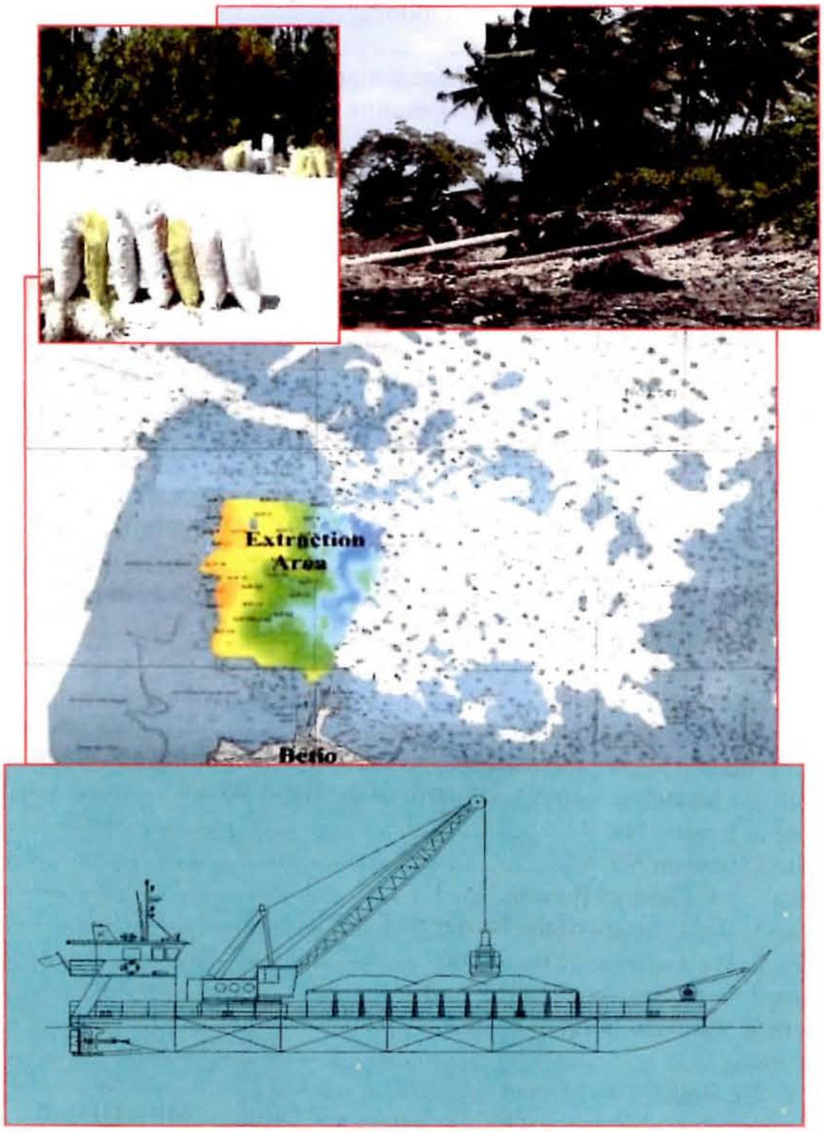
Environmental Impact Assessment Report for the ESAT Dredging Project



Edward Lovell
Biological Consultants, Fiji
Suva, Fiji
July 2011

Table of Contents

1.0 Executive summary 7
2.0 Introduction 7
2.1 Background 8
2.2 Analysis of the need for the proposed dredging activity 8
2.3 Description of the proposed activity 9
2.3.1 Design, plans and map of the operation 10
2.3.1.1 Vessel 10
2.3.2 Location, Area and Quantities of Extraction 10
2.3.3 Schedule of implementation and operation 13
2.3.4 Depots: Stockpiling and distribution 13
2.3.5 Plans for decommissioning the works 14
2.3.6 Level of noise and hours of operation 14
3.0 Environmental Impact Assessment (EIA) process and objectives 14
3.1 Environmentally significant activity 15
3.2 Technical data to allow assessment of the dredging impact 15
4.0 Field Assessment Methods 16
4.1 Manta tow 17
4.2 Point Intercept Transects (PIT) 18
4.3 Paced reef flat walks 18
4.4 Paced photo transects 18
4.5 Permanent transects 18
4.6 Permanent photo-quadrat transect 18
4.7 Sediment traps 19
4.8 Water clarity 19
4.9 Seawater temperatures 20
4.10 Salinity 20
4.11 Ambient wind and current 20
5.0 A description of the existing environment 20
5.1 Area of proposed aggregate extraction with survey, monitoring and depot sites 21
5.1.1 Site 1: Channel beacon No. 10 north of the Betio Wharf 21
5.1.2 Site 2: Beacon No. 9. 23
5.1.3 Site 3: Beacon No. 8 26
5.1.4 Site 4: NE Channel Beacon No. 3 27
5.1.5 Site 5: West margin of the barrier reef 29
5.1.6 Site 6: West margin of barrier reef 31
5.1.7 Site 7: West margin of barrier reef 33
5.1.8 Site 9: West and north of Betio's inter-tidal reef flat 35
5.2 Depot sites 37
5.2.1 Site 10: Betio Wharf Depot 38
5.2.2 Site 11: Betio Ministry of Public Works and Utilities (MPWU) yard 41
5.2.3 Site 13: Bonriki Depot 43
6.0 Baseline data 45
6.1 Sedimentation: Sediment trap assessment 45
6.2 Temperature records 46
6.3 Wind speed and direction 48
7.0 Description of the environment likely to be impacted by the proposed activity 49
7.1 The extraction site 49
7.1.1 Proposed rate of extraction 49

7.2 Coral reef, sea grasses, and soft-bottom benthos 50
7.3 The depot sites 50
7.4 Water quality 51
7.5 Ecosystem function 51
7.6 Fisheries 52
7.7 Summary of impacts on the environment 53
7.8 Intended investigations or studies of the possible impact of the proposed activity on the environment 54
7.9 An account of any similar projects elsewhere and a description of the impact, and controls used. 54
8.0 Climate change and variability 55
9.0 Controls, safeguards, standards applied for the protection of the environment 55
9.1 Managed extraction 55
9.2 Monitoring 55
9.3 Monitoring and reporting of the impact activity 56
10.0 A summary of benefits 57
11.0 Alternatives to the current extraction design 58
12.0 Rational for the proposed activity as opposed to the alternatives 58
13.0 Legal requirements 58
14.0 Community Consultations 58
15.0 Other consultation 59
15.1 Interview 59
16.0 Participants 60
17.0 References 60
18.0 Appendices 64
18.1 EIA Terms of Reference 64
18.2 Proposed vessel type with crane and clam dredge. 68
18.3 Public Consultations 73
18.4 Survey data: Compiled and archived on DVD and deposited in the SOPAC library 91
18.5 Manta tow data and description 91
18.6 Site and transect locations (GPS) 94
18.7 Sediment trap information 96
19.0 Summary of the report in the Kiribati language 98

Figures

Figure 1. Location of Tarawa Atoll, Kiribati 8
Figure 2. Proposed vessel type with crane and clam dredge. 10
Figure 3. Southwest Tarawa lagoon showing the proposed extraction site as colour-coded bathymetry annotated with the jetprobe sampling sites. 11
Figure 4. Proposed expanded extraction site with jet probe sample site numbers (after Smith & Biribo 1995). 12
Figure 5. The scale of extraction within the lagoon and relative to the atoll is shown by the small coloured area north of Betio (bathymetry from Smith, Biribo and Etuate 1995). 13
Figure 6. Location of proposed aggregate extraction and depot sites in South Tarawa. 15
Figure 7. Location of benthic survey sites. GPS locations are listed in Table 22. 16
Figure 8. A) Manta board. B) Data recording by MFMRD staff Toaea Tewatei 17
Figure 9. Location of manta tow surveys 17
Figure 10. Sediment trap No. 1 with Vemco logger (affixed below white sediment trap) at Site 1. 19
Figure 11. Secchi Disk 20

Figure 12. Location of Site 1 survey and monitoring area. GPS location is listed in Table 22. Site location beacon (insert)....21
Figure 13. Percentage of substrate types at Site 1. 22
Figure 14. A) Irregular colony of *Porites sp.* affected by silt. B) *Halimeda*-covered rock at Site 1.22
Figure 15. Silt-covered *Halimeda macroloba* dominates the living cover. 23
Figure 16. Location of Site 2 survey and monitoring area. GPS location is listed in Table 22. Site location beacon (insert)....24
Figure 17. Percentage of substrate types at Site 2. 25
Figure 18. A) Silt covered rocky substrate at Site 2. B) Quadrat showing macroalgae on rubble on sand. 25
Figure 19. Location of Site 3 survey and monitoring area. GPS location is listed in Table 22. Site location beacon (insert)....26
Figure 20. Percentage of substrate types at Site 3. 27
Figure 21. A) Rocky bottom example with algae, sand and rubble. B) The macro-algae *Padina sp.* is dominant in this Site 3. 27
Figure 22. Location of Site 4 survey and monitoring area. GPS location is listed in Table 22. Site location beacon (insert)....28
Figure 23. Percentage of substrate types at Site 4. 29
Figure 24. A) *Halimeda macroloba* and *H. incrassata* meadow. B) Hemispherical *Porites* colony on sand with macro-alga covering rock outcrop at Site 4....29
Figure 25. Location of Site 5 survey area. GPS location is listed in Table 22. 30
Figure 26. Percentage of substrate types at Site 5. 31
Figure 27. Location of Site 6 survey area. GPS location is listed in Table 22. 31
Figure 28. Percentage of substrate types at Site 6. 32
Figure 29. A) Reef outcrop in murky water. B) A *Pocillopora eydouyxi* colony in a....33
Figure 30. Location of Site 7 survey area. GPS location is listed in Table 22. 33
Figure 31. Percentage of substrate types at Site 7 on the western margin of the submerged barrier reef. 34
Figure 32. General location of transects at Site 9. GPS location is listed in Table 22. 35
Figure 33. Transect tracks at Site 9 over the inter-tidal survey area to the west and northwest of Betio. 36
Figure 34. Percentage of substrate types on the intertidal sand flat at Site 9: A) north and B) west of Betio....37
Figure 35. Site 10: Betio Wharf Depot with the suggested landfill area for storage and shore access for distribution. 38
Figure 36. Location of the Wharf Depot site with the position of the transects and sediment traps. See Table 22, Site 10 for the GPS coordinates. 39
Figure 37. Percentage of substrate types at Site 10 (Wharf Depot): A) Sand flat north of the borrow pit. B) Northern rim of the borrow pit....40
Figure 38. PWU location Site 11. 41
Figure 39. Location of the Public Works and Utilities Depot site with the position of the transects and sediment traps. See Table 22, Site 11 for the GPS coordinates. 42
Figure 40. Percentage of substrate types at Site 11. 43
Figure 41. Eastern South Tarawa showing the location and context of the Bonriki Depot site at the western end of the airport runway....43
Figure 42. Image of the Bonriki habitats and potential stockpile Site 13....44
Figure 43. Bonriki Depot site with the position of the transects and sediment traps. See Table 22, Site 13 for the GPS coordinates. 44
Figure 44. Anemone (*Cerianthus sp.*) living among the surface algae (*Enteromorpha sp.*)....45
Figure 45. Large Arenicola mound with surface algae....45

Figure 46. Sediment traps accumulation per site (mg/cm²/day). 46
Figure 47. Temperature logger (#3123) deployed at Site 1. 47
Figure 48. Temperature logger (#3872) deployed at Site 4 adjacent the channel north of the submerged reef. 47
Figure 49. Frequency of wind direction (1993-2009) (Kiribati Meteorological Bureau). 48
Figure 50. Wind speed frequency (1993-2009) (Kiribati Meteorological Bureau) 48
Figure 51. Proposed extraction area is outlined (Smith and Biribo 1995) with the amount of seafloor affected after 1-year and 5-years. 49
Figure 52. Wind rose showing the frequency of winds during the El Nino/La Nina years after Webb (2005). 50
Figure 53. Location of the sediment trap, PIT and photo transect stations. 57
Figure 54. Example of the crane to be used by the dredge ship. 72
Figure 55. Two examples of enclosed grabs with lipplate sealed jaws. 72

Tables

Table 1. Table of Abbreviations and Acronyms. 6
Table 2. Vessel specifications (see Table 15 for full specifications): 10
Table 3. Point Intercept survey for Site 1. 22
Table 4. Point Intercept survey for Site 2. 24
Table 5. Point Intercept survey for Site 3. 26
Table 6. Point Intercept survey for Site 4. 29
Table 7. Point Intercept survey for Site 5. 30
Table 8. Point Intercept survey for Site 6. 32
Table 9. Point Intercept survey for Site 7. 34
Table 10. Point Intercept survey for Site 9A. 36
Table 11. Point Intercept survey for Site 9B. 36
Table 12. Point Intercept survey for Site 10A. 39
Table 13. Point Intercept survey for Site 10B. 40
Table 14. Point Intercept survey for Site 11. 42
Table 15. List of the individuals and bodies who have been consulted. 59
Table 16. People interviewed for their views on the proposed aggregate removal. 59
Table 17. List of contributors to the report and their contact details. 60
Table 18. Vessel specifications: 68
Table 19. Manta tow 1 91
Table 20. Manta tow 2 92
Table 21. Manta tow 5 93
Table 22. Table of GPS locations 94
Table 23. Table of the sediment trap information 96
Table 24. Sediment rate calculation 96
Table 25. Sediment trap information 96

Table 1. Table of Abbreviations and Acronyms.

ACP	African, Caribbean, Pacific
ACL	Atinimarawa Co. Ltd.
ADB	Asia Development Bank
DNC	Dai Nippon Causeway
EDF	European Development Fund
EIA	Environmental Impact Assessment
ESAT	Environmentally Safe Aggregates for Tarawa project
EU	European Union
GoK	Government of Kiribati
hp	Horsepower
KAC	Kiribati Aggregate Company
KAP	Kiribati Adaptation Project
KDPP	Kiribati Disaster Preparedness Project
KIT	Kiribati Institute of Technology
km	Kilometre
KPA	Kiribati Port Authority
ktm	nautical miles
kts	Knots
l	Litres
m	metres
MELAD	Ministry of Environment, Lands, Agriculture Development
MFMRD	Ministry of Fisheries and Marine Resource Development
MPWU	Ministry of Public Works and Utilities
MPWU	Ministry for Public Works and Utilities
NGO	Non-Governmental Organization
PIT	Point Intercept Transect
PVC	Polyvinyl chloride
SCUBA	Self Contained Underwater Breathing Apparatus
SOPAC	Pacific Islands Applied Geoscience Commission
SPC	Secretariat of the South Pacific Community
SPREP	Secretariat of the Pacific Regional Environmental Programme
t	Tonnes

1.0 Executive summary

There is an increasing need for sand and gravel for building materials in Tarawa and on other atolls. However, supplies from overseas are expensive. Furthermore, the mining of local beaches contributes to coastal erosion and lacks sufficient quantities for the current and future requirements. An answer to these problems is to source supplies from the lagoon. A purpose-built vessel capable of dredging lagoon aggregates in Tarawa and further afield is available through a European Union grant. A proposed extraction site is located adjacent to the submerged western barrier reef north of Betio Island. The resource is large (est. >50 years' supply).

Environmental assessment of the resource area revealed the living cover to be algal-dominated with a low biodiversity. A natural turbid environment has pre-conditioned the biological community to chronically high silt loads, minimising the dredging impact created by the resuspended sediments. The overall impact of the dredging on the general area is thought to be low due to the amount of aggregate required in terms of both daily activity and total annual extraction, while the specialized clamshell grab and side release spillover design is thought to limit the sediment plume. Complementing the EIA, an additional survey is to be undertaken by the Kiribati Dept. of Fisheries in concert with the Secretariat of the Pacific Community (SPC) to assess the nature, productivity and impact on the local fisheries. As part of the mitigation process, the dredging location will be positioned to minimise impact on sensitive fishery habitats. Alternative areas are considered to provide site flexibility in the event the operation has unacceptable effects on the environment or fishery.

2.0 Introduction

The proposed aggregate extraction site is located within Tarawa Lagoon (Figure 1). The area is on the eastern portion of the submerged barrier reef north of Betio, South Tarawa (Figure 5).

Sand and gravel are essential materials for construction whether it is roads, dwellings or other works requiring fill or cement. Though blessed with a number of atolls where clean seawater and marine resources are in abundance, Kiribati has limited land. Islands of carbonate aggregate material occur along the atoll rim, with the floor of the central lagoon composed of reef rock, sand and rubble.

Out of necessity, there has been extensive removal of aggregate resources (i.e. sand and gravel) from the South Tarawa beaches. This has proved problematic as it interferes with the natural coastal processes that maintain protection for the land. This protection is being compromised by the beach mining (Howorth 1982, 1983; Webb 2005b; SOPAC 2007). Alternative aggregate resources of sand and gravel are found subtidally within the atoll's lagoon. It is the objective of this study to conduct an environmental impact assessment (EIA) regarding the use of this material.

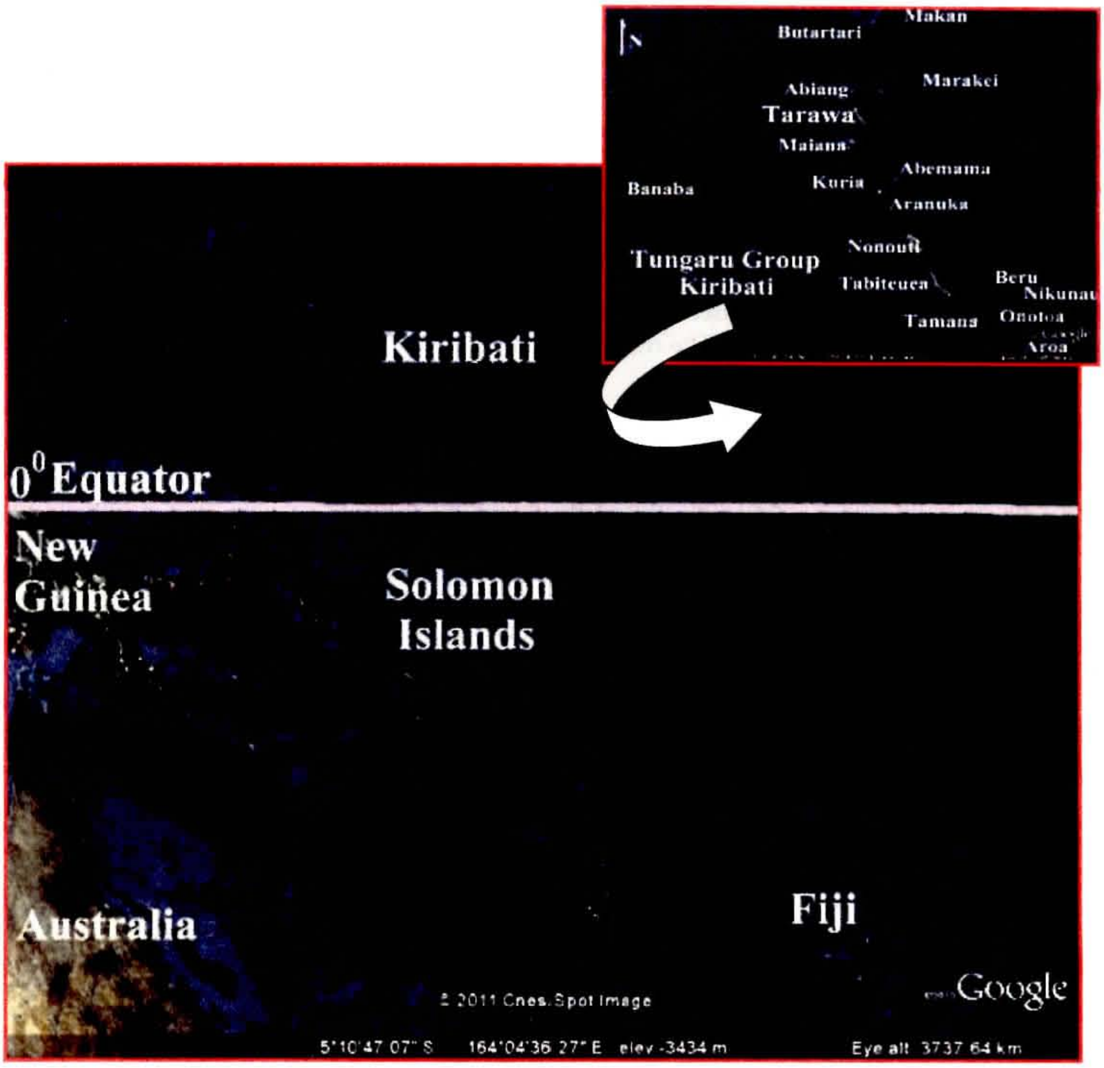


Figure 1. Location of Tarawa Atoll, Kiribati

2.1 Background

Substantial research relating to the current issue of aggregate extraction and the EIA study has been conducted over the past 30 years. This has been collated and reviewed for background information on the need for an alternative aggregate resource (Howorth 1982, 1983; Forbes and Hosoi 1985; Gillie 1993; Webb 2005; Greer 2007a, b), the nature of the lagoon resource (Biribo and Smith 1994; Richmond 1990; Smith and Biribo 1995) and the economic feasibility and environmental impact of the proposed extraction (Cruickshank & Morgan 1998; Damlamian 2008).

2.2 Analysis of the need for the proposed dredging activity

Aggregates from terrestrial sources necessary for construction are in short supply and are presently imported or taken from local beaches. The latter is unsustainable and impacting on the natural coastal processes (SOPAC 2007; Forbes and Hosi 1985; Forbes and Biribo 1995; Webb 2005). Studies indicate that the magnitude of this land-based extraction is of serious concern. Greer (2007a, b), in their economic analysis of aggregate mining, found that there was substantial extraction from beaches by households (70,000m^3/yr.). Such activities threaten coastal protection by removing the sand barrier, and affect the dynamics of the natural coastal current-borne sediments and processes that maintain a stable, protective shoreline. In addition, local construction firms and Government remove material from permitted sites as well as import more to fulfil an annual requirement for aggregate construction material of 82,500m^3/year. This is projected to increase 5-7% for South Tarawa, annually (Greer 2007a, b). This rate is substantiated by the increase in the population for South Tarawa from 43,000 in 2005 (i.e. 43% of the total population (100,743) (CIA, 2011)) to 50,010 in 2010 (Anon, 2010), representing 5.6% annual growth.

In considering the current and future state of coastal barriers, Maharaj (2000) highlighted the need for understanding beaches, beach dynamics and nearshore processes within the framework of coastal hazards and risks from erosion, its processes and hydrodynamic aspects of nearshore environments. He discussed engineering in the Tarawa coastal zone with reference to current port and harbour development in South Tarawa and the Dai Nippon Causeway (DNC). Coastal protection structures were illustrated as were construction material used along the shorefront.

Webb (2005a) assessed the coastal processes in three areas of critical infrastructure threatened by erosion. Demonstrating longer-term changes in the coastal beaches and recognizing the potential for climate change-related influences, beach mining is highlighted as an important contributing cause. Currently, a substantial quantity of aggregate is required for the remedial coastal defence of the Tunguru Hospital, Nanikai-Bairiki causeway, and protecting the eastern end of the Bonriki Airport. Additional to these requirements are the proposed World Bank/Asia Development Bank (ADB) main road upgrade and, with the current rate of sea level rise and increased storm action, the continued need for seawalls. Housing and general building requirements further prompt the need for an alternative offshore aggregate source. Cessation of all beach mining is highly recommended.

Costs of aggregates are varied. The household collection forms the bulk of the current supply with a sale value of \$50/m^3 but at a high environmental cost borne by the residents of South Tarawa. Imported material is more that twice that figure at \$104/m^3. This expense will have to continue for the more durable forms of aggregates (silicates) but, for the most part, would be reduced by the use of locally sourced material estimated at a cost of around \$58/m^3 (Greer 2007a).

2.3 Description of the proposed activity

The proposed utilisation of lagoon-based aggregate material entails the removal of subtidal sand, gravel and larger-sized aggregates from an extensive resource area identified by the Pacific Islands Applied Geoscience Commission (SOPAC) that is north of Betio I. This is to be accomplished by a large capacity ship, fitted with a crane and a clamshell-style bucket for extraction, with the aggregate transported to depots on shore.

The designated area north of Betio represents the potential for progressive extraction of aggregates to meet the needs of South Tarawa for more than 50 years at the present rate of consumption. With the current requirement for extraction, 2% annually will be methodically removed from the proposed resource site (Figures 4, 5, 51).

2.3.1 Design, plans and map of the operation

2.3.1.1 Vessel

The dredging operation is to be run by a Government of Kiribati-owned company, Atinimarawa Co. Ltd. (ACL) and carried out by a purpose built vessel. It is fitted with a crane and clamshell grab system. It can also be fitted with a pumping system with greater capacity for specialised purposes such as coastal reclamation. The vessel can carry cargo and has oceanic capabilities allowing it to be used in the outer islands of Kiribati and in other Pacific Island countries. The ship's outline and a summary of the ship's details are shown in Figure 2 and Table 2. Full details of the vessel, crane and grab set-up are in Appendix 18.2

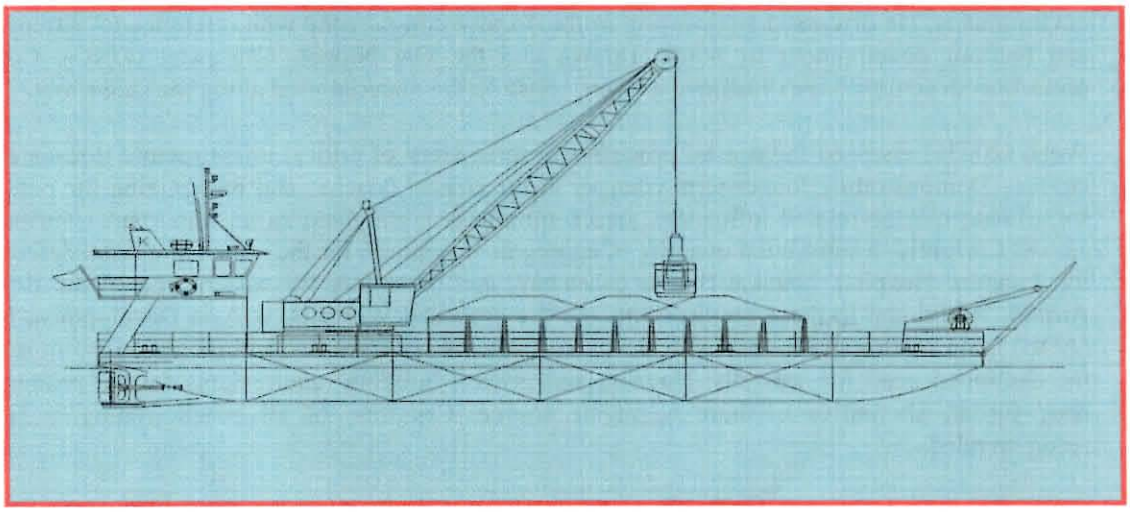


Figure 2. Proposed vessel type with crane and clam dredge.

Table 2. Vessel specifications (see Table 15 for full specifications):

Length overall	36.00m
Beam (mld)	12.00m
Depth (mld)	2.40m
Power	2X350hp
Service speed	7.5kts
Fuel	20,000l
Full displacement	780t

The general operation is for the port-moored vessel to travel daily to the resource area to remove aggregate and transport it to depot sites for processing and stockpiling. The sand, gravel and cobbles will be available to Government, industry and the public from these locations on shore.

2.3.2 Location, Area and Quantities of Extraction

The proposed aggregate extraction area is located 0.5-3.3km north of Betio I. and is shown in Figure 3 as the coloured image. It occupies an area of approximately 5.6km^2. This is 1.6% of the entire lagoon. The area proposed by Smith and Biribo (1995) is approximately 41% of this area measuring 2.27km^2. The volume of the sediments is in water depths of 1.0-12.5m and has been assessed to contain 5.2 million m^3 or the equivalent of 63 years' supply at current usage (Greer

2007a, b). With the projected increase in requirements, the resource supply would be substantially less with the requirement estimated to double to 165,000m^3 in 20 years. This area is delineated in Figure 4.

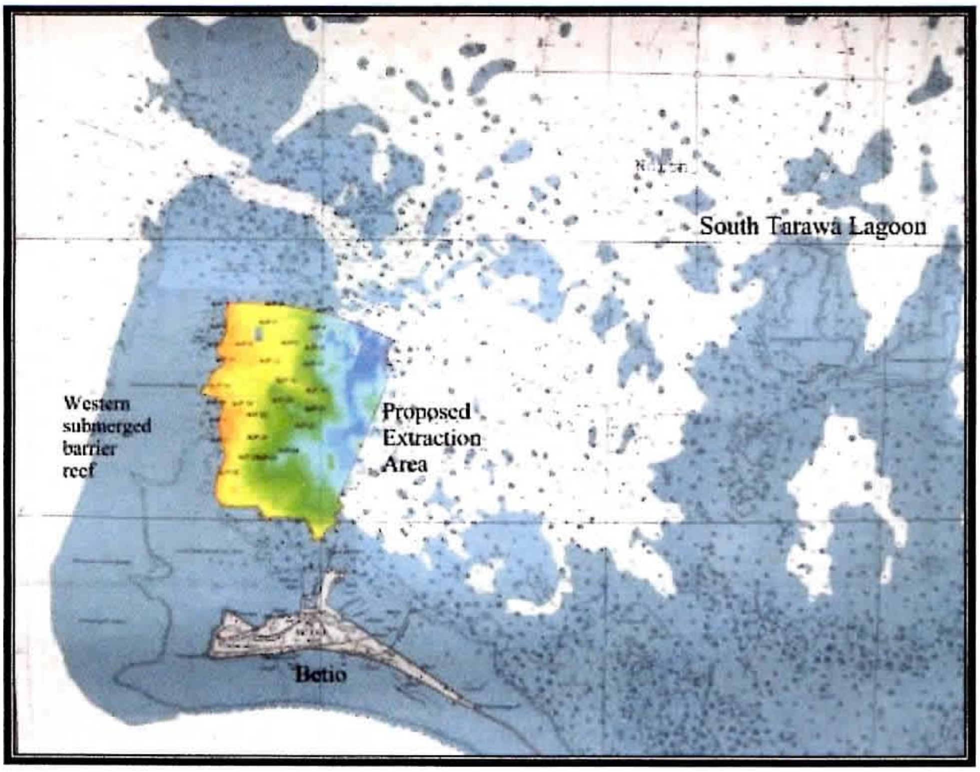


Figure 3. Southwest Tarawa lagoon showing the proposed extraction site as colour-coded bathymetry annotated with the jetprobe sampling sites.

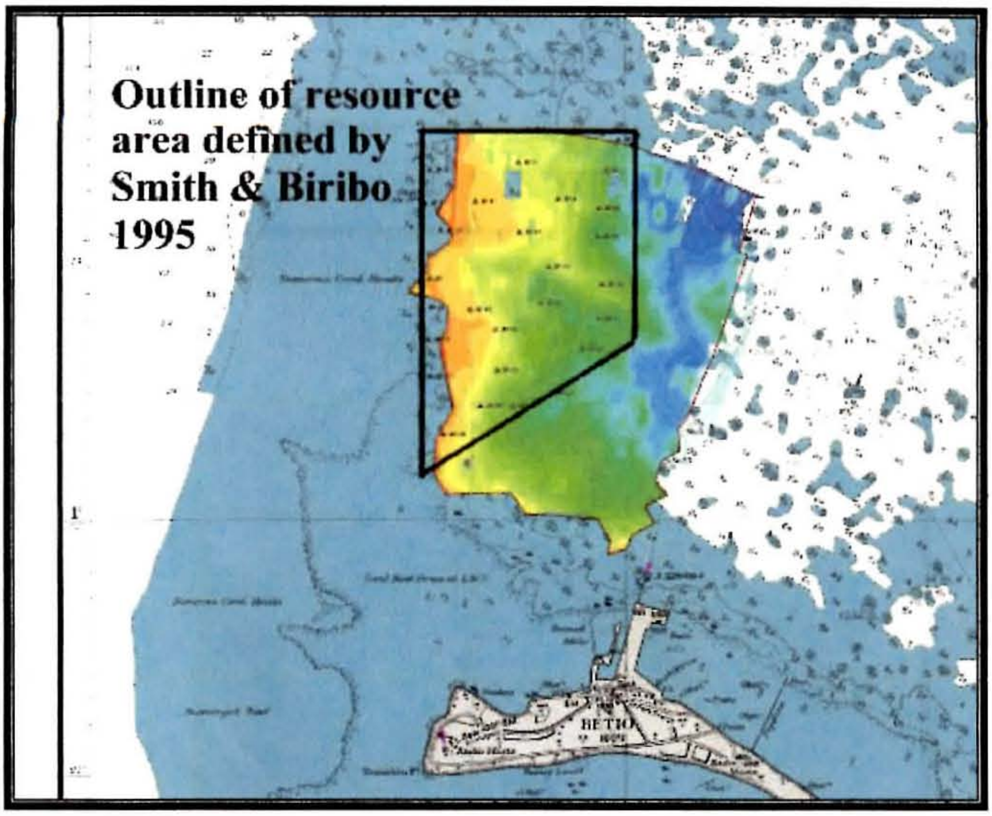


Figure 4. Proposed expanded extraction site with jet probe sample site numbers (after Smith & Biribo 1995).

In Smith and Biribo (1995) aggregate resources in the Tarawa Lagoon were identified and mapped for two alternative aggregate sites. The resource in Figure 4 was described in terms of bathymetry and the depth profile of the resource based on the jetprobe sampling. They obtained samples for grain size analysis, and determined sediment thickness, distribution and composition. Potential volumes of the resources were estimated. According to the sediment assessment, the resource is variable in composition depending on location. Determining the area for extraction will depend both on the nature of the aggregate, current demand and fishery sensitivity. Considering Tarawa Lagoon has an area of $359km^2$ (Damlamian 2008), the area of extraction is 0.69% of the entire lagoon. Figure 5 illustrates the relative size of the area.

Five other areas both in and outside the lagoon would also provide alternative aggregate resources (Cruickshank and Morgan 1998), though they have not been assessed for composition nor environmental impact. They are located further from South Tarawa, thereby increasing operation costs.

Figure 5. The scale of extraction within the lagoon and relative to the atoll is shown by the small coloured area north of Betio (bathymetry from Smith, Biribo and Etuate 1995).

2.3.3 Schedule of implementation and operation

The construction of a barge fitted with a crane is underway requiring 6-9 months with the vessel ready for operation by mid-2012. It is estimated that the channel and fill works for the depot sites will be carried out during the barge construction period.

2.3.4 Depots: Stockpiling and distribution

Three depot areas are being considered as part of this EIA with the view that some coastal modification will be required, which may involve reclamation to provide for stockpiling and the deepening of a channel for vessel access (Figure 6). They are adjacent to the wharf (Site 10), at the existing PWD aggregate yard (Site 11) and at Bonriki (Site 13). Other sites between Betio and Bonriki will be considered based on the practical aspects of accessibility and product demand once the dredge is in operation.

For the proposed depots, there is a pre-existing shallow channel and ponded borrow pit which would limit the degree of coastal modification required. The location of these areas will allow more efficient distribution of the aggregate material without the need for road transport from a single site, such as the Betio wharf area at the western end of the atoll.

2.3.5 Plans for decommissioning the works

The size of the resource has been estimated to last 63 years at current demand. Other sites have been identified, which could extend the operation further into the future. The life of the current dredging unit is estimated to be 40 years.

With the ever-increasing population and desire for development, there are no plans for decommissioning the operation, as the aggregate resource in the lagoon will be required for the foreseeable future.

Full restoration of functional properties such as benthic productivity and trophic relationships are desirable objectives once the extraction is complete. Penn (1983) provides guidelines for promoting rehabilitation. Pelesikoti (2007) recommends site closure to be based on the exhaustion of the resource.

2.3.6 Level of noise and hours of operation

The operation of the dredging is intended daily Monday to Friday, on Saturday if required with cessation on Sunday. The period of operation is based on demand but is envisaged to be only an hour of dredging per day to fill the barge. The daily-cycle duration is estimated at one hour preparation, one hour travel, one hour dredging to fill to capacity, travel to the depot, return to harbour for refuelling, restocking, clean-up and maintenance (approximately 8 hours in total). Its travel time is dependent on the stock requirements but it will generally return to one of three depot areas along South Tarawa to deposit its load and then return to the harbour for mooring security. For a smaller capacity grab, Cruickshank and Morgan (1998) estimated 2hrs./day transport, 3hrs./day dredging and 3hrs./day unloading using a suction pump and smaller unit. They estimated cost on 250 operating days per year.

As the extraction location is offshore and operating during normal working hours, noise is not considered an issue. Transporting the sediment load to depot areas onshore and unloading the cargo should also be within working hours and not exceed acceptable limits of noise.

3.0 Environmental Impact Assessment (EIA) process and objectives

The EIA involves several activities and follows the terms of reference in Appendix 18.1. Published reports relating to the proposed dredging were reviewed. A field study of the proposed aggregate extraction site and peripheral areas were then undertaken over a 21-day period. Government departments were contacted to seek their views of the proposed dredging operation. Subsequently over an 18-day period (March 4-18, 2011), community consultation was undertaken to both explain the dredging program and elicit their views on the project.

The study is subject to 4 main areas of investigation: i) A description of the existing biological and physical environment in the designated extraction area plus the 3 proposed depot sites to be used for stockpiling and commercial access (Figures 6 and 7); ii) Assessment of the likely impacts at the extraction and depot sites; iii) Assess options for the mitigations of impacts; and iv) Recommend monitoring of the impacting factors and the biota at risk. Planning guidelines for sustainable development and management of offshore aggregates dredging (Pelesikoti, 2007) complemented the terms of reference. The assessment of the fishery in proximity to the dredging will be undertaken in a joint study by the Dept. of Fisheries and the SPC. Their assessment will provide information on the nature of the fisheries, and their importance to the subsistence and artisanal fishers of South Tarawa. A monitoring program will be employed for the duration of the extraction.

Figure 6. Location of proposed aggregate extraction and depot sites in South Tarawa.

The EIA process involves working closely with the Ministries of Fisheries & Marine Resource Development (MFMRD) and that of Environment, Lands, Agriculture Development (MELAD) during the fieldwork and the consultation program.

3.1 Environmentally significant activity

The environmentally significant activity is the disturbance of the sea floor through the removal of the substrate. Additionally, the removal re-suspends sediments that are transported by currents, increasing the effect of the dredging on nearby communities.

3.2 Technical data to allow assessment of the dredging impact

The dredge will be fitted with three clamshell grabs, which differ in size and design. To varying degrees, each has features to reduce the sediment plume. The most environmentally friendly is a closed bucket, which reduces any spillover of sediment-laden water during sediment removal. Once on board, this excess water is re-piped to the bottom for disposal. The other two will be open buckets with side plates affixed to limit spillage on retrieval. The closed version is to be used in areas where there are a high proportion of fine sediments. The others are to be used in areas of rock, cobbles and course sands.

Cruickshank and Morgan (1998) modelled the deepening due to extraction as potentially increasing coastal storm wave damage and concluded it to be inconsequential. They also confirmed the resource size by providing an alternative analysis to that of Smith and Biribo (1995).

Damlamian (2008) has developed a hydrodynamic model for the water circulation of the Tarawa Lagoon. Complementing this is a dispersion model based on a suction dredge design, which creates a more extensive plume than the clamshell design and represents an extreme plume pollution scenario. Despite this, the plume density was within acceptable limits in all but one case. The prediction of the behaviour of the plume, with regard to both spatial behaviour and intensity at different locations within and around the resource area, indicates acceptable impact. This is expected since the clamshell approach is being employed with modifications to make it more environmentally friendly.

4.0 Field Assessment Methods

A field assessment program was undertaken to determine the nature of the living communities and physical aspects of the marine environment. This data adds to previous research to provide a more comprehensive understanding on the circumstances surrounding the nature of aggregate removal. Particularly, this information complements the hydrographic studies (Damlamian 2008; Damlamian and Webb 2008) and provides baseline information on ambient conditions for monitoring during the dredging period.

The biological communities were identified and described (e.g. coral reefs, algal assemblages, seagrasses and soft bottom benthos) in the proximity of the proposed aggregate resource and at the three depot sites located along South Tarawa. Various methodologies were used. Larger areas were assessed using manta tows. For the extraction area, description was made using self-contained breathing apparatus (SCUBA) and snorkelling to conduct Point Intercept Transects (PIT), photo-quadrat transects and general inspection at 8 sites offshore and inter-tidally (Site 9) north of Betio. The establishment of permanent and photo transects served both in baseline description and as a basis for monitoring.

Figure 7 shows the locations of the study sites. The GPS locations for these sites and elsewhere are found in Table 22, Appendix 16.6. Permanent transects were established at stations 1-4 along the eastern portion of the barrier reef. Point Intercept Transects were conducted at each site. Manta towing complemented this information with broader observations.

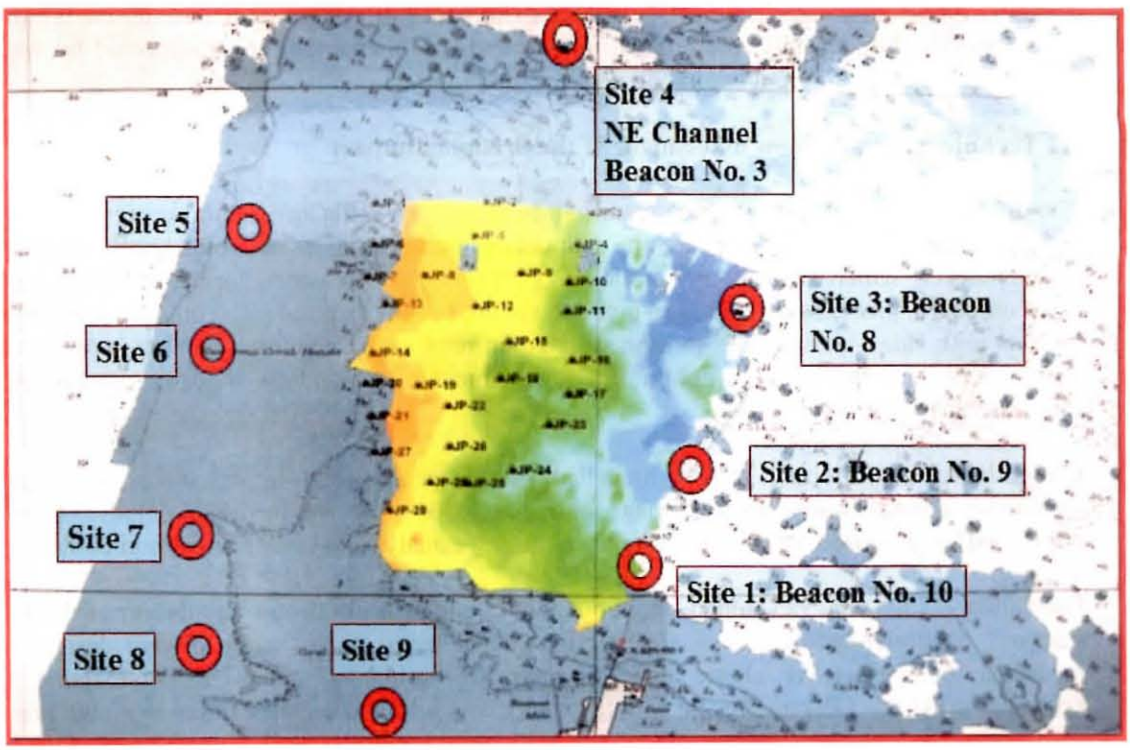


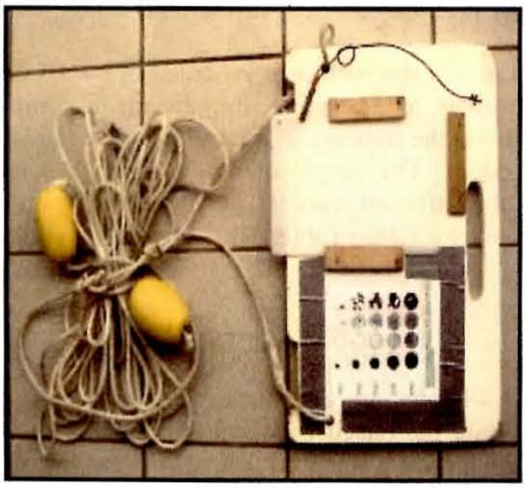
Figure 7. Location of benthic survey sites. GPS locations are listed in Table 22.

Environmental information was gathered through paced walks on the inter-tidal reef flat west and north of Betio and at the three depot sites (Figure 6). Additionally, the depot sites were subject to swimming and photo transect description. Sediment trap stations, comprising five traps each, were established in both the extraction and depot areas (Appendix 18.7; Tables 23-25). Sea surface temperatures, water clarity, and salinity measurements were recorded.

4.1 Manta tow

Manta towing was used to provide a rapid and broad-scale inspection of the marine areas (English et al. 1997). The diver, holding onto the manta board (Figure 8), is towed behind a boat and records observations on a plastic slate aided by a percentage cover scale with examples. Progress along the transect is noted by a driver and observer on board the boat, which stops every 2 minutes for the diver to record general and benthic observations. The location of the transects are shown in Figure 9.

A)



B)

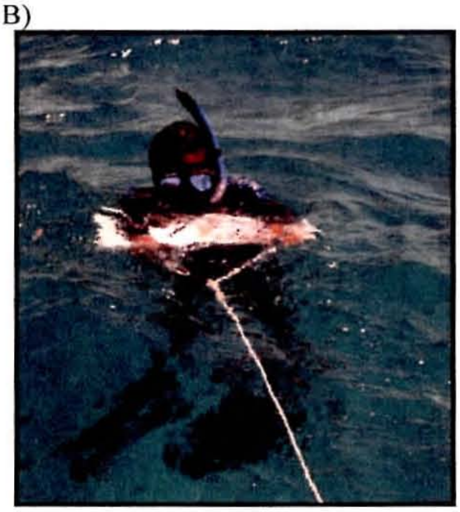


Figure 8. A) Manta board. B) Data recording by MFMRD staff Toaea Tewatei

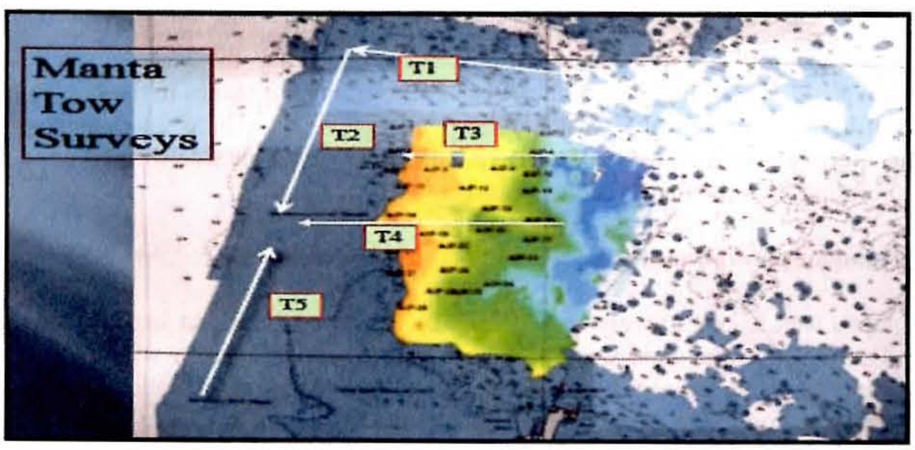


Figure 9. Location of manta tow surveys.

The results of the manta tow surveys revealed the broad-scale picture of the marine environment and are summarised in Appendix 18.5; Tables 19-21.

4.2 Point Intercept Transects (PIT)

Point intercept transects were employed to assess the percentage of benthic organisms. The assessment is made by laying a 20m transect line over the substrate and assessing the type of substrate or living items under the tape at 0.5 m intervals. In some instances and for all of the permanent transects, the Pacific Point Intercept method was used whereby benthic attributes are assessed at 0.5 m distances on either side of the tape as well as under it (Hill and Wilkinson 2004). Several transects were conducted at designated sites. The location of the assessment station was noted by GPS. The data points are then entered into a spreadsheet to determine the relative percentages of the benthic composition. These PIT's were employed at the offshore sites 1-9 around the perimeter of the barrier reef (Figure 7).

4.3 Paced reef flat walks

Paced reef flat walks are similar to the PITs in that the surface is recorded every 10 or 20 paces and like the PIT data, entered into a spreadsheet to determine the percentage composition of physical and biological features at intervals along the transect. The walks were conducted at low tide from the shore to the lagoon water's edge. The length of stride for each surveyor was averaged over a 10m length to determine the different transect lengths. The positions at the beginning and end of the transects were noted by GPS (Table 22). The general locations are shown in Figures 36, 38, 39.

4.4 Paced photo transects

This approach complements the paced walks. Photos are taken at a constant distance from the surface approximating an area of ¼ m^2. While the paced transects are conducted from shore lagoonwards, the photo transects start from the lagoon water's edge to shoreward, finishing at the spring high water mark.

4.5 Permanent transects

Three permanent PITs were established at sites 1-4 along the eastern side of the proposed extraction area. These entailed affixing 14mm reinforcing bar stakes in the beginning and end of a 20m transect tape. The tape was laid from east to west. Three assessment points per 0.5m segment were recorded as well as two perpendicularly on either side of the tightly stretched tape. This is referred to as the Pacific Point Transect.

4.6 Permanent photo-quadrat transect

Photographs were taken at every metre along the permanent transect lines on the right side of the tape. The replicate quadrats were ¼ m^2. The images were taken with an underwater-housed Canon digital camera fitted with a 20mm lens. The locations of both the permanent PITs and photo transects along with the sediment trap stations are shown in Figure 7 at sites 1-4.

4.7 Sediment traps

Five sediment traps were established at each site in the extraction and depot areas. They were constructed of 55mm diameter PVC tubes with a 12 x 5.5 cm cloth insert of a polyester 43T monomesh. The inserts had a cloth lip that fitted neatly over the tube opening and was secured with a cable tie with the opening oriented vertically. The tube was affixed to a 14mm re-bar stake, 20cm above the substrate at 7m depth at Sites 1-4 adjacent the extraction area. For the proposed depot areas, the sediment traps were placed in the ponded water of the borrow pits at depths of 0.3m at low tide.

Figure 10. Sediment trap No. 1 with Vemco logger (affixed below white sediment trap) at Site 1.

The sediment trap sleeves were deployed and retrieved over different periods (7-10 days) due to logistical considerations. The inserts were frozen for preservation until post-processing. The sleeves were dried in an Isuzu drying oven (EGA52A) at $50C^0$ for 36 hrs. The pre-weighed sleeves were re-weighed using a Libror (AEX-2006) Shimadzu electronic balance. Pre-weighed zip- lock plastic bags were used to contain the cloth inserts and any material that may escape the bag during drying or weighing.

4.8 Water clarity

Comparative water clarity was determined by using a 27cm diameter Secchi disk with a graduated line (0.5m). The disk was deployed over the side of the boat at each station. The depth was recorded at the moment the disk disappears from sight.

Figure 11. Secchi Disk

4.9 Seawater temperatures

Seawater temperatures were assessed using Vemco temperature loggers (Figure 10), which recorded every 30 minutes. The loggers were placed in association with the sediment trap stations at 7m depth at Site 1, 1km offshore from the Betio Wharf and at Site 4 a distance of 4.75km further to the north at 6.5m depth (Figure 7). The duration of the recording was from Thursday January 13 to Monday January 24, 2011. The loggers were calibrated and error applied (Figures 47, 48).

4.10 Salinity

Salinity was recorded using an Atago hand refractometer. The samples were taken from the surface water at each site during the survey period.

4.11 Ambient wind and current

Wind speed was estimated from the sea state. Current was estimated from the surface water flow and the angle of Secchi disk line during deployment respectively. In both cases, directions were noted using uncorrected compass bearings.

Meteorological information was collated from previous reports (Cruickshank and Morgan 1998, Damlamian 2008; Webb 2005 (Figure 52)) and from the Kiribati Meteorological Bureau (Figure 49, 50).

5.0 A description of the existing environment

Atolls by their very nature are coral reefs that have kept pace with vagaries of island subsidence and sea level fluctuations (Marshall and Jacobson, 1985). The coral reefs of Kiribati were described in Lovell et al., 2000, 2002. A description of Tarawa Lagoon was conducted by Paulay and Kerr (1994, 2001). They found the biodiversity decreased from north to south with the southeast area of Temaiku Bight the least diverse. Similarly, the area of extraction north of Betio was low in terms of species numbers relative to similar habitats in areas further northward.

The Tarawa Lagoon is characterised by a supra-tidal rim with a broad shallow lagoon. It is unusual in that its western barrier reef rim is subtidal. Lovell et al. (1999) has described the coral reefs of both Tarawa and Abiang atolls.

5.1 Area of proposed aggregate extraction with survey, monitoring and depot sites

The proposed aggregate extraction area is described in Section 2.3.2 *Location, Area and Quantities of Extraction*. The resource assessed by jetprobe sampling, is composed of gravels (17.2%) and gravelly sand (6.9%). The sediment composition is 1) shell and coral detritus, 2) *Halimeda* fragments, 3) Foraminifera test, 4) Fine calcium carbonate sediments (Smith and Biribo, 1995). Additionally, there are extensive areas of coral reef rock and cobbles occurring to varying degrees along the eastern perimeter of the submerged barrier reef.

5.1.1 Site 1: Channel beacon No. 10 north of the Betio Wharf

Site 1 is the most inshore location, approximately 0.8km north of Betio wharf on the SE corner of the proposed extraction area (Figure 12). It is located by navigational beacon No. 8.

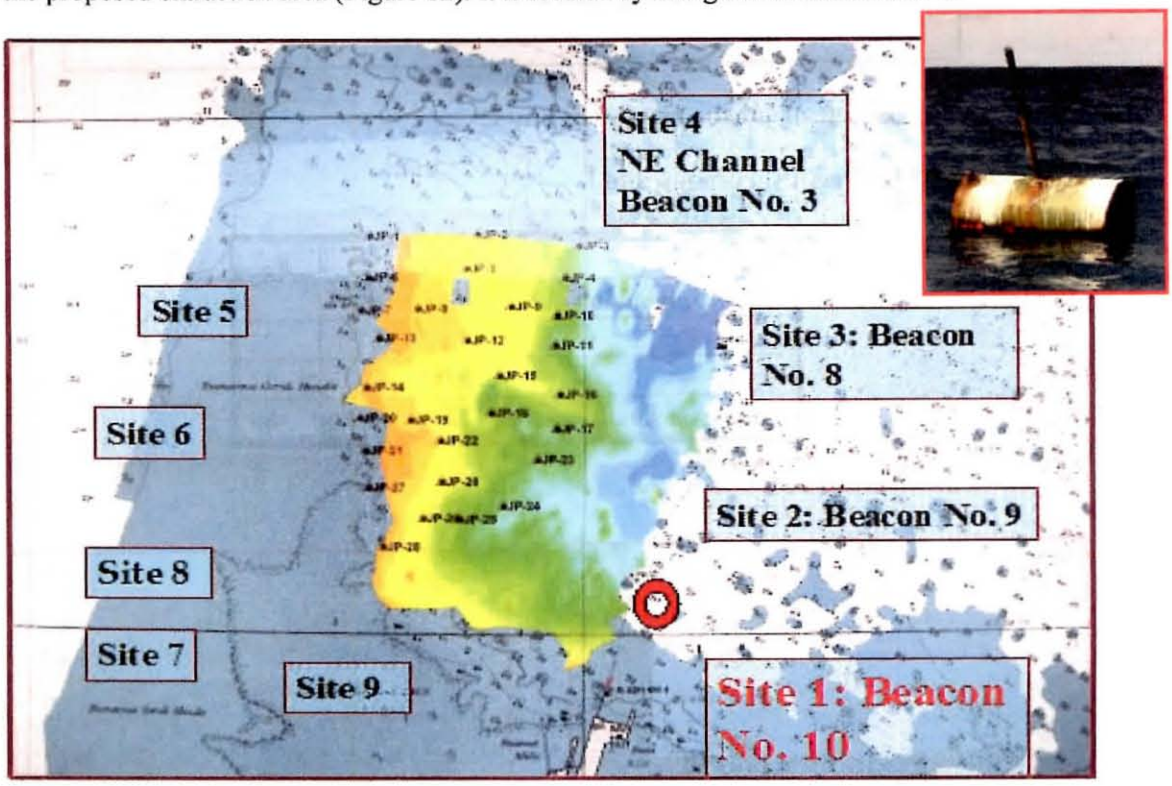


Figure 12. Location of Site 1 survey and monitoring area. GPS location is listed in Table 22. Site location beacon (insert).

The substrate is mainly small rubble on sand and includes larger rocks. The dominating biota are 3 species of Halimeda algae (*H. macroloba, H. opuntia, H. incrassata*) with 23% living cover (Figure 13; Table 3). There was only 2% living coral, which comprised a few massive *Porites spp.* These colonies appeared to be silt-affected, with dead patches over the colony making the normally hemispherical growth form irregular. 64% was small rubble on sand, with 11% rocky outcrops and coral boulders (Figures 14A, B).

Water temperatures were +0.54^{0}C warmer than at Site 4. This was considered due to the embayed location and proximity to shallow depths (Figures 47, 48).

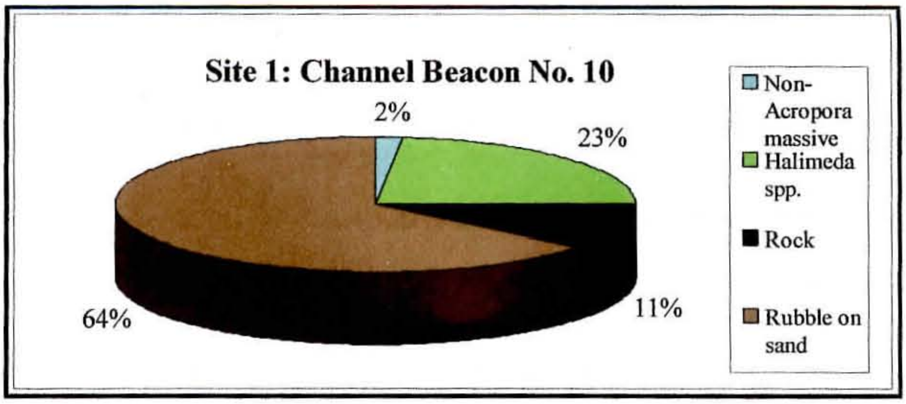
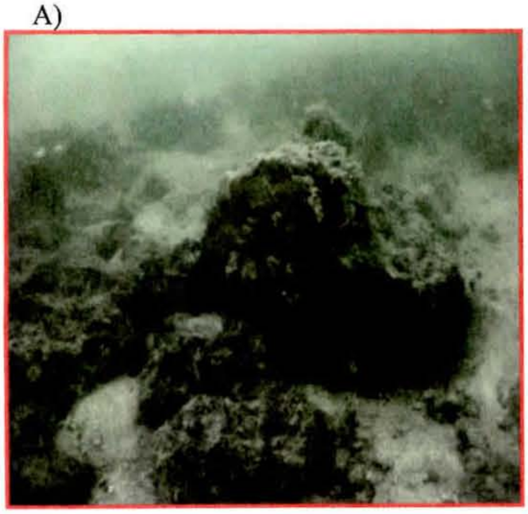


Figure 13. Percentage of substrate types at Site 1.

Table 3. Point Intercept survey for Site 1.

Substrate type	**Mean**	**SD**	**%**
Non-Acropora massive	0.33	0.58	2
Halimeda spp.	4.33	3.21	23
Rock	2.00	2.00	11
Rubble on sand	12.00	7.00	64

A)



B)

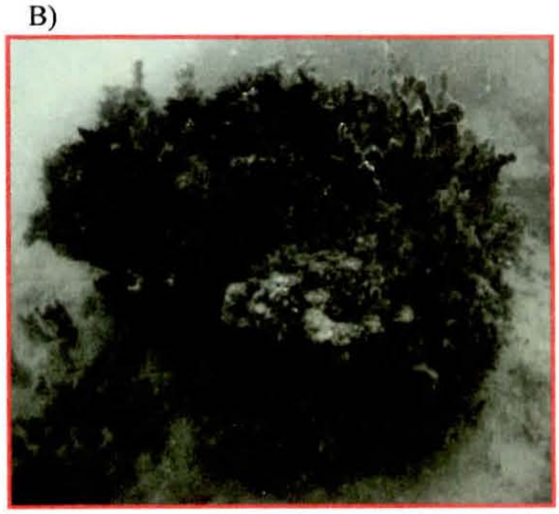


Figure 14. A) Irregular colony of *Porites sp.* affected by silt. B) *Halimeda*-covered rock at Site 1.

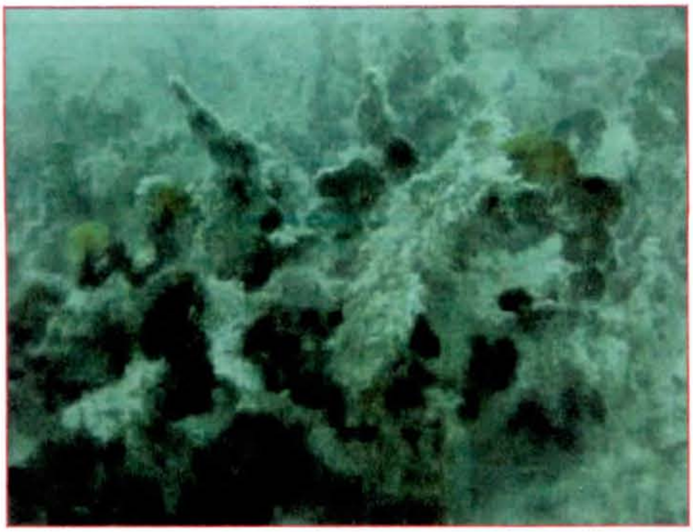


Figure 15. Silt-covered *Halimeda macroloba* dominates the living cover.

Modelling of the sediment plume for suction pump dredging by Damlamian (2008) has determined that the removal of aggregates from this area would result in greater suspension of fine sediments due to the silty nature of the substrate. These levels are well above acceptable levels for coral tolerance but are in an area of very low coral cover. Importantly, the suction pump system relies on a slurry transport of sediment and creates a much larger plume than the utilised grab system. As such, his model represents an extreme effect by comparison with the system to be employed.

During inspection, visibility was very poor, and likely due to the proximity of the shore and being embayed by the coast and the inter-tidal southwestern barrier reef. The prolific *Halimeda spp.* was covered by fine sediment (Figure 15).

5.1.2 Site 2: Beacon No. 9.

This site is 450m to the NE of Site 1 (Figure 16). It is situated by navigational beacon No. 9. Visibility was poor at both sites 1 and 2. These sites were marked by permanent navigational surface beacons so that the monitoring sites at the base could be reliably located.

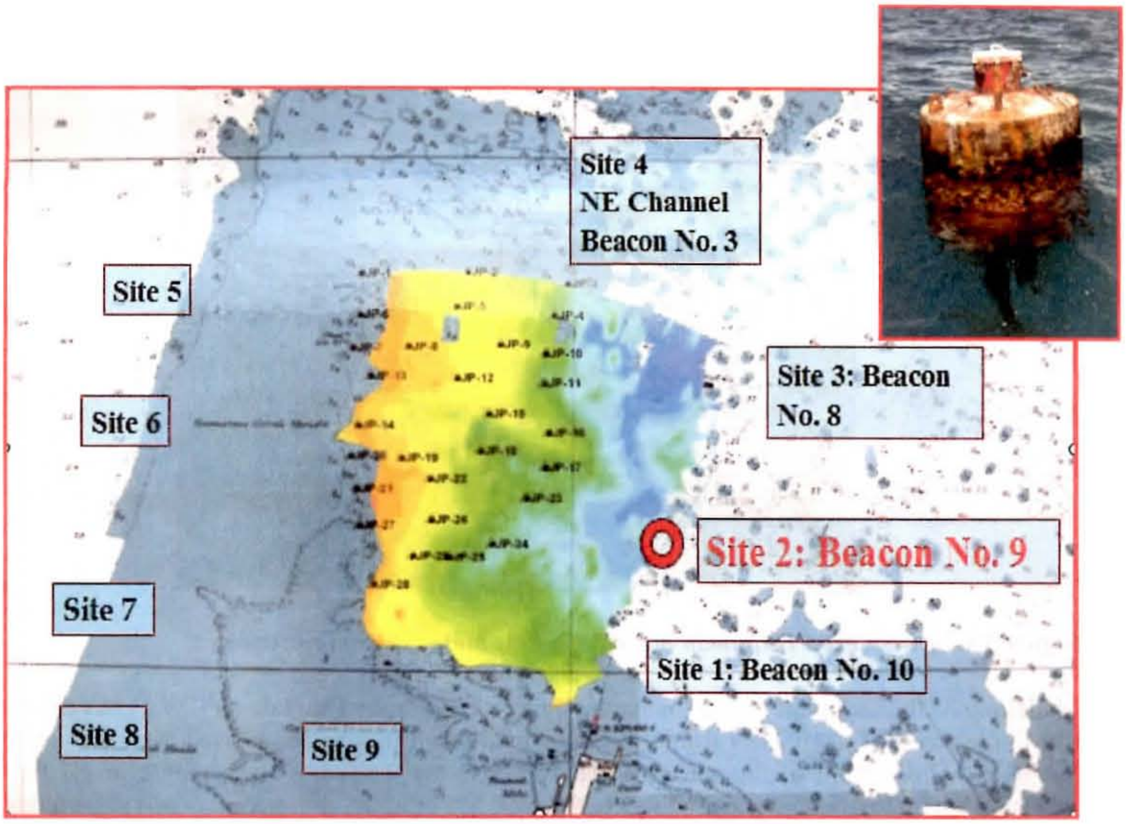


Figure 16. Location of Site 2 survey and monitoring area. GPS location is listed in Table 22. Site location beacon (insert).

The substrate is predominately sand (33%) and rubble (20%). The dominate benthic cover is the algae *Halimeda spp.* (41%). Rocky substrate comprised 6% (Table 4, Figures 17-18).

Table 4. Point Intercept survey for Site 2.

Substrate	Mean	SD	%
Halimeda spp.	15.00	1.73	41
Rock	2.00	0.00	6
Rubble	7.33	3.21	20
Sand	12.00	2.65	33

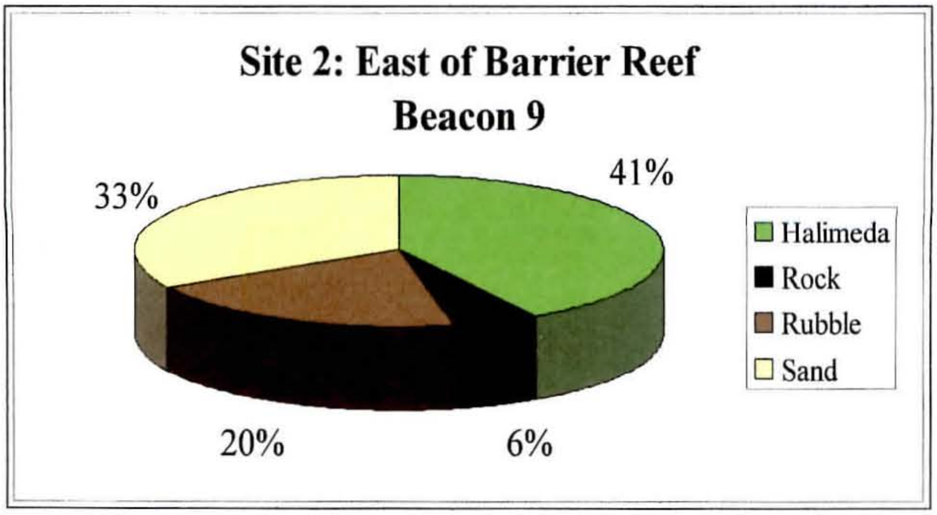


Figure 17. Percentage of substrate types at Site 2.

A)

B)

Figure 18. A) Silt covered rocky substrate at Site 2. B) Quadrat showing macroalgae on rubble on sand.

5.1.3 Site 3: Beacon No. 8

This site is north of Site 2, midway along the eastern side of the barrier reef.

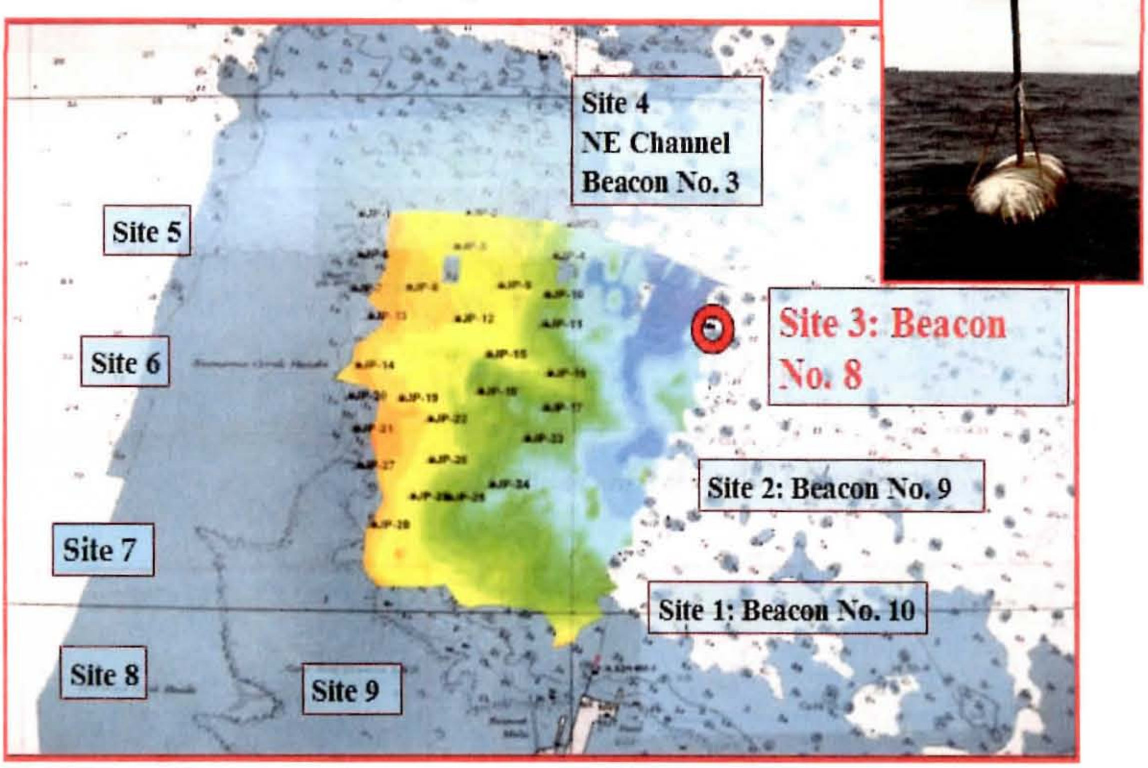


Figure 19. Location of Site 3 survey and monitoring area. GPS location is listed in Table 22. Site location beacon (insert).

The sand substrate is 31%, rubble 8% and rock 7%. The algae are *Halimeda spp.* (18%) and mixed macroalgae (19%). Rocky substrate comprised 18%, and was often covered by turfing algae (5%) (Figures 19-21, Table 5).

Table 5. Point Intercept survey for Site 3.

Substrate	Mean	SD	%
Halimeda spp.	7.00	2.65	31
Macroalgae	7.33	2.08	19
Turfing algae	2.00	0.00	5
Other	0.33	0.58	1
Rock	7.00	4.58	18
Rubble	3.00	0.00	8
Sand	11.67	2.52	31

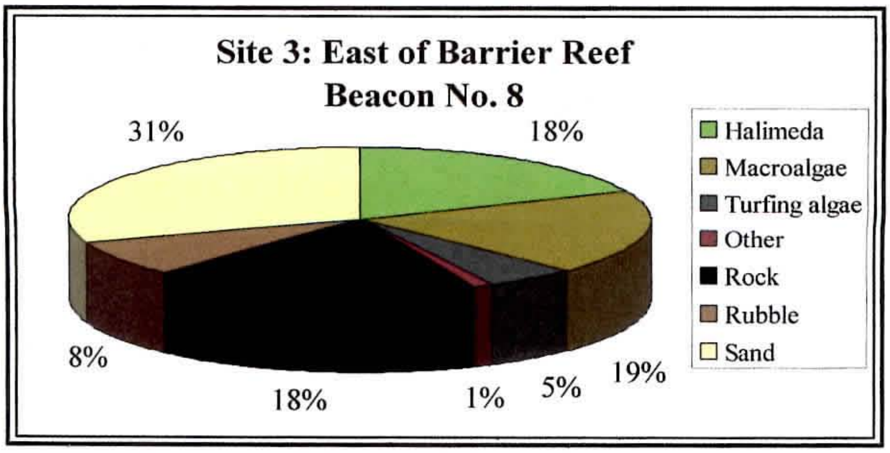


Figure 20. Percentage of substrate types at Site 3.

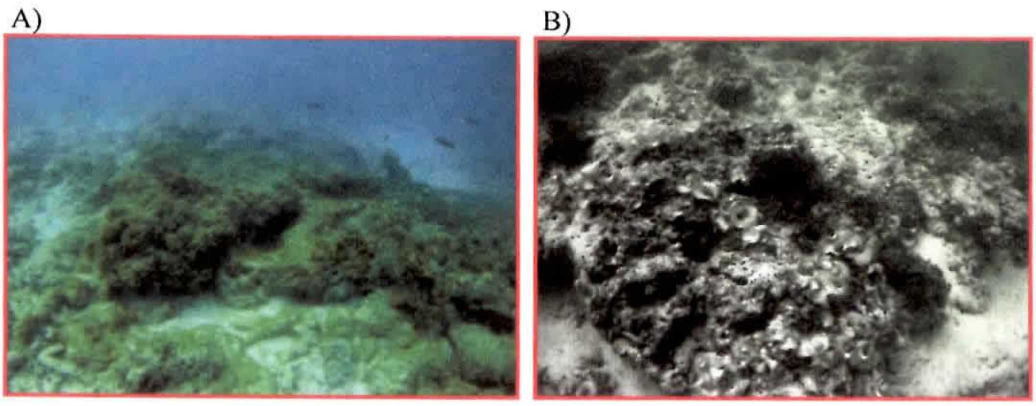


Figure 21. A) Rocky bottom example with algae, sand and rubble. B) The macro-algae *Padina sp.* is dominant in this Site 3.

5.1.4 Site 4: NE Channel Beacon No. 3

Site 4 is located on the NE corner of the submerged barrier reef adjacent the eastern entrance to the northern channel. The sample site with permanent transects is located at the base of the navigational beacon No. 3 (Figure 22).

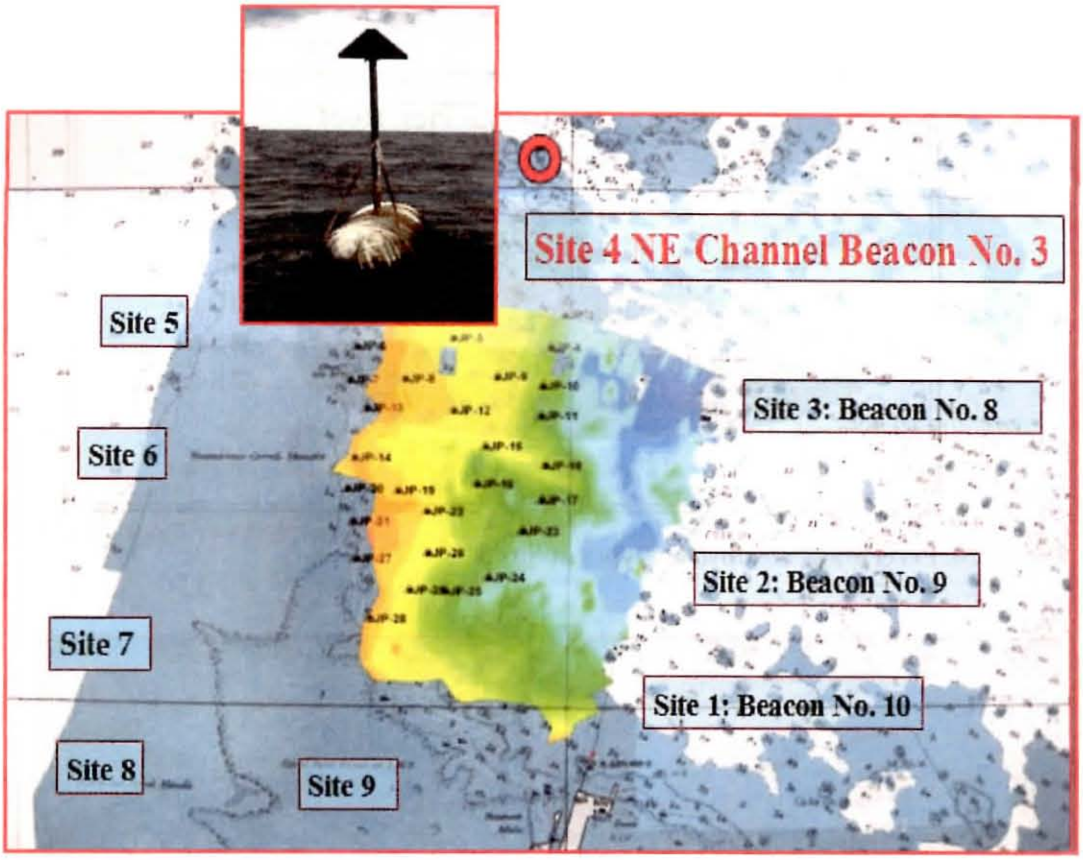


Figure 22. Location of Site 4 survey and monitoring area. GPS location is listed in Table 22. Site location beacon (insert).

This area is characterised by white sandy substrates (22%) with large sections of low-lying rock covered by *Halimeda spp.* (55%). Heavily grazed rock (14%) and rubble (9%) made up the remainder of the benthic substrate (Table 6, Figure 23). It is a relatively clear-water environment as compared to the other more inshore stations located along the eastern side of the reef. The clear conditions were accompanied by the abundance of *Halimeda spp.* and reef fishes particularly damsels such as Blue-Green Chromis (*Chromis viridis*) and Sergeant major (*Abudefduf vaigiensis*). Much more hard coral was found here as were molluscs (Figures 24A, B).

The improved water clarity was the result of the influence of the channel where tidal water flowed in and out of the atoll. The current was often strong, and wave surge from outside of the atoll was noticeable and responsible for the removal of fine sediment from the area. This aspect is attributed to the mean temperature being -0.54^{0}C cooler than that of Site 1 (Figures 47, 48).

Table 6. Point Intercept survey for Site 4.

Substrate	Mean	SD	%
Halimeda spp.	22.33	0.58	55
Rock	5.67	2.52	14
Rubble	3.67	3.06	9
Sand	9.00	4.36	22

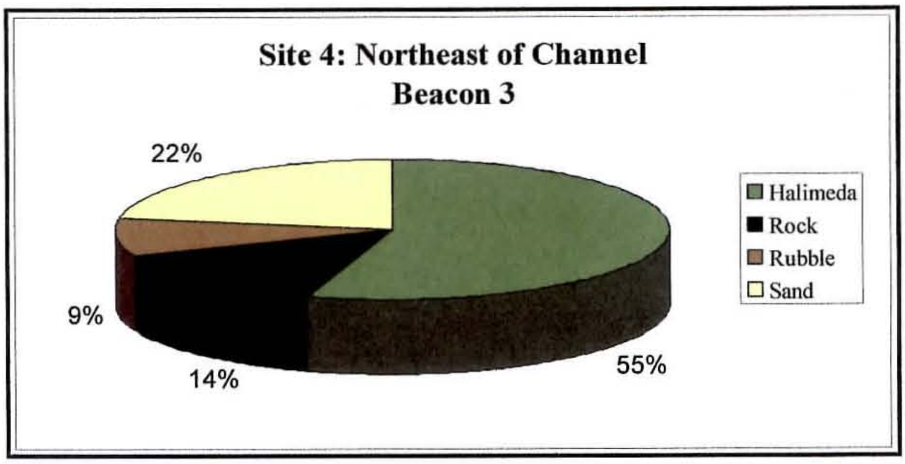


Figure 23. Percentage of substrate types at Site 4.

Figure 24. A) *Halimeda macroloba* and *H. incrassata* meadow. B) Hemispherical *Porites* colony on sand with macro-alga covering rock outcrop at Site 4.

5.1.5 Site 5: West margin of the barrier reef

This location is outside of the atoll on the oceanic side of the submerged western barrier reef (Figure 25). The area is characterised by reef rock with isolated colonies of hard corals (e.g.

Pocillopora spp., Fungia spp. and *Heliopora coerulea*). Visibility was limited to 2m due to the suspended lagoon sediments coming across the reef and creating turbid conditions.

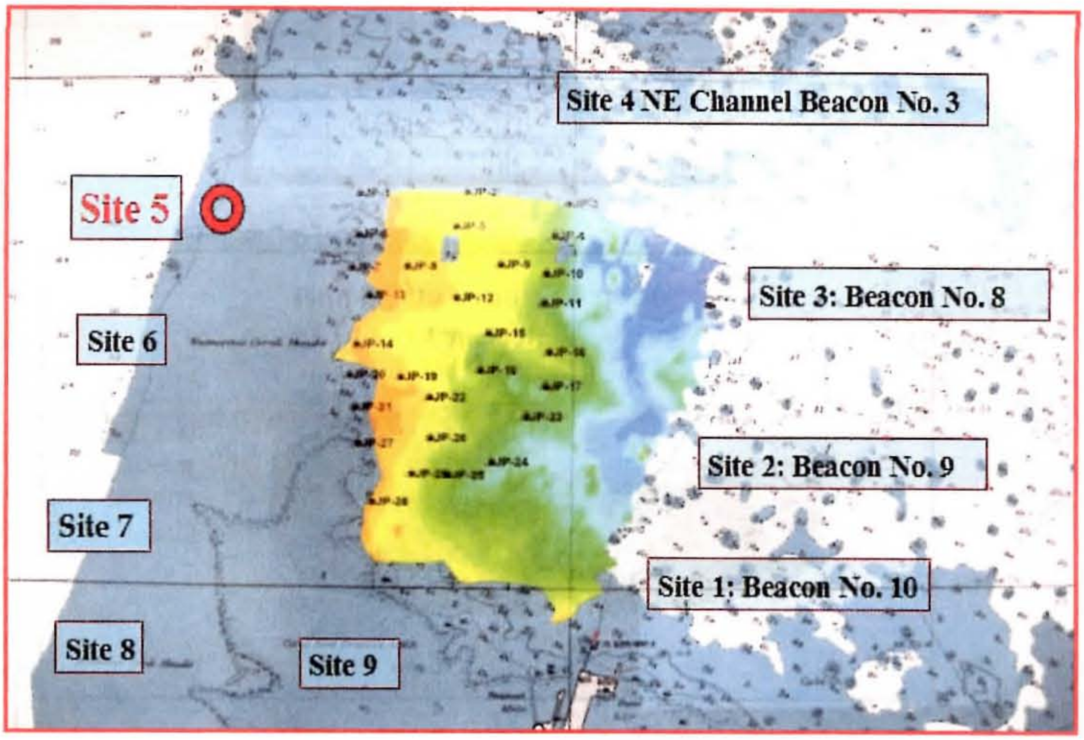


Figure 25. Location of Site 5 survey area. GPS location is listed in Table 22.

Coral colonies were few and generally small (< 5cm) with bare rock surfaces (46%) common. Rubble was the dominant substrate (6%) or with sand (6%) forming the substrate between the rocky areas. *Halimeda spp.* colonised the rock (6%) (Table 7, Figure 26).

Table 7. Point Intercept survey for Site 5.

Substrate	Mean	SD	%
Pocillopora spp.	1.00	1.73	9
Fungia sp.	0.67	1.15	6
Heliopora sp.	1.67	2.89	15
Halimeda spp.	0.67	1.15	6
Dead coral	0.67	1.15	6
Rock	5.33	9.24	46
Rubble	0.67	1.15	6
Rubble on sand	0.67	1.15	6

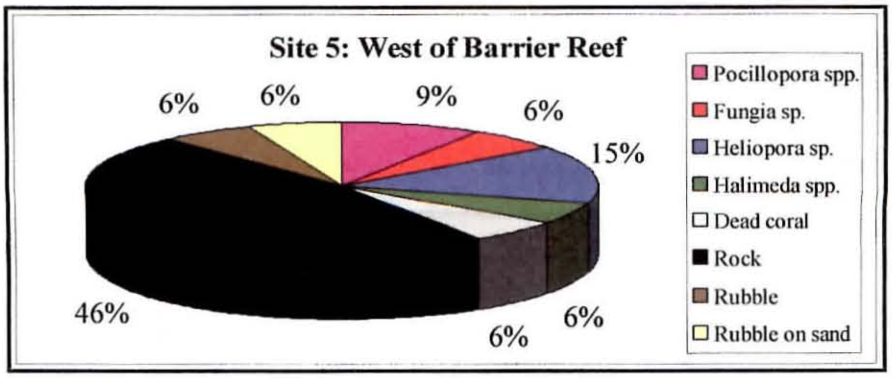


Figure 26. Percentage of substrate types at Site 5.

5.1.6 Site 6: West margin of barrier reef

This site is seaward of the surf zone in 3m depth (Figure 27). It is represented by large boulder-like reef patches with sparse living cover on broad sandy patches. Corallimorph colonies are common. Visibility was very poor.

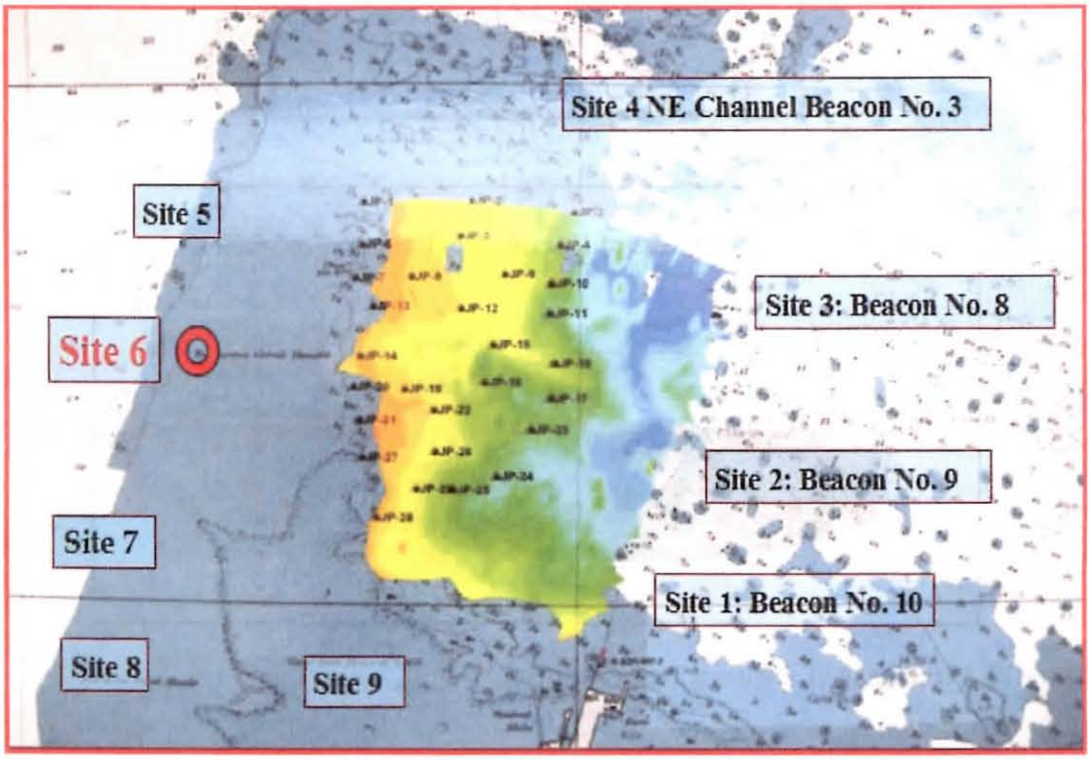


Figure 27. Location of Site 6 survey area. GPS location is listed in Table 22.

The reef area is characterised by an increase in hard coral diversity with a variety of life forms representing several genera (Table 8, Figure 28). Corallimorph anemones dominated the assemblage with large colonies covering the reefal outcrops. The non-Acropora branching forms were comprised of *Pocillopora eydouyxi* and *P. verrucosa* (Figure 29). The Acropora categories were represented by *Acropora aculeus*, *A. digitifera* and *A. muricata*. *A. hyacinthus* was the tabulate representative. *Montipora sp.* occurred as the foliose category.

Table 8. Point Intercept survey for Site 6.

Substrate	Mean	SD	%
Acropora submassive	0.33	0.58	1
Acropora tabulate	1.00	1.00	3
Non-Acropora branching	3.67	2.08	9
Non-Acropora foliose	0.67	0.58	2
Non-Acropora massive	0.67	1.15	2
Corallimorphs	7.67	3.51	20
Other	0.33	0.58	1
Dead coral	0.33	0.58	1
Rock	12.67	0.58	32
Rubble	2.33	1.53	6
Sand	9.00	1.73	23

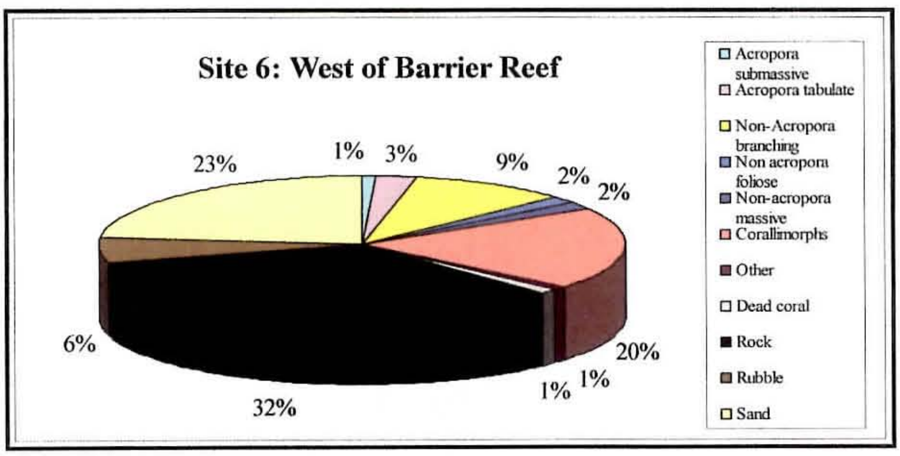


Figure 28. Percentage of substrate types at Site 6.

A) B)

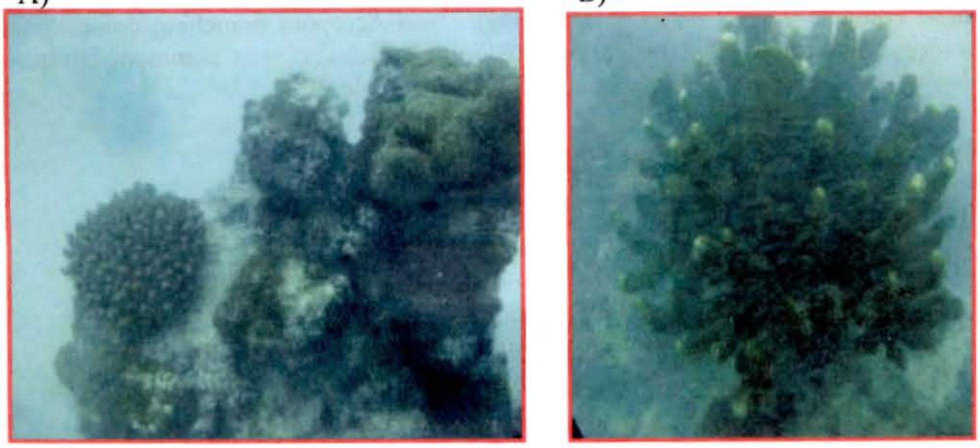


Figure 29. A) Reef outcrop in murky water. B) A *Pocillopora eydouyxi* colony in a turbid environment at Site 6.

5.1.7 Site 7: West margin of barrier reef

Site 7 and the adjacent Site 8 were the most biodiverse areas (Figure 30).

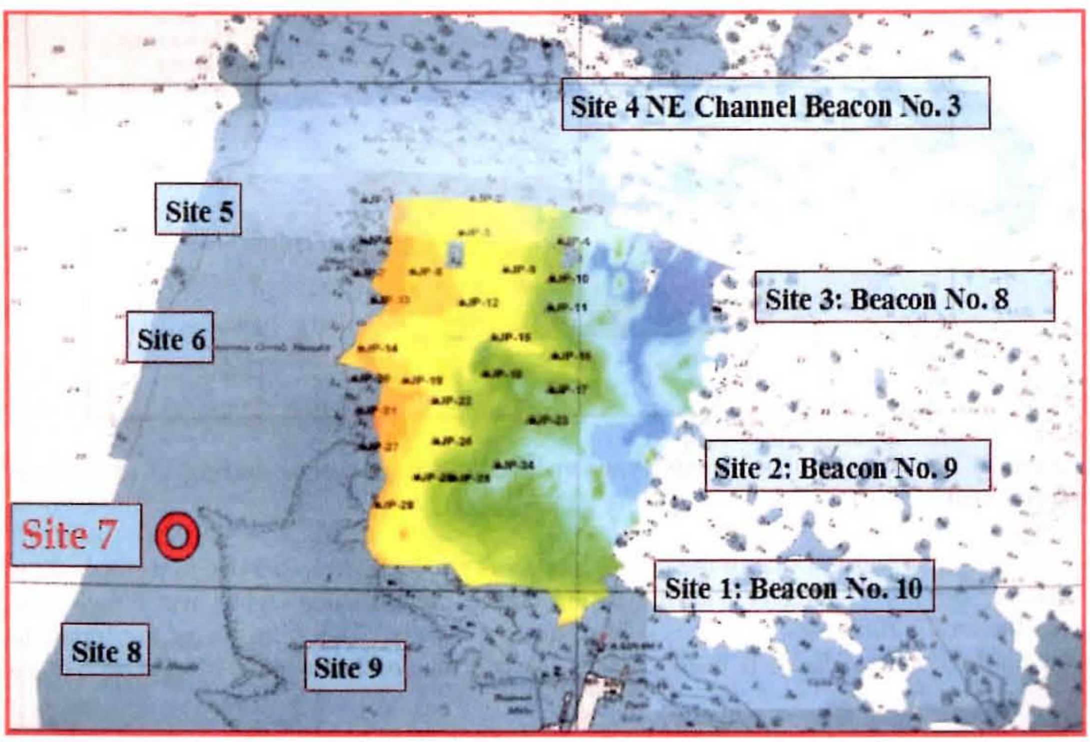


Figure 30. Location of Site 7 survey area. GPS location is listed in Table 22.

Though sand channels formed the reef floor (41%), patches of reef rock (~2-3m high) exhibited good coral cover with a number of Acropora species present. *Heliopora coerulea* was very common on reef pinnacles (8%). The solitary *Fungia spp.* were present (2%). Non-Acropora foliose colonies were *Montipora spp.* (3%). Non-Acropora branching colonies were generally *Pocillopora verrucosa* but the larger *Pocillopora eydouyxi* was common. Uniquely, branching colonies of *Acropora nobilis* were seen (Figure 31, Table 9).

Table 9. Point Intercept survey for Site 7.

Substrate	Mean	SD	%
Acropora branching	2.00	0.00	10
Non-acropora branching	1.67	1.53	8
Non-acropora foliose	0.67	0.58	3
Fungia sp.	0.33	0.58	2
Heliopora sp.	1.67	1.15	2
Halimeda spp.	2.33	1.53	12
Macroalgae	0.33	0.58	2
Rubble	2.67	0.58	14
Sand	8.00	3.00	41

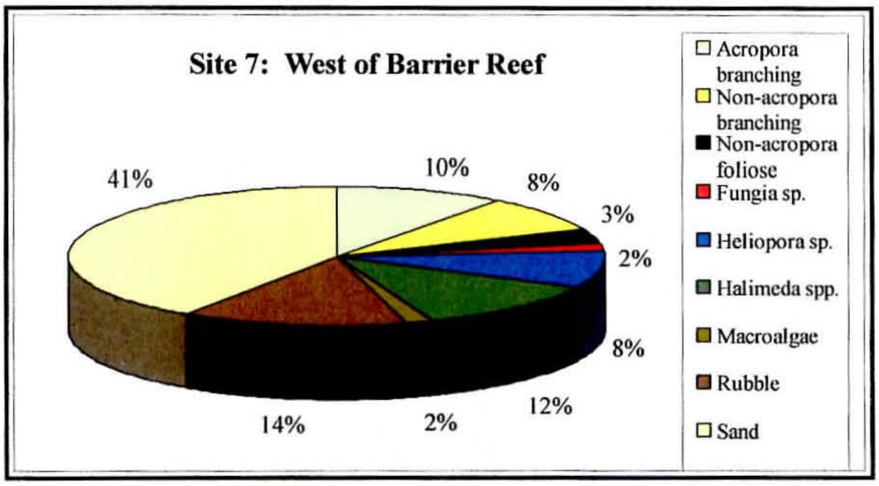


Figure 31. Percentage of substrate types at Site 7 on the western margin of the submerged barrier reef.

In summary, the western side of the barrier reef hosts much clearer water due to the oceanic waters adjacent. Turbidity is greater with the falling tide as the silt-laden lagoon water flows seaward from the atoll. Biodiversity increases from north to south. The influence of the turbid lagoon water is less west of Betio I. in the islands lee and the southeast trade wind-generated current flowing from the south.

Considering the nature of the reef, the deeper water is characterised as a largely sandy expanse with reef outcrops and ridges extending from the main reef occur inshore. The reef top is a combination of hard reef and sand or rubble substrates. Wave action and turbidity is limiting in the shallow areas. Large tabulate colonies are evident on reef ridges, which extend from the barrier reef in 7m depth. Further south, large outcrops rise from a sandy bottom.

5.1.8 Site 9: West and north of Betio's inter-tidal reef flat

During a spring low tide, the reef flat to the west and north of Betio was examined. This area is a flat expanse of sand with little change since the description by Zann (1982). A series of paced transects were conducted on the exposed inter-tidal flat. The biotas were burrowing or confined to ponded water or the peripheral shallows (Figures 32, 33). The most notable feature is a sand cay to the west with shallow channels to the north. In water ponded by low tide where a variety of macro-algae. The reef flat dries to the north approximately 1/3 the length of the submerged barrier reef.

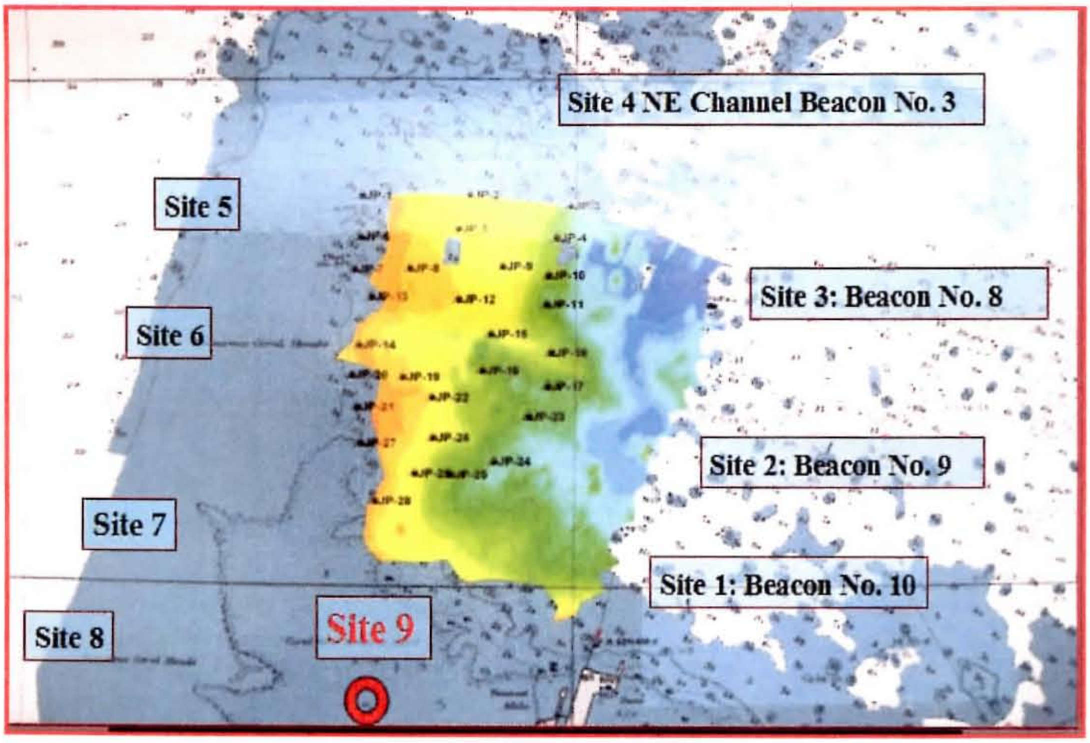


Figure 32. General location of transects at Site 9. GPS location is listed in Table 22.

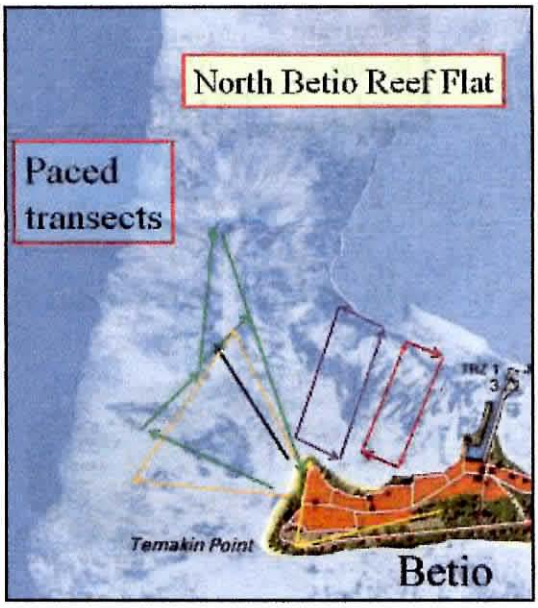


Figure 33. Transect tracks at Site 9 over the inter-tidal survey area to the west and northwest of Betio.

There were large quantities of algae stranded at low water. Many fishers were evident. Sipunculids (Ibo) were being collected on the cay. Line-fishermen were in the shallow water peripheral to the large cay west of Betio I. and around the perimeter of the sand flat. Out on the submerged barrier reef, gleaners were collecting the mollusc *Strombus luhuanus*. Anecdotal comment indicated that octopus were a common fisheries item in the subtidal area as were lobsters.

Algae exclusively predominated the living cover to the north in what was a sand and rubble-covered expanse with intermittent rocks. To the west, the exposed intertidal sand or rubble hosted only beached algal fragments with evidence of burrowing infauna (Table 10, 11; Figures 33, 34).

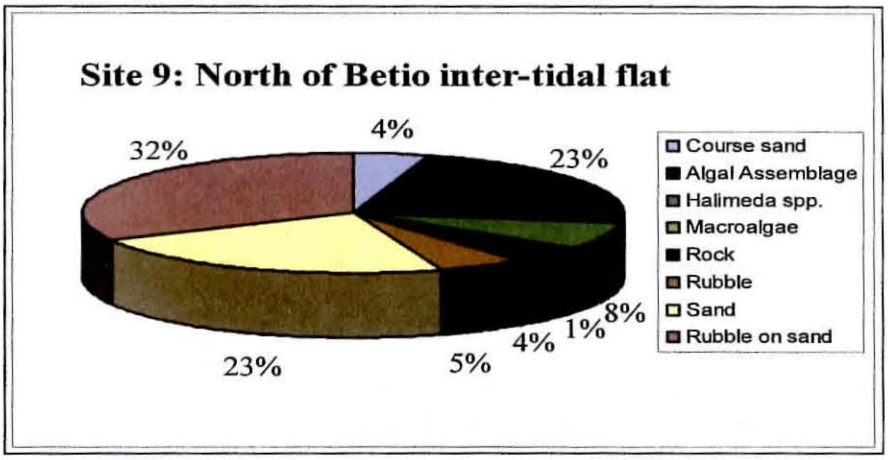
Table 10. Point Intercept survey for Site 9A.

Substrate	Mean	SD	%
Course sand	1.67	2.89	4
Algal Assemblage	8.67	7.09	23
Halimeda spp.	3.00	3.00	8
Macroalgae	0.33	0.58	1
Rock	1.33	1.15	4
Rubble	2.00	3.46	5
Sand	8.67	10.97	23
Rubble on sand	12.33	7.23	32

Table 11. Point Intercept survey for Site 9B.

Substrate	Mean	SD	%
Rubble	0.33	0.58	2
Sand	14.67	3.21	98

A)



B)

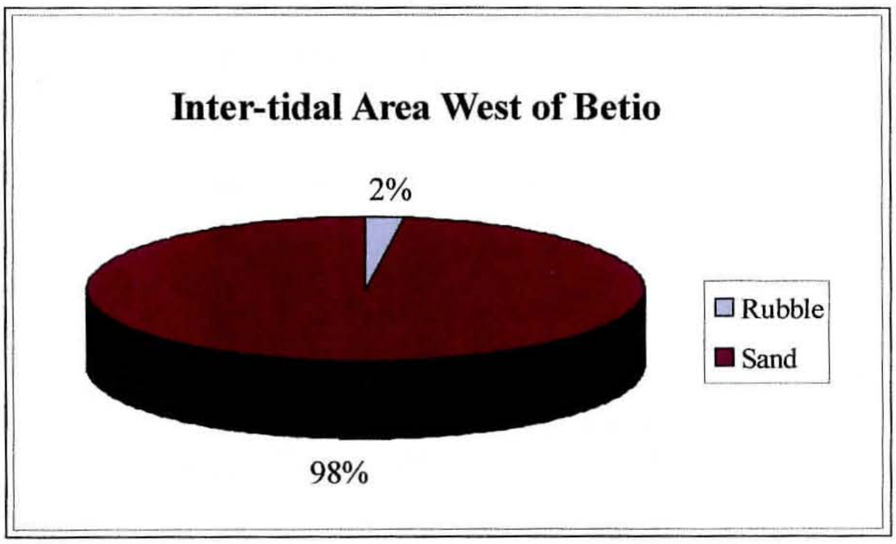


Figure 34. Percentage of substrate types on the intertidal sand flat at Site 9: A) north and B) west of Betio.

5.2 Depot sites

The purpose of these areas is to stockpile the sand and gravels for processing, storage and access to the public. In the following sections are a series of Ikonos satellite images that show the potential sites and the results of the benthic assessment. Currently, there are three proposed depot sites along South Tarawa. These are in the wharf area adjacent to the Kiribati Ports Authority (KPA), the

Public Works & Utilities (MPWU) yard on eastern Betio, and Bonriki on the northern border of the Temaiku Bight at the eastern end of the atoll near the airport.

An inter-tidal sand flat along the northern or lagoon shore of South Tarawa (Figure 6) bound all of the proposed depot sites. The soft shore is generally of equal width as it extends into the lagoon. The area experiences unequal diurnal tides, which leave it exposed to varying degrees of exposure during the lunar tidal cycle. This creates a biological zonation resulting from proximity to the lagoon. The biota is more diverse and prolific in the outer margin of the flat that is subject to exposure only at spring low water tide level. This area is characterised by denser algal growth, and is where the seagrass beds dominate subtidally. The algae provides habitat for the many invertebrate fauna. Less evident are the infauna within the sandy environment as it stretches sublittorally.

An additional habitat of the three depot sites are the channels and the deeper borrow pits previously used for landfill for coastal development. These excavations are located adjacent to the shore and provide ideal access, manoeuvring and mooring areas for the off-loading of the vessel. The benthos has been assessed for composition and percentage of living cover.

5.2.1 Site 10: Betio Wharf Depot

This area is logistically the most convenient site for stockpiling, as it is closest to the resource. The vessel will generally be at the wharf or moored in the borrow pit during the night, and return to the dredging site daily.

The area is to be modified to allow for vessel entry to the shore where stockpiling will occur. To facilitate the unloading, a channel will be deepened to navigable depths extending from the lagoon into the borrow pit. Adjacent to the road, west and south of the borrow pit, a landfill area will be developed, expanding the port area and providing convenient access for aggregate material and distribution to western South Tarawa (Figure 35).

Figure 35. Site 10: Betio Wharf Depot with the suggested landfill area for storage and shore access for distribution.

The assessments conducted at Site 10 were swim, paced and photo transects. A sediment trap station was established in the NW corner of the borrow pit. Figure 36 shows the relative positions of the transects conducted.

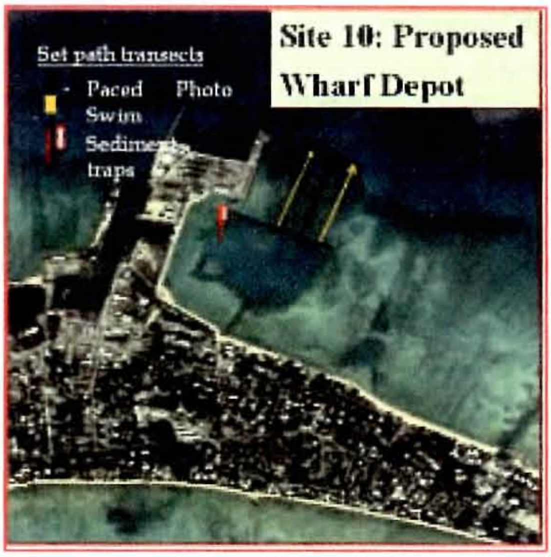


Figure 36. Location of the Wharf Depot site with the position of the transects and sediment traps. See Table 22, Site 10 for the GPS coordinates.

Biota on the sand flat (Site 10A) and in the borrow pit (Site 10B) were dominated by algae. The dominant feature of the intertidal area is sandy substrates with a 20% rubble component. 36% of the living cover was macro-algae (Table 12, Figure 37A). The macro-algae were generally in clumps, either free-living or attached. The species composition was dominated by *Sargassum sp., Acanthophora sp.*, and *Hypnea sp. Sargassum* was most often associated with large rubble and rock substrates, and *Acanthophora sp.* were free-living clumps often associated with *Hypnea sp.*

By contrast, the borrow pit (Table 13, Figure 37B) was margined by a rock rim on the lagoon side. A band of algae extended subtidally to a depth of approximately 1.5m subtidally in the ponded water, limited by light and soft-sediment substrates. The green algae, *Caulerpa racemosa* was abundant. In the band of algae surrounding the borrow pit, *Halimeda* was common comprising 14% or 1/3 of the macro-algal occurrence. The deeper areas of the pit were comprised of fine sediments, with numerous holes in the surface indicating sediment dwellers such as bivalve molluscs and burrowing worms.

The fisheries on and adjacent to the sand flat were octopus, the black sea cucumber (*Holothuria atra*) and half-beaked gar (*Hemi-* or *Hyporhampus spp.*).

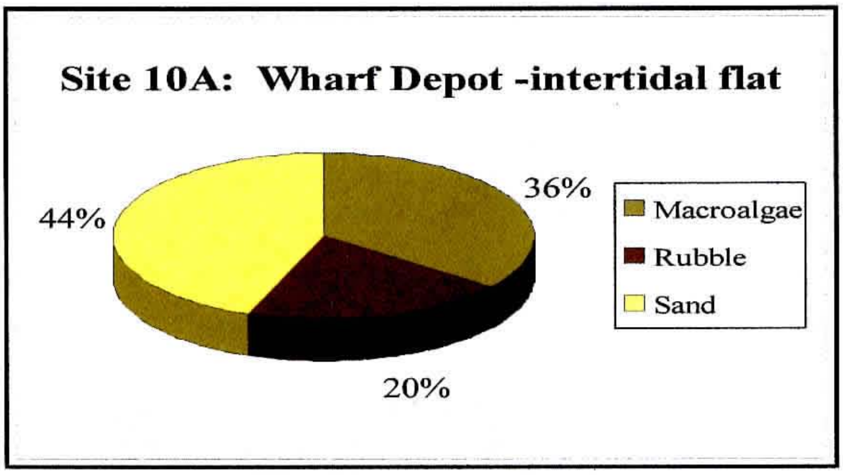
Table 12. Point Intercept survey for Site 10A.

Substrate	Mean	SD	%
Macroalgae	7.00	1.00	36
Rubble	4.00	2.00	20
Sand	8.67	8.50	44

Table 13. Point Intercept survey for Site 10B.

Substrate	Mean	SD	%
Halimeda	0.67	1.15	14
Macroalgae	1.33	2.31	29
Rock	0.33	0.58	7
Rubble	1.33	2.31	29
Sand	1.00	1.73	21

A)



B)

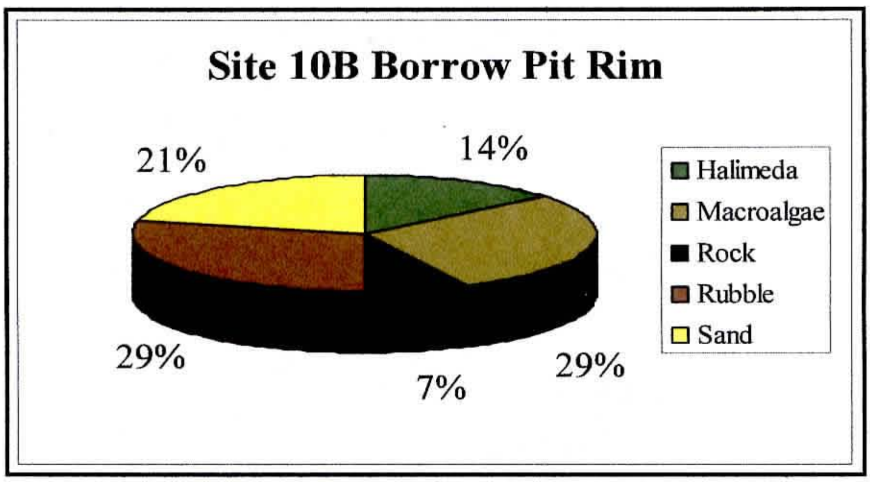


Figure 37. Percentage of substrate types at Site 10 (Wharf Depot): A) Sand flat north of the borrow pit. B) Northern rim of the borrow pit.

5.2.2 Site 11: Betio Ministry of Public Works and Utilities (MPWU) yard

This location is conducive to a depot site as it is the existing yard for the MPWU aggregate facility. The presence of a borrow pit adjacent to the shore with a shallow channel extending into the lagoon predisposes it to access by the vessel for unloading. The yard's southern perimeter is on the main road and is convenient for distribution (Figure 38).

A similar assessment to the proposed wharf depot was conducted involving walks, swims, and photo transects. Sediment traps were placed in the borrow pits (Figure 39) which also shows the relative positions of the assessments. The GPS coordinates are noted in Table 22.

The intertidal area is characterised by a sand flat exhibiting a zonation typical of the southern lagoon margin where luxuriance is greater with decreasing tidal aerial exposure. The area is dominated by macro-algae (33%) and sand (31%). The macro-algae, as with the Wharf Depot Site 10, are dominated by *Sargassum sp., Acanthophora sp.*, and *Hypnea sp.* The presence of *Enteromorpha sp.* inshore indicates nutrient pollution. The large rubble component (19%) and scattered rocks on the sandy surface are often substrate for algal attachment. In the borrow pit and areas of ponded water, *Caulerpa* colonies were abundant. The deeper areas of the borrow pit had fine silt in very turbid conditions. Polychaete worm burrows were numerous. *Halimeda spp.* was reasonably common, comprising 9% or approximately 1/3 of the macro-algal occurrence (Table 14, Figure 40).

The fisheries in the area are bivalve molluscs such as *Anadara spp.* (Te bun). The black sea cucumber (*Holothuria atra*) was common and being collected by intertidal fishers.

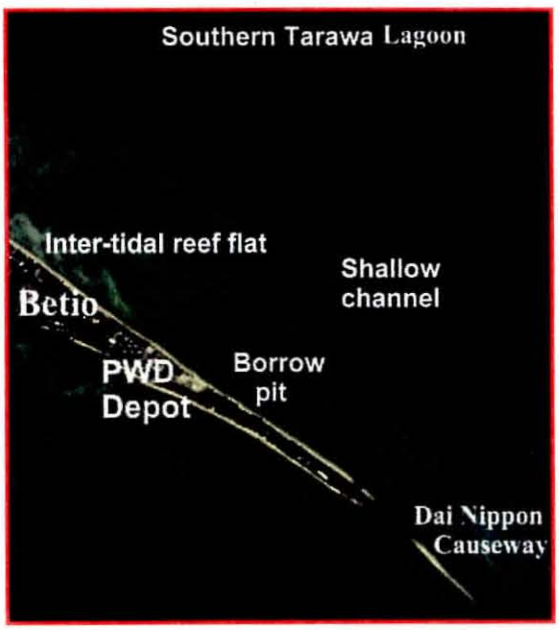


Figure 38. PWU location Site 11.

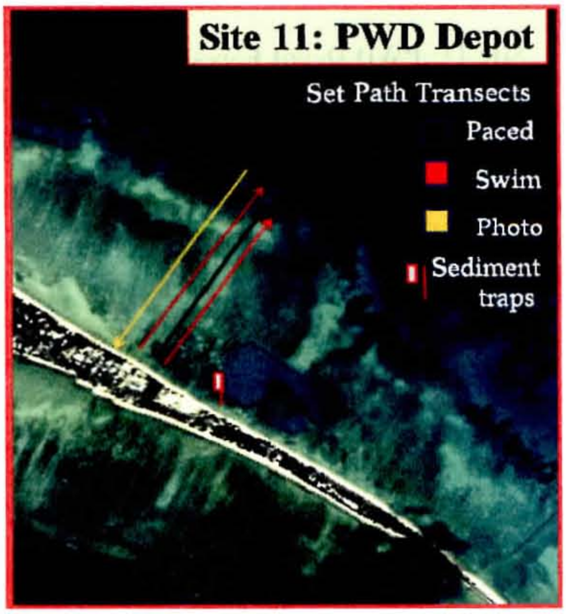


Figure 39. Location of the Public Works and Utilities Depot site with the position of the transects and sediment traps. See Table 22, Site 11 for the GPS coordinates.

Table 14. Point Intercept survey for Site 11.

Substrate	Mean	SD	%
Non-Acropora massive	0.33	0.58	1
Enteromorpha spp.	0.67	1.15	3
Halimeda spp.	2.00	2.65	9
Macroalgae	7.33	4.04	33
Rock	0.67	0.58	3
Rubble	4.33	0.58	19
Sand	7.00	6.08	31
Silt	0.33	0.58	1

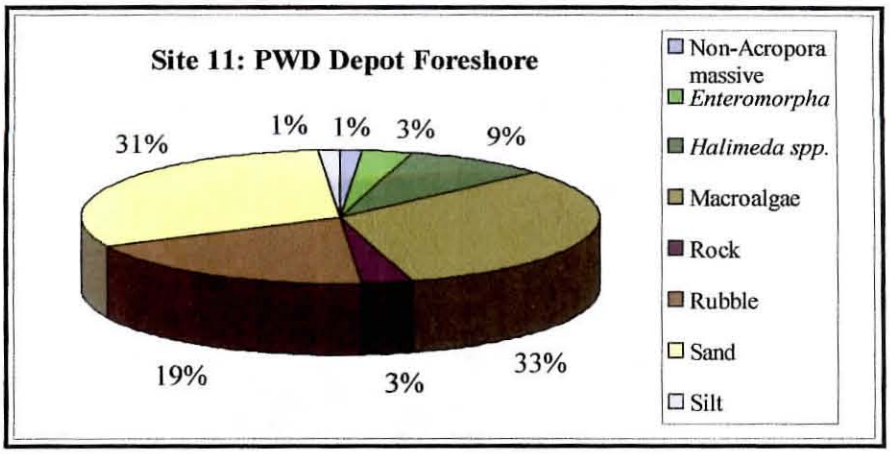


Figure 40. Percentage of substrate types at Site 11.

5.2.3 Site 13: Bonriki Depot

The Bonriki site was chosen due to its location at the eastern end of South Tarawa (Figures 6, 41-43). The site is adjacent to the lagoon at the southern end of the runway, and to Bonriki Village. The offshore area in the past has served as a source for aggregates, and there is a groyne, channel and excavated areas nearshore. The inter-tidal environment is comprised of sand banks that are exposed partially with every neap tide and extensively during the spring low tides. The banks border the deeper water of the Temaiku Bight.

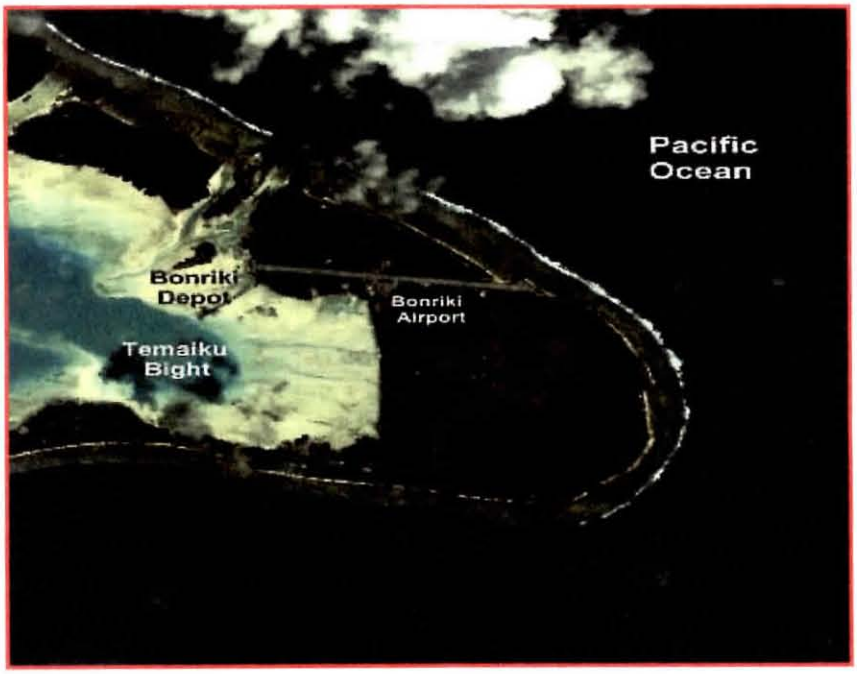


Figure 41. Eastern South Tarawa showing the location and context of the Bonriki Depot site at the western end of the airport runway.

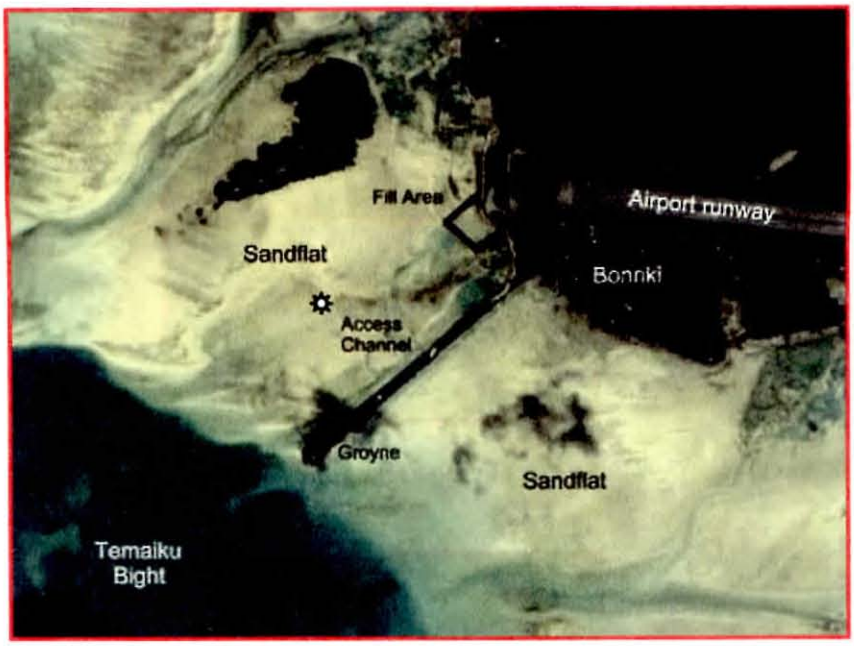


Figure 42. Image of the Bonriki habitats and potential stockpile Site 13.

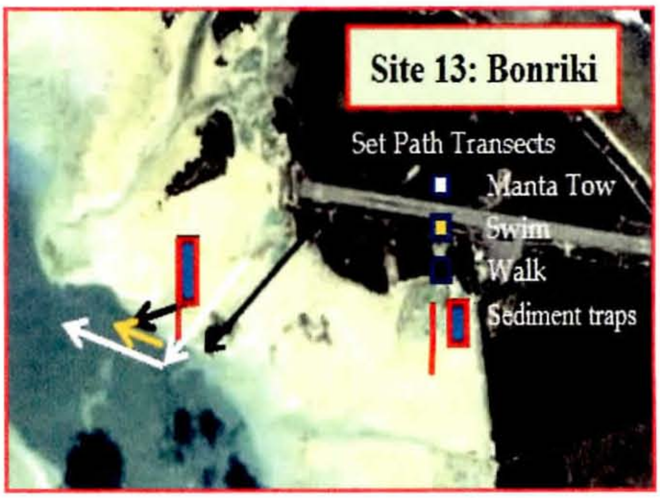


Figure 43. Bonriki Depot site with the position of the transects and sediment traps. See Table 22, Site 13 for the GPS coordinates.

Figure 42 shows the section of proposed reclamation at the end of the runway. The southeast corner of the Tarawa Lagoon has the lowest biodiversity in the lagoon (Paulay and Kerr 1994, 2001). This is due to the generally homogeneous habitat offered by the extensive inter- and subtidal sand areas. The surface biota was very sparse with *Enteromorpha sp.*, a common cover of the sand surfaces, indicating nutrient pollution from coastal sources. Large mounds, burrows and other holes indicate substantial infauna, such as the burrowing worm *Arenicola sp* (Figure 45). Small anemones (*Cerianthus sp.*) and molluscs were common (Figure 44).

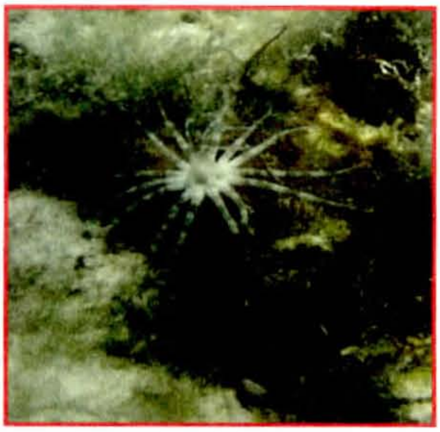


Figure 44. Anemone (*Cerianthus sp.*) living among the surface algae (*Enteromorpha sp.*).

Figure 45. Large Arenicola mound with surface algae.

6.0 Baseline data

6.1 Sedimentation: Sediment trap assessment

Sediment type and quantity collected from the extraction and depot sites varied widely but provided insights into the rates of sedimentation. Low values in the most turbid water are thought to be due to the fine, floccular suspended sediment. At Site 4, the current-washed sand is coarse due to the more vigorous nature of the environment, and has a high capture weight per unit time. The eastern site of Bonriki has a higher natural rate of sedimentation; this was confirmed by the mean sediment trap deposition reflecting the highest rate of capture of all sites. Appendix 18.7 Tables 21-23 provide information the location, collection time and capture rate. Figure 46 graphs the capture rate at the sediment trap stations.

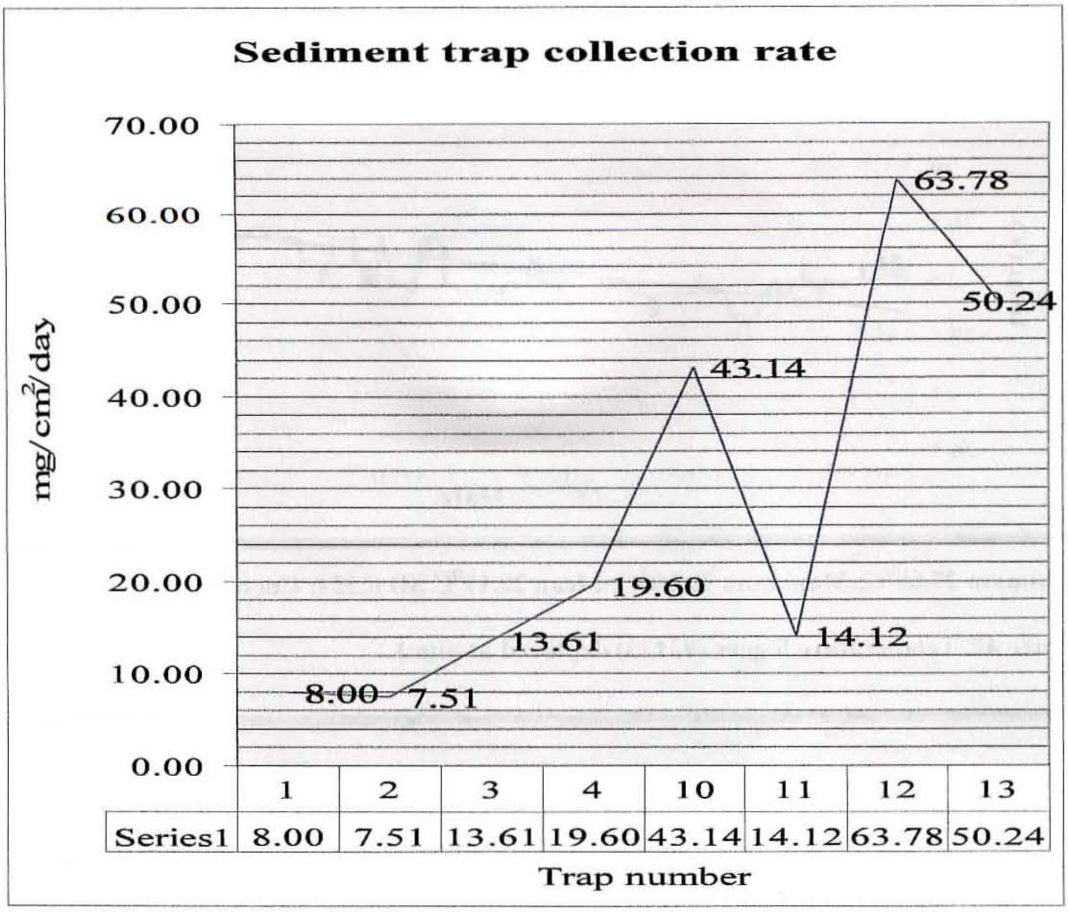
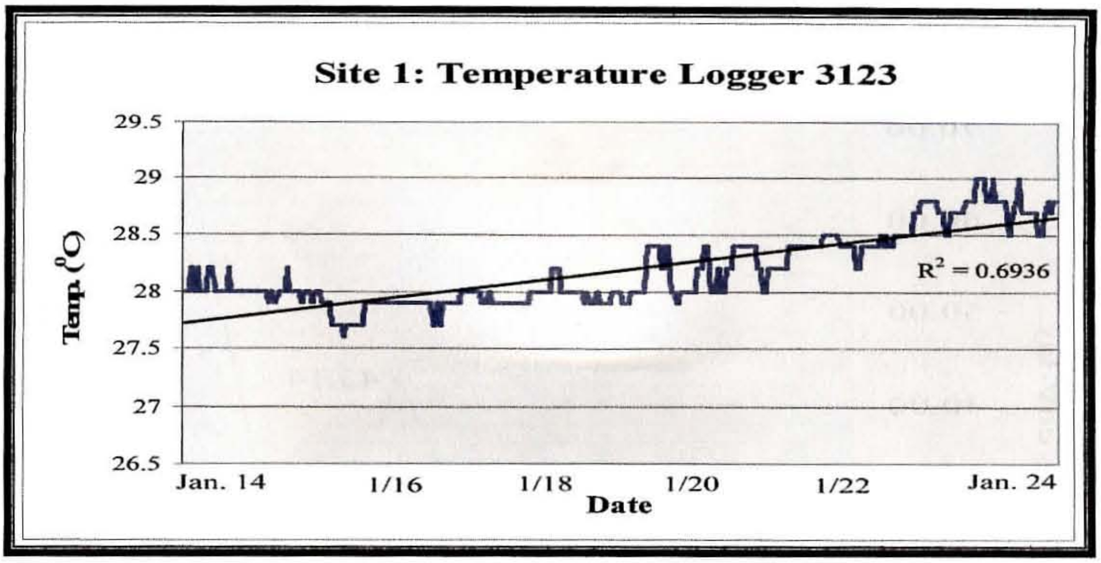


Figure 46. Sediment traps accumulation per site (mg/cm^2/day).

6.2 Temperature records

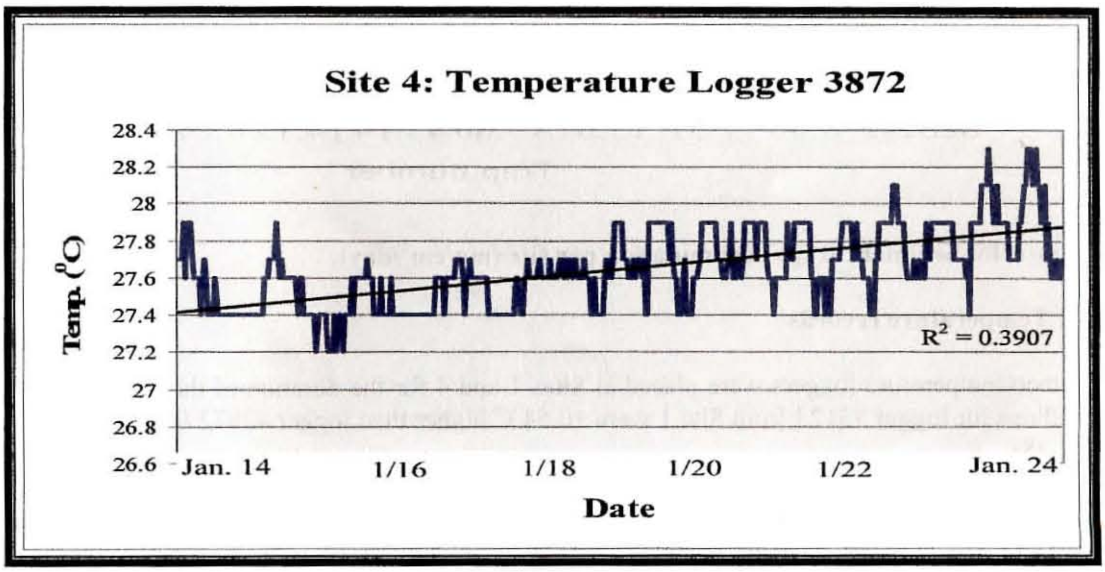
Vemco temperature loggers were placed at Sites 1 and 4 for the duration of the study. The mean readings for logger #3123 from Site 1 were +0.54^{0}C higher than logger #3872 from Site 4 (Figures 47, 48).

This disparity is thought to occur as the result of the logger at Site 1 experiencing embayed conditions where the currents coming from the east (Damlamian, 2008) have warmed over the lagoon waters and shallow inter-tidal areas to the southwest. By contrast, the logger at the entrance to the lagoon is registering the temperature of the tidal flow as the water comes into the lagoon and at ebb from water with a shorter lagoon residence time than that at Site 1. This is also reflected in the higher variability at Site 4.



Minimum 27.60°C; Maximum 29.00°C; Mean 28.19°C SD 0.324; Correction +0.5°C

Figure 47. Temperature logger (#3123) deployed at Site 1.



Minimum 27.20°C; Maximum 28.30°C; Mean 27.65°C SD 0.212; Correction +0.8°C

Figure 48. Temperature logger (#3872) deployed at Site 4 adjacent the channel north of the submerged reef.

6.3 Wind speed and direction

During the field study, the wind varied from East to Northeast at speeds of 15-18kts. for 15 of the 21 field days. For 5 days, the sea conditions were calmer with 5-10kts. These conditions are the predominant wind pattern as average over 16 years (Kiribati Meteorological Bureau: Figures 49 and 50). It is this prevailing easterly wind blowing across the lagoon, which contributes to the chronic turbidity on the western submerged barrier reef and along the South Tarawa nearshore shallows.

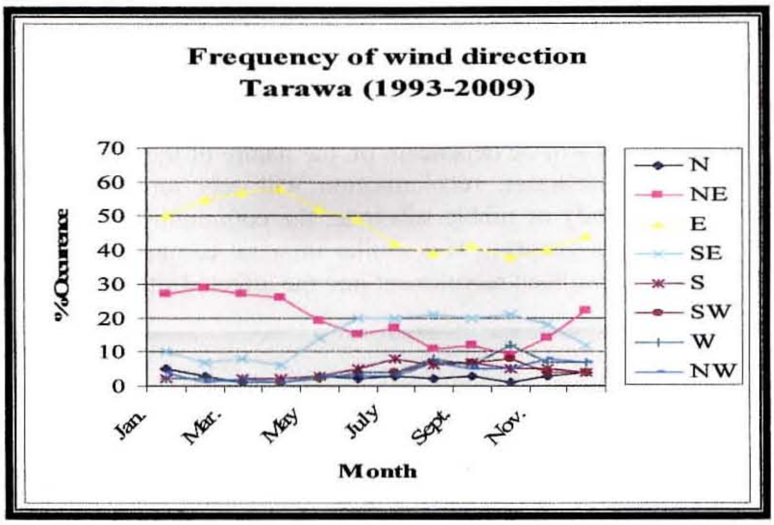


Figure 49. Frequency of wind direction (1993-2009) (Kiribati Meteorological Bureau)

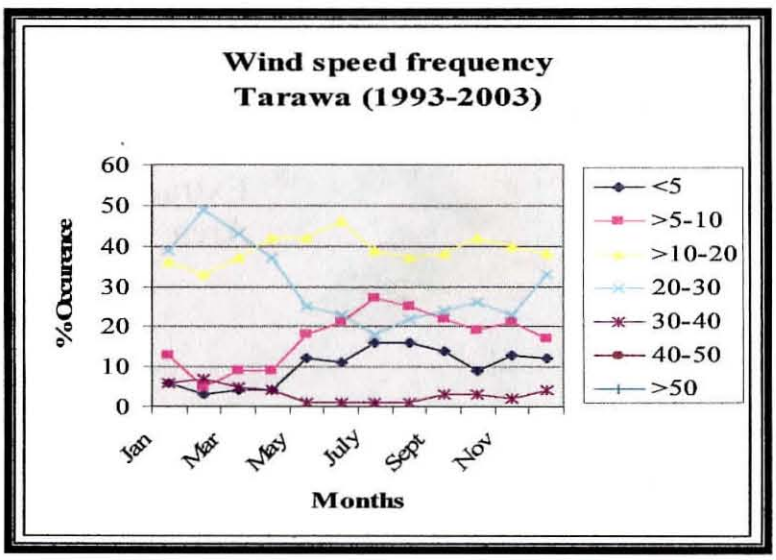


Figure 50. Wind speed frequency (1993-2009) (Kiribati Meteorological Bureau)

By contrast, it is the west and northwest winds in the November, December and January period that are responsible for the deposition of rock and sand on the eastern margin of the submerged reef. Wave action, strong at times, moves carbonate facies eastward across the reef and into the lagoon (Cruickshank and Morgan 1998). Based on this process of storm wave-transported sediments, a degree of sustainability of aggregate extraction is assured through natural deposition.

7.0 Description of the environment likely to be impacted by the proposed activity.

7.1 The extraction site

7.1.1 Proposed rate of extraction

There is an incomplete understanding as to how much of the sea floor will be impacted and how quickly the benthos will recolonize the disturbed area by the extraction over the periods of 1 and 5 years (Figure 51). The rate will be dependent on the nature of the substrate. For habitat relief and benthos requiring rock substrates, recolonisation will rely on the amount of hard substrate remaining. In areas of sandy or rubble substrate, the community should re-establish reasonably quickly once the extraction ceases. If a similar infaunal community or hard substrate-attached organisms surround the areas, then recruitment into the affected sites would be more rapid.

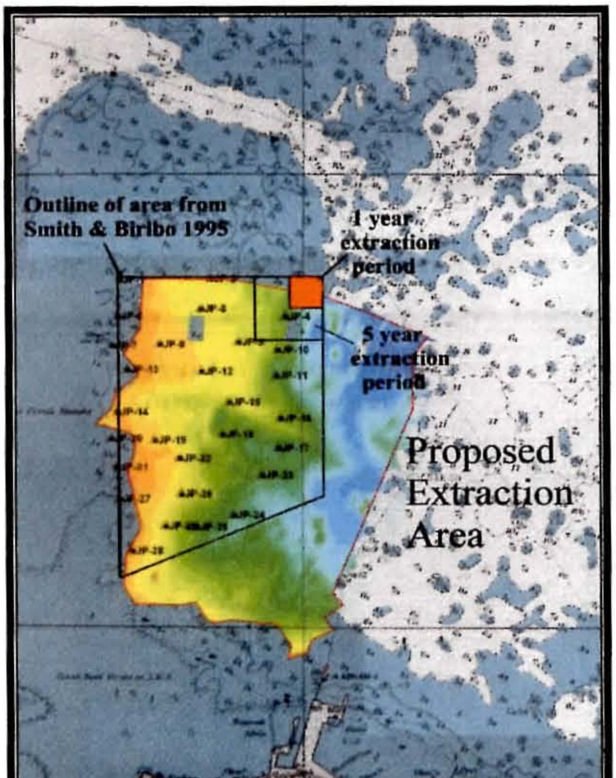


Figure 51. Proposed extraction area is outlined (Smith and Biribo 1995) with the amount of seafloor affected after 1-year and 5-years.

7.1.2 Prevailing wind (see Section 6.3)

An important feature of the proposed extraction site is the turbid nature of the water. Fine sediments from the relatively shallow lagoon east of the sites are naturally continually re-suspended by the wave action from the prevailing easterly winds. Together with wave and current transport, there is a net migration across the bay and along the northern shore of South Tarawa.

A) Strong El Nino **B) La Nina**

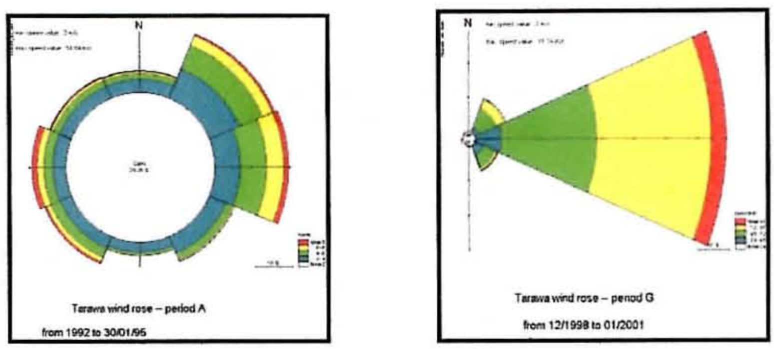


Figure 52. Wind rose showing the frequency of winds during the El Nino/La Nina years after Webb (2005).

7.2 Coral reef, sea grasses, and soft-bottom benthos

Impacts differ with regard to the sites near the extraction area and those of the depots. For the extraction area, the two principal impacts are: 1) the removal of the substrate, which represents a localised disturbance of benthic habitat; 2) creation of a plume that impacts on areas peripheral to the site. The habitats have been inspected during the EIA field survey, and have been shown to be quite variable in its general nature and composition. The naturally chronic sedimentation strongly conditions the biota of the submerged barrier reef. Macro-algae are the dominant biota with particular abundance of *Halimeda spp.* on the eastern margin. Corals, both hard and soft, are poorly represented. On the southwestern side of the barrier reef, water clarity improves, as does the biodiversity, particularly for hard corals. The deepening of the resource area by up to 3m depth, and the removal or alteration of habitat, are the major consequences of the extraction along with the impact of the sediment plume on adjacent communities.

It must be kept in mind, that the area of extraction is relatively small percentage compared to the entire submerged barrier reef. This is particularly the case when compared with the entire western margin. In this context, the removal from the area creates minimal impact (Figure 5).

7.3 The depot sites

At the depots, there are impacts associated with the required infrastructure modification and those associated with the dredging operation. The main environmental impacts occur during the period of reclamation and the deepening of the channel. Impact is localised in an area that has been previously subject to modification in which a shallow channel and borrow pit remain. These were created by the local fill extraction. As such, the localities require different degrees of channel and borrow pit deepening. The surface biota is algal-dominated with seagrasses in the deeper waters nearshore. Burrowing organisms are abundant in the sandy intertidal flats where molluscs represent an important fishery.

The operational impacts of the vessel off-loading the sand and gravel may involve some degree of benthic disturbance but this would be confined to the relatively small channel and borrow pit areas. The vessel usage is considered to have a minor influence on the coastal fishery or general biodiversity.

7.4 Water quality

The impact on the water quality from the dredging is largely due to the perturbation of the seabed from the removal of sediments by the grab and the spillover of silt-laden water as the sediment is raised to the surface and deposited on the barge. An environmentally friendly grab will minimise the spillover, and an over-flow pipe returning sediment-laden water to the seabed will mitigate the size of the sediment plume. Both adaptations are part of the ESAT barge design.

Damlamian (2008) modelled a sand pump dredge design that creates a much larger plume than the clamshell design to be employed on the ESAT vessel. This is because the clamshell has far less impact due to less sediment being entrained in the water column. The acceptable sedimentation rate above ambient has estimated to be $10mg/cm^2/day$ based on the work of Lasker (1980), and Pastorok and Bilyard (1985). In the study, two locations were modelled for two types of sediments (sand (62.5 μm) and mud (4.0 μm)). Coarse sediments are assumed to settle in the vicinity of the extraction area and, in a high current situation, will range widely as a dispersed plume with a sedimentation rate within acceptable limits. By contrast, if the sediments being extracted are mainly fine-grained, then the plume may exceed the limit considered as non-impacting (see Section 8). Using a clamshell grab approach and choosing the dredge site with a lower proportion of fine sediment will greatly minimise the plume impact. An area more central in the lagoon and northeast of the proposed Betio reef site was recommended (Damlamian 2008) based on the lower current velocities limiting the plume spread.

There is currently significant natural turbidity along the submerged barrier reef in the vicinity of the extraction area. However, simulation results predict virtually no significant build-up over a production period of 12 days, concluding that turbidity from the mining operation will not cause significant environmental impacts (Cruickshank and Morgan 1998: Addendum D *Dispersal of Fine Grained Sediments*).

From the atoll lagoon of Funafuti, Tuvalu, Smith (1995b) using Secchi disk data showed that the direction in which the plume moves is largely dependent on wind direction, with tidal effects being secondary. During east to southeast trade winds, the plume is seen to move in a northwest direction towards the deeper parts of the lagoon away from any coral reefs. Monitoring by the dredge operators for water turbidity indicates that, on average, the plume has completely dissipated within 200m of the dredge. The average plume length and width generated by the pilot dredge was 115m by 15m respectively.

7.5 Ecosystem function

The question of the degree of impact on ecosystem function is one of scale. With the 50-year extraction area occupying 0.69% of the Tarawa Lagoon, impacts are proportionally small with regard to the lagoon/reef environment. The resource area is characterised as a turbid environment for much of the year due to the prevailing winds. The impact of the entrainment of silt in the water column is less severe when the ambient suspended sediment is already naturally high. In considering the much more polluting suction pump design, Damlamian (2008) noted that any material contributing to the ambient levels should be non-damaging to marine life in most cases.

The removal of habitat may have a progressive effect in terms of ecosystem function as a basic framework for interaction by adult and juvenile fishes recruiting to the area. Most coral reef fish species have a cycle which includes a planktonic larval phase (in the open ocean), which usually lasts from three to six weeks, followed by a sedentary reef phase (in the lagoon) for the juveniles and adults (Werner 1988). During the oceanic phase, the larvae may move far from their native reef due to currents and/or their swimming abilities (Leis & McCormick 2002). Larvae, then, return to the reef (natal or not) to continue their development into juveniles and to adults. Generally, larvae enter the lagoon across the reef crest by night (colonisation phase, Dufour & Galzin, 1993). In the hours following this colonisation, larvae undergo metamorphosis and choose suitable habitats (settlement phase) based mainly on the characteristics of coral habitat and the presence or absence of conspecifics (individuals of same species) as well as other species. After several months in their settlement habitat, the juveniles will make an ontogenetic habitat shift, and move towards their adult habitat (Lecchini & Galzin 2005) and eventually become sexually mature. Both the annual extraction quantity and the resource, which includes substantial sandy areas, are relatively small, thus minimizing the impact. Spawning aggregations are usually located in areas such as the northern channel and which is removed by some distance from the resource area. If monitoring reveals a likely impact on the fishery of the area, then having the flexibility to move to an alternative site will provide an adaptive solution.

7.6 Fisheries

Marine resources are very important to Kiribati people, particularly in an environment where subsistence fisheries are a fundamental component of their well-being. Therefore, it is essential to ensure that the removal of aggregate does not impact on the sustainability of marine resources.

Initial research describing the carbonate structure of the Tarawa Lagoon formed the basis for choosing the aggregate resource site north of Betio (Weber and Woodhead 1972; Richmond 1990). Before the Nippon causeway was constructed, Betio was isolated and the population much lower. With the development of the causeway, anecdotal information from the consultations on South Tarawa indicated a reduction in bonefish stocks (*Abula sp.*) in areas where they were previously abundant around Betio/Bairiki. The causeway allowed for increased access and economic activity, with a concurrent rise in the population. In 2005, Betio had a population of 12,509 and by November of 2010 it had increased to 15,737 (Anon., 2010). The most accessible fisheries for the Betio residents are the reefs to the north. This is particularly so with ciguatera becoming a common feature of the reef fishery south of Betio (Tebano 1990, 1991, 1992). With the added value of this fishery area, concern has increased over the nature of the impacts of the dredging on this reef environment.

Zann (1982) noted the large north Betio Reef was more productive with greater fishing activity than the Bairiki-Betio platform and adjacent lagoon, which was considered poor fishing grounds (anecdotal info.) and biologically impoverished (benthic survey). The fisheries observed were *Sipunculus indicus* (Te Ibo) on the western sand cay, gillnetting for the finfish *Euleptorhampus* (te anaororo), cast netting, and pole-and-line.

In considering the aggregate removal's influence on these fisheries, it is essential to define the impacts, understand which fisheries are likely to be affected and to what extent. Habitat removal and a sediment plume may be destructive if extensive. In this case, the potential impact is a question of degree. The area is relatively small, and monitoring will assess the nature of the operation. Should impacts present as unacceptable, adaptive management alternatives will be employed.

The goal is to ensure that the dredging impacts are an acceptable compromise in balancing the need for a domestic source of sustainable aggregates with the potential for, what is often, an unquantifiable effect on the local fishery. Thorough monitoring and careful control is the key to minimal negative influence on the productivity of the fisheries.

Importantly in assessing nature and degree of impact on the fisheries will be an additional survey investigating the fishery resource by fisheries scientists from the Dept. of Fisheries and SPC. Interview with fishers, monitoring catch and sampling the area subject to extraction influence are also vital to information gathering. A monitoring program to assess the immediate and longer-term impact of the extraction will follow this effort.

Other lesser impacts which may be considered a harmful disturbance to the fish resource, are the vessel's engine noise during transit and at mooring, and with the mechanical din of the clamshell grab during the removal of the substrate (1hr./day). Additional impacts may include the hydrocarbon waste discharge from the ship's engines, and the refuse that may result from the ship's operation and on-board personnel.

7.7 Summary of impacts on the environment

In summary, two main impacts have been identified: habitat removal and the consequences of the associated sediment plume. Important is the temporal component (short-term and longer term) associated with potential severity of the impacts. Those influences on the biota may be evident in a relatively short period of time. During this period, the effects of the plume may be more obvious and can be more clearly evaluated. The longer-term impact mainly concerns the progressive removal of habitat, which as time progresses, becomes more extensive. The issue here is the natural resilience of the ecosystem which may limit the amount of disturbed area. Monitoring will provide a better appreciation of the degree to which natural rehabilitation will occur.

Mitigating features of the environment and nature of the operation are that the South Tarawa Lagoon environs are naturally subject to chronic sedimentation resulting from re-suspension of fine carbonate sediments due to prevailing physical elements of wind, wave and current. The biota is adapted to a sedimentary environment both in terms of substrate and the prevalence of chronic siltation. A significant mitigating component is the naturally low biodiversity of benthos characteristic of the submerged barrier reef, particularly the very low coral cover to the east.

Though the sediment-laden plume will add to the existing sedimentary regime, the amount is not considered detrimental. However this will vary on the location of the dredging activity. A monitoring program will provide vital information on the extent and impact of the plume.

The EIA is tasked with weighing up the potential for increase in sedimentation and substrate removal, and its effect on the nature and value of the fisheries in the area. This is achievable through a good understanding of the dredging operation and the fisheries. Monitoring is an indispensable component of this. Clearly, some degree of impact is expected and acceptable as extraction from a small area in the lagoon will be greatly beneficial and preferred over the current practice of taking it from the coastal beaches around South Tarawa.

7.8 Intended investigations or studies of the possible impact of the proposed activity on the environment

A study is to be conducted by the Ministry of Fisheries & Resource Development in conjunction with the Secretariat of the South Pacific Community (SPC) to provide a description of various fisheries on the submerged barrier reef and surrounding waters area north of Betio. This will entail a questionnaire and interview study: 1) What are fishers catching? 2) What species are being taken? 3) What fishing methods are being employed? 4) What is the level of dependence of the population of Betio and elsewhere on the resource? Are there known spawning aggregation sites likely to be affected? How sensitive are the fisheries to such impacts? In addition, is the conducting of a resource assessment employing field survey and sampling. The information will allow a better assessment of impact by the physical factors associated with the dredging operation.

7.9 An account of any similar projects elsewhere and a description of the impact, and controls used.

Atoll countries share a common problem of requiring aggregate resources for domestic building and infrastructure projects without adverse impact on the scarce land. Fortunately, offshore resources created through the atoll's evolution are abundant and safe for extraction, if caution is exercised with regard to sensitive fisheries areas and the potential for erosional impacts on the atoll islands. A number of examples on utilising the offshore resources exist.

Similar to the present situation, Webb (2005a) reported on Smith (1995a, b) in assessing the nearshore aggregate resources in the central Fongafale area of Tuvalu. There was a pilot dredging project in 1992 confirming the adequate supply of the resource as a cost-effective product to Funafuti. South Pacific Regional Environmental Programme (SPREP) concluded that there were no significant environmental impacts on lagoon communities before, during and after the completion of SOPAC's pilot dredging project (Kaly and Jones 1994). Additionally, the borrow pit filled with this aggregate material now supports crops (e.g. taro and bananas), and is no longer vulnerable to flooding. The project is generally perceived by stakeholders to be a success (Webb, 2005a).

For Majuro Atoll in the Marshall Islands, Smith and Collen (2003) have assessed the sand and gravel resource removal from nearshore and shore areas. Lindsay (2008) conducted an environmental impact assessment where habitat removal and increased turbidity were similar impacts to the Tarawa aggregate extraction. Monitoring of the impacts was considered essential to adequate management.

For Tonga, Lovell (2004) investigated several sites north of Tongatapu. Aggregates being sourced from the island were problematic as in South Tarawa. Sites for sand removal were prioritised based on environmental and social considerations. Both private and government companies were engaged in the aggregate extraction.

In Smith and Biribo (1995), a case study of sand mining near Suva for ~ 40 years for the purpose of cement and lime production was described. This operation has similarities to the current proposed extraction in Tarawa Lagoon (e.g. the 100,000t/yr. rate of extraction by clamshell grab). Re-suspension of sediments within the tidal estuary and river effluent is comparable in effect to the natural turbidity of the Tarawa Lagoon. The area is dominated by vegetation (for Suva: seagrass and for Tarawa: algae) with very low coral coverage. It is different in the windward nature of the barrier reef, though in the case of Tarawa's summer monsoon, there are similarities. Penn's (1983) environmental impact assessment found impacts in terms of borrow pit creation and the alteration of the benthos from seagrass to mobile invertebrates such as holothurians, starfish and burrowing infauna. The removal of hard substrate leaves behind soft substrate with different environmental characteristics. There was minimal sluicing away of fine sediments with the operation of the bucket grab. There was no reduction in irradiance resulting from the plume nor evidence of a toxic anaerobic layer beneath the surface sediments. The study recommended discontinuous extraction areas to assist with natural remediation. It was predicted that the filling of the pits might be episodic through storm action, which may be similar in the Tarawa situation.

Comparing the dredging units, the bucket capacity is smaller ($0.7m^3$ vs. $2.5m^3$) i.e. < 1/3 of the proposed Tarawa dredge unit, but the Fijian barge capacity is more than twice (1000m3 vs. $480m^3$). The distance travelled is more than 3 times the one-way trip to the closest depot, and equivalent to the furthest depot (15 km. at Bonriki). Operation has ceased due to the need for a higher-quality calcium carbonate resource that is now being imported. It is likely that a new cement company will reopen the resource. During the time of the operation, adverse environmental impacts were not an issue with the resource in the lagoon behind a barrier reef, and with the biotas largely seagrass or lagoonal infauna communities. The plume of coarse sands was not extensive and did not influence the barrier reef corals due to the cross reef wave-generated currents flowing into the bay.

8.0 Climate change and variability

For the operation of the company, sea level rise is considered to be of little immediate consequence as the rate of rise is low (3mm/yr., Cabanes et al. 2001) For the longer term and with more extreme forecasts, a country with such low relief needs to be concerned. Both this rate and the more extreme projected rates will continue to have dire consequences for the atolls of Kiribati (e.g. erosion, saline pollution of groundwater).

Predicted variability in weather and projected increase in storm intensity will augment the need for aggregate construction materials, for both coastal protection (e.g. seawalls and revetments) and repair of damage (e.g. to infrastructure and dwellings).

9.0 Controls, safeguards, standards applied for the protection of the environment

9.1 Managed extraction

Successful protection of the environment with regard to the aggregate extraction is based on developing a management regime of monitored incremental removal. The objective is to have the resource utilised efficiently, and confining the area of disturbance to the smallest possible. Procedural protocols should be mandated as part of the operational management. Moorings should be required to minimise unnecessary vessel movement at the dredging location. Alternative sites should be identified to allow for the contingency that the impacts become unacceptable.

9.2 Monitoring

Additionally, the monitoring must be employed to allow for an adequate assessment of the effect of the dredging both from the standpoint of seafloor disturbance, and from the impact of the sediment plume. Quantification of the plume at varying distances from the extraction is essential for assessment. Trigger values, if exceeded, will require the dredge to cease operation or relocate to areas away from reef environment. Currently SOPAC has identified an alternative location for extraction in the more easterly portion of the bay. Alternating the extraction between several sites may be the best way to mitigate the impact of dredge-initiated sedimentation.

A safeguard built into the removal mechanism is an environmentally safe clamshell grab. The Valstar clamshell grab, developed by the Dutch firm Nemag, is designed to remove products such as coal where the spillover of the fines faction causes contamination. Equipped with special enclosed shells and special lip-plate plate sealing to limit the plume and load loss, it is often used in the dredging industry. It differs from other clamshell grabs in that it encapsulates the load preventing the loss of sediment as it conveys the load from the seabed to the dredge. The contained water or sediment-laden spillover is to be channelled back to the bottom. Release near the removal site limits the sediment spread by current transport and keeps the water column clear. The prospect of using a bubble screen or curtain to limit the sediment is considered unnecessary, as the option of relocating the dredge may be preferred.

The development of a dredging program with good documentation of the resource characteristics on removal is paramount. Knowing the quantities of extraction from designated locations in documenting the resource demand, type of materials and aggregate is important for planning subsequent operations.

A report (DEMAS 2008) commissioned by SOPAC has detailed the engineering options available to the Atinimarawa Co. Ltd. (ACL), previously known as Kiribati Aggregate Company (KAC), for the most efficient and environmentally-safe operation (Appendix 18.2, pg. 75).

9.3 Monitoring and reporting of the impact activity

Monitoring is an essential part of the continued assessment of impacts, both predicted and unpredicted. Baseline information is collected through the establishment of permanent PIT, photo transects and sediment trap measurements. Implementation of the inspection program will commence with the beginning of the project.

During the current field study, the basis for the monitoring program was established. A baseline record of permanent transects (photo & PIT) as well as sediment traps were set up at Sites 1-4 offshore along the eastern perimeter of the extraction site (Figure 53). Additionally, an identical monitoring program was also deployed at the depot sites 10 and 11.

Monitoring is to be conducted by participants from the MFMRD and MELAD. Personnel from these Ministries took part in the field study and consultation stages and are listed in Section 16.0. The monitoring will begin with the initiation of the dredging in which the impacting operation of the clamshell will be inspected particularly with regard to the plume. The density and movement of sediments into peripheral areas is crucial to the understanding of the extent and degree of likely impact on the biota of the submerged reef and surrounding environs.

The monitoring involves reporting on: 1) Comparison of permanent transect PITs; 2) Comparison of quadrat information along the permanent photo transect; 3) Replication of the sediment trap stations for baseline comparisons; 4) Liaison with the Dept. of Fisheries regarding the monitoring and assessment of fisheries impacts.

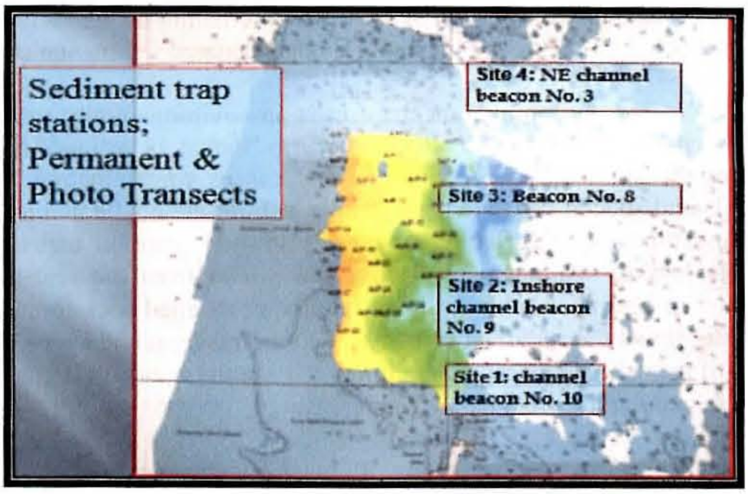


Figure 53. Location of the sediment trap, PIT and photo transect stations.

At the depot sites, monitoring will involve: 1) Comparison with the paced walking transects; 2) Comparison of photo transect information; 3) Replication of the sediment trap stations for baseline comparisons.

It is recommended that monitoring is initiated at the beginning of the dredging operation, undertaken again weekly for the first month, and then fortnightly for the next 2 months and every 6 months following. Modification of this program may occur depending on the monitoring observations.

10.0 A summary of benefits

The principal benefit of utilising the lagoon resource is in providing Kiribati with sand, gravel and stones for more than 50 years. This will allow for the cessation of beach mining and the return of natural protective coastal processes in the restoration of beach barriers to tide and storm surges.

Greer Consulting Services (2007a, b) discussed the economic analysis of aggregate mining on Tarawa. It considered the dredging operation to be highly preferable with regard to environmental damage, and economically.

From this study and that of Cruickshank and Morgan (1998), the dredging program is adequate to monitor and manage, the impacts resulting from the aggregate removal. From this study, it is believed that the impacts will be acceptable and not significantly impacting on the barrier reef benthos or its fishery. The primary benefit is that the aggregate resource is abundant and useful long into the future. During this period, it will provide a boost to economic activity of South Tarawa and Kiribati generally, enhancing well-being within the foreseeable future in terms of housing and infrastructure. Development will provide jobs, and a wider employment base will make for an improved economy.

The current reliance on the beach-mined resource traditionally used by communities will be phased out, with alternative employment enabled through the operations of ACL, or spin-offs from the company's activities, or an increase in products from the aggregates.

11.0 Alternatives to the current extraction design

Alternatives to the current program rely on the potential use of other lagoon extraction sites. This flexibility in the program allows for lagoonal removal from the best site selected based on the commercial aggregate requirements, and the minimising of impacts on the environment, particularly local fisheries. As the vessel is being provided through a European Union grant, finding the best source of aggregate is an important responsibility.

Damlamian (2008) recommended that a site, to the northwest of the proposed extraction area and more central in the atoll lagoon, be utilised due to the low current velocity minimising the spread of the plume. This is a suitable option if the impacts near Betio prove unacceptable.

Not taking advantage of the lagoonal aggregate resource will promote continued beach mining with its undesirable consequences. As well, the importation of sand and gravel incur higher building costs than if sourced domestically. Not only is the overseas material expensive but the logistics of importing it causes delay and often proves inadequate in supply. A clear consequence is that development will be greatly slowed. The benefits of an uninterrupted, affordable aggregate supply ensure a level of progressive development that would not be available with present aggregate resources.

12.0 Rational for the proposed activity as opposed to the alternatives

The lagoonal aggregate resource is currently unutilised. With the EU funded dredging ship, the prospect of an inexpensive, locally available resource will become a reality in which many benefits are evident and the impacts manageable. Monitoring of the proposed extraction site and the possibility of alternative sites provide a wide scope for satisfying the need for building materials while minimising the impact on the living environment.

13.0 Legal requirements

Developments, such as causeways and borrow pits, have not been subject to the environmental impact assessment (EIA) process as the Environmental Act requiring EIAs was passed in 1999. As such, no EIA's were undertaken for the Dai Nippon Causeway (DNC) that was completed in 1986/87 and created the borrow pits at Takoronga. In addition, exempt from an EIA was the port reclamation in 1990 resulting in the extensive foreshore borrow pit east of the wharf and adjacent to the Kiribati Institute of Technology (KIT) facility.

Considering national legislation, it is currently illegal to take sand and gravel from coastal environs without a permit from MELAD. There are designated areas for sand removal. With the lack of alternative sources, there is little enforcement to counter illegal sand removal. Webb (2005) recommended banning beach mining based on erosional damage to the coast where extraction is implicated. Greer (2007a, b) concurred that, as well as the environmental issue, the financial success of the dredging operation relies on the banning of utilisation of the beach resources.

With the Government supporting the dredging company, enforcement and additional regulations will be introduced to deter the illegal collection and sale of the beach material. Enforcement by MELAD will become more effective with Government-backed initiatives to curb illegal collection.

14.0 Community Consultations

The community consultations were held in Maneabas over a period of 19 days (4-22 March 2011). The Ministry of Fisheries & Resource Development (MFMRD) compiled a report on these consultations. The public consultations are compiled in Appendix 18.3.

15.0 Other consultation

Table 15. List of the individuals and bodies who have been consulted.

Name	Position	Organisation
Ribaanataki Aware	Permanent Secretary	Ministry of Fisheries & Resource Development, Kiribati
Herve Dalmanian	Researcher	Pacific Islands Applied Geoscience Commission
Nick Harding	Project Manager, ESAT Project	Pacific Islands Applied Geoscience Commission
Robert Smith	Research scientist	Pacific Islands Applied Geoscience Commission
Dr. Temakei Tebano	Facilitator for the consultations	The EcoCare Group, Tarawa, Kiribati
Dr. Arthur Webb	Principal Research Officer	Pacific Islands Applied Geoscience Commission

15.1 Interview

Table 16. People interviewed for their views on the proposed aggregate removal.

Name	Position	Organisation	Date of interview
Matereta Raiman	Permanent Secretary	Ministry of Public Works & Utilities	Thursday March 10, 2011
Moana Taki	Director	Ministry of Public Works & Utilities	Thursday March 10, 2011
Iannang Tearo	Director	Central Processors (CPPL)	Thursday March 10, 2011
Mere Raieta	Permanent Secretary	Ministry of Communication, Transport & Tourism	Thursday March 10, 2011
Ueneta Torua	Senior Officer	Division of Meteorology	Friday March 11, 2011
Farran Redfern	Director	Ministry of Environment, Lands, Agriculture Development: Department of Environment.	Wednesday March 9, 2011
Karibananja Aram	Acting Director	Ministry of Fisheries & Resource Development: Department of Fisheries.	Friday March 11, 2011

16.0 Participants

Table 17. List of contributors to the report and their contact details.

Name	Organisation
Ed Lovell	Team Leader - Biological Consultants, Fiji
Toaea Tewatei	Min. of Fisheries & Marine Resource
Aranteiti Tekiau	Min. of Fisheries & Marine Resource
Teema Biko	Min. of Environment, Lands, Agriculture
Noketi Karoua	Min. of Environment, Lands, Agriculture
Nick Harding	ESAT Kiribati Project Manager- SOPAC

Nemag Valstar Clamshell Grab: Nemag - P.O. Box 110 - 4300 AC Zierikzee - The Netherlands Phone +31 (0)111 418 900 - Fax +31 (0)111 41 61 54 E-mail: grab@nemag.com - Web: www.nemag.com

17.0 References

Anon 2010. Island preliminary data by sex for 2010 census. Ministry of Finance, Govt. of Kiribati.

Biribo, N. and Smith, R. 1994. *Sand and Gravel Usage South Tarawa, Kiribati 1989-1993.* Ministry of Environment & Natural Resources, Kiribati, SOPAC Secretariat, Suva, Fiji Preliminary Report 75.

Cabanes C., Cazenave A., and Le Provost 2001. Sea level rise during past 40 years determined from satellite and in situ observations. *Science;* Oct 26, 2001; Vol. 294, 5543; Research Library pg. 840.

CIA 2011. Central Intelligence Agency, United States (CIA). The World Fact Book, Kiribati. https://www.cia.gov/library/publications/the-world-factbook/geos/kr.html.

Cruickshank, M. J. & Morgan, C. L. 1998. *Economic Feasibility and Environmental Impact Assessment for Extraction of Sand Offshore Tarawa.* Report prepared for Ministry of Natural Resources Development, Kiribati by M.J. Cruickshank & C.L. Morgan Consultants.

Damlamian, H. and Webb, A. 2008. Inter-tidal channel flow in North Tarawa, Kiribati. *EU EDF 8 – SOPAC Project Report 136.* Pacific Islands Applied Geoscience Commission: Suva, Fiji, iv +19 p.

Damlamian, H. 2008: Hydrodynamic Model of Tarawa, Kiribati: Water circulation and applications. *EU EDF 8 – SOPAC Project Report 134.* Pacific Islands Applied Geoscience Commission: Suva, Fiji, iv + 35 p.

DEMAS 2008. Engineering options and solutions to establish Tarawa's proposed offshore aggregate dredging company. Report Version FJ02RepR20.doc submitted to SOPAC March 2008.

Durfour, V., Galzin, R. (1993). *Colonization patterns of reef fish larvae to the lagoon at Moorea Island, French Polynesia*. In, *Marine Ecology Progress Series* (102), 143-152.

English, S., Wilkinson, C. & Baker, V., (Ed). 1997. Survey manual for Tropical Marine Resources, 2nd Edition. Australian Institute of Marine Science publication. 390 pp.

Forbes, D. L. and Hosoi, Y. 1985. *Coastal erosion in South Tarawa, Kiribati. SOPAC Technical Report 225,* Suva, Fiji.

Gillie, R.D. 1993. Historical changes of shoreline accretion and erosion Betio Islet, South Kiribati. South Pacific Geosciences Commission (SOPAC), Suva, Fiji. *Technical Report 179. 22 p. + maps.*

Greer Consulting Services 2007a. *Economic Analysis of Aggregate Mining on Tarawa.* Kiribati Technical Report, *EU EDF 8 – SOPAC Project Report 71,* 110p. SOPAC Secretariat, Suva, Fiji.

Greer Consulting Services 2007b. *Summary Report on Economic Analysis of Aggregate Mining on Tarawa.* Kiribati Technical Report, *EU EDF 8 – SOPAC Project Report 71b.* SOPAC Secretariat, Suva Fiji.

Hill J. and Wilkinson C. 2004. *Methods for Ecological Monitoring of Coral Reefs – A Resource for Managers.* Australian Institute of Marine Science. ISBN 0 642 322 376.

Howorth R. 1982. *Coastal erosion in Kiribati, South Tarawa. CCOP/SOPAC Technical Reports nos. 22 and 25.* CCOP/SOPAC UN Mineral Prospecting, Suva (Fiji).

Howorth R. 1983. *Report on Coastal Erosion in Kiribati*; Visit to South Tarawa 23 August – 8 September 1983. *SOPAC Technical Report 31*. Suva (Fiji).

Kaly, U.L. & Jones, G.P., 1994. Assessment of ecological impacts on lagoon communities: Final report on the pilot dredging project, Funafuti, Tuvalu. Report 86. South Pacific Regional Environmental Program, Apia, Samoa.

Lasker, H. R. 1980. Sediment rejection by reef corals: the roles of behavior and morphology in *Montastrea cavernosa* (Linnaeus). Journal experimental marine Biology and Ecology 47: 77–87.

Lecchini, D., Galzin, R. (2005). *Spatial repartition and ontogenetic shifts in habitat use by coral reef fishes (Moorea, French Polynesia)*. In, *Marine Biology* 147:47–58.

Leis, J., McCormick, M. (2002). *The biology, behavior and ecology of the pelagic, larval stage of coral reef fishes*. In P. F. Sale (Ed.), *Coral Reef Fishes: dynamics and diversity in a complex ecosystem.* (pp. 171-198). San Diego: Academic Press.

Lindsay S. 2008. Rapid Biological Marine Assessment of the Proposed RMI-EPA Sand and Aggregate Dredging Site Locations within Majuro Lagoon Republic of the Marshall Islands. *Technical Report 105, EU EDF-SOPAC*. SOPAC Secretariat, Suva.

Lovell, E.R. 2004. Environmental Impact Assessment of Sand Resource Extraction North of

Tongatapu. South Pacific Geoscience Commission, Suva, Fiji in partnership with Biological Consultants, Fiji.

Lovell E.R., Awira R., Kirata, T., and T. Beiateuea (1999) Description of the Coral Reefs of Tarawa and Abaiang Atolls. *SOPAC Technical Report 310*. South Pacific Applied Geoscience Commission, Suva, Fiji, 87 pp. August 2000.

Lovell E.R. T. Kirata and T. Tekinaiti (2000). National Coral Reef Status Report: Kiribati, International Ocean Institute (IOI) – South Pacific and the Kiribati Fisheries Division for the International Coral Reef Initiative (ICRI) and the South Pacific Regional Environmental Programme (SPREP), Biological Consultants, Fiji, and Marine Resource Assessment, Management and Monitoring (Inshore) Fisheries Division, Kiribati, 33pp. Status of Coral Reefs 2000 in Southeast and Central Pacific "Polynesia Mana' Network Edited by Bernard Salvat.

Lovell E.R. T. Kirata and T. Tekinaiti (2002). Status report for Kiribati coral reefs. Coral reefs in the Pacific: Status and monitoring, resources and management. Les récifs du Pacific: etat et suivi, resources et gestion. International Coral Reef Initiative (ICRI). Documents Scientifiques et Techniques Vol. II5 (special); Institut de recherché pour le développement (IRD).

Maharaj, R.J. 2000. Guidelines for Monitoring and Evaluating Beach Erosion and Shoreline Dynamics. Tarawa, Kiribati, 14-16 March 2000. April 2000 *SOPAC Training Report 84.*

Marshall, JF. and Jacobson G. 1985. Holocene growth of a mid-Pacific atoll: Tarawa, LJ Kiribati, *Coral Reefs*. 4: 11-17.

Paulay G. and Kerr A. 1994. Coral Reefs and Coral Communities of Tarawa. BioSystems Analysis Inc. Sept. 1994.

Paulay G. and Kerr A. 2001. Patterns of Coral Reef Development on Tarawa Atoll (Kiribati). *Bulletin of Marine Science, 69 (3): 1191-1207.*

Pastorok, R.A. and Bilyard, G.R. 1985. Effects of sewage pollution on coral-reef communities. *Marine Ecology Progress Series 21: 175–189.*

Pelesikoti N. 2007. Planning Guidelines for Offshore Aggregates Dredging: Sustainable Development and Management of Marine-Sourced Aggregates. Pacific Islands *Technical Report EU EDF 8 & 9 – SOPAC Project Report 128*. SOPAC Secretariat, Suva.

Penn N., 1983. The environmental consequences and management of coral sand dredging in the Suva region, Fiji. MSc thesis, Pacific Collection, University of the South Pacific.

Richmond, B.M. 1990. Near-shore sediment distribution, South Tarawa, Kiribati. *CCOP/SOPAC Technical Report 91*. South Pacific Geosciences Commission, Suva. Fiji.

Smith, R. 1995a. Assessment of Lagoon Sand Funafuti Atoll, Tuvalu and Aggregate Resources. 1995 *SOPAC Technical Report 212*. SOPAC Secretariat, Suva.

Smith, R. 1995b. Bathymetric and Physical Monitoring of the Pilot Project Dredging Site in Funafuti Atoll, Tuvalu February 1995 *SOPAC Technical Report 21 6*. SOPAC Secretariat, Suva.

Smith, R., Collen, J. 2003. Sand and gravel resources of Majuro Atoll, Marshall Islands. *SOPAC Technical Report 360.* SOPAC Secretariat, Suva.

Smith R. and Biribo N. 1995. Marine aggregate resources in Tarawa lagoon, Kiribati - including current meter studies at three localities SOPAC Secretariat, *SOPAC Technical Report 21 7,* SOPAC Secretariat, Suva.

Smith R., Biribo N. and Etuate, B. 1995. Bathymetric Map of Kiribati-Tarawa Lagoon, 1:45,000 *SOPAC Bathymetric Series Map 28,* SOPAC Secretariat, Suva.

Tebano, T. (1991). Is it development or destruction? Impact of physical innovations on atolls. Biological and ecological implications. Institute of Marine Resources; The University of the Pacific.

Tebano, T. (1992). Ciguatera poisoning and reef disturbance in South Tarawa, Kiribati. Atoll Research Program, Tarawa, Kiribati. SPC Ciguatera Information Bulletin (1992). Bulletin no. 2. Fisheries Information Project, SPC.

Tebano, T. and R. Lewis (1990). Ciguatera fish poisoning and reef disturbance: observations on ciguatoxin level in reef fishes at Nei Tebaa channel, Dai Nippon causeway, South Tarawa, Kiribati. Fisheries Division, Ministry of Natural Resource and Development, Tarawa, 18 pages.

Webb, A., 2005a. Tuvalu Technical & Country Mission Report – Aggregate supply, lagoon water quality and causeway construction Funafuti and Vaitupu atolls. *EU-SOPAC Project Report 36.*

Webb, A., 2005b. Technical Report -- An assessment of coastal processes, impacts, erosion mitigation options and beach mining. (Bairiki/Nanikai causeway, Tungaru Central Hospital coastline and Bonriki runway -- South Tarawa, Kiribati). *EU-SOPAC Project Report 46.* South Pacific Applied Geoscience Commission, Suva, Fiji.

Weber J.N. and Woodhead P.M.J (1972) Carbonate lagoon and beach sediments of Tarawa Atoll, Gilbert Islands. *Atoll Res. Bull. 221.*

Werner, E. E. (1988). *Size, scaling and the evolution of complex life cycles. In: Ebenman, B., Perssons, L. (Eds.) Size-structured populations*. In P. L. Ebenman B (Ed.), *Size structured populations* (pp. 61-88). Berlin: Springer-Verlag.

Zann, L.P. 1982. The marine ecology of Betio Island, Tarawa Atoll, Republic of Kiribati. *United Nations Committee for the Co-ordination of Joint Prospecting for Mineral Resources in the South Pacific (CCOP-SOPAC) Technical Report #23* 25 p. +appendices.

18.0 Appendices

18.1 EIA Terms of Reference

1. Purpose:

Assess, identify and communicate possible impacts of the dredging operations in the aggregate resource area, unloading areas and broader Tarawa lagoon environs and provide practical advice on best practise operations and where appropriate mitigation measures.

2. Tasks:

The consultant is expected to:

- Work closely with Mineral Unit, Environment and Conservation Division, Public Works Division, Fisheries Division (key local counterparts) and SOPAC to develop a work plan of activities including timeframe of each activity and submit it to the ESAT/ Aggregate Company Project Coordinating Committee through the Mineral Unit two weeks prior arrival in Kiribati for undertaking the consultancy work for further adjustment by the Committee.

- To carry out an Environmental Impact Assessment of the project and to prepare a report in accordance with the EIA report format (Environment Act 1999 – as amended in 2007 - copy attached with this TOR…see Annex 2).

- Submit six hard copies of the EIA report to the Principal Environment Officer, Ministry of Environment, Lands and Agricultural Development (MELAD) and SOPAC (electronic copy only) for review. An electronic copy of the report must also be provided to the Ministry.

- In the course of undertaking the EIA studies involving baseline data collection and monitoring work, the consultant is expected to work closely with local Ministry counterparts to impart practical training on the assessment and monitoring techniques.

- Work closely with the local counterparts to develop relevant environmental baselines for monitoring purposes (e.g. assess ambient water column sediment loads, sedimentation rates, transects in sensitive neighbouring benthic habitats, etc.).

- Undertake an assessment of the biological components and their broader ecological function in the location of the resource area (e.g. fish, epifaunal/infaunal invertebrates, seagrass, corals, algae, etc).

- As it relates to environmental management, develop best practice guidelines for ESAT for environmental protection - in consultation with the Kiribati Government and ESAT Management.

- Develop a user-friendly environmental monitoring guideline, which will be used by local counterparts as a guidance document in future monitoring. The copy of the monitoring guideline must be made available to the ESAT / Aggregate Company Project Coordinating Committee the same time the first draft EIA report is submitted for review.

- Present preliminary results and findings to stakeholders including the Project Coordinating Committee and South Tarawa local communities in Kiribati at the completion of the two weeks fieldwork. The presentation must be delivered in a power point format and appropriate form (graphical, non-technical) to local stakeholders.

- Consult and review previous reports related to this activity including geophysical, oceanographic, coastal, environmental and social/economic work carried out by SPREP and SOPAC (e.g. Community Consultation on Household Surveys on Beach Mining, SOPAC, 2007). Review and include the main findings of such work in the context of the current EIA.

- Consult relevant bodies including Ministry of Communications, Ministry of Works and Public Utilities, Central Product Producers Limited, Betio Fishermen Association, brick makers, aggregate mining community.

3. Outputs:

An important output of the assignment will include:

- The first draft EIA report and data
- The final draft of the EIA report
- Best practise operational guidelines
- The Environmental Monitoring Guidelines
- Practical training to local counterparts
- PowerPoint presentation to local stakeholders

4. Reporting:

- The first draft of the EIA report must be submitted five weeks after the start of the fieldwork.

- The final draft must be submitted one week after the receipt of comments of the first draft after public display from the Government of Kiribati.

Requirements of basic environmental impact assessment report

For the purposes of section 33(1)(d) of the Act, a basic environmental impact assessment report must include the following details—

Item	Detail
1	the objectives of the proposed activity
2	an analysis of the need for the proposed activity
3	a description of the proposed activity, including— (a) if the activity includes construction work— (i) designs, plans and maps; (ii) the quantities of any materials and equipment

	needed; (iii) the nature of any construction or works process; (iv) construction working hours; (v) proposed schedule for implementation and completion; (b) if the activity includes carrying on an environmentally-significant activity— (i) the nature and extent of the activity; (ii) materials needed; (iii) sourcing of material, whether imported or locally sourced; (c) if the activity includes taking, harvesting, growing or keeping of organisms, the type and number of organisms involved; (c) if the activity includes the generation of any waste substances or energy— (i) the nature and quantity of any waste products; (ii) proposed methods for controlling and dealing with any waste products; (d) if the activity includes harm to a coral reef, mangrove or sea grass bed, the nature and extent of the harm; (e) if the activity includes harm to a protected species or ecological community, the nature and extent of the harm; (f) if the activity is in a protected area or World Heritage area, the nature and extent of any harm to the protected area or World Heritage area
4	a description of the environment likely to be affected by the proposed activity
5	the potential or actual impacts of the proposed activity on the environment
6	a description of any intended investigations or studies of the possible impact of the proposed activity on the environment
7	a description and assessment of the controls, safeguards, standards or other measures intended to be adopted or applied for the protection of

	the environment
8	a description of how climate change and climate variability may impact on the activity
9	a description of any intended monitoring and reporting of the impact of the activity
10	the benefits of the proposed activity, including any economic, social and cultural factors
11	reasonable alternatives to the proposed activity, including, at least, the alternative of not undertaking the activity
12	an outline of the reasons for the proposed activity as opposed to the alternatives
13	a description of any other legal requirements relating to the proposed activity
14	a summary of the results of consultations with communities likely to be affected
15	a list of the persons and bodies who have been consulted
16	a list of contributors to the report and their contact details
17	a summary report written in Kiribati

18.2 Proposed vessel type with crane and clam dredge.

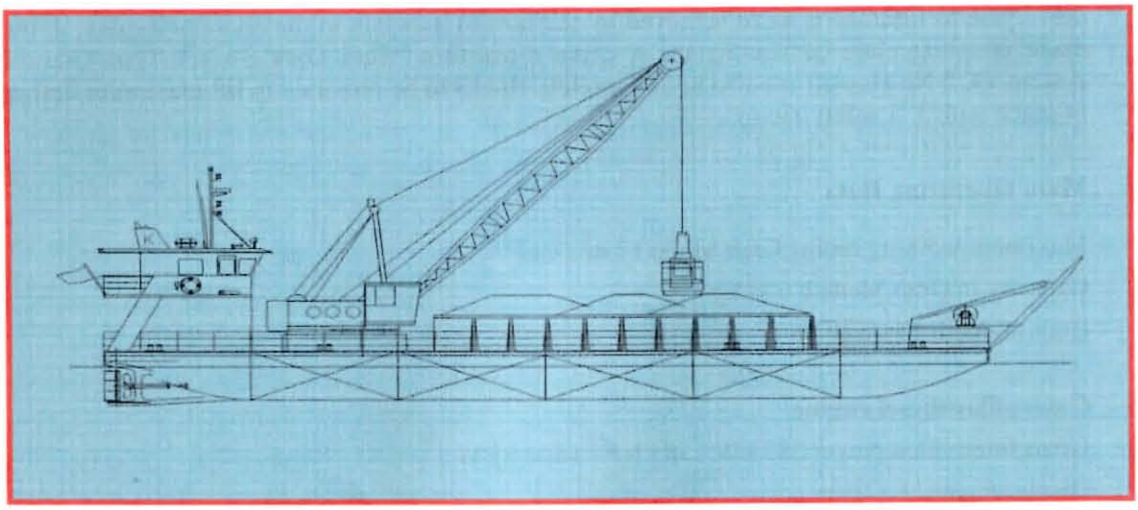


Table 18. Vessel specifications:

Length overall	36.00m
Beam (mld)	12.00m
Depth (mld)	2.40m
Draft aft loaded	2.00 max.
Power	2X350hp
Service speed	7.5kts
Fuel	20,000l
Fresh Water	6,000l
Light displacement	300t
Deadweight	480t
Full displacement	780t

Crane specifications:

Duty Cycle Crane: PLM Cranes, Sluisweg 25, 4794 SW Heijningen, Netherlands.

Basic description

The dredge will have a pedestal mounted crane with a boom length of 17m using a 2.6 m^3 heavy duty clamshell for the dredging of coarse aggregates and a 3.5 m^3 standard clamshell to dredge the fine aggregate and for the discharging of the hopper when required. A duty cycle 4 rope crane with a capacity to lift 8.1 tonnes at a reach of 17 m offering maximum stability and loading of the dredge hopper including a slew bearing mounted on a pedestal to be provided. The production requirements and capacity required of the dredging system is as follows:

The dredge will have a crane with a boom length of 17m with a maximum boom reach during dredging of 14.5 m using a 2.6 m^3 clamshell for the dredging of coarse aggregates and a 3.5 m^3 clamshell to dredge the fine aggregate and for the discharging of the pontoon. The dredging cycle times required are as follows: Cycle time per clamshell load of fine aggregates 51 seconds at 10 m water depth; Cycle time per clamshell load coarse aggregate 55 seconds at 10 m water depth. The duty cycle crane will also have the facility of being able to work purely in **liftcrane mode**, where the crane is automatically slowed down and load moment protection is provided. The switch from duty cycle to liftcrane is to be achieved by the turn of a switch in the operator's cabin. A purpose made coupling plate connecting the 4 crane ropes to a "Sure Lock Swivel Type Crane Hook system (X 2 No Hooks) are also to be supplied. Hooks to be provided to lift maximum design load of crane with 5 :1 safety factor.

Main Operating Data

Maximum working radius Grab Mode 17 m

Capacity in Grab Mode 8.000 kg

Boom Length 17,0 m

Caterpillar diesel engine

Gross intermitted power 287 kW / 385 HP / 1800 RPM

Displacement 11.1 liters

N^O of cylinders 6 in line

The Cat11 selected is a four-stroke, directly injected electronic diesel engine.

Carbody

A main feature of the car body is the rugged construction of the superstructure. The whole superstructure is of one piece welded incorporating all winches, sheaves and machinery mountings into a single fabrication. All construction steel plates used for the superstructure are to be S355(St. 52-3) or suitable equivalent. Base of the superstructure is a thick bedplate on which the slew ring is mounted. After welding the bedplate and the rest of the construction is machined as a complete unit. Winch mountings, boom hinges and machinery mountings are line bored for a high accuracy. This type of construction is necessary to achieve overall stiffness and accuracy for a long, crack free length of life.

Boom

The lattice boom consists of two sections: the heel and the head section. Boom sections are joined by pins and cast steel clevis assemblies. The boom is a heavy section tubular structure with square section chords and round lacings. All sections to have a very heavy wall thickness to avoid fatigue cracking as a result of side loading.

Operators cabin

A large operator's cabin will be mounted on the crane in which an operator can work comfortably all day long. The cabin stands for exceptional operators comfort. It is a large and silent cabin equipped with an air conditioning, which will contribute to the concentration of the operator and (indirectly) to a high and continuous productivity.

The cabin will be mounted on the chassis with rubber connections. These will reduce noise and vibrations. Safeties are provided to prevent the engine from running if the driver leaves the cabin. The cabin and chair are designed in such way that they can give the operator all the comfort he needs. The chair is completely adjustable and has comfortable suspension.

The crane will be handled by means of two hydraulic joysticks. These joysticks provide great ease of use and avoid the use of pressure pipe lines. The control panel can be adjusted electronically to the preference of the operator. He can choose different levels that vary from fast and productive to low and very precise. These set ups can be altered with a button on the bracket in such way that the machine can be set correctly for every application.

Large cabin 1.1m with headroom of 1.75m. In the cabin, a fire extinguisher of 3kg is mounted Excellent view from the cabin afforded by the provision of large and wide windows. with a large skylight to give a good view above the head. The upper window is equipped with a single windscreen wiper and the under front window has a parallel windscreen wiper and washer in order to provide a good view during bad weather conditions. Top window white glass and can be can opened Under front window white glass fixed mounted with remaining windows tinted. All windows are to be made of hardened safety glass. Retractable blind to be provided to large skylight.

Sound Suppression
The machinery cabins on both sides of the superstructure are to be covered with sound suppressing insulation. The engine is connected to a large silencer with vertical exhaust stack mounted on the bottom of the chassis.

Fuel Tank and Filters
The diesel tank is integrated in the superstructure and standard has a capacity of approx. 600 liters. The tank has fuel filters on the outside to ensure that the engine only receives clean fuel. Extra filters are provided on the engine. Filter replacements must be readily available in region from Fiji.

Safety gate

The drivers cabin has an entrance safety handle. Before the crane driver can leave the cabin the handle has to be lifted. When the handle is lifted crane controls are locked.

Emergency stop
The dashboard is provided with an emergency stop to switch off the machine in one movement, if necessary. The emergency stop can also shut down the machine at the end of working time. Emergency stops will also be mounted on both sides of the gantry near the stairs.

Environmental Features

The following environmental features are to be incorporated:

- Loss of pressure detection
- Sound suppressed and insulated machinery house
- Large engine exhaust silencer

Protection of the environment from fluids in the crane – the crane's hydraulic oil system is to be self contained therefore should any leakage to the system occur all fluids are to be retained within the structure of the crane to ensure the environment is fully protected from all hydraulic fluids. – Details of how the environment will be protected from potential fuel oil leakage are to be provided.

Clam Shells

Grab dredging involves the aggregate being cut and removed by the clamshell and directly taken up by the grab. The clamshell edge or teeth cut through the aggregate and collects the same in the shell thus disturbing a small percentage of the material whilst picking it up at near seabed density and little dilution.

Some material will escape to the outside of the clamshell and washed on the way up and into the hold of the pontoon. The overflow of the hold will be limited to the washout of the process water at the dredge site which is less than with a suction dredge because the aggregate does only pick up a limited percentage of water when grabbing. The aggregate will release the process at a lower rate than with suction dredge and thus result in lesser load of suspended solids in the water column both at the dredging and at the discharge location.

At the discharge side the clamshell will grab the aggregate and place it in a stockpile in the shape of a pond with a bund high enough to contain the whole of the cargo. The process water will be released through the pores of the bund, which will keep the fines in. Any stockpile must be given sufficient time to release the process water before a new cargo is discharged in the same pond (DEMAS, 2008).

Two environmental clamshells are required these are to be mechanically operated grabs compatible with the duty cycle crane:

- Four Rope operated: 2 Holding Ropes & 2 Closing Ropes

One grab with a capacity of 2.5 m3 for the purpose of dredging gravel aggregates, heavier material like broken coral and broken rock compact sand, provided with teeth of the make VSG. One grab with a capacity of 3.5 m3 for dredging of light materials, provided with smooth edges of the make VS, for the purpose of dredging finer marine aggregate sands and barge unloading. The shells are to be fitted with heavy-duty interchangeable teeth, which are easy and quick to replace. The rotation points are to be equipped with heavy duty bearings. The bearings are double sealed to prevent entering dirt into the bearings. The grabs to be manufactured of high wear resistant steels such as Hardox 400, Weldox 700.

The environmentally safe grab built by the Dutch firm Nemag is the Valstar grab. The grab can be designed with open, half-open or fully-closed shells. The (partial) closure of the shells makes this type of grab well suited for loading and unloading of coal and other powdery bulk materials like alumina and phosphates. The grab can also be fitted with a product-specific lipplate sealing. One of the most remarkable innovations the company has made is the development of the closed Valstar grab for coal handling which is particularly clean in use and well suited for the dredging of aggregates where the escape of fines is of concern through plume pollution.

Figure 54. Example of the crane to be used by the dredge ship.

Figure 55. Two examples of enclosed grabs with lipplate sealed jaws.

The dredge is positioned with four to six mooring anchors and is capable to dredge progressively which limits the disturbance of the bottom. This allows for accuracy in returning to the dredging site. The mooring anchors can be positioned at different sites which are characterised by different aggregate types.

18.3 Public Consultations

GOVERNMENT OF KIRIBATI

EIA Public Consultation Report

Introduction:

An EIA public consultation was conducted from the 4th to the 22nd March, 2011, to 22 Mwaneabas on South Tarawa. A team conducting this consultation included Dr Ed Lovell, an EIA Consultant from the University of the South Pacific, Nick Harding, the ESAT project Manager and local counterparts from the Fisheries Division, Environment and Conservation Division and the Mineral Resources Unit. Dr Temwakei Tebano facilitated the consultation.

The main objective of the consultation is to present to the public, results of the EIA work undertaken in regards to the ESAT project dredging sites and stockpile areas and to seek their views, opinions and concerns towards the project.

For background information, the EIA fieldwork was conducted by Ed Lovell with local counterparts from the Fisheries Division and Environment and Conservation Division. The field survey involves collecting baseline data on marine fauna and flora at:

- The two proposed dredging sites
- Stockpile areas which includes PWD existing stockpile area, end of Bonriki air field and the proposed reclamation area behind KIT
- propose channel or pathway to allow the barge able to ship the materials onshore

The result of the EIA at the two proposed dredging sites which was the main focus of the study are as follows:

- South Tarawa Lagoon environment is subject to chronic sedimentation resulting from re suspension of fine carbonate sand and silt due to prevailing wind actions.
- The biota are adapted to a sedimentary environment both in terms of substrate and chronic siltation.
- Generally at the proposed depot sites, the reef surface is covered by sand & rubble with algae predominating
- Low biodiversity for hard coral and other benthos exist on the submerged barrier reef.
- Reef rock with coral fauna but low coral cover
- Notable are the large tabulate Acropora colonies
- Algae predominate in the western portion of the submerged reef.

It was concluded from the fieldwork that Extracting sand and gravel from a confined area in the South Tarawa lagoon will be greatly beneficial over the current practice of taking it from the coastal beaches. The impacts of sand, rubble and rock removal are minimized by the natural environment where siltation and low biodiversity are characteristic. The impact of dredging will progressively inundate the sand surface with the local extraction progressing over a 50 year period. The sediment laden nature of the environment means that the infauna (worm and clam) will not be affected peripheral to the site. The increase in bathymetry may be beneficial to the finfish. The relative area of disturbance is small compared to the larger lagoon-reef ecosystem,

- Mitigation: Sediment plume will be reduced by the selection of an environmentally friendly clamshell dredging grab.
- Regular Monitoring of the operation and particularly the plume to be undertaken to further understand the nature of the impacts.
- It is recommended that monitoring is engaged with beginning of dredging, undertaken again in the first 3 months and every 6 months following.
- Re-assess permanent transects: PIT, Photo & Paced.
-

Venue	Date	No of people present	Concerns raised	Answers
Bairiki East (Labour Line KPC Maneaba) 4th March 2011, 2am (7 people) Kabure				
1. Are we going to buy the Aggregate from the Company?				1. Yes, the idea is to distribute aggregate to miners to sell them or you can buy directly from the company
2. What will be the likely impact of the dredging ship to the fisheries?				2. The likely impact anticipated from the study is minimal however we do not really know until the dredging operates and regular monitoring is carried out. The impact on fisheries is not covered in the study because it is very difficult to count the fish at the area however the Fisheries Division will undertake fishing surveys at the dredging area and see what kind of fish can be found in the area.
3. Are we going to stop mining and selling aggregate once the company is up and running?				3. Landowners have a customary right over the beaches, however this is just an alternative source of aggregate and promoting the impact of mining on coastal areas. The government can not stop people from mining, but the intension behind the project is to provide a source of aggregate in which people can turn to if they do not want to lose their land from mining.
Tabonkabwauea, Bairiki West 5th March 2011, (9am) – Riakaina. Teiwaki				
1 Which place is more suitable				1. From lagoon rather than mining it straight off the

for taking sand for daily use needs? 2 Do we have to buy sand from the company?	beaches. 2. Yes, aggregate/gravel dredged by the barge will be made available at an affordable/reasonable price. However no confirmation has been made for the price of aggregate/gravel that will be made available by the company.
3 What about Outer Island people? Are they also under the same scheme, where they will be restricted from mining the beach, and buy aggregates from the company?	3. Yes, basically if outer island people need a significant quantity of aggregate for infrastructural development or projects, the barge will take sand available for whatever purpose and needs of the outer island people.
4. Will the dredge have any impact on the atoll?	4. We cannot confirm on the impacts of the dredging, however the EIA was purposefully employed to assess the likely impacts of the dredge to the surrounding environment. Surveys will be carried out before, during and after the dredge periods to assess impacts of the dredge to the lagoon area.
5. Why isn't sand/aggregate mined from Banaba instead? – and why isn't the Ministry of Environment initiate the dredge, and why is it that a company has to do the dredging?	5. To mine sand/aggregate from Banaba, will add cost to the sand/aggregate that will be made available to people. Thus lowering the cost will give a reasonable price of a bag of sand to people. The Ministry of environment and Lands are involved in the project and all activities of the company, mainly the Environment Impact Assessment. The Ministry of Environment also has a capacity to which it comprises the team members of the carried out EIA done for the proposed dredge sites.
6. How much will a bag of sand/aggregate cost? Because it will not make sense if it's expensive since people will remain mining the beaches.	6. Price is still to be determined. The barge will be here around March, 2012, and the price will be competitive to the price of the current sand miners in Temwaiku and Bonriki.
Nanikaai, Teetu Mwaneaba 5th March 2011, (2 pm)	
1. What do you mean by dredging aggregate/gravel?	1. To mine, or to make aggregate/gravel available from the lagoon for multipurpose needs, such as road constructions, airport upgrading, and other development needs.
2. If mining from the beach will be restricted, then where will we get our sand and gravel from?	2. You are required to buy it from the company at an affordable price.
3. Are we allowed to build seawalls?	3. Yes, but under certain conditions, where you have to obtain a license in order to be assisted/advised by the Ministry of Environments on the sea wall that you are

4. What about people who continue to mine sand from the beach? And what are some ways in which mining sand beach can be minimized or stopped?	about to construct/build. 4. MELAD is the ministry responsible against any acts of beach mining. The police can also assist in such situations, where you can toll free the nearest police station and report suspicious sand mining to be investigated.
Mwaneaban te Katorika, Bonriki Tuesday 8th Feb 40 to 50 pple (Titeem)	
1. We depend on mining as our main source of income, so if mining is going to be banned, is there a way the government can help us as we do not have any jobs?	1. ESAT will help in finding alternatives for earning money. It is also very important to find our own ways to earn money and not wait for the government to help.
2. Is there any stuff like stones/rocks that will not be used by the company that we could use?	2. Only aggregate will be taken from the extraction site and the rest remain in the sea for marine life.
3. Can the people in Bonriki help to work in the company and sell aggregate to others?	3. Yes,
4. Question by Alice Leney,CPP TA :Do you work at the seawall that is currently underway in Bonriki right now?	4. No, if we get a job then we could give up selling aggregate, by Bonriki people
5. Can you buy the aggregate first from the company and then sell it?	5. Answer from Bonriki people, We want to know first how much will it cost from the company.
6. Question by Alice, Are there any miners among you right now?	6. No, most of them live at the New Road area. People live in Bonriki village do the mining inland as they do not have beaches and it is an individual business. Temwakei explained that there will be a community Consultation Programme that will be carried out from April and the miners will be visited.
7. Can women be employed too in that company?	7. Yes, the company is for everyone
Reieintebukaniman, Betio 8th March 2011 - Atantonga	

1. If the company is going to sell aggregates, how can I afford to buy it if I do not *have money?* 2. Is the quality going to be the same with what is going to be extracted from the lagoon? 3. Will there be any impacts to the land if they start dredging?	1 The company will sell it at the lowest price, cheaper than what miners are using right now. 2 Yes, there is no different. 3 That is why the monitoring will be carried out every 3 or 4 months to see whether there are impacts or not.
KPC Maneaba, Temwaiku 9th March 2011 – Riakaina	
1. If the company is successful, will people need to buy sand? How much will it cost us?	1. The company was setup for the purpose of providing aggregate/gravel to meet needs of people with these materials, and in order to keep the company running, you will have to pay for a bag of sand/gravel. Cost has not been projected yet, however it will be competitive with the current price of sand.
2. What will happen to those people who sell sand from Temwaiku and Bonriki? Will they be stopped from selling sand?	2. The Ministry of Lands are responsible for any illegal mining activity carried out. One way in which people can help eliminate or minimize illegal beach mining is by helping assist the police in reporting any major mining activity carried out.
3. There are people who have been mining the beaches, and there's nothing that has been done to them. What are some of your ways to eliminate or minimize such acts, and how can we stop people we see from mining the beaches?	3. The company will try and assist such people who heavily depend on the sales of sand for the livelihood. There are ways such as providing them employment opportunities in a way that their livelihood is not affected from when stopping them from selling their sand and gravel.
Mid Betio, JSS 10 March 2011, Kabure	
1. I think it is wiser for the Government to relocate the People of Betio to another village, because we will now lose our marine resources from this dredging ship. 2. Do you think the dredging operation from the lagoon will solve coastal erosion along the shoreline? Do you think it will have an impact to the shoreline?	1. As indicated from the EIA work, it is anticipated that the impact will be minimal. It is also the responsibility of the Fisheries Division and the Environment Division to keep monitoring the sites for any negative impact of the dredging. 2. Yes, the idea of the operation is to minimize beach mining that is now causing a lot of coastal erosions. Also dredging in the lagoon is also anticipated to have no or minimal impact to the shoreline. Studies have highlighted that the dredging site is like a basin which is the end point of the natural longshore drift of sediment.

3. Isn't the dredging site, fishing ground for octopus and turtles?	3. The EIA survey team did not come across any turtles or octopus at the site, however the fisheries division will undertake a survey at the area. The fisheries division will start fishing to collect data on what kind of fish can be found at the site. They will also undertake a social survey, interviewing local fishermen on what kind of fish they could catch from the area.
4. Not supportive -What if we want to cease the operation? Can we do that?	4. Yes, you can cease the dredging operation maybe through the house of parliament or you can directly write to the Mineral Unit of the Ministry of Fisheries and Marine Resources Development.
5. We do not trust the EIA work and especially foreigners to do studies for us. We have a bad experience with the Causeway. I am sure the EIA was also done but we still lose our marine resources and Bikemaen.	5. The causeway might be the cause of the loss in the marine resources within the lagoon, as well as Bikemaen, however, the causeway have also allowed efficiency in transportation between Betio and Bairiki. It has also enhanced sediment transportation along and results in accretion towards Betio. The causeway has increases the land area for Betio.
6. Is it possible to get a copy of the Video presentation about beach mining?	6. The Video presentation will be provided to the community
7. If the monitoring exercise proven that there are potential impacts of the dredging to our marine resources? Can the operation be stopped?	7. Yes, regular monitoring will be undertaken and the results will be considered by the Project Coordinating committee. Any impacts arise from the dredging will be discussed in the committee and the committee will make recommendations to the Cabinet whether to close down the company or to continue.
Otan Bikenibeu Mwaneaba, Bikenibeu Friday 11th March (12 people) – Titeem	
1. We want to know if the extraction is not disturbing the marine life.	1. That is why this EIA is carried out to see how this site looks like now, when the dredging starts and if there is any problems then the Project Coordinating Committee will consider them.
2. Is the aggregate going to be free?	2. It will cheaper than the price miners are using right now as the transportation cost and other expenses are covered by the project.
3. Question by Temakei, Can your place be used for a stockpile site for aggregate?	3. Because we agree and support that erosion is now the problem, yes our place can be used for stockpiling.
4. Has any other Pacific Islands carried out this kind of extraction?	4. Yes in Tuvalu
5. What is the quality of the	5. Same quality with the ones on the beach.

aggregate that is going to be taken from the lagoon? 6. How the salty can be drained out from this aggregate? 7. What you think of Ara Bike Rerei? We support this company cause we think it will bring Kiribati up to the high stand for construction.	 6. It will need a lot of water for that but the company will find a way. 7. Sounds good
Santa Maria Mwaneba, Bikenbieu Friday 11th March 2:00 pm 0 People at 3:00 pm so meeting did not proceed	
Moroni High School, Eita Saturday 12th March. 20-30 Titeem	
1. Why are you choosing that site in Betio? Isn't it going to disturb the place for fish? 2. Can this extraction be done on Christmas Island as it is big and high? 3. Why are you so slow in making policy or laws on sand mining? Time is running for this kind of problem They have selected their site for the Sandwatch and will start on it soon. Clamshell does not disturb the sediment trap.	1. The habitat is not going to be damaged but your question will be answered through the monitoring. 2. Could be possible but the distance is the problem as the demand is on South Tarawa. 3. To establish this company first to have alternatives for aggregate.
Tangintebu Theological College, Tangintebu Saturday 12th March. 20-30 people (Titeem)	
1. Question by Temakei, Do you agree that erosion is the problem? 2. Do you think this company will solve this problem? 3. That company will only	1. Yes 2. No comments 3. It is for South Tarawa right now but the ship can

meet the demand on Tarawa or to outer islands too?	go to outer islands if there is a need.
4. That company will sell out aggregate to people?	4. Yes to anybody want to use and it is for all purposes like road maintenance, building construction, domestic need, etc…
5. The company needs a place for stockpiling?	5. The company can use our seawall for stockpiling area
6. How much will it cost for a truckload of aggregate?	6. It will be a lot cheaper than the normal price used these days.
7. Would there be a potential problem to the land?	7. That will be answered through monitoring and future surveys.
8. So the company will operate until when?	8. Depends on the need
9. So the mining should be banned now?	9. This consultation is to inform the public on the EIA results and to educate people on erosion to get support from them. Laws and policies will be discussed by Environment or others.
10. We want to know if the corals displayed in the presentation, are they dead corals.	10. Yes and they are the ones to be extracted.
11. Any employers needed?	11. Yes there will be recruitment.
We would like to offer our place for a stockpiling area.	
Eita Village Mwaneaba 14th March 2011 (	
1. Where did you do the diving? At the ocean side or lagoon side? And what will be the impacts of the dredge?	1. The diving was done at Betio (lagoon side), this is where the dredge will take place. Monitoring of the dredge site will be on a continuous basis to assess the impacts that may arise, thus monitoring will be in place on specific times throughout the dredging periods.
2. What will you do? Dredge? It is not wise to dredge, and it shouldn't be carried out!	2. Currently there is a high demand for aggregate/gravel and there are no alternatives to meet these demands. Road construction, airport upgrading, and other developments need a significant amount of aggregate and gravel, and this company is what the government has come up with as a solution to the everyday demand of aggregate and gravel.
3. If the dredging start, will it mean that we have to buy sand from the	3. Yes, basically the company is set up to meet demands of aggregate and gravel, and to continue meeting

company? 4. You should not dredge that site since it is the only breeding ground of fish. There is no other Islet or ground on the whole Tarawa that supports marine life except that area that you will dredge.	the demands, you will be required to buy sand at an affordable price and at a much cheaper rate compared to the current price that you are used to. 4. Prior to the dredge and throughout the dredging sessions, the Ministry of Fisheries and Marine resources development will carry out a fish analysis where a fish survey will be conducted to assess marine life at the dredge site. Reports on any diversity change will be considered and procedures will be taken to avoid any disturbance of marine life at the area.
5. When the Causeway was built, there were a lot of impacts like, the disappearance of bony fish (ikarii). Now that dredging will be carried out at the site, what sort of impact would likely to arise? And what measures will you come about with, when such impacts arise?	5. EIA's main purpose was to assess the environmental impacts that may arise with the dredging; this involves all other sort of impacts such as loss of biodiversity. This will be conducted with the cooperation of the Ministry of Fisheries (MFMRD) and Environments (MELAD) who will continuously assess impacts of the dredging and therefore try to minimize the disturbance as little as possible.
6. Isn't there enough sand on the beaches to meet the current demands of aggregate and gravel?	6. No, beach mining will not meet the demands of major projects that need thousands of cubic meters of aggregate/gravel.
7. What sort of impacts are likely to arise from dredging the site?	7. So far we cannot determine the impacts that may arise since dredging has not commenced yet, however we have allocated a number of sediment traps in the proposed dredged sites to measure the amount of suspended sediments over time to have an idea on the current environment and hence to adopt measures to prevent whatever impacts the dredge may impose. There will also be monitoring on specific time and location during the dredge in a way to be able to identify arising impacts.
8. How deep is the proposed dredge site?	8. Dive at the site was around 7-9m
9. Where at Betio is the proposed dredge site? How close is it to where the ships dock?	9. It is further West of where the ships dock.
10. When will the final report be available for public sighting?	10. The final report will be made available around April this year.
11. We hope that when the report is available, it will allow us time to comment, since from your findings at the site, we don't believe that there was no fish seen during your survey.	11. The report will be made available on April and any further comments can be lodged at the Ministry of Fisheries and Marine Resources Development (Bairiki)
LDS Cultural Hall, Mackenzie Point, 15th March 2011 - No body turned up so no record taken	
Catholic Mwaneaba Bwangantebure 2pm, 15th March 2011, Attendance 18 people	
1. Will there be any likely	1. There will be minimal impacts to marine life, as

negative impacts as a result of the dredging?	the area that will be dredged cover only a small area. The survey that was conducted shows that very little fish is found around the proposed dredge site.
2. Who has ownership over the company? Will it be owned by the Government or the people?	2. The company will be owned by government
3. Will people have access to the dredged material, meaning, can people take sand from the Stockpile and maybe resell the material?	3. Government is looking at ways in involving those already in the sand mining business. It is yet to be seen as what our options may be, but the intention is to try and include those in the sand mining community
Buota Village, (LDS mwaneaba) 16th March, 2011 - Kabure Cancelled – no one turned up	
Temakin, Betio, Angaieta KPC Mwaneaba 17th March 2011 – Riakaina – 30	
1. What sort of benefits can we get from that dredge?	1. The dredge company will able to provide significant amount of sands to refill areas of the atoll that has undergone coastal erosion. Meet current demands of sand for road and airport upgrading, building construction, and project constructions on outer islands.
2. When the construction of the Causeway was completed, Bikemaan gradually disappeared, and now with the aggregate/gravel dredging, what might happen to the fish stocks in the proposed dredging site?	2. The Causeway was constructed without any public consultation, and we are hosting one for people to raise their concerns, which we will take note of. Now for concerns, during the EIA carried out at the proposed dredge site, there was no fish seen during the time of assessment, however that might be due to a factor not known, nevertheless the Ministry of Fisheries (MFMRD) will do a fish survey to note species catch, and over time if it is affected, then appropriate actions will be taken.
3. I would like to compare the fishing method "te ororo" which makes a lot of noise when used. This noise I believe has scared away a lot of bony fish up in North Tarawa, and its impact that can be seen is the loss of certain fish species in north Tarawa, in particular Bony Fish. Now with the mentality of that such noise	3. When the company starts dredging the site next year (2012), we might as well have divers up in North Tarawa who will have to dive during dredging to listen if the amount of noise made by the barge scares away the fishes Like mentioned previously, fish survey will be conducted at the dredge site, and any major findings such as a decrease in species catch, will be noted and appropriate actions will be taken in a way that people dependent on fish at the site will not be affected.

produced, will it not make the same impact when the barge digs up sand from the lagoon bed?	
4. What are some of the benefits that Betio will get from the company?	4. The company will be able to provide the needs of Betio in particular aggregate and gravel, and to build up sites of the atoll which have undergone coastal erosion. Building construction and road upgrading are other benefits which Betio can get from the company with the provided aggregate and gravel.
5. If the barge comes in next year (2012) can there also be a survey prior to the dredge on lagoon bed on the remains of bomb on sunken ships from World War II?	5. It has been more than 60 years now after World War II ended, and the company has still yet to determine what is underneath the bed surface, since by now most ship remaining's are likely to be buried by sand, however surveys will be done to find out the possibility on the remaining's of bombs
6. What will happen to the fish stocks in the proposed dredge site if the dredging commence? And if problems arise, what solutions have you to solve such problems? Will fish be affected when the barge starts dredging the site? Because I am one who depends on fish with my family at the proposed dredge site	6. Since the dredge has not commenced, we cannot identify any problems yet, but we have in place our monitoring team who will continuously monitor the dredge site for any impact or changes to the environment and fish stocks caused by the dredge.
7. If a new government is elected in the coming election, what will happen to your project/company? Will it still continue to dredge?	7 The project will be in the hands of the new government, and whatever decision will be made to it will all depend on the government.
8. We have dug a lot of sand from the beaches, and what happens over time is the holes are naturally filled up back to normal. This, from my understanding is replaced by sand from the lagoon. Now what if the	8 Loss of land due to erosion can be replaced with the help of the company, however for loss of fish, there are appropriate channels that can be taken to prevent such loss of fish that is due to the dredge. Monitoring of sites is one, which is in place to minimize disturbance as low as possible to prevent such loss. Studies of lagoon currents indicate a path that will not affect the atolls surrounding the lagoon, and it is also found that

dredging takes place, and by natural forms, our atolls maybe dragged back to the lagoon and replace the dredged site? If aggregate/gravel is dredged from the proposed site, North Tarawa will be affected, because the lagoon current as we know moves in from the North and if dredge begins, North Tarawa will be affected. If there is loss of coastal land, or loss of fish that is due to the dredging, will there be compensation for these loses?	there is no relationship between sand in the proposed site and the atolls, however monitoring will still be in progress during the dredge to monitor environmental impacts of the dredge.
Beterem Mwaneaba, Betio 18th March 2011 (9am) – Kabure 30ppl	

1 What will be the impact of the dredging barge on the marine lives?	1. According to this EIA work, it is anticipated that the likely impact of the dredging is minimal because most of the living corals and algae are covered with sand. The environment is already turbid. All living marine resources at the site seem to be prone to such a turbidity environment. The area to be dredged is only 2% of the total lagoon area of Tarawa. Therefore the impact seems to be insignificant.
2. Will the dredged aggregate be used by the PWD only?	2. The dredged aggregate will be used by the PWD and also by the public
3 Given that the Road Project is the government's initiative, then the Government should be responsible for importing aggregate for the Road project rather than having it dredged in the lagoon and might create problems that will affect our livelihood	3. There is an allocation budget under the Road project for Aggregate of about 3 to 4 million dollars. The idea is for the Government to provide its own aggregate so that the 3 to 4 million dollars will remain in Kiribati.
4 Not supportive -Causeway is creating problems – decrease number of marine resources and it is the main cause of the disappearance of Bikemaen Island.	4. The causeway has allow transport to go from Bairiki to Betio and back more efficiently. Studies have also proven that the causeway have enhance the
5 Tuvalu is importing aggregate from overseas why not Kiribati imports such material for its project?	5. Because the government would like to save money by using its own aggregate rather than importing it from overseas.
6 Proposes for all Islands to contribute aggregate for the Road Project and more Projects to come….	6. It will be expensive to collect all aggregate from the outer islands, and that the impact of mining the beaches will affect the outer islands. IT will be much cheaper to use the aggregate from the Tarawa Lagoon.
7 What if we want to stop the project	7. You can cease the operation if you wish to.
8 what would become the source of income for those people who already sell the	8. The company will try to find a way to involve the beach miners in the business community.

aggregate?	
9. Are we going to stop selling aggregates?	9. No one can stop you from mining the beaches. We are only doing consultations to promote the idea that mining the beaches will continue to damage our natural protection against sea level rise and storms.
10. The community proposes for a study to confirm what makes Bikemaen Disappear...	10. Secretariat took note of the proposal.
11. How long will the company be dredging at the lagoon	11. The resource at the dredging site contains material that could cater for 50 years, however the project is only for three years.
12. How many employers will be needed? The Community proposes if Betio villagers could be employed in the company, Truck hire, labour work	12. 12 to 13 people will be needed for the Company including crew for the barge.
13. If the monitoring activity reports for any impacts of the dredging operation, Will the Company stop operation?	13. The monitoring activity reports will be considered by a Project Coordinating Committee to decide. But yes, the company can ceased operation if there are major impacts found.
14. To provide the DVD Kiribati version to the village	14. This is noted and will be provided by the community.

Takoronga Betio
18th March 2011 – Kabure

1 What will be the impact of excavation?	1. According to this EIA work, it is anticipated that the likely impact of the dredging is minimal because most of the living corals and algae are covered with sand. The environment is already turbid. All living marine resources at the site seem to be prone to such turbidity environment. The area to be dredged is only 2% of the total lagoon area of Tarawa.
2 Who are members of the Committee?	2. Government officials from the MELAD, MPWD, MFMRD, MFEP, MISA, and many others
3. Propose for a separate consultation to the Tokatarawa Association. The rep from Tokatarawa will inform other members and see how they feel about having a separate consultation to them. The rep from Tokatarawa proposes if one of their member could also join the committee	3. The request to have a rep from the Tokatarawa to be a member of the committee is noted and to be brought forward for consideration.

Ierutarem ae boou Mwaneaba, Teaoraereke 21st March 20 people – Titeem	
1. Is there any fish at the extraction site?	1. According to the survey, no fish at the site
2. Now the sand will be extracted from the lagoon in Betio, would there be any compensation to the people of Tarawa?	2. There is no straight answer for that question but the people depend on mining are going to be included in the system like they will help and work in the company to sell out aggregate at the reasonable price. This company is for everyone.
3. Therefore, people should stop mining so that erosion will not exist.	3. Yes and they are encourage not to mine off the beach
4. Is that project going to be sustainable cause there are projects in the past that	4. That is why we need to give all our hands to make this company work

have failed like the Bread Company in Betio. We want this project to be successful	
5. Just words of help, if this consultation can be carried out at places where many could attend cause this is important and people need to aware of it.	5. We have done many mwaneaba from Buota to Betio and in addition to this consultation there will be more visits in the future.
6. The aggregate that the company will sell out, is it going to cheap?	6. The price will be way cheaper and there will be more aggregate can be obtained from this company.
7. Who is doing the survey in the first place and selected this site?	7. SOPAC
8. Can this company sell fine sand?	8. This company can provide different sizes for construction or any other purposes.
9. Is the extraction site deep?	9. It's shallow because lots of sand/gravel moved to this place.
10. What is the quality difference with the aggregate ordered from overseas?	10. That type of aggregate is very expensive and the aggregate from here is good enough for our situation as no tsunami or earthquake.
11. Would there be any potential problem to the lands or with more rising in sea level? Would there be any land lost?	11. It is better to dredge this sand and use it instead of falling off to the deep ocean.
12. Now that the company is going to extract the sand from this site, where would the replacement is coming from?	12. The dredging will make this available aggregate thin cause it is very thick. This can bring life back to the sea grass at the site.
13. My place has been eroded 10m since the causeway was completed and what if problems occur after the company has started?	13. No straight answer but this project will be monitored up until the dredging starts.
14. Is the extraction site is in the lagoon?	14. Yes

USP Mwaneaba, Teaoraereke 21st March *1 – Titeem*	
1. What benefits the people can get from this company? 2. If extracting starts, isn't it going to affect our land? I would suggest if you could visit the mwaneaba at Ambo near the lagoon club so that they aware of this important message but they cannot go other mwaneaba because of land dispute.	1. The ESAT will find a way to get the public involved as part of the system. There will be another visit to the people where they will be told ways of earning money. The government is trying to balance things and not to be one sided. 2. It is explained in the EIA presentation that there are lots of sand and gravel at this site but still it will be monitored through out the dredging.
Beterim Maneaba, Ambo 22/03/2011 Notes taken by Aranteiti. Fisheries Division	
1. Fish Concern – Very happy and supportive of the dredging and no fish will be affected. 2. Would there be an effect on Bonefish Fishery? 3. Sediment plume? 4. Price of aggregate when sold to the public? 5. what happens to us that sell aggregate for living when there dredging company starts? 6. if the dredging starts will it continue to stay here or will it leave when company fails? 7. operation runs by funding, what happens when funding ends? 8. will it travel to outer islands? Kiritimati Island?	

9. Will the captain and crew of the ship be I-Kiribati?	
Banraeaba Catholic Mwaneaba 22/03/11 Notes taken by Kabure 50 people, mostly kids	
Supportive to the project The community confirmed that the dredging sites are not fishing grounds. The community believes that the sites are only breeding sites for Tebwawe and Temabo	
1. Will the price of Aggregate to be sold out by the company cheaper than the aggregates being currently sold in Temwaiku and Bonriki?	1. Yes, the company's price is going to be cheaper than the aggregates currently sold out by beach miners.
2. Is the Road Project has to wait until the Aggregate Company is able to provide aggregate?	2. No.
3. Is the quality of the dredged aggregate good enough for the Road Project?	3. The dredged material will be processed so that it reaches the quality of the aggregate taken from the beaches. It will be good only for the infill material.
4. Is the Project already been approved by the Government to start operating?	4. Yes, the project formulated back in 2005 and it involves a lot of studies. It has been approved and the Government has already received 2.2 Million EURO for implementation. The project is now at the stage of undertaking Environmental Impact Assessment to confirm the likely impacts of the dredging and to once again seek the public's view and concerns about the project.
5. Will there be any plans in exporting the disturbed seaweed and corals at the dredging site?	5. At the moment, no plans has been put in place for exporting the disturbed seaweed and corals at the dredging site, however, this will be noted and will put forward for consideration.
6 Community proposes for exporting Te Kakawa to Japan. Temwakei commented that	6. Exporting Te Kakawa to Japan can also be included as part of the plan.

Tekakawa is very expensive in Japan.	

18.4 Survey data: Compiled and archived on DVD and deposited in the SOPAC library.

18.5 Manta tow data and description

Table 19. Manta tow 1

Transect no.	Observer	Category	Coral cover	Seagrass	Algal covered substrate	Substrate	Latitude	Longitude
1)	Beirtaua	1: 0-10%	~1%		<40%	<50% sand	N01^0 23.828'	E172^0 55.590'
2)	"	1: 0-10%	"	20%	<30%	<40% rubble & sand	N01^0 23.929'	E172^0 55.643'
3)	"	1: 0-10%	"	15%	<55%	<20% rock, rubble & sand	N01^0 24.021'	E172^0 55.662'
4)	"	1: 0-10%	"	5%	<50%	<35%\ Rock, rubble & sand	-	-
5)	Tekiau	1: 0-10%	"	60%	-	<30% sand	N01^0 25.147'	E172^0 55.603'
6)	"	1: 0-10%	"	9%	-	90% sand	N01^0 25.212'	E172^0 55.364'
7)	"	2: 11-30%		20	-	50% sand	N01^0 24.317'	E172^0 55.204'

Table 20. Manta tow 2

Trans. no.	Observer	Category: Percent coverage (%)	Coral cover (%)	Seagrass (%)	Algal covered substrate (%)	Substrate (%)	Latitude	Longitude	Comments
1)	Lovell	1: 0-10%	5	0	25	<70% relief is a shallow rock reefs intersperse w/ sand	N01^0 23.828'	E172^0 55.590'	*Pocillopora eydouyxi* common; numbers of dispersed but large table Acroporas; some massive Porites colonies.
2)	"	1: 0-10%	3	20	<30	<40% rubble & sand	N01^0 23.929'	E172^0 55.643'	Mushroom (Fungidae) corals on sand at 8m depth. Large boulders forming a reef with a large but diffuse in tabulate Acropora. Branching and Pocillopora eydouyxi also common with dispersed coral isolates.
3)	"	1: 0-10%	2	15	<55	<20% rock, rubble & sand	N01^0 24.021'	E172^0 55.662'	Triton Trigger Fish; Acanthurid fish common; Table and branching Acropora common with *A. humilis* and *A. digitifera.*
4)	"	1: 0-10%	1-2	5	<50	<35%\ Rock, rubble & sand	-	-	Isolated colonies of coral with the mean size increasing when compared with the previous.
5)	Beirtaua	1: 0-10%	"	60	-	20% large & small rock boulders; intersperse w/ sand w/h rubble on surface	N01^0 25.147'	E172^0 55.603'	
6)	"	1: 0-10%	"	9	-	50% small boulders w/ sand & rubble; more extensive rock reef.	N01^0 25.212'	E172^0 55.364'	Coral cover low but Pocillopora, Acropora & Montipora dominate.

Trans. no.	Observer	Category: Percent coverage (%)	Coral cover (%)	Seagrass (%)	Algal covered substrate (%)	Substrate (%)	Latitude	Longitude	Comments
7)	"	2: 11-30%	"	20	-	50% sand	N01^0 24.317'	E172^0 55.204'	Coral cover increasing with Pocillopora, Acropora & Montipora.

Manta tows 3, 4 Generalise the description

Table 21. Manta tow 5

Trans. no.	Observer	Category: Percent coverage (%)	Coral cover (%)	Seagrass (%)	Algal covered substrate (%)	Substrate (%)	Latitude	Longitude
1)	Lovell	1: 0-10%	5	0	20	relief is a shallow rock reefs intersperse w/ sand	-	-
2)	"	2: 11-30%	30% in some area 5% diseased	0	<20	rubble & sand	-	-
3)	"	"	30	0	40	35% rock, rubble & sand	-	-
4)	"	"	>25	0	25	55% Rock, rubble & sand		
5)	Beirtaua	2: 11-30%	30	0	-	Rock reef structure intersperse w/ sand w/h rubble on surface	N01^0 24.077'	E172^0 55.072'
6)	"	"	"	0	-	50% sand & rubble; more extensive rock reef.	N01^0 24.042'	E172^0 55.182'
7)	"	1: 0-10%	"	0	-	-	N01^0 24.086'	E172^0 55.292'
	Biko	1: 0-10%	"	"	-	-	N01^0	E172^0

Trans. no.	Observer	Category: Percent coverage (%)	Coral cover (%)	Seagrass (%)	Algal covered substrate (%)	Substrate (%)	Latitude	Longitude
							24.913’	55.364’
		“	“	“	-	-	N01^{0} 24.624’	E172^{0} 55.243’
		2: 11-30%	“	“	-	-	N01^{0} 24.552’	E172^{0} 55.232’
	Tekiau	1: 0-10%	5%					
		“				50% rubble With dead standing coral.		
		2: 11-30%	Many small Pocillopora recruits					

18.6 Site and transect locations (GPS)

Table 22. Table of GPS locations

Sites	Location
Site 1	N01^{0} 22.055 E172^{0} 56.183
Site 2	N01^{0} 22.538 E172^{0} 56.228
Site 3	N01^{0} 23.199 E172^{0} 56.123
Site 4	N01^{0} 24.344 E172^{0} 55.790
Site 5	N01^{0} 23.609 E172^{0} 54.758
Site 6	N01^{0} 21.933 E172^{0} 54.369
Site 7	N01^{0} 22.267 E172^{0} 55.487
Site 8	N01^{0} 21.939 E172^{0} 54.543
Site 9	N01^{0} 21.217 E172^{0} 54.950
Transect 1: Beach heading west	N01^{0} 21.559 E172^{0} 55.160
Seaward to west –	N01^{0} 21.832 E172^{0} 54.758
Transect 2: NE toward wreck	N01^{0} 21.648 E172^{0} 55.058

50cm deep ponded water with algal assemblage		N01^0 21.007 E172^0 54.001
Transect 3: Wreck heading NNE		N01^0 21.952 E172^0 55.047
Most northerly transect		N01^0 22.172 E172^0 54.001
Transect 4: Return south to original departure		N01^0 22.170 E172^0 54.987
End of T4 at beach		N01^0 21.658 E172^0 55.165
Site 10		N01^0 21.733 E172^0 56.033
Paced transect	Borrow Pt.	N01^0 21.695 E172^0 56.158
	Seaward to the Nth	N01^0 21.757 E172^0 56.176
Site 11		N01^0 20.975 E172^0 56.953
Photo transect	Beach EHWS	N01^0 20.945 E172^0 56.926
	Offshore sand flat	N01^0 21.206 E172^0 57.068
Site 12		N01^0 20.526 E173^0 01.582
Photo transect	Beach EHWS	N01^0 20.490 E173^0 01.572
	Offshore sand flat	N01^0 20.753 E173^0 01.419
Paced transect	Beach EHWS	N01^0 20.495 E173^0 01.575
	Offshore sand flat	N01^0 20.798 E173^0 01.422
Site 13		N01^0 22.715 E173^0 07.961

18.7 Sediment trap information

Table 23. Table of the sediment trap information

Area	Sites	Deployment		Retrieval		Days and hours	Hours Deploy Hrs	Average Sediment Weight	mg/ cm^2/day
		date	time	date	Time				
Offshore	1	14/1/11	11am	24/1/11	3:30pm	10d 4.5hr	244.5	1.86545	8.00
	2	"	1:30pm	"	1pm	9d 23.5hr	239.5	1.71526	7.51
	3	"	2:30pm	"	11:30am	9d 21hr	237	3.078525	13.61
	4	"	12:30pm	"	10:00am	9d 21.5hr	237.5	4.4418	19.60
Onshore -Depots	10	17/1/11	2:30pm	25/1/11	3:30pm	8d 1hr	193	7.94404	43.14
	11	18/1/11	11:30pm	"	1pm	7d 5hr	173	2.33054	14.12
	12	18/1/11	1pm	"	11:30am	6d 22.5hr	166.5	10.13248	63.78
	13	15/1/11	12:30	"	10:00am	8d 21.5hr	213.5	10.23446	50.24

Table 24. Sediment rate calculation

Sites	Gm accumulated	Hrs.	cm2	gm/hr	gm/hr/cm2	gm/cm2/hr
1	1.86545	244.5	22.9	0.00763	0.00033317	0.00033
2	1.71526	239.5	22.9	0.007162	0.00031274	0.00031
3	3.07853	237	22.9	0.01299	0.00056723	0.00057
4	4.4418	237.5	22.9	0.018702	0.0008167	0.00082
10	7.94404	193	22.9	0.041161	0.00179742	0.00180
11	2.33054	173	22.9	0.013471	0.00058827	0.00059
12	10.13248	166.5	22.9	0.060856	0.00265746	0.00266
13	10.23446	213.5	22.9	0.047937	0.0020933	0.00209

Table 25. Sediment trap information

Sites	Trap nos.	Location	Deployment date	Retrieval date	Duration (Days)
Site 1	1-5	N01^0 22.055 E172^0 56.183	14/1/11	24/1/11	10
Site 2	16-20	N01^0 23.538 E172^0 56.228	14/1/11	24/1/11	10
Site 3	12-15	N01^0 23.199 E172^0 56.123	14/1/11	24/1/11	10
Site 4	6-10	N01^0 24.344 E172^0 55.790	14/1/11	24/1/11	10

Site 10	26-30	N01^0 21.733 E172^0 56.033	17/1/11	25/1/11	8
Site 11	36-40	N01^0 20.975 E172^0 56.953	18/1/11	25/1/11	7
Site 12	31-35	N01^0 20.526 E173^0 01.582	18/1/11	25/1/11	7
Site 13	21-25	N01^0 22.715 E173^0 07.961	15/1/11	25/1/11	9

19.0 Summary of the report in the Kiribati language

Te Ribooti Iaon Mwiin te Tirobaa Ibukin te Karikirake iaon te Tabeatama ao Tabetano n Naman Tarawa

e koreaki iroun
Edward Lovell
Biological Consultants, Fiji
Suva, 2011

(rairaki iroun Dr. Temakei Tebano)
t-m'akei services
Teaoraerek, Tarawa

1.0 Kimototon Rongorongo

E bon rang ni mwaiti kainnanoan te atama ma te tano ibukin mwakuri aika a mwaiti iaon Tarawa ao aonaba naba. E ataaki bwa e bon boobuaka kaoan bwaai aikai mai tinaniku. Ma anaan te atama ma te tano man te bike ao mataniwiin te aba e bon aki tau ibukin te tai aei ao nakon naba taai aika a na roko; irarikina ao a na bon karekea te kabuanibwai ma te kanganga are te kanakinako. Kaekaan ao tobwaan kanganga aikai bon anaan te atama ao te tano man te nama. Bon te kaibuke ae e na ken bwaai aikai man te nama are e karekeaki n ana mwane ni buoka Bootakin Aban Eurobe. Te tabo are e na kenaki e bon mena imarenan te rawa ni kaibuke ma te matabaiawa are i Betio. E katautauaki bwa e kona n kaaerakeaki te atama ma te tano inanon te maan ae 50 te ririki ke e nako riki.

E kaotia mwiin te tirobaa bwa a rang ni mwaiti uteuten taari ma nimroona ao e a karako marin taari ake tabeua n te tabo aei. E bon mamantoa naba te tabo aei n te aro bwa a bon taneiai iai maan ma sroka ake a maiu ikekei n akea aia kanganga. E na bon rang n uarereke mwiin te keniken n aron are e na kaaerakeaki n te bong teuana ma teuana, ao e kauarerekea naba te mantoa aron wiin te bwai ni keniken are kanga wiin te kima are e na uarereke n tiinako mai iai te tano ma te riburibu. A na uaia ni ibuobuoki te Bootaki n Akawa ao te SPC iaon nooran mwiin te ika ao marin taari n te tabo aei bwa a rootaki ke a aki n te karikirake aei. N reitaki ma aei ao e na kataaki naba ni karaoaki te keniken n te aro bwa a na kararoaaki taabo ake a na kona ni kai roótaki. Bon iai riki taabo ake a tia ni kataunaariaki bwa a kona naba ni kenaki ngkana arona bwa e na iai te aananga ni kabuanibwai n taabo ake a taraaki ngkai.

2.0 Moantaeka

E mena te tabo n tabe atama ao tano n naman Tarawa (Tamnei – Figure 1) n te rakai are n tanimaeaon te aba i meang maeaon Betio (Tamnei – Figure 5). A rang ni kainnanoaki bwaai aikai ibukin kateitei ao waaki aika a mwaiti n aron katean autin te mweenga, karaoan te kawai, kateitei riki tabeua ma te marae ni waanikiba. A mwaiti bwaai aikai i taari e nage ngke a uarereke abara aikai. A mwaiti bwaai ni mwakuri aikai inanon te nama ao ni katobibi ara atimwakoro aikai.

E a rang ni mwaiti te atama ma te tano, ao te atiibu naba, ake a tia n anaaki man te bike ao mataniwiin te aba, n ikotaki ma aonteaba naba. Anaan baikai man taabo aikai e bon riki ni kamamaarai aia otanga ara bike ma mataniwiin abara. Bon iai naba taabo ake a tia ni kuneaki iaon riburibu ao inanon te nama ake a kona n reke mai iai baikai. Ao bon aei bukin karaoan te tirobaa ao ni kamatebwai aei bwa e na taraia bwa e na aki roota te ootabwanin kamanenaan bwaai aikai man karikirake aei.

2.1 Rongorongoron iaon te Kirikirake

E a boongata aron te kamatebwai ma te kakaae iaon kenakin te atama ma te tano bwa ai 30 tabun ngkai te ririki manna. A tia ni bane ni boobootaki rongorongo ni kabane man taian kakaae aikai ao riki rongorongo ake a ibuobuoki nakon katokan kainnanoan bwai ni mwakuri n aron aikai. Mai buakon rongorongo naba akanne ao bon iai naba rongorongo iaon aron marin te nama., te mabiao ae kona n reke man te karikirake ao a na tera mwiina nakon te ootabwanin.

2.2 Taubwiian kainnanoan te atama ma te tano

Atama ma taano ake a kona n reke maiaon te aba a bon kaoaki ibukin kainnanoaia ma bon iai naba ake a karekeaki man te bike ke mataniwiin te aba. E katautauaki bwa bon te kabuanibwai ae e abwaabwaki nakon abara mwiin anaan bwaai aikai n te aro ae e mwaiti ao inanon te tai ae e maan.

E kaotia temanna te tia rabakau ae Maharaj (2000) bwa e bon rang ni kakaawaki bwa e na oota raoi te bootanamata n aron kakawakin ao boonganan te bike ma mataniwiin abara bwa bon ngaiia aika a otanganiira man buakan ao tokan naomoro iaon abara. E kaotia naba Webb (2005b) bwa e moanna ni bitaki ngkai aron tein mataniwiin abara n te aro bwa a moanna n rootaki taabo aika a mwaiti n aron te Oo-n-aoraki are i Nawerewere. Ao e taku naba bwa ai aron naba mataniwiin te aba are e tei iai te kootiweei are imarenan Bairiki ma Nanikaai ke n taabo riki tabeua.

N te tai aei ao boton reereken te tano ma te atama bon mairouia uaake/naake a katoa bong n riko atama ao tano ma atiibu. A kakaokoro aia boo ao e kona n rokoroko n te mwaiti ae $50/m^3, ao mwiina ane a na kanna taan maeka iaon Tarawa. Boon te atama ma te tano mai tinaniku n aron ana rongorongo SOPAC ao bon $104/m^3. Te katautau bwa tao e na bae ni keerake boon bwaai aikai mai Kiribati ngkana arona bwa a na onea mwiin are e kaoaki mai tinaniku.

2.3 Tamnein te waaki ni keniken

E na kenaki te atama, te tano ao te atiibu naba man te tabo are e a tia ni kamataaki irarikin ao meaangin Betio n te kaibuke ae boorarabaua kabina ke te bwaati (barge). E na iai te bwai ni keniken iaon te bwaati aei ao a na kaaerakeaki baikai nakon taabo ake a na kabwarikoaki iai. Buburan te tabo are e na kenaki n te tai teuana ma teuana e bon rang n uarereke ni kabootauaki ma buburan te nama ke te aono are e mena iai.

E katautauaki bwa tao e na nakon 50 te ririki maanin te keniken n aron tangiran bwai ni kateitei aikai n te tai aei.

2.3.1Tamnein ao babaire iaon te waaki

2.3.1.1 Te Kaibuke (te bwaati)

E na karaoa te keniken ana kambwana te Tautaeka ae te Atinimarawa Co. Ltd. (ACL) n ana kaibuke ke ana bwaati ae te MV Tekimarawa. E kona ni kabonganaaki te bwaati aei ibukin naba te uraki kaakoo ke urakinan bwaai nako aonaba ke nakon taabo aika a raroa i tinanikun Kiribati. Abwakin te bwaati aei bon 36 te miita ao rababana bon 12 te miita. Nnen te atama ma te tano ake a kona ni kabooaki mai iai bon ana tabo te PWD are i tabon Takoronga ao te uaabu are i Bonriki; bon naba aika a tia ni katautauaki.

2.3.2.1Nnena, te tabo ao Mwaitin te Keniken

Nnen te tabo are e na kenaki e bon mena i marenan te rawa ni kaibuke ma KPA i meangin Betio (Tamnei – Figure 3). Bon te tabo ae moan te uarreke ni kabootauaki ma buburan naman Tarawa n aron aia katautau Smith ma Naomi (1995) ao e katautauaki iroun Greer (2007a,b) bwa e kona ni kenaki te tabo aei inanon te maan ae 63 te ririki (Tamnei –Figure 4).

Bon iai riki taabo aika a tia ni katarataraaki (Cruickshank and Morgan, 1998), ma a tuai tirobaaeaki ibukin bwaai aika a mena ao ni maiu ikekei ao n aron naba aananga n rootaki nakon te oo-tabwanin.

2.3.3 Tain te waaki

E a tia ngkai ni moanaki kabaan te bwaati ao e kantaningaaki bwa e na roko i nuukan 2012. E katautauaki bwa e na moanaki kabuburaan taabo ibukin nnen te atama ma te tano inanon tain kabaan te bwaati.

2.3.4 Nne te atama/tano, ao tibwatibwaaia

Taabo ake a tia ni katarataraaki bwa nnen te tano ma te atama bon ana tabo te PDW are i tabon Takoronga, tenuaabu are i Bonriki, ao te katenua ae tabe ngkai ni kakaaeaki inuukan taabo aikai. Aikai tabo ake a kamataaki ibukin aron kabebetean karaaian bwaai aikai nakon kaawa ma taabo ake a na kainnanoaki iai.

2.5 *Tain tokin* te keniken

N aron te katautau ao e kona ni waaki te keniken nakon te maan ae 63 te ririki ma e katautauaki naba maiun bwai ni mwakuri aikai bwa tao 40 te ririki. E kona nireiti nako riki te keniken ngkana arona bwa a manga reke riki taabo aika a kona ni kenaki. Tao e na memeere moa iangoan katokan te keniken kioina bwa a na bon tiku naba ni kainnanoaki bwaai ni kateitei ma ai bon inanon taina.

E katautuaki bwa e kona ni manga oki te maiu ao te mari nakon taabo ake a tia ni kenaki ngkana e a manga oki te ane ma te enga ao marin taari nakon taabo aikai.

2.3.6 Mwaitin te karongoa ao abwakin te tai ni keniken

E katautauaki tain te keniken bwa man te Moanibong nakon te Kanimabong ao te Kaonobong ngkana iai kainnanoana ni bon aoan te mwakuri are bwainaki; akea te keniken n te Taabati. E na bon kaitara tain te keniken ma aron kainnanoan tangiran bwai ni mwakuri ao e katautauaki bwa e nakon teuana te aoa n teuana te bong maanin te keniken n te nama. E na bon uarereke mwaitin te karongoa man te uki are e na keniken n te aro bwa e na aki rang n uruanii aron mweroia iika ma maan n taabo akekei.

3.0 Tirobaaean te Ootabwanin (EIA)

Moan te kakawaki bwa e na karaoaki te tirobaa nakon taabo ake a na kumekumeaki ao riki imwaain, inanon ao imwiin te waaki teuana ma teuana n te aro bwa e na ataaki bwa iai aananga ni kabuanibwai nakoia maan, aroka, iika ao bon nakon naba te tabo ma te ootabwanin e akea. E boboto te tirobaa n te kamatebwai ke te kakaae aei iaon iango aika aua bwa:

1) Katuruan ao kinaakin bwaai ake a mena ao a maiu n taabo ake a na kenaki n ikotaki ma nnen kaaerakeaia;
2) Kataunaarian aananga ni kabuanibwai ake a na reke man te keniken ao nnen te atama ma te tano;
3) Tirobaaean aanga ake a kona ni kauarerekea te aananga ni kabuanbwai man te waaki ni keniken;
4) Katautau ma waaki ibukin manga tirobaa riki nakon taabo ke kiboa ni maiu ake a na aananga ni kabuanibwai man te karikirake.

Teuana mai buakon waaki n tararua ao n tirobaa bon tarataraan te aananga n rootaki nakon marin ao ikan taabo ake a na karaoaki iai keniken.

Te tirobaa iaon te ootabwanin ma marin te nama e na bon kainnanoa aia ibuobuoki ana rabwata nako te Tautaeka aika a kakaokoro n aron te MFMRD ao te MELAD.

3.1 Waaki ake a riiriinga te ootabwanin

Uruan aroaron kabin te nama rinanon kamwaean ao anaan te atama ma te tano bon ngaia naba te aro teuana ae kona ni karekea te nakobuaka. Ni ikotaki ma aei ao e bon kona naba te mantoa man wiin te uki n rooti maiuia ma aroia iika ao maan ma aroka ake a kaan ma te tabo are e kenaki.

3.2 Anuan wii ni keniken

Iai tennai wiin te uki ni keniken ake a kona ni kabonganaaki ao are a kona n nooraki bwa e ngaa ae te kabanea ni kamantoa mai buakoia. A na bon kabonganaaki wii aikai n taai ake e nooraki bwa a na aki kabatiaa kamantoaan taari.

4.0 Aanga ni Waaki ibukin te Tirobaa

A mwaiti aanga ake a karaoaki ibukin mwakuri ni kakae ma n tirobaa n aron aikai:

4.1 Karebaba (Manta Tow)

Aei te anga teuana are e kabonganaaki iai te raubaba ibukin te tebo rikaaki ao n otirake ngke e tabe ni katikiko te booti. Ko kona n teborikaaki, nako rarikim ao nako eeta ngkana ko na anaa ikem. Ko kona naba n rawei am tamnei ake ko tangiri ke ni karaoa am warebwai ae ko iangoia.

4.2 Warebwai n te Rain (Point Intercept Transect - PIT)

Aio te anga teuana are ko kona ni warebwai mwaitin maan ma aroka ake a reke iaan am rain are ko katikia man te tabo teuana nakon teuan n te abwaki are ko ataia, tao 100 te miita. Ko kona ngkanne n tau mwiin bwaai ake ko noori inanon teuana te tikuea miita (1 sq. m) ni katoa 5 ke iraua te miitaa marangaia.

4.3 Te Warebwai n Rangata (Paced Reef Flat Walk)

E kuri tii tebo ma te PIT ma e kakaawaki ae ko na ataa te abwaki n am rangata teuana ke iraua am rangata ao e koro teuana te miita. Ko kona ni kabongana naba 5 te miita ke are ko bon taku.

4.4 Te Rangata n Rawetamnei (Paced Photo Transect - PPT)

E kuri n tii tebo aei ma 4.3 ma e aki kakua bwa ko a rawei naba am tamnei ao ko a warebwaii n te tai teuana ngkana ko a oki.

4.5 Taabo ake a kanikinaaeaki (Permanent Transects)

Aikai taabo ake a kanikinaaeakai ao n te roo ae tao 100 te miita abwakina ao n raweaki tamneia ni katoa tao 5 te miita (mainiku – maeao) n te aro are a kona ni manga okiraki ao n raweaki riki tamneia ao n nooraki bwa tera te kaokoro inanon te maan are a katukaki iai.

4.6 Tamnein taabo (Permanent Photo-quadrat transect)

Aikai taabo ake a kanikinaaeaki n te roo ke te kora ma buburaia are e ataaki ao e koreaki tamneia ao ni warebwaiaki kiboa ni maiu, aroka ao maan ake a mena inanona. A na manga okiraki ibukin manga te koro tamnei ao te warebwai.

4.7 Bwai n Tau-Mantoa (Sediment Trap)

Aikai bwaai ake a katukaki i aantari bwa a na raumeai ao n taui mwaitin riburibu ma mantoa ake a kaoti inanon te tai euana ma teuana. E na katineaki te riburibu are e reke man te mantoa ao mai ikanne are e kona n ataaki bwa iai rakan te mantoa man kenakin te atama ma te tano mai taari ke akea (Tamnei – Figure 10).

4.8 Itiakin te Ran (Water Clarity)

E kona naba n katautauaki te iabuti man kateboan te bwai ae mainaina ae e aranaki bwa te Secchi Disk.Ko kona n ataa te iabuti man abwakin te kora are e bae iai te bwai aei ngkna ko a moanna n aki kona n nooria (Tamnei – Figure 11).

4.9 Kabuebuen te Ran (Temperature)

E rang ni kakaawaki ataan mwaitin kabuebuen te ran. N te kakaea aei ao e anaaki te kabuebue man taabo ao naano aika a kakaokoro n te aro bwa e na ataaki bwa iia taabo aika a kabuebue ke a mwaitoro riki. E karaoaki naba aei n te tirobaa ae e a tibwa tia ni karaoaki.

Mwaitin Mamim te Ran (Salinity)

E kakaawaki ataakin te mam ke mamin te ran ma tarikana ao a mwaiti aanga ake a kona ni kabonganaaki ibukin kakaaan te man ma te tarika. N te tirobaa ae karaoaki aei ao e bon anaaki te mam mai aontari bwa kanga te tabo ae e bibitaki riki iai te mam ma te tarika.

4.10 Te Tarika (Salinity)

E rang ni kakaawaki ataan te tarika ibukin maiun kaai ma marin te nama.

4.11 Mwaitin Butin te Ang ma te Aira

N te kakae aei ao è kataunaariaki man aron nakonakon taari. E katautauaki birin te aira man raran ao tein kaon te Secchi Disk ao birin ma unin te ang man raran naba kaon te SD.

5.0 Aron Taraan te Ootabwanin

E ataaki bwa a bon kekeiaki naba abara aikai n uaia ma keeraken iabutin taari. Iai kakaae aika a tia ni karaoaki iaon nanon naman Tarawa ao a kaotia ae iai te kaokoro n aron te maiu bwa e maiu raoi riki naman Tarawa Teinaieta ao ni kekeerikaaki nako Teinainano. Ao te aono are irarikin Betio, riki are e na kenaki e bon aki rang ni bati naba te maiu iai.

5.1 Te Tabo are e na kenaki

E a tia ni kuneaki imwiin te tirobaa bwa riburibun te tabo are e na kenaki bwa a mwaiti iai bwaai n aron aikai: 1) nanaia maan ake a mate ma mwaotooton ane ake a mate; 2) e mwaiti iai mwakorokoron te uteute are kiritanotano (*Halimeda*); 3) te tanobakoa; 4) te tano ma te riburibu. A mwaiti naba atiane ma eenga aika a bubura ma angiia a bon mate.

5.2 Nnen te Atama ma te Tano ni kaaerakeaki

Aikai taabo ake a tia ni katautauaki bwa nnen kaaerakean te atama ma te tano: 1) te Uaabu are i Betio mai moan te KPA. E na taunaki te abo aei ni karaababaaki riki nakon ae ngkai; 2) te tabo are e mena iai ngkai te PWD imarenan Tenimnraoi Maneaba ao te tabo n anai kantoka; 3) te uaabu are i Bonriki are ana tabo ngkoa te Bootaki n Akawa ibukin anaan abeaia kaibuke n roa. (Noori Tamnei – Figures 35, 36, 38 ao 39)

6.0 Mwiin te Tirobaa ma te Kakaae

6.1 Tauan mwiin te Mantoa (Sedimentation)

Iai bwaai aika a katukaki iaantari aika a raarawea te mantoa man te ran. A katukaki bwaai aikai n taabo ake a na kenaki ao taabo naba ake irarikiia. A na tuutuoaki ao ni kaaerakeaki bwaai aikai imwiin taai akana a tia ni baaireaki imwaain, inanon ao imwiin te keniken. A na katineaki kanoan bwaai aikai ao ni kabootauaki bwa iai te kaokoro ni mwaitin te mantoa imwaain, inanon ao imwiin te waaki ke akea. Ngkana e nooraki bwa iai te keerake inanon tain te waaki ao e na bon manga iangoaki bwa tera ae e na karaoaki (Tamnei – Figure 46).

6.2 Te Tau Kabuebue (Temperature)

E kakaawaki bwa e na ataaki bwa mwaitira kabuebuen taari imwaain, inanon ao imwiin te waaki ni keniken n te aro bwa ngkana iai te aananga ni bitaki nakon kabuebuen taari n te tabo are e kenaki ao e riai n nooraki ma ni iangoaki bwa tera are e na karaoaki (Tamnei – Figures 47, 48).

6.3 Korakoran te Ang

E bon tauaki naba korakoran ao unin te ang n tain te te tirobaa. E kuneaki bwa n angiin te tai ao e un te ang mai mainiku ke mainiku meang ma birina ae nakon 15 te knot inanon 15 mai buakon 21 te bong ni mwakuri. E teimaan unin te ang aei ni katoa ririki. (noori Tamnei – Figures 49ao 50).

7.0 Tamnei te tabo are e na kenaki

7.1 Te Tabo ni Kenken

7.1.1 Te Mwaiti ae e na Kenaki

E tuai n tabwanin raoi bwa mwaitira bwaai ake a na rekenako n tain te keniken ao mwaitira ake a kona ni waekoa ni manga okira aroia. Te mwaiti are e na kenaki n te tabo teuana ma teuana e bon nakon mwaitin te tano ma te atama n te tabo anne. E katautauaki bwa a na bon waekoa ni manga oki maan ma aroka ake uruakaki nnneia ngkana e a manga mwae te keniken nakon taabo riki tabeua (Tamnei – Figure 51).

7.2 Kiboa ni Maiu n Taabo ni Keniken

A bon mwaiti aeka ni maiu n taabo ake a na kenaki ma a karako mwaitiia ni kabootauaki ma mwaitin te uteute ao te nimroona. E rang ni karako te ane ao te enga ma atiane aika a maiu bwa a taunaki n te tano ma te riburibu ao a manga taonaki nako n taian uteute.

7.3 Nnen te Atama ma te Tano

A na bo iai naba rootaki n taabo ake a na katukaki iai te atama ma te tano inanon karaoan ao karaababaaia. E na bon iai naba rootakiia maan ma aroka ake a mena ni kawain te bwaati are e na kakaaerakei bwaai aikai, ma te katautau bwa bon bwaai aika a uarereke ni kabootauaki ma te mabiao are e na reke man te waaki ni karikirake.

7.4 Itiakin te Ran

E na bon iai teutana te mantoa n te ran man te keniken ma e na rang n uarereke kioina bwa bwai ni mwakuri ake iaona n aron wiin te uki a tia ni karaoaki n te aro bwa a na aki katiinakoa te ran ae bati ke te bokaboka inanon tain uotakirakean te atama/tano mai inano. Bon iai naba te bwaibu iaon te bwaati are e kona naba ni kaoka te riburibu are e ran maiaon te atama ma te tano nako kabin te nama n te aro are akea te mantoa ae na tiku ni beibeti inanon te ran bwa e a bon tekateka naba i nano.

7.5 Aron Mwakurin te Kiboa ni Maiu

N aron uarereken te tabo are e na kenaki bwa e nakon 0.69% man buburan te nama inanon 50 te ririki ao e na bon rang naba n uarereke aanangan rootakin kiboa ni maiu ake n taabo aikai riki n te mantoa kioina bwa a bon mamantoa taabo aikai, ni ikotaki ma te nama inanon mwamwaen te iabuti ma te aira ao te ang. E bon mena te tabo are e na kenaki n unin te aira ma te ang ai ngaia are e riki ni mmatenten te atama ma te tano iai. A bon taneiai maan ma aroka n te mantoa are e bon riiriki n te tai teuana ma teuan.

N aron buan aia tabo maan ma aroka man te keniken ao tiaki nanona bwa a na aki kona ni manga oki. Ngke e kiitanaki te tabo are e kenaki ao a na manga waekoa n oki ao ni mwaiti riki, riki te ane ma te enga ao a na manga kauiia ikan te tabo anne ao n riki bwa taabo n akawa aika a kau-ika.

7.6 Te Mautari

A mwaiti titiraki ni kaeineti ma aananga n rootaki nakon taabo n akawa ke reereken te ika man taabo ake a na kenaki iaan nooran keerikaakin marin taari n aron te ikarii ao iika riki tabeua. E a tia ni mataata aron tamnein kiboa ni maiu n taabo aikai are e kaotia bwa kanga a na akea rootakin te akawa bwa kuri akea ikan taabo aikai ma a bon kona ni buti iika n aron te maebo inanon te namwakaina teuana ma tteuana. E na iai naba te kakae n aron aekan iika ake a kona n reke n taabo aikai ao ngkana e kakoauaaki bwa iai rootakin reken te ika ao e a manga bon maroroakinaki.

Oin te kantaninga ikai bwa e kataaki ni kai-ieinaki te mabiao ae buubura nakon te botanaomata ibukin reereken bwai ni mwakuri n aron te atama ma te tano n te tai ae maan ao ae e nakoraoi ni kabotauaki ma te aananga n rootaki nakon te tabo ae e uarereke n aron iterant te akawa.

N aron te karongoa are tao e na kona naba n roota anuan te ika ma baikara riki ao e na bon rang n uarereke te tai ni keniken n te bong teuana ma teuana bwa bon tii teuana te aoa, ao riki n te ngaina are e bon karongoa naba taari n taian mooto n akawa ma kaibuke ni mwamwananga.

7.7 Kimototon Rongorongo Iaon Rootakin te Ootabwanin

Iai uoua aanangan rootakin te ootabwanin bwa: buan nneia maan ma aroka n reitaki ma te mantoa are e kona n reke. E na iai rootakin te maiu n taabo aika n te tai ae uarereke ao a kona n nooraki man tirobaa aika tabe ni karaoaki ngkai. Rootakiia inanon te tai ae maan a bon kona ni manga taneiai ma ngaia ao n aki meeuti. Te bwai ae kakawaki bwa e na reitinako te tirobaa n itera aika a mwaiti ngkai imwaain te waaki, inanon tain te waaki ao imwiin te waaki.

E a tia n oti n ribooti aika a mwaiti, n ikotaki ma aei, ae a bon mamantoa taabo aikai n angiin te tai, e uarereke te maiu iai n aron te ane ma te enga, ao a mwaiti atiane aika a mate man rabunaki nako n te tano ao te riburibu ao ni manga taonakinako riki n aeka n uteute aika a mwaiti. E katabeaki te tirobaa ma itera aika a mwaiti ao e a bon tia naba n taakin ana kukune te tiim ni kakae/tirobaa nakon te Tautaeka ao te botanaomata n namwakiana aika a nako.

7.8 Bwaai ake a iangoaki ni karaoaki ibukin reitan te tirobaa n taabo ni keniken

A na uaia te Botaki-n-Akawa ma te SPC n reita nako te tirobaa iaon itera aikai: 1) Tera aekan konaia taan akawa n taabo aikai; 2) Iika raa aika a reereke man taabo aikai; 3) Baikara bwai-n-akawa aika a kabonganaaki; 4) Mwaitira kainnanoan maari aikai irouia kaain Betio; 5) Tera mwiin te waaki iaon marin tari n taabo aikai. A na rang ni bongana rongorongo aikai ibukin kanakoraoan ma tungtungaan aron te waaki ao noorana bwa iai kabuanibwai aika a bubura n reke mai iai ke tera.

8.0 Bibitakin Kanoan te Bong

E na bon uarereke rootakin te karikirake iaon te keniken man keeraken iabutin taari ngkana arona bwa iai ma a na rootaki riki abara aika moan te rinano aikai. E na tokitoki te keniken inanon tain te angibuaka ma buakan te nama ao e kona n ibuobuoki te karikirake aei nakon kainnanoan katean bwaai ake a kona ni kamanoa mataniwiin te aba.

9.0 Aanga n Tararua ibukin kamanoan te Ootabwanin

9.1 Babairean te Anai Atama/Tano

E na iai te aro ni babaire iaon mwitin tea tama/tano are e na kenaki ao e na taraaki bwa e na kabonganaaki raoi te kaubwai aei n aron kainnanoana, ao a na karaoaki kai-ni-baaire ibukin kanakoraoan te waaki n itera aika a mwaiti. A riai naba n tia n ataaki taabo aika a kona ni kenaki ibukin te kabirinako ngkana arona bwa e a aki raoiroi te waaki ni keniken n taabo aikai.

9.2 – 9.3 Tirobaa ae Reitinako ao Ribooti

E kakaawaki bwa e na reitinako te aro n tirobaa nakon taabo ake a na kenaki n te aro bwa e na ataaki man te tai teuana nakon te tai teuana bwa baikara bwaai aika a tabe n riki ao tera mwiia nakon te kiboa ao te reita ni maiu n taabo aikai ao nakon te nama ma te aba ni kabane. A na ibuobuoki ana botaki ni mwakuri nako te Tautaeka iaon te itera n tirobaa ao n tararua are e kainnanoaki. Tabeia naba bootaki aikai ribootinakin kanganga aika a riai n tirinanoaki.

10.0 Mabiao ake a kona n reke

Te mabiao ae na reke man te waaki ni karikirake aei bon reereken bwai ni mwakuri n aron te atama, te tano ao te atiibu irouia te botanaomata, taan kateitei ao bon te Tautaeka naba inanon te maan ae kona n raka iaon 50 te ririki. Ae e kakawaki riki bon kauarerekean anaan bwaai aikai man te bike, aonteaba ao aon-te-ora; aika waaki aika a kawaekoai rokn kanganga aika amwaiti nakon abara ae Tarawa ao Kiribati ae bwanin, riki n tain te angibuak ma korakoran te nao.

A mwaiti kaubwai aika ai aron aikai n ara nama ao a kona ni buoki waekoan karikirake aika a mwaiti ao reken te mwakuri irouia ara botanaomata inanon te tai ae maan. A na rang ni buokaki riki koraki ake a tabe atama ma tano ao ni karekei maiua mai iai ngkana a butimwaea te karikirake aei ni ibuobuoki n aanga aika a mwaiti ao ni kabonakoi baikai n onea mwiin ataman ma tanon biken aaia ma abaia ake ameaka iai.

11.0 Taabo riki tabeua

A bon riai naba ni kakaeaki taabo riki tabeua i meangin taabo aikai ke n aaba tabeua n te aro bwa e kona n karaoaki te keniken iai ngkana iai te aananga ni kabuanibwai nakon taabo aika tabe n taraaki ngkai. E nooraki bwa a boraoi riki bwaai aikai ake bon mai abara, a tau matoaia ma raoiroia ibukin kainnanora ma ara mwakuri ni kabotauaki ma bwaai ni kateitei ake a kaoaki mai tinaniku ake tao bon tii tabeman ake a kona ni kabooi.

12.0 Bukin kaungaan te waaki aei nakon ake tabeua

Moan te mwaiti te kaubwai n te nama ae e aki kabonganaaki. MV Tekimarawa are e kabooaki man ana buoka Bootakin Aban Eurobe ao are e na karaoa te keniken e bon rang ni boraoi ni kabotauaki ma aaro ni keniken riki tabeua. A na mwaiti aika a na buokaki man reereken bwai ni mwakuri aikai ao e na kaunga riki te nano manga reken riki taabo tabeua aika a kona ni kenaki naba ibukin te atama ma te tano ao te atiibu.

13.0 Te Tua

Bon iai te Tua ibukin katabuan te keniken n aki akaaka irarikin taabo ake a bon kariaiakaki. E memeere te Tua iaan kainnanoan bwai ni mwakuri ao aki taun mwaitiia taan mwakuri ake a na kamatoa te Tua. Ao ngkai te Tautaeka e boutokaa katean te kambwana aei ao e na waekoa ni kamatoaaki te Tua iaan nooran taun bwai ni mwakuri ao kamanoan ara bike ma abara ma kanganga aika a mwaiti aika a irekereke ma te anai atama ao tano n aki akaaka.

14.0 Te Marooroo ma te Botanaomata

A mwaiti maroroo aika a karaoa inanon kaawan Tarawa Teinainano n ikotaki ma Buota (Tarawaleta) iaon katean ma ana waaki te kambwana n tabe atama/tano. A mwaiti naba titiriaki n raraoma ao n nano-uoua iaon itera aika a mwaiti ao ake a na kataaki n tobwaaki n te karikirake aei.

15. Maroroo riki tabeua

A mwaiti naba koraki aika a tia naba kaain te tiim ni kakae ni marooroo ma ngaiia inanon aia tai ni waaki. A kona n nooraki n Taibora – Tables 15 ao 16 ao iai naba araia naake/uaake a ibuobuoki nakon kabobongaan te ribooti aei (Taibora – Table 17).

19.3 Kakimototoan marooroo ma te Botannaomata

Aikai boto n iango aika a oti inanon marooroo ake a karaoaki inanon kaawa:

1. A na tera rootakin te ootabwanin man te karikirake?
2. Kam kona n tuangiira bwa akea te bwai ae kona n riki nakon te nama?
3. A na tera mwiin te karikirake aei nakon kaubwain taari ao riki te ika are ti maiuakinna?
4. Tera arou ngai are I maiuakina te anai atama ao tano ngkana e a toki au waaki aei?
5. E na kabooaki te atama/tano ke e aki?
6. Ao ngkana ti katoka te kambwana bwa ti aki kukurei iai, riki ngaira kaain Betio ma Tarawa?
7. E aera e aki karaoaki te karikirake aei iaon aba ke Banaba ke Kiritimati?
8. E kona n reke ara mwakuri n te kambwana?
9. Tera ae na riki nakoia ake a na bon tiku naba n tabe atama/tano?
10. E na totokoa kanakinakoan te aba te karikirake aei?
11. A na raoiroi bwaai aikai ibukin te kateitei?
12. Tao iraua booia ao e aera a aki kaoaki mai tinaniku?
13. E a boongata te Tua iaon tabun te anai atama/tano ao tao n ningai ae na kamatooaki iai te Tua?
14. E kona n reke katotoon te ribooti ngkana e tia?
15. A kona n tuoaki taabo akanne ibukin te boom imwaain te waaki?
16. Tera ana urubwai te keniken nakon iika man te karongoa?
17. Tera ara mabiao ngaira taan bitineti man te karikirake aei?
18. E kona n reke te kabomwii nakoia kaain te aba ao riki kaain Betio ibukin te mweebuaka?

A bon bane ni maroroakinaki titiraki ma nanououa aikai ao e oti bwa e raoiroi te waaki ma e riai n reitinako te tirobaa n tararua ngkana a na iai aananga ni kabuanibwai ake a kona ni kaoti. Ibukin rongorongo aikai ma bwaniniia ao ko kona n noori iteranibaan te ribooti n te taetae ni I-Matang aika 73 – 90 ao ni ikotaki ma mwiin kakaae n iteranibaa 91-97.