GULF HOLDINGS PTY. LTD.

ENVIRONMENTAL REVIEW AND MANAGEMENT PROGRAMME

ONSLow SALT PROJECT

VOLUME 1

APRIL 1990
SUMMARY

1. PROPONENT

Gulf Holdings Pty. Ltd. (the Proponent) proposes to construct and operate a new solar salt field at Onslow capable of producing a nominal 1.5 million tonnes per year of salt.

2. BACKGROUND

Rising demand for salt has revived interest in a solar salt project, based on the salt flats on the eastern shore of Exmouth Gulf, that was abandoned for various reasons 18 years ago. Over the past year logistics of that project have been reviewed with the result that a project based initially on the salt flats around Onslow has been investigated in detail. Given the current and projected demand for salt, it is considered that the Onslow based project will be viable and a valuable export earner for Australia.

3. PROPOSAL

3.1 INTRODUCTION

The proposal involves production of solar salt for export. The development proposed has initial condenser ponds constructed on salt flats south-east of Onslow and crystalliser ponds on the flats to the south-west of Onslow.

A new jetty will be constructed west of Beadon Point with a dredged channel leading to deep water. A washplant located 1.5 km inland from the base of the jetty will be linked to the crystallisers by a private haul road and to the shiploader at the end of the jetty by a conveyor.
During design, the Proponent has had extensive discussions with the local community through the Shire of Ashburton and the Onslow Residents Liaison Group and as a result several significant changes to the Project have been made to accommodate local concerns and desires, including relocation of the washplant and stockpile further from town.

Expansion of the Project is possible in the future. This will involve construction of further condenser ponds on the salt flats on the eastern shore of Exmouth Gulf, and a brine channel linking the ponds to additional crystallisers on the flats south-west of Onslow.

At this time only Stage 1 is being addressed.

3.2 THE PROJECT

3.2.1 Process
In simple terms, the Project involves pumping seawater from the eastern arm of Beadon Creek into condenser ponds where concentrated brines will be produced. These brines will be channelled through the ponds to the crystallisers where salt will crystallise out. Bitterns left after this process will be released in a controlled manner through Middle Creek. Salt harvested from the crystallisers will be trucked on the private haul road to the washplant near the base of the new jetty. After washing, salt will be stockpiled ready for loading by conveyor onto ships.

3.2.2 Condenser Ponds
Eight condenser ponds will be constructed covering 70 km² on the supratidal flats south-east of Onslow. In the main, the ponds are located inland of the mangrove/algal mat communities that colonise the upper reaches of the tidal channels and the lower tidal flats. Run off from inland will be diverted around the ponds to discharge into the sea.
3.2.3 Crystalliser Ponds
Eighteen crystalliser ponds covering 7.2 km² will be constructed on the flats south-west of Onslow, generally inland of the mangrove/algal mat communities. Bitterns from the crystallisers will be released through Middle Creek.

3.2.4 Harvesting and Trucking
Salt will be mechanically harvested and trucked along a private haul road to a ramp and overhead truck dump at the washplant 1.5 km inland from the base of the new jetty. These facilities are located over 1 km away from the nearest residential area, behind low scrub covered hills.

3.2.5 Washplant, Stockpile and Reclamation
Salt from the washplant will be stockpiled at the start of the conveyor and reclaimed by two D8 bulldozers.

3.2.6 Jetty and Dredging
The jetty will be a 950m long open pile steel trestleway carrying a conveyor system. The conveyor will also extend inland to the stockpile. In places, this conveyor will be in an excavation to maintain public access to the beaches west of Onslow.

A new channel will be dredged to -9m at low water, allowing ships of 28,000 dwt access to the jetty at half tide or better. Material dredged from the channel will be disposed of approximately 600m to the east of the channel.

3.2.7 Housing and Services
The laboratory, workshops and power station will be sited near the washplant complex. The construction workforce will preferably be accommodated in the WAPET construction camp site located near Beadon Creek.

Housing for the 60 fulltime employees is planned in Onslow and in a new subdivision south of the hospital.
Servicing for housing will be provided, after initial contribution from the Proponent, by State Agencies who have indicated that there is sufficient capacity to supply domestic power, water and sewerage facilities for the added population.

Industrial power for the saltworks will be provided by the Proponent.

4. EXISTING ENVIRONMENT

4.1 PHYSICAL

Onslow is an isolated town situated in the tropical arid climate zone of Western Australia. It lies at the western end of the Pilbara coastal plain between the flood plains (deltas) of the Ashburton and Cane Rivers. The plain extends offshore as the Rowley Shelf which slopes gently to the north to a depth of 20m about 20 km offshore. The surface of this shelf is broken by discrete limestone (coral) reefs and sandy islands.

Reworking of sediment brought to the coast by the river systems has led to formation of a number of coast parallel dune systems. Extensive tidal and supratidal flats lie between and on either side of the deltas of the two rivers. The flats are linked to the sea directly or through breaks in the coastal dune system.

The coast is generally sheltered from prevailing swell by aspect and the shallow shelf, though it is exposed to prevailing westerly winds. Tidal range is moderate (1.8m), though sea level can rise to over 3m as a result of storm surge. Onslow is subject to cyclones which tend to cross the coast, or pass close by, every two to three years. Rainfall averages 265mm/year, however this figure is not representative in that most rainfall occurs as heavy falls every two to three years (e.g. highest one day fall is 356mm). Evaporation is around 3000mm (3m) per year.
4.2 BIOLOGICAL

Extensive mangrove and algal mat communities colonise the seaward margin of the flats that are subject to tidal inundation. The supratidal flats which are rarely inundated are generally covered with a salt crust. The total area of flats within 100 km of Onslow is around 1650 km². The areas of mangroves, algal mat and supratidal flats around Onslow is summarised in the following table.

Areas of Mangroves, Algal Mat and Supratidal Flat in the Onslow Area (Note: 1 km² = 100 ha)

<table>
<thead>
<tr>
<th>Creek Name</th>
<th>Mangroves</th>
<th>Algal Mat</th>
<th>Supratidal Flat</th>
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<tbody>
<tr>
<td>Hooley's</td>
<td>90.34</td>
<td>468.43</td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>8.50</td>
<td>193.65</td>
<td></td>
</tr>
<tr>
<td>Four Mile</td>
<td>4.81</td>
<td>297.04</td>
<td>3,800</td>
</tr>
<tr>
<td>Beadon</td>
<td>134.67</td>
<td>453.76</td>
<td></td>
</tr>
<tr>
<td>Second</td>
<td>29.60</td>
<td>50.86</td>
<td></td>
</tr>
<tr>
<td>Third</td>
<td>160.55</td>
<td>249.93</td>
<td></td>
</tr>
<tr>
<td>Coolgra Point</td>
<td>514.16</td>
<td>253.96</td>
<td>17,300</td>
</tr>
<tr>
<td>Total</td>
<td>942.63 ha</td>
<td>1967.63 ha</td>
<td>21,100 ha</td>
</tr>
</tbody>
</table>

A study of the biological environment indicates that there is nothing rare or unique in the Onslow area. The mangrove/algal mat association is the most significant biological ecosystem as it is recognised as being an important element in the nutrient cycle for all organisms that inhabit the shelf zone. While only three species of mangrove are found at Onslow, the association is similar to that found elsewhere along the coast. Likewise the offshore areas in the vicinity of the planned jetty and channel are similar to much of the shelf. There also does not appear to be any vegetation of regional significance in the area.
4.3 SOCIAL

Onslow is a small isolated town without any real economic base. Its population is around 800-1000 which includes at least 200 Aborigines, 200 construction workers and 200 visitors. The pace of life is slow and the lack of common purpose has produced a community without much internal cohesion. The community relies on external support and upgrading of public facilities and services has been difficult to justify, with the result that progress has been slow. Thus Onslow has the reputation of being the last undeveloped town in the North-West.

4.3.1 Historic, Archaeological and Ethnographic Sites

A survey of Aboriginal sites was carried out in late 1989. Because of their relevance in locating the stockpile, washplant and part of the haul road, it is appropriate to mention that the following three ethnographic sites are in close proximity to the works:

Barubarladji
Dew Talu
Jinta 1

5. ENVIRONMENTAL IMPACTS

The physical, biological and social impacts associated with the Project are varied.

5.1 PHYSICAL

The major physical impact will involve change in the landscape around Onslow. Part of the condenser ponds will be visible from the highway, while the jetty will be visible from Back Beach and the top of the stockpile will be visible from Four Mile Creek Road. In the main, the majority of the Project will not be visible from existing roads or the town.
Noise emissions are predicted to fall within accepted levels for residential areas during both day and night. In order to minimise output of noise at night, operation of bulldozers will, if necessary, be restricted to below the crest of the stockpile. It is possible that under certain calm, hot and humid conditions noise levels during ship loading will exceed the limits. These conditions are not expected more than three times per year.

5.2 BIOLOGICAL

5.2.1 Areas Affected by Construction

The major biological impact involves direct or indirect disturbance to the mangrove/algal mat communities.

The area of mangrove and mat directly affected by the Project is summarised in the following table.

<table>
<thead>
<tr>
<th>Impact on Mangrove and Algal Mat Communities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Station</td>
</tr>
<tr>
<td>Condenser Ponds</td>
</tr>
<tr>
<td>Crystalliser Ponds</td>
</tr>
<tr>
<td>Bittern Channel</td>
</tr>
<tr>
<td>TOTAL</td>
</tr>
</tbody>
</table>

Thus construction will involve loss of only 0.16% of the mangroves and 12% of the algal mats in the Onslow area.

The major indirect impact on these communities involves possible change to the groundwater salinity and the flow of freshwater from inland.

5.2.1.1 Effect of Pond Operation on Groundwater Salinity

In general the condenser ponds will hold water with lower salinities (37-140 ppt) than the groundwater (200 ppt) and accordingly any change to the groundwater is not likely to be deleterious.
The crystalliser ponds will hold high salinity water (300 ppt) which may increase the local groundwater salinities. The nearest mangroves are 700m distant and leakage from the ponds is not expected to be significant. Experience elsewhere shows that this indirect impact is minor or difficult to detect.

Discharge of bitterns also has the potential to affect the groundwater, although experience elsewhere indicates that groundwater salinities have not increased in the adjacent mangroves or algal flats.

5.2.1.2 Effect of Flood Diversion on Groundwater Salinity

Construction of the ponds will direct floodwaters away from some of the tidal creeks. Beadon Creek will be surrounded by ponds. Although it will retain a 9.6 km$^2$ catchment, there may be a small reduction in mangrove productivity. The other creeks will still receive similar volumes of floodwater as they did previously. It has been observed that tidal flushing is of far greater importance to mangrove communities than the comparatively rare flooding by rainfall and in this respect this impact is not likely to be significant.

In order to assess these indirect impacts, monitoring of groundwater and mangrove communities will be carried out.

5.2.2 Dredging

It is not expected that dredging and disposal of spoil will have any significant impact on the seabed communities as the area has already been extensively modified by trawling and the flora and fauna is widespread.

Likewise, it is not anticipated that there will be any major impact on the commercial fishing as studies elsewhere have indicated that the fish and prawn stocks near other salt projects have not been affected.
5.2.3 Isolated "Islands"
There is likely to be increased pressure on the landscape and its flora and fauna through isolation of some islands in the flats and through increased human activity in the area. Of the 36 salt flat islands with areas over 4 ha, 16 (13% in area) will become isolated and hence movement of ground dwelling animals will be restricted. This is not considered to be significant because of the number of salt flat islands in the Onslow area. The human impacts will be kept to a minimum through locking off seawalls etc. (if required), that provide access to major islands and the coast.

5.2.4 New Habitats
The condenser ponds and jetty are expected to create new habitats. Birds in particular are likely to utilise the ponds if they are colonised by brine shrimp.

5.3 SOCIAL
The Project will have a significant social impact on Onslow. The town's resident population will increase which in turn will increase pressure on commercial services, housing, schooling and lead to increase in local business activity, employment opportunities and tourism.

The local community, through the Shire and the Onslow Residents Liaison Group, expressed a number of concerns and desires in relation to the Project. The major concern related to location of the washplant/stockpile and associated noise. With relocation of the facilities to a site further from town, this concern has to a large extent been addressed.

Major desires of the community related to employment and contribution to the towns infrastructure. The Proponent is sensitive to the need to assist locals to take advantage of employment opportunities and has made a number of commitments to achieve this. In addition, the Proponent has offered to provide a number of community facilities to a value not exceeding $500,000.
Any negative social impacts during the establishment period of the Project will to a large extent be offset through the Proponent employing a community worker or personnel officer who will assist the new population to integrate with the town.

The Project will not affect directly any archaeological or ethnographic sites.

6. MANAGEMENT AND MONITORING

In order to minimise and quantify the identified impacts during construction and operation of the Project, an environmental management and monitoring programme has been proposed, as detailed in Section 8.

6.1 MANAGEMENT RESPONSIBILITY

A Corporate Project Manager will be created and charged with the responsibility of operating the salt project and associated activities. The Project Manager, through the Onslow based Operations Manager and environmental consultants, will also be responsible for implementing the environmental and management monitoring programme. This commitment to environmental management will be incorporated in a State Government Agreement Act. A summary of environmental management commitments is given in Section 10.

7. CONCLUSION

The Project, as proposed, will result in major changes to the landscape around Onslow in that saltflats will largely be occupied by shallow ponds and a new jetty will be built west of Beadon Point. Apart from the jetty and the stockpile/washplant area which will be over 1.0 km from the nearest residents (Clarke Place), the major works associated with the Project will be remote from the town.
The Project will have only a minor direct impact on the biological communities in the area in that the ponds have been located where possible on the supratidal flats landward of the mangrove communities. This conforms with the recommendation made by the CTRC Committee to the EPA (CTRC 1974) that solar salt production be restricted to the supratidal zone. In all only 1.3 ha of mangroves out of a total of 943 ha (ie. 0.16%) and 230 ha of algal mat out of a total of 1968 ha (ie. 12%) will be directly affected.

The Project may have some indirect impact on these communities in that one of the creeks will be cut off from fresh floodwaters, while the remainder will experience minor change. Because nutrient input to mangroves and algal mats is largely dominated by input from marine sources and tidal flushing, this impact is not likely to be significant. Dredging will directly affect the seabed, though the impact is unlikely to be significant as the sea floor is only sparsely vegetated and the habitat is widespread.

The most significant aspect of the Project will be its social impact on Onslow. As a result of an ongoing participation and consultation process, the local community has had every opportunity to become familiar with, comment upon and contribute to the Project. On balance, the community has expressed support for the Project, subject to resolution of several matters of concern, notably, stockpile and washplant location and noise associated with these facilities. These concerns have been resolved with relocation of these facilities to a new site over 1.0 km from the town.

It is clear that the Project will bring change to Onslow. Depending on ones point of view the Project will add or detract from the town. Some of those who retreated to Onslow because it is a sleepy backwater have expressed concern at the change. Conversely those seeking employment, a future for their children,
more and varied community services and a wider range of people from whom to choose friends, playmates etc., have welcomed the prospect of the Project.

While the additional workforce will add significantly to the permanent population, they will be mostly accommodated in a new subdivision so that Onslow should retain its relaxed atmosphere and the day to day lifestyle of the retired residents is unlikely to be altered.

The Project will benefit Onslow in the long term as it will provide an economic base and common purpose for the town and enhance its attraction for tourism. Overall it is considered that provided the Proponent adheres to the commitments given in this ERMP to:

a) contribute to community recreation facilities in the town;
b) employ local labour where possible and participate in training schemes;
c) assist in integration of the new workforce with the existing residents

the Project is unlikely to have any significant negative impact on the Onslow community. In fact it is considered that the Project will have a few disbenefits and a significant net benefit to Onslow. In terms of the wider community the Project will have a significant benefit in that it has potential to create directly and indirectly around 80 new jobs as well as significant export income.

In conclusion, the production of solar salt involves use of solar power and a single natural material, seawater. No unnatural toxic waste is produced and insignificant fossil fuel is consumed. The production of solar salt is therefore totally sustainable in the long term as the major resources required (sun and seawater) are totally renewable.
ACKNOWLEDGEMENT

The assistance of State Government officers and the people of Onslow is acknowledged.

STUDY TEAM

This report was prepared by Dr. Peter J. Woods of Peter J. Woods & Associates and Mr. John Lewis of Gulf Holdings Pty. Ltd., with specialist assistance from:

Sally Woods - Social Consultant - Social Impact
Eric Paling - Biological Consultant - Biology
Halpern Glick Maunsell - Consulting Engineers - Flooding
Norman Disney & Young - Consulting Engineers - Noise
Steedman Science & Engineering - Consulting Engineers - Oceanography
Gary Quartermaine & Rory O'Connor - Consulting Archaeologists and Anthropologists - Aboriginal Sites
Sagamore Pty. Ltd. - Saltfield Consultants - Design of Saltfield
Taylor Woodrow International - Management Contractors - Logistics, Schedules and Cost Estimates
ENVIRONMENTAL REVIEW AND MANAGEMENT PROGRAMME

GUIDELINES FOR MAKING A SUBMISSION

The Environmental Protection Authority (E.P.A.) invites people to make a submission on this proposal.

The Environmental Report (E.R.M.P.) for the proposed Onslow Salt Project has been prepared by Gulf Holdings Pty. Ltd. in accordance with the E.P.A.'s procedures. The report will be available for comment for ten weeks.

Following receipt of comments from Government agencies and the public, the E.P.A. will discuss the issues raised with the Proponent, and may ask for further information. Then the E.P.A. will prepare its Assessment Report with recommendations to Government, taking into account issues raised in public submissions.

WHY WRITE A SUBMISSION?

A submission is a way to provide information, express your opinion and perhaps suggest an alternative approach. It is useful to the E.P.A. if you indicate any suggestions you have to improve the proposal.

All submissions received by the Environmental Protection Authority will be acknowledged. Submissions will be evaluated in the development of the report and recommendations made by the E.P.A. to Government. Please indicate if you are prepared to have your submission quoted in summary form.
DEVELOPING A SUBMISSION

You may agree or disagree, or comment on, the general issues discussed in the E.R.M.P., or with specific proposals. It helps if you give reasons for your conclusions.

You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the E.R.M.P. -

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
  and
- suggest recommendations, safeguards or alternatives.

POINTS TO KEEP IN MIND

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- Attempt to list points so that the issues raised are clear.
  A summary of your submission is helpful;

- Refer each point to the appropriate sections, chapter or recommendation in the E.R.M.P.

- If you discuss different sections of the E.R.M.P., keep them distinct and separate, so there is no confusion as to which section you are considering.

- Attach any factual information you wish to provide and give details of the source. Make sure your information is accurate.

- Please indicate whether your submission can be quoted, in part or in full, by the E.P.A. in its Assessment Report.
REMEMBER TO INCLUDE

YOUR NAME
ADDRESS
DATE

SUBMISSIONS SHOULD BE ADDRESSED TO:

The Chairman
Environmental Protection Authority
1 Mount Street
Perth WA 6000

ATTENTION: Mr. D. Betts
CONTENTS

1. SECTION 1 - INTRODUCTION 1
1.1 BACKGROUND 1
1.2 OBJECTIVES 2
1.3 PROPONET 2
1.4 BRIEF DESCRIPTION OF PROJECT 3
  1.4.1 Timing 3
  1.4.2 Land Tenure 4
  1.4.3 Project Managers 4
1.5 OTHER EXISTING SOLAR SALT OPERATIONS 5
  1.5.1 The Onslow Salt Operation 6
1.6 LEGISLATIVE REQUIREMENTS AND APPROVAL PROCESS 6
1.7 ENVIRONMENTAL REVIEW AND MANAGEMENT PROGRAMME (ERMP) 7

2. SECTION 2 - JUSTIFICATION FOR PROPOSAL 9
2.1 INTRODUCTION 9
2.2 BENEFITS TO THE LOCAL COMMUNITY 9
2.3 BENEFITS TO THE STATE AND NATION 10
2.4 COSTS TO THE COMMUNITY 11
2.5 DISBENEFITS 12
  2.5.1 Social 12
  2.5.2 Physical, Biological 12
2.6 BENEFITS OF PROPOSAL 13
  2.6.1 Social 13
  2.6.2 Physical and Commercial 14
  2.6.3 Biological 15
2.7 SUMMARY 15
3. THE PROPOSAL

3.1 INTRODUCTION

3.2 PROJECT COMPONENTS

3.2.1 Seawater Pumping Station
3.2.2 Condenser Ponds
3.2.3 Crystalliser Ponds
3.2.4 Harvesting and Transport of Salt
3.2.5 Washplant and Truck Dump
3.2.6 Stacker, Stockpile Reclaim
3.2.7 Jetty Shiploader and Conveyor
3.2.8 Approach Channel
3.2.9 Bitterns Discharge
3.2.10 Services

3.3 MANAGEMENT OF OPERATIONS

3.3.1 Management Structure

3.4 MANAGEMENT

3.4.1 Construction Workforce
3.4.2 Operation Workforce

3.5 SOURCES OF CONSTRUCTION MATERIAL

3.6 STABILITY OF BUND WALLS

3.7 REPAIR AFTER EXTREME EVENTS

3.8 DECOMMISSIONING

3.8.1 At End of Project Life
3.8.2 Catastrophic Events
3.8.3 Financial Failure

3.9 REHABILITATION OF AREAS OUTSIDE PROJECT

3.9.1 After Catastrophic Event
3.9.2 At Close of Project

3.10 ENVIRONMENTAL CONTROLS AND SAFEGUARDS
4. SECTION 4 - EVALUATION OF ALTERNATIVES

4.1 HISTORICAL

4.2 ALTERNATIVES CONSIDERED

4.2.1 Shipping
4.2.2 Condenser and Crystalliser Ponds
4.2.3 Workforce Infrastructure
4.2.4 Pump Station
4.2.5 Seawalls
4.2.6 Bitterns Discharge
4.2.7 Harvesting and Slurry Pumping
4.2.8 Stockpile and Washplant Area
4.2.9 The Jetty Structure
4.2.10 Operation Alternatives
4.2.11 Berth Orientation
4.2.12 Housing
4.2.13 Power Supply

4.3 SELECTED ALTERNATIVE FOR PROJECT

4.4 THE NO PROJECT OPTION

5. SECTION 5 - THE EXISTING ENVIRONMENT

5.1 INTRODUCTION

5.2 REGIONAL SETTING

5.3 PHYSICAL ENVIRONMENT

5.3.1 Meteorology
5.3.2 Oceanography
5.3.3 Tides
5.3.4 Cyclone Frequency
5.3.5 Cyclone Wind, Waves and Surges
5.3.6 Geomorphology
5.3.7 Geology

5.4 BIOLOGICAL ENVIRONMENT

5.4.1 Regional Setting
5.4.2 The Onslow Biological Communities
5.4.3 Regional Significance
<table>
<thead>
<tr>
<th>Section</th>
<th>Subsection</th>
<th>Title</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5</td>
<td>5.5.1</td>
<td>Introduction</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>5.5.2</td>
<td>Location</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>5.5.3</td>
<td>Population and Community Groups</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>5.5.4</td>
<td>Community Services</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>5.5.5</td>
<td>Recreation Facilities</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>5.5.6</td>
<td>Lifestyle</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>5.5.7</td>
<td>Economic Base</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>5.5.8</td>
<td>Summary</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>5.5.9</td>
<td>Historic, Archaeological and Ethnographic Sites</td>
<td>71</td>
</tr>
<tr>
<td>6</td>
<td>6.1</td>
<td>Introduction</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>6.2</td>
<td>Information and Public Participation Programme</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>6.2.1</td>
<td>Public Meeting</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>6.2.2</td>
<td>Shire Meetings</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>6.2.3</td>
<td>Onslow Residents Liaison Group (ORLG) Meetings</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>6.2.4</td>
<td>Summary</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>6.3</td>
<td>Identified Issues</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>6.3.1</td>
<td>Concerns</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>6.3.2</td>
<td>Desires</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>6.4</td>
<td>Benefits</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>6.5</td>
<td>Summary</td>
<td>82</td>
</tr>
<tr>
<td>7</td>
<td>7.1</td>
<td>Introduction</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>7.2</td>
<td>Impact on Physical Environment</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>7.2.1</td>
<td>Landscape</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>7.2.2</td>
<td>Coastal Processes</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>7.2.3</td>
<td>Riverine Processes and Drainage</td>
<td>85</td>
</tr>
<tr>
<td>Section</td>
<td>Topic</td>
<td>Page No.</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>------------------------------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>7.2.4</td>
<td>Groundwater</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>7.2.5</td>
<td>Extraction of Materials</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>7.2.6</td>
<td>Cyclonic Flooding and Storm Surges</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>7.2.7</td>
<td>Emissions</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>7.2.8</td>
<td>Access</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>7.3</td>
<td>IMPACT ON THE BIOLOGICAL ENVIRONMENT</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>7.3.1</td>
<td>Mangroves</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>7.3.2</td>
<td>Algal Mats</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td>7.3.3</td>
<td>Offshore Areas</td>
<td>97</td>
<td></td>
</tr>
<tr>
<td>7.3.4</td>
<td>Other Impacts</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>7.3.5</td>
<td>Creation of New Habitats</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>7.3.6</td>
<td>Fisheries</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>7.3.7</td>
<td>Conclusions</td>
<td>101</td>
<td></td>
</tr>
<tr>
<td>7.4</td>
<td>IMPACT ON SOCIAL ENVIRONMENT</td>
<td>102</td>
<td></td>
</tr>
<tr>
<td>7.4.1</td>
<td>Identified Local Impacts</td>
<td>102</td>
<td></td>
</tr>
<tr>
<td>7.4.2</td>
<td>Other Potential Impacts</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>7.4.3</td>
<td>Historical, Archaeological and</td>
<td>111</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnographic Sites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td>SYNTHESIS OF SIGNIFICANT ENVIRONMENTAL IMPACTS</td>
<td>111</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>SECTION 8 - ENVIRONMENTAL MANAGEMENT</td>
<td>113</td>
<td></td>
</tr>
<tr>
<td>8.1</td>
<td>INTRODUCTION</td>
<td>113</td>
<td></td>
</tr>
<tr>
<td>8.2</td>
<td>OBJECTIVES</td>
<td>114</td>
<td></td>
</tr>
<tr>
<td>8.3</td>
<td>MANAGEMENT COMMITMENTS</td>
<td>114</td>
<td></td>
</tr>
<tr>
<td>8.3.1</td>
<td>Construction Phase</td>
<td>114</td>
<td></td>
</tr>
<tr>
<td>8.3.2</td>
<td>Operation Phase</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td>8.4</td>
<td>MONITORING COMMITMENTS</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>8.4.1</td>
<td>Introduction</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>8.4.2</td>
<td>Dust</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>8.4.3</td>
<td>Noise</td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>8.4.4</td>
<td>Bunds and Sea Walls</td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>8.4.5</td>
<td>Bitterns and Mangroves</td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>8.4.6</td>
<td>Rehabilitation and Tree Planting</td>
<td>122</td>
<td></td>
</tr>
<tr>
<td>8.4.7</td>
<td>Access</td>
<td>123</td>
<td></td>
</tr>
</tbody>
</table>
LIST OF TABLES

TABLE 1  Comparative costs of alternate location of jetty and dredged channel.

TABLE 2  Area of mangroves, algal mat and supratidal flat in the study area.

TABLE 3  The impact on mangroves and algal mats due to construction of the ponds.
LIST OF FIGURES

Cover Sheet  General Layout of Salt Project and Land Tenure
FIGURE 1  The Onslow Salt Project works.
FIGURE 2  Schematic cross-section through condenser ponds showing relation of walls, tide, surge and flood levels etc.
FIGURE 3  The Onslow Region showing tidal and supratidal flats, rivers and major islands.
FIGURE 4  Pump Station and Seawall- Alternative Locations.
FIGURE 5  Seawall option for Ponds 1 and 2.
FIGURE 6  Location of Crystallisers.
FIGURE 7  Process area location options - Alternative locations for stockpile and washplant.
FIGURE 8  Schematic cross-section of the Onslow area showing basic geology and geomorphology.
FIGURE 9  Noise curves and criteria
FIGURE 10  Environmental monitoring sites
<table>
<thead>
<tr>
<th>Appendix</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EPA guidelines.</td>
</tr>
<tr>
<td>3</td>
<td>Report on the biological environment near Onslow, Western Australia, by Eric Paling, Botany Dept., Murdoch University.</td>
</tr>
<tr>
<td>4</td>
<td>Preliminary report on effect of proposed salt pond levee on flood flows - Onslow, by Halpern Glick Maunsell Pty. Ltd.</td>
</tr>
<tr>
<td>5</td>
<td>Report on acoustic effects on environment of proposed salt handling facility at Onslow, by Norman Disney &amp; Young.</td>
</tr>
<tr>
<td>6</td>
<td>Letter from Shire of Ashburton to Gulf Holdings Pty. Ltd.</td>
</tr>
<tr>
<td>7</td>
<td>Storm surge levels at Onslow by Steedman Science &amp; Engineering.</td>
</tr>
<tr>
<td>8</td>
<td>Meteorological Statistics for Onslow and description of seabed sediments.</td>
</tr>
<tr>
<td>9</td>
<td>Report on a survey for Aboriginal sites at the proposed Exmouth Salt Pty. Ltd. saltworks, Onslow, by Gary Quartermaine and Rory O'Connor. (not included)</td>
</tr>
<tr>
<td>10</td>
<td>Bitterns.</td>
</tr>
<tr>
<td>11</td>
<td>Construction Schedule.</td>
</tr>
</tbody>
</table>
ABBREVIATIONS

CALM Conservation & Land Management
DEET Department of Employment, Education & Training (Commonwealth)
DET Department of Employment & Training
DPUD Department of Planning & Urban Development
DRD Department of Resources Development
DRD:NW Department of Regional Development & the North West
DOLA Department of Land Administration
EPA Environmental Protection Authority
ERMP Environmental Review & Management Programme
ORLG Onslow Residents Liaison Group
SECWA State Energy Commission of Western Australia
Shire Shire of Ashburton
WAWA Western Australian Water Authority

m³/s cubic metres per second
ha hectare (100 ha = 1 km²)
km² square kilometre (1 km² = 100 ha)
tph tonnes per hour
dwt deduced weight in tonnes
Mt/yr millions tonnes per year
m/s metres per second
ppt parts per thousand
BRIEF BIBLIOGRAPHY

Ascidians - sea squid squirt - small cylindrical animals attached to a hard surface

Bioturbated - mixed up by bottom dwelling or burrowing organisms

Brine - concentrated, salty, seawater

Bitterns - liquid formed after salt is crystallised, containing the bittern salts (see Appendix 10)

Bunds - earth walls

Condenser Ponds - where seawater is evaporated and brine is produced

Crystalliser Ponds - where salt is crystallised from brine

Diatoms - small one celled algae with silica walls

Epiphytic - small animals or plants growing on other plants

Holocene - period of time from around 10,000 years ago to the present

Hydrozoans - small colonial jellyfish - look like small branched plants 1-4 cm high

Hypersaline Water - water more than twice as salty as the sea

Macro Algae - large algae, visible to the naked eye

Micro Algae - small algae which cannot be seen without the aid of a microscope

Molluscs - marine snail with a calcium carbonate shell

Pleistocene - period of time from around 1 million years ago to 10,000 years ago

Storm Surge - rise in sea level due to influence of high winds and low pressure associated with storms or cyclones

Supratidal Flat - that part of the salt flats above the reach of normal spring high tide. May be flooded during storms or cyclones when winds and low pressure combine to raise water level along the coast
Luffing  - the raising or lowering of the boom of a stacker, shiploader or crane
Slewing  - the horizontal swinging of the boom of a stacker, shiploader or crane
Warping  - the movement backwards or forwards of a ship along a berth by means of winches
SECTION 1 - INTRODUCTION

1 INTRODUCTION

Gulf Holdings Proprietary Limited (the Proponent) propose to construct and operate a new solar salt field at Onslow. This Environmental Review and Management Programme (ERMP) describes the Project, assesses the impacts of the Project on the physical, biological and social environment, and describes management measures designed to reduce unavoidable impacts.

1.1 BACKGROUND

Rising demand for salt has revived interest in the Proponent's previous solar salt project based on the salt flats on the eastern shore of Exmouth Gulf that was abandoned for various reasons eighteen years ago. Over the past year the logistics of that project have been reviewed with the result that a project based initially on the salt flats around Onslow has been investigated in detail. Given the current and projected demand for salt, it is considered that an Onslow based project will be viable and a valuable export earner for Australia.

A number of major consumers of salt have been approached and the degree of interest has prompted the Proponent to undertake engineering and environmental studies with a view to refining design and management details so that construction can commence in July 1990.

As part of the design process, the Proponent has had extensive discussions with the local community through the Ashburton Shire and the Onslow Residents Liaison Group. As a result several significant changes have been made to the Project to accommodate local concerns and desires.
1.2 OBJECTIVES

The object of the Onslow Salt Project is to construct a solar saltfield capable of producing a nominal 1.5 million tonnes per year (M t/yr) of sodium chloride (salt) with handling facilities to transfer, store and load the salt into 28,000 dwt ships at 1,300 tonnes per hour (t/h), together with all the necessary support facilities.

1.3 PROPONENT

The Proponent is Gulf Holdings Pty. Ltd., a wholly owned Western Australian company of 679 Murray Street, West Perth, Western Australia.

Gulf Holdings Pty. Ltd. owns:-

a) all documents relating to site investigations, surveys, feasibility studies, engineering design, drawings, specifications, cost estimates and financial projections

b) three Exploration Licences 08/335, 08/372 and 08/373, covering all relevant production areas

c) approval from the Minister for Resources to proceed to develop the Project and sell salt subject to satisfying the State in relation to financial viability of the Project, availability of funds, environmental approval and other normal statutory approvals

d) Budget Estimates for the whole project from its Construction and Cost Adviser, Taylor Woodrow International

e) Financial studies from its financial advisers Pannell Kerr Forster and its Merchant Bankers.

f) This ERMP.
1.4 BRIEF DESCRIPTION OF PROJECT

The Project involves construction of a solar salt field at Onslow. The development proposed includes condenser ponds constructed on salt flats south-east of Onslow and with crystalliser ponds on the flats south-west of Onslow. A new jetty will be constructed west of Beadon Point with a dredged channel leading to deep water. Salt will be trucked from the crystallisers along a private haul road to a washplant located 1.5 km inland from the base of the jetty. Washed salt will be stockpiled here prior to being transported by conveyor to ships.

The Project will employ an estimated 60 permanent staff who will mostly live in the town and in a new area south of the existing township.

Expansion of the operation is possible at some future date. This will involve construction of further condenser ponds on the salt flats on the eastern shore of Exmouth Gulf with additional crystallisers adjoining the existing ponds on the flats south-west of Onslow. This Stage II expansion will also involve construction of a brine channel or pipeline linking the new condenser ponds and the crystallisers. As the project will be constructed in two stages, only Stage I will be addressed in detail at this time.

1.4.1 Timing

The time for completion of construction is around 24 months. A detailed construction schedule is appended (Appendix 11). The sequence requires commencing the earthworks and commissioning seawater pumps as soon as possible so that production of brine can commence at the earliest possible time. After about eight months, brine concentration is sufficient to allow salt to form in the first crystallisers at an average rate of about 2.5 cm per month. A layer of salt thick enough for harvesting with heavy equipment will exist before the end of two years.
Apart from the earthworks and seawater pumps, the major cost items including the loader, stacker, reclaimer and operating plant are not scheduled for arrival or completion until commissioning for export is required.

In general it is preferable to undertake construction outside the cyclone season (November – March), especially dredging and pile driving for marine structures. The earthworks are less critical and can be completed in 20 weeks working two shifts. However, in order to avoid cyclonic surge, flooding and heavy rainfall, it is preferable to commence earthworks in early winter, (i.e. June). For environmental reasons it is also desirable to undertake dredging during winter.

Assuming the establishment of the Onslow Joint Venture by September 1990 (Section 3.3.1), it is proposed to commence construction of the earthworks in the last quarter of 1990, with the first seawater pumps installed and operating by January 1991. Dredging is planned to commence in March 1991, provided Commonwealth approval can be obtained in time, and to be completed by August 1991. Jetty construction would take place in 1991. Under this programme, the first salt would form in the crystallisers in mid-1991, and the first shipment is planned for late 1992.

1.4.2 Land Tenure

The land around Onslow is basically Commonage, Vacant Crown Land (VCL) or Pastoral Lease. The area occupied by the condensers covers mainly VCL (90%) and a small part of Peedamullla Station. The crystallisers haul road and process plant area are mainly on Commonage vested in the Ashburton Shire, although a corner of the crystallisers is in Mindaroo Station. The Project does not impact on Urala Station (see Cover).

1.4.3 Project Managers

Taylor Woodrow have co-ordinated the collection of field data, undertaken design drawings and verification of budget estimates by reference to subcontractors and if appointed will oversee the construction phase of the Project.
No operator has yet been appointed but skilled personnel are available in Western Australia and have been used as Consultants during design of the Project. Production of salt is a well established technique in Western Australia and the Proponent does not anticipate any difficulty in obtaining suitable personnel to operate the Project.

1.5 OTHER EXISTING SOLAR SALT OPERATIONS

Existing solar salt producers operate at Port Hedland, Dampier, Lake Macleod and Shark Bay.

In the early 1980's the Western Australian Government was reluctant to allow another producer to commence because of over-capacity in existing fields. With the exception of Lake Macleod, which was supposed to be a potash operation, all existing producers are now at or near full design capacity as originally constructed, producing a total of 6-7 million tonnes per year.

The Proponent anticipates further growth in the salt market especially in Southeast Asia and the Government has given Gulf Holdings Pty. Ltd. permission to revive its Salt Project.

West Australian solar salt producers were increasing their annual sales by about 5% per annum up to last year when most reached the limit of production for the evaporating area available. In a world growth of 2% per annum, the solar salt producers have therefore been increasing market share quite rapidly. Other factors such as rapid growth in the petrochemical industry in South-East Asia have also helped together with a resurgence of mothballed chloralkali plant in Japan itself.

Over the operating lives of the West Australian solar fields a number of technological problems have been experienced that need to be considered in any new venture, as follows:

a) One project had continued problems with leakage which could be tolerated to some degree in the condensers but the crystallisers finally had to be lined with plastic sheeting
because the brine would not reach salting point. This was due to the sandy nature of the soil and the danger was signalled by low salinity of the groundwater.

b) A different project had extreme problems in one particular year with flood damage to its flood diversion walls and condenser banks. This is understood to have been partly due to overtopping and partly to not having any rip rap (rock) protection on the bank slopes. The flooding came from an adjacent river and overland sheet flooding from behind the condensers.

c) Another project had a biological problem extending over a number of years relating to the entry of nutrients by drainage from an adjacent pastoral property which had extensive grassy blacksoil flats carrying large numbers of sheep, cattle and kangaroos etc. There was also a contribution from drowning of extensive mangrove creeks and algal flats by the project itself. The result was that a particular hypersaline algae was able to flourish in the condenser ponds right through to the crystallisers where it gave trouble in the crystallisation process and made the salt product hard to wash.

These problems have been resolved by the operators whose evolving experience has enabled the consistent production of a premium quality product.

1.5.1 The Onslow Salt Operation

In reviewing the operations of the other salt works, the Onslow operation has a distinct advantage in that its design and operation take into account 20 years of experience of the other salt producers.

1.6 LEGISLATIVE REQUIREMENTS AND APPROVAL PROCESS

Existing salt producers operate under separate State Government Agreement Acts. For this Project, the Proponent and the State Government are currently negotiating a similar Agreement Act. Such an Act would enhance its attractiveness to potential investors.
As the Project will involve dredging and disposing of spoil, export of salt and foreign investment, approvals from the Commonwealth Government via the Commonwealth Environmental Protection (Impact of Proposals) Act, Department of Trade and Industry and the Foreign Investment Review Board will be required.

Specific matters such as navigational aids and channel marking beyond port limits, seabed leases and Department of Transport permits need to be finalised.

As the Project has potential to impact upon the physical, biological and social environment of Onslow, the Environmental Protection Authority has called for this Environmental Review and Management Programme to be prepared.

1.7 ENVIRONMENTAL REVIEW AND MANAGEMENT PROGRAMME (ERMP)

Following submission of a Notice of Intent for the Project by the Proponent, the EPA decided to assess the Project under Part 4 of the Environmental Protection Act 1986. The level of assessment was set at an Environmental Review and Management Programme and guidelines were issued following discussions with the Proponent and the various State and Commonwealth Agencies involved (Appendix 1).

This ERMP which has been prepared along the lines of the EPA's guidelines, contains two volumes. Volume 2 contains detailed reports from specialist consultants on specific aspects of the Project. Volume 1 integrates these reports in an attempt to provide an overall understanding of:

a) the proposal (Sections 1, 2, 3 and 4)
b) the natural and social environment (Sections 5 and 6)
c) the impact the development will have on the environment (Section 7), and
d) the management strategy proposed to minimise the identified impacts (Section 8)

Section 9 is a Conclusion and there is a Summary at the beginning of the document.
The EPA has agreed to release of this ERMP which is now available for public comment for a nominated period of time. Upon receipt of submissions from the public and relevant State and Local Government Agencies, the EPA will advise the State Government as to the environmental acceptability of the proposal with or without special recommendations.

It should be noted that the Notice of Intent foreshadowed a two stage project, with Stage 1 utilising salt flats around Onslow and a future Stage 2 utilising salt flats around Exmouth Gulf.

This ERMP deals solely with Stage 1. Should the Proponent wish at some time in the future to construct Stage 2, a separate Notice of Intent and an Assessment by the EPA will be required.
SECTION 2 - JUSTIFICATION FOR PROPOSAL

2.1 INTRODUCTION

The Proponent believes that the Onslow Salt Project is financially viable and capable of generating export income. The Proponent believes that the market for export of solar salt is expanding and that profits can be made from the operation over a long period of time. Production of solar salt does not involve use of a finite resource and accordingly the Project will generate export income without depletion of natural resources. The Project will also create a permanent workforce in a town without any major employment opportunities. Thus the Project will not only benefit those residents of Western Australia, and Onslow in particular, but also Australians as a whole.

2.2 BENEFITS TO THE LOCAL COMMUNITY

The completed Stage I Project cost is estimated at A$80 million and much of this construction expenditure will be committed to West Australian based construction, manufacturing and service companies. A considerable amount may be spent with Onslow suppliers and contractors who have the necessary skills and capacity.

This Project will be different from the offshore oil developments near Onslow which have largely bypassed the town, in that the operating workforce will be resident in Onslow. The Project's net annual operating cost at design capacity will be about A$15.0 million. This includes wages, maintenance and stores which will have considerable benefits commercially for Onslow.

At present Onslow is largely dependent on provision of Government funding and services. The Project will bring directly or indirectly around 60 employees to the town and from experience at
other saltworks it can be expected that 60% or more will be families. The Company assumes it can get 20% of the workforce locally either coming off other jobs or through retraining programmes, implying 50 new personnel with say 40 of them married making a total increase of 170 persons. Although there appears to be no reliable data, it would seem reasonable to expect a multiplier effect in the local community of 0.5:1.0 or 80 persons making a total population increase of around 250.

This is significant in a town of 800, especially when the influx is self-supporting and spending money in the town. The employment opportunities offered by the Project will tend to offset the impact of the Shire office moving out of Onslow and reducing local employment.

As concluded in Appendix 2, one of the major benefits to flow from the Project will be the Project’s contribution to the economic base of the town and to a common purpose or focus for its population.

2.3 BENEFITS TO THE STATE AND NATION

Onslow is the only coastal town which has not benefitted from the general development of the Pilbara region and as a result it has not had the justification for upgraded infrastructure conferred on other towns.

The Onslow Salt Project will provide justification for infrastructure upgrading and it will create additional employment opportunities in the town.

The Onslow Salt Project will supply the State with revenue from royalties, lease rentals, rates, land tax, payroll tax, f.i.d. and sales tax. Onslow and the State will also benefit from provision of a $20 million jetty, dredged channel and loading facility which could be made available to the State or other third parties on reasonable commercial terms subject to the priority of this Project.

The Commonwealth will benefit from 39% corporate tax on profits of the Project and taxation on personal incomes as direct revenue from those new jobs created. It will also benefit in balance of
payments from an export income in current dollars of about US$24 million per annum (A$30 million) at design capacity. Allowing normal escalation in prices, the Onslow Salt Project should produce in excess of A$500 million of export income for Australia over the first 10 years of production.

2.4 COSTS TO THE COMMUNITY

This Project imposes no costs to the community and proposes certain benefits.

The Proponent will construct and maintain at its sole cost the following works associated with the Project:

i) sea walls enclosing portions of natural saltflats near the town of Onslow, together with a seawater intake;
ii) primary concentration and crystalliser ponds;
iii) new jetty and ship loading facilities;
iv) salt washery and stockpile;
v) service facilities including a powerstation, workshop, office and store;
vi) services and general facilities;
vii) haulroads and other roads;
viii) floodwalls to divert drainage away from the Works and Onslow itself.

In addition, the Proponent has offered to undertake certain works, to a value to be negotiated, at its cost within the town for the benefit of the local community. These works, which are subject to confirmation by the community and resolution of the matters of public liability and long term maintenance, are detailed in Section 2.6.1 vi) a)-f).

The Proponent will also contribute to upgrading the water main from Cane River (see Section 3.2.10.2).

The Proponent has held discussions with the Government regarding the provision of land for a new residential sub-division. The Proponent has also received a proposal from Homeswest regarding the provision of housing for its workforce.
2.5 DISBENEFITS

While the local community has demonstrated that it sees merit in the Project proceeding, several issues of concern have been identified. In general they relate to location of the jetty and the original location of the associated washplant and stockpile at the base of the jetty. These concerns are discussed in detail in Appendix 2 and mitigation measures designed to reduce or minimise these concerns are discussed in Sections 4, 7 and 8 of this document.

As a result of discussions with the local community, alterations made to the Project, and the commitments given by the Proponent to manage these concerns, the Proponent believes that disbenefits associated with the Project are few. These include:

2.5.1 Social

i) The town may not retain its "sleepy" atmosphere.

ii) It is predicted that noise generated by facilities at the selected washplant/stockpile site will not affect residents of Onslow (Section 4.2.8 and 7.2.7.1). No effect will be noticed in the town itself. However there is a possibility that noise levels in Clarke Place may occasionally exceed normally accepted limits of 35 decibels at night when shiploading occurs during an unusual temperature inversion in the atmosphere (possibly three nights per year).

2.5.2 Physical, Biological

i) One of the prawn fishing grounds will be disturbed along the length of the dredged channel and nearby spoil disposal areas.

ii) Only 1 ha (0.01 km²) of mangrove will be destroyed as a result of the Project out of a total of 943 ha (9.43 km²) around Onslow.
iii) About 230 ha (2.3 km\(^2\)) of algal mats will be inundated. This is a small fraction of the algal mats in the Onslow area (19.68 km\(^2\)) and even smaller in the Region which includes the Exmouth Flats.

iv) The condenser ponds and crystalliser ponds will cut off floodwater supply to Beadon Creek.

These concerns and disbenefits are described in detail in Appendix 3 and in summary form in Sections 5, 6 and 7.

2.6 BENEFITS OF PROPOSAL

The Proponent perceives the following benefits:-

2.6.1 Social

i) The town and Shire will benefit commercially, especially tradesmen and suppliers. There is currently no bank, hairdresser or chemist. A successful project would increase the likelihood of such businesses, and possibly others, being established.

ii) The State and nation will benefit commercially.

iii) There will be more employment opportunities, especially for young people and those prepared to be trained.

iv) The State will have more reason to preserve and upgrade existing infrastructure.

v) The main entry to Onslow will be more attractive as the existing causeways will be flanked by large lakes.

vi) The following projects in Onslow have been suggested as being possible subject to resolutions of public liability, long term management, operational procedures, security, insurance and tenure, to which a contribution by the Proponent could be made.
a) provide controlled access to a jetty, fishing platform, lookout points and some embankments,

b) provide a sealed walkway/cycleway around Beadon Point connecting the town to the jetty,

c) upgrade facilities at Back Beach providing sealed and landscaped carparking, barbecues and sun shelters,

d) assist in developing the Workers Club,

e) establish a second caravan park possibly at the Wapet Camp Site initially for the sole use of the Company during construction. Once the construction workforce leaves the site, the park will be open to the public.

f) establish and maintain a tree planting programme in the whole area in conjunction with the Shire.

2.6.2 Physical and Commercial

i) The jetty may be available to third parties on a reasonable commercial basis and will eventually bring other benefits to Onslow.

ii) The jetty may encourage an industry that would use local oil and/or gas and/or salt.

iii) Local fishermen and small to medium craft may be able to use landings attached to the jetty.

iv) A tug/workboat will be needed and will be permanently based in Onslow.

v) Heavy rainfall flooding of the Beadon Creek area and the aerodrome will be greatly reduced because of containment by the ponds and the diversion by the perimeter bank layout.

vi) Dust generation from the supratidal flats will be significantly reduced.
2.6.3 Biological

i) An extensive environment suitable for wading birds will be established. Other saltfields have found many new species using their ponds of lower salinities.

ii) There is potential to establish a new fish community in the primary condenser ponds including algae, brine shrimp and large fish.

2.7 SUMMARY

The Proponent believes the benefits of the Project greatly outweigh the perceived disbenefits on any basis of commercial judgement, and on most social counts. The impact on the physical and biological environments is believed to be minimal. This is borne out at other saltfields even though they were built with virtually no environmental restraints at the time.
SECTION 3 - THE PROPOSAL

3 THE PROPOSAL

3.1 INTRODUCTION

The aim of the Proponent is to produce solar salt for export.

In simple terms the Project involves pumping seawater into condenser ponds where concentrated brine is produced. This brine is channelled through the ponds to the crystallisers where salt crystallises out. Bitterns left after this process will be released in a controlled manner to the sea. Salt harvested from the crystallisers will be trucked on a private haul road to a washplant located 1.5 km inland from the base of a new jetty west of Beadon Point. After washing, salt will be stockpiled ready for loading by conveyor onto ships.

The layout of the Project is shown in Figure 1.

3.2 PROJECT COMPONENTS

3.2.1 Seawater Pumping Station

The pumping station is located on the eastern arm of Beadon Creek about 3 km from Onslow. This is a protected location selected after examining other alternatives (see Section 4.2.4). Initially, three diesel driven pumps each with a capacity of 4m³/sec at average head will be installed. There is provision at the site to add two more identical pumps in Stage 1 as production and sales of salt increase. The creek has about 25m bottom width at the pump site. Any material excavated during construction of the pump station will be disposed of within the pond walls.

The pumping station will have vertical screens around the intake to prevent access by children and floating debris. The engines will be operated automatically from batteries and run continuously.
except for low water cutout. They will be fenced off from the public as security for both parties and are far enough away for no noise to reach the town.

3.2.2 Condenser Ponds

The Condenser Ponds will be constructed on the flats south-east of Onslow behind a chain of coastal islands which will protect the pond walls from wave attack on three sides. In general, the ponds are located on the supratidal flats, inland of the mangrove/algal mat communities that colonise the tidal channels and lower tidal flats. Runoff from inland will be diverted around the ponds to discharge into the sea.

The total area of condensers is around 70 km². The proposed layout of the internal walls makes maximum use of the many 'islands' on the saltflats to incorporate natural stable land and to reduce the length of embankments. There are a number of alternative flow paths and short circuits available to meet early brine requirements and to accommodate seasonal variations.

The condenser walls will be about 2m high with pond water about 0.6-0.7m deep inside (Figure 2). Because the condenser ponds will drown the existing freshwater main from the Cane River, one of the internal banks has been placed on the same alignment as the water supply main which will be upgraded.

The pond layout has been designed to split the natural drainage system so that about half flows away to the north-east and about half to the west behind the crystallisers. There is great advantage in the above drainage system in that it prevents local floodwaters entering the evaporator ponds. This will avoid the river and sheet flooding experienced by one other saltfield and the nutrient algae problems experienced by another as mentioned in Section 1.5.

3.2.3 Crystalliser Ponds

Eighteen crystalliser ponds totalling 720 ha (7.2 km²) will be constructed on the salt flats south-west of Onslow. It is a useful
feature of this area that much of the first stage saltflat floor consists of very hard limestone nodules in a clay matrix. This is virtually impervious and capable of supporting heavy loads without having to build up a thick base of salt. In addition, the most exposed seawall has been located with its corners coincident with two natural islands.

The volume of bitterns discharged per day will be around 25,000m$^3$. Release of bitterns (see Appendix 10) will take place in a controlled manner into Middle Creek to maximise mixing. (See Section 8.3.2.4). Allowance has been made in the design to recover at some future stage most of the 30% sodium chloride from the bitterns through redissolution with seawater pumped from Middle Creek and recirculated through the crystallisers.

The crystalliser area is well located so that if sufficient demand for salt develops in the future the number of ponds can be increased with additional brine brought in from the Exmouth saltflats to the west (i.e. Stage II).

3.2.4 Harvesting and Transport of Salt

After about four months from the start of pumping concentrated brine will be delivered to the initial crystalliser ponds where it will crystallise out in a layer at an average of about 2.5 cm per month depending on the season. Over the course of a year a layer about 30 cm deep is deposited which normally acts as the working base of the salt pond. Over the next several months a harvest bed is built up which ideally should be at least 15 cm thick. Salt will then be mechanically harvested, loaded into bottom dumping trucks and transported along a private haul road to a ramp and overhead truck dump at the washplant site which is situated 1.5 km inland from the base of the new jetty. The harvesters will operate each with a nominal capacity of 1500 tph.

The haulroad will be constructed along the inland edge of the narrow depression leading to the washplant and as such will not cross any public road. The haulroad will not be sealed but will be dust free, having 200mm compacted gravel sheeting and watered with brine or bitterns from time to time.
It should be noted that all major trucks and machinery movements will take place between the crystallisers and the washplant. Accordingly there will be no heavy vehicle movements through town along the main highway or along Four Mile Creek Road.

3.2.5 Washplant and Truck Dump

The truck dump bridge runs over 100t hoppers in each bay. Trucking capacity is 800 tph using four 475hp trucks of 120t each. The washplant contains centrifuges which avoid the need for drainage in the stockpile. The layout is designed for six parallel lines, of which four will be installed initially at a rated output of 220 tph per line (i.e. a total of 880 tph). The washplant will be able to handle initial output comfortably in a single shift. The washplant floor has gravity drainage to settling ponds from which pumps will return the brine to the crystalliser pond area. Washing of the salt will use seawater makeup obtained through a 150mm pipeline along the jetty.

3.2.6 Stacker, Stockpile Reclaim

Salt from the washplant is fed via a conveyor leading to a butterfly stacker with twin stockpiles of 500,000t total capacity. Salt on the stockpile will be reclaimed by two D8 bulldozers fitted with special salt blades pushing into moveable boxes and conveyors leading to the reclaim conveyor. The reclaim rate is 1300 tph available on double shifts. When a ship is loading, incoming salt can bypass the stockpile.

3.2.7 Jetty Shiploader and Conveyor

The shiploading operation is designed for 1300 tph from a new jetty located west of Beadon Point. The jetty head is approximately one kilometre offshore in a natural water depth of 7.2m below chart datum. This allows incoming carriers in ballast to make a free turn to port or starboard without being confined to the dredged
channel. Loading will be from a fixed point requiring warping of the ship which is common in the salt industry. At 1300 tph the jetty should only have one ship per week which will be loaded within 24 hours.

The Proponent may be prepared, subject to the resolution of the public liability, insurance, security, ongoing maintenance and operational issues, to allow public access to the jetty at times other than ship loading. Under the above circumstances, lighting would be provided to 10.00 p.m. each night along that part of the jetty open to the public. The jetty may also be made available to other users on a commercial basis if the need arises.

3.2.7.1 Trestleway
The trestleway structure is 950m long and consists of twin steel pile piers at 35m centres with steel beams and longitudinal timber decking. The deck is 3.6m wide and will accommodate light vehicles with a speed limit of 20 kph. It has a handrail on one side and a conveyor on the other side beyond the roadway. There is a substantial kerb and windguard between the conveyor and the roadway, which is therefore safe for visitors and tourists to walk along and fish from.

The deck height varies from +6.0m at the shore to +10.0m at the jetty head. This has been based on the maximum possible wave crest height in the relevant water depth after allowing for tidal surge, (e.g. at the jetty head the 50 year tidal surge height is +3.1m and the total water depth 10.3m, permitting a maximum wave not exceeding 8.0m with a crest height of about +9.0m above chart datum). Data reported in Appendix 7 indicates such waves cannot get into Onslow and allowing for phase differences between maximum wind, wave, surge and tide, gives a crest height of +6.5m for 50 year frequency and 7.2m for 100 year frequency.

3.2.7.2 Pierhead (Shiploader Platform)
The pierhead is 18m square supported on steel piles and allows turning of light vehicles. It has been designed to support a shiploader capable of delivering 3,000 tph of salt with a 30m boom and capable of slewing and luffing. There is a tiedown provision for the boom during cyclones.
3.2.7.3 Dolphins
There are at least 6 steel piled fender and mooring dolphins separate from the pierhead structure. There is no walkway between them. They can handle the forces due to a fully laden 60,000 dwt ship making quarter point impact on a single fender should it return to berth. The mooring dolphins have twin 60t quick release hooks and the intermediate dolphins single 60t bollards for spring lines.

3.2.7.4 Design criteria
All of the marine structures are designed for cyclonic wind conditions (69m/s, 3s gust) and maximum possible wave heights in the water depth applicable. The fender and mooring dolphins can be safely overtopped by such waves. The design forces for the trestleway and pierhead are both governed by wind rather than waves and for the forces on the dolphins, berthing loads are much higher than wave loading. All structures will withstand the forces from natural events of 100 year frequency.

3.2.7.5 Piling
Indications from preliminary jet probes and seabed samples recovered in the region of the proposed jettyhead, indicate that stiff red clay soils with shell and coral nodules persist to a considerable depth as it does on the tidal flats. This should provide good pile friction for both tension and compression. The Department of Marine & Harbours indicate that firm clays and silts were generally encountered around the old jetty head about 1 km to the east. There was never any record of difficulty in driving piles in that location. Obviously some surface reef will be encountered on the trestleway but this is expected to be thin. It has been assumed that the following pile penetrations will be achieved:

<table>
<thead>
<tr>
<th>Pile Type</th>
<th>Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trestle Piles</td>
<td>8m</td>
</tr>
<tr>
<td>Shiploader Platform</td>
<td>10m</td>
</tr>
<tr>
<td>Dolphin Piles</td>
<td>12m</td>
</tr>
</tbody>
</table>

All piles are tubular steel 460 to 610mm diameter and most are driven on a 1:3 rake.
3.2.7.6 Operation

The Proponent has been advised that it will have to pay for all the marine facilities including navigation aids. The last advice from Marine & Harbours was that the Proponent would also have to maintain all the facilities including lights. The Proponent understands that in this event no wharfage is payable.

The Proponent has requested the right to employ its own qualified pilot either itself or in association with other nearby users. The tug and lineboat services will be chartered out to an experienced operator. The Proponent will supply personnel to handle lines.

There will be a small boat landing for small craft near the conveyor trestleway and a mooring position for the tug near the pierhead but during cyclones the tug will, in the normal way, have to seek shelter behind the offshore islands or at sea.

3.2.8 Approach Channel

3.2.8.1 Dredged Channel

A dredged channel approximately 4 km long and 120m wide will need to be dredged to a depth of -9m at low water (ie. a maximum depth of 1.8m below the seabed). This will provide access to 28,000 dwt ships at half tide or better. In the berth area at the head of the jetty dredging to -12m will take place. In order to create this channel and the berth area about 600,000m³ of material will need to be dredged. The dredged spoil will be disposed of about 600m east of and parallel to the channel in a mound about 120m wide x 1.2m high. The dredged channel will average 1.2m depth below the seabed.

A series of jet probes has been made by divers which shows that the surface material to a depth of several metres is generally unconsolidated. The material is clayey sand, sand and shelly coral sand with significant clay content and minor calcareous bands increasing with depth.
At a later date it may be necessary to accommodate larger ships. For ships of 40,000 dwt the channel will need to be dredged to -10.8m and extended 6 km out to sea, requiring 2,000,000m³ of dredging in total. Incoming ships in ballast will still be able to turn free on either hand in natural water without regard to the channel. At this stage, approval is only sought for the initial dredging.

3.2.8.2 Navigation Aids and Marine Craft

Pairs of steel piled beacons with solar powered lanterns are proposed at 1.0 km intervals along the channel, together with the two existing leading lights. A tug/workboat and lineboat will be stationed in Onslow to assist shipping manoeuvres.

3.2.9 Bitterns Discharge

During the first few years of operation bitterns will be mainly used to build up the floors of the crystalliser ponds (see Appendix 10). However, periodically it will become necessary to release them in a controlled manner via a drain into Middle Creek (see Section 8.3.2.4).

3.2.10 Services

3.2.10.1 Power

An automatic outdoor power station and switchyard of 2,000KW capacity will be constructed to service the Project's needs. All of the process plant including washplant, stockpiling, reclaim, shiploading, office and workshop will be served by reticulated power (mostly underground or in cable trays or ducts) complete with transformers and substations. The seawater pumps, crystalliser feed and drain pumps will be direct diesel driven.

It is anticipated that locally produced oil will be used to fuel the power station, trucks and heavy plant. Power for the residential housing in Onslow will be supplied by SECWA through the normal power grid, as advised by letter dated 10th November 1989.
3.2.10.2 Water

The Water Authority of Western Australia has advised the Proponent that it requires a contribution of $840,000 towards upgrading the rising main from the Cane River which would replace 8.4 km of the existing main with a new 300mm diameter main. The main would be placed in a trench within one of the internal condenser banks which has been located specifically for that purpose. This same bank may serve as access for the Water Authority to Cane River and for the local community running Peedamulla Station. The Proponent will reticulate water through its industrial and process plant areas for drinking and other domestic purposes only, in accordance with bylaws and other requirements of WAWA.

It should be noted that no fresh water will be used in the washplant or for washing down trucks or conveyors or any other industrial purpose.

In a new sub-division the Proponent, directly or indirectly, will be required to pay normal headwork charges and development costs, together with rates, on an annual basis.

3.2.10.3 Sewerage

WAWA has advised that the Proponent will pay, directly or indirectly, normal headworks and development costs for any sub-division together with annual rates when and if sewerage becomes available. The Proponent will provide reticulated sewerage through its industrial and process plant areas in accordance with bylaws and other requirements of WAWA and connect to the Onslow town sewerage scheme when the headworks including pumping station and treatment plant are available. In the meantime septic disposal will be provided by the Proponent.

3.2.10.4 Office Block, Laboratory, Workshop, Store, First Aid, etc.

These facilities will be located near the washplant complex 1.5 km inland from the base of the jetty, however, consideration is being given to siting the office in the town.
3.2.10.5 Housing and Accommodation

About 60 fulltime employees will be needed initially plus casual labour from Onslow as required. Up to 40 of these employees will be married and will require homes which will be constructed over a 2 year period. Rental guarantees may be provided by the Proponent. Employees may be given the right to purchase these homes with a guaranteed buy-back by the Proponent. A new sub-division is planned by DOLA behind the hospital and the Proponent or Homeswest would require a substantial number of lots.

The Proponent is also investigating the purchase of 10-12 existing lots from Homeswest which are located within existing suburbs of Onslow.

Single accommodation for 10-15 persons in self contained units will be provided in three blocks of five units each on ground level in the new subdivision. (Subject to approval of Ashburton Shire, DOLA and DPUD).

All accommodation will be airconditioned and built to standards applicable to cyclone-prone areas.

3.2.10.6 Fuel Storage and Lubrication

Arrangements for use of locally produced fuel have not been finalised yet but provision has been made for a 250mm diameter petroleum products pipeline on the jetty.

The oil company under contract to supply fuel will provide all storage facilities etc. Power station and pumping station day tanks will also be provided and maintained under the contract.

All storages will be enclosed, protected by suitably lined bunds against leakage and generally secured as required under the relevant regulations.
3.3 MANAGEMENT OF OPERATIONS

3.3.1 Management Structure

Gulf Holdings Pty. Ltd. as Proponent of the Onslow Salt Project is pursuing the establishment of an unincorporated joint venture called the Onslow Salt Joint Venture. It is proposed that Onslow Salt Management Pty. Ltd. (OSM) be created as the Project's Manager with responsibility to the Joint Venture Board for the operation of the field and associated activities including environmental management. In more detail, responsibilities of the Project Manager will include:

- successful commissioning of the Project
- management of the Perth office
- management of site operations including environmental management
- cost control and profitability
- public and industrial relations
- shipping management out of Onslow
- ongoing development of the salt field
- marketing and shipping management for Gulf Holdings

In order to undertake these tasks, the Project Manager will employ a number of key personnel as follows:

- Managing Director (Perth)
- Shipping and Marketing Manager (Perth)
- Cost Controller (Perth)
- Public and Industrial Relations Manager (Perth)
- Operations Manager (Onslow)
- Production Manager (Onslow)
- Maintenance Manager (Onslow)

Environmental consultants will be engaged as required and will report directly to the Operations Manager at Onslow. A personnel officer responsible to the Operations Manager will be responsible for community liaison and Aboriginal training amongst his other duties. The Project Manager, through the Operations Manager and environmental consultants, will therefore be charged with implementing the environmental management and
monitoring programme described in Section 8 in this document in addition to managing the Project as a whole (see Section 8.4.12).

3.4 MANAGEMENT

3.4.1 Construction Workforce

The maximum workforce of about 100 will occur during the first four months of construction when the earthworks contractor is working on two shifts. Subsequently the workforce is unlikely to exceed 50 at any time until another peak of around 100 occurs in the second year when the jetty and process plant are being constructed. The construction workforce will be mainly housed in a new caravan park which may be located on the site of the WAPET camp.

The skills required during construction are plant operators of all kinds, welders, fitters, mechanics, electricians, plumbers, concrete workers, carpenters and barge hands. There will be a modest requirement for general labour and clerical persons.

There will probably be a significant number of married men on longer contracts that will be housed on a semi-permanent basis at the new camp while new houses are being constructed. The longer contracts are earthworks, culvert structures, washplant, marine structures, conveyors, shiploader and housing.

The Contractors will be requested in the contract documents to use local labour and local subcontractors wherever possible, provided they are competitive in cost and output. The Proponent will provide prior information through the Shire or its own offices of the content of various contracts during the tendering period and a list of successful tenderers.

3.4.2 Operation Workforce

Pumping of seawater is intended to start within three months of the start of construction. From that time operating personnel will be on site and will increase in the following manner:
<table>
<thead>
<tr>
<th>Month from Start</th>
<th>Perth Office</th>
<th>Site Staff</th>
<th>Wages</th>
<th>Leave + 10%</th>
<th>Total Site</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>11</td>
<td>4</td>
<td>2</td>
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<tr>
<td>9</td>
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<td>11</td>
<td>7</td>
<td>2</td>
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<td>15</td>
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<td>8</td>
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<td>4</td>
<td>39</td>
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</tr>
<tr>
<td>25</td>
<td>7</td>
<td>19</td>
<td>22</td>
<td>5</td>
<td>46</td>
<td>53</td>
</tr>
</tbody>
</table>

These figures include subcontracted activities such as truck haulage, but not maintenance workshops and marine services (say 14). The number of direct employees of the Proponent is expected to be about 40. About 60% of the men are expected to be married and need housing. About 20% of employees, married or single are expected to come from Onslow or nearby and have their own housing.

The following is a list of skills required on site (including subcontractors):

- Managers
- Supervisors
- Pump Operators
- Harvester Operators
- Grader Driver
- Truck Drivers
- Washplant Operators
- General Works Operators
- Dozer Operators
- Shiploader Operator
- Tug Captain
- Engineer
- Crew
- Truck Mechanics
- Plant Mechanics
- Plant Fitter
- Auto Electrician
- Mains Electrician
- Trades Assistants
- Chemist
- Laboratory Technicians
- Accountant
- Clerk/Typists
- Storeman
- Industrial Safety Officer
- Shipping Officer

There is only a small requirement for unskilled workers due to use of plant and automation. It has been assumed that casual labour can be obtained locally. It has been assumed that
backhoe, front end loader, cranes, water carts and rollers etc. can also be obtained locally when required.

The Proponent notes the suggestion made in Appendix 2 and will make provision to train at least two unskilled workers throughout the Project under the DEET Scheme (see Section 8.3.2.9).

3.5 SOURCES OF CONSTRUCTION MATERIAL

The condenser and crystalliser banks will contain a core topped with selected material that can be compacted. The external face of the seaward facing walls and internal condenser walls will be protected by rock armour. Sources of rock and gravel are shown in Figure 1.

a) Core Material

This will be natural sandy clay or clayey gravel with sufficient clay to render the banks impervious and to compact into a tough mass of high integrity. In most places however, the core will be formed by dozing or scraping the sand/clay/gravel mix from the salt flats adjacent to the banks, provided there has not been prior flooding by rainfall or exceptional storm tide. Normally this material will be moist and suitable down to about 0.6m. If excessively wet, the material will be pushed up and left to dry until it is sufficiently dry to allow placement on the banks. At least half the core is expected to be built in this way. The material especially for the crystallisers may be won from selected borrow pits around the various islands and hauled onto the banks by trucks or scraper where deemed suitable.

b) Topping

This material will consist of a sandy clay mix obtained from selected borrow pits on the salt flats or around the edges of the islands where the grading and moisture content allow compaction by roller. Batters will be covered with the same material but not compacted by roller.
c) **Rock Armour**

This material will be clean limestone won from designated quarries on the various larger islands. This material can be won by ripping with a D9 tractor or better. Oversize stone will be set aside for other purposes. The rock armour will be placed with great care to avoid segregation and avoid weak areas not properly protected. The surface will be bladed or picked over to produce a reasonably even surface with a thickness not less than that specified. Stone facings around interpond structures will be placed by hand.

d) **Borrow Pits and Quarries**

Borrow pits for all materials will be designated on the construction drawings and no new sources of material will be used without prior approval from the Proponent. It is not expected that explosives will need to be used. On completion of construction all pits and quarries will be tidied up, rubbish removed and topsoil replaced wherever possible except for nominated pits to be used for maintenance of banks.

3.6 **STABILITY OF BUND WALLS**

a) **Storm Surge**

In designing the sea walls, the Proponent is relying on local observations of old walls built 20 years ago on the Exmouth Flats, debris levels on the tidal flats around Onslow and a study by Steedman and Russell for Exmouth Gulf (1986) which estimated that the 50 year storm surge at the head of Exmouth Gulf would be +3.1m above chart datum (+2.0m AHD).

The authors are currently extending this study to include Onslow, through examining tidal records and notes from the original jetty at Beadon Point completed in 1925.
The Exmouth study took account of field measurements of high surges at the lower end of Exmouth Gulf where convergence has caused surges up to 3.0m above normal tidal predictions.

Onslow is an open coastline without lateral convergence and the extrapolations from Exmouth are supported by observations of surge levels on the pipeline causeway behind the aerodrome. In 14 years experience of the local water supply officer, the sea levels have only reached +2.8m which is about the 14 year prediction.

In addition, a large monsoonal depression of 1,000 km diameter with unusual duration passed by Onslow on 26th January 1990. Wind speeds of up to 127 km/hr caused a maximum sea level of +2.91m (surge of 0.8m on a spring tide of 2.11m) at Beadon Creek. (Maximum surge was 1.25m at low tide). In the opinion of a reliable long standing resident of Onslow, the sea level during this event was one of the highest in his memory. This experience and the studies to date in Appendix 7 provide evidence that the highest sea levels likely to be encountered are in the order of +3.0-3.3m at 50 year frequency and possibly +4.0m at 100 year frequency.

The top of the sea walls in the Onslow Salt Project are set at +4.5m above chart datum and so will be safe for storm surges to +3.5m-4.0m.

The side slopes of the sea walls will be pitched with armour stone and will stand any wave attack that could be envisaged. Under storm surge conditions, the depth of water on the seaward side of the sea walls will only reach around 0.6m-1.0m generally except near the creeks where there is mangrove protection (Figure 2).

The operating water level inside the ponds is similar to the predicted 50 year storm surge outside and all internal faces of sea walls and dividing walls are also stone pitched to protect from wind driven surge and waves within
the ponds for which there is now a great deal of experience from the other saltfields. The internal slopes of the crystallisers are not stone pitched as they will quickly become lined with salt.

b) Greenhouse Effect

The proposal carries a margin of freeboard on the sea walls. If this is ever exceeded, it will be necessary to raise the external walls but not the internal walls. This would not be an unduly expensive exercise.

Any raising of sea level will not affect the pumping station except to decrease the net head for the pumps. In the extreme no pumps would be needed and the intake could be controlled by gates alone.

c) Flooding by Rainfall

A study into the impact of changing the flooding regime is described in Appendix 4. The internal drainage system will be diverted by the pond walls. This will cause a new flow regime, from the previous sheet flooding over the flats, to a confined drainage course. This study indicates that the perimeter flood walls which are 2m high and rock faced will not be overtopped by a flood of 50 years frequency and that flood waters from inland will successfully be diverted around the ponds to discharge into the sea. The study does note that some modifications to:

i) the existing causeway on the main road into Onslow (ie. increase the culvert capacity and upgrade the existing embankment), and

ii) condenser walls east of the Highway will need to be made to accommodate extreme flooding.

The fact that the area is so flat means that flood water has to find its own gradient to the sea and consequently water flow velocities are low. This in turn implies that scouring by flood waters in the confined channels will not occur. (See Appendix 4).
d) **Effects on Onslow**

Concerns have been expressed by some Onslow residents and by the Shire concerning the possible effect of the construction on flooding in the town, whether by storm surge or storm water runoff.

It will be evident from the foregoing and the various plans that storm water runoff from inland is in fact being diverted away from the town and the aerodrome in particular. Even if a bank or floodwall broke it could not produce a level in the Beadon Creek area higher than about +2.8m above chart datum which has been experienced already from storm surge. Levels being set in the town for building pads are understood to be +5.1m above chart datum (+4.0m on AHD).

Regarding storm surge in Beadon Creek, the saltworks construction will make no measurable change to surge levels.

3.7 **REPAIR AFTER EXTREME EVENTS**

The four possible events that could occur are:-

(a) **Cyclone Damage to Marine Structures**

The only modern marine structure which has failed since real development of the Pilbara and Kimberley began in 1960 was the jetty at Cape Cuvier, north of Carnarvon.

Severe damage during cyclones to the older wooden or even concrete piled jetties at Broome, Point Samson and Onslow has been attributed partly to prior sustained attack by marine borers and/or seawater which decimated their design strength.

Modern jetties in the Pilbara are built of steel piles with fair to good corrosion protection. Many of the jetties are now 25 years old with plenty of useful life left.
The other problem with the old jetties was that they were designed by guesswork when it was not easy to calculate maximum wave height, wave and wind forces. For instance, the early jetties at Old Onslow did not have adequate deck heights to prevent "slamming" of waves from underneath. Even with adequate deck heights (such as the last Onslow jetty), the spans were short and the timber spring pile fendering system so complex as to present an almost solid wall to oncoming waves. When the fender piles became eaten through by marine borers, the whole fendering system collapsed against the jetty structure which would eventually fall over and disintegrate under a storm. Remains of jetty piles and fendering can be found washed up at several tidal creeks and on the saltflats around Onslow.

The new jetty has been designed as a steel piled structure offering minimal wave resistance. In fact wind forces are the governing design factor on the trestleway and shiploader platform, and ship berthing forces govern the design of the fender structures. Combined with experience in the Pilbara over the last 25 years, it is reasonable to expect a similar life from the structure proposed.

(b) Ship Damage to Marine Structures

For a ship to damage the shiploader structure, it would be necessary for the tug to be absent and the ship deliberately to come in between the fender dolphins.

The fender dolphins are each designed to take full quarter point impact from a fully loaded 60,000 dwt salt carrier coming back into the berth with a velocity of 0.25m/s normal to the dolphin. The normal expectation is for a 40,000 dwt salt carrier in ballast approaching at a velocity of 0.15m/s (i.e. about one eighth of the design capability).
(c) Cyclone Damage to Sea Walls
The studies done by the Proponent's Consultants indicate a 50 year storm surge of +3.0m-3.3m above chart datum. This is only about 0.6-1.0m above the general ground level of the condenser flat and about 1.0m above the general level of the crystalliser flat (local experience and trashmarks verify this). Such depths will only permit wave heights of 0.5-0.7m which does not require very large rock armour. The armour provided for in the Specifications would be safe against 1.2m waves at least.

These small wave heights will also give limited runup on the armoured slope. The top of the sea walls has been set at +4.5m above chart datum providing a freeboard of 1.2-1.5m on the 50 year surge level and possibly 0.5m at 100 year frequency. The experience with properly constructed rock slopes of this height is that they cannot fail unless the construction is defective allowing small stones to be sucked out and wave attack on the core. Usually a well constructed core with some cohesion (integrity) will stand attack by small waves for the two or three hours while the high tide drops.

As previously mentioned, the position is probably worse inside the various ponds because a water level of +3.1m above chart datum (i.e. 0.6-0.7m deep) or just above is maintained continuously. However, the same arguments apply as above and it is essential that good supervision of construction be provided on all sections of embankments and rock pitched slopes. Failure of internal banks is not catastrophic and can usually be repaired very quickly.

(d) Floodwater Damage to Flood Walls
Wave attack from inland is not a real problem so the only danger is that the flood walls may not be high enough. The Consultant's calculation of the hydrology of the catchments and waterways indicates that a 50 year flood can escape through the waterways provided, without overtopping the flood walls (Appendix 4).
If the flood walls are breached inland, it may be conceivable that floodwater could come through a number of condensers and raise their level such that a seawall may be breached from inside. For this to happen, all of the hydrological calculations would have to be exceeded by a factor of 2 or more. This scenario is not likely and in any event would not significantly impact Onslow.

The top of the seawalls is +4.5m above chart datum so this hypothetical flood would overtop at that level causing long breaches in the seawall and dropping the internal levels. Since natural ground level in the Beadon Creek catchment is about +2.2m above chart datum, the escaping flood water level would drop quickly to whatever sea level was at that time (say +2.5m at the most), since any cyclone surge would have passed many hours previously.

Since building pads are being set in Onslow at +4.0m above AHD (= +5.1m above chart datum), there is no way that floodwaters escaping from the condenser system can adversely affect Onslow itself. Even if 0.45m of rain fell in a single day, which exceeds the highest one day fall of 0.356m (356mm), this also would not breach the condenser banks or affect Onslow. Such rains have been experienced at rare intervals and cause considerable local flooding in the town.

(e) Fuel Spills

Terrestrial spills will be contained with bunds (see Section 3.2.10.6).

A tug/workboat and lineboat with necessary equipment (boom and skimmer) will be permanently stationed at Onslow and would be available to handle marine spills (see Section 8.3.2.8).
3.8 DECOMMISSIONING

3.8.1 At End of Project Life
The solar salt making process is self-renewing and the lease is expected to be 21 years with two options for a further 21 years each.

Use of salt in the chemical industry seems likely to keep expanding unless a substitute for sodium and/or chlorine is found.

No consideration has been given to terminating the works for this reason.

3.8.2 Catastrophic Events
If the catastrophe was sufficient to destroy more than half the Works and sales contracts were cancelled due to non-delivery of salt, then one option would be to decommission the Works and return the site to nature.

However, the solution to non-delivery of product is to have enough salt stockpiled for say 12 months supply, or to have at least that much stored in the crystallisers within a sea wall so secure that it cannot be lost. This procedure is adopted by some of the existing producers and will be adopted by the Proponent.

One of the existing salt producers suffered substantial loss to its condenser pond walls about 9 years ago. This is understood to have been due not so much to seawater surge but to flooding from a large nearby river which had been diverted around the perimeter of the condensers. This river flooded to such an extent that it did breach the flood wall and then flowed from one condenser pond to the next. This particular salt producer had not placed armour on any of the bank slopes at the time because it was not readily available. This has subsequently been done at considerable cost and there has been no trouble since.
3.8.3 **Financial Failure**

The Project will not proceed unless a long term contract for at least 1.0 Mt/yr is first obtained, thereby ensuring that it will be financially viable. In the event of financial failure by the Proponent, the Project could be sold to another producer or new partners such as happened to a solar potash producer some years ago. That Project is now working satisfactorily without any burden or concern to the State.

If the Project cannot be sold, see Section 3.9.2 below.

3.9 **REHABILITATION OF AREAS OUTSIDE PROJECT**

3.9.1 **After Catastrophic Event**

As detailed in Section 3.6, damage could occur to the jetty, seawalls and inland flood walls as well as damage from fuel spills. Damage to the jetty is unlikely to lead to any remote impacts. Damage to the crystalliser seawalls could lead to the release of contained brines. Obviously it is in the Proponent's interests to close off breaches as soon as possible. The impact of escaping brines from condenser ponds is likely to be minimal as the seaward ponds generally contain the lowest salinity brine and the level and volume of brine escaping is insufficient to raise external water levels to the extent that they could flood public or private property.

The changed inland flooding regime could lead to flooding at 10 year frequency of part of the Onslow-N.W.Highway link and a need to re-design culverts under the highway. This will be monitored and action taken by the Proponent in conjunction with the Shire if required.

Fuel spills are a remote possibility, though every effort will be made to comply with the standard regulations for conveying fuel in a sensitive environment.

3.9.2 **At Close of Project**

Much of the Project involves construction and maintenance of walls made of locally won material. With close of the Project, the walls will be breached and the ponds will be drained. With lack of maintenance, the walls will break down and return to
the flats or accumulate sand and revegetate. The materials handling and associated facilities can be sold off and unsaleable parts such as foundations can be cleared up and made safe. The jetty is a valuable asset that should revert to the State and be maintained at public expense if it is no longer used by the Proponent.

3.10 ENVIRONMENTAL CONTROLS AND SAFEGUARDS

The Project has been designed to cope with known and predicted environmental conditions using sound engineering principles based on experience of similar projects elsewhere in Western Australia. Additionally, the ponds have been located where possible inland of the mangrove/algal communities and tidal creeks to minimise impact on the local biological system. It is not expected therefore that the project will have a significant impact upon the local environment, or cause any significant environmental hazards.

The only effluent is the bitterns which, from experience elsewhere, does not have a significant impact on the environment. The only emission likely to have an impact is noise associated with the truck dump, stockpile and conveyor. This, however, is not likely to affect the local community as the noise generating facilities will be located away from the town and management measures will be taken to reduce noise levels potentially affecting the nearby residential area (see Section 7.2.7.1).

Fuel spills, particularly marine, are another potential emission, however, the presence of a tug/workboat with necessary equipment should minimise this impact.
SECTION 4 - EVALUATION OF ALTERNATIVES

4.1 HISTORICAL

During 1969–1971, Gulf Holdings Pty. Ltd., in joint venture with Mitsubishi Shoji Kaisha, carried out all necessary engineering, testing and feasibility studies for a new solar salt field on the eastern shores of Exmouth Gulf. A camp was established and construction of earth banks commenced, following favourable investigations by French consultants C.S.M.E. and successful site production trials.

At the end of 1971, after spending $1,500,000 and calling for tenders for the major equipment, the United States imposed drastic import restrictions on Japanese products and Mitsubishi withdrew from the project. They subsequently bought the National Bulk Carriers Saltfield in Mexico.

A revival of the Exmouth Salt Project 18 years after it was stopped required the logistics to be re-examined. In particular, it was found that consumers in emerging industrial nations do not need and in most cases cannot handle the large salt carriers which were an integral part of the original project. This meant it was no longer necessary to locate the salt works on the Exmouth flats where barge transport to large salt carriers loading in the deep waters of Exmouth Gulf was planned.

A second factor is that the cost of maintaining remote mining townships in Australia has risen greatly over the period. Since the labour intensive part of any saltworks is in materials handling, it was concluded that it would be desirable to locate the crystallisers and all the harvesting, washing and shiploading near Onslow, and to establish a new loading jetty at Onslow. By this means the workforce will stay at Onslow and benefit from, and contribute to, the town's facilities including school, hospital, shops, recreation and its economic base.
In redesigning the Project an area suitable for the crystallisers was found south-west of Onslow which could be supplied with concentrated brine from the Exmouth saltflats by means of a brine channel and/or pipeline some 35 km long. This is quite feasible as both Leslie Salt at Port Hedland, and Shark Bay Salt at Shark Bay operate brine channels. The brine channel is made shorter by locating the primary evaporation area (condensing ponds) at the northern end of the Exmouth Saltflats rather than in the central position where they were originally located to minimise haulage distance to deep water.

Subsequently it was found that the saltflats southeast of Onslow were suitable for the condenser ponds and that the usable area was big enough to supply brine for a 2.5 Mt/yr production of shipped salt in the limit.

Thus the present plan for the new salt works involves condenser ponds south-east of Onslow and crystallisers south-west of Onslow (Figure 3). This plan has a distinct advantage in that additional condenser ponds on Exmouth Gulf can be constructed at a later date, with brine fed to additional crystallisers south-west of Onslow via a brine channel as originally planned. This Stage 2 of the Project, will be considered separately at a later date if warranted.

4.2 ALTERNATIVES CONSIDERED

For a salt producer to be economically viable, it must have a suitable area available to evaporate seawater (condenser ponds), an area where salt can crystallise (the crystalliser ponds), loading and shipping facilities which can accommodate ships of designated size, and infrastructure to house the workforce.

In reviewing alternatives all four factors must be accommodated at any one site.
4.2.1 Shipping

4.2.1.1 Early Alternatives

Based on the original plan to use the Exmouth Flats, the following alternatives were examined in considerable detail, drawn up and costed:

(a) Slurry Pumping to Ships
This involved pumping a salt slurry to a ship with a return pipeline bringing back the brine. Centrifuging is needed to avoid shipping brine with the salt. There is also a problem with unloading the salt out of the carrier at the other end because it "sets up" hard during transport.

(b) Floating Terminal
This involves constructing a floating terminal or utilising an old ship and equipping it with grabs to unload barges and reclaim to load ships. This is a slow operation involving double handling in the open sea. On the Australian coast the cost would be prohibitive.

(c) Burnside Island (28,000 dwt)
The eastern half of Exmouth Gulf is very shallow. It would have been possible to load 28,000 DWT ships off Burnside Island in a similar way to the current proposal for Onslow, but the dredging is many times greater and for larger ships in the future, is hardly feasible.

(d) Y-Island (60,000 dwt)
This involved constructing a transhipment terminal on Y-Island some 20 km offshore where there is reasonably deep water nearby and a pusher tug/barge operation. Y-Island did not have to be permanently occupied but this alternative involves double handling which costs perhaps $2.00 per tonne apart from the barge operation.
(e) **Tent Point (60,000 DWT)**

This avoided the barge operation but involved a 12 km long truckhaul and a trestleway conveyor 4.0 km long, as well as some dredging. The Y-Island proposal was generally favoured over Tent Point.

(f) **North West Cape (Bundegi Reef) (120,000 dwt)**

Mitsubishi were determined to use 120,000 dwt carriers to match Mexican Salt and they had three ports in Japan that could take them even if the consumers were unable to take that much salt at any one time.

This was the alternative finally adopted. It required a pusher tug/barge operation right across Exmouth Gulf to North West Cape (40 km) where there was access to water 20m deep without dredging. This required extensive barge unloading, stockpile and reclaim facilities as well as an expensive shipping terminal with travelling loader.

4.2.1.2 Current Alternatives

With the decision to locate the saltworks near Onslow, re-examination of (a) and (b) above was carried out and rejected.

The current market for salt in several countries requires salt carriers of quite modest size so (f) was not revived.

As a result, an investigation of a more conventional system was carried out. Four alternatives were costed on the basis that the loading terminal would be located 1.0 km offshore and linked to deep water by a dredged channel. The jetty (trestleway with conveyor) costs in the order of $7.0 million per km with dredging in the order of $5-6 million for the first kilometre in shallow water. A summary of the costs of the alternatives is shown in Table 1 (see Figure 1 for location).
(a) **Middle Creek**

Other things being equal, this is the closest to the crystallisers and the favoured location for a loading facility. Unfortunately the site is fronted by shallow water which requires considerable dredging and mobile sand on the seabed implies maintenance dredging. This alternative would have avoided any problem with the townspeople but the jetty would not have been so accessible to locals and tourists alike.

This alternative does have minor savings in truck haulage operating costs but these are insignificant compared to the extra capital costs of dredging and maintenance of channel and lights.

(b) **West of Onslow (Beadon Point)**

This location which is about 1.0 km west of the old jetty lies close to deep water and hence requires minimal dredging. It also allows free turn of incoming carriers outside the dredged channel. The jetty at this site offers many benefits for the town and tourist. However, there are concerns from some locals and the Shire regarding the location of the stockpiles and process plant near the base of the jetty.

(c) **East of Beadon Creek**

This alternative was suggested by some townspeople. It involves locating the process plant area near the existing marine industrial area and the jetty near the Beadon Creek shipping facility. Unfortunately this site is fronted by shallow waters which would require considerable dredging.

Another solution suggested was a land backed wharf at Beadon Creek. This was not costed because the proposal involves major inshore dredging and possibly some hard dredging in the entry to Beadon Creek. This suggestion could cost at least $10 million above Option C.
There is another problem for this site in that it would require relocation of the crystalliser area which is not as good as the one adopted and does not fit in with the development strategy (ie. Stage 2).

(d) Coolgra Point
A jetty at this site has merit in that water 7m deep exists one kilometre off the Point and there is a possible shipping entry. The quantity of dredging for 28,000 dwt ships is about 2.5 million cu.m., somewhat less than alternatives (a) and (c), but the shipping channel is 12 km long.

This alternative is a long way east of Onslow, away from infrastructure and would involve the crystallisers being in about the worst place, (ie. soft floors, extensive mangroves and algal mats, suitable construction material many kilometres away, susceptible to storm damage). Above all a jetty and crystallisers at this site are not central and therefore are poorly located for future expansion.

4.2.1.3 Preferred Position
On the basis of investigations the preferred and only viable position for a shipping facility is located immediately to the west of Beadon Point (i.e. option (b)).

4.2.2 Condenser and Crystalliser Ponds
In considering the location of the crystalliser and condenser ponds, the following alternatives were considered.

4.2.2.1 Exmouth Flats
The saltflats at Exmouth Gulf are outstanding by world standards for their potential to make solar salt or any other product requiring large ponds of saline water. They are so large (1000km²) that a normal commercial user has choices within them depending on logistics of transport for the purpose intended.
a) **Original Location - Central Area**

This area was chosen originally because it presented a suitable area for condenser and crystalliser ponds and access to Exmouth Gulf via Explorer Creek and Burnside Island for shipping purposes. Maintaining a town and infrastructure is, however, a problem. There is also no water supply available.

b) **Northern End (Urala)**

Boring and testing done by Gulf at this site more than 20 years ago showed it a perfectly feasible saltfield and reasonably well protected.

Suitable materials are available for bank building and suitable seawater pump locations exist in either of two tidal creeks. Occasional floods down Chinty Creek would need to be diverted around the northern extremity of the evaporating ponds. The extreme northern end is marginally lower than most of the Exmouth flats and a substantial area is inundated by normal spring tides. As a consequence that area is covered by algal mats. There are also considerable areas of mangroves along the two tidal creeks. There is, however, no feasible shipping possibility at the northern end of the Exmouth flats. The area has similar problems to the central site in maintaining a town and infrastructure. There is no water supply here either.

4.2.2.2 **Onslow Flats**

Because of inherent problems and costs associated with using the Exmouth Flats, the flats around Onslow were also investigated. In considering their use, the Proponent has attempted, where possible, to locate the ponds on the supratidal flats in order to avoid damage to the algal mat and mangrove communities that inhabit the tidal flats.

(a) **South West of Town - Four Mile Creek - Hooley Creek**

This area is suitable for salt making but after deleting a margin for flood diversion and tidal areas, it is not big enough to support a viable project in its own right. It is
however quite big enough for a large crystalliser, bitterns and re-dissolution system. There are suitable construction materials available, the site is protected and it is relatively close to deep water where a jetty can be located (Beadon Point).

(b) **South East of Town**
The flats are close to infrastructure and link with the adjacent south-western flats which in turn lie close to a possible jetty site. These flats provide sufficient area after allowing for flood diversion and tidal areas to construct condenser ponds of sufficient size to provide enough brine to make a viable operation. Suitable construction materials are readily available and the flats are protected from the open sea. There is also a good water supply source available from the nearby Cane River.

(c) **East of Coolgra Point**
These saltflats are narrow, fragmented and affected by flooding. They are far from infrastructure and do not provide a viable alternative to either the Onslow or Exmouth flats.

4.2.2.3 Selected Position

As a result of these investigations, the position adopted involves condenser ponds on the flats south-east of Onslow and crystalliser ponds on the flats south-west of Onslow.

4.2.3 **Workforce Infrastructure**

Integrating the new workforce with an existing town offers many advantages, both economically and socially.

4.2.3.1 Preferred Position

The preferred position is to integrate the workforce with the local community of Onslow rather than constructing a new town.
4.2.4 Pump Station

4.2.4.1 Alternatives Considered

The pump station should ideally be located as near the open sea as possible in order to take advantage of large volumes of clean water. The creeks east of Onslow were investigated for possible sites. For various reasons including depth of creeks, mangrove colonisation, substrate and exposure to the open ocean, the eastern arm of Beadon Creek was selected as the preferred site because it:

a) involves only minor impact on the mangrove and algal mats
b) is close to the town and infrastructure
c) is well protected
d) the creek is deep enough and there is sufficient water flow to allow pumping at the designed rate without significant impact on the tidal flow upstream.

Originally it was planned to locate the pump station on a bund across the eastern arm of the creek. Because this would have cut off a significant area of mangroves and algal mats, the bund has been redesigned to skirt around all of the mangroves and the majority of algal mats (Figure 4).

Although this redesign will double the cost of the wall, the pump station at either of the two sites investigated in this location will result in damage to less than 1 ha of mangroves and enclosure of 37 ha of algal mats out of a total 135 ha of mangroves and 454 ha of mats in Beadon Creek. Any material excavated from the creek bed (sand and partially cemented sand) during construction of the pump station will be disposed of within the Pond 2 wall.

4.2.4.2 Selected Position

The selected position of the pump station is the downstream site on the northern shore of the eastern arm of Beadon Creek (ie. Option 1).
4.2.5 Seawalls

4.2.5.1 Alternatives Considered

The initial design showed nine condenser ponds and thirty crystalliser ponds (with areas of expansion) on the saltflats around Onslow. It is clear that some mangrove communities (99 ha) and a significant area (235 ha) of algal mats would have been enclosed by the condenser ponds. Equally the crystalliser ponds would have enclosed a significant area of mats (see Table 3).

Condenser Ponds:

In order to reduce the direct impact upon the biological community, the seawalls around condenser ponds 1 and 2 have been redesigned.

The seawall across the eastern arm of Beadon Creek has been relocated as described in Section 4.2.4.1. As a result, no mangroves and only 37 ha of algal mats will be trapped within Pond 2.

The original layout of Pond 1 involved creating a large (2195 ha) pond by linking the coastal islands across the tidal creeks. This layout has a significant direct impact upon the biological communities in that it smothers 99 ha of mangroves and 235 ha of algal mats. It also has the potential to constrict floodwaters from inland. This however is the most economical and productive alignment for the seawalls (see Table 3).

The layout for Pond 1 was reviewed and a number of options considered (Figure 5). Option 1 involved a long seawall linking the upper reaches of the tidal creeks. This option results in a slightly smaller pond but with a significant reduction in the areas of mangroves (19 ha) and algal mat (155 ha) enclosed. This option, however, involves a long unprotected seawall.

Option 2 involved linking a chain of islands with a long seawall inland of the mangroves and algal mats. This Option results in a smaller pond (1000 ha) with minimal impact on the biological
communities and allows more space for flood waters. A sub-option (Option 2B), was also considered as it does not involve blocking one of the major floodways.

Option 3 involved a shorter seawall with links to stable islands which avoids all but 6 ha of algal mats and allows more space for floodwaters. This Option however results in the smallest pond (350 ha).

Because a pond in this location should ideally be of similar size to Pond 2, justification for a separate, smaller Pond 1 located away from stable islands was questioned. As a consequence it was decided to abandon Pond 1 and to increase the size of Pond 2 through relocating the proposed wall between Ponds 1 and 2 approximately 1 km to the north-east and linking several islands in the area (ie. the Option 3 alignment). This results in an increase of 350 ha in Pond 2 with no impact upon the mangroves or algal mats. In addition, the impact upon floodwaters and consequently the indirect impact upon freshwater flooding of the algal mats and mangroves is much reduced.

Crystalliser Ponds:

Because the crystalliser ponds hold the Projects most valuable product (ie. the brine and salt), they must be secure. From an engineering point of view it is desirable therefore to locate the seawalls, especially the corners, on natural hard points. Two islands are conveniently located on the flats for this purpose and accordingly the most seaward wall has been located with its corners on these islands. While no mangroves will be affected by constructing the ponds in this location, around 190 ha of algal mat (out of a total of 1967 ha) will be lost (Figure 6). However, the Proponent considers that the extra security provided by linking the walls to the islands (ie. less chance of concentrated brine being discharged to the external environment) justifies this location.

With the Stage 1 ponds in this location, there is sufficient room to expand the crystallisers significantly to accommodate Stage 2 if it proceeds.
4.2.5.2 Selected Position

Based on the assessment of alternatives, the seawalls of the eighteen crystallisers and eight condensers have been located as shown in Figure 1. This arrangement has minimal direct impact on mangrove communities and only minor impact on the algal mats. The floodway to Coolgra Point is considered to be sufficient to cope with the flood waters from inland and the alignment of the seawall will allow much of the floodwater to make its way to the west so that the three major creek systems receive freshwater during floods.

4.2.6 Bitterns Discharge

4.2.6.1 Alternatives Considered

The original plan was to discharge bitterns in a controlled manner into the south arm of Beadon Creek near the aerodrome. This site was chosen on the basis that the Creek is no longer in pristine condition and that the small volume of bitterns released at spring tide would be so diluted as to be unnoticeable. Because Beadon Creek is one of the main tourist fishing spots other alternatives were investigated.

As Four Mile Creek is closest to the crystalliser ponds and is only very sparsely colonised by mangroves, it was selected as the site for bitterns discharge. However, representation from the local community that this is a favoured recreation spot led to investigation of Middle Creek. As Middle Creek lies in the centre of the crystalliser areas it is also suited as a site for bitterns discharge. The creek is 125m wide immediately downstream of the discharge point, with an average depth of 2m at mid-tide. Its mouth is open to the sea and a mobile bar indicates that there is considerable littoral current along the coast implying that any bitterns discharged will be well mixed and dissipated before entering the ocean.

4.2.6.2 Selected Position

Based on this assessment bitterns will be discharged into Middle Creek.
4.2.7 Harvesting and Slurry Pumping

There is an ongoing study over the next 12 months to see if dredge harvesting and slurry pumping are feasible for this project. The layout suits such a method extremely well and it would avoid having to dewater the crystallisers and eliminate the truck operation.

The method is being used with carnallite on a large scale on both potash works on the Dead Sea. Carnallite has much better pumping characteristics than salt which on shutdown drops in the pipeline and can be hard to restart. Pumping salt is not a true "slurry" because the mixture lacks fines to support it. Therefore pumping tests on salt have involved high head loss and energy consumption. Nonetheless, the method shows such benefits to the operation that it will be pursued.

Use of a conveyor over the 8 km truck haul is capital intensive but is nearing breakeven operating cost at 2.0 Mt/yr. It will also be further investigated - no new technology is involved in this.

In the absence of a decision to the contrary, trucks will haul salt along the private haul road to the washplant.

4.2.8 Stockpile and Washplant Area

The most economical location for the truck dump, washplant and stockpile is at the base of the jetty (Option 1). However, this site is relatively close to Clarke Place and some of the residents there are concerned about noise and the proximity of these facilities. At this site the jetty will be visible from Back Beach, and the top of the stockpile will be visible from the beach and various vantage points. Because the plant will be located in a low area with natural high points around the plant, it is predicted that noise emissions will be within acceptable levels in Clarke Place provided that certain operating procedures are adopted. This issue of noise is discussed more fully in Appendix 5 and Section 7.2.7.1.
Relocation of the plant approximately 1 km to the south (ie. Option 2) has been costed (see Figure 7). The Shire supports the plant in this location as the majority of the community’s concerns will be satisfied. Because of its greater distance from residential areas and natural barriers in between, the predicted noise levels at Clarke Place will be lower than those from the nearer site. Direct connection of the stockpile at the new site to the jetty would require the conveyor crossing a major ethnographic site. Discussions have been held with the Aboriginal people regarding this and other ethnographic sites in this area. By constructing the conveyor with a transfer point (a corner), all sites can be avoided. Thus this option is viable, however, it will cost the Proponent at least an extra $2,200,000 plus overheads.

4.2.8.1 Preferred and Selected Positions

On the basis that visual impact and noise emissions can be minimised through management measures (i.e. through bunding, planting and operating techniques, etc.), the preferred position is to have the truck dump, washplant and stockpile located at the base of the jetty (ie. Option 1). However, the Proponent is prepared to accede to the community’s desire that these facilities are located further south and accordingly Option 2 has been selected as the site of the washplant and stockpile.

4.2.9 The Jetty Structure

Original plans for the jetty showed a rockfill causeway of several hundred metres leading out to a trestleway. Because of the impact of the causeway on littoral processes the jetty has been redesigned to an open trestleway which will have minimal impact on coastal processes and allow complete public access beneath it.

4.2.10 Operation Alternatives

There are options in the stockpile reclaim system. The cheapest and most effective system involves using tracked D8 dozers (as
rubber wheeled machines do not have enough traction to do the job). Some noise is generated by these machines, however it will be attenuated by distance and natural barriers for Option 2 to acceptable limits at the nearest houses in Clarke Place. It is not expected that special operating techniques nor additional bunding will be necessary at this location.

Alternative tunnel reclaim, which is cheap and effective with many granular materials, will not work properly with salt which "hangs up" after a very short time in storage.

Shiploading options considered were a travelling loader or fixed point loader. The latter is cheaper, reasonably effective and used by nearly all salt exporters. It involves additional stop/starts of the loaded conveyor system which is undesirable plantwise, but does not add to the conveyor noise levels.

4.2.10.1 Preferred Option

The preferred option is to reclaim salt from the stockpile with D8 dozers and to load with a fixed point loader.

4.2.11 Berth Orientation

Having decided on fixed point loading there were options in berth orientation for:-

(a) Lowest first cost
(b) Lowest operating cost (tug or not)
(c) Ease of berthing ships
(d) Ease of ships departure.

There is adequate information available regarding wind and currents. As commonly found elsewhere these factors cannot both be favourable all of the time for any berth orientation that was tried. The original Onslow jetty head built in 1925 was on 360° and the replacement in 1934 was on 292°30'. Most captains of State Ships at the time had different views. However Onslow was not regarded as a difficult port, and State Ships masters would
often use slack water and ships anchors to assist in the absence of a tug. Berthing accidents are believed to have been rare.

The channel alignment could not be varied much from 157° and there were two main alternatives left for berth orientation.

**Orientation 67° - Tee Head**
This allows free turn for incoming carriers to port or starboard depending on the prevailing wind and tide. Tug assistance would not be essential. On departure, carriers need to swing 90° in the dredged turning basin and would need tug assistance.

**Orientation 157° - Finger Pier**
This allows free turn for incoming carriers on starboard only. Tug assistance would not be essential.

On departure, no turn is required and tug assistance could possibly be avoided but a 10t bollard pull tug/workboat would be needed.

The trestleway/conveyor is 300m longer than for 67° ($2,000,000 extra) but the cost of the dredged turning area is reduced by about $700,000. The saving in operating cost without tugs is a very significant factor in favour of this option. Shark Bay Salt has never used tugs in similar manoeuvres in similar conditions.

Current measurements taken on site indicate spring tide currents are 0.6-0.8 knots, parallel to the coast. These velocities do not present a problem to ship manoeuvring with either option.

**4.2.11.1 Preferred Option**

The option drawn and costed is the Tee-Head but the final choice has yet to be made pending further investigation which is in hand.

**4.2.12 Housing**

The Company may purchase suitable existing housing if available and arrange for building new houses in a new subdivision. Discussions have been held with DOLA which have indicated that
sufficient land will be made available in a new subdivision south of the hospital for the Proponents needs. Homeswest also has some vacant lots in the town.

The Shire's Town Planning Scheme shows subdivision of the Beadon Point area. If approval is given, subject to environmental and other considerations, the Proponent would purchase lots closest to the jetty for its employees as it has no doubts about the ability of its proposed methods of managing noise impacts even at this relatively close range.

4.2.13 Power Supply

Discussions held with SECWA have indicated that it would be more economical for the Proponent to generate its own industrial power rather than to obtain it from the existing power station. SECWA will supply power for domestic and other commercial needs in Onslow.

4.3 SELECTED ALTERNATIVE FOR PROJECT

Based on an assessment of the options available and various alternatives investigated, the selected location and design of the Project is shown in Figure 1.

4.4 THE NO PROJECT OPTION

Given the projection that the saltfield can produce salt for sale at a profit, the No-Project option has no appeal to the Proponent. Considering that salt production produces no toxic waste, uses minimal fossil fuel and is a sustainable industry without significant impact on the social, biological or physical environment, the No-Project option has few benefits. In fact, the No-Project option should be considered as a 'missed opportunity' for the town of Onslow, and the wider Australian community, in that the project will contribute to Onslow's economic base and community purpose, lead to creation, directly or indirectly, of 80 new jobs and significant export income. It may also lead to creation of a chemical industry in the area based on the two naturally occurring products, salt and gas.
SECTION 5 - THE EXISTING ENVIRONMENT

5.1 INTRODUCTION

This section provides an overall description of the regional environment and a more detailed description of local physical, biological and social systems likely to be affected by the Project.

5.2 REGIONAL SETTING

Onslow is an isolated town situated in the tropical arid climate zone of Western Australia. It lies at the western end of the Pilbara coastal plain between the flood plains (deltas) of the Ashburton and Cane Rivers. The plain extends offshore as the Rowley Shelf which slopes gently to the north to a depth of 20 m about 20 km offshore. The surface of this shelf is broken by discrete limestone (coral) reefs and sandy islands (Figure 3).

Reworking of sediment brought to the coast by the river systems has led to formation of a number of coast parallel dune systems. Extensive tidal and supratidal flats lie between and on either side of the deltas of the two rivers. The flats are linked to the sea directly or through breaks in the coastal dune system. Extensive mangrove and algal mat communities colonise the seaward margin of the flats that are subject to tidal inundation. The supratidal flats which are rarely inundated are generally covered with a salt crust. The total area of flats within 100 km of Onslow is around 1650 km².

The coast is generally sheltered from prevailing swell by aspect and the shallow shelf, though it is exposed to prevailing westerly winds. Tidal range is moderate. Onslow, however, is prone to cyclones which tend to cross the coast or pass close enough to cause a warning every two to three years. Onslow is also located near the junction of the Carnarvon and Fortescue/Ashburton Botanical Districts.
5.3 PHYSICAL ENVIRONMENT

5.3.1 Meteorology

Onslow experiences a typical Pilbara coast climate with fine sunny days and easterly winds during winter, and hot humid weather with afternoon westerly winds during summer. In summer tropical cyclones, which are generated in the Timor Sea, commonly move parallel to the coast and often cross between Onslow and Broome before dissipating over the interior. These cyclones can be violent, bringing strong winds, heavy seas, raised sea levels and heavy downpours.

Onslow's average rainfall is 265mm a year, with most rain falling between summer and autumn (January to June). The average figure is somewhat distorted in that major heavy falls which contribute to the average occur every two or three years. For instance the highest recorded one day falls in January, February, March and April were 158, 356, 283 and 157mm respectively. The highest ever monthly rainfall was 539mm. Annual evaporation exceeds 3,000mm a year. Average summer maximum temperature is around 36°C with average winter maximum temperature around 26°C. Meteorological statistics are shown in detail in Appendix 8.

5.3.2 Oceanography

There is generally no swell offshore from Onslow. For much of the year the sea is calm as morning breezes are mostly from the land and overnight the weather is generally calm. The west and north-west seabreeze which occurs during most of the year causes a short period sea to develop most afternoons.

5.3.3 Tides

(a) Range

The tidal regime in the area is predominantly semi diurnal with a mean spring range of approximately 1.8m.
The port of Onslow is a 'Standard' port as defined by the Department of Defence (Navy Office) and annual predictions of times and heights of high and low water are available for every day of the year from the 'Australian National Tide Tables'.

The 1989 Tide Tables define tidal levels as:-

- **HAT**: +2.6m above chart datum
- **MHWS**: +2.0m
- **MHWN**: +1.4m
- **MSL**: +1.1m
- **MLWN**: +0.8m
- **MLWS**: +0.2m
- **LAT**: -0.2

Chart datum is 1.062m below AHD. In this document all references to level refer to Chart Datum unless qualified.

(b) **Tidal Frequency Analysis**

The Tidal Frequency Analysis shown in Appendix 8 is useful in determining how much time will be lost in pumping at certain levels and what percentage of high tide is available to large ships departing at higher than mid-tide. For example:

1. At a pumping cutoff of +0.6m, 67% of all low tides will cause a cutoff for various periods of time.
2. 28,000 dwt ships departing at mean sea level or better would have no limitations.
3. 30,000 dwt ships departing at high water neaps (+1.4m) or better would have limitations for 17% of all high tides.
4. 35,000 dwt ships departing at mean high tide (+1.75m) or better would have limitations for 50% of all high tides.
(c) Tidal Currents

A series of current measurements is given in Appendix 8. Measurements at the berth site on full ebb tide, during a normal spring range of 1.8m, gave velocities ranging from 28 cm/s at the surface, 40 cm/s at 4m below surface, and 33 cm/s near the bottom. Current direction varied from 237-253° (approx ENE to WSW) parallel to the shoreline.

On the flood tide at the berth site, during a spring tide range of 2.0m, the velocities were lower ranging from 20-24 cm/s at the surface, to 22-25 cm/s 3-5m below surface, and 15-19 cm/s near the bottom. Directions varied from 37-53° (approx SW to NE) more or less parallel to the shore.

During these measurements there was a low sea, no swell and light breeze.

5.3.4 Cyclone Frequency

Onslow is situated within a zone of Northern Australia that is known to be affected by tropical cyclones. The frequency and intensity of cyclones passing close to any particular location is variable, however records of all cyclones over the period 1909 to 1980 have been analysed.

The number of cyclones crossing the coast for each 100 km length centered on Onslow is as follows:

Number of Coastal Crossings 1909 - 1980 71 years of record

<table>
<thead>
<tr>
<th>Coastal Strip for 100km South</th>
<th>Onslow Coastal Strip 100km</th>
<th>Coastal Strip for 100km North</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>
All crossings are from sea to land. The frequency of such cyclones at Onslow is therefore about 1 in 10 years.

The number of cyclones approaching Onslow is as follows:

**Number of Cyclone Approaches to Onslow 1909 - 1980**

<table>
<thead>
<tr>
<th>Range</th>
<th>100km South</th>
<th>Onslow</th>
<th>100km North</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 50km.</td>
<td>7</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>50 - 100km.</td>
<td>11</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>100 - 150km.</td>
<td>15</td>
<td>7</td>
<td>5</td>
</tr>
</tbody>
</table>

This averages 24 Warnings of cyclones coming within 150km of Onslow but not crossing the coast. Therefore there appears to be a 1 in 3 year frequency that a cyclone would come close enough to be capable of causing some minor damage, perhaps causing rain and certainly resulting in cyclone precautions being taken throughout the Works and ships having to leave the port. The average duration of such shutdowns is about 2 days.

Experience of other ports on the Pilbara coast indicates that precautions are taken more frequently (with cyclones more than 150 km away), however most of the shutdowns are for short durations only and ships are not required to leave port.

**5.3.5 Cyclone Wind, Waves and Surges**

Estimates of the return period storm wind, wave and surge levels at Onslow are shown in Appendix 7.

There are few significant measurements of ocean wave heights and water levels during storm conditions at Onslow notwithstanding that the first jetty was built at Beadon Point in 1925. However there are reasonable estimates of the tropical cyclone track and gradient intensification storm variables in the Bureau of Meteorology archives. Since satellite imagery commenced, reliable tropical cyclone track variables have become available for the period 1959 to 1989 (30 years). Also wind measurements at Onslow provide good data on storms affecting the area.
From these data, surface wind, spectral wave and surge mathematical models, were used to hindcast the variables for 31 tropical cyclones and 21 gradient intensification storms. These studies are continuing in an effort to better calibrate the hindcasting method with known data and events such as Cyclone Tina.

The 50 year return period magnitudes in this region for wind speed, maximum wave height, maximum wave crest above sea level, surge and maximum wave crest elevation (including astronomical tide) were estimated at 33 m/s, 5.2m, 4.2m, 0.6m and +6.5m (above chart datum) respectively (refer Steedman and Russell 1986). The total static surge level on the same basis was estimated at 3.1m above low water (chart datum). (The wind speed is 10 minute average not 3 second gusts, water depth -6m, a surge of 0.6m at the jetty could be equivalent to 0.9m in Beadon Creek).

Local verification of surge levels at Onslow consists of measuring the levels of old debris that are not subject to influence of wave runup, (e.g. substantial pieces of old jetty timber around the Hooley Creek area), observations by Water Authority personnel on the pipeline causeway and anecdotal references by Marine & Harbours personnel. Levels around the town and particularly on the road causeways leading into town are often confused with flooding due to heavy rainfall accompanying the cyclones. The Shire and Department of Civil Aviation were also able to provide some useful information. A complete tidal record for Cyclone Tina was obtained from Beadon Creek. This produced a level of +2.91m on high water spring tide equal to the highest in local memory.

Salt water only comes over the saltflats as a whole during cyclones and then only to a depth of 0.3-0.6m making a surge level of about 2.5-2.8m above chart datum. Nothing reliable has been found to suggest static levels above +2.9m when allowance is made for runup of waves on the island beaches and windage on light debris. Thus, the anticipated maximum water level during a cyclone is expected to be 3.1m above datum on 50 year frequency. On 100 year frequency the water level could possibly reach +4.0m above chart datum but there is no ground evidence of such a level.
5.3.6 Geomorphology

Onslow is situated on the western end of the Pilbara coastal plain between the flood plains (deltas) of the Cane and Ashburton Rivers. The coastal plain rises gently inland and extends offshore as the Rowley Shelf. The surface of the plain is generally flat though broken by sand dunes and low depressions, especially in the area prone to flooding by the rivers. The Rowley Shelf is also flat though numerous islands rise above the seabed. The coast adjacent to the rivers is characterised by sandy beaches and dunes systems. Between the river deltas there are extensive tidal and supratidal flats which link directly to the sea or through breaks in sandy island chains.

The flats around Onslow which will be affected by the Project occupy what was probably an embayment containing an archipelago of coral reefs and sand topped islands. Over time the embayment has become filled with silt washed in by the Ashburton and Cane Rivers and general sheet flooding, to the extent that the seaways between the now land-bound "islands" have been totally filled with silt and mud.

In general, the flats slope down towards the sea from an elevation of around 2.5m. The supratidal flat, which is rarely inundated by tidal waters, is basically an alluvial fan covered with a salt crust. Towards the coast at an elevation of around 2.0m the flat experiences regular tidal inundation and is colonised by algal mats. These tidal flats are broken by a network of tidal channels whose banks are colonised by mangroves. The channels connect to the open sea through breaks in the chain of sandy islands which appear to be located on extinct coral reefs.

Onslow itself is located on a large sandy island, the most seaward point of which is located over an old coral reef forming Beadon Point. The seaward face of the coastal islands is generally marked by series of coast-parallel storm ridges.
5.3.7 Geology

Sediments in the Onslow region are a complex of superimposed and interfingerling Holocene (modern) and older Pleistocene units. It is likely that the coral reefs and islands and their superimposed cemented dune systems are Pleistocene and that the infilling sediments and unconsolidated coastal dunes are Holocene. A sketch cross-section of the area around Onslow is shown in Figure 8.

In general the Pleistocene corals are well cemented. The Pleistocene dunes are typically sandy, however where lime content was high they have lithified forming poor to well cemented limestone. Accordingly a range of material from dense limestone to pea gravel is present in the area.

The Holocene sediments are generally unconsolidated sands (along the coast and immediately offshore) and muds and silts (beneath the flats and offshore). The surface of the supratidal flats is partially cemented with evaporites forming cemented nodules in a clay matrix. In areas subject to tidal inundation the flats are generally unconsolidated mud.

5.4 BIOLOGICAL ENVIRONMENT

A detailed description of the biological environment is contained in Appendix 3. The following is a brief summary.

5.4.1 Regional Setting

The coast around Onslow is characterised by extensive supratidal and tidal flats and associated ecosystems, notably the mangrove and algal mat communities. In all there are approximately 1,650 km² (165,000 ha) of flats in the region (1,000 km² on the eastern coast of Exmouth Gulf, 270 km² near Onslow and 380 km² within 100 km of Onslow to the north east. (Note: 1 km² = 100 ha). The mangroves of the Pilbara coast are unique in Australia because they are the only example growing in a tropical arid climate. Mangroves and the associated algal mats are considered to be an important part of the coastal ecosystem (EPA, 1975; Gordon, 1987).
5.4.1.1 Mangrove Ecosystem

Mangroves are an assemblage of trees and shrubs that are adapted to growing between mean sea level and mean level of the highest tide. They are adapted to survive in oxygen deficient poorly consolidated muds. Mangroves are primary producers, they use sunlight to fix atmospheric carbon-dioxide and incorporate this carbon along with nitrogen, phosphorous and other elements from the sediments into organic compounds necessary for growth.

Much of this organic material remains in the mangrove system but a significant portion is released by litter fall. Some of the litter is trapped within sediments, the remainder is distributed via tidal creeks to the ocean and other areas within the creeks. The litter may be ingested by living animals (insects and crabs) and may also be decomposed by bacteria and fungi which proliferate and increase the nutrient content of the material. Both these processes result in the production of detritus which forms the basis of many coastal food chains.

Other primary producers associated with mangroves include algae, lichens, mosses and salt marsh plants. Two other important components are the fungi and bacteria, particularly since these are associated with the breakdown of mangrove detritus.

The mangrove ecosystem supports a wide variety of animal life that exploits the mangal as a habitat, a food source or a nursery area. These animals may be divided into two groups, the resident fauna and the temporary users. Resident animals include burrowing marine organisms, hermit crabs, molluscs, shrimps and worms, with encrusting organisms such as oysters and barnacles also present. Insects, spiders, reptiles, birds and bats also use the mangrove canopy as a habitat and food source. Temporary fauna include fish and crustaceans that come in on the high tide and fauna such as birds, reptiles and mammals that invade at low tide. Crustaceans and fish also use the mangroves as a nursery.

Although there is much speculation on the importance of mangroves to coastal ecosystems, the general view is that these systems play an important role in the supply of tidally exported detritus to
coastal waters (CTRC, 1974). Many authors consider that decomposition within the mangrove system is insufficient to replenish the losses of nutrients. Along the tropical arid coastlines, the ocean is thought to be important in supplying nutrients.

A feature of the Onslow coastline is the presence of bare intertidal areas inland from the mangrove communities which are too saline to be colonised by mangroves or halophytic shrubs. These bare zones often contain large areas of well developed algal mats which have been shown to fix nitrogen from the atmosphere and because they are also primary producers incorporate carbon and other elements into organic models.

Hence algal mats are important to the general mangrove ecosystem and the nearshore environment. This has been documented elsewhere in the world and at Dampier where studies show that these mats provide significant nitrogen and phosphorous to the mangrove system (Paling, 1986).

5.4.2 The Onslow Biological Communities

The tidal flats, mangroves, algal mat communities and offshore areas around Onslow were mapped and inspected in November 1989.

5.4.2.1 Mangroves:
Only three species of mangroves were observed around Onslow. The Grey Mangrove and the Red Mangrove were dominant with the smooth fruited spurred Mangrove noted only on the landward edge at Beadon Creek. The Red Mangrove lines tidal creeks in some areas as a discontinuous band with the Grey Mangrove extending from these to the most landward extent of the mangrove stand where occasional spurred mangrove trees are present. The Grey Mangrove also occurs at the mouth of tidal creeks.

5.4.2.2 Salt Flat and Algal Mat:
At the landward edge of the mangroves the tidal flats are colonised by samphires. Away from the tidal creeks where the flat surface is heavily burrowed by crabs and other organisms, algal mats form a continuous cover. The algal mats in the region vary in form from most commonly flat dark green sheets at lower elevations, to a pustular or crinkled form at higher elevations.
The most landward extent of the mat is covered in a layer of crystallised salt. The mat is reasonably consistent in thickness (8-10mm) at all elevations. However the green algal layer varies from 2mm at lower elevations to 0.5mm at higher elevations.

The algal mats examined were made up almost exclusively of blue-green algae which, at Dampier, have been shown to fix nitrogen in significant quantities. Around the sand islands there is generally a 20m wide band of soft mud/sand which is uncolonised between the algal mat and the sandfire border. These samphires mark the beginning of the vegetation on the islands.

Table 2 shows the areas of mangroves and algal mats in the catchment area of the creeks around Onslow.

5.4.2.3 Salt Flat Islands

The smaller islands in the flat are covered with a low (0.5m high) vegetation cover consisting mainly of soft spinifex. The larger islands have this species and also the limestone spinifex. Larger shrubs (under 2.0m tall) commonly noted are the currant bush and acacia and mulla mulla. The larger islands also have stands of Eucalyptus (the Coolibah and Hakea).

5.4.2.4 Offshore areas

Adjacent to Wards Reef in waters 3-4m deep, there is active coral growing. All of the corals are covered in a layer of fine silt and diatoms. Along the line of the proposed dredged channel the bottom is predominantly fine bio-turbated mud with small macroalgae and occasional hydrozoans, starfish and ascideans. Bottom vegetation varies from bare mud to a light covering of macroalgae, all of which are attached to small shells. All algae is covered with an epiphytic diatom layer.

Around the site of the jetty head, water turbidity is high enough to block light and no bottom algae is present. Closer inshore, the bottom sediment changes to bare muddy sand with rare patches of sea grass. Green algae is commonly seen on small outcrops and on the sandy bottom. On the larger rock outcrops small corals and sponges occur.
Opposite Four Mile Creek the inshore sediments consist of bare rippled sand. Up to a kilometre offshore the seabed is composed of sand with a low density of sponge species. Opposite Middle Creek and Hooley Creek, the bottom is predominantly bare rippled sand with only occasional sponges. No seagrass was observed along this section of coast.

5.4.3 Regional Significance

The study of the biological environment indicates that there is nothing rare or unique in the Onslow area. The mangrove/algal mat associations are recognised as being an important element in the nutrient cycle for all organisms that inhabit the shelf zone and are similar to those found elsewhere along the coast. Likewise the offshore areas are similar to much of the shelf. There also does not appear to be any vegetation of regional significance in the area.

5.5 SOCIAL ENVIRONMENT

5.5.1 Introduction

A detailed description of the Onslow community and the social environment is presented in Appendix 2. Following is a brief summary of salient points:

5.5.2 Location

Onslow is a small isolated coastal town three hours drive from Karratha and five from Carnarvon. It is linked by sealed road to the North-West Highway and via weekly Cessna flights to Karratha.

5.5.3 Population and Community Groups

The town population is estimated to be around 800-1000, which includes not less than 200 Aborigines, provision for 200 construction workers in the Wapet camp and 200 plus visitors. Within the town there are two major community groups with a number of sub-groups as follows:
a) the whites, which include
 i) long term residents who were born and bred in Onslow and with strong links with the town,
 ii) short term residents who are mostly government workers on a tour of duty,
 iii) seasonal visitors or tourists,
 iv) construction workers on a fly-in/fly-out basis, and
 v) retirees who have made Onslow their home.

b) the Aboriginal community, which includes:
 i) members of the original tribal groups centred on the Cane and Ashburton Rivers (e.g. the Noala, Jadira, Talandji and Buruna);
 ii) members of other tribal groups from inland areas including Panjima from Wittenoom and Innawonga from Tom Price.

5.5.3.1 Interest Groups

During discussions about the proposed project, several interest groups have been identified:

1) the local fishermen whose main interests relate to minimising impact of the proposal on fishing grounds
2) the Clarke Place group whose residents are located closest to the stockpile/washplant
3) the combined Aboriginal groups whose concerns relate to sacred sites, education and employment opportunities for young people
4) pastoral stations who have concerns over use of station land, and
5) commercial/tourism oriented people.

5.5.4 Community Services

Onslow was the administrative headquarters of the Shire of Ashburton, with the Shire relocated to Tom Price in early 1990. Agencies in the town that provide a community service include the
Department of Community Services, Education Department (pre-school, primary school and limited curriculum high school), Distance Education, Community and Child Health Service, a hospital (with no resident doctor), Police and Department of Social Security.

Commercially, there are two supermarkets, a general store, a bakery, a post office and two service stations. There is however no permanent banking facility, hairdressing salon, butcher, greengrocer etc. For these services residents must go to Karratha.

5.5.5 Recreation Facilities

Facilities for leisure and recreation are few. There is a hotel, a restaurant, licenced sportsmens club, two tennis courts, a basketball court and a grassed oval. There is no regular organised sport.

5.5.6 Lifestyle

Some people have described Onslow as quiet and restful (a sleepy backwater), which has led to their retirement there. Others have described the town as "cliquey" and lacking in community cohesion and civic pride. The town also has a reported high level of frustration, drinking problems and domestic violence which probably stems from a lack of common purpose and any real employment opportunities, especially for the young.

5.5.7 Economic Base

As previous studies have shown, there is little economic base to Onslow. Apart from the local fishing industry and limited tourism, the town's economy relies heavily upon provision of government funding and services. The major employers in the town are the hospital, the Shire and various Government Departments. Wapet, which has maintained a fly-in/fly-out construction camp at Onslow for eighteen months, has provided employment for thirty to forty locals. The construction phase however has finished and the camp will probably be removed by early 1990.
1986 Bureau of Statistics figures show the Onslow labourforce as 294 and the number of employed people as 253. Of these, 93 were employed by Commonwealth, State and Local Government Agencies with 148 employed by the private sector and 10 not stated. The total number of unemployed was 41.

Current Social Security figures (November 1989) put the total number of pension and benefit recipients at 127. Thus welfare recipients and Government workers total 220 adults in a total adult population of around 360.

Recent studies have shown that the future viability of the town rests with tourism or industry, or both. Advice from the Tourism Commission is that tourism growth in Onslow will occur at a slow rate. Onslow has no uniquely attractive features that are not available to visitors elsewhere on the Pilbara coast. Its isolated character does however, attract a certain type of tourist (i.e. the offshore fisherman). The only potential industries that are likely to locate in Onslow are those related to natural mineral resources found in the area. Apart from natural gas/oil and solar salt, there appears to be very limited opportunity to develop any other natural resource in the area.

5.5.8 Summary

Onslow is a small isolated town without any real economic base. It has a pleasant winter climate although it has not as yet attracted any large scale tourist development. The pace of life is slow and the lack of common purpose has produced a community without much internal cohesion. The community relies on external support and upgrading of public facilities and services has been difficult to justify, with the result that progress has been slow. Thus Onslow has the reputation of being the last undeveloped town in the North-West.

5.5.9 Historic, Archaeological and Ethnographic Sites

A survey of Aboriginal sites was carried out in late 1989 by G. Quartermaine and R. O'Connor following discussions with the local Aboriginal community. As their report contains information and
diagrams which the Aboriginal people do not wish to be made public, the full report is not appended to this document. The following is a brief summary.

In carrying out the survey:

i) Aboriginal people having traditional links with, and knowledge of, the Onslow area were brought to Onslow and on-site discussions were held with them and other nominated local Aboriginal people.

ii) Data from previous work was assembled.

iii) A systematic sample archeological survey was made of the proposed development area.

iv) All Aboriginal sites located were recorded.

As a result of the survey, the following sites were identified but are not yet approved by the local community:

NEWLY RECORDED ETHNOGRAPHIC SITES

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Dimensions</th>
<th>Site Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burubarladji</td>
<td>1.9 x 0.15km</td>
<td>Mythological</td>
</tr>
<tr>
<td>Dew Talu</td>
<td>20 x 20m</td>
<td>Spring</td>
</tr>
<tr>
<td>Jinta 1</td>
<td>20 x 20m</td>
<td>Soak</td>
</tr>
<tr>
<td>Jinta 2</td>
<td>20 x 20m</td>
<td>Soak</td>
</tr>
<tr>
<td>Four Nile Creek Camp</td>
<td>500 x 200m</td>
<td>Campsite</td>
</tr>
<tr>
<td>Old Racecourse Camp</td>
<td>250 x 300m</td>
<td>Campsite</td>
</tr>
<tr>
<td>Old Racecourse - Ceremonial Ground</td>
<td>150 x 300m</td>
<td>Ceremonial Ground</td>
</tr>
</tbody>
</table>

NEWLY RECORDED ARCHAEOLOGICAL SITES NEAR PROJECT AREA

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Dimensions</th>
<th>Site Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Site 1</td>
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<td>Midden/Artefacts</td>
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<tr>
<td>Field Site 2</td>
<td>50 x 100m</td>
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</tr>
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</table>

PREVIOUSLY RECORDED ARCHAEOLOGICAL SITES

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<th>W.A. Museum Site No.</th>
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<tbody>
<tr>
<td>Four Mile Creek</td>
<td>20 x 35m</td>
<td>Midden</td>
<td>P5890</td>
</tr>
<tr>
<td>Onslow</td>
<td>1.0 x 0.25 kms</td>
<td>Artefacts/Midden</td>
<td>P3563</td>
</tr>
<tr>
<td>North East of Beadon Creek</td>
<td></td>
<td>Burial/Artefacts</td>
<td>P4351</td>
</tr>
</tbody>
</table>
Because of their relevance in locating the stockpile/washplant and conveyor, it is appropriate to mention that the following three ethnographic sites are in close proximity to the works:

Burubarradji
Dew Talu
Jinta 1

The Proponent is aware of the importance of these sites and has had further onsite discussions with tribal elders, local nominated Aborigines and Rory O'Connor on the implications of the site on the Project and vice versa.

The sites have been identified on the ground and surveyed, and by constructing the conveyor with a transfer point, none of these three sites will be affected. The Proponent is committed to ongoing liaison with the local community during construction concerning these and other sites.
SECTION 6 - PUBLIC PARTICIPATION AND CONSULTATION

6.1 INTRODUCTION

In order to inform the local community about the Project and to involve them in the decision-making process, the Proponent has undertaken an information and public participation programme. A full description of the programme and the types of activity undertaken is provided in Appendix 2. This Section provides a summary of the programme undertaken and the issues (concerns and desires) raised by individuals and various interest groups. A summary of benefits associated with the Project is also included.

6.2 INFORMATION AND PUBLIC PARTICIPATION PROGRAMME

On 20th July 1989 a meeting was held at the Department of Resources Development (DRD) where the Proponent briefed officers from eleven Government Departments and the Ashburton Shire President and Shire Clerk on the proposal to set up a saltworks at Onslow. A brief description of the Project and a set of maps was provided.

On 16th August 1989 a Notice of Intent was lodged with the Environmental Protection Authority which described the Project. The Notice of Intent was circulated to various State and Commonwealth Government Departments prior to the Environmental Protection Authority (EPA) issuing a set of guidelines for preparation of an Environmental Review and Management Programme (ERMP) (see Section 1.7).

6.2.1 Public Meeting

A public meeting was held in Onslow on 4th October 1989 at which representatives of the Proponent outlined the proposal and the environmental assessment procedure and the ways in which the public could comment on the proposal both during the planning of the Project and also during the public review period of the ERMP. Maps and a brief description of the Project were handed out.
This meeting attracted between 150 and 200 people which represents a large proportion of the adult population of Onslow. An invitation was made to the audience to come forward with their concerns and the names and phone numbers of directors and consultants were provided for future contact.

A number of Government Departments had representatives at the meeting including DRD, EPA, Mines, SIU, WAWA, DEET, DET, DRD NW, and the local MLA and members of various media.

Many views were expressed both for and against the Project. Questions related to information required and concerns regarding possible direct and indirect impacts. Many of these were easily answered or not applicable, but some required further study and are dealt with in this ERMP.

Summaries of the meeting were taken by the Shire, Resources Development, Social Impact Unit and the Proponent. The Proponent's impression indicated a majority of the town in favour of the Project provided that certain concerns were met. Both during and after the meeting the Aboriginal community expressed support for the Project.

By far the strongest reaction against the Project came from the pastoral lease holders of Urala Station which is not impacted by Stage 1 of the Project, although at the time of the meeting they thought it was. Nevertheless the owners were not convinced and have kept up a protest to the media and in the town.

As a result of this meeting, a number of individuals and groups made contact and these have been followed up with meetings, correspondence and phone calls.

6.2.2 Shire Meetings

On 17th October 1989 three of the Proponent's Directors and their consultants attended a full council meeting of the Ashburton Shire at Onslow. The Project was discussed and a tour conducted of the washplant and stockpile site and the jetty location (marked by pegs and a buoy offshore). A follow-up
letter from the Shire detailed the issues raised (Appendix 6). At this time follow-up meetings were held with various interest groups and individuals identified on a previous visit.

The Proponent’s impression was that the Shire supported the Project and was reasonably happy with the jetty location but would prefer the stockpile area moved further away from the town, particularly Clarke Place, if possible. Following a subsequent meeting in January 1990, the Shire confirmed by letter its support for the Project but indicated their preference for the stockpile and washplant being located at the second site (ie. Option 2 of Section 4.2.8) (see Appendix 6).

6.2.3 Onslow Residents Liaison Group (ORLG) Meetings

In early November 1989 the Onslow Residents Liaison Group - Salt Project (ORLG) was formed by the Shire President to facilitate the flow of information from the Proponent to the community and vice versa. The committee included representatives of various interests within the community.

On 13th November 1989 the Proponent’s representatives attended an ORLG committee meeting at which various issues regarding the salt project were discussed. At this meeting the question of relocating the jetty, stockpile and washplant was raised, specifically a suggestion to shift everything to the east of Beadon Creek.

A further meeting on 18th December 1989 was held at which issues raised in previous meetings were followed-up. The comparative costings of four alternative jetty locations as described in Section 4.2.1.2 were tabled. Also letters were tabled from the Water Authority and the Tourism Department confirming that sufficient water would be available and that the Project would benefit tourism.

At the time of writing this report the ORLG meetings are ongoing. However, there has been insufficient guidance given to the Proponent on the types of facilities the community would like to see in the town.
6.2.4 Summary

During the course of the public participation and consultation programme the community has had every opportunity to understand the Project and to contribute their views. As a result of the programme, various concerns and desires have been raised and addressed by the Proponent. The following Section summarises the issues (concerns and desires) which have been raised by the Shire and various interest groups within the Onslow community over the course of the public participation programme.

6.3 IDENTIFIED ISSUES

At this stage, it appears that the majority of the local population sees merit in the Project proceeding, though with certain reservations listed below. Despite the community dividing on certain issues it is recognised and generally appreciated in the town that the Project has the potential to bring a number of benefits to the town. These include:

i) increased employment opportunities
ii) greater tourist attraction
iii) more stable economic base
iv) more justification to upgrade public services and facilities
v) common focus for town
vi) more organised sporting opportunities.

A summary of the community's concerns and desires and the perceived benefits of the project is given below.

6.3.1 Concerns

The following are the major concerns identified by the Shire and the community in general:

6.3.1.1 Location of Jetty

This was one of the major concerns as it implies that
a) a structure will be built on Back Beach which is seen as a recreation area and possible future residential area, and
b) the washplant and stockpile will be located close by (see 6.3.1.2 below).

6.3.1.2 Location of Washplant and Stockpile

This was and still is a major concern as it implies that
a) activities associated with these facilities which may generate noise, blowing salt and a visible salt pile, will be close to the existing Clarke Place residential area,
b) future residential areas near Beadon Point may be close to these facilities, and
c) the physical presence of these facilities may prevent expansion of the town along Back Beach.

Both 6.3.1.1 and 6.3.1.2 led to the request from the ORLG for the Proponent to review alternative sites for the jetty and associated facilities. Further discussion on these issues is contained in Section 4.2.1.2 and 4.2.8.

6.3.1.3 Fishing Industry and Discharge of Bitterns

The local fishermen are also concerned about other potential impacts of the Project on their livelihood, including:

a) the potential exclusion or restriction of fishing boats from any new shipping lanes
b) the impact of bitterns (see Section 7.3.3.1)
c) the changed freshwater flushing of tidal creeks.

These impacts are discussed in Section 7.3.7.1.

6.3.1.4 Tourism

Some people have questioned the general impact of the Project on tourism. This is discussed in Section 7.4.1.4.
6.3.1.5 Cyclones and Flooding

Concern was expressed that during cyclones

a) heavy rainfall, high tides and wave action may separately or combined cause a breach of the pond walls leading to flooding of the town and its surrounds

b) runoff from inland which flows across the flats will be diverted, possibly increasing the risk of flooding.

This is addressed in Appendices 4, 5 and 7, and discussed in Section 7.2.6.

6.3.1.6 Pastoral Industry

The pastoral lease holders of Peedamulla Station have concerns relating to potential increased tourist access through the Station if access across the flats is opened up and to the payment of rates for Station land utilised by the Proponent. This is discussed in Section 7.4.1.5.

The pastoral lease holders of Urala Station have concerns relating to Stage 2 of the Project if it is implemented, including construction of a brine channel or pipeline across the Station. This concern is noted as any work associated with Stage 2 will require a new Notice of Intent and subsequent assessment by State Agencies.

6.3.1.7 Loss of Character

There has been concern expressed by some members of the community that the sleepy atmosphere of Onslow will be changed if the Project proceeds, eg. caravan park residents.

6.3.1.8 Other Concerns

A number of other concerns (e.g. blowing salt, mosquitoes, brine flies, recreational fishing, road trains, turtles, dugongs and migrating birds) were raised (see Section 7.4.2.1).
6.3.2 Desires

The following are the major desires expressed by the community:

6.3.2.1 Medical Officer

There is a desire for a fulltime doctor or at least more frequent visits from a doctor.

6.3.2.2 Upgraded School and Child Care Facilities

Desire for an upgraded highschool and child care facilities has been expressed.

6.3.2.3 Sporting Activities

A desire for more sporting activities, especially for children, has been expressed.

6.3.2.4 Employment

There is a strong desire expressed by sections of the community for employment opportunities for locals, especially the Aboriginal community.

6.3.2.5 Public Access to the Jetty

There is a strong desire that the public has access to the jetty.

6.3.2.6 Contributions by the Proponent

As contributions from other industries (ie. the offshore oil industry) are perceived to have been minimal, there is a strong desire that the Proponent contributes to some community facilities in the town. This is discussed in Section 2.6.1 (vi).
6.4 BENEFITS

The following are the benefits of the Project for Onslow as perceived by the Proponent:

a) **Jetty**
   
   The jetty, its fishing platforms and the sealed carpark at its base will be an asset that will be available to the public (provided public liability issues are resolved). This provides locals with an additional facility as well as a town attraction for tourists. In addition, the jetty may be available for use by other industries in the future.

b) **Tourism**
   
   Tourism could be enhanced by the provision of the publicly available infrastructure and commercial services provided by the project.

c) **Direct Contribution to Onslow by Proponent**
   
   The Proponent has proposed a number of ways in which it could contribute to the town to a maximum of $500,000. These may include, but are not limited to:
   
   i) public access to jetty with fishing platform
   ii) upgrading of some community facilities
   iii) sealed cycleway linking jetty with town
   iv) sealed carpark at base of jetty
   v) establishing a tree planting programme.

   However it remains for the ORLG and the Shire to give their views on what would be helpful for the town (see Section 2.6.1 vi) a) to f)).

d) **Employment Opportunities**
   
   The project offers increased employment opportunities in the town.
e) Schooling and General Infrastructure
The project and its resident population may provide impetus for upgrading a number of public services including school, child care and medical services. The project may also provide a catalyst to move the school to the favoured location near the town oval - a site that will be central to the existing town and the new subdivision.

f) Commercial
The project will create new opportunities for business and better services for the local population.

g) Economic Base
The project will contribute substantially to the economic base of the town which in turn may provide more justification to upgrade public infrastructure.

h) Caravan Park
The Proponent proposes to use the Wapet camp, subject to availability, and to convert it into a caravan park which will become available for public use as the construction workforce vacates it.

i) Community Focus
The Project has potential to provide a common focus of purpose for the local community.

6.5 SUMMARY
The public participation programme undertaken by the Proponent has given the Shire and local community every opportunity to become familiar with, comment upon and contribute to the Project. As a result of this programme, the Project has been altered in an attempt to accommodate the concerns of, and recommendations given by, the Shire and the local community. However, as pointed out in Section 4 a re-arrangement of the jetty and shipping point, is not economically feasible. Despite this last point the Shire and the community in general have indicated to the Proponent that they now support the Project in principle.
SECTION 7 - ENVIRONMENTAL IMPACTS

7.1 INTRODUCTION

Construction of any major industry has the potential to have an impact on the local physical, biological and social environments. In order to minimise the potential impact of this project, the Proponents have investigated, as described in Section 4, a number of alternative locations and designs before selecting the preferred option that not only achieves their design criteria but minimises environmental impacts. In addition, the Proponent, as outlined in Section 6, has made an effort to seek input from the local community so that potential social concerns are addressed and decisions taken to change, where possible, those parts of the project that cause concern.

This section therefore, describes the anticipated impact of the project on the physical, biological and social environment of Onslow.

7.2 IMPACT ON PHYSICAL ENVIRONMENT

7.2.1 Landscape

The project will change the landscape of the salt flats in that they will be occupied by shallow ponds and low walls (banks or bunds) some of which will be visible from the main road. The jetty will be visible from Back Beach. The conveyor leading to it will be in an excavation or screened by landscaped bunds. The washplant and the stockpile will be largely screened by bunds and plantings and natural high sand dunes. Overall, the visual impact will be slight as the majority of the ponds will not be visible from Onslow and the close-by facilities will be largely screened.
7.2.2 Coastal Processes

The only facility that will affect coastal processes is the jetty. As the structure is an open pile trestleway it will have minimal impact on littoral drift and general water movement. The jetty and the seawalls of the ponds will be affected by coastal processes, particularly during cyclones. Both the structures are designed to withstand forces associated with cyclones and accordingly should not fail. With location of seawalls totally inland of the mangroves and generally inland of the limit of algal mats (i.e. the area subject to normal tidal inundation), the seawalls will have little if any impact on tidal flows.

It is not anticipated that the dredged channel or spoil bank will have any impact on normal coastal processes. However, it is anticipated that some sand may be moved during cyclones, which will in time lead to a requirement for maintenance dredging (Section 8.3.2.3).

7.2.2.1 Tidal Flushing

Pumping large volumes of water from the eastern arm of Beadon Creek, has the potential to alter the tidal regime upstream with the result that tidal range and length of wetting may be changed. At the pump site, the creek has a bottom width of 25m. The elevation of the creek bed is such that pumping at full capacity is not feasible below +0.6m above chart datum, which results in a 20% loss of pumping time over the year. At high water springs, the cross section area of the creek at the pump site is about 150m$^2$, which is capable of passing 100m$^3$ per second without significant head loss. The three pumps will extract a total of 12m$^3$ per second, allowing the bulk of the water to pass upstream. A calculated reduction in water level above the pump site during spring high tide will not exceed 0.1m.

At high water neaps, the effect of pumping will be greater. At mean sea level the cross section area is around 20m$^2$ so that a large part of water reaching the pump station will be extracted.

The changed tidal regime may have some impact on the upper reaches of the algal mats above the pump station on the eastern arm of
Beadon Creek. These mats comprise at most around 40-50 ha (ie. 12%) of the 420 ha found in the Beadon Creek System (excluding the 37 ha to be enclosed within Pond 2) and therefore any impact on the Beadon Creek System is not likely to be significant. In order to determine the extent of the impact, monitoring of the affected area will be carried out (see Section 8.4.5).

Despite the fact that the mangroves which colonise to the upper reaches of spring tide limit, will still receive regular flushing by spring tides, they may be affected by the dampened neap tide regime. The impact of this is not known, but monitoring will clarify the nature of change, if any (see Section 8.4.5).

7.2.3 Riverine Processes and Drainage

The system of ponds will influence the flow of inland floodwaters to the coast. This has two implications:

i) constriction of floodwaters, and
ii) restriction of floodwater flow to tidal creeks.

i) In order to accommodate floodwaters, a floodway has been left around the inland margin of the ponds. Calculations indicate that this floodway has sufficient capacity to accommodate predicted floods from the catchment around the flats (see Appendix 4). As the area is so flat water velocities will be insufficient to cause scouring in the floodway. Equally it is unlikely that significant scouring of algal mats will take place around Pond 2 as the floodway here widens out downstream of the last major constrictions.

It is possible, however, that the floodwaters may on rare occasions be constricted by the culvert under the highway. The Proponent recognises this and is prepared to monitor the situation and modify the road culverts and stone pitch the shoulders should it become necessary (see Section 8.4.8).

Natural flow in the south west flats is around the area occupied by the crystalliser ponds, thus it is not considered likely that the crystallisers will have any impact on floodwater flow through to the coastline.
ii) Construction of the ponds will restrict flow of floodwaters to some of the tidal creeks. Beadon Creek will be cut off and the next creek east (Second Creek) will be partially cut off. However, the three major creeks at Coolgra Point will be little affected by the ponds and will receive floodwaters as they do now. It is possible that given suitable conditions, floodwaters will flow westward around Pond 2 to Second Creek, thereby feeding all the eastern creeks apart from Beadon Creek.

Hooley Creek on the south-west flats will not be affected by the ponds. It is possible that Middle Creek and Four Mile Creek will experience some change to the influx of floodwaters though this is likely to be minor.

The issue of changing frequency of freshwater flooding is complex and the impact, if any, is not known. In order to provide some data, the Proponent will monitor sites around Beadon Creek, the system most affected by this change (see Section 8.4.5).

7.2.4 Groundwater

Groundwater in the flats is generally 0.5 to 1.0m below the surface with salinities ranging from 90 ppt near the tidal creeks to about 200 ppt below the supratidal flats. With construction of the condenser ponds, water, with salinities ranging from 35 to 200 ppt, will be held approximately 0.6m deep over the flats. Any leakage through the seaward ponds (Ponds 2 and 5), which contain concentrated seawater with salinities ranging up to 140 ppt, will therefore tend to dilute the groundwater. As crystallising gypsum tends to seal the ponds and leakage is not desirable from the Proponents point of view, this is not considered to be a significant issue. Experience from elsewhere indicates that there are no apparent negative impacts as a result of condenser pond leakage on adjacent biological communities.

Around the crystallisers any leakage of brine (or bitterns), which has a salinity of over 200 ppt, has the potential to change the chemistry of the groundwater with unknown impact on the biological
communities downstream. Leakage from these ponds will be minimal because of the dense bed of rocksalt that forms their floors. In order to check for leakage and changes to groundwater and the biological system the Proponent will monitor sites around the crystallisers (see Section 8.4.5).

Groundwater in the Onslow area is brackish, of limited supply and is not extracted for human use. The floor of the salt pile will slope towards the adjacent linear depression and a channel will take outwash brine from the salt pile and the washplant away to the southwest where it will be ponded prior to pumping back to the crystallisers. As the depression is saline and generally covered with a salt crust, it is not considered that the impact of the brine from the washplant etc. will have any significant impact on the local groundwater, especially the springs on the north-western side of the depression.

7.2.5 Extraction of Materials

A range of materials will be extracted to construct the bunds and seawalls as described in Section 3.5. The majority of the material in the bunds will be excavated from the pond side of the bund so that when the pond is full the excavation will be covered. In the case of seawalls, this nodular clay will be compacted and sheeted with rock armour extracted from quarries on the major islands. Because of the widespread occurrence of limestone in the area a few major quarries will be designated and worked. Once work is complete these will be rehabilitated except for one or two which will remain for maintenance purposes.

It will also be necessary to obtain suitable material for roads etc. Currently the MRD and Shire extract partly cemented sand (pea gravel) from pits on the main Onslow "island". The Proponent will use these quarries and others in more distant areas. At the completion of construction these quarries will be rehabilitated except for one or two which will remain for maintenance purposes.

Because the bulk of the material in the bunds will be won locally, the quarries will be small and therefore easily rehabilitated (see
Section 8.3.2.5). The Proponent undertakes to rehabilitate the quarries and accordingly the impact of extracting construction material will be minor (Section 8.4.6).

7.2.6 Cyclonic Flooding and Storm Surges

Cyclonic events with associated high seas, high winds, high tides and heavy rainfall have the potential to affect the structures built for the project. All structures have been designed to withstand the predicted impacts of cyclones and accordingly should not fail. However, there is always potential for a combination of events which may lead to some unexpected local failures.

If the jetty fails presumably it will sink to the seabed (as opposed to the old wooden jetty which washed along the coast). If any floodwalls break (i.e. those along the floodway), it is possible that a surge of water through the ponds could lead to successive breaches of the banks ultimately leading to discharge of floodwaters onto the tidal flats. As this is what happens now, the impact of breached walls should have no significant impact on Onslow. In fact it is probable that the ponds will protect Onslow as they will divert floodwaters around the town.

Heavy cyclonic rainfall in the ponds is also unlikely to lead to breach or overtopping of the pond walls as the "freeboard" above pond level is over 1m and the highest one day fall recorded at Onslow is 356mm (i.e. 0.356m) and the highest monthly fall recorded is 539mm (0.539m).

7.2.7 Emissions

7.2.7.1 Noise

The impact of noise is fully discussed in Appendix 5.

During construction use of machinery which emits noise will be operating. As the majority of the works are remote from Onslow, the impact of emissions will be minimal. Construction works on the jetty and washplant area have the potential to generate noise that may affect local residents. However, the construction phase will
be of short duration (3-4 months) and work will be restricted from 10.00 p.m. to 6.00 a.m. if necessary to minimise this impact.

During operation the equipment and operations which generate noise are:
- the tracked vehicles operating on the stockpile
- power generator which operates 24 hours per day
- movement of salt hauling trucks.

Tracked vehicles are the strongest noise source with trucks 3 dB quieter. The recognised limits for noise levels in residential areas are 45 dB(A) during the day and 35 dB(A) at night.

During daytime it is predicted that tracked vehicles operating at the top of the stockpile at Site 1 (at the base of the jetty) will produce noise levels below 45 dB(A) at the nearest residential area.

At night lower noise levels will need to be achieved. Accordingly it may be necessary to restrict the operation of tracked vehicles to below the crest of the stockpile at Site 1. Data presented in Appendix 5 illustrates that (if this restriction is applied) noise levels at the nearest residential area will be below 35 dB(A).

In addition:
- reversing beepers on mobile equipment can be set to lower sound power levels so as to minimise nuisance at a distance.
- acoustic screening (earth bunds) can be constructed around the dumping facilities and the conveyor (especially the transfer point) to limit operating noise levels if necessary.

Figure 9 illustrates the predicted day and night sound pressure levels (in dB) at various frequencies, generated from the facilities located at Site 1, at the nearest residential area. The figure also illustrates that sound levels inside the closest dwellings, both during the day and night, will be close to, or below, the threshold of hearing.
As sound levels generated from the selected site for these facilities (ie. Site 2) will be 5 dB lower, it is anticipated that noise levels at Clarke Place will fall within acceptable levels without restrictions on operations.

In order to ensure that the impact of noise from Site 2 complies with statutory levels, operation of the jetty and stockpile also will be managed to minimise noise output (see Section 8.3.2.1). In addition, the Proponent will construct vegetated bunds in appropriate positions around the area to reduce noise levels outside if monitoring demonstrates they are required. Accordingly, noise emissions are not expected to result in any significant impact. If they do, the Proponent undertakes to take whatever action is necessary in conjunction with State agencies.

It is possible that under certain conditions noise levels may exceed 35 dB(A) in the nearest residential area. For this to happen, shiploading must take place on a calm, rainless night with temperature over 30°C and relative humidity over 30%. At worst, this combination of conditions may occur up to 3 times per year.

7.2.7.2 Dust

During construction, dust may be generated in the stockpile/washplant area and along unsealed roads. This will be minimised through use of water trucks. There will be little dust associated with seawall and bank construction as the material is moist.

Dust generation during operation of the project will be strictly controlled as dust in salt is not desirable. Hence, the haulroad and washplant area will not generate dust, as the Proponent will water the haul road with brine or bitterns to minimise dust generation (see Section 8.3.1.1). A side effect of the project will be a reduction in natural dust generation off the saltflats which is a common phenomenon during windy periods.
7.2.7.3 Light

Light will be emitted from the washplant/stockpile area and from the jetty. Light emissions may affect wildlife on the beach, notably nesting turtles, and impact upon the nearest residential area. The Proponent is aware of the need to design and operate the lights on the jetty to minimise illumination of the beach and will design lights in the work area to minimise emissions that may impact on the residential areas (see Section 8.3.2.2).

7.2.7.4 Suspended Sediment

During construction of the shipping channel around 600,000m³ of dredged spoil will be generated. Surface sampling and jet probing indicates that this material will be mainly quartz sand, coral sand and fine terrigenous silty mud, which will be disposed of in a shallow mound approximately 600m to the east of the channel and about 1600m east of Wards Reef. Due to the clay and silt content it can be expected that a plume of suspended fine sediment will be generated during dredging. Because disposal will take place into seawater, it can be expected that silt and flocculated clay particles (0.045mm in diameter) will settle out relatively quickly. Based on work by Hunter and Hearn (1985), these particles will settle to the bottom of 8m deep water at a distance 125 times the depth in a current of 0.2m/s (the maximum anticipated during ebb spring tides) from the point of discharge (ie. 125 x 8 = 1000m).

As Wards Reef is at least 1600m from the disposal site, it is not expected that anything other than fine suspended clay particles will reach the reef. As a result it is considered that the short term plume will not have any significant long term impact because the water off Onslow is already generally turbid (i.e. most afternoons) due to the presence of clay, delivered to the coast by the Ashburton River, being continually winnowed and transported to the north east.

The Proponent is aware of the potential impact of dredging and accordingly it is planned to carry out as much of the dredging as possible during winter when biological activity is lowest. In
addition, if the plume drifts towards Wards Reef, which at its closest lies 1600m west of the disposal areas, then disposal of spoil can be switched to another area by realigning the pipeline. The plume will be monitored during dredging and action taken to minimise its impact on Wards Reef. Therefore it is not considered that the construction phase will lead to a permanent deterioration in water quality, or damage to the Ward Reef ecosystem. (See Section 8.3.1.3).

7.2.7.5 Salt

Some residents expressed concern that salt would blow off the stockpile. This does not happen as salt is hygroscopic (i.e. absorbs moisture). As a result it is always moist so that it sticks together. Experience from other salt fields shows that salt forms a crust on the stockpile which does not blow.

7.2.8 Access

Flooding of the condenser ponds will lead to some of the islands on the south-eastern flat being surrounded by water. This has the potential to isolate small wildlife and to change the pattern of movement between islands and the mainland. Most of the wildlife is likely to be supported on the several large islands which will be linked to each other with bunds, or on islands with access to the mainland across the floodway. Thus the impact of flooding will not have any major implications apart from restricting travel across the salt flats and possibly changing the patterns of movement between the islands surrounded by the ponds (i.e. the wildlife will use the bunds).

The ponds will also drown the current access road and water supply pipeline across the flats. The Proponent has undertaken to construct a bund and road along the alignment of the pipeline and to raise and renew the pipeline, thereby guaranteeing a continued water supply to Onslow and maintaining access across the flats.

Access to and along Back Beach will not be affected, as the conveyor will pass beneath the road and the jetty is open piled. Additionally, the public may have access to the jetty (subject to suitable public liability arrangements being reached).
Construction of the pond walls could lead to better public access to the coast east of Onslow in that the pump station seawall and the Pond 2 seawall will provide a link with the coastal "islands". In addition, access to Coolgra Point will be improved somewhat through formalisation of the track which currently crosses the flats. Because of the limited attraction of this coast, the difficulty of access beyond the seawalls and the small population in the area, it is unlikely that the changed access patterns will lead to any significant impact on the coast. The Proponent will however fence off these access points to the coast.

7.3 IMPACT ON THE BIOLOGICAL ENVIRONMENT

A full description of the impact of the Project on the biological communities is given in Appendix 3. The following is a summary based on the various ecological components.

7.3.1 Mangroves

7.3.1.1 Direct Impacts

Mangroves will be directly affected when construction of the ponds takes place. Construction of the pump station will involve direct loss of about 0.8 ha of mangroves from the eastern arm of Beadon Creek. Apart from this construction of the condenser pond walls will not have any direct impact on the mangroves. The bitterns channel will impact upon one group of mangroves (0.56 ha) and may affect another (0.34 ha). Both these mangrove stands contain a sparse cover of grey mangroves. Construction of the crystalliser ponds will not have any direct impact on the mangrove communities.

Thus the total area of mangroves directly impacted will be around 1.5 ha out of a total of 943 ha (ie. 0.16% of the mangroves in the Onslow area - see Table 3).

7.3.1.2 Indirect Impacts

Indirect impacts include dust generation, ground water, bitterns and freshwater flushing and nutrient input. While the indirect
impacts are not expected to be significant, a monitoring programme to quantify the impacts, if any, will be implemented (see Section 8.4.5).

i) Dust:
The only mangroves likely to be affected by dust during construction are those on Beadon Creek where the pump station and Pond 2 walls will be constructed. As dust associated with construction will only be short-term and insignificant in relation to dust generated naturally off the flats, it is not expected to have any significant impact on the mangroves. Dust generated from roads has led to decline in health of mangrove stands elsewhere. Around Onslow this will be minor as most roads are located well inland of the mangroves, though the mangroves near Beadon Creek will be monitored for signs of stress (see Section 8.4.5).

ii) Groundwater:
The landward limit of mangroves is determined by groundwater salinity with the highest salinity tolerated of around 90 ppt. In general, the seaward condenser ponds will have salinities lower than the groundwater (200 ppt) so any negative impact may take a long time to become apparent.

Experience from Dampier indicates that mangroves have colonised up to the bund walls in the first pond (ie. Pond 2).

The crystalliser ponds will contain high salinity water (over 200 ppt). In this case there may be a local increase in groundwater salinity which may be transmitted to the adjacent mangroves. Since the stands in Four Mile Creek and Middle Creek are 700m distant, it may be some time before any impact is detected. Additionally, these mangroves have a combined area of only 13.3 ha out of a total of 103 ha west of Onslow. Thus the impact is not likely to have any regional significance.
Discharge of bitterns also has potential to affect the groundwater. Monitoring at Dampier adjacent to the bitterns discharge channel has shown no apparent increase in salinities in both the mangroves or the salt flats. The transient nature of bitterns discharge, (i.e. short bursts), is not expected to raise groundwater concentration significantly.

iii) Bitterns Discharge:
Apart from the removal of mangroves during construction of the bitterns channel, there is expected to be no effect on mangroves by the release of bitterns at selected times (i.e. above average tide). It should be noted that the bitterns are to be disposed of in a relatively wide creek (125m) and that this creek was chosen for its relative paucity of mangroves (8.5 ha). It is also relatively isolated for recreational fishing. (See Section 7.3.3.1).

iv) Freshwater Run-Off and Nutrient Input:
There is no permanent freshwater input to the Onslow saltflats. However, periodic freshwater flooding associated with cyclonic rains does occur. In the Onslow area therefore, mangroves have developed under conditions of non-reliable freshwater input. It is most likely however that their landward distribution is influenced by a seasonal reduction in groundwater salinity. The input of nutrients via freshwater run-off also should be considered, though the impact is likely to be sporadic. It is generally considered that on arid coasts, mangroves derive most nutrients from marine sources.

The presence of algal mats which can fix nitrogen and leach dissolved organic material to mangroves via floodwater flow or rainfall is another source of nutrients. Restriction of flooding from rainfall is not expected to occur on the flats west of Onslow where only 7 km² is affected out of a total of 38 km².
Beadon Creek will be cut off from its wider catchment, however 9.6 km$^2$ of catchment will remain. Some algal mats (37 ha out of a total of 453 ha) will be smothered by Pond 2 and hence there may be a small reduction in mangrove productivity as a result. East of Beadon Creek, the revised Pond 2 will have only a minimal impact on fresh floodwaters and no impact on direct rainfall to the mats and mangroves, and therefore nutrient input to these creeks should be maintained.

7.3.2 Algal Mats

7.3.2.1 Direct Impacts

Construction of the pump station bund will smother approximately 37 ha of algal mat in Beadon Creek (Table 3). Apart from this, construction of the condenser ponds will have a direct impact on only 6 ha of algal mats east from Onslow. Construction of the bitterns channel will remove 0.3 ha of mat around Middle Creek, however construction of the crystalliser ponds will inundate 190 ha of mats. This impact is considered to be unavoidable due to the desire to link seawalls to the natural islands on the flats.

Thus, the area of algal mat affected by the Project will be around 230 ha out of a total of 1968 ha (ie. 12% of the mats in the Onslow area).

7.3.2.2 Indirect Impacts

i) Bitterns Channel:
Observations at other saltworks show that erosion of the bitterns channel walls and the adjacent algal mud flats may occur if the walls are not supported.

ii) Dust:
Dust generated during construction will be short-term and therefore the impact upon the algal mats will be negligible. In addition, algal mats are able to grow in sedimenting environments by growing through covering sand. At Dampier, algal mats colonised up to within 4m of bund walls.
iii) General:
Algal mats grow in the top 2cm of soil and are therefore not greatly affected by the groundwater underneath. Growth is determined by the frequency of tidal inundation and temperature which affects the drying rate. In winter, reduced temperatures cause lower evaporation rates and reduce salinity within the mat leading to increased growth. Rainfall also helps to reduce salinity in the mat surface by flushing salt. Tidal water also performs the same function. Therefore it is not expected that the restriction of floodwater flow by the bund wall construction will reduce algal mat distribution. There may however be some impact caused by lowering of water levels as a result of pumping (see Section 7.2.2.1).

The use of algal mat areas for four-wheel drives and trail bikes for recreational purposes has severely affected mat structure. Any increase in access to the algal mats will be monitored to ensure that large scale damage does not occur (Section 8.4.7).

7.3.3 Offshore Areas

7.3.3.1 Bitterns Discharge

The seabed off Middle Creek is bare rippled sand up to 800m offshore with a low density of colonising sponges. Monitoring of bitterns discharged into Nickol Bay shows that bitterns with a concentration of 340 ppt were diluted to 42 ppt at mixing point near the shore and 37.1 ppt 1.5 km offshore (seawater is 36 ppt). The conclusion reached as a result of this monitoring is that there has been no significant long term change in regional salinity in Nickol Bay caused by bittern discharge. In contrast to Dampier, where bitterns enter the sheltered Nickol Bay through a channel, the bitterns at Onslow will initially mix in Middle Creek before entering the open ocean. This creek is depauperate in mangroves and algal mats. The volume of bitterns discharged will be around 25,000m³/day. The volume of the creek at mid-tide is around
125,000m$^3$. Under average tidal range of 1.2m the volume of water discharging from the creek each day will be around 150,000m$^3$ (ie. 75,000m$^3$ twice a day).

As bitterns will be discharged during times of above average tidal range, mixing and dilution should take place within the creek and accordingly there should be no significant impact on the adjacent mangroves or ocean. (See Section 7.3.1.2 iii)). Biological monitoring at Dampier also concludes that discharge of bitterns has no affect on juvenile prawn numbers and fluctuations in indicator populations show no relationship to bitterns discharge. The conclusion reached as a result of the study is that bitterns discharge has had only minor effect on Nickol Bay and its environs.

Thus, monitoring of indicator species is probably not necessary at Onslow. Monitoring of salinity and water chemistry at Middle Creek and the adjacent ocean is considered worthwhile before discharge takes place over several seasons so that the nature of the receiving environment can be determined. When discharge does take place comparison to background data can be made and the mode of release modified if required (see Section 8.4.5).

7.3.3.2 Jetty Construction

The environment where the jetty is to be constructed consists of bare muddy sand in water 4-5m deep, which changes to silty mud at the end of the jetty. Flora and fauna were predominantly associated with small rock outcrops. The environment is not considered rare and is similar to other environments in the area. It is not considered that the jetty will remove any significant areas of habitat.

7.3.3.3 Dredging Effects

The benthic (seabed) flora and fauna is widespread so dredging and disposal of spoil will not remove any significant habitat or communities. Neither is it expected that removal of seabed flora and fauna will substantially alter the nature of the bottom...
communities around Onslow. It should be noted that this area has already been extensively modified through clearing the seabed for trawling. Because the water in the area is already turbid, suspended sediment created by the dredging will not have any long-term significant impact. Because Wards Reef has actively growing coral, dredging should be carried out if possible during winter to minimise the impact of the additional plume. In addition, if the plume drifts towards Wards Reef, then disposal of spoil can be moved to another area (Section 8.3.1.3).

7.3.3.4 Salt Flat Islands

Approximately 36 islands will be isolated within the condenser ponds, however only 16 islands with areas over 4 ha will be totally isolated with the rest connected via bund walls which will provide a limited corridor for fauna to move between them. These islands are occasionally surrounded by fresh floodwaters, however they will become surrounded by seawater when the ponds are built. It is expected therefore that soil salinities may increase around the perimeters of the islands, which may lead to the mortality of some of the margin vegetation. Rainfall, however, should maintain a fresh groundwater lens beneath the islands. The Proponent has undertaken to carry out a survey for rare flora and fauna on these islands.

7.3.4 Other Impacts

7.3.4.1 Mangroves

In addition to the changes described above, there may be increased pressure on the mangrove habitats through recreational fishing which includes exploitation for fish, crabs and prawns. The mud crab is a species particularly vulnerable to this type of pressure. If the bund walls are breached at any time, the resulting uncontrolled flow of high salinity water into the mangrove creeks may have a deleterious effect on the resident marine life. This however is likely to be short-term and no permanent damage is expected.
7.3.5 Creation of New Habitats

New habitats will be created on the jetty piles and in the condenser ponds. Jetty piles will provide a hard substrate for attached macro-algae, crustaceans and molluscs such as barnacles and oysters. This will set up a food chain leading to increased fish populations around the jetty. The evaporative ponds will provide an environment for blue-green algae and brine shrimps. Birds will be attracted to the ponds for loafing and feeding so an increase in bird numbers is expected. It is recommended that if any stocking of ponds with brine shrimp occurs that they be of the non-invasive species such as Parartemia which occurs naturally on the Pilbara coast.

7.3.6 Fisheries

Discussions held with officers of the Fisheries Department and Onslow based fishermen confirm that there will be some impact on the local fishing grounds. The main impact relates to construction of the dredged channel and its navigation markers across one of the trawling areas near Wards Reef. Whilst this area is not the prime fishing ground, these works will lead to declaration of an exclusion zone on either side of the channel which will impede fishing in this area. Apart from this there will be no other direct impact on the fishing grounds as the prime areas lie west of the Ashburton mouth or further offshore.

Concern has been expressed about the possibility of high salinity water, including bitterns, impacting on nursery areas. Studies at Dampier show that discharge of bitterns into Nickol Bay has not had any noticeable impact on the biota (including juvenile prawns and fish) or fishing, and accordingly it is not anticipated that discharge of bitterns into Middle Creek and then into the open ocean off Onslow will have significant impact on the biota (see Section 7.3.3.1). Discharge of hypersaline waters due to breakdown of the crystalliser ponds is a remote possibility. If this was to occur the volume of saline water in each pond is relatively small (40 ha x 0.3m) and presumably breakdown would occur as a result of heavy rain, intense flooding or high seas, in which case rapid mixing and dilution would take place. In any
event the impact would be short term in nature. Consequently, it is not anticipated that discharge of high salinity water due to some extreme event is likely to cause any long term damage to the ecosystem.

7.3.7 Conclusions

This Project, excluding Pond 1, will have a minimal direct impact on the mangroves in the Onslow area (a maximum of 1.5 ha or 0.16% of total). It is therefore consistent with the CTRC (1974) recommendations that solar salt production should be restricted to the supratidal zone landward of mangroves. The indirect impacts (ie. changes in groundwater salinities, reduced freshwater flushing), are yet to be determined but will be monitored for changes.

Impacts on algal mat, in terms of smothering, will be minimal on the eastern side of Onslow (37 ha or 3.7%). Approximately 20% of the total on the western side, however, will be smothered by the construction of the crystalliser ponds. Thus a total of 230 ha (11.5%) will be removed from the Onslow region, mostly on this western side and in a region of two creeks that show low densities of mangroves. There are likely to be few indirect impacts to algal mats from this Project. The exception to this is in regard to reduced levels in Beadon Creek due to pumping and increased access to mangroves for recreation and possible algal mat trampling.

Bitterns discharge has been shown to have little effect on the biological environment in Dampier, and it is expected that this will occur in the Onslow environment.

Dredging is a short term pressure on the environment and, if carried out at the correct time, should not significantly alter the offshore ecosystem. There appear to be no unique ecosystems in the dredge channel compared to adjacent areas, and the benthos has been modified by trawling already. The presence of a jetty is more likely to provide new substrates for plants and animals rather than remove ecosystems already present.
Of the 36 salt flat islands over 4 ha isolated by the condenser ponds, only 16 islands (13% in area) will not be connected by bund walls. Ground dwelling animal movement may be restricted since it can only take place via the bund walls. On the totally isolated islands, species composition may be changed by the lack of migration. This loss however, providing there are no rare species of fauna or flora, is considered insignificant in relation to the amount of salt flat islands in the Onslow area. An undertaking to survey the islands has been given by the Proponent.

The condenser ponds, particularly if stocked with shrimp species, are expected to create a new habitat for birds. Bird numbers, particularly in Pond 2 which has salinities similar to that experienced on the tidal flat in the natural environment, are therefore expected to increase as they utilise the ponds for loafing and feeding.

7.4 IMPACT ON SOCIAL ENVIRONMENT

Assessing the social implications of the Project has been an important part of the ERMP process. A full description of the local community and the impacts of the Project are contained in Appendix 2. The following is a summary based on the concerns noted in Section 6.3.1.

7.4.1 Identified Local Impacts

7.4.1.1 Jetty, Stockpile and Washplant

Location of the jetty, stockpile and washplant has been the major issue because of their original proximity to the Clarke Place residential area and their impact on Back Beach. The Proponent has taken note of the concerns of the Clarke Place residents that noise generated by the facilities during loading may have exceeded acceptable noise standards if not properly managed, that the salt pile would have been visible if not screened, and that the facilities would have encroached on what is perceived to be town space.
These concerns have, to a large extent, been satisfied through the Proponent agreeing to relocate the washplant and stockpile to a site away from Clarke Place (ie. Option 2), which has the support of the Shire and ORLG, the Clarke Place residents and the local Aboriginal community. Apart from these concerns there does appear to be a general consensus that a jetty near Beadon Point would be of benefit to the local residents and an attraction to tourists. Consequently, it is anticipated that construction of these major facilities will have little negative impact on the local community or the tourism industry.

7.4.1.2 Discharge of Bitterns

As discussed in Section 7.3.3.1, discharge of bitterns will have a minimal impact on the local ecosystem.

7.4.1.3 Fishing Industry

As discussed in Section 7.3.7.1, it is not expected that the Project will have any adverse impact on the fishing industry. However, there is some concern that an exclusion zone around the dredged channel and navigation markers will limit the area available for trawling. It is acknowledged by the fishermen that this ground is not one of the main fishing areas as catches there have been poor in recent years. Nevertheless the Proponent has made representation on behalf of the fishermen in attempting to secure replacement areas if possible.

7.4.1.4 Tourism

Concern has been expressed that the Project may affect future tourism opportunities. Advice from the Tourism Commission is that Onslow's tourism growth over the foreseeable future will be at a slow but steady rate. The Tourism Commission also suggests that there is no reason that tourism and a well managed salt industry cannot be mutually beneficial. In fact the prospects for tourism could well be enhanced through provision of an extra attraction with its publicly available infrastructure and additional community services. To this end, the Proponent has undertaken, subject to the resolution of public liability, insurance, security, ongoing maintenance and operational matters, to provide public access
to its jetty, as well as upgrading roads, carparks and pathways around Beadon Point.

7.4.1.5 Pastoral Industry

The concern about rating of station land utilised by the Proponent has been resolved as the Proponent will assume responsibility for rates of that land. Advice from Peedamulla Station is that the land utilised by Gulf is not stocked, and hence the Project will have minimal impact on Peedamulla Station. It is likely that the small amount of Peedamulla affected will be excised from the Pastoral Lease and leased to the Proponent under the Mining Act.

The concern that construction of ponds will decrease tourist access to the coast east of Coolgra Point across the flats and thereby increasing tourist access through Peedamulla is unfounded as the Proponent is required to upgrade the existing pipeline and its service road which will be trafficable throughout the year. As this will be a private road, use by the public is subject to resolution of public liability issues and ongoing maintenance cost sharing.

Stage 1 of the Project will not have any direct impact upon Urala Station except that it raises the possibility that some time in the future Stage 2 may be built. Stage 2 will have an impact on Urala as a brine channel and/or pipeline will have to be constructed across the Station. As this concern is not of direct relevance to Stage 1, it is merely noted for the future.

7.4.1.6 Contributions to the Town

The Proponent has offered (see Section 2.6.1 vi) a) to f)) to contribute some tangible assets to the town provided that public liability, insurance, security, ongoing maintenance and operational matters are resolved and that ongoing management and maintenance of facilities is assumed by the Shire or other appropriate State Authority. As yet the community, through the Shire or ORLG, has not made a clear statement on its priorities.
In addition, the Proponent has made commitments to continue liaising with the ORLG and Shire and to assist in employing local labour where possible.

7.4.1.7 Cyclones and Flooding

The concern expressed about increased potential for flooding in the town is address in Section 7.2.6. In brief, construction of the ponds and floodways should direct floodwaters away from Onslow without increasing the risk of flooding due to storm surge or direct rainfall.

7.4.2 Other Potential Impacts

7.4.2.1 Increased Population

It is possible that the Project will lead to an increase in the population of Onslow of around 250 people. Given that Onslow's population is around 600-800 people, the workforce associated with the Project will lead to a significant increase in the town's resident population, which in turn will put pressure on supply of residential land, community facilities and provision of services. Although in terms of numbers the new population will effectively replace the Wapet construction force, the nature of the population will be different in that it will become part of the town and will need to be catered for by the town infrastructure. The additional resident population is likely in the long term to benefit the town in that there will be increased commercial and social activity and probably more justification to upgrade services and facilities.

7.4.2.2 Schooling

It is likely that there will be an increase of 100-130 children in the town. According to Ministry for Education statistics, the likely new enrolment one could expect in the local school would be around 45. Enquiries suggest that the school could physically accommodate an extra 50 children in existing buildings although more resources would be required (ie. teachers, etc.). The Ministry for Education advises that increased numbers for the school and pre-school would give impetus to plans to relocate the
school in the foreseeable future. Furthermore, should district High School classification be desired by the Onslow community, the only requirement would be the regular attendance of 25 students over a period of time. The pre-school centre lease for the Shire expired at the end of 1989 and it is understood the Shire has reason to want the pre-school building moved onto the school site, but the Education Department is resisting the move until a decision on whether or not to relocate the school is made. The influx of children as a result of the Project should enhance the chance of better education opportunities in the town.

7.4.2.3 Medical and Public Health Services

The influx of a new resident population implies that services will need to be expanded. The town's desire for upgrading the medical services is likely to be justified if the Project goes ahead. It is understood that the desire for a full-time medical officer has already been approved by the Health Department but that this has not yet transpired because of a lack of appropriate accommodation. A resident doctor would create his own need to increase the number of hospital beds as there would be less need to fly seriously ill people to other regional hospitals. The Community Health Nurse is working to capacity and could need an extra assistant and there could be justification for a Child Health Nurse. The visiting Dentist reports that he can cope with double the population.

7.4.2.4 Department of Community Services

The Department employs one district officer to deal with welfare issues in the town. The officer reports that the town has a high level of frustration, drinking problems and domestic violence related to lack of resources and facilities. The Project will provide more resources and facilities and real employment opportunities in the town which may assist in reducing these problems. This officer has also drawn to the attention of the Proponent a recommendation in a document being prepared by a Department Working Party that new employees, and especially wives, should undergo some kind of orientation programme to prepare them for the way of life, the unexpected costs of living and to minimise culture shock and the resulting social problems. The Proponent
acknowledges the suggestion made in Appendix 2 that a skilled community worker or personnel officer be employed to provide an orientation programme for families to assist them to settle into life in the north-west. Accordingly, the impact of the new population on Onslow should be greatly reduced.

7.4.2.5 Police

Discussions with the local police indicate that with their current force they will be able to cope with the predicted increase in population and this has subsequently been confirmed by advice from the Police Department.

7.4.2.6 Housing

The Project will generate a requirement for around 40 new houses plus single accommodation. The Proponent has had discussions with the Department of Land Administration regarding the purchase of existing blocks within the town and release of blocks over the next two years in the new sub-division south of the hospital and with Homeswest over the provision of rental housing. The Proponent is committed to assisting in creating a sensibly planned new suburb where Project homes are mixed in with non-Project homes as far as possible. Accordingly, the impact of a significant number of new houses will be minimal on Onslow.

7.4.2.7 Commercial Enterprises

The increased demand for commercial enterprises will create new opportunities for existing as well as new businesses. It is possible that the extra population will be sufficient to support some new facilities which are currently absent, eg. bank, newsagent, chemist etc., which should be of benefit to the town.

7.4.2.8 Character and Lifestyle

As the new population will be housed away from the immediate commercial centre any detrimental physical impact on the townscape will be minimal. While there is potential for the Project population to form a new group in town, this will be reduced as far as possible by mixing the Project and non-Project housing in the
existing town and the new sub-division. Some people have described the town as "cliquey" and lacking in community cohesion and civic pride, which possibly stems from its lack of common purpose and real employment opportunities. Others have described it as quiet and restful (a sleepy backwater) which has led to their retirement there. The young people with young families appear to want some progress in the town for the sake of their children, whereas the older generation who want a peaceful retirement would be just as happy if no change takes place. Clearly a potential benefit is the generation of community cohesion through creating a purpose or focus for the town, especially with the recent departure of the Shire offices and its administrative workforce.

7.4.2.9 Change in Population Mix and Characteristics

Clearly the increase in population will alter the age ratio and employment ratio in that there will probably be an influx of whites and more employed people in town. This in turn will generate more disposable income which will presumably be of benefit to the commercial enterprises. As in other north-west towns, there is a possibility that the Aboriginal community may become more marginalised. However, with the creation of employment opportunities and the availability of training schemes and the commitment of the Proponent to participate in training schemes, this potential impact can be minimised (see Section 7.4.2.10 below).

7.4.2.10 Employment

During construction a maximum workforce of about 100 will be on site during the first four months of construction (see Section 3.3.2). Where possible local labour and local subcontractors will be used provided they are competitive in cost and output. The workforce will be housed in a newly created caravan park in the area currently occupied by the Wapet construction camp. The size of the workforce will not exceed 100 during the major phases of construction. Between these phases the workforce is unlikely to exceed 50. It is therefore expected that this construction
workforce will have no more effect on the town than the existing Wapet workforce of around 200, which from local feedback has been minor.

Once the Project is operational, it is in the Proponent's interest to employ local labour as it is less expensive because of housing and removal requirements, the workforce is stable and has ties to Onslow. Accordingly the Proponent is committed to give preference to local Onslow residents.

In making this commitment it should be recognised that the basic aim in the early stages of operation is to get the Project up and running on a viable economic basis. Once this is achieved, the Proponent will be in a position to help in the on-site training and upgrading of local skills.

To this end the Proponent has met with the relevant Government Agencies to help in the preparation of training schemes aimed at developing the specific skills in the community that the Proponent will require in its operations phase.

The Proponent recognises the special needs of the Aboriginal community in competing for jobs in the open market and is committed to employ in conjunction with DEET (Commonwealth) a special person to liaise on the Proponent's behalf with the Aboriginal community to establish an Aboriginal employment action plan. This person will in turn liaise with a community based resource person which the State, via DET (State), has committed itself to provide. The Proponent is aware that the other saltfields have been successful in employing Aboriginal people and sees no reason why a similar situation cannot be achieved at Onslow.

The Proponent also commits itself, via this liaison officer, to create specific employment training strategies and to provide opportunities for training courses in conjunction with DEET. Where appropriate the Proponent undertakes to make provision to train at least two unskilled workers in specific skills and tasks and provide opportunities for formal industrial training for the period outlined in Section 8.3.2.9.
In summary, the Proponent has a strong and positive attitude to training local people as an investment in its future workforce. In addition, the Proponent has indicated that it is prepared to contract out tree raising, planting and maintenance to the Bindi Bindi village who have expressed an interest in this operation. Given the employment opportunities provided, and the Proponent's commitment to assisting local labour, the Project will lead to a significant increase in local employment opportunities.

7.4.2.11 Other Impacts

Blowing Salt - see Section 7.2.7.5.

Mosquitoes and brine flies - enquiries regarding Dampier and Port Hedland salt works indicate that these insects which occur naturally in mangrove/algal mat areas are generally not a problem in residential areas.

Recreational fishing - no significant change to recreational fishing in Beadon Creek or Four Mile Creek is anticipated, especially as Beadon Creek is already extensively modified by maritime industries.

Road trains - there will be no road trains hauling salt through Onslow as all heavy haulage and machinery movement will take place on the haul road and crystallisers.

Turtles and dugongs - there have been reports but no ground truthed sightings of turtles on the beaches near Onslow. Dugongs are known along the coast, especially in Exmouth Gulf and the offshore islands in areas where seagrass colonises the seabed - there is no seagrass in the area affected by the Project.

Migratory birds - experience at other salt works indicates that bird numbers are likely to increase as a result of the new habitat created by the ponds (see Section 7.3.5). Very little tidal habitat is being lost to the ponds as they are mostly located on supratidal flats.
7.4.2.12 Conclusion

Based on the assessment carried out in Appendix 2, it is considered that the Project will provide a range of benefits to Onslow with few disbenefits. The local issues of concern which are highlighted in Appendix 2 have, to the Proponents belief, been resolved.

7.4.3 Historical, Archaeological and Ethnographic Sites

As outlined in Section 5.5.9, there are a number of ethnographic and archeological sites around Onslow. Of the seven ethnographic sites recorded from information given by Aboriginal people, the mythological site Burubarladji, the Talu (Dew Talu) and Jinta l are located close to the area considered for the stockpile and washplant.

Discussions have been held with nominated Aboriginal people and tribal elders and the sites identified on the ground. As a result, the conveyor will be built with a transfer point thereby avoiding these three sites. No other Aboriginal sites will be directly impacted by the Project.

7.5 SYNTHESIS OF SIGNIFICANT ENVIRONMENTAL IMPACTS

While the Project will cause some changes to the physical landscape around Onslow, they are not likely to have a negative impact on the local community. However, during construction dust, noise, turbidity caused by dredging, disturbance due to extracting materials and movement of vehicles will need to be managed.

While the Project may have some impacts on the biological ecosystem, they are likely to be insignificant. The Project has been designed so that the direct impact on the mangroves and algal mats is minimal (ie. 1.5 ha of mangroves affected out of a total of 943 ha and 230 ha of algal mat affected out of a total of 1968 ha). Dredging will also have a direct impact on the offshore environment. However this is not considered to be significant as the environment affected is already extensively modified and widespread.
There may be some indirect impacts caused by changed tidal regimes in Beadon Creek and the presence of ponds which contain seawater ranging in concentration from 37 ppt (seawater) to 300 ppt (bitterns). Experience from elsewhere shows that these indirect impacts are minor or difficult to detect. In order to assess these indirect impacts, a monitoring programme will be established.

Discharge of bitterns is also likely to cause minimal change as established elsewhere. Monitoring of the discharge will however be carried out to confirm this.

There is also likely to be increased pressure on the landscape and its flora and fauna through isolation of some islands in the flats and through increased human activity in the area. These impacts will be kept to a minimum through locking off seawalls (if required) etc. that provide access to major islands and the coast. The impact of isolating islands is unavoidable, though probably not significant due to the number of other salt flat islands in the area.

The Project will have a significant social impact on Onslow. The town's resident population will increase which in turn will increase pressure on commercial services, housing, schooling and lead to increase in local business activity, employment opportunities and tourism. Any negative impacts due to the Project will to a large extent be offset through the Proponent employing a community worker or personnel officer who will assist the new population to integrate with the town. In addition the Proponent is sensitive to the need to assist locals to take advantage of employment opportunities and has made a number of commitments to achieve this.

The Project will not affect directly any ethnographic or archaeological sites.

Overall, the Project will have a minimal impact on the physical and biological environment. It will have a significant impact on the Onslow community, though this impact will be largely beneficial as the major concerns of the community have been addressed through relocation of some of the major works associated with the Project.
SECTION 8 - ENVIRONMENTAL MANAGEMENT

8.1 INTRODUCTION

As outlined in Section 7, the development will have a number of impacts on the local environment. Many of the impacts associated with construction and those likely to require management in the future, have been addressed in the location, design and operation of the Project. This Section describes the Management Programme aimed at minimising the unavoidable impacts during construction and during operation of the Project.

During construction, management of the following will be required:
  a) Dust, noise and vibration associated with construction of the stockpile, washplant area and conveyor;
  b) Turbidity caused by dredging;
  c) Disturbance caused by creating access to islands along the line of the bund walls and to quarry sites;
  d) Disturbance of Aboriginal sites.

During operation of the Project, management of the following will be required:
  a) Noise, vibration and light emissions associated with operations of the washplant, stockpile, reclaim and shiploader;
  b) Bunds, sea walls and dredged channel, haul road etc.;
  c) Bitterns discharge;
  d) Rehabilitation of quarry sites and other disturbed areas;
  e) Tree planting programme;
  f) Access to the coastal islands along the sea walls;
  g) Fuel storage and conveyance;
  h) Local employment and training.

This Section also describes a monitoring programme which will provide a guide to management action.
8.2 OBJECTIVES

The objectives of the Management Programme during construction will be to:

a) Minimise generation of noise, dust and vibration, especially from the stockpile, washplant and jetty conveyor;
b) Minimise the impact caused by suspended sediment during dredging;
c) Minimise disturbance during creation of access tracks and quarry sites;
d) Minimise the impact on the local community; and
e) Avoid any impact on Aboriginal sites.

The objectives of the ongoing Management Programme will be to:

a) Maintain the emissions of noise and vibration to below levels set for residential areas, both during the day and at night;
b) Minimise the impact of light emissions on Back Beach and residential areas;
c) Maintain bunds, sea walls, dredged channel and all operating plant and machinery to a high standard;
d) Discharge bitterns so as to minimise impact on the external environment;
e) Maintain the rehabilitation programme in quarry sites and disturbed areas;
f) Maintain the tree planting programme;
g) Manage unauthorised access to coastal islands along the sea walls;
h) Train and employ local residents, especially Aboriginal people, in conjunction with Government Agencies.

8.3 MANAGEMENT COMMITMENTS

8.3.1 Construction Phase

During construction the following Management Programme will be adopted to achieve the objectives outlined in Section 8.2 above:
8.3.1.1 Dust

There is potential to generate dust during construction of facilities around the stockpile/washplant area. In order to minimise this impact, suppression of dust will be carried out as required through watering. Water will be obtained from a pit constructed within the area to be disturbed when the facilities are built. Once works are complete, the areas will be covered with vegetation and topsoil recovered from the area prior to the earthworks. All roads and carparks in the vicinity will be sealed (including Back Beach), with the haul road sheeted with gravel and watered.

Earthworks in the new subdivision have the potential to generate dust. However these works will be carried out by DOLA.

It is proposed that a full scale tree and shrub planting programme will be initiated by the Proponent. In the stockpile/washplant area and around the base of the jetty and in the new subdivision, plantings will be watered with the mains water until such time as they become established (see Section 8.3.2.6 and Section 7.4.2.10).

8.3.1.2 Noise and Vibration

Earthworks and construction of facilities around the jetty and washplant area will generate noise and vibration that may affect the adjacent community. In order to reduce this impact construction near the town will be limited to daylight hours (7.00 a.m. - 6.00 p.m.) where possible. If any complaints are received, the Proponent is committed to reducing noise levels to acceptable standards in consultation with the appropriate State Agencies.

8.3.1.3 Turbidity

Turbidity generated during dredging will be a temporary phenomenon with no significant long term impact. In order, however, to reduce this impact, dredging will be carried out as far as possible during winter months when biological activity is lowest. The plume will be monitored during dredging and if it drifts towards Wards Reef, then disposal of spoil will be switched to another area.
8.3.1.4 Disturbance Through Access and Quarrying
During the construction phase, access to quarry sites and to the take off points for sea walls and bunds will need to be created. In order to minimise this impact, quarries and routes will be selected and cleared. A condition of the Construction Contract will specify that personnel are to keep to designated tracks only and to extract material only from selected sites. Once construction is complete, access tracks to sea walls will be fenced off, including the route which follows the pipeline and provides access to Peedamulla Station. Gate keys will be provided to Peedamulla and the Water Authority subject to insurance, liability and operational issues being resolved. Any material excavated during construction of the pumpstation will be disposed of within the Pond 2 walls.

Quarry sites will be made safe and rehabilitated as described in Section 8.3.2.5.

8.3.1.5 Social Impact
Because of the scale of the operation and the proximity of some works to residential areas, it is likely that there will be some impact on the local community. In order to minimise this impact, noise, vibration and dust emissions will be managed as described above. Movement of vehicles etc. on local roads will be kept to the bare minimum as the majority of work will take place off road and away from the town. The construction workforce will probably be housed and catered for in the old Wapet Camp and therefore will be relatively distant from the town. As work is completed, new families will begin to occupy the new subdivision and take their place in the community.

As suggested in Appendix 2 the Proponent will engage a part-time community worker to assist the new workforce to integrate with the established locals.

8.3.1.6 Aboriginal Sites
The Proponent is aware of the location of Aboriginal sites and will consult with local nominated Aborigines during the construction phase whenever works are in close proximity to known sites.
8.3.2 Operation Phase

8.3.2.1 Noise and Vibration

A most important part of the operation will be management of noise and vibration emissions so that the impact on residential areas both during the day and the night is within acceptable levels. As described in Section 7.2.7.1, a bund will be constructed if monitoring demonstrates it is required to reduce emissions to acceptable levels in the nearest residential areas. In addition, the following operations will be managed to reduce the generation of noise:

a) Reversing beepers on reclaim dozers will be adjusted to operate within a range that will not be affected by wind;

b) Trucks will operate within limits set for tracked machines.

Accordingly, emissions are not expected to exceed levels set for residential areas during the day (45 dba) and at night (35 dba). Emissions will be monitored in the early stages of operation and if unacceptable levels are detected, the Proponent is committed to take action in conjunction with State Agencies to reduce the emissions to acceptable levels.

8.3.2.2 Light Emissions

It has been pointed out that strong lights shining on the beach may affect nesting turtles. The only place this will occur is at the base of the jetty. In order to minimise this impact these lights will be shrouded to minimise indirect illumination away from the jetty. The lights will only be used during loading operations which is estimated to be one night per week. During other times, low intensity lights will be used to provide illumination for the public at night. These lights will automatically be turned off at 10.00 p.m. or at any other time deemed desirable by responsible authorities.

Other light emissions from the washplant/stockpile area will also be designed to minimise impact on the adjacent residential and public areas.
8.3.2.3 Management of Bunds, Sea Walls and Dredged Channel

The economic viability of the Project relies on maintaining the integrity of the bunds and sea walls around the condenser and crystalliser ponds. In other words, it is in the Proponent's interests to make sure that the walls are maintained to a high standard so that loss of brine or entry of flood waters does not occur. Accordingly, maintenance of these structures will be ongoing. Likewise, maintenance of the shipping channel is critical. The Proponent anticipates that, mainly as a result of cyclones, there will be a requirement to carry out maintenance dredging every ten years or so.

8.3.2.4 Bitterns Discharge

During the first year of the Project, there will be reduced discharge of bittern salts to the sea as they will be used to line the crystalliser ponds. Thereafter it is planned that bitterns will be discharged in a controlled manner through a shallow drain into Middle Creek. Discharge will be timed to coincide with average, or better, tides so that mixing with seawater is maximised. During the initial discharges the creek will be monitored for changed ionic ratios etc., to determine how much bittern salts can be discharged without significant impact on the creek waters (Section 8.4.5).

8.3.2.5 Rehabilitation Programme

Management of areas disturbed during construction will be ongoing. It is planned that quarry sites will be made safe, covered with top soil and local seeds and fenced off once construction work has ceased. Evidence elsewhere in Onslow demonstrates that natural revegetation will take place in quarries provided that the areas are fenced off. In this regard, maintenance of rehabilitation sites will be ongoing.

8.3.2.6 Tree Planting

Maintenance of the tree planting programme will be ongoing. It is planned that all work areas near the town, especially near the base of the jetty and particularly the bunds, and the roads in the
new subdivision, will be planted with trees and shrubs. These plantings will be a contribution to the general atmosphere of the town and will soften the impact of the works area. As mentioned in Appendix 2, the Proponent is having discussions with the Bindi Bindi community to determine whether the community can establish a nursery and supply trees and the workforce to undertake and maintain the tree planting programme.

8.3.2.7 Access

Management of access through the condenser ponds raises several issues including legal liability. The Proponent and WAWA will maintain an all weather road across the ponds along the pipeline which will be available to Peedamulla Station subject to insurance, public liability and operational issues being resolved. Apart from that, it is proposed that all other sea walls and roads will be fenced off so that public access to the islands and coast is generally no better than at present.

8.3.2.8 Fuel Storage and Conveyance

All fuel stored on land will be enclosed and protected by appropriately lined bunds of sufficient size to contain any fuel spills. All fuel facilities will be maintained by the oil company under contract to supply the fuel. Should locally produced oil be utilised it is likely that it will be supplied via the pipeline on the jetty. This pipeline will be constructed according to standard regulations to minimise the chance of fuel spills into the marine environment. If however a spill does occur, the Proponent will have the necessary equipment (including tug/workboat with boom and skimmer and line boat) stationed in Onslow that will be equipped to deal with spills. The Proponent will lodge a contingency plan before construction.

8.3.2.9 Employment and Training

As outlined in Appendix 2 and Section 7.4.2.10, the Proponent undertakes to:
1) employ a person, in conjunction with DEET, to liaise with the Aboriginal community to establish an Aboriginal Employment Action Plan. This will be for a period of 12 months initially and subject to annual review.

2) create specific employment training strategies for the local community and to provide opportunities for training courses in conjunction with DET. (NB. DET has committed itself to providing a community based resource person to liaise with the person in 1) above);

3) to make provision to train at least two unskilled workers in specific skills and tasks and to provide for formal industrial training.

8.4 MONITORING COMMITMENTS

8.4.1 Introduction

In order to achieve the management objectives set out in Section 8.2, the following will be monitored:

a) Dust during construction and operation,
b) Noise during construction and operation,
c) Bunds, seawalls and dredged channel,
d) Bittern discharge and impact on mangroves,
e) Rehabilitation and tree planting programme,
f) General access to the coast,
g) Floodwaters across the highway.

8.4.2 Dust

During construction the work site will be monitored and appropriate action taken to suppress dust as described in Section 8.3.1.1. During operation dust will be suppressed through watering. In order to determine whether dust has any impact on adjacent mangroves, regular monitoring of mangrove and algal mat quadrats near the pump station in Beadon Creek will take place.
8.4.3 Noise

Noise emissions will be monitored during construction and initial operation of the Project in conjunction with State Agencies to confirm that predicted noise emissions are within acceptable limits. If unacceptable levels are detected during subsequent operations the Proponent will take whatever action is necessary in conjunction with State Agencies to reduce noise levels experienced by surrounding areas to acceptable levels (see Section 8.3.1.2 and 8.3.2.1).

8.4.4 Bunds and Sea Walls

All bunds, sea walls, the dredged channel and the bitterns channel, will be monitored as part of normal operations (see Section 8.3.2.3).

8.4.5 Bitterns, Mangroves and Coral

The monitoring programme detailed in Section 8 of Appendix 3 will be implemented as follows (see Figure 10).

Monitoring of the corals on Wards Reef (including turbidity monitoring) will be initiated to quantify the impact, if any, of dredging.

A series of shallow monitoring bores will be placed in the upper reaches of Beadon Creek to monitor the impact of bunding and flooding the supratidal flat and of pumping in the eastern arm. The bores will be placed and monitored prior to construction commencing to provide background data on groundwater. Monitoring of selected areas of mangroves and algal mats will also be undertaken to check for signs of stress related to changes in groundwater, tidal flushing or dust.

A series of shallow bores will also be placed in the upper reaches of Four Mile Creek and Middle Creek to monitor the impact, if any, of the crystalliser ponds and the discharge of bitterns into Middle Creek. Monitoring of water in Middle Creek during spring
tides before and during bittern discharge will also be undertaken to assess the impact of discharge on the creek waters and the degree of mixing achieved in the creek.

It is anticipated that groundwater monitoring will initially be carried out over a neap to spring cycle (28 days), once in winter and once in summer, and thereafter every month at low tide to determine long term changes in groundwater. Groundwater (ionic ratio and salinity) and soil chemistry (ionic ratio, salinity, cation exchange properties, nutrient and organic matter) changes will be noted.

However, it is proposed that details of the monitoring programme are finalised on site in conjunction with officers of the EPA immediately the Project receives the "go-ahead".

Monitoring will commence once the Project receives the "go-ahead". This will allow around four weeks monitoring before construction commences and approximately a further 12 weeks before the pump station becomes operational. Thus there should be at least 4 months of monitoring before pumping into the condenser ponds commences.

As the first brine will not enter the crystalliser ponds for around eight months after pumping starts, there will be at least one full year in which to obtain baseline data before any changes are induced in the groundwater system around Middle and Four Mile Creek.

As the data provided by this monitoring programme will be of scientific and general interest in assessing the impact of bunds and ponds on mangrove and algal communities, all work will be carried out under the supervision of a contract biologist with experience in this field.

8.4.6 Rehabilitation and Tree Planting

All disturbed areas subject to rehabilitation and the ongoing tree planting programme will be monitored.
8.4.7 Access

The use of roads along sea walls by the general public will be prohibited. If a problem does occur with uncontrolled access across the ponds, action will be taken in conjunction with the Shire and State authorities.

8.4.8 Flooding

The level of floodwaters on the highway will be monitored and if required the road will be modified in conjunction with the MRD and Shire.

8.4.9 Sample Analysis and Interpretation

Installation of bores and monitoring of groundwater and biological communities will be carried out under the supervision of a contract biologist with experience in the field.

8.4.10 Reporting and Review

Results of monitoring and any management action will be collated and analysed and made available to the Environmental Protection Authority on an annual basis or as required.

8.4.11 Contingencies

The Project has been designed as far as possible to minimise the impacts of known natural forces. The Proponent and his successor, the Project Manager, will be equipped to deal with breaches in bund walls, fuel spills, noise and dust emissions and the impact of storms and floods. The Proponent and his successor are prepared to negotiate with the Shire to carry Public Liability Insurance so that as far as practical the public may have access to parts of the jetty. This matter is subject to resolution of a number of other issues. In the event that some unforeseen event occurs which leads to an impact on the surrounding environment, the Proponent and his successor would undertake to address this problem.
8.4.12 Management Responsibility

As detailed in Section 3.3.1, a Project Manager will be created and charged with the responsibility of operating the salt project and associated activities. The Project Manager, through the Onslow based Mine Manager and environmental consultants, will also be responsible for implementing the environmental and management monitoring programme. In undertaking these tasks, the Project Manager will comply with relevant Standards identified by State and Local Government Agencies and will undertake appropriate action to meet these standards. This commitment to environmental management will be incorporated in the State Agreement Act.
SECTION 9 – CONCLUSION

The Project, as proposed, will result in major changes to the landscape around Onslow in that saltflats will largely be occupied by shallow ponds and a new jetty will be built west of Beadon Point. Apart from the jetty, the major works associated with the Project will be remote from the town with the stockpile/washplant area over 1.0 km from the nearest suburb (Clarke Place).

The Project will, however, have only a minor direct impact on the biological communities in the area in that the ponds have been located where possible on the supratidal flats landward of the mangrove communities. This conforms with the recommendation made by the CTRC Committee to the EPA (CTRC 1974) that solar salt production be restricted to the supratidal zone. In all only 1.5 ha of mangroves out of a total of 943 ha (ie. 0.16%) and 230 ha of algal mat out of a total of 1968 ha (ie. 12%) will be directly affected.

The Project may have some indirect impact on these communities in that one of the creeks will be cut off from fresh floodwaters, while the remainder will experience minor change. Because nutrient input to mangroves and algal mats is largely dominated by input from marine sources, this impact is not likely to be significant. The biological communities in the eastern arm of Beadon Creek may experience some change due to draw down caused by pumping. Dredging will directly affect the seabed, though the impact is unlikely to be significant as the sea floor is only sparsely vegetated and the habitat is widespread.

The most significant aspect of the Project will be its social impact on Onslow. As a result of an ongoing participation and consultation process, the local community has had every opportunity to become familiar with, comment upon and contribute to the Project. On balance, the community has expressed support for the Project, subject to resolution of several matters of concern, notably, stockpile and washplant location and noise associated with these facilities. These concerns have been resolved with relocation of these facilities over 1.0 km from the town.
It is clear that the Project will bring change to Onslow. Depending on one's point of view the Project will add or detract from Onslow. Those who retreated to Onslow because it is a sleepy backwater have expressed concern at the change. Conversely those seeking employment, a future for their children, more and varied community services and a wider range of people from whom to choose friends, playmates etc., have welcomed the prospect of the Project.

While the additional workforce will add significantly to the permanent population, they will be accommodated in a new suburb so that Onslow should retain its relaxed atmosphere and the day to day lifestyle of the retired residents is unlikely to be altered.

It is difficult to see how the Project will not benefit Onslow in the long term as it will provide an economic base and common purpose for the town and enhance its attraction for tourism. Overall it is considered that provided the Proponent adheres to the commitments given in this ERMP to:

a) contribute to community recreation facilities in the town;
b) employ local labour where possible and participate in training schemes;
c) assist in integration of the new workforce with the existing residents

the Project is unlikely to have any significant negative impact on the Onslow community. In fact it is considered that the Project will have a significant net benefit on Onslow. In terms of the wider community the Project will have a significant benefit in that it has potential to create directly and indirectly around 80 new jobs as well as significant export income.

In closing, the production of solar salt involves use of solar power and seawater. No unnatural toxic waste is produced and insignificant fossil fuel is consumed. The production of solar salt is therefore totally sustainable in the long term as the major resources required (sun and seawater) are totally renewable.
SECTION 10 - SUMMARY OF COMMITMENTS

The following is a summary of commitments made by the Proponent:

**Dust**
- Dust will be suppressed in areas likely to affect residents. (Section 8.3.1.1).

**Noise**
- Noise will be maintained at or below statutory levels for residential areas through construction of bunds, work practice and design of machines. Noise will be monitored in the early stages of operation and if unacceptable levels are detected, the Proponent will take action to reduce emissions to acceptable levels. (Section 8.3.1.2, Section 8.3.2.1).

**Dredging**
- Dredging will be carried out as far as possible during winter to reduce the impact of suspended sediment (Section 8.3.1.3). The plume will be monitored and if it drifts onto Wards Reef, disposal will be moved to another area.

**Disturbance to Countryside**
- A condition of the Construction Contract will specify that personnel are to keep to designated tracks and to extract material only from selected sites to reduce the impact of vehicles and quarrying on the countryside. (Section 8.3.1.4).

**Social Impact**
- Noise and dust emissions will be managed and movement of vehicles on local roads will be minimised. (Section 8.3.1.5).

- A part-time community worker will be engaged to assist the new workforce integrate with locals. (Section 8.3.1.5).
Aboriginal Sites Consultation with local Aboriginal people will be ongoing during construction near known sites. (Section 8.3.1.6).

Water Supply The Proponent will, subject to agreement, contribute towards the cost of upgrading the water supply main in conjunction with WAWA. (Section 3.2.10.2).

Light Light emissions will be managed through design so as to have minimal impact on Back Beach and the adjacent residential area. (Section 8.3.2.2).

Bunds, Seawalls, Dredged Channel All structures and machinery will be maintained to a high standard. (Section 8.3.2.3).

Bitterns Bitterns will be discharged in a controlled manner into Middle Creek during average and above tides. Monitoring will assist in determining the volume capable of being discharged without significant impact on the creek system. (Section 8.3.2.4).

Rehabilitation All quarry sites will be made safe and rehabilitated apart from those required for maintenance. (Section 8.3.2.5).

Tree Planting A tree planting programme will be initiated for the areas affected by the Project, including the new subdivision. If the Bindi Bindi community wishes to supply and maintain the trees they will be contracted to do so. (Section 8.3.2.6).

Access In conjunction with W.A.W.A., an all weather controlled access road will be maintained along the pipeline which will be dependent on the resolution of public liability, insurance, security, ongoing maintenance and operational matters. All access to bunds and sea walls will be fenced off (Section 8.3.2.7).
Fuel Storage
& Conveyance Fuel will be stored and conveyed according to standard regulations. A tug/workboat with boom and skimmer and line boat permanently stationed at Onslow will be equipped to deal with marine spills. (Section 8.3.2.8).

Employment & Training The Proponent will:
(Section 7.4.2.10)
1) employ a person, in conjunction with DEET, to liaise with the Aboriginal community to establish an Aboriginal Employment Action Plan;

2) create specific employment training strategies for the local community and provide opportunities for training courses in conjunction with DET. (NB. DET has committed itself to providing a community based resource person to liaise with the person in 1) above);

3) make provision to train at least two unskilled workers in specific skills and tasks and provide for formal industrial training.

Monitoring The monitoring programme described in Appendix 3 and Section 8.4 will be initiated and maintained. In summary the following will be monitored:

a) Dust and suspended sediment during construction and operation,
b) Noise during construction and operation,
c) Bunds, seawalls and dredged channel,
d) Bitterns discharge,
e) Impact on mangroves and Wards Reef,
f) Rehabilitation and tree planting programme,
g) General access to the coast,
h) Floodwaters across the highway.

This biological work will be carried out under the supervision of a contract biologist with experience in this field. The details of the monitoring programme, designed to
clarify the impacts of bunding and ponding on the biological communities, will be finalised on site in conjunction with officers of the EPA once the Project receives the go-ahead.

Contributions to Onslow (Section 2.6.1 vi) a)-f)).

The following projects, to which a financial contribution may be made, have been suggested by the Proponent as being possible subject to resolutions of public liability, insurance, security, ongoing maintenance and operational matters:

a) the provision of controlled access to a jetty fishing platform, look-out points and some embankments;

b) the construction of a sealed walkway/cycleway around Beadon Point connecting the town to the jetty;

c) the upgrading of facilities at Back Beach providing landscaped carparking, barbecues and sun shelters;

d) the assistance in developing the Workers Club;

e) the establishment of a second caravan park probably at the Wapet Camp Site to be used by the Proponent during construction. Once the construction workforce leaves the site, the park would be open to the public.

f) the establishment and maintenance of a tree planting programme in the whole area in conjunction with the Shire.

The Proponent also notes the recommendation in Appendix 3 and accordingly the ponds will be stocked with a native artemia such as Parartemia (brine shrimp).
REFERENCES

EPA, 1975, Conservation Reserves for Western Australia - System 9 : EPA, Perth.

CTRC, 1974, Recommendations for Conservation Reserves for Western Australia - System 9 : DCE, Perth.


TABLES

TABLE 1  Comparative costs of alternate locations of jetty and dredged channel.

TABLE 2  Area of mangroves, algal mat and supratidal flat in the study area.

TABLE 3  The impact on mangroves and algal mats due to construction of the ponds.
## ONSLOW SALT PROJECT
PORT OPTIONS - DREDGING COSTS
STAGE I - 28,000 DWT, -9.0M x 120M

**November 1989**

<table>
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<tr>
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<td>7.8</td>
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<td>5.7 846,000</td>
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<td>3.3</td>
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<td>4.5 641,000</td>
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<td>3.3 450,000</td>
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<td>-</td>
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<td><strong>Total Volume</strong></td>
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<td></td>
<td>3,494,000</td>
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<td>$4,487,000</td>
<td></td>
<td>$23,934,000</td>
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$25,404,000

**Notes:**
- Comparative costings of three alternative locations for the jetty and dredged channel. The costing for a fourth alternative (i.e. at Cooliga Point) is not presented as it will be more expensive than Option C due to the need for a long channel.
### TABLE 2

**Areas of Mangroves, Algal Mat and Supratidal Flat in the Study Area**  (Note: 1 km$^2$ = 100 ha)

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<thead>
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<th>Creek Name</th>
<th>Mangroves</th>
<th>Algal Mat</th>
<th>Supratidal Flat</th>
</tr>
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<tbody>
<tr>
<td>Hooley's</td>
<td>90.34</td>
<td>468.43</td>
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</tr>
<tr>
<td>Middle</td>
<td>8.50</td>
<td>193.65</td>
<td></td>
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<tr>
<td>Four Mile</td>
<td>4.81</td>
<td>297.04</td>
<td>3,800</td>
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<tr>
<td>Beadon</td>
<td>134.67</td>
<td>453.76</td>
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<tr>
<td>Second</td>
<td>29.60</td>
<td>50.86</td>
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</tr>
<tr>
<td>Third</td>
<td>160.55</td>
<td>249.93</td>
<td></td>
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<tr>
<td>Coolgra Point</td>
<td>514.16</td>
<td>253.96</td>
<td>17,300</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>942.63 ha</strong></td>
<td><strong>1967.63 ha</strong></td>
<td><strong>21,100 ha</strong></td>
</tr>
</tbody>
</table>

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9.4 km$^2$</td>
<td>19.7 km$^2$</td>
<td>211 km$^2$</td>
</tr>
</tbody>
</table>
TABLE 3

The Impact of Various Options on Mangroves and Algal Mat Due to Construction of the Ponds

<table>
<thead>
<tr>
<th>Option</th>
<th>Area Smothered or Removed (ha)</th>
<th>Freshwater Flow/Runoff*3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Algal Mat</td>
<td>Mangrove</td>
</tr>
<tr>
<td>1. Pump Station Construction in Pond 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option A (SO)</td>
<td>36.57</td>
<td>0.82</td>
</tr>
<tr>
<td>Option B</td>
<td>37.48</td>
<td>0.41</td>
</tr>
<tr>
<td>2. Condenser Ponds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With original Pond 1</td>
<td>234.86</td>
<td>98.60</td>
</tr>
<tr>
<td>With Pond 1 Option 1</td>
<td>154.84</td>
<td>18.52</td>
</tr>
<tr>
<td>Option 2a</td>
<td>14.23</td>
<td>0</td>
</tr>
<tr>
<td>Option 2b</td>
<td>14.23</td>
<td>0</td>
</tr>
<tr>
<td>Option 3 (SO)</td>
<td>5.81</td>
<td>0</td>
</tr>
<tr>
<td>Without Pond 1 Option 4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. Crystalliser Ponds</td>
<td>189.50</td>
<td>0</td>
</tr>
<tr>
<td>4. Bitterns Channel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impacted</td>
<td>0.30*1</td>
<td>0.56</td>
</tr>
<tr>
<td>Possibly affected</td>
<td>n/a</td>
<td>0.34*2</td>
</tr>
</tbody>
</table>

*1 based on a strip 10m wide, the length of the channel
*2 this stand occurs 50m from the channel
*3 relative measure only (the more "+" the better flow into the tidal mangrove creeks)
(SO) = Selected Option
FIGURES

FIGURE 1 The Onslow Salt Project works.

FIGURE 2 Schematic cross-section through condenser ponds showing relation of walls, tide, surge and flood levels etc.

FIGURE 3 The Onslow Region showing tidal and supratidal flats, rivers and major islands.

FIGURE 4 Pump Station and Seawall - Alternative Locations.

FIGURE 5 Seawall option for Ponds 1 and 2.

FIGURE 6 Location of Crystallisers.

FIGURE 7 Process area location options - Alternative locations for stockpile and washplant.

FIGURE 8 Schematic cross-section of the Onslow area showing basic geology and geomorphology.

FIGURE 9 Noise curves and criteria

FIGURE 10 Environmental monitoring sites
SUMMARY OF AREAS

<table>
<thead>
<tr>
<th>POND No</th>
<th>AREA (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2950</td>
</tr>
<tr>
<td>3</td>
<td>1100</td>
</tr>
<tr>
<td>4</td>
<td>940</td>
</tr>
<tr>
<td>5</td>
<td>695</td>
</tr>
<tr>
<td>6</td>
<td>480</td>
</tr>
<tr>
<td>7</td>
<td>310</td>
</tr>
<tr>
<td>8</td>
<td>420</td>
</tr>
<tr>
<td>TOTAL</td>
<td>7000</td>
</tr>
</tbody>
</table>

FIG. 1

O Source of Rock Armour and Gravel.
Floodwalls generally +4.5 but up to +6.0 in places

Seawall +4.5

Cyclone Surge +3.1 50 Year Frequency

Algal Mats +2.0 to +2.2

Mangroves +1.0 to +2.0

Pond Operating Level +3.15

Ground Level of Condensers +2.5 av.

Crystallisers +2.3 av.

HWS +2.0

MSL +1.10

LWS +0.2

All relative to Chart Datum = 0.00 (A.H.D. = 1.1 m)

FIG. 2
RELATION OF WALLS, TIDE, SURGE AND FLOOD LEVELS

NOT TO SCALE

ONSLOW SOLAR SALT FIELD FOR GULF HOLDINGS PTY LTD
FIG. 3
TIDAL AND SUPRATIDAL FLATS WITHIN 100 km OF ONSLOW

ONSLOW SOLAR SALT FIELD FOR
GULF HOLDINGS PTY LTD
PUMP STATION AND SEAWALL ALTERNATIVES

PS. OPTION 1 & SEAWALL A'-A
PS. OPTION 2 & SEAWALL B'-B
PREFERRED OPTION
PS OPTION 1 & SEAWALL A'-B

FIG. 4
PUMP STATION AND SEAWALL ALTERNATE LOCATIONS

LEGEND

ALGAL MAT
MANGROVES

ONSLOW SOLAR SALT FIELD FOR GULF HOLDINGS PTY LTD
**NOTE**

500m and 1000m radii shown above are measured from the western end of Clarke Pl.

**LEGEND**

- Water Tank
- Oil Tank
- Old Car Bodies

**FIG. 7**

**PROCESS AREA LOCATION OPTIONS**

**ONSLOW SOLAR SALT FIELD FOR**

**GULF HOLDINGS PTY LTD**
NORTH — WEST

Tidal flat

Supratidal Flat

Mangroves

Algal Mat

SOUTH — EAST

Offshore island / reef

Sandy beach

Coastal Island

Limestone Platform

Sandy "Island"

Quartz sand (beach dune & shallow seabed)

Coral sand

Silt and mud

Cemented quartose sand (dunes)

Limestone (coral & shelly) sand

Cemented coral limestone (coral reef & islands)

Sandy clay

FIG. 8

SCHEMATIC CROSS-SECTION SHOWING BASIC GEOLOGY AND GEOMORPHOLOGY

ONSLOW SOLAR SALT FIELD FOR GULF HOLDINGS PTY LTD
FIGURE 9  A family of noise criteria curves with a table of acceptable criteria for a variety of environments. The predicted sound pressure levels for day and night operation for Site 1 are plotted as solid lines. The broken lines show the further reduction which will typically occur between inside and outside of a domestic dwelling. These plots demonstrate that night time noise levels inside of a house will be below the threshold of hearing. Noise levels for Site 2 (the selected site) will be 5dB lower than from Site 1.

<table>
<thead>
<tr>
<th>Environments acceptable noise criteria</th>
<th>Broadcasting and recording studios</th>
<th>NC 20–25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concert and opera halls</td>
<td>NC 20–25</td>
<td></td>
</tr>
<tr>
<td>Theatres, assembly halls and churches</td>
<td>NC 25–30</td>
<td></td>
</tr>
<tr>
<td>Cinemas</td>
<td>NC 30–35</td>
<td></td>
</tr>
<tr>
<td>Hospital wards and operating theatres</td>
<td>NC 25–35</td>
<td></td>
</tr>
<tr>
<td>Homes, bedrooms</td>
<td>NC 25–35</td>
<td></td>
</tr>
<tr>
<td>Private offices, libraries, courrooms and schoolrooms</td>
<td>NC 30–35</td>
<td></td>
</tr>
<tr>
<td>General offices</td>
<td>NC 35–45</td>
<td></td>
</tr>
<tr>
<td>Mechanised offices</td>
<td>NC 40–50</td>
<td></td>
</tr>
<tr>
<td>Restaurants, bars, cafeterias and canteens</td>
<td>NC 35–45</td>
<td></td>
</tr>
<tr>
<td>Department stores and shops</td>
<td>NC 35–45</td>
<td></td>
</tr>
<tr>
<td>Swimming baths and sports arenas</td>
<td>NC 35–50</td>
<td></td>
</tr>
<tr>
<td>Kitchens</td>
<td>NC 40–50</td>
<td></td>
</tr>
<tr>
<td>Factories (light engineering)</td>
<td>NC 45–65</td>
<td></td>
</tr>
<tr>
<td>Factories (heavy engineering)</td>
<td>NC 55–75</td>
<td></td>
</tr>
</tbody>
</table>

ONSLOW SOLAR SALT WORKS
PREDICTED NOISE LEVELS FROM
WASH/PLANT STOCKPILE AREA

FIG. 9