possible outcomes for the discharge of bitterns which are presented in Appendix 1. These options are discussed below.

Scenario A

The strategy refers to Scenario A as 'worst than possible worst case' claiming that other salt fields in WA discharge this concentration of bitterns, which has a dilution rate of one to five, with a commitment to remove most of the remaining sodium chloride and other salts to significantly reduce the volume of bitterns discharge.

Scenario B

This scenario represents the proponent's 'worst case scenario' with the removal of most of the remaining sodium chloride and indicates that this option will include discharge into the barge harbour should further bitterns resource recovery be 'unexpectedly not practicable'. Ecotoxicity testing and ecological risk assessment for this scenario has not been undertaken. According to Appendix 1 the bitterns research program will address these issues for any discharge scenario.

Scenario C

This scenario involves the removal of additional salts and other compounds and results in bitterns residue with a distinctive magnesium chloride composition and further reduced volume.

Discussion

Table 2-2 (page 2-5) of the ERMP identifies that bitterns discharge has the potential for lethal and/or sub-lethal impact to benthic primary producers.

DEC is concerned that options for bitterns management involving potential for discharge into the natural environment are included in the bitterns management strategy when neither the strategy nor the ERMP includes adequately detailed information on the potential impacts of discharge of bitterns into the environment.

While the ERMP (section 1.1.1 page 1-1) states that the proponent *"is not seeking approval for discharge of bitterns"* and *"has set the goal of zero discharge and maximum recovery through a continuous improvement"*, a number of statements in the ERMP (page 1-1) (for example *"the financial and technical feasibility of achieving zero discharge will be assessed within the first ten years of operation of the salt field"* and *"an initial feasibility study by the CSIRO on the technical capacity for bitterns re-use...has identified significant long term opportunities"*) does not provide confidence that the proponent has a substantial and irrevocable commitment to avoidance of discharge or has an understanding of the potential consequences or manageability of impacts on ecosystems or biota in the event that discharge is required.

It is arguable at present that the ERMP (section 1.1.1 page 1-1, Chapter 6 pages 6-14 – 6-19 and Appendix 1 'Bitterns Resource Recovery Strategy') does not provide sufficient information on the potential economic or technical viability of bitterns recovery to warrant exclusion of the possible need for bitterns discharge from consideration in this assessment.

Recommendations:

41. Possible impacts from discharge of bitterns should be taken into account by the EPA as a potential disposal option under consideration by the proponent, on the basis that

statements within the ERMP indicate significant technical and economic uncertainty with respect to the feasibility of bitterns recovery and there appears to be a reasonable likelihood that discharge will be required under scenarios A, B or C as referred to in Appendix 1 of the ERMP.

42. There needs to be recognition that options for bitterns disposal, other than discharge to the Exmouth Gulf, may be extremely limited if the project is approved and the construction and operational phases have commenced, and as a result, the assessment of this proposal needs to consider the full range and extent of environmental impacts that are at least reasonably likely to result.

43. Prior to completion of the assessment of this proposal, the proponent should provide a comprehensive impact evaluation of 'worst case scenario' options for bitterns management including options involving discharge of bitterns into the natural environment and provide sufficient information to the EPA on the financial costs and environmental impacts of these methods to provide confidence that they would not make the project either economically unviable or environmentally unacceptable. Ecotoxicity testing and an ecological risk assessment of disposal options should be undertaken by the proponent and presented to the EPA so that the likely biological and ecological consequences of possible bitterns disposal to the environment can be assessed.

44. The EPA should seek independent expert advice on the feasibility of the proposed bitterns resource recovery strategy and possible disposal strategies prior to completing its assessment.

5.2 Bitterns storage

The storage of bitterns forms a component of the current proposal presented in the ERMP (section 1.4.2, page 6-16). A bitterns management area to the north of the crystalliser ponds will be used to store bitterns until an assessment of the resource recovery options has been completed. The ERMP states that bitterns storage facilities will be built to withstand extreme storm events and also states that these impoundments are *"not expected to fail"* (page 6-16) because similar structures at other salt fields have not failed.

DEC is of the view that comparison with other salt operations within WA may be inappropriate as other salt operations in WA are not at the same size or scale or in a similar location to the proposed Yannarie Solar Salt project and therefore different site characteristics, storm intensities, levels of storm surge, rainfall and flooding effects and design and material considerations may apply.

Secondly, given that there is no definition of a "severe storm event", there is a high level of uncertainty as to whether the bitterns management area will be built to withstand worst case scenario storm events and storm surges (such as from severe cyclones), taking into account possible sea level change, that may occur in the proposal area.

More importantly, despite the lack of a quantitative risk assessment for the potential failure of structures, the ERMP does not include any discussion of the potential ecological and biodiversity consequences of a failure of the bitterns management impoundment (page 6-16).

Recommendations:

45. The proponent should provide detailed discussion and conceptual designs of the bitterns management area demonstrating that the bitterns management area will be

built to withstand storm events equal to or greater than a predicted one in 100-year annual return interval event.

46. The proponent should properly investigate and document the potential risks associated with seepage from the bitterns storage facility into groundwater systems, tidal creeks, mangrove and algal mat communities directly (note that without the hydrogeological investigations recommended in Section 2 of this submission, the potential extent of bitterns seepage is currently unknown).

47. The proponent should provide the EPA and decision making authorities with a detailed scientific discussion on the ecological consequences of worst case scenarios including impoundment failure, bitterns seepage and overtopping.

5.3 Seawater Uptake

During a presentation provided by Dr Jim Penn on 5 February 2007 at a forum organised by the Conservation Council of Western Australia, Dr Penn expressed a view that there are potential issues associated with the intake of significant volumes of water that will be pumped into the salt ponds via the intake pumps at Dean's Creek and Naughton's Creek. The suggestion was also made that potential changes in the (marginally hypersaline) water chemistry of the shallow tidal creeks areas caused by intake of hypersaline tidal creek and nearshore marine water, and replacement of this water by lower salinity sea water from the adjacent Gulf, may affect the survival or productivity of prawn and /or other larvae, which form an important element of the nearshore marine ecological community. Potential effects of altered salinity could include direct effects on larvae survival or increased predation caused by the removal of natural restriction of access to shallow areas by larger fish with lower tolerance to hypersalinity. In view of these comments, there is an apparent need for the proponent to model and predict the effect of seawater intakes on tidal creek and nearshore water chemistry over a short temporal scale and if appropriate, evaluate the potential effects of any water salinity / chemistry changes on larvae and other biota. It is important that in doing this, the proponent properly investigates and discusses the potential for changes in salinity within creek systems and the nearshore marine environment and the ecological and conservation implications of such changes.

Recommendation:

48. The proponent should model the potential changes in the salinity regime in the area of Naughton's Creek and Dean's Creek (and any other proposed sites for intake pumps) and discuss the potential impacts on prawn recruitment and other ecological and biodiversity values potentially affected. This information should be provided to the EPA and decision making authorities (e.g. Department of Fisheries and DEC) as part of the assessment of this proposal.

5.4 Dredging

The ERMP states that the area of benthic habitat that will be directly impacted due to dredging of the shipping channel will be 16.4 ha, which is less than 1% of the proposed benthic habitat management unit (section 1.3.2, page 7-5). The proponent concludes that the "impact of such a change in habitat on marine fauna is likely to be negligible" (page 6-117).

However, there is no discussion in the ERMP (in particular Chapter 6 section 2 pages 6-21 – 6-41) on the significance of the habitat that will be impacted at the local scale, and whether it will impact on critical habitat for key fauna, such as dugong and marine turtles (e.g. green turtles *Chelonia mydas*) (also refer to Section 6.2 of this submission).

Recommendations:

49. The proponent should identify any secondary impacts from the dredging that may impact on water, quality benthic habitat and biota (including the release of Monosulphide Black Oozes MBOs - see Section 6.2, Attachment 2 of this submission) and define and discuss the local and regional significance of the habitat impacted by the dredging.

50. The proponent should identify dredging techniques to address the potential for MBO accumulation. Clear mitigation measures to reduce the risk of disturbing MBOs need to be identified. This information should be provided prior to a decision on this proposal.

5.5 Fuel and oil management

There will be three fuel storage holding areas which include both intake pump stations where 250kl of diesel will be located in an area just above the one in 25-year storm event contour. The adequacy of this setback is questioned given the likelihood of the occurrence of a one in 100-year storm event in this region. A definition of the one in 25 and one in 100-year or greater return interval storm event in terms of contour heights above sea level should be clearly articulated. The fuel storage facilities at Dean's Creek and Naughton's Creek also pose a significant potential threat to biodiversity values including mangals, marine turtles and dugong. These threats are not discussed adequately in the ERMP (page 6-70 'Surface water contamination).

There is no information in the ERMP (section 3.9.6 'Fuel Storage' page 2-41) on the fuel storage capacity of the Main Island Fuel Storage facility including its capacity and mitigation measures apart from its proposed location above the one in 100-year storm event contour.

The potential for areas of high soil permeability within the project footprint may lead to groundwater contamination. Spillage into the marine and surface water flows can have significant consequences for marine flora and fauna. This aspect has not been discussed to an adequate level of detail within the ERMP (Chapter 6, specifically section 2.6.11 page 6-83 and section 3.4 pages 6-115 - 6-135).

In addition, there are potential consequences associated with large scale shipping to and from the area and with barging operations between Hope Point and the anchorage in the Gulf. The potential impacts and proposed measures for avoidance and management of oil spills have not been addressed in sufficient detail within the ERMP (Chapter 6). Despite the close proximity to and the requirement for large ships to navigate through Ningaloo Marine Park and the Muiron Islands Marine Management Area, these marine protected areas have been excluded from the oil spill risk assessment (section 2.6.11 'Assessment and management of oil spills on subtidal BPPH, page 6-83). Unless an oil spill risk assessment that incorporates the wider Exmouth Gulf, Ningaloo Marine Park and Muiron Islands is undertaken and management measures to address risks are identified, environmental management of this significant issue must be considered unsatisfactory.

Overall there is considered to be insufficient information in relation to the potential impacts of oil spills in the ERMP. Oil spills can have highly significant effects on marine fauna and flora through poisoning, smothering and deprivation of light. Given the close proximity of significant benthic primary producer habitats and conservation significant fauna to shipping, barging and fuel storage activities, this issue warrants further discussion and impact assessment in the ERMP.

Recommendations:

51. The proponent should undertake a risk assessment of oil spills including impact analysis and dispersion modelling to identify the worst case impacts to the Exmouth Gulf, Ningaloo Marine Park and the Muiron Islands and their ecosystem and biodiversity values. This assessment should include specific details on the potential impacts to conservation significant species.

52. The proponent should provide more detailed information on the fuel storage facility at Main Island including the proposed capacity of fuel storage and the potential consequences of fuel spillage.

6. Acid sulphate soils

6.1 Soil excavation and mangrove disturbance

The construction of the salt crystallisation ponds and other infrastructure at the site will require large amounts of sediments to be excavated and dewatering will be required for the construction of harbour facilities. These activities have the potential to expose acid sulphate soil materials to oxygen and trigger the release of acidity and soluble metals into the receiving environment, particularly if the mangals are disturbed by the construction and management of the site. For example, investigations carried out on a disturbed mangal on the East Trinity Inlet in Queensland (Hicks *et al.* 1999) indicated that bunding and drainage of the area triggered the acidification of about 110 ha of soil and released at least 76,000 tonnes of sulphuric acid into the marine environment and 33 tonnes of CO_2 into the atmosphere on an annual basis. Soils on the site still contain about 600 tonnes per hectare of stored sulphuric acid. Large amounts of readily bioavailable metals including aluminium, zinc and arsenic are being discharged into the nearshore environment, either in acidic leachate or adsorbed onto iron oxyhydroxide particles. The Queensland Government is currently carrying out a multi-million dollar treatment program to ameliorate the environmental impacts of metal and acid discharge from the site.

Recent visual inspection from the air of the nearby Onslow salt works by officers from DEC and the Department of Water suggests that soil acidification may be taking place as a result of earthworks at this site, and as consequence there is a risk that bio-available metals are being discharged at least periodically into the nearshore environment. Given the much larger size of the Yannarie project and its proximity to sensitive fish nursery areas, there is the potential for larger impacts with significantly greater impacts on the marine and coastal environment from this site without adequate management.

The proponents have not indicated how excavated acid sulphate soil materials will be managed to meet DEC requirements and national best management practices for these materials. Given that it is likely that significant quantities of lime may be required to treat these soils, and that storage will need to take place on constructed and bunded limestone pads, there is much uncertainty as to whether sufficient limestone of suitable quality is available on site to undertake this work. Additionally, there is question over the ability to successfully mix lime into soils given their heavy texture. The ERMP does not discuss how acid generating materials will be confined, disposed of or otherwise managed (pages 5-11 – 5-13 'Acid Sulphate Soils').

6.2 Formation of Iron Monosulphide Black Oozes (MBOs) and maintenance dredging

There is a high risk that earthworks for constructing the facility will disturb potential acid sulphate soil materials on the site and increase the discharge of iron to Exmouth Gulf via groundwater discharge and episodic high volume surface water flows. Given sufficient iron,

conditions within the Gulf may be suitable for naturally occurring sulphate reducing bacteria to generate biochemical precipitates containing large concentrations of colloidal iron monosulphide minerals (so called monosulphide black oozes or MBOs). These materials can smother benthic substrate and associated biota and can rapidly deoxygenate the water column (Bush *et al.* 2004; Burton *et al.* 2006a; Burton *et al.* 2006b) and cause fish kills if disturbed by storm surges or by dredging. During this process, heavy metals stored within the MBOs can be released into the water column and become bio-available.

6.3 Dewatering impacts on acid sulphate soil materials

The limestone features of Hope Point will make it difficult to confine the dewatering footprint within the area of excavation and treatment, increasing the risk that sulphide minerals will be oxidised below the ground and then continue to discharge acid and metals into the receiving environment. The high hydraulic conductivity of the limestone is likely to mean that very large volumes of water will need to be pumped to enable dewatering to take place. The proponents have not indicated how this water will be managed, or how sufficient holding time will be provided to ensure that any acidity can be effectively lime treated and iron and aluminium oxyhydroxide precipitates removed.

The ERMP (page 5-11) states that the volume of excavated material that may be potentially acid generating is small compared with the total volume of material. Although this may be the case, the scale of the proposal must be taken into account. Given that the area of the primary footprint is over 40,000 ha, the volume of acid forming material that could potentially be disturbed is significant. The ERMP (specifically Chapter 5) has not provided a map that identifies where potential acid sulphate soils exist overlaid with areas of proposed disturbance and excavation. This information is critical for assessing the potential impacts of the proposal with respect to this issue.

Recommendations:

53. The ERMP is largely deficient in information on the management of acid sulphate soils, the extent of acid sulphate soils and the consequences of acid sulphate soil impacts on the ecology of Exmouth Gulf. The following additional information is required in order to continue with the assessment:

    - A map that identifies where potential acid sulphate souls exist overlaid with proposed areas of disturbance.
    - Quantitative and adequately justified estimates of the volumes of acid forming material that could potentially be affected during construction, dewatering and operational activities of this proposal.
    - Acid sulphate soil management commitments consistent with national standards.
    - The volume of lime required and the sources of lime that will be utilised.

54. The proponent should undertake a scientific analysis of the risks and consequences associated with the disturbance and exposure of acid forming materials including potential impacts on benthic habitats, water quality and marine and coastal fauna and should provide the results of this analysis to the EPA and decision making authorities during the assessment of this proposal.

7. Conservation significant fauna

7.1 Importance of Exmouth Gulf for marine fauna

Conservation significant species such as humpback whales, dugong, marine turtles, sea snakes, rays, sharks (including the whale shark) and a diverse range of fish of tropical Indo-West-Pacific affinity inhabit the waters and habitats of Exmouth Gulf. Tidal creeks are known to support barramundi spawning events between September and March and provide protected habitat for marine turtles and species of mangrove dependent fish. In addition, the diverse communities of epibenthic fauna are supported within the benthic primary producer habitats of the eastern side of Exmouth Gulf, including some species that are endemic to the Pilbara/Kimberley Region (Wilson et al. 1994).

It has been shown that the waters of the Ningaloo Marine Park and Exmouth Gulf provide habitat for significant populations of sea turtles and dugong. Some of the other larger marine vertebrates including large and small cetaceans and whale sharks and manta rays are also a feature of the region (Preen *et al.* 1997).

It should also be noted that the fish fauna of the eastern side of the Gulf have not been extensively studied and scientific understanding of marine fauna and their habitat associations is extremely limited. A study currently in progress by the University of Queensland has led to the discovery of a new genus of goby which is associated with algal mats, and may be dependent on the use of these areas for certain stages of its life cycle. This new species is yet to be described.

The key issues with respect to potential impacts on marine fauna can be summarised as follows:

- Loss of benthic habitats, including recognised important fish nursery areas and regionally significant dugong habitat (direct and indirect, short-term and long-term);
- Decline in the productivity of marine fauna communities and fisheries (including prawns);
- Decline in water quality associated with fuel/oil spills, breaches in levee walls, discharge of waste water and/or bitterns; and
- Adverse long-term impacts on the viability of threatened and conservation significant fauna populations;
- Vessel disturbance including collision and interference.

The ERMP (in particular section 3.4.3 pages 6-117 – 6-119) fails to demonstrate that impacts on the long term survival and behaviour of these fauna in Exmouth Gulf will be satisfactorily avoided or mitigated.

The following sections discuss the uncertainties in relation to impacts on marine fauna with a focus on conservation significant marine fauna of Exmouth Gulf.

7.2 Dugong

The dugong is a species of State, national and international conservation significance. The dugong is listed as specially protected fauna under the *Wildlife Conservation Act 1950.* The population of dugong that occurs in northern Australia is considered to be of vital importance on a world scale, primarily because other populations have declined and become fragmented (Marsh and Lefebvre 1994). The animals that occur in the north-west of Western Australia form part of the largest population in the world (Marsh et al. 2002).

The conservation of dugong is a high priority for conservation management of marine environments in Western Australia (Simpson and Holley 2003) and for this reason DEC is currently preparing a management plan for the dugong. The plan is expected to indicate that marine and coastal development has been ranked in the top five of the seven major threats to dugong in Western Australia. Any proposal for industrial development, such as the proposed Yannarie Solar Straits Project, must include a thorough analysis of the likely impacts on dugong and their habitat.

Surveys of the distribution and abundance of dugong at Ningaloo Reef and in the Exmouth Gulf found that animals were mostly sighted on the eastern side of Exmouth Gulf (Preen *et al.* 1997) and coincided with the distribution of seagrass beds consisting of *Halodule* and *Halophila* (Marsh *et al.* 2002). The number of dugong recorded in 1999 was small compared to earlier surveys, indicating that dugong numbers had diminished after Tropical Cyclone Vance following the destruction of seagrass beds. Some evidence has been collected that indicates relatively large scale movements of dugong in WA waters, for example the Shark Bay population increased by 40% from an estimated 10,000 in 1989 and 1994 (Marsh *et al.* 1994, Preen *et al.* 1997) to around 14,000 in 1999 (Gales *et al.* 2004). The authors of the latter study concluded that the most likely explanation for this change was that the population had shifted south from Exmouth Gulf following Tropical Cyclone Vance in March 1999. In support of this hypothesis, the population of Exmouth Gulf and Ningaloo Reef declined from around 1,000 in 1989 and 1994 (Preen *et al.* 1997) to only 337 animals in 1999 (Gales *et al.* 2004), and effectively to near zero by April 2000 (Prince *et al.* 2002), when the Exmouth Gulf seagrass community had not yet shown recovery from the effects of Tropical Cyclone Vance (Loneragan et al. unpublished report FRDC). The course of replenishment of the resident dugong population within Exmouth Gulf in response to the seagrass re-establishment in the gulf to December 2001 was not documented. Dugongs had however returned to Exmouth Gulf by December 2001, and there was evidence of exodus from Shark Bay by February 2002 (Holley et al. unpublished report). The current size of the dugong population in Exmouth Gulf is unknown and DEC is intending to conduct a further dugong survey in 2007/8 following on from surveys conducted in 2002, 1999, 1994 and 1989.

There is no discussion in the ERMP (section 3.3.4 pages 6-108 – 6-109) of the significance of the Exmouth Gulf and Pilbara dugong population at the regional, State or national level, and the potential impact that the range of possible disturbances (direct and indirect) associated with this proposal could have on the conservation status of dugong in WA. As mentioned in section 1.3.2 (page 7-5), the ERMP asserts that a loss of 16.4 ha of benthic habitat through dredging will be negligible, but there is no discussion on the type of habitat that will be destroyed, and whether there will be a significant effect on the amount of cover and composition of seagrass in terms of the value of the area for dugong. It is also likely that the continuous movement of barges to and from Hope Point will cause disturbance to dugongs, potentially adding to the effects of disturbance caused by dredging activity.

A key management action in the Draft Dugong Management Plan under preparation for Western Australia (DEC unpublished) is the identification, protection and management of important dugong habitat. As there is little known about important dugong habitats in Western Australia, protection and research of dugong habitats is a priority for their conservation and management. The ERMP (section 3.4 pages 6-115 – 6-141) does not discuss or address impacts of the proposal on dugongs on the basis that the area of the proposed development appears to be an important habitat for dugongs and that the development may have a significant impact on the dugong. The following issues will require resolution in order to ensure protection of the long-term viability of the Exmouth Gulf dugong population from the impacts of this proposal:

- Lack of knowledge of dugong populations and movements;
- Lack of knowledge of important dugong habitats;
- Potential impacts of climate change on the development and implications for the dugong population;
- Loss of habitat due to dredging of the barge harbour and barge channel;
- Habitat modification and loss of productivity from indirect impacts such as changes to water quality caused from breaches in brine impoundment areas;
- Disturbance at important sites due to vessel displacement and noise;
- Death and displacement due to vessel collision;
- Entrapment through pump stations; and
- Secondary impacts such as fuel/oil spills and toxic wastewater discharge.

The impact mitigation measures discussed in the ERMP (e.g. page 6-121 'Entrapment') show a lack of understanding of the potential for impacts of the development on dugong. For example, the proponent's mitigation measure to reduce the risk of dugong boat strike is a 10 knot per hour speed limit for barges, which is regarded as inadequate. The 10 knot per hour speed limit measure is apparently based on the recommendations of Preen (2001) for speed restrictions in the Hinchinbrook Channel, Queensland. Preen's research was focused largely on recreational/tourism vessels. The size, acoustic effects and manoeuvrability of barges and ships is likely to be quite different to these kinds of vessels. In addition, the proponent's analysis of the potential impacts of vessel traffic does not take into account more recent research into the topic (e.g. Gerrard 1999; Gerstein et al. 2001, Hodgson 2004).

Recommendations:

55. The proponent and the EPA should recognise that Exmouth Gulf provides the second largest and important known dugong habitat in Western Australia and that the long-term maintenance of this population may be important for the conservation of the Western Australian Pilbara coastal and main Shark Bay dugong population.

56. The breeding and calving season for the dugong population of Exmouth Gulf should be determined prior the completion of this assessment. This should include the use of Exmouth Gulf as dugong habitat for feeding, lekking, travel, shelter from weather, thermal refuges, calving, protection from predators and refuge in the event of habitat change.

57. Seagrass distribution and dugong habitat associations should be determined in Exmouth Gulf prior to the completion of this assessment. Detailed dugong habitat mapping should be undertaken by the proponent to determine the extent of prime habitat throughout Exmouth Gulf prior to the completion of this assessment.

58. Targeted dugong surveys should be conducted in both winter and summer seasons to provide a baseline dataset on dugong prior to the completion of assessment of this proposal.

59. Boating traffic should be managed to avoid impacts on dugong by restricting movements, setting standard speed conditions and minimising vessel activity during dugong breeding and calving seasons.

7.3 Marine turtles

Aerial surveys over the period 1989 to 2000 have indicated that substantial numbers of marine turtles are resident within Exmouth Gulf (Preen et al. 1997, Prince, 2001). The estimate of turtle numbers in Exmouth Gulf in April 2000 (8461 ± 1126, Prince 2001) exceeded earlier mid-year estimates of 4512 (±877) for 1989 and 3252 (±684) for 1994 (Preen et al. 1997). This apparent difference is likely to reflect a seasonal variation in the behaviour of turtles, making them less likely to be detected by aerial surveys. The estimates are in any case conservative, as turtles below approximately 50 cm carapace length are not readily detected on standard surveys conducted at 137 metres (450 ft) altitude where dugongs are the primary target. Aerial surveys at greater heights, such as are standard for large cetaceans, are even less efficient for turtles. Other data obtained from the Western Australian Marine Turtle Project, with volunteer collaboration from the fishing industry working nets in the southern part of Exmouth Gulf, have shown that the majority of turtles recorded across the intertidal and shallow sub-tidal zone in Exmouth Gulf are green turtles (*Chelonia mydas*) (88.4%) with the majority of these classed as juveniles (Bob Prince pers. comm. 2006). Loggerhead (*Caretta caretta*) and hawksbill (*Eretmochelys imbricata*) turtles were much less common, comprising 9.2% and 2.4% of the tagged adult female turtles found off Sandalwood Peninsula and included turtles from known breeding groups: two loggerheads from the Dirk Hartog Island group, one green from North West Cape (Ningaloo), and two greens from the Barrow Island Group (R Prince, pers. comm. 2006).

Exmouth Gulf provides prime marine turtle foraging habitats, particularly among the inshore seagrass, algal bed and mangrove communities where juvenile turtles are found. Anecdotal evidence suggests that green turtles in Exmouth Gulf feed on algae on mangrove pneumatophores and have been seen feeding on mangrove propagules (Helen Penrose, pers. comm. 2007). There is little doubt that Exmouth Gulf is an important foraging habitat for green, hawksbill and loggerhead turtle turtles and is supporting foraging habitats of turtles that nest in Shark Bay, on the Ningaloo coast and on Pilbara islands such as Barrow Island. Tagged adult female flatback turtles from Pilbara nesting groups have also been captured in the northern waters of Exmouth Gulf. Leatherback turtles have also been recorded (R Prince, pers. comm. 2006).

It should also be noted that DEC beach surveys in 2006 showed that loggerhead, green and likely flatback turtle nesting was observed on Locker Island to the north of the proposed project site and that green turtles are known to nest on the western side of Exmouth Gulf near Bundegi beach. The Muiron Islands at the head of Exmouth Gulf have the southernmost flatback turtle nesting records in Western Australia.

To adequately assess and manage the risks posed by this project to turtle conservation, the proponent should develop an understanding of marine turtle habitat associations and requirements in the Exmouth Gulf, including feeding patterns, migration and linkages with nesting populations. It must be emphasised that, due to the life history and biology of marine turtles, impacts at a population level that may occur will not become evident for 20-40 years. It should also be acknowledged that prime turtle nesting and foraging habitats in other parts of the Pilbara have been degraded, modified or removed via other large scale industrial projects and that an assessment of the cumulative impacts of these projects on regional turtle populations is warranted given their conservation status and migratory behaviour. In the absence of an understanding of the population dynamics of marine turtles within Exmouth Gulf and given the lack of certainty that the proposed salt project can be managed to avoid impacts on marine turtle habitat, a precautionary approach to consideration of potential development impacts is recommended.

A discussion on the potential impacts of vessel strike, entrapment in intake pumps and light overspill and glow as a result of the development is also warranted (section 3.4 pages 6-115

– 6-141). Marine turtles are prone to vessel strike, particularly when resting and feeding in the shallow inshore waters. Entrapment in the intake pumps stations is also a potential issue given the likelihood for the occurrence for small juvenile turtles within the tidal creeks and appropriate mitigation and management measures should be discussed (page 6-121). The impacts of light pollution should be evaluated from both coastal infrastructure and on vessels (barges and ships) within Exmouth Gulf given there is potential for disorientation of juvenile turtles, resulting in increased exposure to predation.

In summary the ERMP (section 3.4 pages 6-115 – 6-141) is deficient in assessing the direct and indirect, short and long-term impacts on marine turtles, and given that each species found in the Gulf is threatened, this is considered to represent a significant information gap for the assessment of the proposal.

Recommendations:

60. The proponent should undertake the necessary studies in consultation with DEC to determine the habitat importance of Exmouth Gulf for the turtle populations of northern Western Australia as there is a high likelihood that the loss of prime foraging habitats in the Exmouth Gulf, possibly as a result of this proposal, will result in long-term impacts to populations nesting in other areas. Taking into account the risks and potential impacts associated with this project as identified in other sections of this advice, such information is considered necessary to enable the impacts of this project on turtles to be properly assessed.

61. The proponent and the EPA should consider to what extent the potential for loss of benthic primary producer habitats, in particular mangroves, macroalgae and seagrass and other zoobenthos communities through the proposed project could have a significant long-term implications for marine turtle populations given that extensive marine habitat degradation has already occurred throughout the Pilbara region.

7.4 Migratory avifauna

The east coast of Exmouth Gulf is known to provide internationally significant habitat for migratory shorebirds and waders. The ERMP (section 5.3.4 'Birds' page 5-78) suggests that 28 migratory waders recorded from the survey by Biota (2005) are listed as migratory species under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The site is of international importance for five species: Grey-tailed Tattler, Greater Sand Plover, Bar-tailed Godwit, Ruddy Turnstone and Sanderling (page 5-78 – 5-79). Of these, the area is of international importance in all three seasons (breeding, non-breeding, and migration) for the Grey-tailed Tattler.

There is very limited discussion of the impacts that the project may have on these migratory species or how these impacts may affect their migratory patterns and life cycle (section 5-4, pages 5-91 – 5-94). There is also no detailed discussion on how the proponent will mitigate impacts to migratory avifauna resulting from the project.

Three activities have been identified by the proponent as having significant potential to directly impact migratory birds. These are site preparation, vehicle and equipment movement, and noise emissions.

The impacts of 'Site preparation' are described as of being of minor importance by the proponent as this component is only described as involving the clearing 5.36 ha of mangrove habitat. However, in addition to failing to address whether the remaining habitat in the vicinity of impacted areas will be adequate in providing suitable roost sites for the various species of migratory shorebirds, the discussion does not recognise the potential for larger

scale impacts that may result from changes to ecosystem processes from infrastructure including water intakes and large scale development of salt ponds on the supratidal flats. The ERMP does not indicate that the proponent has recognised or assessed the full range and scope of potential impacts on migratory waterbirds, and other avifauna that utilise Exmouth Gulf (section 5-4, pages 5-91 – 5-94), including indirect effects from possible nutrient changes.

Vehicle and equipment movement and noise emissions are considered by the proponent to be "difficult to quantify" (page 5-93). Given that Exmouth Gulf is significant on a global scale for at least five species of migratory waders, a more through assessment of the long-term, direct and indirect impacts is warranted. The proponent should consider:

- localised changes in hydrology due to intake of seawater at the north and southern intakes (resulting in changes to ecosystem processes);
- light emissions;
- creation of modified or artificial habitat by constructing salt ponds and borrow pit lakes;
- indirect impacts to mangrove habitat due to changes in hydrology and coastal processes; and
- infrastructure such as powerlines and towers affecting flight and nesting patterns.

The ERMP states that the proponent will 'minimise' loading operations during the breeding and nesting season of shorebirds and waders (page 5-92). This may assist in reducing impacts to migratory birds, and further information is required from the proponent on this commitment.

Given that Exmouth Gulf, in particular the Hope Point area, provides important habitat for migratory birds, many of which are listed under the Japan-Australia Migratory Birds Agreement (JAMBA) and China-Australia Migratory Birds Agreement (CAMBA), the proposal presents a high risk of direct and indirect disturbance to birds utilising these habitats. The information provided in the ERMP on the distribution of each species and the likely areas of disturbance is inadequate (Section 5.3.4 pages 5-78 – 5-84). A clear statement about the numbers and proportions of birds recorded in different areas adjacent to the project area (especially around North Hope Island), and along the coast to the north and south, would be helpful in assessing the direct and potentially indirect impacts to waders.

The ERMP (page 5-81) uses comparisons of the site to Barrow Island as important habitat for migratory birds. Although there is some validity in this comparison, the view that it is acceptable to disturb the Exmouth Gulf habitat because it is not the best known habitat in the region is not supported. If only the best habitats were retained, wader population sizes would reduce overall and eventually the numbers at the best sites would also decline. Exmouth Gulf is a significant area for waders in that it is a key part of one of the most important regions of the west coast of Australia for bird habitat, and is clearly a very important area for Grey-tailed tattlers. The mapped distribution and abundance of waders during foraging is an important spatial dataset that is absent in the ERMP (section 5.3.4, pages 5-78 – 5-84).

Recommendations:

62. The EPA should take into account that the eastern Exmouth Gulf area affected by the proposal is a nationally important wetland and is ranked as being of international significance for at least five species of migratory waders. The modification or destruction of internationally important habitat for migratory waders could have ramifications for future assessments of our commitments to the JAMBA and CAMBA migratory bird agreements.

63. The proponent should provide more detailed maps of the distribution and relative abundance of each species of migratory bird in relation to foraging activity.

64. The proponent should provide a clear statement about the numbers and proportions of birds recorded in different areas adjacent to the project area (especially around North Hope Island), and along the coast to the north and south, to assist in assessing the direct and potentially indirect impacts to waders.

65. The proponent and the EPA should recognise that the key issue for wader conservation in Exmouth Gulf is the maintenance of mangrove and tidal flat systems and the quality of inter-tidal habitats, and that at present, the long-term risks and associated impacts to these habitats are uncertain.

7.5 Humpback whales

According to the Centre for Whale Research reports, Exmouth Gulf is the key resting area on the WA coast between the Kimberley and Shark Bay for humpback whales, in particular, mothers and calves.

The ERMP (page 6-130, paragraph 1) states, in regard to vessel movement impacts, that "it is probable that animals will quickly habituate and the noise will not produce any startle or alarm type of responses". There is no reference provided to justify this statement. McCauley *et al.* (1998) state that cow/calf pods are more sensitive to acoustic disturbance than adult pods, suggesting that these pods in Exmouth Gulf are likely to be particularly vulnerable to vessel movement, noise and vibration. Recent work by the Centre for Whale Research (2005) also suggests that further research is required to determine the sensitivity of whales and calves to the proposed shipping movements.

In the absence of information on the pathways of humpback whales within Exmouth Gulf and their utilisation of gulf waters during resting phases, it is difficult to determine whether the disturbance associated with the proposal will have a long-term adverse impact on humpback whale populations.

Recommendations:

66. The proponent should commit to limiting shipping activities and/or special whale impact avoidance measures during the peak of the southward whale migration season, between August and October annually.

67. The proponent should undertake studies to develop an improved understanding of humpback whale movements and behaviours in Exmouth Gulf in order to determine the potential extent of displacement impacts as part of the assessment of this proposal.

7.6 Whale Sharks

There is an absence of published scientific knowledge about the importance of Exmouth Gulf for whale sharks. Whale sharks have been sighted in Exmouth Gulf opportunistically outside of the season of whale shark activity in the Ningaloo Reef area (March-July), specifically December 2005, and September and November 2006. There is a possibility whale sharks are present in Exmouth Gulf during the annual whale shark 'season' for Ningaloo Reef that is centred on the month of April.

Recommendation:

68. The EPA should note that whale sharks occur in Exmouth Gulf outside of the peak whale shark season and that there is very little known about whale shark ecology and biology on a global scale. To date, there is no specific knowledge of the location and nature of whale shark breeding areas.

8. Translocation of Non-Indigenous Marine Species

The introduction of non-indigenous marine species can lead to significant adverse ecological impacts including large-scale habitat alteration, disease and decline in biodiversity. Given the ecological significance of Exmouth Gulf, the proposal represents an elevated risk to biodiversity in the Gulf due to increased shipping in the region, including bulk carriers, barges and dredges from international and other State waters.

The ERMP (section 3.4.9 pages 6-134 – 6-140) does not provide sufficient detail in relation to the risks of introduction of non-indigenous marine species associated with dredging activity and refers only to bulk carriers as the primary risk of introduction. Ballast water is managed by the Australian Quarantine and Inspection Service (AQIS), however this does not cover the possibility of introduction via vessel hulls in particular slower moving barges and dredges. It should be noted that these vessels often spend significant periods of time in one location and operate in shallow waters. These factors increase the risk of non-indigenous marine species establishing in the region.

The risk of non-indigenous marine species from vectors such as barges and dredges should be subject to detailed risk assessment and management for the following reasons:

- AQIS processes do not establish a solid framework for the management of non-indigenous marine species from vessel hulls and deal primarily with ballast management.
- Dredges and barges are likely to present higher risks given their slow movement and potential docking for long periods of time in waters that could potentially support species that could establish in the tropical waters of Exmouth Gulf.
- The locations for barge and dredge operations associated with the proposal are associated with relatively shallow waters which increases the risk of establishment of non-indigenous marine species.
- It is likely that maintenance dredging will be required periodically over the life of the mine, therefore increasing the risk of dredges as a non-indigenous marine species vector.

DEC supports mechanisms recommended by the Department of Fisheries for the quarantine and surveillance of non-indigenous marine species prior to vessels entering State waters. These include:

- Best practice anti-fouling systems approved by Department of Fisheries;
- Inspection of vessels in a 'dry dock' environment prior to departure from docked location;
- Evidence of adequate inspection of vessels by suitably qualified personnel to the satisfaction of the Department of Fisheries prior to departure from dock, or otherwise inspection by a suitably qualified Department of Fisheries officer prior to arrival in State waters; and

- Clear and immediate management responses should non-indigenous marine species be detected on the vessel or associated equipment. This information should be included in a Marine Management Plan to the satisfaction of the Department of Fisheries and DEC prior to any approval.

Although there are a number of management measures that can be utilised to prevent non-indigenous marine pest incursions, the number of slow-moving vessels and international ships entering the waters of Exmouth Gulf is currently low. It is important that the EPA notes that the approval of this proposal will substantially increase the risk of marine pest incursions and that the consequences of introductions for the ecologically significant Exmouth Gulf ecosystem and habitats are potentially high.

Recommendations:

69. The EPA should note that the risk of non-indigenous marine species being introduced and establishing in Exmouth Gulf will be increased by the significant rise in shipping traffic that is associated with this proposal. The possible impact to the marine environment of Exmouth Gulf from the introduction and establishment of non-indigenous marine species is significant.

70. Should the proposal gain EPA endorsement, the following condition is recommended "Prior to the commencement of any activities associated with the proposed development, a Non-Indigenous Marine Species Management Strategy must be developed to the satisfaction of the EPA on the advice of the Department of Fisheries and the Department of Environment and Conservation to establish management procedures to detect non-indigenous marine species and ensure that non-indigenous marine species are not introduced to State waters".

9. Subterranean Fauna

The ERMP (section 3, page 3-7) indicates that the proponent considers that subterranean fauna is a minor environmental factor for this project, however there have been no subterranean fauna investigations undertaken in the area to provide a basis for this view. The argument in the ERMP that sampling has been limited as "clearance to drive a drilling rig into the area has only recently been received" (page 3-9) is not sufficient reason for inadequate investigation. Similarly the assumption that the area is "unlikely to provide habitat for stygofauna or troglofauna" on the basis that the aquifer is hypersaline is not adequate, particularly given that full geotechnical surveys have not been undertaken (page 5-22). Ideally, all investigations should have been undertaken prior to release of the ERMP so that an informed assessment can be made.

DEC is aware that subterranean fauna studies are required to be undertaken to the satisfaction of the EPA on the advice of DEC and the WA Museum prior to the final assessment of this proposal. It is understood that this assessment has the purpose of establishing whether subterranean fauna occur within the study area or other areas likely to be affected by the proposal and if so, whether subterranean fauna of conservation significance are present. It is essential that the species distribution, abundance and richness of subterranean fauna are established if these fauna are detected during sampling.

It is important to note that this information may be critical to the assessment given that the Exmouth Gulf area falls within the same biogeographic region as Barrow Island and the Cape Range peninsula (Cape Range sub-region of the Carnarvon bioregion). Both of these areas are known to support high levels of subterranean biodiversity, including both stygobitic and troglobitic fauna, some of which are specially protected as threatened fauns pursuant to the *Wildlife Conservation Act 1950*. Furthermore, the development could potentially impact

on subterranean fauna through dewatering and groundwater abstraction, contamination of groundwater, and extraction of material for the limestone quarries. Limestone areas in particular may provide habitat for troglobitic fauna (as seen elsewhere in the Cape Range sub-bioregion).

Recommendation:

71. In the event that significant subterranean fauna is detected during the proponent's preliminary sampling program, further studies will be required to determine the distribution, abundance and species richness of subterranean fauna within areas that could be potentially affected by the proposal. Should conservation significant subterranean fauna occur, the impacts on subterranean fauna cannot be ascertained in the absence of an adequate understanding of the hydrogeology of the site and therefore a satisfactory assessment of the risks to subterranean fauna will be difficult until the required information on hydrogeology referred to earlier in this submission is available.

10. Impacts on Conservation Reserves in the project area

The ERMP states that there is no direct link of waters between the east coast of the Gulf and the Ningaloo Marine Park (page 4-7). While some references are cited to support this statement (Massel et al. 1997; APASA 2005a & b) and the main direct water transport pathways to and from the eastern Gulf are described, there is a need for more detailed discussion to explain the seasonal variation in currents, other oceanographic processes and faunal movements in the Exmouth Gulf region. It cannot be assumed that impacts on Exmouth Gulf will not have any impact on Ningaloo Reef without substantiated evidence.

The report and recommendations of the EPA in the document *Conservation Reserves for Western Australia* (EPA, 1975) identified the islands of Exmouth Gulf as being of value for nature conservation, and recommended that they be set aside as nature reserves (recommendation 9.7). Since 1975 a number of the islands in close proximity to the proposed development have been designated as conservation reserves. These areas are:

- Gnandaroo Island Nature Reserve (no. 33216)
- Rocky Island Nature Reserve (no. 42759)
- Victor Island Nature Reserve (no. 42761)
- Y Island Nature Reserve (no. 42762)
- Tent Island Nature Reserve (no. 42758)
- Burnside and Simpson Island Nature Reserve (no. 42760)
- Whalebone Island Nature Reserve (no. 42756)
- Whitmore-Roberts-Doole Islands and Sandalwood Landing Nature Reserve (no. 42755)

Additionally, the former Giralia pastoral lease has been purchased by DEC for establishment of a conservation reserve. Until the area is formally added to the conservation reserve system, it is being managed by DEC under section 33(2) of the CALM Act.

A number of potential impacts on these reserves and lands managed by DEC may result from the implementation of the proposal and associated infrastructure. These have not been mentioned or discussed in the ERMP (Chapter 5 'Terrestrial Factors') but would require management and include:

- Potential clearing for land-based access through Giralia Station (the ERMP does not discuss options for land-based access but DEC is aware that there will be a need for an access road to the site during the construction and possibly also operational phases); and
- Increased long term pressure on the Cape Range National Park and Ningaloo Marine Park from the flow-on effects of increased permanent residency of approximately 200 staff and their families.

Recommendation:

72. The proponent should provide a description of the potential direct and indirect impacts of the project relating to possible use of, and visitation to, conservation reserves and other lands managed by DEC under the CALM Act within the project study area, and address any relevant management issues prior to the completed assessment of this proposal.

11. Terrestrial vegetation and flora

Exmouth Gulf is situated within the Cape Range Subregion of the Carnarvon Biogeographic Region, of which only 2.2% is protected in the conservation reserve system. The report *Biodiversity Audit of Western Australia's 52 Biogeographic Subregions in 2002* (CALM, 2003) specifically identifies the islands of Exmouth Gulf and the mangroves of eastern Exmouth Gulf as being of high conservation value. The Audit identifies five ecosystems (vegetation associations) that occur within the proposed Yannarie solar project footprint which are of high priority for reservation, as follows:

- Medium woodland; Coolibah (E. microtheca) – 0 ha currently reserved;
- Bare areas; mudflats – 0 ha currently reserved;
- Bare areas; claypans – 0% currently reserved;
- Succulent steppe; samphire – 51 ha (non-IUCN) and 40.1 ha (IUCN) currently reserved;
- Shrublands; open dwarf scrub, waterwood (Acacia coriacea) on recent dunes – 267.3 ha (IUCN) currently reserved.

All of these communities are likely to be disturbed to some degree by the Yannarie salt project (page 5-60). In particular, the ERMP (Table 5-6, page 5-60) recognises that within the project area, the proposed salt ponds will affect approximately 40,000 hectares of the 'bare mudflats' association, which is a high priority for reservation, and will impact on the majority proportion of the largest expanse of supratidal salt flats in the Cape Range subregion.

The flora and vegetation report undertaken for the proponent (Biota, 2005) identified that a total of 41 species occurring in the project area are range extensions, with 21 of these being species at the northern limits of their distribution. Biota also reported that the majority of vegetation within the project area is generally in "very good to excellent condition, with little ground disturbance and very few weed species" (page 5-59). This is indicative of the relatively inaccessible nature of the area, and the fact that the area has had little or no previous disturbance.

It is noted that a botanical field survey was undertaken in the project area in August 2004, which concentrated on the northern expansion area, and that further botanical surveys have been commissioned to be completed by April 2007 (page 5-52). While impacts on specific

flora and vegetation communities do not appear to be the focus of this assessment, comprehensive botanical data for the whole project area are required by DEC in order to provide conclusive advice on the impacts on terrestrial flora and vegetation and to facilitate informed approval and management decisions. In particular, areas that are proposed for disturbance such as the limestone quarries, haul roads and vegetation around the weir diversion, need to be surveyed for vegetation and flora prior to a decision on the project, on order for an adequate assessment of impacts to be made.

Various comments are made in the ERMP (section 4.3 Terrestrial vegetation and flora, pages 5-53 – 5-70) regarding impacts on vegetation, which are not justified without adequate survey data. For example, the ERMP states that coolibah communities, which are of conservation significance, will not be affected by the development (page 5-56). However, on page 5-44 it is recognised that the Yanrey Land System (where the diversion weir is proposed to be constructed) contains coolibah woodland, suggesting that communities may be impacted by the changes in hydrology due to the diversion weir. Vegetation surveys do not appear to have been undertaken in this location to determine whether there will be any impacts to this and other communities. Statements that there are no declared rare flora or threatened ecological communities in the project area should not be made until the results of the full botanical survey are available.

The ERMP identifies significant vegetation communities ('high reservation priority ecosystems') as they relate to the project area (table 5-6, page 5-60) and briefly outlines which of these communities will be impacted by the development. There is however, no discussion of the level of impacts to these communities, their representation in conservation reserves or management measures that will be implemented by the proponent to mitigate impacts to these communities.

The following information gaps and deficiencies in the ERMP (section 4.3 Terrestrial vegetation and flora, pages 5-53 – 5-70) have been identified with respect to flora and vegetation:

- Clearing for land-based access to the site has not been assessed or subject to impact assessment.
- The location and requirements for vegetation clearing for the proposed construction camp have not been discussed.
- The floodplain area in the hinterland that will be impacted by the proposed weir diversion has not been subject to flora and fauna assessment.
- There are inadequate data to determine the uniqueness of the claypan communities which have been identified by DEC as having high reservation priority.
- An analysis of vegetation clearing based on the regional and sub-regional extent and level of reservation of remaining vegetation communities has not been undertaken. Instead, the proponent has made a comparison between the total footprint size and the amount of clearing required, which is not an acceptable method for vegetation impact assessment.
- A vegetation assessment of all mainland 'islands' within the supratidal flats has not been undertaken. Given there is potential for groundwater contamination through hypersaline intrusion of groundwater, baseline data for all islands are needed.
- The waste water from the treatment plant and the construction camp will be treated to upper secondary levels and discharged to irrigate landscape areas located in the hinterland. There is no discussion on the potential impacts on vegetation communities and further assessment of the risks to biodiversity has not been provided.

- An evaluation of the need for management measures to address vegetation decline is absent from the ERMP.

Furthermore, the ERMP (pages 5-22 'Groundwater dependent ecosystems') fails to recognise that groundwater dependent ecosystems are not limited to subterranean fauna, but also include phreatophytic vegetation. There is a need to identify whether there is any phreatophytic vegetation in the area that may potentially be impacted by dewatering. Samphires are sometimes known to display some level of groundwater dependency, and therefore may be impacted by dewatering. This needs to be addressed by the proponent.

Recommendations:

73. Further assessment by the proponent of the risks associated with wastewater discharge into the hinterland is warranted given previous problems encountered with artificial watering of vegetation. The proponent should provide this information for inclusion in the additional flora assessment report required by the EPA.

74. Further assessment of flora and vegetation within the study area to address the above mentioned gaps should be undertaken by the proponent to the satisfaction of DEC prior to finalising the assessment of the proposal.

75. A decision should not be made on this proposal until comprehensive botanical data for the whole project area are provided by the proponent. In particular, flora and vegetation surveys are required for areas that are proposed for disturbance such as the limestone quarries, haul roads and vegetation around the weir diversion to facilitate adequate assessment and management of impacts.

76. The proponent should provide information on the level of impacts expected to vegetation communities of high reservation priority, provide information indicating whether remaining vegetation in the local area and region will adequately represent communities that will be impacted, and outline mitigation measures that will be implemented to mitigate impacts to these communities.

12. Terrestrial fauna

The discussion on prediction and management of impacts on terrestrial fauna in the ERMP (section 5, pages 5-79 – 5-93) lacks detail and does not indicate that a thorough assessment of impacts has been undertaken. As with migratory shorebirds (see Section 7.4 of this submission), the scope and detail of assessment of impacts on terrestrial fauna is poor, and only focuses on three elements: site preparation, vehicle and equipment movement, and noise emissions (the latter of which are claimed by the proponent to be "difficult to quantify" page 5-93). There is no discussion on other indirect impacts on fauna such as lighting, habitat fragmentation, and alterations in hydrology.

The utilisation of the "barren salt flat" for the evaporator ponds is a project characteristic. It is not considered to be a specific management measure adopted by the proponent to mitigate impacts on fauna, particularly in the absence of necessary hydrogeology and subterranean fauna information.

It should also be noted that mulgara were trapped (and vouchered with the WA Museum) during a recent DEC fauna survey on Giralia Station and that this is considered a northern extension of the known distribution. Therefore, it should be noted by the proponent that there is a likelihood that mulgara occur within (or at least adjacent to) the project area. It is important that the proponent verifies whether this threatened species occurs within the

proposed site and that potential impacts are addressed in the assessment and appropriately managed.

The proposed establishment of fauna surveys, wildlife corridors and linkages requires further clarification of the purpose and proposed outcome at a regional level. The proposal for involvement in collaborative feral animal control programs in the local area warrants consideration, but needs to involve close consultation with DEC.

Recommendations:

77. The proponent should undertake necessary fauna surveys in consultation with DEC to determine the presence/absence of conservation significant terrestrial fauna in or adjacent to the study area prior to the completion of assessment of the ERMP.

78. The proponent should provide further information on the full range of potential impacts, direct and indirect, on terrestrial fauna as a result of the development, focusing on impacts including, but not limited to habitat fragmentation, changes in hydrology and light emissions. Adequate management strategies should be developed in consultation with and to the satisfaction of DEC.

13. Wilderness and nature-based tourism values

It is important to recognise that Exmouth Gulf potentially possesses what fall into the generally accepted category of significant 'wilderness' values attributed to near-pristine environments and is currently subject to a very limited access and level of commercial activity. The area provides known and potential important habitat for conservation significant and commercially valued marine fauna and extensive coastal, nationally important wetlands and tidal creeks that have been recognised as having international significance for migratory waders. Humpback whales, dugongs, manta rays and marine turtles utilise the Gulf for certain stages of their lifecycles and provide for sustainable wildlife tourism and education opportunities. Furthermore, the extensive mangrove, algal mat, seagrass and algal mat communities along the majority of the southern and eastern coastlines of the Gulf are intact and provide extremely important fish habitat areas. As the area is classified as unallocated Crown land (UCL) rather than pastoral lease, there has been little formal grazing of livestock. As a result there is little obvious land degradation, the vegetation is in good condition, and there are apparently few weeds present.

Given the relatively low level of pre-existing anthropogenic impacts and activities in the eastern Exmouth Gulf, the area, in conjunction with Ningaloo Reef, provides nationally and internationally important habitats. It is considered highly important that these intrinsic and wilderness values are maintained. Major developments in industrial areas to the north of the site (e.g. the Burrup Peninsula) in the Pilbara region have largely diminished the 'wilderness' values of the Pilbara coast. The Exmouth Gulf is considered one the last remaining near-pristine areas in the Pilbara where wilderness experiences and sustainable nature-based activities can occur and may continue to occur in the absence of large scale industrial development. It is inevitable that the development of the Yannarie Solar Salt project would significantly reduce the wildness values of Exmouth Gulf in perpetuity.

Recommendation:

79. The EPA should take into account in its assessment of this proposal, the highly significant 'wilderness' values of Exmouth Gulf, and acknowledge that the project area is one of the last remaining areas on the mainland Pilbara coast without significant industrial development.

14. Social Impacts and sustainability

14.1 Increased visitation to the conservation reserve system in the Exmouth area

The proponent predicts that the proposed salt mine will generate employment for up to 200 people who will be located in Exmouth. DEC wishes to bring to the proponent's attention, through this submission, the issue of workforce management and the need to manage the predicted increase in visitation to and impacts on the conservation reserve system of the Pilbara region.

The direct and indirect effects of a significant additional number of people residing in Exmouth leading to additional visitation to the Cape Range National Park and Ningaloo Marine Park will require additional management input from DEC, which will ultimately be responsible for managing environmental impacts and visitor safety associated with additional visitors.

Recommendation:

80. The proponent needs to discuss and address the potentially negative impacts associated with an increase of approximately 200 employees and their families to Exmouth, and should develop strategies in consultation with DEC, to avoid or manage adverse ecological impacts that may flow from this significant increase in permanent residency.

14.2 Opportunity costs and alternative development scenarios

The ERMP (Table 2.2, page 2-9). states that the economic benefits to the State from this project through royalties will be in the order of $5 million per annum. The economic costs of assessing and managing direct and indirect impacts of the project and the risks associated with changes to economic values such as fisheries are not known but are potentially significant.

By comparison, tourism in Western Australia, which is closely linked to the appreciation of the natural environment (terrestrial and marine), is a major, long-term and sustainable contributor to the State economy with the Ningaloo Reef area being recognised as a major tourism asset for the State.

The decision by Government on whether or not to approve the project should, in part, be determined on the basis of whether the environmental and social impacts of the project are adequately balanced by the economic benefits to the State as a result of the project proceeding. An economic/social assessment of the potential loss of wilderness and nature-based tourism values of Exmouth Gulf through industrialization should also be undertaken to enable the economic and social benefits of the project to be compared with the costs of foregoing or limiting long-term opportunities for nature-based tourism.

Exmouth Gulf also provides significant fish habitat areas and supports a productive prawn trawl fishery. Given that there are likely to be important faunal linkages between Exmouth Gulf and Ningaloo Reef, it is important that the EPA and State Government take into the account the potential for degrading habitat that may support the recruitment of valuable recreational and commercially valued fish species that inhabit the Ningaloo Reef and offshore waters.

14.3 Decommissioning strategy

There is no decommissioning plan associated with this proposal. Notwithstanding DEC's view on the environmental acceptability of this project it is important that the costs associated with decommissioning and restoring the site, should the proposal be approved but become unviable in the future, be taken into account in the assessment and decision-making process.

It should be a requirement that the proponent provides an analysis of the feasibility of site restoration in the event that the project became economically unviable, given the potential large scale ecological consequences that could result from abandonment of bunds and other project infrastructure.

Recommendations:

81. The significant contribution that nature-based tourism in the Ningaloo area provides for the State should be recognised in consideration of the costs and benefits of this proposal and the potential for ecologically sustainable nature-based tourism in Exmouth Gulf focused on wilderness tours, sustainable recreational fishing and wildlife interactions should be taken into account. These opportunities are likely to be foregone through the large-scale industrialization of Exmouth Gulf.

82. The EPA should give consideration to recommending that the Government undertake an economic and social analysis of the value that Exmouth Gulf and its productive habitats, commercial fishery, wilderness, geoheritage and intrinsic natural values provide to the State in comparison to the social and economic gains proposed through the construction of the proposed Straits Solar Salt mine. This would enable a cost-benefit analysis of the environmental, social and economic aspects of this proposed development.

83. There should be a requirement for a decommissioning strategy associated with this proposal, should it proceed, to protect the State in terms of restoration and management costs.

15. Greenhouse Gas Emissions

Greenhouse gas emissions for the Yannarie Solar Project have been discussed in the ERMP on the basis of these emissions being a minor environmental factor (refer to ERMP section 3, page 3-7).

It should be noted however, that climate change attributed to increased greenhouse gas emissions and the ongoing loss of carbon sinks such as forests (including mangals) and coral reefs will continue to have significant impacts on biodiversity. Given that the mangroves of Exmouth Gulf are at significant potential risk from this project and can be considered some of the most extensive "woodlands" in the Pilbara, the proponent should be required to assess and document the potential for 'worst case scenario' greenhouse gas emissions associated with possible changes to the ecology of the eastern Exmouth Gulf .

Recommendations:

84. The proponent should assess and document the potential for 'worst case scenario' greenhouse gas emissions associated with possible changes to the ecology of the eastern Exmouth Gulf such as loss of mangrove communities and hinterland vegetation.

Conclusion

DEC is of the view that this proposal is environmentally unacceptable due to the significant risks associated with the design, size, scale and location of the proposal and the inability of the proponent to demonstrate either the lack of impacts to biodiversity values or that the impacts can be mitigated. Without the information outlined in many of the recommendations throughout this submission, there is insufficient basis for the Department to be satisfied that the risks to the ecologically significant ecosystems of the Exmouth Gulf can be successfully mitigated. These potential impacts include large-scale changes to coastal processes, loss of critical habitats for significant fauna, decline in water quality from hypersaline and toxic leachate and potential major impacts on the project and area resulting from projected sea level rise and major cyclonic and storm surge events.

The site of the proposal is within a complex coastal area with uncertain hydrogeology and valued coastal ecosystems of high conservation significance. Given that the information in the ERMP is not sufficient to understand the hydrogeology of the area, the importance and role of the supratidal flats, the groundwater and surface water dependence of native vegetation, mangals, seagrass and algal mats, it is extremely difficult to undertake an informed and technically sound impact prediction analysis of the long-term consequences for Exmouth Gulf ecosystems. The cumulative effects of the project's operations and potential changes in natural hydrology are not sufficiently well discussed or documented by the proponent for the Department to be satisfied that major adverse ecological impacts will not occur. Unless the proponent undertakes the identified studies recommended by the Department to confirm assertions the proponent has made that the project poses a low level of environmental risk from altered hydrology, it is DEC's view that the EPA will not have enough information to make an informed assessment.

There are a number of conservation significant species that occur on the eastern side of Exmouth Gulf. Given there is a high degree of uncertainty relating to the potential impacts on the water quality and benthic habitats of the Gulf, the proposal does not provide an adequate level of confidence that impacts to marine fauna are acceptable.

The ERMP provides no evaluation of the ecological value and interconnectivity between the marine waters, inshore coastal habitats, the supratidal 'sabkha' salt flat system and the hinterland area. It is not clear from the ERMP that the risks associated with major change to the 'sabkha' system will be acceptable or manageable. Further ecological studies into the role that the supratidal flats play in maintaining Exmouth Gulf's ecosystem health should be available to enable an evaluation of the potential long-term impacts. Furthermore, there is no recognition of the ecological linkages between the eastern Exmouth Gulf (incorporating the supratidal flats) and the coral reef communities of Ningaloo and the Muiron Islands.

Finally proceeding with the proposal would represent a foregone opportunity to conserve an outstanding area of a largely intact coastal ecosystem type with significant potential as an area for economically important nature based tourism and fisheries protection. The costs associated with loss of these values need to be compared with the level of economic and social benefits and potential liabilities associated with the project.

On the basis of available information indicating that the ecological and conservation values of the Exmouth Gulf ecosystem are very high at the regional, national and international scales, and in recognition that the ERMP does not provide an adequate assessment of the environmental risks and management requirements, this proposal represents a high risk of permanent loss of significant environmental values and is therefore not supported.

Department of Environment and Conservation
March 2007

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Conservation Significance of the Eastern Exmouth Gulf

The Exmouth Gulf has for several decades been recognised as having great significance for biodiversity conservation in Western Australia, and the Department of Environment and Conservation (DEC) considers that development of the area for the proposed solar salt project will compromise the biodiversity conservation values of the Gulf. Of particular importance is the ecological complexity of the Exmouth Gulf ecosystem, and its broad range of values for biodiversity conservation at the regional, State and global scales.

Exmouth Gulf is largely undisturbed and the lands and waters of the eastern side are near-pristine and hence are of significant wilderness value. Any industrial development of Exmouth Gulf, particularly to the scale of the proposed solar salt development, would ultimately lead to diminution or loss of these values.

The Yannarie Salt proposal area site falls within the 'Exmouth Gulf East' nationally important wetland listed in *A Directory of Important Wetlands in Australia* (Department of Environment and Heritage, 2001) which extends along the eastern part of Exmouth Gulf from Giralia Bay in the south to Locker Point in the north and includes the coastal supratidal flats between 5-15 km wide and waters less than 6 metres deep at low tide.

Exmouth Gulf East has been listed on the Directory on the basis of information indicating that the area meets essential criteria as the wetland:

- is a good example of a wetland type occurring within a biogeographic region in Australia;
- is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex; and
- is important as the habitat for animal taxa at a vulnerable stage in their life cycle, or provides a refuge when adverse conditions such as drought prevail.

The mangroves of the eastern side of Exmouth Gulf are considered regionally significant and represent the southernmost area of regionally significant arid zone mangroves on the Pilbara coast (EPA, 2001). The algal mats which fringe the mangrove communities, are a key source of nitrogen to the nitrogen-limited Exmouth Gulf (Straits Salt Pty Ltd, 2006). Based on the Pilbara coast estimates of Paling and McComb (1994), the mats are estimated to contribute in the order of 550 tonnes per year of nitrogen to mangrove and nearshore ecosystems of the eastern Gulf (Straits Salt Pty Ltd, 2006).

Extensive supratidal salt flats are located to the east of the mangrove and algal mat communities of the eastern Exmouth Gulf (Figure 1) where the majority of the permanent mining footprint is proposed through the construction of salt ponds. These supratidal flats are up to 13 km in width and are believed to be inundated to varying degrees by tidal surge and freshwater inflow during storm events. The eastern side of Exmouth Gulf provides important examples of arid zone, coastal and supratidal flat ecosystems and has been identified as a candidate area for formal reservation in *A Representative Marine Reserve System for Western Australia* (CALM, 1994). The Marine Parks and Reserves Selection Working Group recommended the reservation of the important mangrove and shallow water benthic fish and prawn nursery habitats in the Eastern Exmouth Gulf and also indicated that the supratidal flats between the mangroves and hinterland would be essential to ensure adequate management of mangroves and coastal habitats (CALM, 1994). The area substantially impacted by the proposed salt project largely overlies the supratidal flats.

More recently, the WA Biodiversity Audit (CALM, 2003) identifies the supratidal mudflats of the Cape Range sub-bioregion, referred to as "Bare Areas; mudflats," as being ecosystems of high priority for reservation, with 0% currently included in the conservation reserve system. The ERMP (Table 5-6, page 5-60) recognises that the Solar Salt Project covers the largest expanse of mudflats in the Cape Range sub-bioregion but does not include discussion of the values of these areas for the broader Cape Range ecosystem, the expected disturbance to the salt flats, or the subsequent impacts on the conservation status of the community.

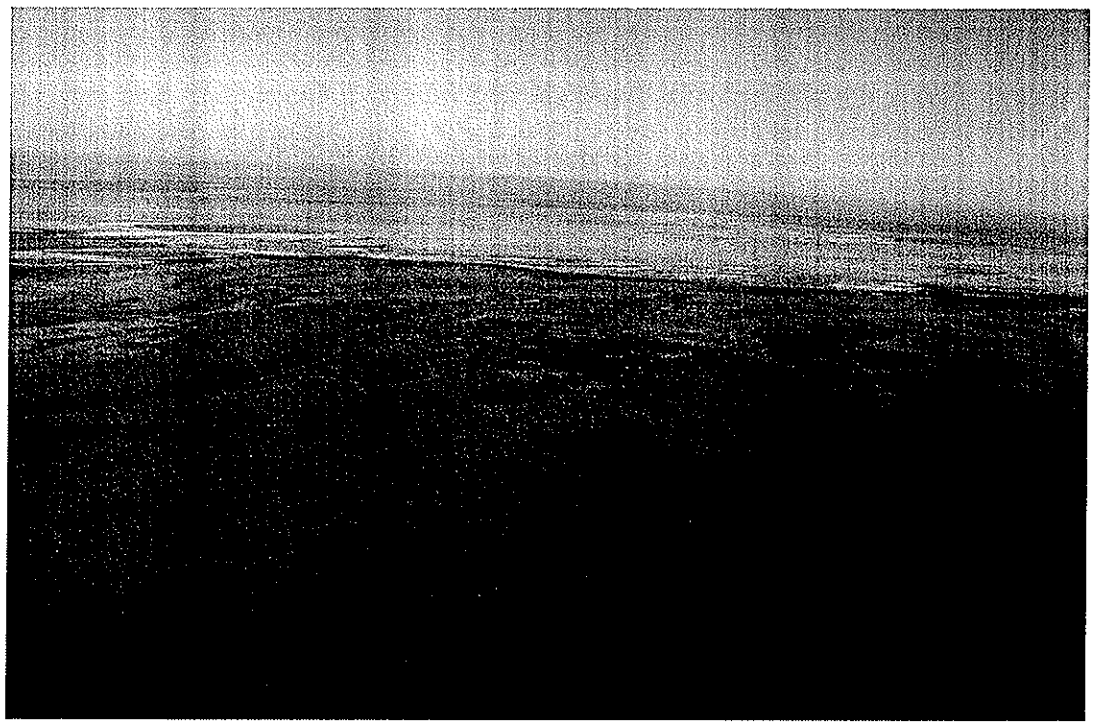

Figure 1: Eastern coastline of Exmouth Gulf showing extensive mangrove wetlands, algal mat communities, supratidal flats and distant hinterland areas (direction of photograph east-west).

A number of conservation significant fauna species protected under the *Wildlife Conservation Act 1950* and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* are supported by habitats within Exmouth Gulf. These species include marine turtles, dugong, humpback whales and migratory waders. Tidal creeks throughout the study area provide important habitat for marine turtles and dugong and act as a nursery for marine fish.

Marine megafauna surveys in Exmouth Gulf found that dugong were mainly sighted on the eastern side of the Gulf (Preen *et al.*1997 and Centre for Whale Research 2005) and coincided with the distribution of seagrass beds consisting of *Halodule* and *Halophila* (Marsh *et al.* 2002). There appears to be linkage through significant dugong movement between the Exmouth Gulf and Shark Bay populations, and the Exmouth Gulf dugong population is regarded as the second largest in Western Australia.

Several species of marine turtles utilise the eastern habitats of Exmouth Gulf for foraging in and around mangroves, and the eastern gulf area appears to be of importance to these species. In addition, the Exmouth Gulf is considered the most important resting area for humpback whales on the Pilbara coast during the annual southwards migration between early August and early November (Centre for Whale Research, 2005).

The eastern Exmouth Gulf area is prone to relatively frequent cyclonic events resulting in strong winds, significant storm and tidal surges, high rainfall and flooding events from the hinterland area to the east, and is potentially highly susceptible to projected long-term sea level rises. Cyclone Vance crossed this coastline in 1999 and is considered one of the largest recorded storm events to cross the Australian coast, resulting in large-scale devastation to the township of Exmouth and extensive mangrove community and seagrass mortality. For this reason the conservation values of the eastern Exmouth Gulf are considered not only highly significant, but potentially vulnerable to anthropogenic changes to natural systems that may interact with these semi catastrophic natural events.

Finally, Ningaloo Marine Park and the Muiron Islands Marine Management Area are located within the vicinity of Exmouth Gulf and there is considered to be a likelihood of significant ecological linkages between these areas and the Exmouth Gulf, particularly through faunal lifecycle migrations between mangroves, seagrass and coral reef communities. Interconnectivity between mangrove, seagrass and coral reef systems has been studied in other parts of the world and there is emerging evidence of similar linkages between Pilbara marine systems. For example, the giant shovel nosed ray (*Rhinobatos typus*), which is a known inhabitant of the waters of Exmouth Gulf, is reported to utilise the intertidal zone and algal mats of the eastern side of the Gulf during juvenile stages of its life cycle (Lovelock, 2006). Preliminary data from a PhD study in Exmouth Gulf have also indicated that coral reef species have been found in the algal mat and mangrove communities (Helen Penrose, pers. comm., 2007). Therefore, the biological connectivity between Exmouth Gulf's extensive mangrove communities and seagrass beds and the proposed Ningaloo World Heritage Area and the Muiron Islands Marine Management Area, although currently understudied, is likely to be an issue requiring consideration in evaluation of the risks posed by this proposal.

DEC, March 2007