbance on their breeding success;"

4.4.3.d) "Describe what monitoring would occur to measure the effectiveness of controls implemented and to enable identification of impacts on wetlands, flora and fauna (particularly nesting marine turtles) during each phase of the project."

This report addresses the issues of: numbers of sea turtles nesting on the respective beaches, the distances travelled inland by each of the sea turtle species, the density height and width of the vegetation forming the buffer zone. Although quantitative tests on noise levels and light pollution were not possible, the effectiveness of the buffer zone is discussed in light of the anatomical and behavioural attributes of nesting Flatback and Olive Ridley sea turtles at similar nesting locations in Northern Australia. Matilda Minerals personnel were trained in the techniques of monitoring the beaches for evidence of sea turtle nesting and systematic recording of such nesting. From this monitoring protocol the effectiveness will be ascertained of the buffer zone in protecting sea turtles, their hatchlings and the nesting beaches from the mining operations at Andranangoo Creek West and Lethbridge Bay West.

Methods

In discussions with personnel from Biodiversity Conservation Division of the Department of Infrastructure Planning and Environment the following methods were formulated:

Sea Turtle Survey

The visit coincided with the neap tides that occur at the first and third quarters of the lunar cycle. During the neap tides the tidal range decreases to a minimum (Figure 1) so that the nesting activity, as indicated by the turtle tracks, for the previous four or five days can be clearly seen on the beach.

1. The species of sea turtle was determined by the maximum width of track and by the morphology of the track as indicated in (Appendix 1) and the size of the eggs or remains of any shells found (Appendix 2).
2. The location of the track with reference to the high water mark was measured and recorded on the sea turtle nest data sheet (Appendix 3).
3. The positions of the nests were recorded with GPS and distances from the seasonal or Spring High Water Mark at the top of the beach were measured and recorded in the sea turtle nest data sheet. (Appendix 3).

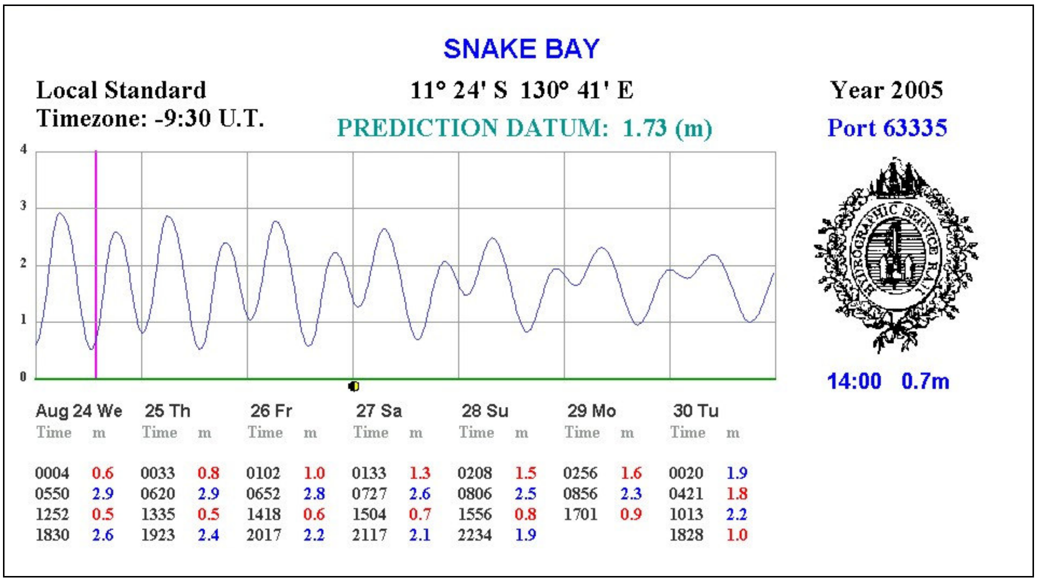


Figure 1. Heights of tides in the days preceding the study at Andranangoo Creek West and Lethbridge Bay West leases on 29 and 30 August 2005.

Vegetation Analysis:

The height, width and density of vegetation were recorded using a plotless sampling technique and analysed using Krebs/win Version 0.94 (Brzustowski 1998) that utilises Krebs's (1989) methods for determining tree density. The point-quarter technique (Krebs 1989, Cox, 1996,) was used as it requires little equipment, is ideal for remote localities with dense vegetation and has been used in assessing mangrove vegetation regeneration (Guinea, 1988).

The procedure involves measuring the distance from a random point to the nearest vegetation in each of four quadrants around the transect line. The sample datasheet that is provided in Appendix 4 has additional columns and includes the girth at breast height (GBH) and the height of the sampled vegetation. The vegetation assessment involved one transect line that was representative of the coastal vegetation in the Andranangoo Creek West lease and another in the Lethbridge Bay West lease. Transect lines ran from the Spring High Water Mark inland for 200 metres. The vegetation of this buffer zone was assessed by systematically sampling twenty random points each one being within a 10 metre segment of the transect line. The nearest tree exceeding chest height in each quadrant, formed by the bisection of the transect line at the random point (Figure 2), was identified and the following measurement recorded: point to plant distance (m), the height (m) the girth (m) and the species if possible.

The total density is given by the following:

$$\text{Total density of all species per hectare} = \frac{10000}{\text{Mean point-to-plant distance}^2}$$

The site at Andranangoo Creek (Figure 3) was visited on Monday 29 August 2005 and the site at Lethbridge Bay was visited on the following day. Access was by four wheel drive vehicle from Snake Bay and by boat from Andranangoo Creek to Lethbridge Bay.

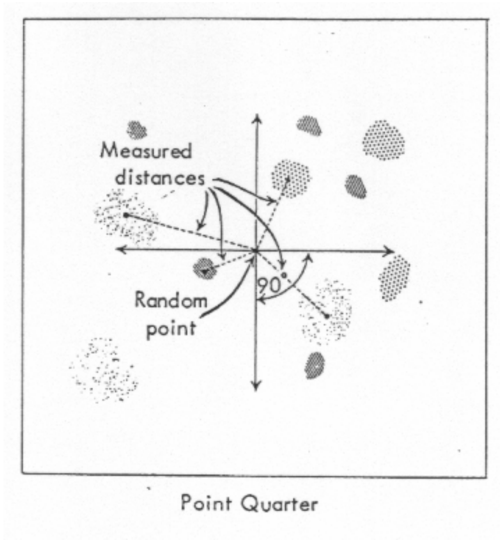


Figure 2 Diagrammatic representation of the point-quarter method of determining tree density (from Cox 1996).

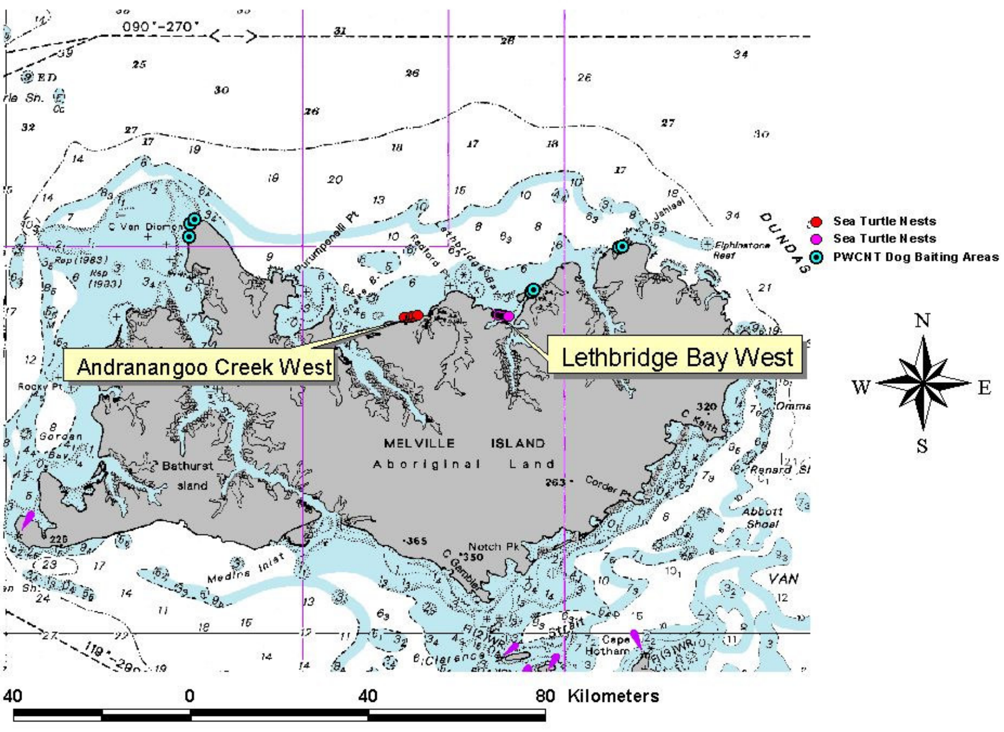


Figure 3. Locality map of the leases at Andranangoo Creek West and Lethbridge Bay West. Also indicated, in green, are the positions of the more significant Olive Ridley sea turtle nesting beaches where dog baiting has been conducted by Parks and Wildlife Commission NT.

Results

Sea Turtle Survey

Andranangoo Creek West

The study at Andranangoo Creek West commenced during the daytime low tide to coincide with maximum beach exposure. The beach had a northern aspect and was exposed to onshore winds. Inland from the high water mark was a small seasonal sand dune or berm. Further inland dunes to 10 metres in height backed the beach. The survey started from the existing track (11°21.752′S 130°49.095′E) and continued to the west to the end of the lease (11°21.817′S 130°48.450′E) and then to the east to the end of the lease (11°21.580′S 130°49.958′E). Seventeen turtle nests were located along the beach (Figure 4). The species of turtle responsible for the nest was identified by a combination of the following factors. The width and symmetry of the turtle track (Appendix 1) and the size of fragments of eggshell (Appendix 2) scattered around the nests were clear indications of the species responsible. Only one nest remained intact, as either dogs or goannas had raided the others. This nest was that of a Flatback sea turtle and, judging by the intact track, had been laid on the night of 27 August 2005.

Nests were located throughout the length of the beach with no obvious demarcation between Flatback and Olive Ridley sea turtle nests. The distances from the Spring High Water Mark also revealed little difference between the species. The ten Flatback sea turtle nests were on average 2.9 metres above the Spring High Water Mark with a standard deviation of 3.9 metres. The seven Olive Ridley sea turtle nests were on average 2.3 metres above the Spring High Water Mark with a standard deviation of 2.5 metres. This pattern of dispersion from the Spring High Water Mark (Figure 5) indicated that nesting Olive Ridley sea turtles on this beach were likely to move inland just as far as were the Flatback sea turtles. Sea turtle nests were seen only within 10 metres of the Spring High Water Mark even though the survey extended beyond the dune crest. A dead and decomposing Hawksbill sea turtle was washed ashore on Andranangoo Creek beach. Details were recorded and are presented in the sea turtle Accident, Injury and Incident Report (Appendix 5).

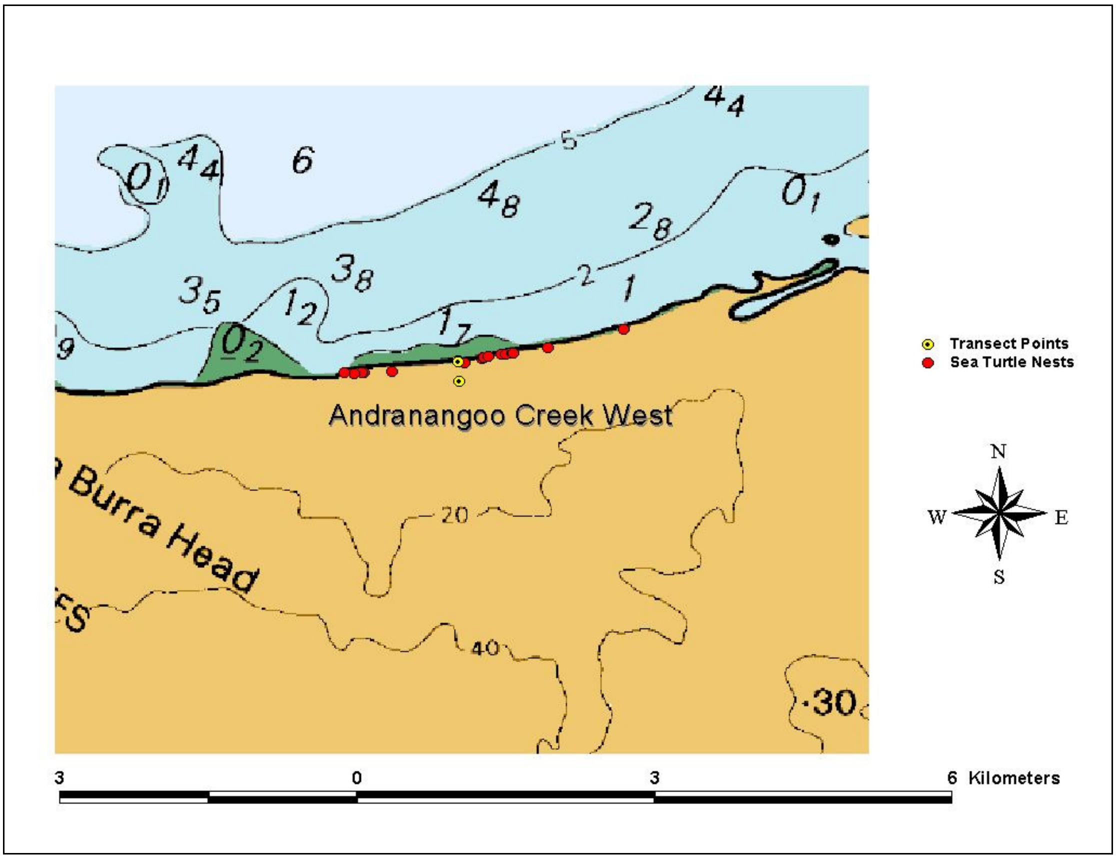


Figure 4 Spatial distribution of sea turtles nests on the beach of the Andranangoo Creek West lease. Indicated are the locations of nests and the start and finish points of the vegetation analysis transect line.

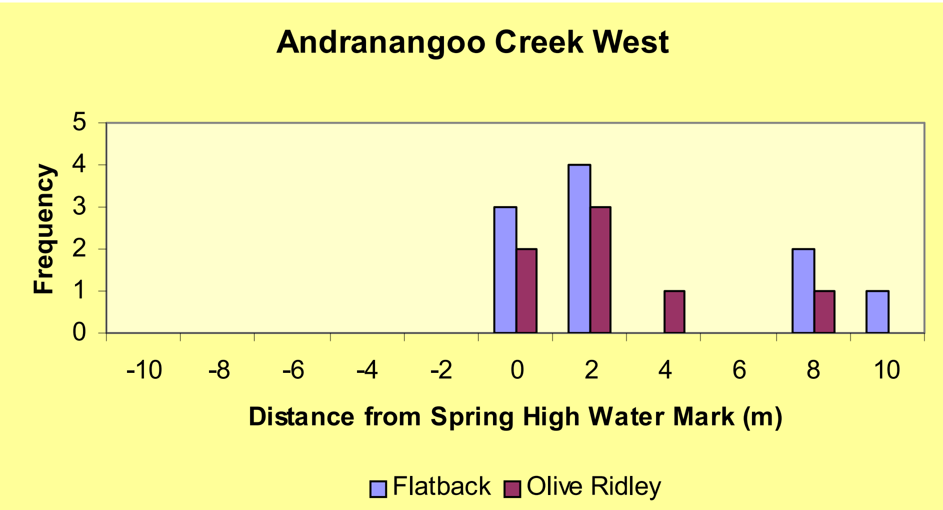


Figure 5. The pattern of Flatback and Olive Ridley sea turtle nests above the Spring High Water Mark at Andranangoo Creek West

Lethbridge Bay West

The survey of the beach at Lethbridge Bay West started at 0900 on the 30 August and was conducted during the period of low tide when a large portion of the beach was exposed. The entire length of the beach was examined for evidence of sea turtle nests. The beach had a north-easterly aspect and lacked the sparsely vegetated seasonal sand dune as was evident on Andranangoo Creek beach. The vegetation grew to the Spring High Water Mark and in some places below it. The survey was conducted from approximately 10 metres above the Spring High Water Mark to the present low tide mark. The survey started at the Western end of the beach near a small creek (11°21.287′S 130°59.458′E) and continued to the mouth of the creek at the eastern end of the lease (11°21.604′S 131°01.015′E).

In the estimated 4 km of beach, 58 sea turtle nests or their remains were located and their positions recorded (Figure 6). Of these only one nest was identified as being that of a Flatback sea turtle. The remainder of the nests had small eggs and belonged either to Olive Ridley or to Hawksbill sea turtles. No turtle tracks were found on this beach and either dogs or goannas had raided all but one of the nests.

The raided nests contained eggshells that in some cases were from eggs that had already hatched. This was evident by the near intact nature of the eggshells similar to those that are left in the nest after the hatchlings have emerged. Some eggs contained the remains of undeveloped yolks. Other nests contained eggshells that were judged to have been from freshly laid eggs.

The nests were located along the beach without any obvious areas of intensive nesting. The single Flatback sea turtle nest was laid at just over 1 metre above the Spring High Water Mark. The other 57 nests belonging to either Olive Ridley or Hawksbill sea turtles or a mixture of both were on average laid 0.14 metres above the Spring High Water Mark with a standard deviation of 2.4 metres. The thick vegetation along the strand at Lethbridge Bay West either prevented sea turtles from moving inland or was sufficiently darkened at night to promote nesting within ten metres of the Spring High Water Mark.

Of the 58 sea turtle nests located on this beach, 85 percent were laid within 2 metres of the Spring High Water Mark (

Figure 7). The furthest a nest was found above the Spring High Tide Mark was 5 metres. It was laid beneath a closed canopy of Casuarina trees. Four nests were below the high tide mark. These had been opened by dogs or goannas and had been washed over by the last Spring High Tide.

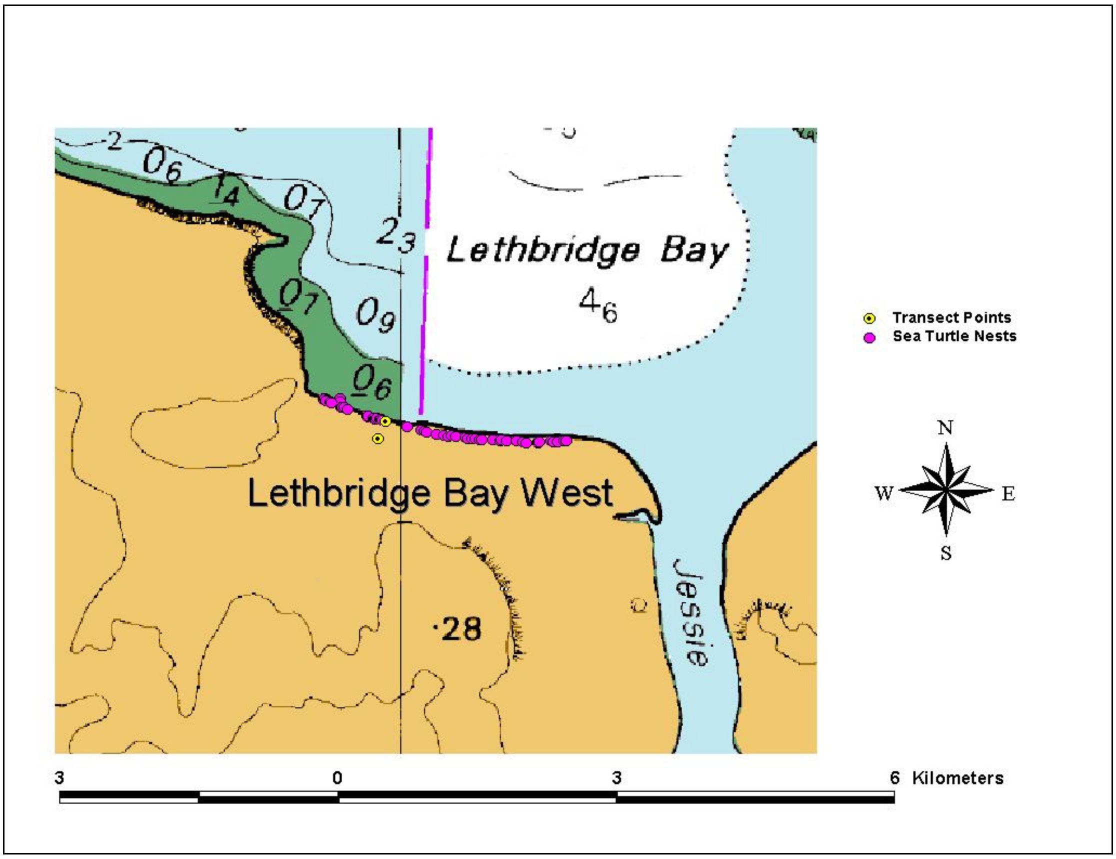


Figure 6 Spatial distribution of the sea turtle nests on the beach of the Lethbridge Bay West lease. Indicated are the positions of the nest and the start and finish points of the vegetation analysis transect line.

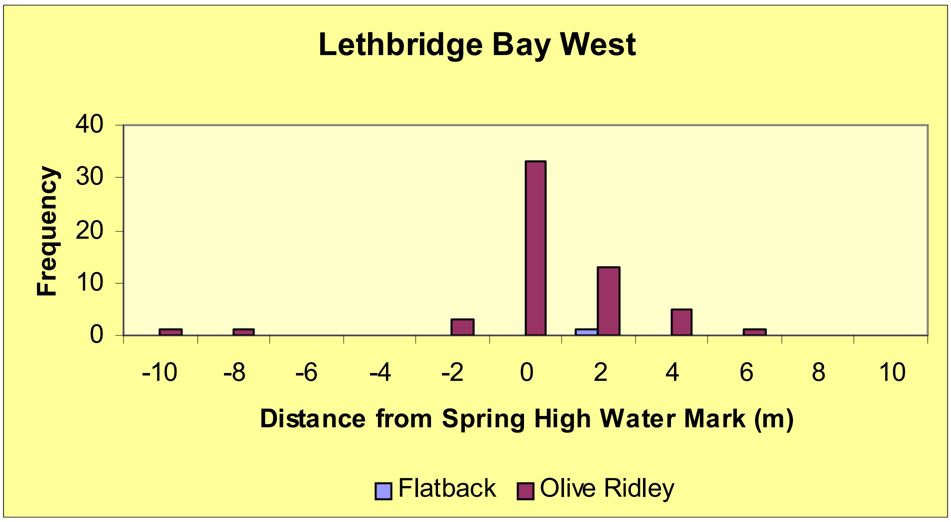


Figure 7. The pattern of Flatback and Olive Ridley sea turtle nests in relation to the Spring High Water Mark at Lethbridge Bay West.

Vegetation Analysis

Andranangoo Creek West:

The starting point of the transect line was the locality of the freshly laid Flatback sea turtle nest (11°21.751′S 130°49.065′E) as it was representative of the beach profile and vegetation where sea turtles nested (Figure 4). Because the vegetation was sparse on the dunes, the first random point with trees above chest height came after the third ten-metre sector had been entered (Photos 1 to 6).

The overall density of the vegetation was 120 trees per hectare with 95% confidence limits between 95.7 and 150 trees per hectare (Appendix 6). Melaleucas were the dominant vegetation being recorded in 52 out of 80 quadrants. However the density and the height of the vegetation changed at the transition between the sparse vegetation of the strand and the closed Melaleuca woodland behind the dunes (Figure 8).

The vegetation on the strand comprised relatively small (less than 5 m in height), thin (girth less than 20 cm) and sparse (less than 100 trees per hectare) and large point to plant distances (6 to 16 m) as indicated in Figure 8. Approximately 110 metres from the Spring High Water Mark the vegetation and the topography changed. The trees became taller (height = 15 m), thicker (girth = 33cm) and closer together (density = 346 trees per hectare). In this sector the transect line crossed a vegetated sand dune with a height of approximately 10 metres. At 130 metres the transect line crossed an ephemeral creek at the edge of the closed Melaleuca woodland. At this point the vegetation was at its most dense (1600 trees per hectare). The canopy of the Melaleucas touched at a height of 24 metres and the trees had a mean girth of 31 cm. Melaleucas dominated the remainder of the transect line. The mean canopy height varied from 14 to 22 metres and the mean girth from 23 to 37cm. Densities in this closed Melaleuca woodland varied from 202 to 339 trees per hectare (Figure 8).

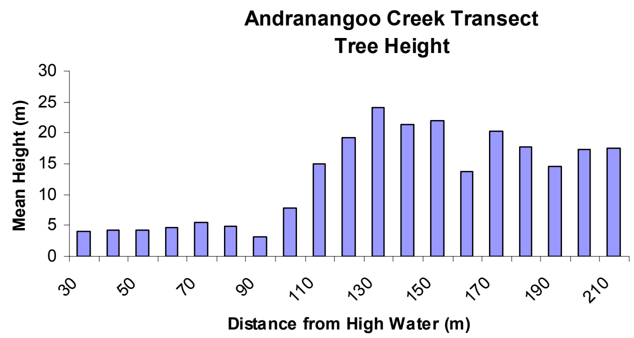
Lethbridge Bay West

The shoreline at Lethbridge Bay West differed from that at Andranangoo Creek in that the vegetation extended to the Spring High Water Mark and the beach lacked a coastal sand dune along most of its length. In the eastern portion of the lease a small seasonal berm fronted a seasonal Melaleuca swamp which was dry at the time of the survey. The position of the transect line (Figure 6) was selected indiscriminately and was representative of most of the beach where sea turtle nests had been encountered (11°21.495′S 130°59.917′E). The overall tree density was estimated to be 270 trees per hectare with ninety five percent confidence limits of between 216 to 336 trees per hectare (Appendix 7). The vegetation varied along the transect line as it passed through the coastal strand vegetation to an open Melaleuca and Acacia forest further inland (Photos 7 to 12).

Vegetation was present at the Spring High Water Mark as indicated in Figure 9. Within the first 100 metres the vegetation included coastal Casuarina trees. Mean tree height varied from 9 to 15 metres with girths ranging from 14 to 37 cm and point to plant distances from 4.5 to 11 m giving mean densities of between 80 to 480 trees per hectare (Figure 9).

At 100 metres from the Spring High Water Mark the vegetation changed as the transect line passed through the ecotone or transition between the beach vegetation and the Melaleuca and Acacia dominated forest. The trees were growing closer together with a mean density of 1600 trees per hectare. They were relatively smaller with mean heights of 7.5 m and girths of 21 cm. Beyond this transition area the tree heights were variable with patches where larger trees had fallen and smaller regrowth was under way. Progress along the transect line was impeded by numerous vines, logs and shrubs that formed an understorey beneath a few emergent Melaleucas and Acacias with heights to 20 metres. Mean tree densities varied from 118 to 1450 trees per hectare. Mean heights ranged from 6.5 to 17.75 metres with mean girths ranging from 9 to 52 cm (Figure 9).

The topography was consistently flat throughout the length of the transect line with only a small dry streambed that was a few centimetres deep at 100 metres inland from the Spring High Water Mark. This pattern of thick vegetation with an almost impenetrable understorey of vines, fallen logs and regrowth was typical of the vegetation along the beach at Lethbridge Bay West. The Casuarinas that were so noticeable at the waters edge in the western part of the beach gradually gave way to Melaleucas backed by coastal seasonal swamps in the eastern regions near the creek mouth.



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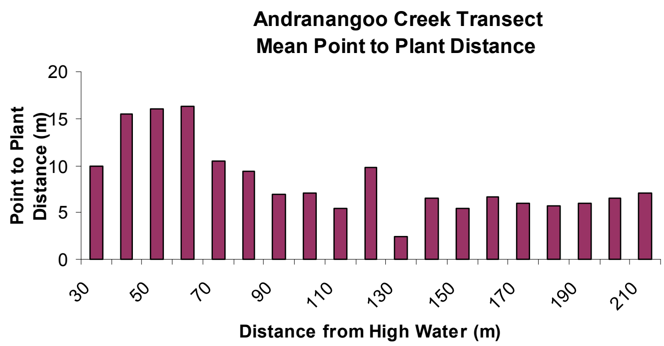

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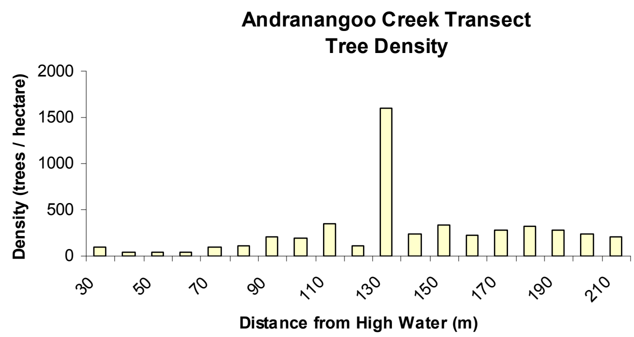

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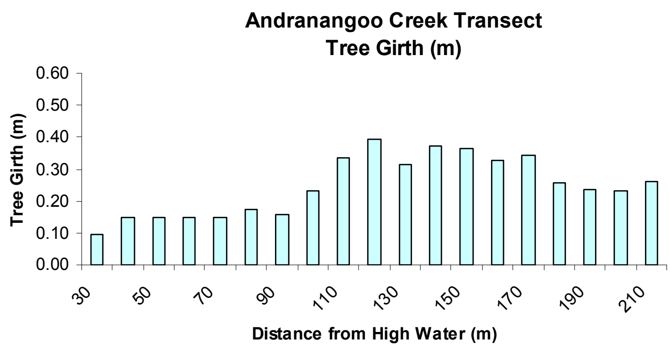
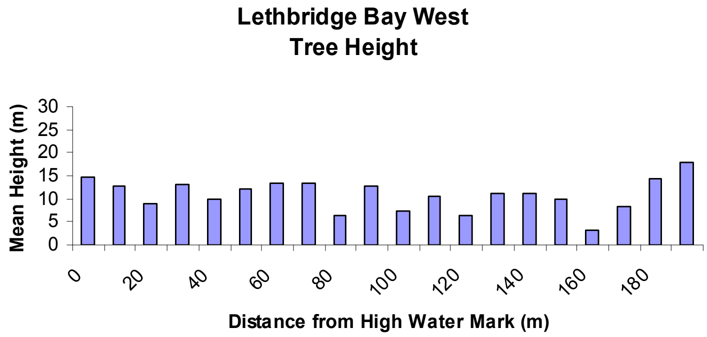


D

Figure 8. Vegetation profile of the 200 metre buffer zone at Andranangoo Creek West showing mean tree height (A), mean point to plant distance (B) mean tree density (C) and mean tree girth per sector (D) for each 10 metre sector.



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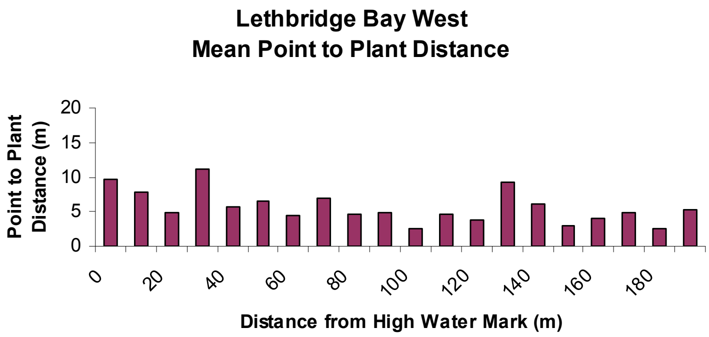

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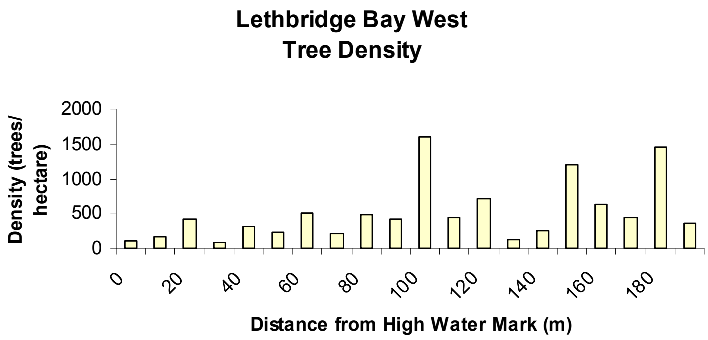

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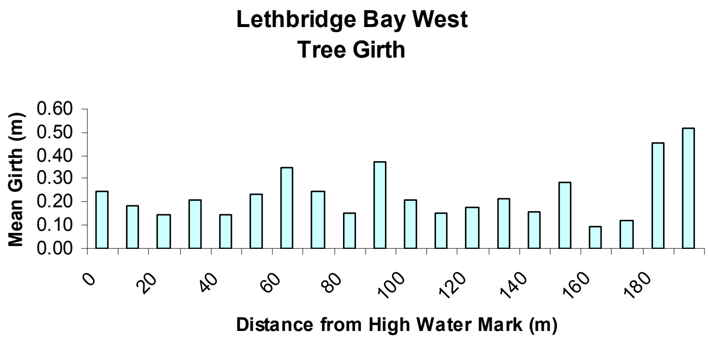

D

Figure 9. Vegetation profile of the 200 metre buffer zone at Lethbridge Bay West showing mean tree height (A), mean point to plant distance (B) mean tree density (C) and mean tree girth per sector (D) for each 10 metre sector.

Discussion

The beaches at the Andranangoo Creek West and the Lethbridge Bay West leases support sea turtle nesting as was indicated in the previous report (Guinea, 2005). The visit in February 2005 indicated that both Flatback and Olive Ridley sea turtles nested on these beaches. This survey provides a comparison between beaches six months later and gives an insight into the numbers of turtle nests laid on each of the beaches. Both Flatback and Olive Ridley sea turtles nest on Andranangoo Creek beach. These 17 remains of nests are an indication of nesting intensity over the expected peak of nesting season during the dry season months. The remains of 58 sea turtle nests were found on the beach at Lethbridge Bay. All but one was identified as belonging to Olive Ridley sea turtles. The other was recorded as belonging to a Flatback sea turtle. It is possible that some of the nests that were thought to belong to Olive Ridley sea turtles at Lethbridge Bay may have been those of Hawksbill sea turtles. This suspicion arose as one on the opened nests had a depth of 50 cm which is at the upper limit of reported nest depths for Olive Ridley sea turtles (Guinea 1990) and within the range of nest depths of hawksbill sea turtles in Arnhem Land (Limpus and Preece 1992). In addition these nests were under vegetation rather than on the open beach where Olive Ridley sea turtles usually nest (Whiting 1997). The presence of nesting Hawksbill sea turtles at Lethbridge bay West is a possibility as there are few distinctive differences between clutch sizes, size of eggs and width of the tracks of Olive Ridley and Hawksbill sea turtles.

The 17 nests on Andranangoo Creek and 58 nests on Lethbridge Bay West leases may represent a good proportion of the nests laid on these beaches during the season. There was no evidence of hatched nests on Andranangoo Creek West beach. This missing evidence included depressions in the dunes from which hatchlings had emerged and hatchling tracks on the beach. At Lethbridge Bay West, discoloured eggshells, intact hatched eggshells and the remains of undeveloped embryos indicated that at least 5 nests of the 58 identified nests had hatched and the nest had been raided after the hatchlings had emerged. In view of this it is obvious that dogs and goannas raid some nests shortly after they have been laid. Some nests escape detection by these predators and remain to hatch at which time the nest and the remains of the clutch are raided. The groups of nests that could not be detected by this survey were the latter group comprising those nests that had escaped detection after laying and had not yet hatched at the time of the survey and the group of nests that escaped detection at the time of laying and had not been detected at the time of hatching. If the peak of nesting for Olive Ridley sea turtles was in April (R. Chatto personal communication) and the peak of Flatback sea turtle nesting was in May (R. Chatto personal communication), then the number of sea turtle nests that remained unhatched by late August would be very small given the expected seven to eight week incubation duration for sea turtle eggs. Without further information to assist, I estimate that the densities observed in this survey represent a low to medium annual nesting density of 10 to 100 nests per kilometre as indicate by the preliminary aerial surveys by Chatto (1998).

High density sea turtle nesting beaches on Melville Island have been subjected to feral dog control programs (Chatto 2004). These locations were in the vicinity of Cape Van Diemen, between Harold Point and Robinson Inlet, and between Brenton Bay and Point Jahleel as illustrated in Figure 3. There is nothing in this present survey to suggest that the nesting intensity by either Flatback or Olive Ridley sea turtles approaches the tens of turtles nesting per night at other localities on Melville Island (Chatto 1998, 2004, Whiting and Hadden 2005). The two visits to the leases at Andranangoo Creek West and Lethbridge Bay West at six month intervals indicate that the sea turtle nesting density is in the low to moderate category of Chatto (1998).

The distance travelled inland by nesting sea turtles was less than 10 metres from the Spring High Water Mark. This finding agrees with observations on the largely unvegetated sand dunes of Bare Sand Island where the vast majority of Flatback sea turtles nest within 20 metres of the Spring High Water Mark. All Olive Ridley nests on Bare Sand Island are a few metres above or even below the Spring High Water Mark. Hope and Smit (1998) found a similar situation at Gurig National Park where only 3 of 143 Flatback sea turtles nested beyond the first dune and all three Olive Ridley sea turtles nested below the dune front or berm. This survey and corroborating reports from other studies on these species in the region indicate that the nesting sea turtles are unlikely to move inland any further than 10 metres to nest. The beach vegetation provides a barrier and a suitable darkened environment in which to nest in the case of Lethbridge Bay West lease. At Andranangoo Creek West the coastal dunes and berm provide a suitable protected and darkened habitat for nesting without the need to venture further inland.

The vegetation at both localities provides a visual and physical barrier to the proposed mining operations further inland. In the case of Andranangoo Creek West the beach vegetation is sparse and comprised mainly of shrubs until the prominent sand dune is reached where the vegetation becomes dense at the transition or ecotone to the Melaleuca woodland further inland. The 200m wide buffer zone with its shrub-like coastal vegetation, the 10 m high sand dune, and the closed Melaleuca woodland will be sufficient to prevent any negative impact by the proposed mine on the sea turtle nesting beach. The vegetation of the escarpment where the camp and processing plant will be located could not be seen from the beach or from any place along the transect line.

The coastal vegetation at Lethbridge Bay West provides an impenetrable visual and physical barrier to the hinterland and the escarpment. The lack of a coastal dune is more that compensated for by the tall stand of coastal Casuarina and Melaleuca trees. Behind the coastal trees is an expanse of open forest with an understorey of shrubs vines, fallen trees and emergent Melaleucas and Acacias. This open forest gives way to closed Melaleuca woodland beyond the end of the 200 m transects line. The density (up to 1600 trees per hectare) is equivalent to many patches of coastal vine thicket found around the Northern Territory coastline. It is important the integrity of this coastal buffer zone remains intact during the mining operations.

In discussions with Mr Dennis McCamish, Operations Manger with Matilda Minerals, he indicated that to reduce any impact on the beach and coastal buffer, employees will have a designated recreation area on the banks of Andranangoo Creek from where they can fish and launch boats. This will take the pressure off the sea turtle nesting area and reduce the chance of any damage to the coastal buffer zone by recreational activities of the employees.

Effects of Light and Noise on Sea Turtle Nesting Behaviour.

Quantitative studies of the effectiveness of the buffer zone to abate noise and light from the mine site was not possible because the mine was not established and the processing plant not in place. In order to assess the impact of noise from machinery and plant equipment on nesting sea turtles, the ability of sea turtles to hear such noise requires investigation. Sea turtles lack external ears (Bartol and Musick 2003). The anatomy of the hearing apparatus is unlike that of terrestrial animals in that the auditory canal is filled with fat and penetrated by a single bone, the stapes, which conveys vibration to the middle ear (Ketten *et al*. 2003). This arrangement of fat deposits and bone enable sea turtle to hear low frequency sounds whilst underwater and very little sound above water. Vibrations, however, can be conducted through the bones of the carapace to reach the middle ear. This would further enhance their response to low frequency sounds whilst underwater (Ketten *et al*. 2003). In loggerhead sea turtles (*Caretta caretta*) the most sensitive threshold to sound was at 250 Hz (Bartol 1999). Little comparative anatomy and physiology has been conducted on Flatback and Olive Ridley sea turtles, However both species have been unresponsive to human voices on nesting beaches, but do respond to touches on the carapace. These field based observations support the experimental laboratory studies that indicate that hearing in sea turtles is best in the water and bone conducting hearing is present in these animals.

Noise abatement is enhanced by the presence of thick vegetation as is provided in the 200 metre buffer zone. Any noise generated by the plant at night, if it is in operation at that time, will be further abated by the presence of strong onshore winds at night on the northern beaches of Melville Island. These winds are a major environmental factor responsible for the formation of the dunes at Andranangoo Creek beach during the dry season. The direction of this wind places the nesting beach up wind of any mining activities. During the survey the winds were gentle in the morning and stiffened to 15 knots in the afternoon and evening. The sound of the waves generated by this wind was sufficient to drown out the noise of a helicopter and a four wheel drive vehicle operating in line-of-sight several hundred metres further along the beach at Lethbridge Bay.

During the survey it was difficult to conduct any lighting experiments given the exact location of the mine was still covered with native vegetation and there was only a rudimentary camp in place some distance back from the escarpment at Andranangoo Creek West lease and there was no clearing of either mine site or camp site at Lethbridge Bay West lease. Any attempt to replicate the lighting of a mine and a mining camp would have been inadequate given the lack of resources at both locations. The added danger of crocodiles and buffalos on the beach at night made any nocturnal activities unsafe. The trees of the escarpment had been seriously affected by tropical Cyclone Ingrid that hit the north coast Melville Island in March 2005. All of the escarpment trees had been stripped of their leaves which were in the process of regrowing at the time of the survey in August. None of these tall trees with dense short regrowth branches were visible form the beach at Andranangoo Creek (Photos 1 to 6) because the coastal vegetation obscured the escarpment and its regenerating vegetation from view. Similarly at Lethbridge Bay West, the coastal vegetation obscured the vegetation n the escarpment (Photos 7 to 12).

In order to assess the likely impact of lighting on a low density sea turtle nesting beach, observations were made on the coastal regions of Darwin. Casuarina Coastal Reserve in Darwin Harbour hosts about 20 sea turtle nests per year. This equates to about 5 nests per kilometre. The species responsible are mostly Flatback, but with occasional Olive Ridley and Green sea turtles. The vegetation density of a 100 metre wide coastal zone was estimated to be about 100 trees per hectare with shrubs and small strand plants not included. The car park and barbeque areas are illuminated by street lights as is the clubhouse of the Darwin Surf Lifesaving Club. Kilometres of Casuarina Beach are in full view of the lights of Darwin and the cliff tops are illuminated by the residential and streets lights of Brinkin. Turtles nest along this beach in numbers that are assumed to have increased in recent years as Casuarina Beach was not mentioned as an important sea turtle nesting area in the early years of the settlement of Darwin (Searcy 1909). On Bare Sand Island, 50 km to the west of Darwin, Flatback sea turtles nest in spite of the camp fires and lights of campers on the island. This tolerance of lights by Flatback sea turtles is thought to be, in part, associated with their strong philopatry or connectivity with a nesting area. Flatback sea turtles return faithfully to a nesting area having nested there previously (Limpus *et al*. 1984). Too little research has been conducted in Australia to make similar claims for Olive Ridley sea turtles. However observations on nesting beaches at Melville Island indicate that Olive Ridley sea turtles remain undisturbed by lights while nesting (S. Whiting personal communication). Regardless of these observations and any possible lack of response by Flatback and Olive Ridley sea turtles to light, it is important that any lights used on the mine and the camp are shielded to prevent extraneous light spilling outside the area where it is required. In general the following rules apply to lighting in the vicinity of sea turtle nesting beaches.

- Orange and red lights should be used wherever possible for external lighting except where safety considerations require other coloured lights. Yellow low-pressure sodium vapour lamps are acceptable.

- Where white and other coloured lights, including fluorescent lights, are used, the light spill should be reduced by either shades or orientation. There should be minimal light visible from the beach where the sea turtles nest. No lights should face seawards except for those required for safe operation of the mine site. Shades should be constructed over lights to prevent sky glow.

- Lights should be low to the ground wherever possible. Pathway lights should be less than one metre in height and shaded to prevent upward illumination. Preference should be given to manually operated switches that enable selected parts of the mine site and the camp site to be illuminated separately.

- Reflective tape may be used to reduce the amount of ambient light where the safety of personnel is not compromised.

During the construction and the operation phases of the mine, the plant and the campsite, light pollution will be prevented by the company adhering to the above rules.

On going monitoring

The operations manager accompanied the survey party along the beach at Andranangoo Creek West and was trained in identifying the single Flatback sea turtle track present at the time. It is important to monitor sea turtles nesting numbers in order to demonstrate that the mining operation has no negative impact on the nesting sea turtles. Guides to the identification of sea turtles by their tracks (Appendix 1) and egg (Appendix 2) have been provided.

Reporting

It is important to compile monthly reports using a standard data sheet (Appendix 3) and the monthly data sheet (Appendix 8). In addition any incident involving sea turtles should be reported on the Sea Turtle Accident, Injury & Incident data sheet as is demonstrated for this survey in Appendix 5. This monitoring should be a combination of beach survey conducted at least weekly with monthly reporting. The operations manager will be the person responsible for the collecting of the data and the compilation of the reports including any Sea Turtle Accident, Injury and Incident Reports.

Reports will be sent from the mine on a monthly basis within 2 weeks of the end on the month to URS for compilation and a monthly report prepared. Reports will be in electronic and hard copy format as well as an oral report in plain English to the Traditional Owners at a Tiwi land Council meeting. Annual report will be supplied in the above formats to:

- The Traditional Owners – Tiwi Land Council.
- Office of Environment and Heritage Department of Planning and Infrastructure (OEH).
- Biodiversity Conservation Division of the Department of Natural Resources, Environment and the Arts.
- The Commonwealth Government Department of Environment and Heritage (DEH).

Should this monitoring reveal that there are very few hatchlings being produced from the beaches in the lease then I encourage dialogue between the company, Matilda Minerals, the Traditional Owners, non-government organisations e.g. World Wide Fund for Nature, the Biodiversity Conservation Division of the Department of Natural Resources, Environment and the Arts and The Commonwealth Government Department of Environment and Heritage with a view to establishing a feral dog removal program.

To aid in the compilation of future reports the data used in this report are supplied in the appropriate data sheets in Appendix 9.

Conclusion

The Survey at Andranangoo Creek West and Lethbridge Bay West on Melville Island revealed:

- Low to moderate density sea turtle nesting by both Flatback and Olive Ridley sea turtles.
- Nesting density is lower than other at areas on Melville Island.
- Most sea turtles nest close to the Spring High Water Mark.
- Neither species of sea turtle moved inland more than 10 metres from the Spring High Water Mark.
- The thick vegetation and the sand dunes that form a visual and physical barrier between the beach and the proposed mining operations at Andranangoo Creek West provide an adequate buffer zone.
- The thick vegetation comprising vines, shrubs, fallen logs and coastal regrowth that form a visual and physical barrier between the beach and the proposed mining operations at Lethbridge Bay West provide an adequate buffer zone.
- Nominating designated recreational areas away from the beach will maintain the integrity of the buffer zones.
- Monitoring of sea turtle nesting numbers using the attached data sheets will enable any negative impact by the mine on the numbers of nesting sea turtle to be assessed on a weekly, monthly and annual basis.
- Reports will be supplied by the company to URS and reports provided to the regulating authorities including the Tiwi Land Council, Office of Environment and Heritage, Biodiversity Conservation Division, and Department of Environment and Heritage.

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Photographs

Photo 1. The seasonal berm at Andranangoo Creek beach with Kiki Dethmers and Dennis McCamish (Matilda Minerals) standing beside a flatback sea turtle nest

Photo 2. The existing track to the beach at Andranangoo Creek beach showing the10 m high dune 90 metres from the high water mark.

Photo 3. View inland at Andranangoo Creek beach showing the sparse vegetation and the Melaleuca woodland 100 metres from the High Water Mark

Photo 4. View inland from the high water mark of the Andranangoo Creek beach showing the berm, strand vegetation and Melaleuca woodland beyond.

Photo 5. View along the transect line towards the beach showing the 10 m high dune and Mr Dennis McCamish and Kiki Dethmers standing beside a Melaleuca tree.

Photo 6. Closed Melaleuca woodland behind the dune at Andranangoo Creek beach.


Photo 7. View to the East along Lethbridge Bay beach with Casuarina trees along the foreshore.


Photo 8 Disturbance amongst the Casuarina litter indicates the position of a Flatback sea turtle nest.


Photo 9 Gaps in the Casuarina trees enable a glimpse of the dense Melaleuca woodland behind the beach

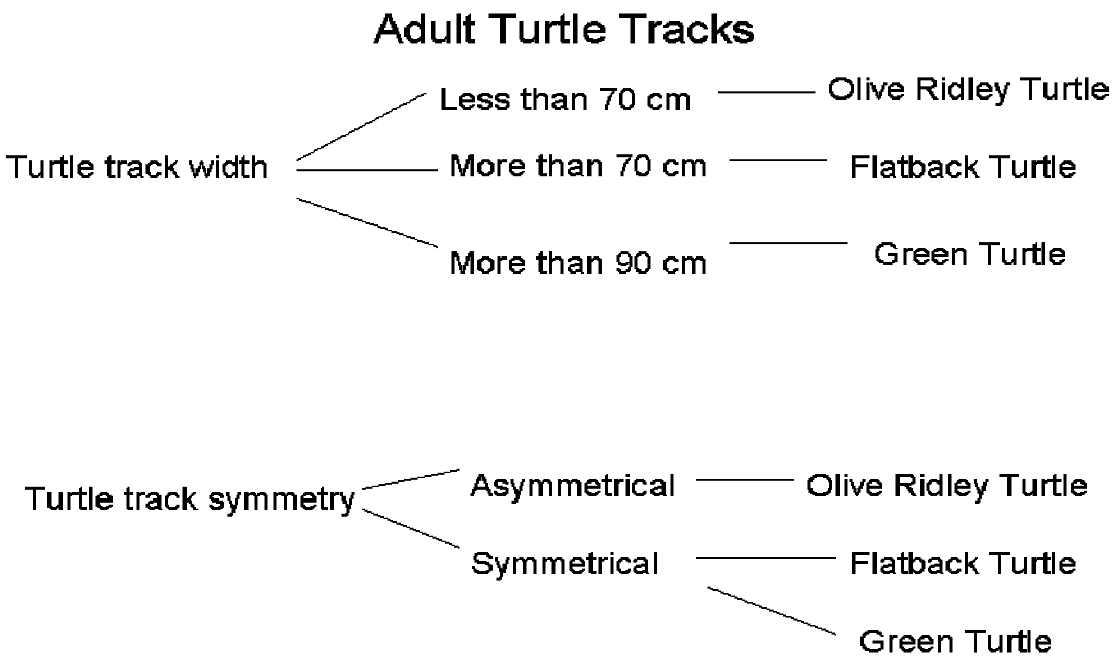

Photo 10. Cyclone damage along Lethbridge Bay beach resulted in several trees being uprooted.


Photo 11. The view inland from the beach where the transect line entered the 200m buffer zone.

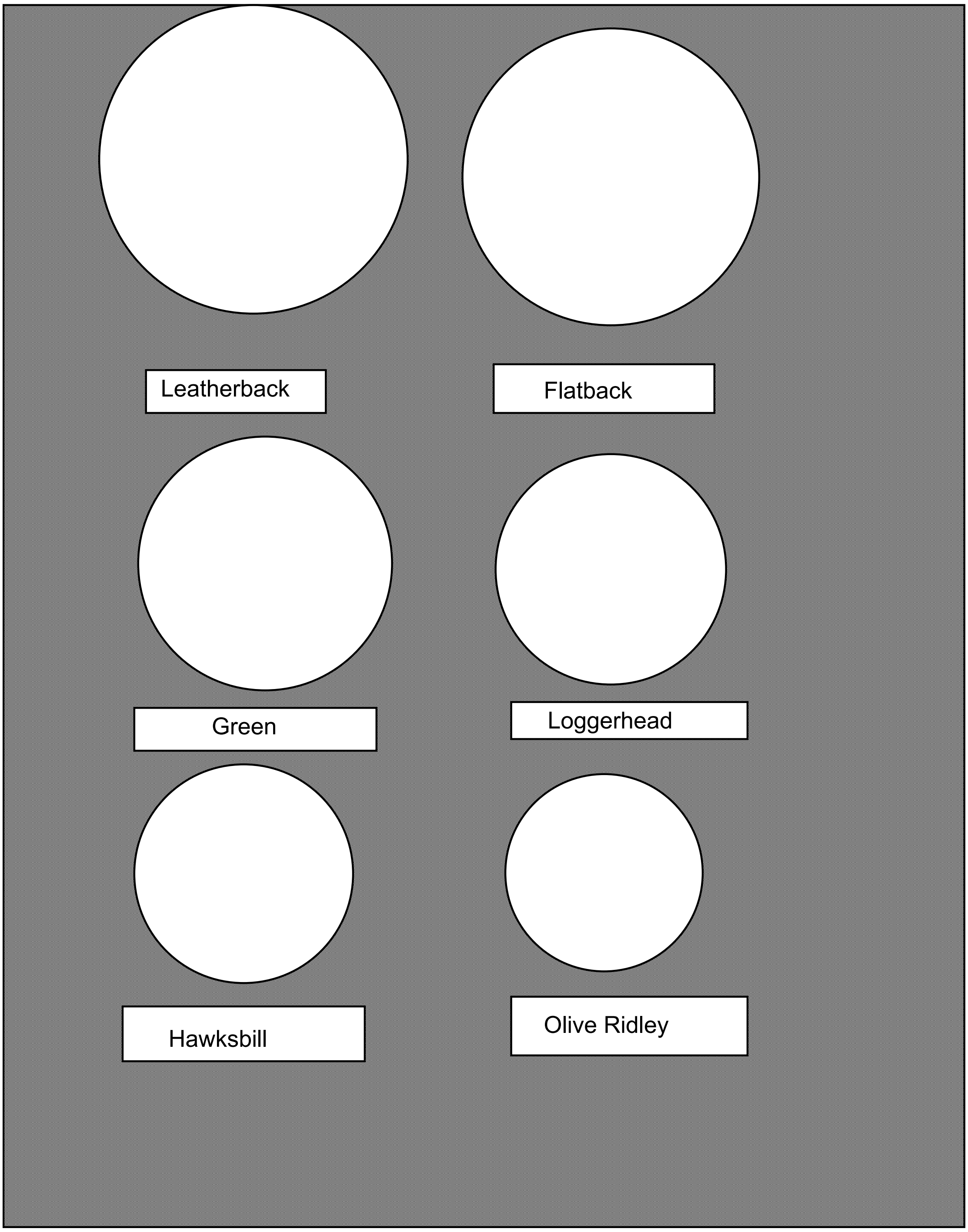

Photo 12. Melaleuca woodland to the eastern end of Lethbridge Bay Beach.

Appendices

Appendix 1. Decision tree for identifying nesting sea turtles by their tracks.



Appendix 2. Chart of relative approximate sizes of sea turtle eggs showing the difference between those of Olive Ridley, Flatback and other sea turtles.



Appendix 3. Nesting Beach Data Sheet

Sea Turtle Nesting Data Sheet

Location: Andranangoo Creek West [ ]
Lethbridge Bay West [ ]

Date of visit [ ]

	GPS At high Water Mark		Species Identification					GPS of Nest		Notes
Turtle Track Number	Latitude	Longitude	Track width (cm)	Track Symmetry	Species	Date of nest	Nest above High water (m)	Latitude	Longitude	
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										

Appendix 4. Vegetation density survey sheet.

Vegetation Density Data Sheet

Location:
Andranangoo Creek West   Date:
Lethbridge Bay West

Start GPS Position	
Latitude	Longitude

Finish GPS Position	
Latitude	Longitude

	Quadrant 1				Quadrant 2				Quadrant 3				Quadrant 4			
Point	Distance	Species	Height	GBH	Distance	Species	Height	GBH	Distance	Species	Height	GBH	Distance	Species	Height	GBH
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																

Appendix 5. Sea turtle Accident, Injury & Incident Report completed for a dead turtle.

Sea Turtle Accident, Injury & Incident Report

Time and Date
Time:_1300____________________
(of first sighting of the sea turtle)

Date:_29/08/2005__________________

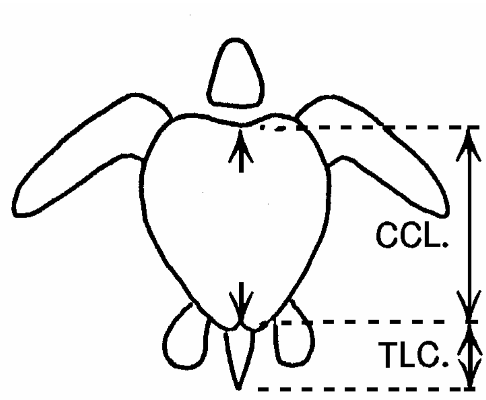
Condition of the Sea turtle at First Sighting:

Dead and beach washed

at any Subsequent Sighting:

__NIL____

External marks or wounds:
X Nil
O Present (as indicated on diagram)



Fate of Sea Turtle OR Photograph

Location:
of Sea Turtle**:_ Andranangoo Creek**

Latitude / Longitude
11° 21.723′S 130° 49.229′E

Species: (indicate by X)
O Flatback (Greenback)
O Olive Ridley
O Green
X Hawksbill
O Loggerhead
O Leatherback

Stage of maturity: (indicate by X)
O Hatchling
O Juvenile
X Adult

Size of Sea Turtle:

Carapace (CCL):_ 77.0___________cm.
(Measured with a flexible tape)

Tail Length (TLC):_ -5.0________cm
(from the end of the carapace)

Sex of Sea Turtle: (indicate by X)
O Male
O Female
X Unknown

Name of Person Making Report:

Mick Guinea, Kiki Dethmers

Entered into Environmental Log by

Name : ________________________

Date : _________________________

Appendix 6. Estimation by Point Quarter Method Andranangoo Creek

```
The sample size is 76 individuals.
For Point to Organism Distances:

Mean:                8.39
Standard Deviation:  5.88
Standard Error:          0.674

For Overall Organism Densities:

Estimate:                 0.012
95% Confidence Interval:  0.00957 to 0.015
Variance:                 1.96e-006
Standard Error:           0.00016

Measurements are in metres,
so the density estimates can also be stated as:

Estimate:  120 /ha   = 48.7 /acre

95% Confidence Interval:
95.7 /ha to 150 /ha  =  38.7 /acre to 60.9 /acre
```

Species	Number Seen	Density	Relative Density	Relative Dominance
Melaleuca	53	83.870	69.737	96.453
unknown	19	30.070	25.000	2.724
Casuarina	2	3.165	2.632	0.729
Bloodwood	1	1.583	1.316	0.078
Acacia	1	1.583	1.316	0.016

Density is in organisms per hectare.
****

Appendix 7. Estimation by Point Quarter Method Lethbridge Bay West.

```
The sample size is 80 individuals.
For Point to Organism Distances:
Mean:                5.61
Standard Deviation:  3.91
Standard Error:          0.437

For Overall Organism Densities:

Estimate:                 0.027
95% Confidence Interval:  0.0216 to 0.0336
Variance:                 9.36e-006
Standard Error:           0.000342

Measurements are in metres,
so the density estimates can also be stated as:

Estimate:  270 /ha   = 109 /acre

95% Confidence Interval:
216 /ha to 336 /ha  =  87.5 /acre to 136 /acre
```

Species	Number Seen	Density	Relative Density	Relative Dominance
Melaleuca	25	84.423	31.250	72.869
Acacia	34	114.815	42.500	14.927
Casuarina	7	23.638	8.750	8.717
unknown	14	47.277	17.500	3.487

Density is in organisms per hectare.

****

Appendix 8. Example of a monthly nesting and hatching data sheet for records of the numbers of sea turtles nesting and the numbers of hatched nests emerging on the respective leases at Andranangoo Creek West and Lethbridge Bay West.

Sea Turtle Nesting and Hatching Data Sheet

Andranangoo Creek West			Month:	
Lethbridge Bay West				
Date	Flatback Nests	Oliver Ridley Nests	Hatched Nests	Notes
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				

Appendix 9. Data sheets containing the result s of the survey to Andranangoo Creek West and Lethbridge Bay West, Melville Island.

Sea Turtle Nesting Data Sheet

Location: Andranangoo Creek West   Date of visit 29/08/05

	Species Identification					GPS of Nest		Notes
Turtle Track Number	Track width (cm)	Track Symmetry	Species	Date of nest	Nest above High water (m)	Latitude	Longitude	
1	70cm	SYM	Flatback	27/08/05	10	698359	8743298	
2	NA	NA	Flatback	old	8	698198	8743278	goanna / dog
3	NA	NA	Flatback	old	7	698158	8743272	goanna / dog
4	NA	NA	Olive Ridley	old	7	697707	8743224	goanna / dog
5	NA	NA	Olive Ridley	old	0	697427	8743214	goanna / dog
6	NA	NA	Olive Ridley	old	1	697400	8743212	goanna / dog
7	NA	NA	Olive Ridley	old	4	697330	8743206	goanna / dog
8	NA	NA	Olive Ridley	old	2	697241	8743212	goanna / dog
9	NA	NA	Flatback	old	1	698595	8743342	goanna / dog
10	NA	NA	Olive Ridley	old	0	698604	8743346	goanna / dog
11	NA	NA	Flatback	old	1	698621	8743384	goanna / dog
12	NA	NA	Olive Ridley	old	2	698680	8743360	goanna / dog
13	NA	NA	Flatback	old	1	698837	8743384	goanna / dog
14	NA	NA	Flatback	old	-1	698897	8743392	goanna / dog
15	NA	NA	Flatback	old	0	698912	8743394	goanna / dog
16	NA	NA	Flatback	old	2	699248	8743458	goanna / dog
17	NA	NA	Flatback	old	0	700003	8743630	goanna / dog

Sea Turtle Nesting Data Sheet

Location: Lethbridge Bay West

Date of visit 30/08/05

	Species Identification					GPS of Nest		Notes
Turtle Track Number	Track width (cm)	Track Sym metry	Species	Date of nest	Nest above High water (m)	Latitude	Longitude	
1	NA	NA	Olive Ridley	old no track	0	717345	8743968	goanna / dog
2	NA	NA	Olive Ridley	old no track	-10	717404	8743050	goanna / dog
3	NA	NA	Olive Ridley	old no track	-8.5	717382	8743954	goanna / dog
4	NA	NA	Olive Ridley	old no track	0	717458	8743912	goanna / dog
5	NA	NA	Olive Ridley	old no track	0	717464	8743908	goanna / dog
6	NA	NA	Olive Ridley	old no track	0	717473	8743908	goanna / dog
7	NA	NA	Olive Ridley	old no track	-3	717492	8743908	goanna / dog
8	NA	NA	Olive Ridley	old no track	5	717494	8743890	goanna / dog
9	NA	NA	Olive Ridley	old no track	0	717491	8743890	goanna / dog
10	NA	NA	Olive Ridley	old no track	1	717529	8743870	goanna / dog
11	NA	NA	Olive Ridley	old no track	2	717532	8743866	goanna / dog
12	NA	NA	Olive Ridley	old no track	4	717544	8743862	goanna / dog
13	NA	NA	Olive Ridley	old no track	4	717648	8743816	goanna / dog
14	NA	NA	Olive Ridley	old no track	1	717656	8743816	goanna / dog
15	NA	NA	Olive Ridley	old no track	1	717678	8743814	goanna / dog
16	NA	NA	Olive Ridley	old no track	0	717715	8743794	goanna / dog
17	NA	NA	Olive Ridley	old no track	2	717924	8743715	goanna / dog
18	NA	NA	Olive Ridley	old no track	0	717939	8743712	goanna / dog
19	NA	NA	Olive Ridley	old no track	0	717937	8743718	goanna / dog
20	NA	NA	Flatback	old no track	1	717986	8743696	goanna / dog
21	NA	NA	Olive Ridley	old no track	1	718004	8743692	goanna / dog
22	NA	NA	Olive Ridley	old no track	3	718010	8743686	goanna / dog
23	NA	NA	Olive Ridley	old no track	0	718013	8743696	goanna / dog
24	NA	NA	Olive Ridley	old no track	0	718059	8743688	goanna / dog
25	NA	NA	Olive Ridley	old no track	0	718058	8743684	goanna / dog
26	NA	NA	Olive Ridley	old no track	1	718072	8743674	goanna / dog
27	NA	NA	Olive Ridley	old no track	-2	718354	8743602	goanna / dog
28	NA	NA	Olive Ridley	old no track	0	718483	8743564	goanna / dog
29	NA	NA	Olive Ridley	old no track	2	718515	8743548	goanna / dog
30	NA	NA	Olive Ridley	old no track	-1	718537	8743456	goanna / dog
31	NA	NA	Olive Ridley	old no track	0	718656	8743522	goanna / dog
32	NA	NA	Olive Ridley	old no track	0	718728	8743508	goanna / dog
33	NA	NA	Olive Ridley	old no track	2	718768	8743500	goanna / dog
34	NA	NA	Olive Ridley	old no track	1	718772	8743500	goanna / dog
35	NA	NA	Olive Ridley	old no track	0	718804	8743502	goanna / dog
36	NA	NA	Olive Ridley	old no track	0	718865	8743492	goanna / dog
37	NA	NA	Olive Ridley	old no track	-1	718962	8743486	goanna / dog
38	NA	NA	Olive Ridley	old no track	-1	718982	8743047	goanna / dog
39	NA	NA	Olive Ridley	old no track	-1	719021	8743474	goanna / dog
40	NA	NA	Olive Ridley	old no track	0	719073	8743466	goanna / dog
41	NA	NA	Olive Ridley	old no track	0	719114	8743462	goanna / dog
42	NA	NA	Olive Ridley	old no track	0	719136	8743464	goanna / dog
43	NA	NA	Olive Ridley	old no track	0	719246	8743454	goanna / dog
44	NA	NA	Olive Ridley	old no track	2	719333	8743450	goanna / dog
45	NA	NA	Olive Ridley	old no track	-1	719343	8743456	goanna / dog
46	NA	NA	Olive Ridley	old no track	-1	719391	8743442	goanna / dog
47	NA	NA	Olive Ridley	old no track	-2	719491	8743444	goanna / dog
48	NA	NA	Olive Ridley	old no track	-1	719565	8743430	goanna / dog
49	NA	NA	Olive Ridley	old no track	4	719604	8743428	goanna / dog
50	NA	NA	Olive Ridley	old no track	0	719719	8743426	goanna / dog
51	NA	NA	Olive Ridley	old no track	-1	719745	8743428	goanna / dog
52	NA	NA	Olive Ridley	old no track	-1.5	719729	8743426	goanna / dog
53	NA	NA	Olive Ridley	old no track	4	719868	8743440	goanna / dog
54	NA	NA	Olive Ridley	old no track	0	719865	8743440	goanna / dog
55	NA	NA	Olive Ridley	old no track	2	719884	8743430	goanna / dog
56	NA	NA	Olive Ridley	old no track	0	719926	8743434	goanna / dog
57	NA	NA	Olive Ridley	old no track	1	719996	8743444	goanna / dog
58	NA	NA	Olive Ridley	old no track	0	720025	8743438	goanna / dog

			Vegetation Density Data Sheet													
	Location:															
	Andranangoo Creek West						Date:		29-Aug-05							
		Start GPS Position						Finish GPS Position								
		Latitude			Longitude			Latitude			Longitude					
		11deg 21.751			130deg 49.065			11deg 21.857			130deg 49.070					
	Quadrant 1				Quadrant 2				Quadrant 3				Quadrant 4			
Point	Distance (m)	Species	Height (m)	GBH (m)	Distance (m)	Species	Height (m)	GBH (m)	Distance (m)	Species	Height (m)	GBH (m)	Distance (m)	Species	Height (m)	GBH (m)
1	7	Unknown	2	0.06	3	Unknown	2.2	0.06	20	Casuarina	9	0.21	0.66	Casuarina	3	0.04
2	28	Melaleuca	10	0.40	15	Unknown	3	0.06	4	Unknown	2.2	0.06	0.2	Unknown	2	0.06
3	25.2	Melaleuca	10	0.40	10.4	Unknown	3	0.06	10	Unknown	2.2	0.06	0.2	Unknown	2	0.06
4	8.3	Melaleuca	10	0.40	8.8	Unknown	4	0.06	13.7	Unknown	3	0.06	0.2	Unknown	2	0.06
5	21.3	Melaleuca	5	0.06	8.6	Unknown	4	0.06	4.8	Unknown	3	0.06	0.2	Melaleuca	10	0.40
6	13	Unknown	2.5	0.16	5	Unknown	4	0.06	8.3	Unknown	3	0.06	0.2	Melaleuca	10	0.40
7	5	Melaleuca	2.5	0.16	9	Melaleuca	3	0.16	7.6	Unknown	5	0.16	0.5	Unknown	2.5	0.16
8	6.2	Melaleuca	10	0.30	10.5	Melaleuca	14	0.32	8.1	Melaleuca	3	0.16	0.5	Melaleuca	4	0.16
9	6	Melaleuca	17	0.25	3	Melaleuca	18	0.48	7.4	Melaleuca	12	0.16	0.5	Melaleuca	13.4	0.45
10	9.8	Melaleuca	11.3	0.33	7.2	Melaleuca	24	0.35	12	Melaleuca	19.3	0.48	1.5	Melaleuca	22	0.41
11	5.7	Melaleuca	24.5	0.38	2	Melaleuca	24	0.35	0.8	Melaleuca	24	0.27	0.85	Melaleuca	24	0.25
12	11.9	Melaleuca	20	0.48	3	Melaleuca	24	0.38	5.7	Melaleuca	17	0.25	0.8	Melaleuca	24	0.38
13	9.3	Melaleuca	20	0.48	0.5	Melaleuca	20	0.22	4.3	Melaleuca	24	0.38	1.2	Melaleuca	24	0.38
14	5.3	Melaleuca	6	0.25	7.6	Melaleuca	20	0.35	7.6	Melaleuca	24	0.64	2	Bloodwood	5	0.07
15	4.8	Melaleuca	20	0.38	9.5	Melaleuca	17	0.32	4.6	Melaleuca	22	0.32	1	Melaleuca	22	0.35
16	6.4	Melaleuca	24	0.38	0.3	Melaleuca	20	0.25	5.5	Melaleuca	5	0.06	0.2	Melaleuca	22	0.32
17	6.9	Unknown	8	0.19	7.2	Melaleuca	22	0.38	7.6	Melaleuca	4	0.03	0.1	Melaleuca	24	0.33
18	7.2	Melaleuca	20	0.25	5.3	Melaleuca	22	0.32	7.4	Melaleuca	5	0.06	0.2	Melaleuca	22	0.29
19	7.4	Acacia	4	0.03	6.7	Melaleuca	22	0.38	6.4	Melaleuca	20	0.32	1	Melaleuca	24	0.32
20																

			Vegetation Density Data Sheet													
							Date:	30-Aug-05								
	Lethbridge Bay West															
		Start GPS Position						Finish GPS Position								
		Latitude			Longitude			Latitude			Longitude					
		11deg 21.495			130deg 59.917			11deg 21.596			130deg 59.873					
	Quadrant 1				Quadrant 2				Quadrant 3				Quadrant 4			
Point	Distance (m)	Species	Height (m)	GBH (m)	Distance (m)	Species	Height (m)	GBH (m)	Distance (m)	Species	Height (m)	GBH (m)	Distance (m)	Species	Height (m)	GBH (m)
1	5.2	Casuarina	15	0.18	9.6	Casuarina	19	0.36	16.4	Melaleuca	5	0.13	7.4	Casuarina	20	0.32
2	7.2	Acacia	15	0.13	4.1	Acacia	2	0.06	12.6	Casuarina	19	0.36	7.4	Casuarina	15	0.18
3	9.6	Acacia	15	0.25	0.3	Acacia	4	0.13	3	Unknown	2	0.06	6.5	Acacia	15	0.14
4	4.6	Casuarina	20	0.32	11	Acacia	12	0.16	15.4	Melaleuca	5	0.06	13.5	Acacia	15	0.29
5	4.9	Unknown	6	0.06	2	Unknown	1.5	0.03	8.6	Acacia	12	0.16	7	Casuarina	20	0.32
6	6.7	Acacia	10	0.13	9.8	Melaleuca	20	0.57	4	Unknown	4	0.03	5.8	Acacia	14	0.19
7	1.5	Melaleuca	20	0.64	3	Melaleuca	20	0.57	7.4	Acacia	4	0.05	6	Acacia	10	0.13
8	18.5	Melaleuca	27	0.64	0.5	Acacia	2.5	0.02	4	Melaleuca	20	0.29	4.5	Acacia	4	0.05
9	4	Acacia	10	0.19	1	Acacia	2.5	0.13	6.7	Acacia	10	0.19	6.5	Acacia	3	0.10
10	5.3	Melaleuca	27	0.80	5	Melaleuca	12	0.38	6	Acacia	2.5	0.13	3	Acacia	10	0.19
11	2	Unknown	2	0.13	3	Unknown	3	0.06	2	Unknown	5	0.16	3	Melaleuca	20	0.48
12	4.4	Acacia	16	0.16	6	Unknown	4.5	0.10	6.5	Unknown	12	0.25	2	Unknown	10	0.10
13	5.3	Unknown	4	0.22	3	Unknown	4	0.06	2.7	Acacia	8	0.10	3.9	Melaleuca	10	0.32
14	14.3	Acacia	20	0.38	12.5	Melaleuca	1.5	0.25	6	Melaleuca	16	0.16	4	Melaleuca	7	0.06
15	6.3	Melaleuca	5	0.16	1	Acacia	2	0.02	12.4	Melaleuca	18	0.25	5	Acacia	20	0.19
16	3.7	Melaleuca	10	0.22	1	Acacia	2.5	0.10	0.5	Melaleuca	15	0.57	6.3	Melaleuca	12	0.25
17	8	Acacia	2.5	0.05	0.5	Acacia	1.5	0.01	2	Acacia	2.5	0.10	5.3	Acacia	6	0.22
18	5	Acacia	3	0.13	4.6	Unknown	4	0.22	7.5	Melaleuca	6	0.13	2	Acacia	20	0.01
19	6	Melaleuca	17	0.60	0.5	Melaleuca	20	0.73	2	Unknown	4	0.10	2	Acacia	17	0.38
20	0.5	Melaleuca	17	0.60	8.8	Melaleuca	17	0.35	5	Melaleuca	20	0.73	6.7	Acacia	17	0.38