Monitoring and Evaluation Plan for Two Coastal Erosion Options for Eastern Tongatapu, Tonga

Prepared for:

SPC – GCCA:PSIS

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Report Status

Version	Date	Status	Approved By:
V 1	20 June 2013	V. 1	STM

It is the responsibility of the reader to verify the currency of the version number of this report.

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: **Cover page: The Makaunga Village beach (17/5/13).**

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1 Background

This document describes the third output for SPC contract CC/13/95 Final Engineering Design and Cost for Coastal Protection Works in Eastern Tongatapu, Tonga; the Monitoring and Evaluation programme for two coastal protection options selected for northeastern Tongatapu. SPC, specifically the Global Climate Change Alliance: Pacific Small Island States (GCCA:PSIS) project in the Strategic Engagement Policy and Planning Facility, has commissioned eCoast Marine Consulting and Research to provide final engineering design and costing for coastal protection works in eastern Tongatapu (Figure 1.1).

Following review of the historic and recent information (Mead *et al*., 2013a), a Draft Design Document (Mead *et al*., 2013b) was prepared and includes a description of the two pilot construction options (one hard, one soft engineering solution), justification of their selection, prioritisation of the options, engineering drawings and specifications, detailed costs and schedule for completion of works for each option. Local contractors have aided in the costing of construction in order to develop the costing for each option, and CTL consultants have also been consulted. The project has a €0.5M cap.

The Draft Design document will be finalised following consultation with key stakeholders, including the GCCA:PSIS project team; SPC-AGTD, Ministry of Lands, Environment, Climate Change and Natural Resources, Ministry of Infrastructure; and others through one-on-one meetings and a national planning workshop in Nuku'alofa involving the aforementioned stakeholders and the affected communities to obtain input. Consultation/workshop is planned for 20/21 June 2013.

In order to consider the efficacy of each of the options, this monitoring and evaluation framework has also been prepared, (the monitoring will be conducted by the Government of Tonga), which covers the construction of the coastal protection works and monitoring over at least a 3 year post-construction period for each option.

An important factor that is being considered during this pilot study is the ADB project for the same area of Tonga, which is also considering climate change resilience and the trialling and monitoring of coastal protection options. While the ADB project is likely to follow this project by approximately 12 months, the potential benefits include extending monitoring to 4 years, trialling more options and developing a far better understanding of the existing coastal processes than currently available for the site. A better and quantified understanding of the existing coastal processes will lead to the development of sustainable and effective methods for these types of environments in Tonga and in the Pacific.

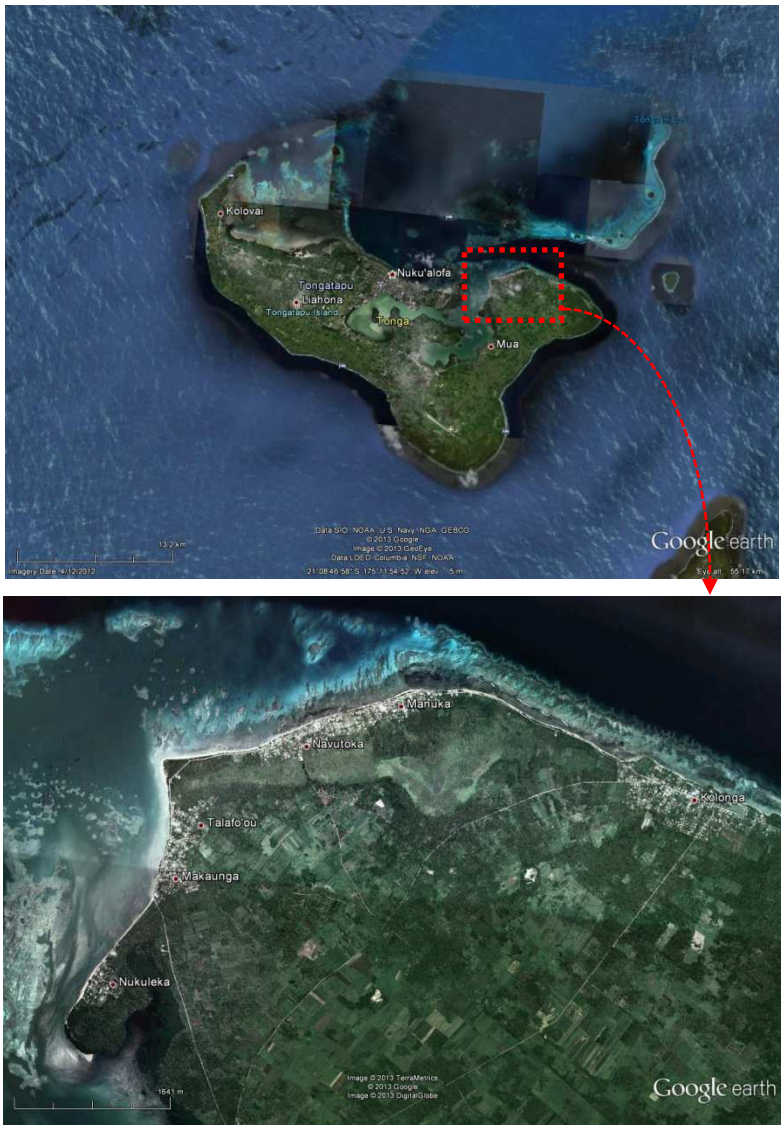

Figure 1.1. Location map of the 5 villages in eastern Tongatapu where the coastal protection pilot studies are planned. The study site incorporates the villages of Nukuleka, Makaunga/Talafo'ou, Navutoka, Manuka and Kolonga (Source Google Earth 2013)

2 Monitoring Methods

Once completed, the two coastal protection options developed for northeastern Tongatapu SPC, specifically the Global Climate Change Alliance: Pacific Small Island States (GCCA:PSIS) project in the Strategic Engagement Policy and Planning Facility project, should undergo a comprehensive monitoring and assessment program. This program should have, at the minimum, these two parts:

1. Shoreline monitoring, and;
2. Structural integrity monitoring.

To monitor these components of the project, the following data will be collected:

- Beach profiles;
- Photographs, and;
- Field notes.

2.1 Existing Beach Profile Data

In order to gain the best understanding with respect to the efficacy and impacts of the 2 trials for developing climate change resilience in northeastern Tonga (Mead *et al*., 2013b), a comprehensive monitoring is required. The best monitoring designs to measure coastal change that is due to modifications (e.g. the addition of structures and sand recharge) from within the natural variation of a coast is a BACI design – Before/After Control/Impact. BACI considers the sites of modification (the Impact), Before and After construction, as well as Control sites (i.e. sites away from the Impact of the modification) Before and After construction. In this way, natural variations are recorded at the Control sites, and the variations/changes at the Impact sites can be compared to both the Control sites (natural variation) and Before data to determine the extent of change due to existing natural processes and the extent due to the construction of the options.

Fortunately some existing beach profile data is available for the area, with profiles both within the trial areas (Impact) and outside these areas (Control). The first set of beach profiles were measured in May 2012, and 9 sites from Kolonga to Nukuleka

(Figure 2.1), 3 of which are within the trial areas – 2 at Makaunga/Talafo'ou, and 1 at eastern Manuka (Figure 2.2). Thus, there are 6 Control sites and 3 Impact sites that have Before data.

Figure 2.1. The 9 beach profile sites in the study area – 3 are within the trial areas.

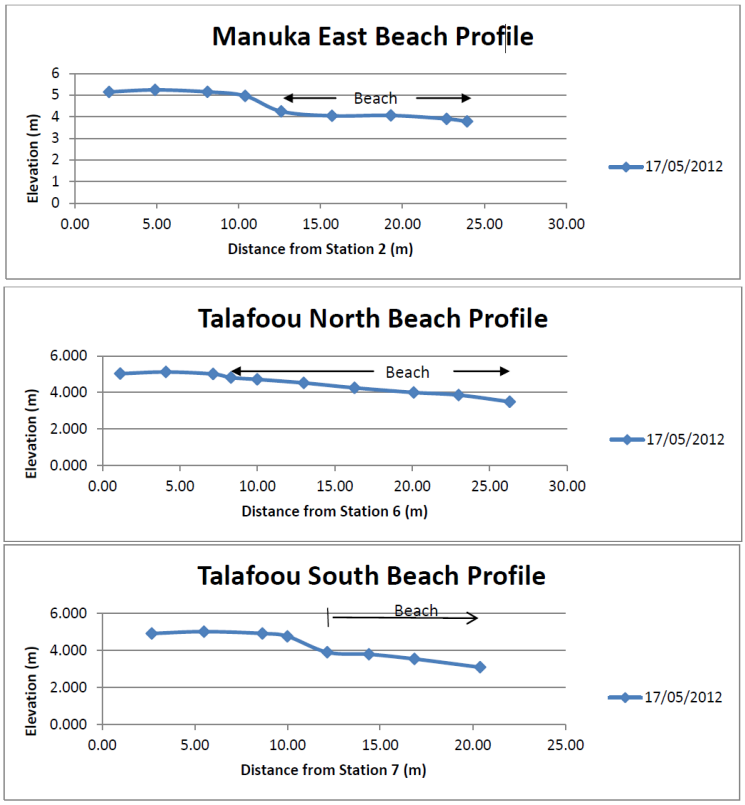

Figure 2.2. Beach profiles within the trial sites.

2.2 Makaunga and Talafo'ou Monitoring

At Makaunga and Talafo'ou villages, 32x 25 m long beach profiles will be monitored, with 32 camera locations (Figure 2.3). Beach profiles will be taken 15 m either side of the groynes, as well as in the middle of the 120 m spacing, and 4 photographs will be taken from the landward end of each groyne – either side of the groyne looking seaward, and each way along the beach back towards adjacent groynes (Figure 2.4).

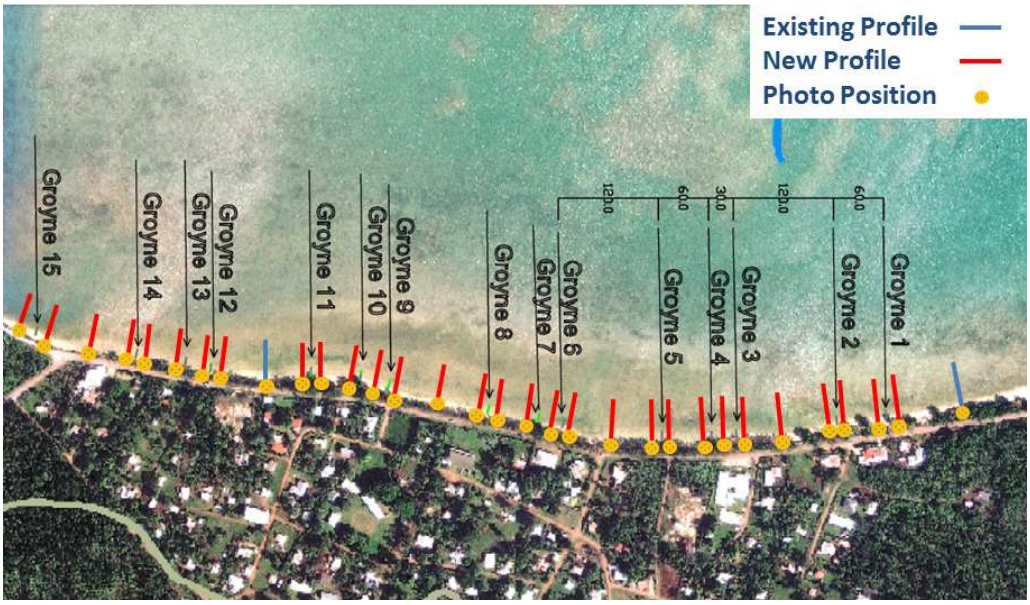

Figure 2.3. Beach profile and camera/photograph locations at Makaunga and Talafo'ou.

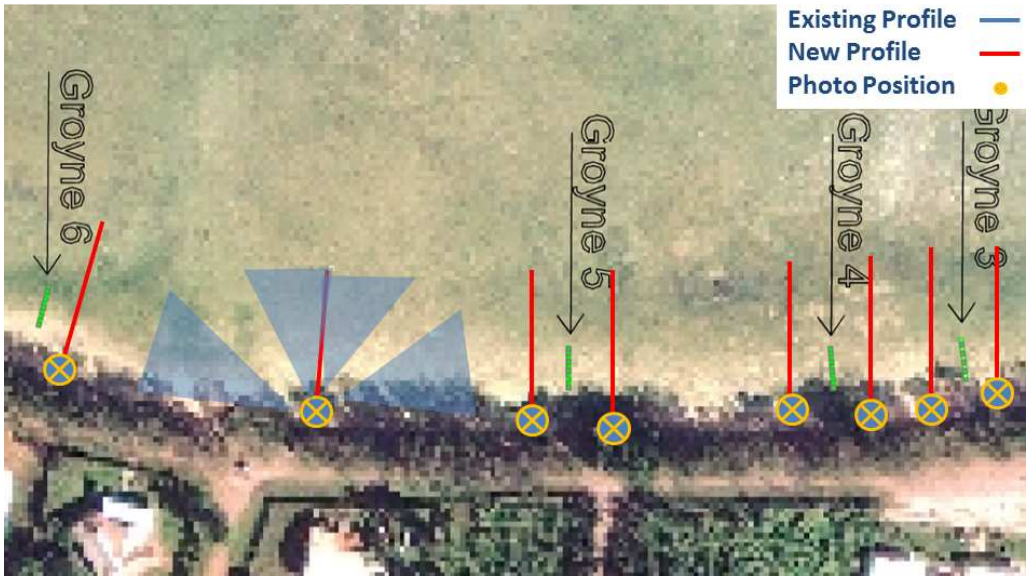

Figure 2.4. Camera shot angles from the landward end of each groyne.

Field notes will be taken for each groyne and provide short comment on both the structure's integrity and the beach response. A hand-held GPS will be used to record the location of each beach profile and camera position and given an appropriate number (e.g. beach profile numbers from 1-32 from south to north).

Permanent bench marks be positioned for each beach profile – this will make subsequent surveys efficient to undertake, with the top of the bench mark being the start of each beach profile each time it is measured. The bench marks can be either a steel or hardwood peg, sledge-hammered into the ground at the edge of the road or top of the beach, in a location that is unlikely to be removed by beach processes. Survey of the permanent beach profile bench marks can be surveyed into a known bench mark at any stage – the relative beach changes can still be determined if each survey includes the permanent bench mark.

2.3 Eastern Manuka Monitoring

At Eastern Manuka, 10x 35 m long beach profiles will be monitored, with 15 camera locations (Figure 2.5). Beach profiles will be taken midway between detached breakwaters, as well as one to the east of the trial site. Photographs will be taken from the landward end of the beach profiles, as well as at 5 offshore sites looking landward towards the structures (Figure 2.6).

Field notes will be taken for each detached breakwater and provide short comment on both the structure's integrity and the beach response. A hand-held GPS will be used to record the location of each beach profile and camera position and given an appropriate number (e.g. beach profile numbers from 1-10 from west to east).

Permanent bench marks be positioned for each beach profile – this will make subsequent surveys efficient to undertake, with the top of the bench mark being the start of each beach profile each time it is measured. The bench marks can be either a steel or hardwood peg, sledge-hammered into the ground at the edge of the road or top of the beach, in a location that is unlikely to be removed by beach processes. Survey of the permanent beach profile bench marks can be surveyed into a known

bench mark at any stage – the relative beach changes can still be determined if each survey includes the permanent bench mark.

Figure 2.5. Beach profile and camera/photograph locations eastern Manuka.

Figure 2.6. Camera shot angles from the landward end of each beach profile and from offshore looking landward towards each detached breakwater.

2.4 Whitehouse Point Borrow Site

At the Borrow Site, 7x 50 m long beach profiles will be monitored, with 9 camera locations (Figure 2.7). Beach profiles will be taken at 30 m intervals along the borrow site, and extend across the excavation area (Figure 2.7). Photographs will be taken from the landward end of the beach profiles, as well as at 2-3 offshore sites to visually record the extent of the excavation.

Field notes will be taken for each beach profile and provide short comment on both the observations of the borrow area and the beach response. A hand-held GPS will be used to record the location of each beach profile and camera position and given an appropriate number (e.g. beach profile numbers from 1-7 from south to north).

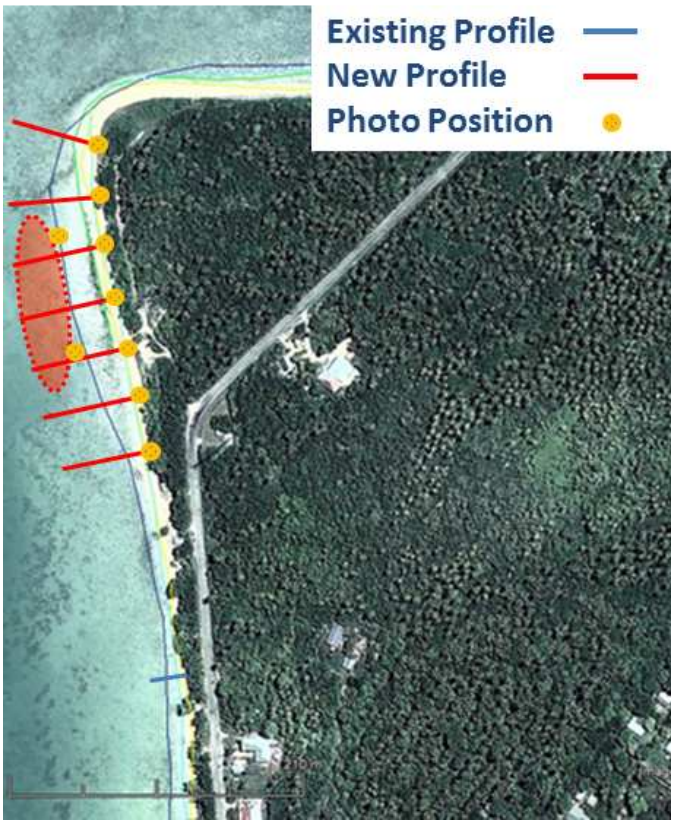

Figure 2.7. Beach profile and camera/photograph locations at Whitehouse Point.

Permanent bench marks be positioned for each beach profile – this will make subsequent surveys efficient to undertake, with the top of the bench mark being the start of each beach profile each time it is measured. The bench marks can be either a steel or hardwood peg, sledge-hammered into the ground at the edge of the road

or top of the beach, in a location that is unlikely to be removed by beach processes. Survey of the permanent beach profile bench marks can be surveyed into a known bench mark at any stage – the relative beach changes can still be determined if each survey includes the permanent bench mark.

3 Monitoring Programme and Results Presentation

The monitoring programme has been designed to provide the following information:

1. Record the beach response;
2. Learn the function of the different structures/trials;
3. Adapt the trails for better outcomes;
4. Understand the sustainability of sand recharge;
5. Apply to other parts of the project site and of Tonga in the Future, and;
6. Use to determine maintenance requirements.

Monitoring of all three sites (Figure 2.3, Figure 2.5 and Figure 2.7), including the 6 existing profiles outside of the study sites (Figure 2.1), will be undertaken at the following intervals:

- Before construction
- 2 months after first borrow
- 4 months after first borrow
- Quarterly for 2 years thereafter (SPC
- Bi-annually for 2 years thereafter

It is expected that the measurement of the beach profiles (55), photographing and taking of field notes will take up to 4 days, with a further day to input the data into spread sheets for analysis – base-point of profile (GPS position and profile number), distance along transect, level. Photographs must be labelled in reference to the position from which they are taken (GPS position and location number). Field notes should include beach response and structural integrity (referenced to structure number/GPS location).

An independent consultant will be engaged to analyse the monitoring data, while maintenance issues will be conveyed to SPC during the 24 months following construction.

References

Mead, S. T., W. Hiliau and D. J. Phillips, 2013a. *Review of Historical and Recent Studies Pertaining to Erosion of Eastern Tongatapu, Tonga*. Report prepared for SPC – GCCA:PSIS, May 2013.

Mead, S. T., W. Hiliau and D. J. Phillips, 2013b. *Draft Design of Two Coastal Erosion Options for Eastern Tongatapu, Tonga*. Report prepared for SPC – GCCA:PSIS, June 2013.