



Protocol for Site-specific ecosystem-based interventions in wetlands, Seychelles

for the project:

Enhancing capacity, knowledge and technology support to build climate resilience of vulnerable developing countries

Ecosystem-based Adaptation through South-South Corporation (EbA South)

Seychelles Pilot Project

Dr. Elvina Henriette

With contributions from Dr. Pughazendhi Murugaiyan, Dr. Anthony Mills, Mr. Jean-Claude Labrosse, Mr. Lemmy Payet, Mr. Allen Cedras, Mr. Rodney Quatre and Mr. Ashley Robson

Draft protocol ver.3. December 2016

TABLE OF CONTENTS

1. INTRODUCTION.....	3
2. DESCRIPTION OF THE PROJECT SITES.....	5
3. SITE-SPECIFIC INTERVENTIONS.....	9
3.1. Indicator and targets.....	9
3.2. Size of intervention and impact areas (ha) within the project sites.....	9
3.3. Ecosystem-based Adaptation targets.....	10
Target 1: 7 culverts to improve hydrological flow through 300 ha of fragmented mangroves.....	10
Target 2: 1.7 km of channel desilting to improve flow between 100 ha fragmented mangrove.....	11
Target 3: 500 m of national highway protected from coastal erosion.....	12
Target 4: 20 hectares of degraded mangroves cleared of alien species and replanted.....	13
Target 5: 9 hectares of degraded mangroves restored.....	18
4. REFERENCES.....	19
ANNEX 1: LOCATION MAPS.....	20
ANNEX 2: TARGET 1 & 2 IMPACT AREAS.....	21
ANNEX 3: TARGET 1 & 2 CULVERT & DESILTING DETAILS.....	22
ANNEX 4: TARGET 3 INTERVENTION AREA.....	25
ANNEX 5: TARGET 4 INTERVENTION AREAS.....	26
ANNEX 6: TARGET 5 INTERVENTION AREAS.....	35
ANNEX 7: PLANT LIST FOR NURSERY PRODUCTION.....	36
ANNEX 8: COSTED WORKPLAN.....	44

1. INTRODUCTION

1.1. Background to the project

Ecosystem-based Adaptation through South-South Cooperation (EbA South) is a full-sized GEF project, implemented by UN Environment and executed by the National Development and Reform Commission of China (NDRC), through the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences (IGSNRR, CAS).

The aim is to address the vulnerabilities of local communities to climate change by using ecosystem-based approaches to adapt to climate change through on-the-ground interventions, increasing institutional capacity, mobilising knowledge and transferring appropriate best-practice adaptation technologies.

The project has three components focussing on capacity building, knowledge sharing and technology transfer.

- i. Inter-regional coordination and capacity building for planning and implementing Ecosystem-Based Adaptation (EbA);
- ii. Inter-regional online EbA knowledge support; and
- iii. The transfer of EbA technologies to pilot African and Asia-Pacific countries supported by national and local level capacity building and knowledge mobilization.

The Ministry of Environment, Energy and Climate Change (MEECC) of Seychelles is one of the executing partners of the project. It is responsible for the pilot EbA interventions in selected project sites in the Seychelles islands.

1.2. Rational of the project

Climate change and climate variability are already impacting the Seychelles islands: El Nino events in 1998 destroyed 95% of corals in the Granitic Islands and subsequent coral bleaching events occurred due to a rise in sea surface temperatures (Spencer et al., 2000); the tropical cyclone in 2006 resulted in flooding and habitat destruction; and various episodes of storm surges have been experienced. Human development and alteration of ecosystems has reduced the capacity of natural systems to buffer local communities against climate variability and disasters. For instance, the majority of lowland wetlands including mangroves have been fragmented, reclaimed and impacted upon through development leading to a loss of 90% of lowland wetlands since the 1900s and accelerated loss since the 1990s (Gerlach 2002). This has resulted in the current critical status of coastal wetland systems (Government of Seychelles 2014a; 2014b). Today, wetlands cover a relatively small area ca. 206 ha in the Seychelles Granitic Islands i.e. about 1 % of land areas (Senterre and Wagner 2014) but play an important role and provide many ecosystem services to humans, e.g. flood control, sediment traps, water quality control, hydrological cycle regulation, freshwater supply (ground water recharge), biodiversity services (habitat for flagship species), and atmospheric carbon sequestration (Woodward and Wui 2001; Bullock and Acreman 2003; Zedler and Kercher 2005; Government of Seychelles 2005). Hence, rehabilitation of natural systems should be an integral part in addressing disasters in the Seychelles. The EbA South (EbA-SSC) project is one avenue to restore coastal ecosystems with the aim of enhancing their functions such as buffering against flooding.

1.3. Purpose of the Site-specific EbA protocol

The purpose of the rehabilitation protocol following an EbA approach is to identify and detail the site-specific interventions for the rehabilitation of 10 wetlands (1 Curieuse, 3 Mahé and 6 Praslin) that will increase the resilience of coastal communities and ecosystems to climate change. Numerous considerations should be considered so that the potential for unintended negative consequences are minimised. Rehabilitation efforts will

have positive short-term consequences, but its greatest benefits will become evident in the long-term. Long-term research and monitoring will ensure that the successes or failures of rehabilitation efforts are properly tracked. Lessons learnt from successful EbA interventions can be replicated to further enhance rehabilitation efforts.

1.4. Preliminary work prior to the development of the site-specific EbA intervention protocol

A baseline assessment to identify potential sites and assess the socio-economic characteristics of local communities, including their vulnerability to climate change was performed in April 2014 by C4 EcoSolutions (C4ES) consultancy based in South Africa that specialises in adaptation to climate change. 13 potential sites were identified (1 on Curieuse, 6 Mahé and 6 Praslin).

A document was produced as a result of the study mission: C4 EcoSolutions (2014). Baseline Assessment for Project: Enhancing Capacity, Knowledge and Technology Support to Build Climate Resilience of Vulnerable Developing Countries

A follow-up visit was undertaken in November 2014 by the project Technical Advisor Dr. Anthony Mills of C4 EcoSolutions to discuss project implementation.

A document was produced as a result of the study mission: Mills, A. (2014a). Seychelles mission report. Mills, A. (2014b). Seychelles photo journal.

A follow-up visit was undertaken in March 2015 by Dr Ahmed Khan for the development of the 'Implementation protocols for coastal mangrove rehabilitation in Seychelles'.

A document was produced as a result of the mission: Khan, A. (2015). Implementation protocols for coastal mangrove rehabilitation in Seychelles. EbA-SSC Project.

Finally, the Project Steering Committee decided to reduce the number of project sites from 13 to 10 (1 Curieuse, 3 Mahé and 6 Praslin, see Annex 1).

2. DESCRIPTION OF THE PROJECT SITES

There are ten project sites (Annex 1).

Curieuse: Baie Laraie

Mahé: Anse Royale, East Coast Lagoons (Cascade to Roche Caiman) and Petit Barbarons

Praslin: Cap Samy, Cote D'or, Kot D'Hauban (Anse Gouvernement) La Pointe (Anse St. Saver – Anse Takamaka), Mare du Ranteau (Au Cap) and Nouvelle Decouverte

2.1. Baie Laraie mangrove (Curieuse Island)

Baie Laraie mangrove (ca.8 ha) is highly diverse comprising of 5 out of the 7 the mangrove species found in the Seychelles. The mangrove is protected under the National Parks and Nature Conservancy Act. Baie Laraie mangrove developed over a century behind the protection of a seawall across the bay. The seawall was built in 1909-10 and was intended to create a pond for breeding Hawksbill turtles but indirectly protected mangroves from sand encroachment. In 2004, a tsunami from Sumatra almost destroyed the seawall resulting in a change in the dynamic of water circulation and sand movement patterns in the lagoon. The mangrove is not sheltered anymore. Exposure to larger waves, tidal surges and increased volume of seawater impact the mangrove in several ways. Increased volumes of sand are deposited inland and cover the mangroves pneumatophores. The two main channels that inundate the mangrove are partially filled with excess sediments. The deposition of sand is also changing the substrate type in some areas from silty clay mud to sand. The impact is not uniform within the mangrove. Whilst sand is deposited onto the north-eastern part of the mangrove which covers mangroves pneumatophores and recruits and creates raised sand bank suitable for colonisation by grasses and Casuarinas; the middle seaward part of the mangrove faces erosion resulting in root exposure, fallen trees (mangrove species and coastal plants like *Cordia subcordata*) and death. The south-eastern part of the mangrove is more intact, free of excess sand and recruitment particularly *Rhizophora mucronata*, is visible. Overall, the mangrove is receding landward and aging with little regeneration.

2.2. Anse Royale (Mahé Island)

Fairly healthy, densely vegetated riparian and mangrove habitats drained by two rivers: Riviere Au Berlin and Rivière Anse Royale. The mangrove is affected by littering and reclamation for agricultural purposes. The seaward mangrove zone is dominated by *Avicennia marina* and *Rhizophora mucronata*. The landward zone is dominated by *Bruguiera gymnorhiza* and *Rhizophora mucronata*. Beyond the mangrove is the riparian forest that comprises of species like Indian almond *Terminalia catappa*, and IAS such as *Albizia Falcataria molucana*, Devil's tree *Alstonia macrophylla* and Agati *Adenantha pavivona*. The adjacent areas are comprised of commercial-business centres, educational and health facilities on the north to east; farmland built on reclaimed land on the south and bounded on the west by forests. Rubbish disposal in the wetland is an issue and pollution from farmland could be a potential issue.

2.3. East Coast lagoons – Cascade to Roche Caiman (Mahé Island)

Much of the east coast consists of reclaimed land and artificial wetlands. The Providence highway which connects the capital Victoria to the South runs along the reclaimed land. Sand banks and islands within the lagoon and channels have been naturally colonised by mangrove species, particularly pioneer species like *Avicennia marina* and *Rhizophora mucronata*. The highway is lined by Casuarina some of which are tall and prone to falling. When they fall, they destabilise the bank rendering it more prone to erosion. A channel on the landward side runs parallel to the highway and this is used by motorised boat owners of the nearby fishing community. Wave splashes from the boats erode the roadside embankment, compromising the stability of the bank of the heavily used highway. Further north at Roche Caiman there is an open artificial lagoon and mudflats resulting from reclamation. Very low vegetation cover consisting mainly of *Rhizophora mucronata* on

the fringes of the rock armouring on the bank and within the lagoon. Closer to Plaisance School, there is a fairly healthy stand of mangrove comprising of *Rhizophora mucronata* and *Avicenia marina*. The project site is adjacent to residential and industrial areas on the southern side, the Providence highway on the north-eastern side and, residential and educational facilities on the northern side. The project site could benefit from mangrove replanting but one of the biggest threats is rubbish disposal and accumulation.

2.4. Petit Barbarons (Mahé Island)

Wetlands fragmented by access roads and reduced in size by land reclamation for residential development. Four fragmented wetlands are the focus of this project site. Historically these wetlands formed a continuous band with the wetlands at Rivière Caiman and Rivière Dupuy. The fragmented wetlands are interconnected by narrow pipes beneath the roads that fragment them. Marsh 1 is a freshwater marsh undergoing natural vegetation succession, located on the landward side, densely vegetated (>80% vegetation cover) particularly with the freshwater fern *Acrostichum aureum*, but Coconut tree, *Cocoplum* (*Chrysobalanus icaco*), and Casuarina are also present. The wetland is enclaved by a fringe of coastal forest and an access road on the east-south-eastern side. Marsh 2 is a brackish marsh on the landward side and south of marsh 1. Its eastern side was reclaimed for housing development. The wetland consists of a large expanse of open water with a vegetated island mount on the western side and bare banks. Vegetation coverage is low. The western bank is lined with tall Casuarina which threatens to destabilise the banks and the invasive creeper *Merremia peltata* is smothering the vegetation. Marsh 3 is a mangrove located on the seaward side consisting of an open water body, low diversity and coverage of mangrove (mainly *A. marina*, *R. mucronata* and *S. alba*), and sparsely vegetated eastern banks. A narrow channel drains into the Anse Boileau bay. A partially damaged stone wall lines the seaward side of the mangrove and initially protected it from excess seawater intrusion and sand accumulation. The seawall was affected by the 2004 tsunami. Marsh 4 is a brackish marsh on the landward side and on the western side of site 3. It has high vegetation cover comprising mainly of *A. aureum* and is undergoing natural succession. It has little exposed inundated substrate but invertebrate wildlife, particularly crabs is clearly visible. Hydrological flow is impeded by the narrow, partially silted pipe, and accumulated wood debris. The wetland margins are forested, in close proximity to a farm, residential areas and an access road. The bank along the road is sparsely vegetated.

2.5. Cap Samy (Praslin Island)

Considering the flat nature of the lowland coastal plateau and the proximity of Cap Samy to Mare du Ranteau and Kot D'Hauban, it is probable that Cap Samy was once part of a more extensive wetland. Today, the mangrove at Cap Samy is fragmented by a network of roads and has been partially reclaimed for agricultural, residential, commercial and industrial purposes. The fragmented wetlands are connected by narrow (0.7 - 0.9 m) drainage pipes and their only access to the sea is through a culvert under the main road. A granite rock quarry exists on the western side of the mangrove where red earth and sediment laden water flows into the wetland. There is also risk of pollution from nutrients, pesticides and fertilisers from adjacent farmlands, residential and industrial estates. Waste and litter also pollute the wetland. Blocked channels by sediments, rubbish, wooden debris and roots means that hydrological flow is hampered leading to poor drainage, reduced storage capacity and increased flooding incidences.

2.6. Cote D'Or (Praslin Island)

Situated in a dense residential and commercial area, Cote D'Or wetland faces many challenges such as pollution, littering and invasion by invasive alien species (IAS). Two rivers flow into the wetland: Rivière Salazie and an unnamed river. The seaward side of the wetland is comprised mainly of healthy stands of mangroves and native coastal plants line the wetland margins along the roadside. The wetland drains into the sea under a 12 m wide bridge. The PUC power lines cross the seaward side of the wetland where mangroves have been relentlessly lopped creating a dead zone beneath the power lines. The central part of the wetland consists of dense stands of mangroves mixed with sparsely vegetated and bare sandy island mounts / sand banks. Some areas on the wetland margins are also bare or sparsely vegetated thus prone to erosion. The landward side

and upper reaches of the wetland (350 m inland) transform from a mangrove dominated wetland to a swamp forest dominated by native coastal plants where surface water is visible. The forest floor however, is covered by a carpet of the invasive *Dieffenbachia seguine* (Dumb cane/Vya Tang). Household waste and litter are also visible in the watercourse. Similarly, litter and waste line up the northern wetland margins alongside the main road. Water channels draining the wetland are silted in several areas and sand accumulation in numerous areas has formed sand banks which further impede hydrological flow. Cote D'Or wetland can be considered as a degraded wetland in recognition of its location amongst residential and commercial areas, potential risks of pollution from households, the amount of littering, and invasion by IAS.

2.7. Kot D'Hauban (Anse Gouvernement, Praslin Island)

Unknown to many, Kot D'Hauban (this is the correct name of the place and should not be confused with Anse Gouvernement which is another place) was once connected to Mare du Rhanteau and both formed a large seawater canal separating Anse La Blague from the rest of Praslin (V. Laboudallon pers. comm.). The original outflow into the bay was greatly reduced during road construction and the water currently flows through a narrow bridge of 2 m wide. A wall was built to partially block the outflow, channelling it through a narrow opening between boulders. Over the years, sedimentation reduced the size of the canal and the floodplain was partly reclaimed for development. The mangrove at Kot D'Hauban receives freshwater from the rocky hills particularly from Fond Bois de Natte on the eastern side of the wetland. There are no permanent rivers which feed the mangrove. Part of the seaward mangrove is occupied by *R. mucronata* and stands of *A. marina*, and a bare patch along the roadside where crabs are common. Further inland there are dense stands of *A. marina*, *L. racemosa* and *R. mucronata* up to about 150 m from the sea. Thereafter, the floodplain transforms from a mangrove dominated system to a sparsely vegetated landscape comprised of a 150 m long and 10 m wide band of *A. marina*, *L. racemosa* and *R. mucronata* running along the foot of the hill where active crab burrows are abundant. Dead empty clam shells are also abundant indicating a different macro-faunal existence from today. Stagnant water and puddles are visible. The substrate in the wet and moist areas is mature sandy clay with high organic matter content and hence potentially suitable for mangrove development. The floodplain area also features islands of *A. aureum*, and other native plants like *Ficus lutea*, *Premna serratifolia* and *C. equisetifolia*. Invasive plants are encroaching onto the floodplain, probably aided by the huge reduction of seawater flow into the mangrove as a result of road construction and blockage of hydrological flow.

2.8. La Pointe (Anse St. Sauveur to Anse Takamaka, Praslin Island)

Historically, La Pointe between Anse St. Sauveur and Anse Takamaka was a continuous wetland but is now severely fragmented by several access roads, paths and partially reclaimed for housing and agricultural development. The main road along the seaward end of the fragmented wetlands almost entirely blocks the exchange between the wetlands and the sea. The only outflows are through two bridges of 2.5 m wide x 1.5 m high along the road, but the outlet of one of the newly built bridges is already blocked by sand deposition and accumulation. An abandoned drain of 0.7 m wide is present on the western side of the wetlands. Two rivers flow into the wetland. R. Nicovo flows from the NW side and R. La Prude drains from the NE side. The biggest wetland fragment on the far East contains dense, healthy stands of mangroves comprising of *R. mucronata* and *L. racemosa* as well as a high abundance of crabs. Seedling recruitment is visible in the wetland. This mangrove fragment is the healthiest of all of project sites visited although there are signs of encroachment by some invasive species.

2.9. Mare du Ranteau (Au Cap, Praslin Island)

Mare du Ranteau was once connected to Cap Samy and Kot D'Hauban wetlands. Today the wetland is fragmented by roads, and has been partially reclaimed for housing development. The Anse La Blague road running along the SW side of the wetland entirely blocks the original outflows except for two outlets beneath the road (1 m and 3 m wide bridge). The Anse La Blague road is also showing signs of damage where flood waters have undermined the road embankment. No permanent rivers drain into the wetland but instead freshwater comes from the extensive rocky granitic outcrop on north and eastern side of the wetland. The

vicinity of the outlet is fairly dense with mangrove and a high abundance of crabs. Fishes are fairly common too. But, the general health of the mangrove is poor with *A. marina* and *L. racemosa* showing signs of dieback; and infestation of the hairy caterpillar (*Euproctis* sp.) on *L. racemosa*. There is no mangrove recruitment despite fruiting. Hydrological flow within the wetland is reduced, particularly when the main outlet is blocked by sand and seaweeds. The secondary channel flowing into the western side of the wetland is visible only for about 10 m inland, and then becomes indistinct as a result of sediment accumulation which has flattened the level of the secondary channel. Wooden debris from dead mangroves blocks the channels. The north-eastern secondary channel flows into an extensive sparsely vegetated mudflat. The substrate is soft, fairly deep, light brownish grey sandy clay suitable for planting mangrove. There is an abundance of active crab holes. Further north, there is an extensive dense, fairly unhealthy stand of *A. marina* showing signs of dieback. Slurry from two pig styles runs into the mangrove where the water turns into a frothy bright greenish-yellow colour. Further inland, an extensive raised sand bank covers most of the original wetland surface. The vegetation has transformed from the typical mangrove and freshwater marsh communities to a mostly native coastal plant community. There are however, signs of the remnant freshwater marsh community as represented by species like *A. aureum* and *Typha javanica*.

2.10. Nouvelle Decouverte (Praslin Island)

Nouvelle Decouverte wetland forms part of the Nouvelle Decouverte water catchment which is one of the two main watersheds on Praslin. A network of rivers flows into the wetland. Rivière Durand flows from the NE direction into the wetland. Rivière Lablache, flowing from East joins the major Rivière Nouvelle Decouverte at 10 m altitude and both drain into the wetland. The main Grand Anse road runs along the western side of the mangrove blocking the entire natural outflow except for a wide box culvert beneath the road which is partially blocked with sand. Dense residential areas, businesses and tourism establishments lay adjacent to the north-western side of the wetland. Degraded hills are found to the north and east side of the wetland, whilst the south-western and southern side of the wetland borders dense coastal forests and the main road that joins Grand Anse to Baie Ste. Anne district. Wooden debris obstructs flow, and rubbish is highly visible. Some parts of the river banks are unvegetated and erosion is visible, thus replanting to stabilize the banks should be envisaged. IAS like *Eucalyptus camaldulensis*, *Falcataria moluccana* (Albizia), *Alstonia macrophylla* (Devil's tree, Bwa zonn), *Leucaena leucocephala* (Kasi) and undesirable non-mangrove species like Coconut and Casuarina trees are found in various areas in the wetland and can spread and impact upon native species changing the composition and structure of the wetland. The hairy caterpillar (*Euproctis* sp.) is invading *L. racemosa* and its spread should be controlled to reduce its impact. Overall, Nouvelle Decouverte wetland is a good habitat for several taxa (e.g. fish, crabs, birds) but its condition needs to be improved to enhance its biodiversity value and functions.

3. SITE-SPECIFIC INTERVENTIONS

Site-specific interventions are detailed as per the below indicator and targets of the project.

3.1. Indicator and targets

Indicator: Number of EbA and EbA related interventions implemented by the project.

Targets: Five different EbA interventions implemented.

1. A total of 7 culverts to improve hydrological flow through 300 hectares of artificially fragmented mangroves;
2. 1.7 km of channel desilting to improve hydrological flow between 100 hectares of artificially fragmented mangroves;
3. 500 m of national highway protected from coastal erosion through embankment stabilization using mangrove rehabilitation;
4. 20 hectares of degraded mangroves cleared of alien species and replanted (at a density of at least 500 seedling/ha);
5. 9 hectares of degraded mangroves restored to protect low cost housing estates, commercial areas and other infrastructure from coastal erosion.

3.2. Size of intervention and impact areas (ha) within the project sites

The 300 ha and 100 ha impact zones for target 1 and 2 respectively have been identified by taking into account the wetland definition for Seychelles: Highland and lowland wetlands, streams, estuaries, mudflats, mangroves and intertidal zone'. Considering that these two targets pertains to Cap Samy (Praslin) and Petit Barbarons (Mahé), fragmented wetlands have thus been delimited to include not only the mangroves, but other types of wetlands like marshes, mudflats, estuaries and the intertidal zones.

The size of intervention areas for targets 3 to 5 has been calculated based on the actual needs for each site. GPS coordinates from site visits, wetland maps and orthophotos were used to delimitate the intervention areas.

Intervention sites	Size of intervention/impact area (ha)	Project Target size (ha)
Target 1: 7 culverts to improve hydrological flow through 300 hectares of artificially fragmented mangroves		
Cap Samy	298	
Petit Barbarons	9	
Total	307	300
Target 2: 1.7 km of channel desilting to improve hydrological flow between 100 hectares of artificially fragmented mangroves		
Cap Samy	87	
Petit Barbarons	9	
Total	96	100
Target 3: 500 m of national highway protected from coastal erosion		
Cascade	500 m	500 m
Target 4: 20 ha cleared of IAS & rehabilitated		
Anse Royale	3	
Petit Barbarons	2	
Anse Gouvernement	6	
Mare du Rhanteau	1	
Cote D'Or	1	
La Pointe	4	
Nouvelle Decouverte	4	
Curieuse	2	
Total	23	20
Target 5: 9 ha of degraded mangrove rehabilitated		
Roche Caiman	8	9
Total of Target 4 & 5	31	29

3.3.Ecosystem-based Adaptation targets

Target 1:

A total of 7 culverts to improve hydrological flow through 300 hectares of artificially fragmented mangroves.

Project sites:

Cap Samy (Praslin) and Petit Barbarons (Mahé).

Description of proposed interventions:

4 culverts at Cap Samy and 3 at Petit Barbarons (Annex 3). Initially, the proposed target was for 10 culverts: 5 at Cap Samy, 1 at Anse Gouvernement (Praslin) and 4 at Petit Barbarons (Mahé). The reasons for the change in the target are explained as follows.

The NMRE was of the opinion that one of the 5 culverts planned for Cap Samy is not justifiable. The bridge is over a channel that is wide and deep enough (approx. 4 m wide x 1 m deep) and there are no apparent signs of any flooding in the area. CAMS successfully negotiated with the contractor to drop the 5th culvert. The decision was also supported by the Project Coordinating Unit (PMU), China.

The one for Anse Gouvernement was dropped by MEECC based on the views that i) the existing culvert was in good condition and ii) placing a larger size culvert could have negative impacts. The NMRE was not consulted on this decision. The NMRE is of the view that enlarging the outlet will be most beneficial to the wetland by allowing a greater flow of seawater (e.g. at spring tides) into the mangrove/mudflat to influence the creation of ecologically suited conditions for mangrove establishment (for existing and replanted mangrove seedlings), and by impeding the actual encroachment of non-mangrove plants onto the shrinking mudflats.

At Petit Barbarons, CAMS informed that there were 4 old dredger pipes to be replaced. These pipes are in 3 locations. One pipe connects wetland 1 to wetland 2. Two of the dredger pipes (double pipes) are under the bridge connecting wetland 2 to wetland 3. The 4th pipe connects wetland 3 to wetland 4. The 4 old dredger pipes to be replaced at these 3 locations, led to the confusion that 4 culverts will be put in place. It was later confirmed that only 3 culverts will be put in place to connect wetland 1 to wetland 2, wetland 2 to wetland 3 and wetland 3 to wetland 4. The mistake was certainly an oversight by CAMS.

The change in the target was approved during the fourth Project Steering Committee on 27-28th September in Nepal (UNEP-IEMP, 2016).

The details of work to be undertaken are as follows.

- i. At Cap Samy, construct and replace the 4 existing narrow drainage pipes with 2 x 1-span box culverts and 2 x 3-span pipe culverts for facilitation of flow within wetlands (Annex 3).
- ii. At Petit Barbarons, construct and replace the four 0.9 m wide dredger pipes with two 1-span box culvert and one 4-span pipe culvert for facilitation of flow within wetlands (Annex 3).

Expected outcomes:

- i. Increased protection of infrastructure and residential areas from flooding and other climate change impacts and variability.

Expected Budget:

Refer to Annex 8.

Target 2:

1.7 km of channel de-silting to improve hydrological flow between 100 hectares of artificially fragmented mangroves.

Project sites: Cap Samy (Praslin) and Petit Barbarons (Mahé).

Description of proposed interventions:

1.5 km at Cap Samy and 0.2 km Petit Barbarons

- i. At Cap Samy, re-profile channels by enlarging them to 4 m wide and 1- 1.5 m depth.
- ii. At Cap Samy, create at least 10 inter-connected channels to main channel for better water circulation and drainage.
- iii. At Petit Barbarons, improve water circulation by creating and or improving inter-connected channels within wetland, through ferns (sites 1 and 4, being careful not to excessively remove the freshwater ferns), and removing accumulated sediments (sites 1, 3, 4) within channels.

CAUTION: Do not remove ferns from sites 1 and 4 (except in inter-connected channels) as they play important roles in the functioning of the wetland such as trapping sediment, providing nutrients (plant litter) and habitats.

Expected outcomes:

- ii. Increased protection of infrastructure and residential areas from flooding and other climate change impacts and variability.

Expected Budget:

Refer to Annex 8. The budget for target 2 is incorporated within the budget of target 1.

Target 3:

500 m of national highway protected from coastal erosion through embankment stabilisation using mangrove rehabilitation.

Project sites: Cascade (Mahé).

Description of proposed interventions:

Rehabilitation of 500 m of embankment at Cascade for protection of important infrastructures i.e. the highway (see map, Annex 4).

- i. Identify and mark Casuarina for felling.
- ii. Selectively lop tall tilting Casuarina trees along 500 m of the erosion-prone road embankment facing the channel (Casuarina should NOT be uprooted because its lateral roots play a role in bank stabilisation; instead tall tilting ones should be lopped. Note that there is no need to remove all the Casuarinas along the embankment.)
- iii. Plant a selection of 500 mangroves and native coastal plants in the lagoon along the eroded embankment and on the upland banks (see plant list, Annex 7).

Although 500 plants per hectare (i.e. 500 plants per 10,000 m², equivalent to 1 plant every 20 m) was recommended by Amed Khan (2015) totalling 75 plants for Cascade, the NMRE is proposing a higher density of 1 plant per m² hence giving at least 500 plants for Cascade. This is being proposed for a better coverage and protection of the embankment.

Expected outcomes:

- i. Increased protection of infrastructure from coastal erosion and other climate change impacts and variability.

Expected Budget:

Refer to Annex 8.

Target 4:

20 hectares of degraded mangroves cleared of alien species and replanted (at a density of at least 500 seedling/ha).

Project sites: Anse Royale, Petit Barbarons, Roche Caiman (Mahé), Anse Gouvernement, Cote D'Or, La Pointe, Mare du Rhanteau, Nouvelle Decouverte (Praslin) and Curieuse (Annex 5).

Description of proposed interventions:

Invasive Alien Species and non-desirable non-mangrove species such as Casuarinas and Coconuts removed and replanted where appropriate with mangroves and other appropriate native coastal plants. The proposed planting density is approx. 3300 seedlings per hectare i.e. 1 seedling every 3 m. This density was chosen to provide sufficient vegetation coverage, but the calculation also took into consideration budgetary constraints.

Anse Royale (ca. 3 ha, Annex 5, Map 1).

Rehabilitating biodiversity of riparian zones through biological strategic interventions (1.72 ha)

- i. Remove IAS in the riparian zones by cutting and uprooting *Leucaena leucocephala* and young *Albizia (Falcataria mollucana)* and ring barking adult *Albizia*. Felling of tall *Albizia* should be avoided to reduce negative impact on under canopy communities and sudden gap creation. Since *Leucaena leucocephala* will be uprooted and disposed off at the Providence dumping site, we do not expect any regrowth/resprouting to occur. A follow-up monitoring will nonetheless be carried out to assess the success of IAS removal and the need for any follow-up treatment.
- ii. If necessary, cover the riparian zone with dead palm leaves and or leaves of the cut/uprooted IAS to reduce germination of IAS seed bank (if replanting is not immediately done).
- iii. Replant riparian zones with 5600 native plants adapted to riverine conditions such as endemic palms and freshwater fern (see plant list, Annex 7).

Rehabilitating mangrove community through biological strategic interventions (0.5 ha)

- iv. Replant at least 1650 mangroves in gaps where IAS have been removed (see plant list, Annex 7)

Rehabilitating swamp forest through biological strategic interventions (0.44 ha)

- v. Remove IAS like Devil's tree, *Albizia* and *Korsol*.
- vi. Replant area with 1450 coastal species adapted to swamp areas and or areas that are periodically waterlogged such as Silver-glass tree (see plant list, Annex 7). The Puzzlenut mangrove can also be considered for this area.

Petit Barbarons (2 ha, Annex 5, Map 2)

Rehabilitating overall wetland areas through biological strategic interventions (2 ha)

- i. Remove IAS like *Albizia* and undesirable non-mangrove species like *Coconut* and *Casuarinas* from within the wetland. Adult *Albizia* can be lopped or ring-barked whilst *Casuarinas* can be lopped so that their roots maintain the stability of the banks. Moreover complete tree removal may enhance invasion by creeper and other IAS. Note that the entire area does not need to be replanted and the removal of IAS species may be sufficient to allow mangrove and native non-mangrove species to regenerate. The sites will be periodically monitored for any need of re-intervention. Specific sites for replanting are detailed below.

Rehabilitating wetland banks through biological strategic interventions (1 ha of the 2 ha)

- ii. Remove IAS like *Albizia*, *Cocoplum* and undesirable non-mangrove species like *Coconut* and *Casuarinas* from the wetland banks

- iii. Replant 3300 native plants to stabilise wetland margins/banks e.g. *Barringtonia asiatica*, (Bonnen kare bor-d-mer), *Cordia subcordata* (Porse), *Scaevola frutescens* (Veloutye), and *Thespesia populnea* (Bwa-d-roz, see plant list, Annex 7)
- iv. Lay sand in sling bags at the coastal front to stabilize area (optional) and replanting of appropriate native coastal species like *Scaevola frutescens* to protect the coastal area from current erosion.

Rehabilitating mangrove community through biological strategic interventions (0.2 ha of the 2 ha)

- v. Replant at least 700 mangrove species in the mangrove i.e. Site 3 and lagoon margin, to increase diversity and abundance and restore function (see plant list, Annex 7).

Anse Gouvernement (the proper name is Kot D’Hauban, 6 ha, Annex 5, Map 3 & 4)

Rehabilitating coastal plateau and wetland through biological strategic interventions (4.2 ha).

- i. Remove IAS like Devil’s tree and undesirable non-mangrove species like Coconut and Casuarinas from the coastal plateau and wetland margin. Note, removal of the freshwater fern (*A. Aureum*) and other beneficial native coastal plants should NOT be envisaged from the sand bank and mudflats.
- ii. Replant ca. 13,800 native coastal plants like *Barringtonia asiatica*, *Calophyllum inophyllum*, *Dodonaea viscosa*, *Ficus lutea* and *Premna serratifolia* (see plant list, Annex 7). Note, it may not be possible to replant in all areas where IAS will be removed depending on the conditions, e.g. already dense, shady areas may not favour the growth of planted seedlings because they will need to compete for sunlight, nutrients etc.

Rehabilitating mangrove and enhancing biodiversity, abundance and density through biological strategic interventions (1.8 ha).

- i. Replant Zone A (0.3 ha) 50 *A. marina* at a low density of 1 plant per 10 m. This area is important for the crab *Uca latea* which are abundant in this zone and hence there should be sufficiently bare spaces for crab burrows. That is why a low density replanting is being proposed. The effect of planting mangroves on crab habitats could be investigated.
- ii. Replant the bare patches and areas where IAS will be removed from Zone B with 100 mangroves i.e. (see plant list, Annex 7).
- iii. Replant the bare patches and areas where IAS will be removed from Zone C with 300 *R. mucronata*.
- iv. Replant the area along the foot of the hill in Zone D with 700 mangroves (see plant list, Annex 7).
- v. Consider experimental replanting of the extensive bare sand/mudflat of Zone E with 1000 mangroves (notably *X. granatum* and *L. racemosa*) and other native coastal plants. This area becomes dry during the dry season as it does not receive sufficient seawater.

Other considerations

- i. Reinstating the abandoned drain running from the main road into the floodplain and which use to drain flood waters from residential areas may be potentially beneficial in draining floodwaters from the nearby Marie-Jeanne housing estate.
- ii. The wetland has very good potential for eco-tourism, leisure, recreation, research and education. Hence any attempt to enhance its aesthetic appeal and biological importance will be beneficial for these activities
- iii. The successful rehabilitation of Anse Gouvernement and the adjacent Mare du Rhanteau may have positive advantages in the wider rehabilitation or natural regeneration of the floodplain considering the presence of remnant freshwater plant communities of *Typha javanica* and *A. aureum* on the landward side of the floodplain.

Mare du Rhanteau (1.14 ha, Annex 5, Map 5).

Rehabilitating mangrove and enhancing biodiversity, abundance and density through biological strategic interventions (0.14 ha).

- i. Replant the exposed mudflat with 500 mangroves to improve cover, abundance and diversity i.e. 100 *A. marina*, 250 *C. tagal*, 125 *R. mucronata*, and 25 *S. alba* (see plant list, Annex 7).

Rehabilitating coastal plateau and wetland margin through biological strategic interventions (1 ha).

- i. Replant the verges of the newly created drain with 3000 native coastal plants (see plant list, Annex 7).
- ii. Replant the bank of the main road with *A. aureum* and *Scaevola sericea* to stabilise and prevent erosion of the banks/roadsides. ca. 300 plants in total.

Other considerations

- i. The freshwater pond can also be rehabilitated through removal of IAS and allowing re-colonisation by freshwater species. Introduction of freshwater species like indigenous sedges that grow on the edge of marshes: *Cyperus alopecuroides*, *Cyperus articulatus*, *Mariscus pennatus*, *Scleria sumatrensis* and *Typha javanica*) or indigenous grasses that grow in wet places (*Echinochloa colonum* and *Paspalidium geminatum*) or the attractive and edible indigenous freshwater fern *Ceratopteris cornuta* and the sedge *Eleocharis dulcris* that grow in freshwater could be trialled. These wetland species were probably originally present and hence their re-introduction could be envisaged.

Cote D'Or (1.03 ha, Annex 5, Map 6).

Rehabilitating sand banks and wetland margins of Zone A through biological strategic interventions (0.22 ha).

- i. Remove IAS trees like *Tabebuia pallida* (White cedar, Kalis dipap), and non-desirable native species like tall Casuarinas on the sand banks and wetland margins of Zone A.
- ii. Replant Zone A with 725 mangrove species see plant list, Annex 7

Rehabilitating mangrove and enhancing biodiversity, abundance and density of Zone B through biological strategic interventions (0.25 ha).

- iii. Replant bare and sparsely vegetated sand banks with mangroves approx. 825 plants. See plant list, Annex 7).

Rehabilitating swamp forest of Zone C through biological strategic interventions (0.56 ha).

- iv. The swamp forest is infested with the invasive Dumb cane *Dieffenbachia seguine* which clogs channels and impedes water flow. The removal of this IAS and replanting with 1850 freshwater ferns and shade tolerant understory plants can be considered.

La Pointe (4 ha of 7 ha, Annex 5, Map 7)

This is a fairly healthy wetland where very little biological intervention is required. IAS and non-desirable native plants are not widely distributed and that is why an impact/intervention area of 4 ha instead of the entire 7 ha of wetland is being considered. However, the size of the intervention area needs to be re-assessed through more field visits.

- i. Remove IAS and non-desirable native species like Casuarina and Coconut from the wetlands. Planting of mangrove is not necessary at this stage as the mangrove stands are fairly dense. Instead, natural regeneration should be allowed.

Nouvelle Decouverte (4 ha, Annex 5, Map 8)

- i. Remove IAS such as Cocoplum (*Chrysobalanus icaco*), Eucalyptus, *Leucaena leuceana*, Devil's tree and Cinnamon, and undesirable non-mangrove species like Coconut and Casuarina from the entire 4 ha of wetland through felling and or ring barking.
- ii. Where possible, replant mangroves and other coastal plants in areas where IAS have been removed. Details for specific areas are given below.
- iii. Replant the wetland margins running along the roadside (0.2 ha) with 700 coastal plants such as Bwa savon, Scaveola and freshwater fern. Note that herbs and shrubs are proposed because the PUC electric power lines run above this zone and hence these plants will not grow that high to affect the power lines.
- iv. Replant ca. 0.13 ha bare river banks along Rivière Durand flowing through the wetland, with 400 desirable native plants like *A. aureum* or mangrove species like *B. gymnorhiza* and *L. racemosa* to stabilise the banks.
- v. Replant ca. 0.1 ha bare river banks on either side of Rivière Nouvelle Decouverte flowing through the wetland with 300 freshwater fern.
- vi. In addition, replant an area of 0.2 ha in the vicinity of the bare river banks with desirable native plants and mangroves totalling 600 plants (See plant list). Note, there is a need to reduce potential impacts onto crab habitats and hence high density replanting should not be envisaged.
- vii. The above replanting areas cover only 0.63 ha of the 4 ha. Depending on the availability of funding under the current project or counterpart funding, a further 2 ha can be replanted with 6,600 native coastal trees.

Other considerations

- i. Remove wooden debris and rubbish from the channels, banks and sand banks. Wooden debris can be piled on site away from the channels and serves as habitats for animals particularly invertebrates.
- ii. Control spread of the hairy caterpillar by periodic spraying with seawater. Chemicals or detergents should not be used in the aquatic ecosystem.
- iii. Indigenous sedges that grow on the edge of marshes can be considered for replanting the degraded exposed wetland banks. Potential candidates are *Mariscus pennatus*, *Cyperus alopecuroides*, *Cyperus articulatus* and *Scleria sumatrensis*. Indigenous grasses that grow in wet places are also good candidates for rehabilitation of degraded wetland banks e.g. *Echninochloa colonum* and *Paspalidium geminatum*. These wetland species were probably originally present and hence their re-introduction could be envisaged.

Curieuse (2.12 ha, Annex 5, Map 9)

Rehabilitating mangrove and freshwater plant species through biological strategic interventions (2.12 ha).

- i. Construct a nursery on the landward side of the mangrove in Zone A to supply mangroves for Praslin sites as well as Curieuse
- ii. In Zone A, remove the IAS Cocoplum (*Chrysobalanus icaco*) along the NW-NE landward side of the mangrove (1 ha), and replant with 3300 freshwater plant species such as Lerb kare (*Scleria sumatrensis*), and mangrove species like *L. racemosa*, *B. gymnorhiza* and *X. granatum*, see plant list, Annex 7).
- iii. Remove dense coconut patches from Zone B (0.7 ha) and replant with 1000 mangrove and coastal plant species, see plant list, Annex 7).
- iv. In Zone C, remove dense Coconut and Cocoplum patches and replant with 2300 mangrove and coastal plant species

- v. Consider experimental replanting of 250 *R. mucronata*, 100 *A. marina* and 50 *S. alba* in Zone D (0.12 ha) along the damaged stone wall/causeway in a trial to investigate if the mangrove can act as a protection barrier.

Other considerations

- i. Consider erecting a bamboo barrier across the main channel feeding the mangrove to reduce sand accumulation into the wetland and mitigate against erosion. Bamboo can be obtained from Curieuse.

Expected outcomes:

- i. Improved resilience of wetland to climate change and climate-related vulnerability like sea-level rise, coastal erosion, flooding and storm surges

Expected Budget:

Refer to Annex 8

Target 5:

9 hectares of degraded mangroves restored to protect low cost housing estates, commercial areas and other infrastructure from coastal erosion.

(Annex 6)

Project sites: Roche Caiman (Mahé)

Description of proposed interventions:

The number of plants produced depends on the feasibility of planting in this area based on the below comments. Hence, the final amount of plants produced may be less.

- i. Replant 3000 mangrove seedlings (e.g. 1000 *A. marina*, 1000 *C. tagal*, 950 *R. mucronata* and 50 *S. alba*, see plant list, Annex 7) on the fringes of the lagoon and on the mudflats.
- ii. Plant 500 native coastal plants along the raised banks along the school.

Roche Caiman already has fairly healthy dense mangrove stands except for some sparsely vegetated areas where bank erosion is evident. There is not much areas where replanting can safely be done. Most of the extensive mudflat in the central lagoon is not safely accessible whilst other areas are used for boat mooring by fishermen and hence replanting in these areas will obstruct navigation. Supplementary replanting of mangrove seedlings and other desirable coastal plants can thus be considered in bare and sparsely vegetated patches within the 9 ha of mangrove wetlands at Roche Caiman to protect the low cost housing estates.

To meet the 9 ha target, there will be a need to go beyond the housing estate towards the highway to include a further 3 ha, (Annex 6, *but 1 ha will still be missing - the extra 1 ha needed to reach the rehabilitation target can be considered under target 4 which has exceeded the area needed to meet that target. The total for Target 4 and 5 is $23 + 8 = 31$ ha, hence exceeding the overall target of 29 ha for the two interventions*). The extra 3 ha along the highway will also protect commercial areas and other infrastructure from coastal erosion. Hence, a recommendation was made by the NMRE to amend the target. The amendment was approved during the fourth Project Steering Committee on 27-28th September in Nepal (UNEP-IEMP, 2016).

Expected outcomes:

- i. Enhanced protection of nearby residential areas and infrastructures from coastal erosion and flooding as a result of climate change.

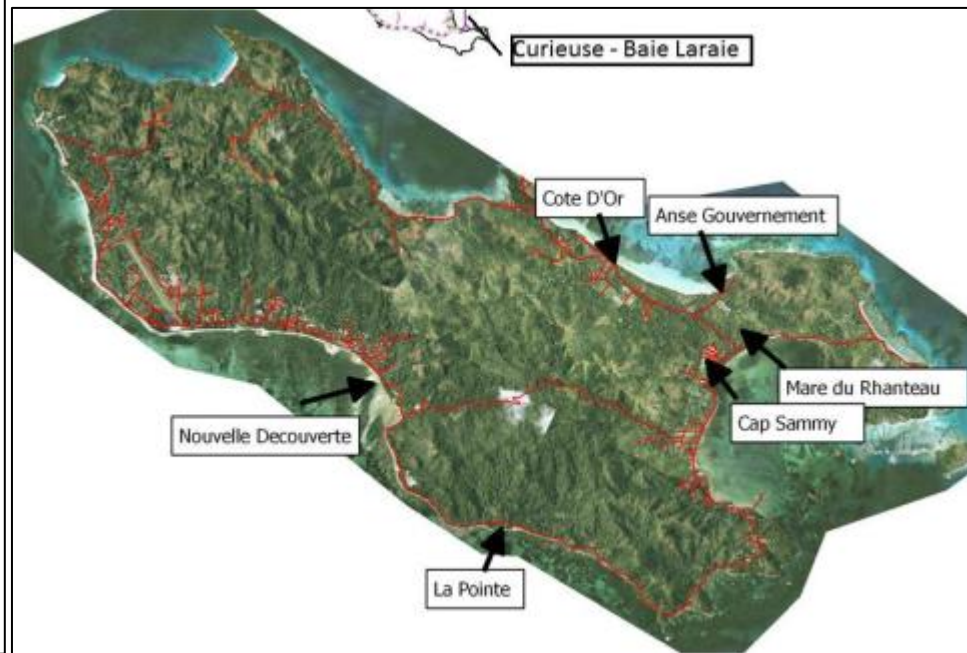
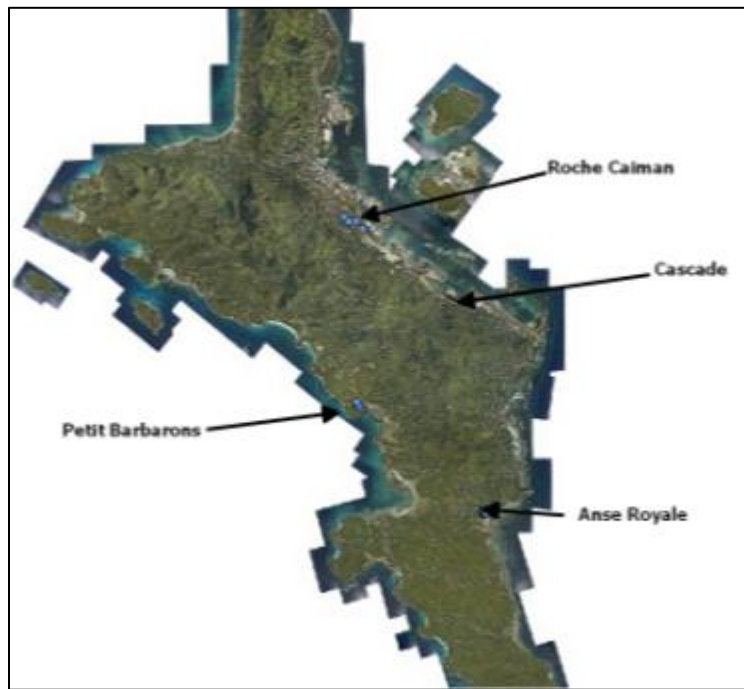
Expected Budget:

Refer to Annex 8

4. REFERENCES

- Bullock, A. and Acreman, M. (2003). The role of wetlands in the hydrological cycle. *Hydrology and Earth System Sciences Discussions*. 7 (3): 358-389.
- C4 EcoSolutions (2014). Baseline Assessment for Project: Enhancing Capacity, Knowledge and Technology Support to Build Climate Resilience of Vulnerable Developing Countries
- Gerlach, J. (2002). Seychelles Terrapin Action Plan. *Phelsuma*. 10 (Supplement B): 1-8.
- Government of Seychelles (2005). Seychelles National Wetland Conservation and Management Policy.
- Government of Seychelles (2014a). Fifth National Report to the United Nations Convention on Biological Diversity. Ministry of Environment and Energy, P.O. Box 445, Botanical Gardens, Mont Fleuri, Victoria, Republic of Seychelles
- Government of Seychelles (2014b). State of Environment Outlook Report.
- Khan, A. (2015). Implementation protocols for coastal mangrove rehabilitation in Seychelles. EBA-SSC Project.
- Mills, A. (2014a). Seychelles mission report.
- Mills, A. (2014b). Seychelles photo journal.
- Senterre, B. and Wagner, M. (2014). Mapping Seychelles habitat-types on Mahé, Praslin, Silhouette, La Digue and Curieuse. Consultancy Report. Government of Seychelles, United Nations Development Programme, Victoria, Seychelles. 119 pp.
- Spencer, T., Teleki, K., Bradshaw, C. and Spalding, M. (2000). Coral Bleaching in the Southern Seychelles During the 1997±1998 Indian Ocean Warm Event. *Marine Pollution Bulletin* Vol. 40, No. 7, pp. 569-586.
- UNEP-IEMP. (2016). Fourth Project Steering Committee Meeting of the EbA South project. 27-28 September 2016. Kathmandu, Nepal. Enhancing Capacity, Knowledge and Technology Support to Build Climate Resilience of Vulnerable Developing Countries.
- Woodward, R.T. and Wui, Y.S. (2001). The economic value of wetland services: a meta-analysis. *Ecological economics*. 37 (2): 257-270.
- Zedler, J.B. and Kercher, S. (2005). Wetland resources: Status, Trends, Ecosystem Services, and Restorability. *Annu. Rev. Environ. Resour.* 30: 39-74.

ANNEX 1: LOCATION MAPS

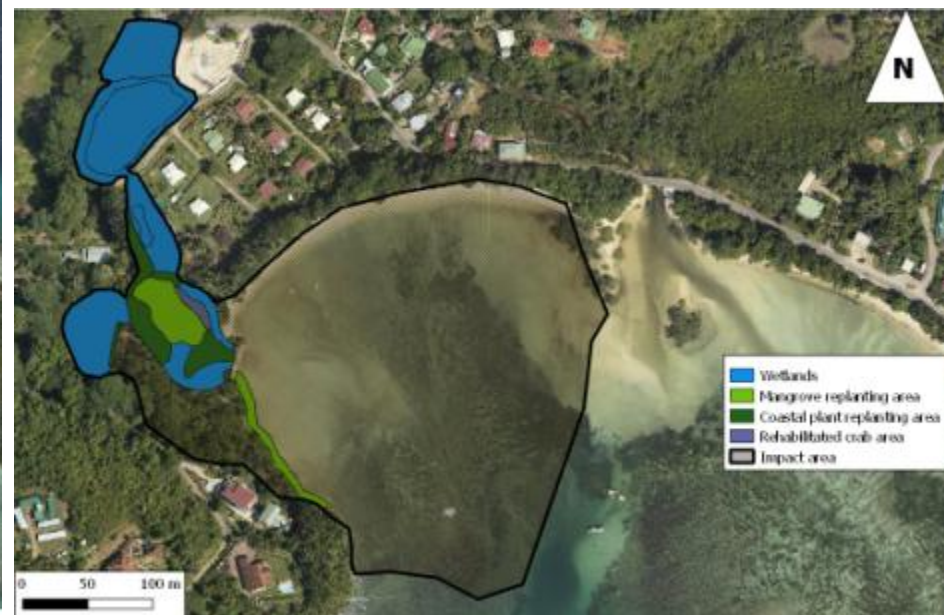


ANNEX 2: TARGET 1 & 2 IMPACT AREAS

300 ha and 100 ha impact areas on Praslin and Petit Barbarons for targets 1 and 2 respectively



Map produced by E. Henriette, 2016. Orthophoto imagery & Wetland maps (2011) provided by GIS Unit, Ministry of National Development, Seychelles.

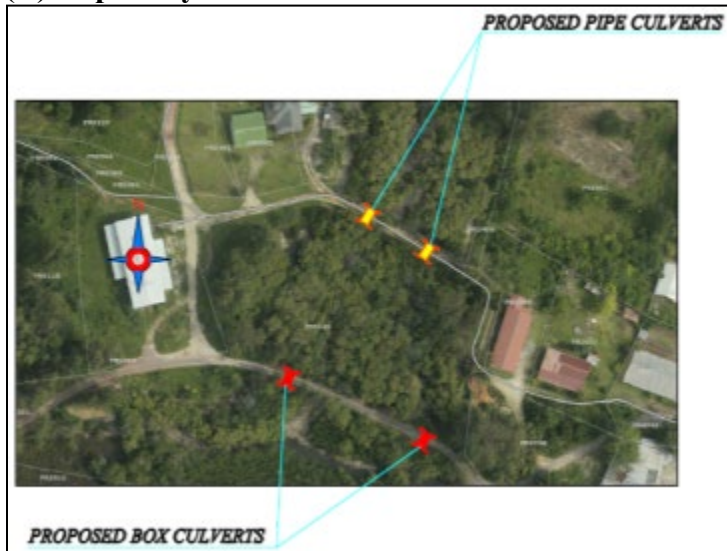


Map produced by E. Henriette, 2016. Orthophoto imagery & Wetland maps (2011) provided by GIS Unit, Ministry of National Development, Seychelles.

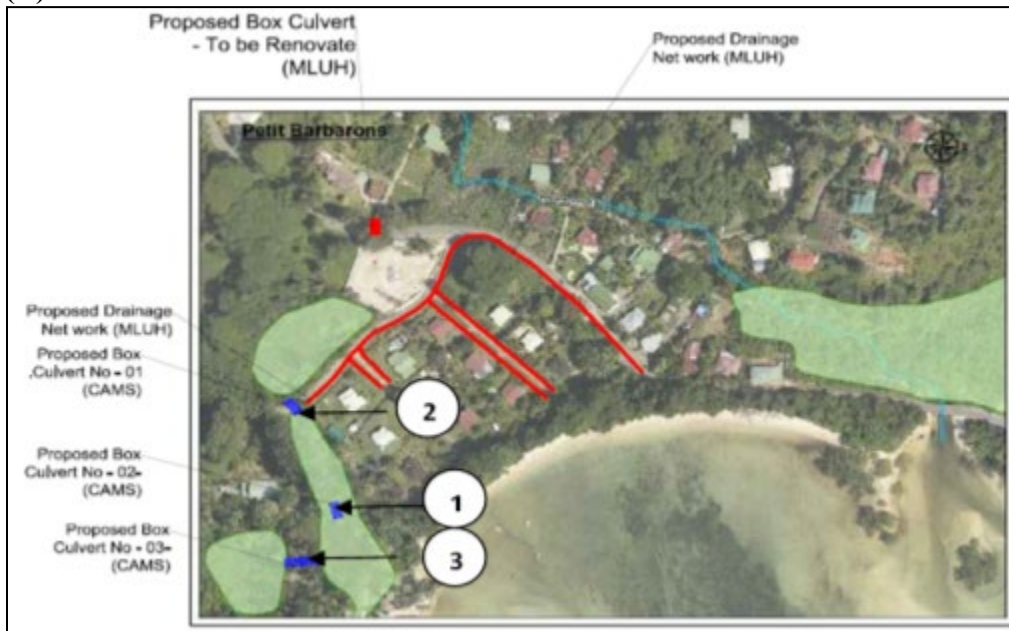
Intervention sites	Size of intervention/impact area (ha)	Project Target size (ha)
Target 1: 300 hectares of artificially fragmented mangroves		
Cap Samy	298	
Petit Barbarons	9	
Total	307	300
Target 2: 100 hectares of artificially fragmented mangroves		
Cap Samy	87	
Petit Barbarons	9	
Total	96	100

ANNEX 3: TARGET 1 & 2 CULVERT & DESILTING DETAILS

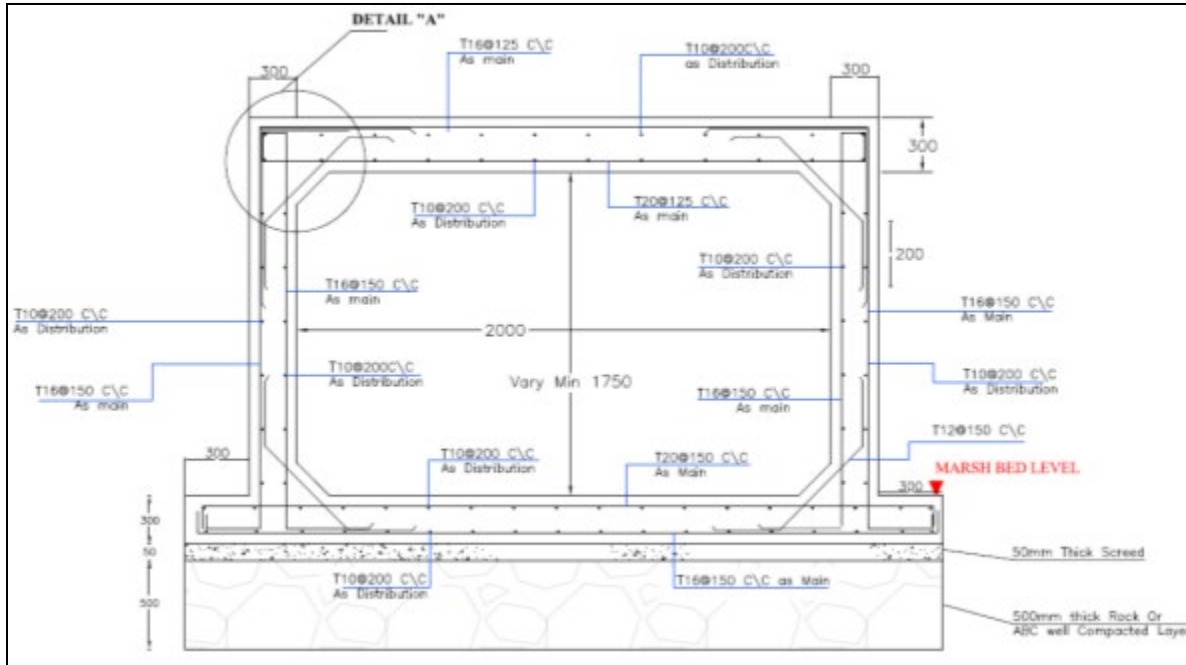
(A) Cap Samy



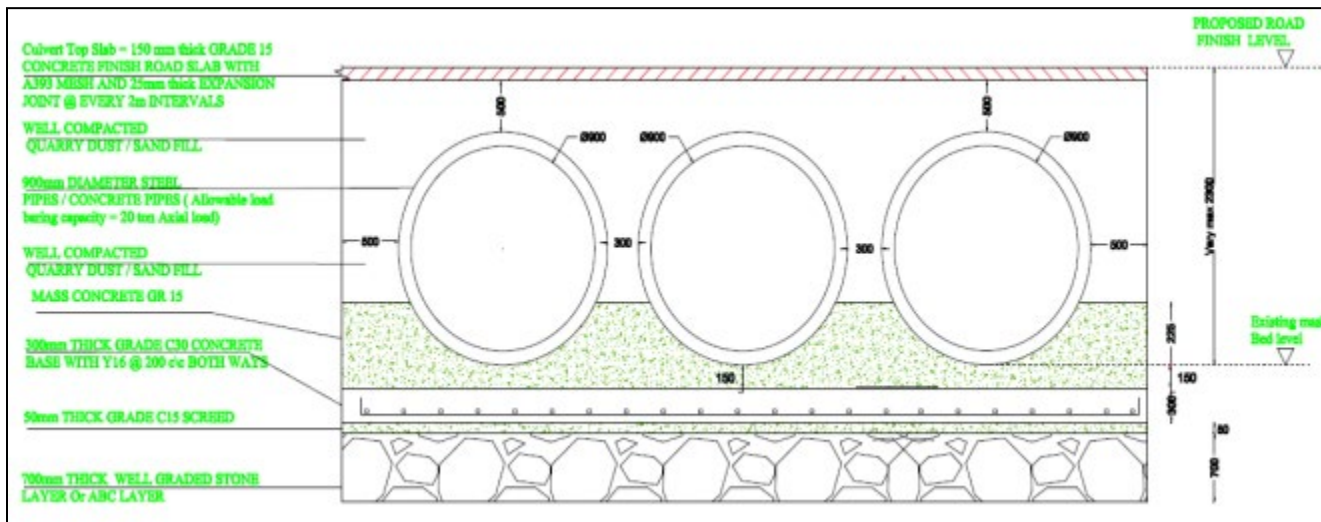
(B) Petit Barbarons



Details of box culvert



Details of pipe culvert



Channel desilting

(A) Cap Sammy – 1.5 km desilting



(B) Petit Barbarons -0 2 km desilting



ANNEX 4: TARGET 3 INTERVENTION AREA

500 m of national highway protected from coastal erosion through embankment stabilization using mangrove rehabilitation

Cascade (Mahé)

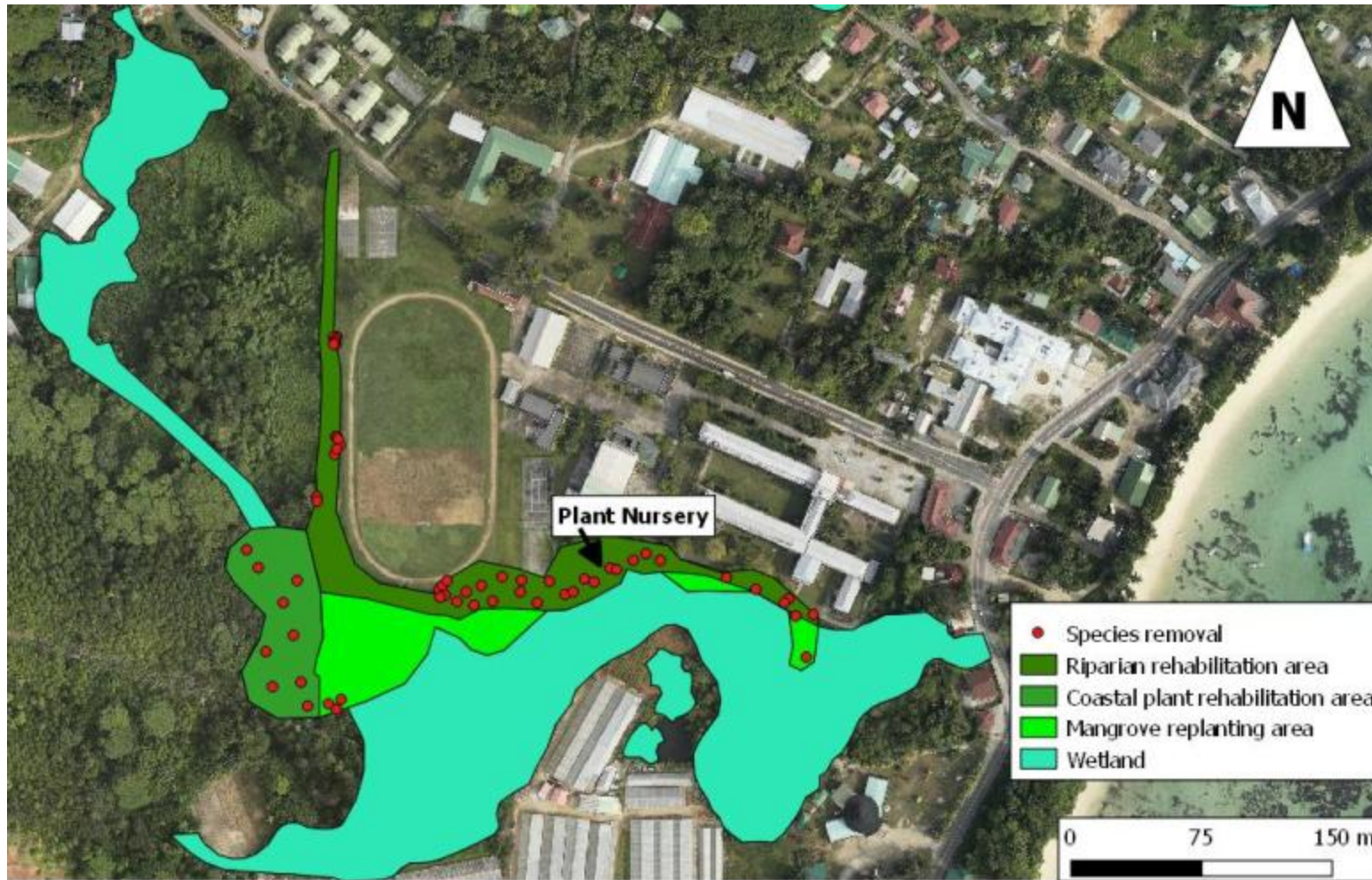


Map produced by E. Henriette, 2016. Orthophoto imagery (2011) provided by GIS Unit, Ministry of National Development, Seychelles.

ANNEX 5: TARGET 4 INTERVENTION AREAS

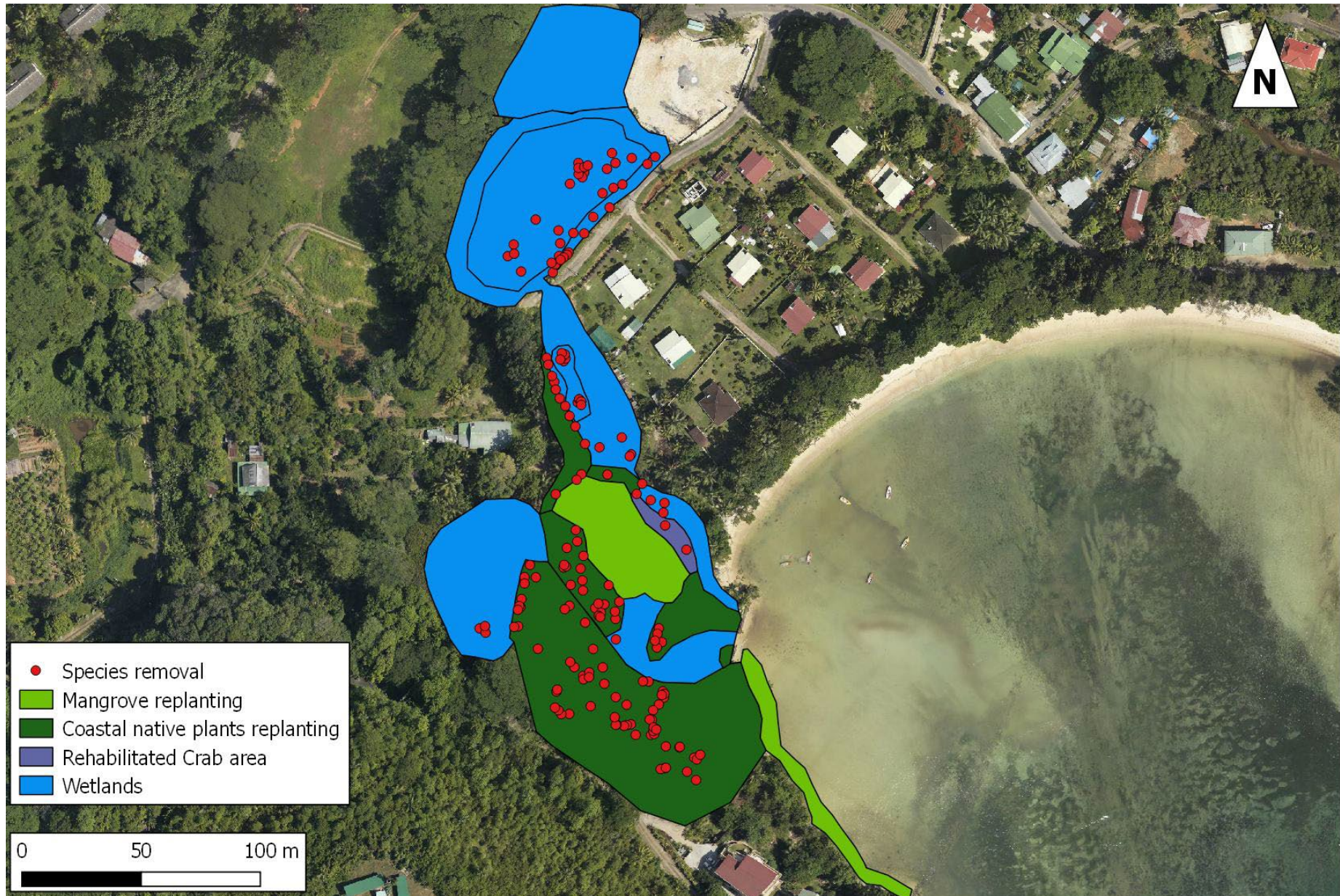
20 hectares of degraded mangroves cleared of alien species and replanted (at a density of at least 500 seedling/ha);

Map 1: Anse Royale (Mahé)



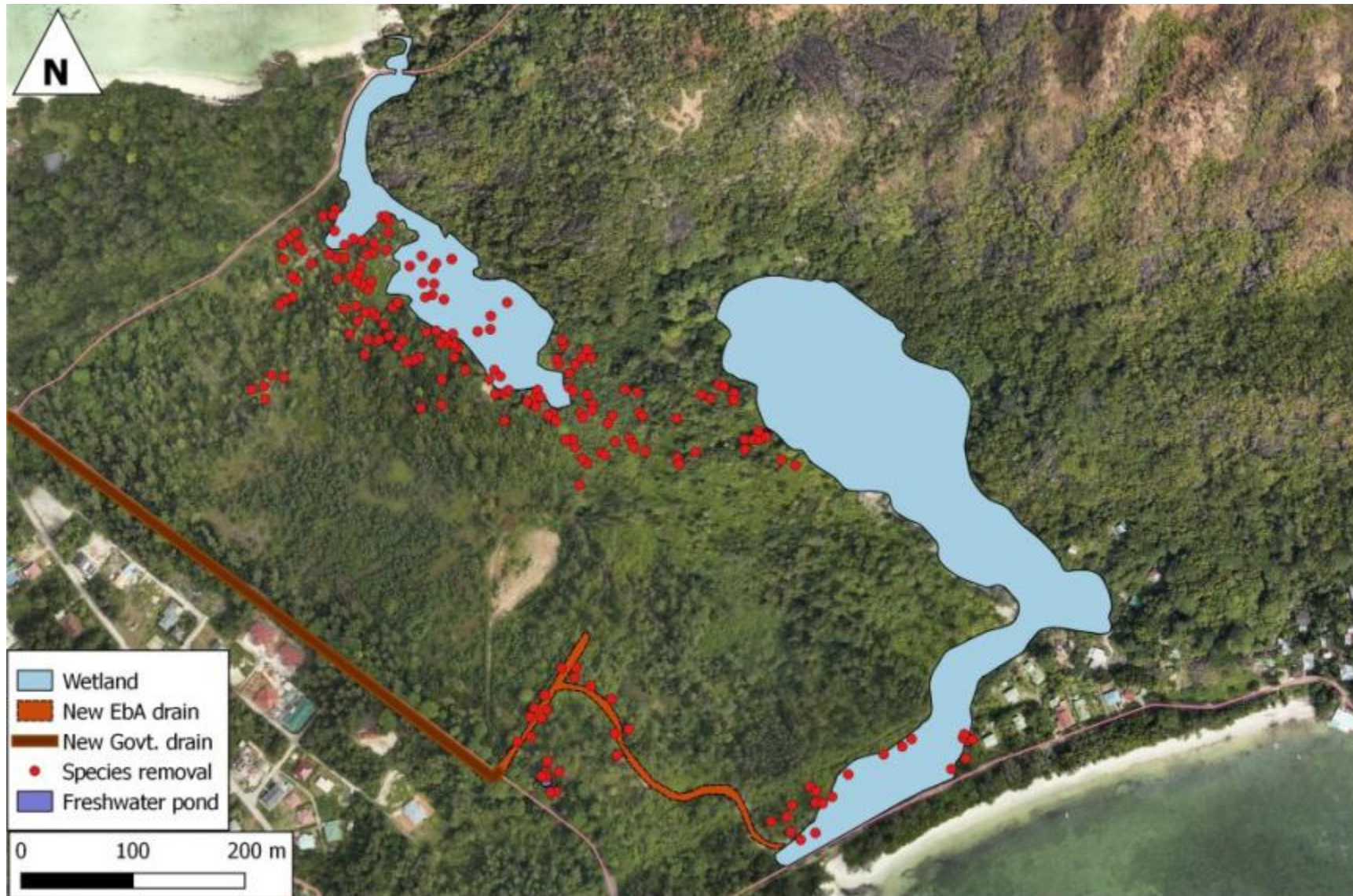
Map produced by E. Henriette, 2016. Orthophoto Imagery & Wetland maps (2011) provided by GIS Unit, Ministry of National Development, Seychelles.

Map 2: Petit Barbarons (Mahé)



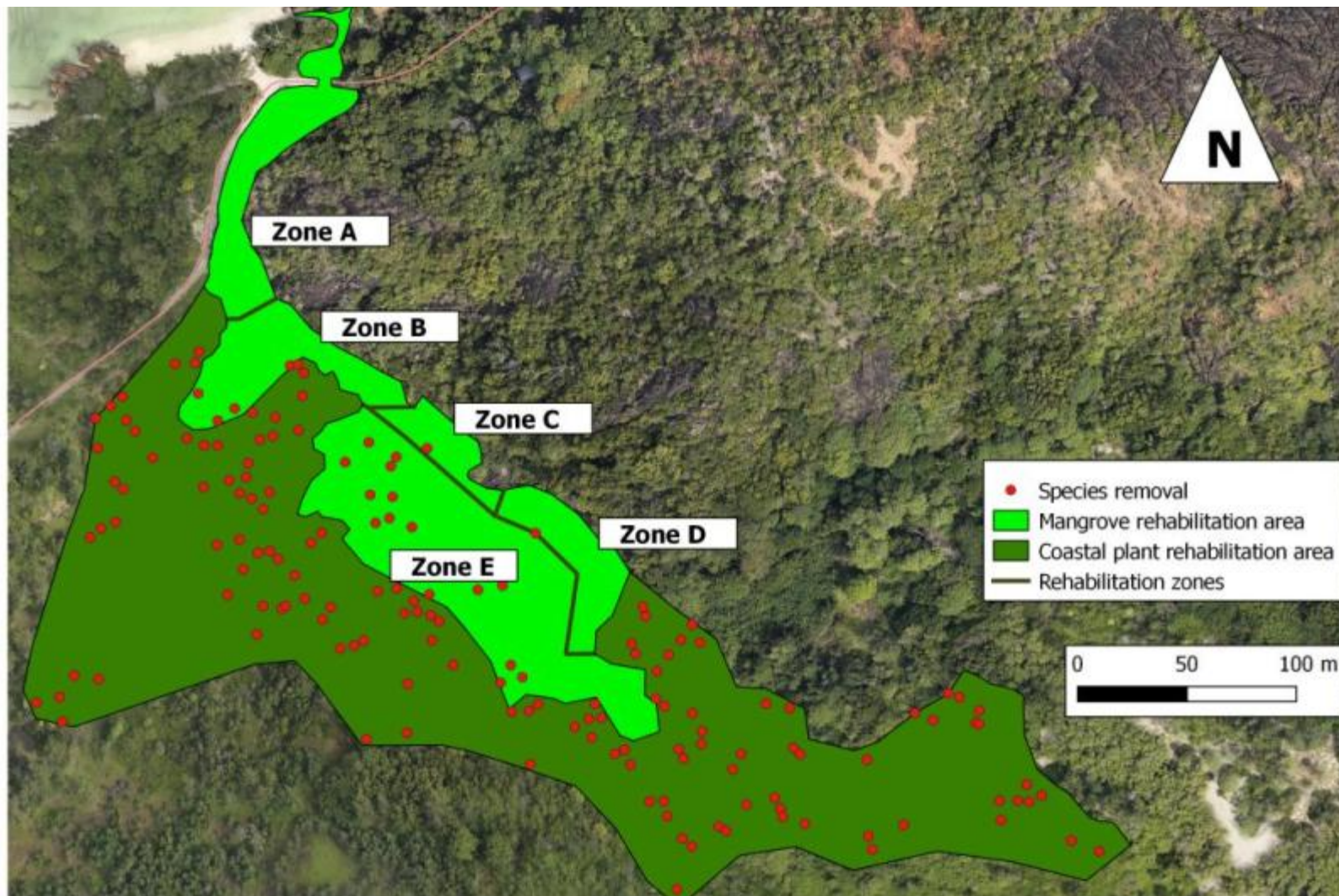
Map produced by E. Henriette, 2016. Orthophoto imagery (2011) provided by GIS Unit, Ministry of National Development, & Wetland maps provided by Senterre & Wagner 2014.

Map 3: Anse Gouvernment and Mare du Rhanteau (Praslin)



Map produced by E. Henriette, 2016. Orthophoto imagery & Wetland maps (2011) provided by GIS Unit, Ministry of National Development, Seychelles.

Map 4: Anse Gouvernment (Praslin)



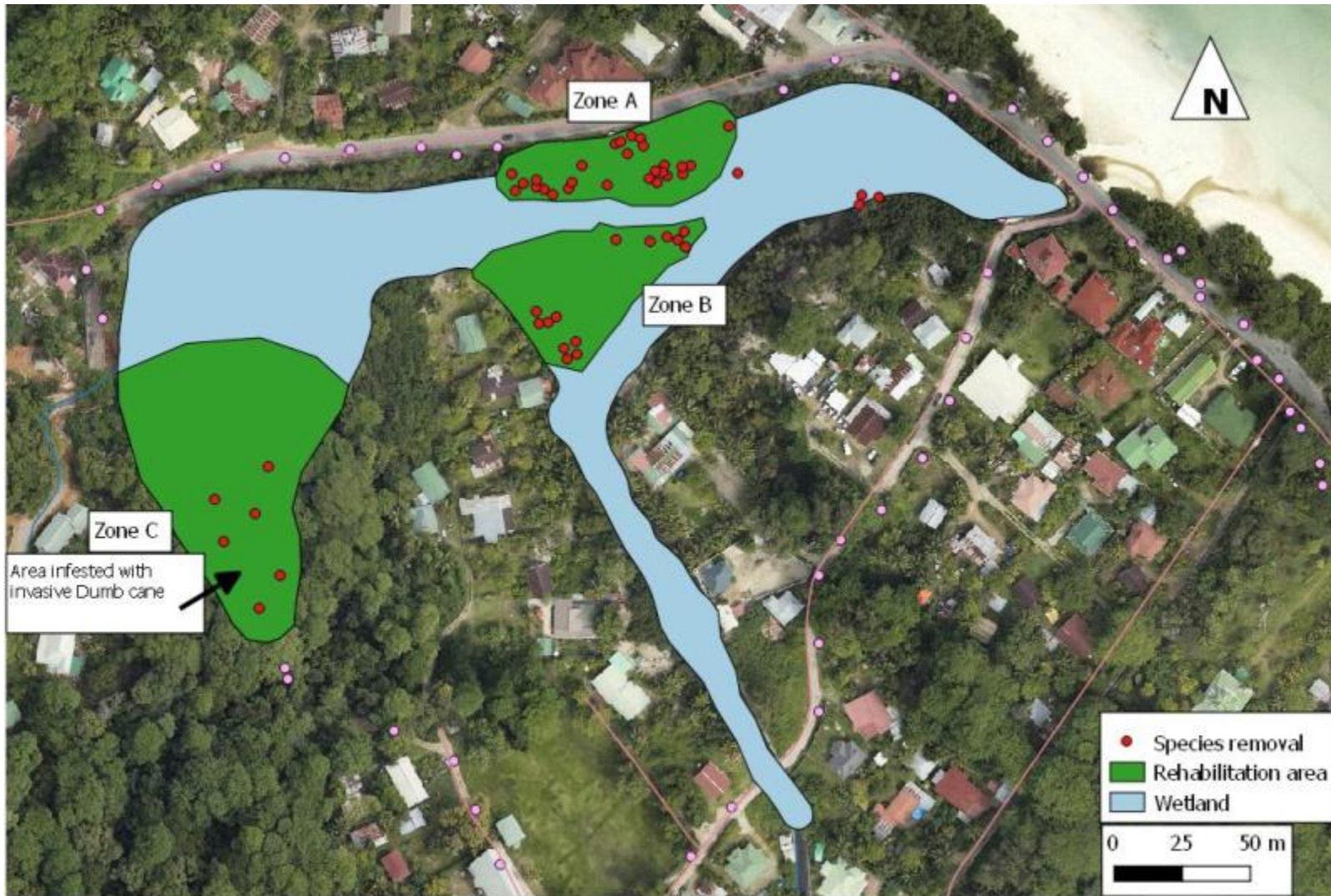
Map produced by E. Henriette, 2016. Orthophoto imagery & Wetland maps (2011) provided by GIS Unit, Ministry of National Development, Seychelles.

Map 5: Mare du Rhanteau (Praslin)



Map produced by E. Henriette, 2016. Orthophoto imagery & Wetland maps (2011) provided by GIS Unit, Ministry of National Development, Seychelles.

Map 6. Cote D'Or (Praslin)



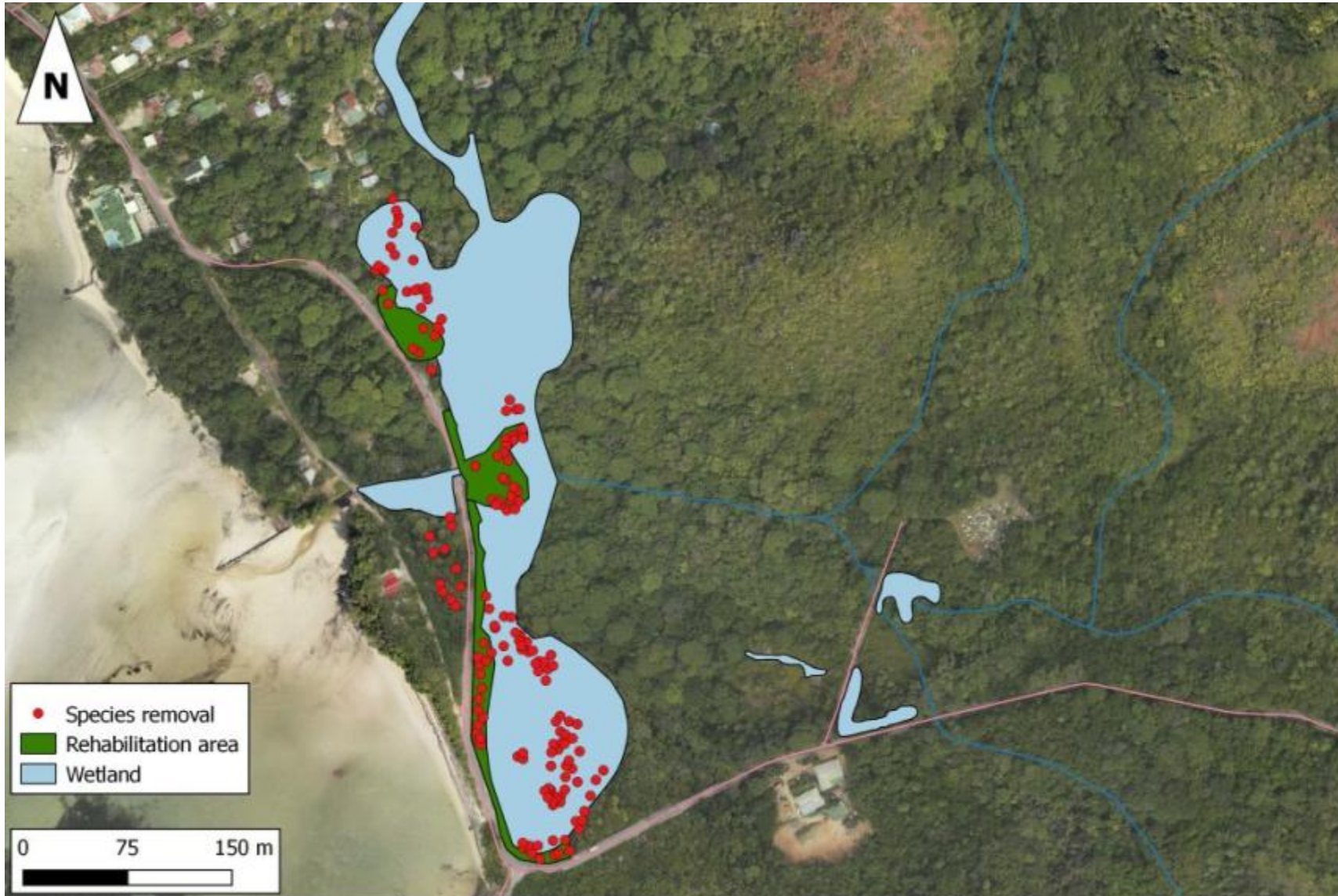
Map produced by E. Henriette, 2016. Orthophoto imagery & Wetland maps (2011) provided by GIS Unit, Ministry of National Development, Seychelles.

Map 7: La Pointe (Praslin)



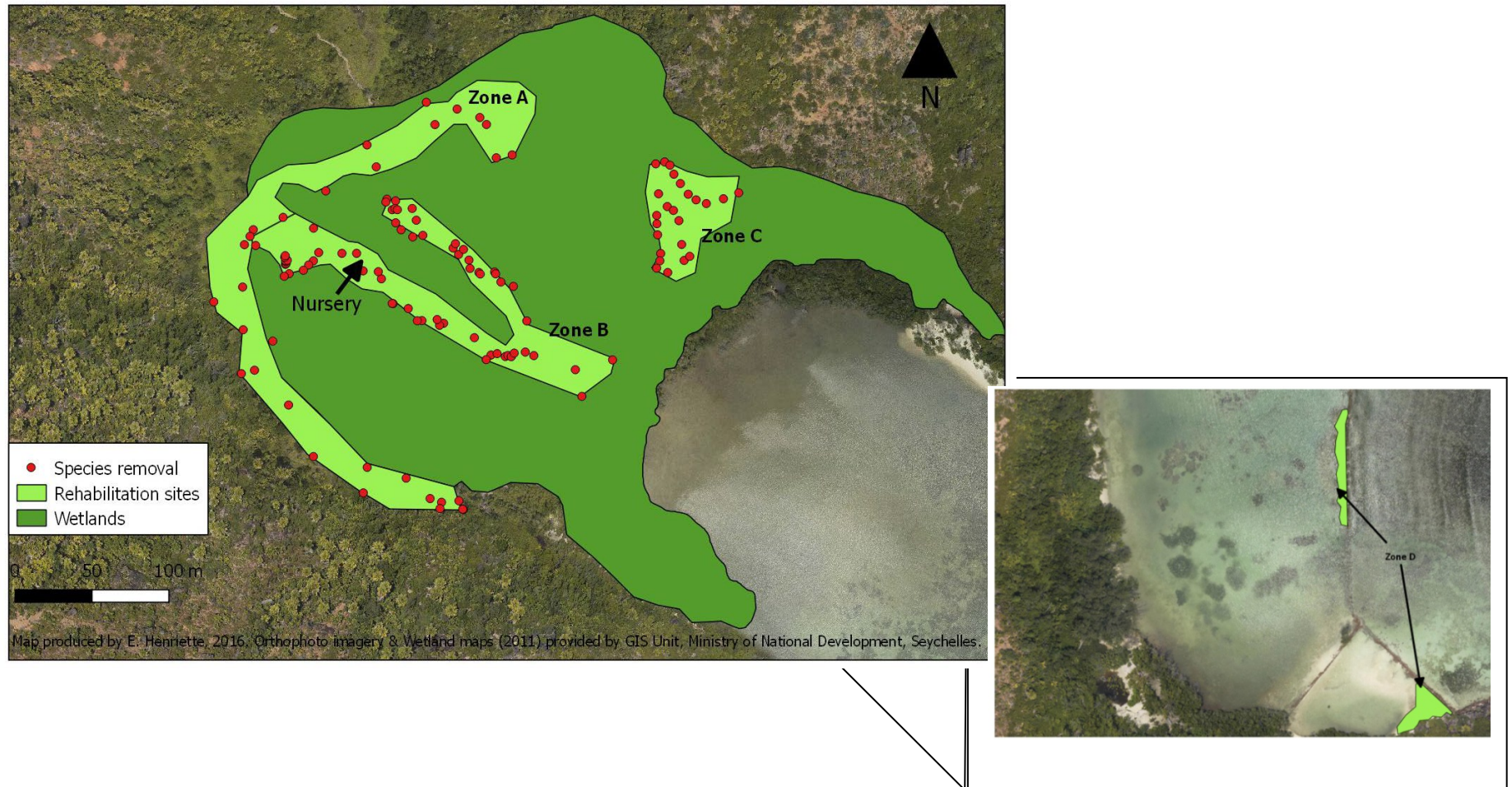
Map produced by E. Henriette, 2016. Orthophoto imagery & Wetland maps (2011) provided by GIS Unit, Ministry of National Development, Seychelles.

Map 8: Nouvelle Decouverte (Praslin)



Map produced by E. Henriette, 2016. Orthophoto imagery & Wetland maps (2011) provided by GIS Unit, Ministry of National Development, Seychelles.

Map 9: Baie Laraie (Curieuse)



ANNEX 6: TARGET 5 INTERVENTION AREAS

9 hectares of degraded mangroves restored to protect low cost housing estates from coastal erosion.



Map produced by E. Henneffe, 2016. Orthophoto imagery (2011) provided by GIS Unit, Ministry of National Development, Seychelles.

ANNEX 7: PLANT LIST FOR NURSERY PRODUCTION

Overall plant quantities

Targets	Sites	Area (ha)	Plant Quantity
Target 3	Cascade	500 m	500
Target 4	Anse Royale	1.72	5600
		0.5	1650
		0.44	1450
	Total	2.66	8700
	Petit Barbarons	1	3300
		0.2	700
		0.8	0
		Total	2
	Anse Gouvernement	4.2	13800
		0.3	50
		0.3	1000
		0.1	300
		0.2	700
		0.9	1000
		Total	6
	Cote D'Or	0.22	725
		0.25	825
		0.56	1850
	Total	1.03	3400
	Mare du Rhanteau	0.14	500
		1	3300
	Total	1.14	3800
	Nouvelle Decouverte	0.2	700
0.13		400	
0.1		300	
0.2		600	
2		6600	
1.38		0	
Total		4.01	8600
La Pointe	4	0	
Curieuse	1	3300	
	0.7	2300	
	0.3	1000	
	0.12	400	
Total	2.12	7000	
Target 5	Roche Caiman	8	3500
	Grand Total	30.96	56350

Summary of plant production

Sites	Plant production
Mahé	16,700
Praslin & Curieuse	39,650
Total	56,350

Plant list per island - Mahé

Scientific name	Vernacular name	Cascade	Anse Royale	Petit Barbarons	Roche Caiman	Total per species
<i>Avicenia marina</i>	Mangliye blan	100	600	100	1000	1800
<i>Bruguiera gymnorhiza</i>	Mangliye lat		300	0	0	300
<i>Ceriops tagal</i>	Mangliye zonn	50	450	250	1000	1750
<i>Lumnitzera racemosa</i>	Mangliye pti fey		200	50	0	250
<i>Rhizophora mucronata</i>	Mangliye rouz	100	100	250	1000	1450
<i>Sonneratia alba</i>	Mangliye fler	50	0	50		100
<i>Xylocarpus granatum</i>	Mangliye ponm	50	750	100	50	950
<i>Barringtonia asiatica</i>	Bonne kare bor-d-mer			300	100	400
<i>Cordia subcordata</i>	Porse			200	300	500
<i>Scaevola frutescens</i>	Veloutye		1000	1000		2000
<i>Thespesia populnea</i>	Bwa-d-roz			200		200
<i>Guettarda speciosa</i>	Bwa kasan bor-d-mer			50		50
<i>Hernandia nymphaeifolia</i>	Bwa blan			50		50
<i>Colubrina asiatica</i>	Bwa savon	50	100	200	50	400
<i>Sophora tomentosa</i>	Bwa saple			100		100
<i>Acrostichum aureum</i>	Freshwater fern		2000			2000
<i>Phoenicophorium borsigianum</i>	Lantannyen fey		500			500
<i>Nephrosperma vanhoutteanum</i>	Lantannyen milpat		500			500
<i>Barringtonia racemosa</i>	Bonne kare de rivyer		100			100
<i>Hibiscus tiliaceus</i>	Var	100	1500	100		1700
<i>Heritiera littoralis</i>	Bwa-d-tab		600	500		1100
<i>Ipomoea pes-caprae</i>	Patatran			500		500
Total per site		500	8700	4000	3500	16,700

Plant list breakdown per intervention sites - Mahé

Sites	Intervention areas	Area (ha)	Plant Qty	Scientific name	Vernacular name	Plant Qty per area
Anse Royale	Riverine banks	1.72	5600	<i>Acrostichum aureum</i>	Freshwater fern	2000
				<i>Colubrina asiatica</i>	Bwa savon	100
				<i>Hibiscus tiliaceus</i>	Var	1500
				<i>Nephrosperma vanhoutteanum</i>	Lantannyen milpat	500
				<i>Phoenicophorium borsigianum</i>	Lantannyen fey	500
				<i>Scaevola frutescens</i>	Veloutye	1000
	Mangrove	0.5	1650	<i>Avicenia marina</i>	Mangliye blan	600
				<i>Bruguiera gymnorhiza</i>	Mangliye lat	300
				<i>Ceriops tagal</i>	Mangliye zonn	450
<i>Lumnitzera racemosa</i>				Mangliye pti fey	200	
<i>Rhizophora mucronata</i>				Mangliye rouz	100	
Swamp forest	0.44	1450	<i>Barringtonia racemosa</i>	Bonne kare de rivyer	100	
			<i>Heritiera littoralis</i>	Bwa-d-tab	600	
			<i>Xylocarpus granatum</i>	Mangliye ponm	750	
Total		2.66	8700			8,700

Sites	Intervention areas	Area	Plant Qty	Scientific name	Vernacular name	Cascade
Cascade	Mangrove	500 m	300	<i>Avicenia marina</i>	Mangliye blan	100
				<i>Ceriops tagal</i>	Mangliye zonn	50
				<i>Rhizophora mucronata</i>	Mangliye rouz	100
				<i>Sonneratia alba</i>	Mangliye fler	50
	Embankment	500 m	200	<i>Xylocarpus granatum</i>	Mangliye ponm	50
				<i>Colubrina asiatica</i>	Bwa savon	50
<i>Hibiscus tiliaceus</i>				Var	100	
Total		500 m	500			500

Sites	Intervention areas	Area (ha)	Plant Qty	Scientific name	Vernacular name	Plant Qty per area
Petit Barbarons	Mangrove	0.2	700	<i>Avicenia marina</i> <i>Ceriops tagal</i> <i>Lumnitzera racemosa</i> <i>Rhizophora mucronata</i> <i>Sonneratia alba</i>	Mangliye blan Mangliye zonn Mangliye pti fey Mangliye rouz Mangliye fler	100 250 50 250 50
	Wetland margins	1	3300	<i>Xylocarpus granatum</i> <i>Barringtonia asiatica</i> <i>Cordia subcordata</i> <i>Scaevola frutescens</i> <i>Thespesia populnea</i> <i>Guettarda speciosa</i> <i>Hernandia nymphaeifolia</i> <i>Colubrina asiatica</i> <i>Sophora tomentosa</i> <i>Hibiscus tiliaceus</i> <i>Heritiera littoralis</i> <i>Ipomoea pes-caprae</i>	Mangliye ponm Bonne kare bor-d-mer Porse Veloutye Bwa-d-roz Bwa kasan bor-d-mer Bwa blan Bwa savon Bwa saple Var Bwa-d-tab Patatran	100 300 200 1000 200 50 50 200 100 100 500 500
Total		1.2	4000			4,000

Sites	Intervention areas	Area (ha)	Plant Qty	Scientific name	Vernacular name	Plant Qty per area
Roche Caiman	Mangrove	7.7	3000	<i>Avicenia marina</i> <i>Ceriops tagal</i> <i>Rhizophora mucronata</i>	Mangliye blan Mangliye zonn Mangliye rouz	1000 1000 1000
	Raised banks	0.3	500	<i>Xylocarpus granatum</i> <i>Barringtonia asiatica</i> <i>Cordia subcordata</i> <i>Colubrina asiatica</i>	Mangliye ponm Bonne kare bor-d-mer Porse Bwa savon	50 100 300 50
Total		8	3500			3,500

Plant list per island - Praslin & Curieuse

Scientific name	Vernacular name	Anse Gouvernement	Cote D'Or	Mare du Ranteau	Nouvelle Decouverte	Curieuse	Total per species
<i>Avicenia marina</i>	Mangliye blan	1500	400	100		800	2800
<i>Bruguiera gymnorhiza</i>	Mangliye lat	0	100		200	2300	2600
<i>Ceriops tagal</i>	Mangliye zonn	750	400	200		500	1850
<i>Lumnitzera racemosa</i>	Mangliye pti fey	200	400		100	300	1000
<i>Rhizophora mucronata</i>	Mangliye rouz	500	250	150		550	1450
<i>Sonneratia alba</i>	Mangliye fler	0	0	50		50	100
<i>Xylocarpus granatum</i>	Mangliye ponm	100		0	200	800	1100
<i>Acrostichum aureum</i>	Fouzer lanmar		1500	1650	700		3850
<i>Allophylus sechellensis</i>	Bwa kafoul						0
<i>Barringtonia asiatica</i>	Bonne kare bor-d-mer	500			1000		1500
<i>Calophyllum inophyllum</i>	Takamaka	300			1000		1300
<i>Colubrina asiatica</i>	Bwa savon				100		100
<i>Dodonea viscosa</i>	Bwa-d-renet	2000					2000
<i>Ficus lutea</i>	Lafous gran fey	5000			2000		7000
<i>Heritiera littoralis</i>	Bwa-d-tab	0	0		600	700	1300
<i>Hibiscus tiliaceus</i>	Var		350		200		550
<i>Pouteria obovata</i>	Bwa monper	1000					1000
<i>Premna serratifolia</i>	Bwa siro	2000					2000
<i>Pyrostria bibracteata</i>	Bwa dir	500					500
<i>Scaevola frutescens</i>	Veloutye	2000		1650	500		4150
<i>Scleria sumatrensis</i>	Lerb kare					1000	1000
<i>Terminalia catappa</i>	Bodanmyen	300			2000		2300
<i>Thespesia populnea</i>	Bwa-d-roz	200		50			250
Total		16850	3400	3800	8600	7000	39,650

Plant list breakdown per intervention sites - Praslin & Curieuse

Sites	Intervention areas	Area (ha)	Plant Qty	Scientific name	Vernacular name	Plant Qty per area
Anse Gouvernement	Mangrove	1.8	3050	<i>Avicenia marina</i>	Mangliye blan	1500
				<i>Bruguiera gymnorrhiza</i>	Mangliye lat	0
				<i>Ceriops tagal</i>	Mangliye zonn	750
				<i>Lumnitzera racemosa</i>	Mangliye pti fey	200
				<i>Rhizophora mucronata</i>	Mangliye rouz	500
				<i>Xylocarpus granatum</i>	Mangliye ponm	100
				<i>Barringtonia asiatica</i>	Bonne kare bor-d-mer	500
	Coastal plateau	4.2	13800	<i>Calophyllum inophyllum</i>	Takamaka	300
				<i>Dodonea viscosa</i>	Bwa-d-renet	2000
				<i>Ficus lutea</i>	Lafous gran fey	5000
				<i>Pouteria obovata</i>	Bwa monper	1000
				<i>Premna serratifolia</i>	Bwa siro	2000
				<i>Pyrostria bibracteata</i>	Bwa dir	500
				<i>Scaevola frutescens</i>	Velotye	2000
			<i>Terminalia catappa</i>	Bodanmyen	300	
			<i>Thespesia populnea</i>	Bwa-d-roz	200	
Total		6	16850			16,850

Sites	Intervention areas	Area (ha)	Plant Qty	Scientific name	Vernacular name	Plant Qty per area
Cote D'Or	Mangrove	0.25	825	<i>Avicenia marina</i>	Mangliye blan	200
				<i>Bruguiera gymnorrhiza</i>	Mangliye lat	100
				<i>Ceriops tagal</i>	Mangliye zonn	200
				<i>Lumnitzera racemosa</i>	Mangliye pti fey	200
				<i>Rhizophora mucronata</i>	Mangliye rouz	125
	Sand banks + Wetland margins	0.22	725	<i>Avicenia marina</i>	Mangliye blan	200
				<i>Ceriops tagal</i>	Mangliye zonn	200
				<i>Lumnitzera racemosa</i>	Mangliye pti fey	200
				<i>Rhizophora mucronata</i>	Mangliye rouz	125
	Swamp forest	0.56	1850	<i>Acrostichum aureum</i>	Fouzer lanmar	1500
				<i>Hibiscus tiliaceus</i>	Var	350
	Total			3400		

Sites	Intervention areas	Area (ha)	Plant Qty	Scientific name	Vernacular name	Plant Qty per area
Mare du Ranteau	Mangrove	0.14	500	<i>Avicenia marina</i> <i>Ceriops tagal</i> <i>Rhizophora mucronata</i> <i>Sonneratia alba</i>	Mangliye blan Mangliye zonn Mangliye rouz Mangliye fler	100 200 150 50
	Coastal plateau + Wetland margins	1	3300	<i>Acrostichum aureum</i> <i>Scaevola frutescens</i>	Fouzer lanmar Veloutye	1650 1650
Total		1.14	3800			3,800

Sites	Intervention areas	Area (ha)	Plant Qty	Scientific name	Vernacular name	Plant Qty per area
Nouvelle Decouverte	Wetland margins	0.2	700	<i>Acrostichum aureum</i>	Fouzer lanmar	100
				<i>Colubrina asiatica</i>	Bwa savon	100
				<i>Scaevola frutescens</i>	Veloutye	500
	River banks	0.2	700	<i>Acrostichum aureum</i> <i>Bruguiera gymnorrhiza</i> <i>Lumnitzera racemosa</i>	Fouzer lanmar Mangliye lat Mangliye pti fey	400 200 100
Sand banks	0.2	600	<i>Acrostichum aureum</i>	Fouzer lanmar	200	
			<i>Hibiscus tiliaceus</i>	Var	200	
			<i>Xylocarpus granatum</i>	Mangliye ponm	200	
Coastal plateau	2	6600	<i>Barringtonia asiatica</i>	Bonne kare bor-d-mer	1000	
			<i>Calophyllum inophyllum</i>	Takamaka	1000	
			<i>Ficus lutea</i>	Lafous gran fey	2000	
			<i>Heritiera littoralis</i>	Bwa-d-tab	600	
			<i>Terminalia catappa</i>	Bodanmyen	2000	
Total		2.6	8600			8,600

Sites	Intervention areas	Area (ha)	Plant Qty	Scientific name	Vernacular name	Plant Qty per area
Curieuse	Zone A - Mangrove	1	3300	<i>Bruguiera gymnorrhiza</i> <i>Lumnitzera racemosa</i> <i>Xylocarpus granatum</i> <i>Scleria sumatrensis</i>	Mangliye lat Mangliye pti fey Mangliye ponm Lerb kare	1500 300 500 1000
	Zone B - Sand banks	0.7	2300	<i>Avicenia marina</i> <i>Ceriops tagal</i> <i>Bruguiera gymnorrhiza</i> <i>Heritiera littoralis</i> <i>Xylocarpus granatum</i>	Mangliye blan Mangliye zonn Mangliye lat Bwa-d-tab Mangliye ponm	500 500 500 500 300
	Zone C - Sand banks + Mangrove margin	0.3	1000	<i>Avicenia marina</i> <i>Bruguiera gymnorrhiza</i> <i>Rhizophora mucronata</i> <i>Heritiera littoralis</i>	Mangliye blan Mangliye lat Mangliye rouz Bwa-d-tab	200 300 300 200
	Zone D - Lagoon	0.12	400	<i>Avicenia marina</i> <i>Rhizophora mucronata</i> <i>Sonneratia alba</i>	Mangliye blan Mangliye rouz Mangliye fler	100 250 50
	Total		2.12	7000		

ANNEX 8: COSTED WORKPLAN

Activity 3.2.6	EbA intervention	Budget in SCR	Budget in USD
Target 1	A total of 10 culverts to improve hydrological flow through 300 hectares of artificially fragmented mangroves		
Cap Samy	Emergency flood mitigation works at Anse Gouvernement (phase I)	104,500.00	8,164
Cap Samy	Emergency flood mitigation works at Anse Gouvernement (phase II)	105,331.25	8,229
Cap Samy	Replace 5 culverts and desilt channels (1.5 km)	2,839,224.00	221,814
Petit Barbarons	Replace 4 culverts and desilt channels (0.5 km)	1,609,300.00	125,727
	<i>Subtotal</i>	4,658,355.25	363,934
Target 2	2 km of channel desilting to improve hydrological flow between 100 hectares of artificially fragmented mangroves		0
Cap Samy	Desilt channels (1.5 km)		0
Petit Barbarons	Desilt channels (0.5 km)		0
Target 3	500m of national highway protected from coastal erosion through embankment stabilization using mangrove rehabilitation		0
Cascade	Selective tree felling/lopping	45,000.00	3,516
Cascade	Mangrove replanting	5,000.00	391
	<i>Subtotal</i>	50,000.00	3,906
Target 4	20 hectares of degraded mangroves cleared of alien species and replanted (at a density of at least 500 seedling/ha);		0
1	Plant propagation		0
Anse Royale	Boardwalk to Anse Royale nursery (optional)		0
Anse Royale	Setting up Nursery (Anse Royale)	248,850.00	19,441
Anse Royale	Collection of seeds, propagules, seedling (mangrove + non-mangrove)	0.00	0
Anse Royale	Plant Propagation: Prepare seedlings in the nursery	375,000.00	29,297
Curieuse	Setting up Nursery (Curieuse)	150,000.00	11,719
Curieuse	Collection of seeds, propagules, seedling (mangrove + non-mangrove)	0.00	0
Curieuse	Prepare 20, 000 seedlings in the nursery	200,000.00	15,625
Curieuse	Produce ca.20,000 coastal native plants in existing nurseries on Praslin	200,000.00	15,625
	<i>Subtotal</i>	1,173,850.00	91,707
2	Restoring biodiversity and ecosystem functioning		0
Anse Royale	Manage IAS	40,000.00	3,125
Petit Barbarons	Manage IAS	40,000.00	3,125
Anse Gouvernement	Manage IAS	150,000.00	11,719

Cote D'Or	Manage IAS	24,000.00	1,875
La Pointe	Manage IAS	20,000.00	1,563
Nouvelle Decouverte	Manage IAS	60,800.00	4,750
Curieuse	Manage IAS	40,000.00	3,125
Anse Royale	Replant riparian bank with natives	2,500.00	195
Anse Gouvernement	Replant wetland bank with natives	8,000.00	625
Mare du Ranteau	Replant wetland bank with natives	6,000.00	469
Nouvelle Decouverte	Replant wetland bank with natives	8,000.00	625
Petit Barbarons	Replant wetland bank with natives	3,000.00	234
Anse Gouvernement	Mangrove replanting	5,000.00	391
Cote D'Or	Mangrove replanting	2,500.00	195
Curieuse	Mangrove replanting	10,000.00	781
Mare du Ranteau	Mangrove replanting	5,000.00	391
Nouvelle Decouverte	Mangrove replanting	3,000.00	234
Petit Barbarons	Mangrove replanting	2,000.00	156
<i>Subtotal</i>		<i>429,800.00</i>	<i>33,578</i>
Target 5	9 hectares of degraded mangroves restored to protect low cost housing estates from coastal erosion		
Roche Caiman	Mangrove replanting	15,000.00	1,172
<i>Subtotal</i>		<i>15,000.00</i>	<i>1,172</i>
Other			
All sites	Tendering and contracting processes (quote 1)	12,000.00	938
All sites	Tendering and contracting processes (quote 2)	52,200.00	4,078
All sites	Wetland clean-up	5,000.00	391
<i>Subtotal</i>		<i>69,200.00</i>	<i>5,406</i>
TOTAL		6,396,205.25	499,704

Available budget (USD) = 500,000