

PROJECT SHEET

VILUFUSHI, MALDIVES

DREDGING, RECLAMATION, RECONSTRUCTION AND ENVIRONMENTAL MONITORING WORKS

INTRODUCTION

The Republic of the Maldives consists of 1,190 small coral islands grouped into 26 atolls. Only 200 islands are inhabited. On 26 December 2004, a tsunami originating from Indonesian waters struck the Maldives. This natural disaster had major economic, social and environmental consequences. Of the 200 inhabited islands, 13 were totally destroyed and 56 suffered major damage, including the island of Vilufushi in Thaa Atoll. Houses and infrastructure were heavily damaged. All the surviving residents had to be evacuated to the neighboring island of Buruni to the west of Vilufushi. The government of the Maldives decided to reconstruct the entire island and to extend it considerably by landfilling the shallow reef. Boskalis International was appointed for this work.

PROJECT SPECIFICATION

Several alternatives were studied. The plan that was finally adopted involved dredging coral sand from an area off the northern reef edge of Vilufushi with a medium-sized cutter suction dredger. The sand was then pumped directly into the area to be filled.

The reconstruction included:

- Removal of all debris.
- Dredging and reclamation of 1,000,000 m³ of coral sand from the reef to increase the surface of, and raise, the island.
- Construction of a 2000 meter rock revetment around the island as a breakwater to protect against wave penetration.
- Dredging of a new harbor to 3 meters below sea level.
- Construction of a 350 meter quay wall using pre-cast concrete elements.
- Construction of a 350 meter breakwater to protect against wave penetration.



FEATURES

Client	Government of the Republic of the Maldives
Location	Vilufushi, Maldives
Period	2005 – 2007
Performed by	Boskalis International bv



- A** View of the dredging activities at Vilufushi, with the cutter suction dredger Ursa at work pumping sand directly to the area to be filled.
- B** Silt screen deployed in the old harbor basin around the discharge point. The monitoring vessel is in the center of the photo
- C** Coral and other marine life in the vicinity of Vilufushi
- D** After the tsunami struck the surviving population was evacuated to the nearby island of Buruni.
- E** A dhoni (local type of boat) was fitted out specially as a monitoring vessel. It was equipped with a multitude of high-tech devices

MONITORING DURING DREDGING AND RECLAMATION

The Maldives have a very rich marine bio-diversity, which requires safeguarding through special measures, in particular during dredging and reclamation activities. A special monitoring program was required to monitor changes in environmental parameters with an adverse impact. The parameters measured included turbidity, dissolved oxygen, sedimentation, nutrients, soil salinity and groundwater quality.



CSD URSA

The dredging and reclamation activities began in May 2006 with the deployment of the Ursa, one of the largest CSD dredgers in the Boskalis fleet. The Vilufushi project included the dredging and reclamation of some 1,000,000 m³ of coral sand at a location far away from the usual sources of logistical support, so using the Ursa had several advantages. Firstly, it is a self-propelled, sea-going dredger and it can therefore sail on its own keel. Secondly, accommodation facilities are available on board, making her ideal for isolated locations. Thirdly, the deck cranes can be used to load and offload barges with containers and pipelines.

ENVIRONMENTAL CONTROL ACTIONS

The dredging work was completely integrated with the environmental measures to reduce the release of suspended solids into the ocean and onto the coral.

- The first environmental control action was to initiate dredging and reclamation works after the bunds around the reclamation area had been completed and the reclamation area was closed off from the ocean (May 29 2006). This meant that the run-off water from the reclamation was released to the ocean in only one location, concentrating the potential source of suspended solids. The reclamation area was divided into four compartments, and landfill started in the first one, on the northern side of the island. At the same time, a stockpile was created in compartment 4 (on the southwest side of the island) to allow salt to be washed from the sand before it was spread out over the original island.
- The second environmental control action was to allow the run-off water to flow through the entire reclamation area (the four compartments) before being discharged to the ocean. This allowed

suspended solids to settle as much as possible, reducing the amount of suspended solids released into the ocean.

- The third environmental control action was to place the discharge point of the reclamation area in the old, unused harbor, using it as a final settling basin before the run-off water reached the ocean.
- The fourth environmental control action was to deploy a silt screen, which was placed in the old harbor around the discharge point of the reclamation area.

POST DREDGING / RECLAMATION MONITORING WORKS

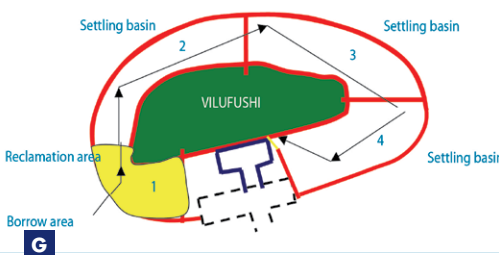
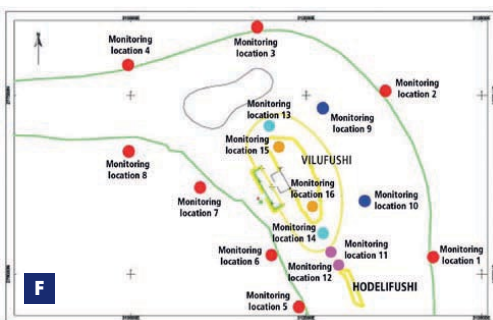
To minimize the environmental impact, an extensive 'post-dredging/reclamation monitoring plan was developed. Parameters measured included turbidity, dissolved oxygen, sedimentation, nutrients, soil salinity and groundwater quality. The following monitoring tasks were performed after the completion of dredging and reclamation work:

- After one week: turbidity, temperature, dissolved oxygen and depth were measured daily.
- During the next three weeks these parameters were measured 1-2 times a week.
- Sedimentation and nutrients were measured fortnightly.
- After 1 month: turbidity and so on, sedimentation, nutrients, coral health, currents.
- After 6 months: soil salinity and erosion.

CONCLUSION

Damage to the precious coral on the reef edge was minimal as a result of the extensive mitigation measures and the continuous monitoring of all relevant parameters. The dredging and reclamation of the coral sand was finished in five months. The reclaimed area tripled the surface of the island from 16 to 62 ha. The existing island level was raised to a safe level of 1.4 m above sea level. At its highest point, the revetment is 2.4 m above sea level.

In February 2007, the 'new' enlarged island was ready and was handed over so that building work could start on homes for the residents. The Red Cross has financed several rebuilding projects. In early 2008, the first of the many evacuated residents of Vilufushi were able to return to their islands.



	Parameters	Frequency	Locations
A.	Water quality	Turbidity	Daily, twice a week
		Depth, DO, Temperature	Daily, twice a week
B.	Sedimentation	Fortnightly	1, 3, 6, 8, 9, 10
C.	Coral reef survey	Monthly	1 - 8
D.	Nutrients	Weekly	9, 10
E.	Soil Salinity	Twice	13, 14
F.	Groundwater	Twice	15, 16
G.	Erosion monitoring	After works finish	10, 11 H

- F** Monitoring locations around Vilufushi Island
- G** Reclamation area layout with surrounding bund and compartments and the sequence for filling the compartments of the reclamation area
- H** Table: parameters measured and their locations and frequencies

Royal Boskalis Westminster N.V.
PO Box 43
3350 AA Papendrecht
The Netherlands
T +31 78 69 69 000
F +31 78 69 69 555
royal@boskalis.com
www.boskalis.com