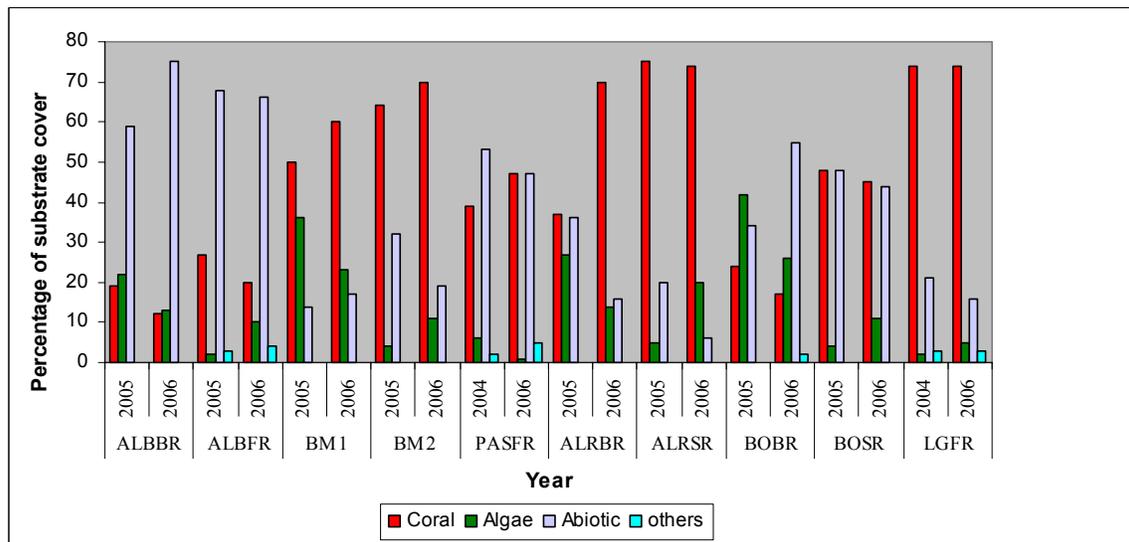


2. MARINE SCIENCE

2.1 Coastal ecosystem research

2.1.1 Long-term monitoring of coral reef ecosystem

The long-term monitoring of coral reefs was continued at the following established sites; Albion, Pointe aux Sables, Anse la Raie, Bel Ombre, Le Goulet, and Belle Mare. Data on substrate cover were collected using the Line Intercept Transect (LIT) method and data on coral cover were recorded to the species level. The data were processed by the CO.RE.MO software and the average percentage cover of substrate is shown in table 2.1 and depicted in figure 2.1. The abundance of fish, sea urchins and sea cucumbers is given in table 2.2.



ALBBER – Albion back reef, ALBFR – Albion fore reef, BM1- Belle Mare site 1, BM2 – Belle Mare site2, PASFR-Pointe aux Sables fore reef, ALRBR – Anse la Raie back reef, ALRSR – Anse la Raie shore reef, BOBR – Bel Ombre back reef, BOSR – Bel Ombre shore reef, LGFR- Le Goulet fore reef

Figure 2.1: Percentage of substrate cover at monitoring stations

In 2006, at most of the monitoring stations there was a slight decrease in coral cover and an increase in the abiotic component made up of rubble and dead corals. This may be attributed to the mortality of corals from such environmental factors as siltation and the effect of previous coral bleaching. At the two stations at Belle Mare there was an increase in coral cover and it was observed that the branching and tabular corals were thriving well. No coral bleaching was observed at any of the sites during the surveys

Table 2.1: Average percentage cover of substrates at monitoring stations

Site	Stations	Year	Coral	Algae	Abiotic	Others
Le Goulet	fore reef	2004	74	2	21	3
		2006	74	5	16	3
Bel Ombre	back reef	2005	24	42	34	N.O
		2006	17	24	55	2
	shore reef	2005	48	4	48	N.O
		2006	45	9	42	N.O
Anse la Raie	back reef	2005	37	27	36	N.O
		2006	70	14	15	N.O
	shore reef	2005	75	5	20	N.O
		2006	74	20	6	N.O
Pointe aux Sables	back reef	2004	39	6	53	2
		2006	47	1	47	5
Albion	fore reef	2005	27	2	68	3
		2006	20	10	66	4
	back reef	2005	19	22	59	N.O
		2006	12	13	75	N.O
Belle Mare (Site I)	back reef	2005	50	36	14	N.O
		2006	60	23	17	N.O
Belle Mare (Site II)	back reef	2005	64	4	32	N.O
		2006	70	11	19	N.O

N.O: Not observed; **Others:** sponges, crown of thorns, soft corals, giant clams

Table 2.2: Abundance of fish, sea urchins and sea cucumber

SITE	Type of reef	Year	Pomacentridae & Chaetodontidae	Acanthuridae	Labridae	Scaridae	Sea cucumber	Sea urchins
Le Goulet	fore reef	2005	XXXX	XX	X	X	XX	X
		2006	XXXX	X	X	X	X	X
Bel Ombre	back reef	2005	XXXX	X	XX	XX	N/O	N/O
		2006	XXXX	XX	XX	X	X	XX
	shore	2005	XX	X	X	X	N/O	N/O
		2006	XXXX	XX	X	X	X	X
Anse la Raie	back reef	2005	XXXX	X	X	X	N/O	N/O
		2006	XXXX	XX	XX	XX	N/O	N/O
	shore	2005	XXXX	N/O	N/O	N/O	N/O	N/O
		2006	XXXX	XX	X	X	N/O	N/O

Pointe aux Sables	fore reef	2004	X	XX	N/O	N/O	N/O	XXXX
		2005	XX	XX	X	N/O	N/O	XXXX
	back reef	2005	XXXX	XX	X	XX	X	XXXX
		2006	XXX	XX	X	XX	N/O	XXXX
Albion	fore reef	2005	X	XXXX	XX	N/O	N/O	XXXX
		2006	XX	XXX	XX	XX	N/O	XXXX
	back reef	2005	XXXX	N/O	XX	N/O	N/O	XX
		2006	XXX	N/O	XX	XX	N/O	XX
Belle Mare (Site I)	back reef	2005	XXXX	XX	XX	N/O	N/O	N/O
		2006	XXXX	XXX	X	X	N/O	N/O
Belle Mare (Site II)	back reef	2005	XXXX	XX	X	N/O	N/O	XX
		2006	XXXX	XX	X	X	N/O	XX

N/O: Not observed, **X :** 0-10, **XX :** 10-50, **XXX :** 50-100, **XXXX :** >100

At most of the monitoring stations, the family pomacentridae (damselfish) and acanthuridae (surgeonfish) were dominant. The species of damselfish recorded were *Stegastes lividus*, *Stegastes limbatus*, *Dascyllus aruanus*, *Chrysiptera unimaculata* and *Chromis viridis*. The surgeonfish were represented by *Ctenochaetus striatus* and *Acanthurus xanthopterus*. The family chaetodontidae (butterflyfish) and labridae (wrasses) were also commonly present. The family balistidae (triggerfish) was least represented and predators from families serranidae (*Epinephelus merra*) and lethrinidae (*Lethrinus sp.*) were rare. Higher densities of sea urchins were observed at Pointe aux Sables (back and fore reef) and Albion (fore reef).

2.1.2 Other ecosystem surveys

2.1.2.1 Port survey in connection with dredging of the English Channel

In October, two permanent stations were established in the port area in connection with the dredging undertaken by the Mauritius Ports Authority (MPA) for deepening of the English Channel, one in the harbour area adjacent to the dredging site and the other opposite the Grand River North West (GRNW) near the pass. Ecological surveys were carried out to assess the existing marine ecosystem before and after the dredging of the channel. Two other stations, one at Bain des Dames and one near the Terre Rouge estuary were also selected to assess the general status of the marine ecosystem.

2.1.2.2 Fish Farm at Pointe aux Feuilles

Annual surveys are carried out at the Ferme Marine de Mahebourg situated at Pointe aux Feuilles to observe any effect of the fish-farming activity on the marine ecosystem. The underwater survey carried out in July showed no abnormal environmental conditions or accumulation of feed on the sea floor.

2.1.2.3 Monitoring of ex-sand mining sites

The yearly monitoring of ex-sand mining sites was carried out at Grand Gaube, Poudre d'Or, Mahebourg and Grand River South East (GRSE). The results showed that the marine ecosystem has recovered to a large extent in terms of flora and fauna (figure 2.2). The colonisation of the sandy bottom by rhizoids of sea grasses was visible practically everywhere and many macroalgae species were also noted. There was an increase in the number of species of fish and coral recruitment was observed.

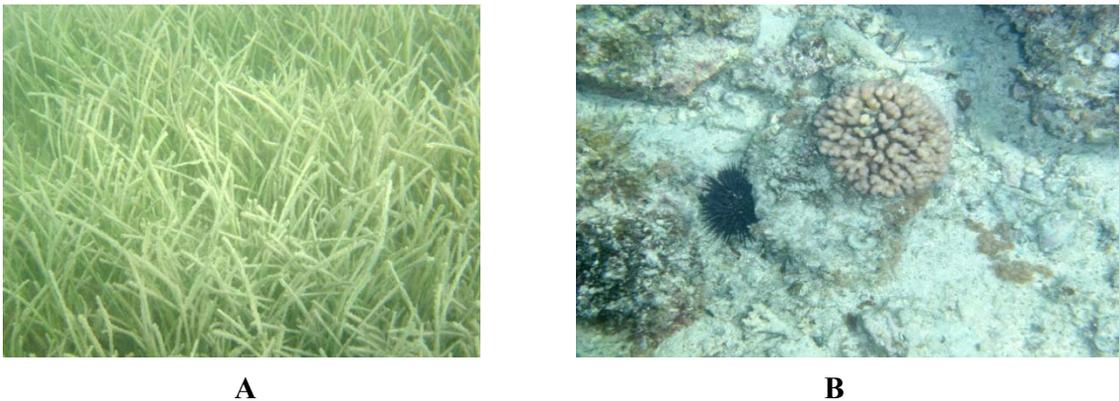


Figure 2.2: Regeneration of the ecosystem (A: Seagrass (*Syringodium isoetifolium* at Grand Gaube); B: Juvenile hard corals (*Pocillopora* sp.) at GRSE)

2.1.3 Regional Coral Reef Monitoring Project

The Regional Coral Reef Monitoring Project under the COI which ended in July 2005 would be provided with funds from the Marine Protected Areas Network Project to continue its activities.

2.1.4 Study on coral bleaching

The CORDIO (Coral Reef Degradation in the Indian Ocean) project, allocated funds for studies on coral bleaching in Mauritius. Two survey sites were selected, one at Belle Mare in the east and the other at Ile aux Benitiers in the west. A data logger was deployed at each site for recording the sea surface temperature. Underwater photography was also taken to support and quantify the extent of bleaching and

recovery. No bleaching was observed at any of the sites and there were no abnormal records in the temperature.

2.1.5 Response plan for stranded marine mammals/turtles

During the past few years, there have been many cases of stranded marine mammals around the island. A Response Plan for stranded marine mammals/turtles will be formulated to address such occurrences, to define the responsibilities of various organisations and to set up an emergency fund.

A male elephant seal (fig. 2.3) weighing about 200kg and measuring 1m60cm was found stranded on the shore at Pointe Koenig in the region of Rivière Noire on 9 August. It was in healthy condition and was named “CYRIL”. The National Coast Guard and Fisheries Protection Services carried out sea and land patrols to protect the animal. The Mauritius Marine Conservation Society and Mauritius Wildlife Fund established contacts for the transportation of the seal to a sanctuary abroad. Meanwhile it was brought to Albion Fisheries Research Centre where it was kept in a pond. On 26 August the seal was boarded on a French ship to Kerguelen.



Figure 2.3: Elephant seal “CYRIL”

2.2 Coastal water quality

2.2.1 Monitoring of chemical parameters

Eighteen sites with a total of 76 established stations in the lagoon around the island were regularly monitored for water quality. Additional monitoring sites, Palmar (four stations), Albion (one station) and Flic en Flac (one station) were included in the context of the Western Indian Ocean Land-Based (WIOLaB) project.

The physical parameters such as sea state, weather conditions, conductivity and pH were recorded. Over 350 samples were analysed in duplicates for chemical oxygen demand (COD), nitrate-nitrogen (NO_3^- -N) and phosphate (PO_4^{3-}). The range of values for results of the analyses over the last three years is shown in table 2.3.

Table 2.3: Range of values for results of water analyses (2004-2006)

Site	Year	Nitrate-Nitrogen (mg/l)	Phosphate (mg/l)	Chemical Oxygen Demand (mg/l)
Ile aux Benitiers	2004	<0.1	0.01 - 0.02	0.1 - 0.8
	2005	<0.1	0.01 - 0.04	0.1 - 0.5
	2006	<0.1	<0.01 - 0.02	<0.1 - 0.4
Bel Ombre	2004	<0.1	<0.01 - 0.05	0.1 - 0.8
	2005	<0.1	<0.01 - 0.07	0.1 - 0.9
	2006	<0.1	<0.01 - 0.02	<0.1 - 0.3
Bambous virieux	2004	<0.1	<0.01 - 0.04	0.1 - 1.6
	2005	<0.1	0.01 - 0.03	0.1 - 1.0
	2006	<0.1	0.01 - 0.04	0.2 - 0.8
Trou d'Eau Douce	2004	<0.1	0.01 - 0.06	0.1 - 0.2
	2005	<0.1	<0.01 - 0.02	0.2 - 0.9
	2006	<0.1	0.01 - 0.02	0.2 - 1.0
	2004	<0.1	<0.01 - 0.05	0.1 - 0.5
	2005	<0.1	0.01 - 0.03	0.2 - 0.3

Anse la Raie	2006	<0.1	0.02 - 0.04	0.2 - 0.5
Trou aux Biches	2004	<0.1	<0.01 - 0.04	0.1 - 0.8
	2005	<0.1	<0.01 - 0.05	<0.1 - 0.5
	2006	<0.1	0.01 - 0.08	0.1 - 0.4
Pointe aux Sables	2004	<0.1 - 0.1	<0.01 - 0.05	0.1 - 0.8
	2005	<0.1	0.01 - 0.06	0.1 - 0.8
	2006	<0.1	0.01 - 0.06	0.2 - 0.6
Bain des Dames	2004	<0.1	0.01 - 0.08	0.1 - 2.0
	2005	<0.1	0.01 - 0.08	<0.1 - 1.3
	2006	<0.1	0.01 - 0.08	<0.1 - 0.6
Grand Baie	2004	<0.1	<0.01 - 0.07	<0.1 - 1.4
	2005	<0.1	<0.01 - 0.07	<0.1 - 0.6
	2006	<0.1	<0.01 - 0.08	0.1 - 0.7
Baie du Tombeau	2004	<0.1	<0.01 - 0.16	<0.1 - 1.6
	2005	<0.1	0.01 - 0.22	0.1 - 1.2
	2006	<0.1	0.01 - 0.05	0.2 - 1.1
Harbour	2004	<0.1	<0.01 - 0.08	0.1 - 0.9
	2005	<0.1	0.01 - 0.08	0.1 - 0.5
	2006	<0.1	0.01 - 0.09	0.1 - 0.7
Poudre d'Or	2004	<0.1	0.01 - 0.08	0.1 - 8.8
	2005	<0.1	0.01 - 0.08	<0.1 - 1.7
	2006	<0.1	0.01 - 0.07	0.1 - 1.8
Balaclava	2004	<0.1	0.01 - 0.05	0.1 - 0.6
	2005	<0.1	0.01 - 0.05	0.1 - 0.7
	2006	<0.1	0.01 - 0.04	0.1 - 0.9
Blue Bay	2004	<0.1	0.01 - 0.10	<0.1 - 0.4
	2005	<0.1	0.01 - 0.07	<0.1 - 0.6
	2006	<0.1	<0.01 - 0.22	<0.1 - 0.5
Belle Mare	2005	<0.1	0.01 - 0.06	0.1 - 0.8
	2006	<0.1	0.01 - 0.04	0.2 - 1.2
Albion	2006	<0.1	0.01 - 0.02	0.1 - 0.2
Flic en Flac	2006	<0.1	0.02 - 0.05	0.1 - 0.4
Palmar	2006	<0.1	0.01 - 0.03	0.1 - 0.4
Bird Sanctuary	2006	<0.1	0.01 - 0.15	0.9 - 2.5

Note: Detection limit for phosphate – 0.01 mg/l

Detection limit for nitrate-nitrogen – 0.1 mg/l

The results of the water quality analyses were generally within the *Guidelines for Coastal Water Quality Requirements for various categories Govt. Notice No. 620 of 1999 (CWQG)* at most of the sites. The levels of nitrate were <0.1 mg/l while those of phosphate ranged between <0.01 to 0.09 mg/l and COD between <0.1 to 1.8 mg/l. However, at one station at Blue Bay, two stations at Terre Rouge Bird Sanctuary and one station at Poudre d'Or values of phosphate slightly exceeded the *CWQG* limit due to the influx of fresh water.

2.2.2 Analysis for trace metals

Monitoring of the level of the four trace metals namely, cadmium, zinc, copper and lead was continued at the 8 monitoring sites (Rivière Lataniers, Grand River North West, Tamarin, Baie du Cap, l'Escalier,

Mahebourg, Grand River South East and Pte Roches Noires). Water samples from the high seas in the North-West of the island were analysed in the context of export of fish to the European Union. No detectable levels of the trace metals were recorded.

2.2.3 Water analysis and fish mortality at other sites

Samples of seawater were collected for chemical analysis in relation to cases of alleged pollution and fish mortality at Trou aux Biches, Solitude, Le Morne, Grand Baie, Bel Air Riviere Seche, Pointe aux Sables and Bain des Dames as shown in table 2.4. Results showed that all the parameters were within the *CWQG* limits except at Trou aux Biches where higher phosphate level and low salinity were recorded due to the discharge of groundwater into the lagoon from a housing complex.

Table 2.4: Sites of alleged pollution

Date	Site
10 February	Trou aux Biches
20 May	Grand Baie
24 May	Bel Air Riviere Seche
25 May	Le Morne (Meridien)
5 August	Pointe aux Sables & Bain des Dames
15 November	Pointe aux Sables

2.2.4 Land-Based Oceanic Industry Project

Water samples were collected from the high seas off Albion, Trou aux Biches, Poste de Flacq, Le Bouchon and Flic en Flac in the context of the Land Based Oceanic Industry (LBOI) project. There was no significant difference in the levels of the parameters between samples collected at the surface and 15 m depth. No trace metals were detected in all samples and levels of the other parameters monitored were below those normally recorded for lagoonal water. Results of chemical parameters are shown in table 2.5.

Table 2.5: Water quality for LBOI sites

Site	Station	Dissolved Oxygen (mg/l)	Nitrate-Nitrogen (mg/l)	Phosphate (mg/l)	Chemical Oxygen Demand (mg/l)
Albion	Surface	6.6	<0.1	<0.01	0.3
	Bottom	6.8	<0.1	0.01	0.6
Flic en Flac	Surface	6.7	<0.1	0.01	0.4
	Bottom	6.8	<0.1	0.01	0.7
Trou aux Biches	Surface	6.8	<0.1	0.01	0.6
	Bottom	6.9	<0.1	0.01	0.4
Poste la Fayette	Surface	6.6	<0.1	0.01	0.1
	Bottom	6.8	<0.1	0.01	0.2
Le Bouchon	Surface	6.6	<0.1	<0.01	0.4
	Bottom	7.0	<0.1	0.01	0.2

2.2.5 Dredging in the port area

A water quality study was conducted at seven stations in the port area in connection with dredging of the English Channel. Results showed that all the parameters were within the *CWQG* limits.

2.2.6 Oil spill

A case of accidental oil leakage/spill occurred in December at the textile factory situated at Poudre d'Or. Some 2 000 litres of oil overflowed from the factory and found its way into a decantation pond and some escaped into the sea. A floating containment boom of 125m was deployed around the mangrove plants to contain the spill. Water quality and ecological surveys were carried out in the lagoon area where the oil spill occurred to assess any damage to the marine ecosystem. No major impact was observed on the marine ecosystem during the surveys. Only the mangrove stands at localised places had their roots covered with a thin layer of oil slick. The water quality parameters were within the *CWQG* limits.

2.2.7 Independent Environmental Audit on wastewater projects

The seawater quality at the three major outfalls namely; Pointe Moyenne, Montagne Jacquot and Baie du Tombeau were monitored to assess the impact of outfall discharge on the water quality near the discharge

points. Results of analyses of water samples were below the norms set under the *Regulation for Effluent Discharge into the Ocean as per GN No 45 of 2003 of the Environment Protection Act 2002* as shown in table 2.6.

Table 2.6: Water quality at the three major outfalls

Site	Nitrate-Nitrogen (mg/l)	Phosphate (mg/l)	Chemical Oxygen Demand (mg/l)
Pointe Moyenne	<0.1	0.01 – 0.05	0.2 – 1.1
Mte Jacquot	<0.1	0.01 – 0.05	0.1 – 1.2
Baie du Tombeau	<0.1	0.01 – 0.08	0.1 – 0.7
<i>CWQG limit (Industrial)</i>	1.0	0.1	5
<i>Standards for Effluent Discharge into the Ocean</i>	-	-	750

A consolidated report on the Independent Environment Audit on Wastewater Projects from November 2005 to November 2006 was prepared in collaboration with the Ministry of Environment & National Development Unit, Ministry of Public Utilities and Ministry of Health and Quality of Life. The report will be presented at the European Union Donors meeting in January 2007 for the assessment of environmental and health impacts of waste water projects in Mauritius.

2.2.8 Western Indian Ocean Land-Based (WIO-LaB) Project

The hotspots selected for monitoring of water quality under the WIO-LaB project were from Bain des Dames to Pointe aux Sables and at Grand Baie, Palmar and Flic en Flac. Data were submitted on a regular basis to the focal point of the project (Ministry of Environment and National Development Unit) for the preparation of the ‘National Pollution Status Report’.

2.2.9 UNEP Global Mercury Assessment Programme

Under the UNEP global Mercury Assessment Programme, the levels of mercury were monitored in the coastal environment at eight sites namely, Rivière Lataniers, GRNW, Tamarin, Baie du Cap, l’Escalier,

Mahebourg, GRSE and Pte Roches Noires. Results of analyses indicated that levels of mercury in the water samples were below the detection limit. Data were submitted twice yearly to the technical committee set up by the Ministry of Environment and National Development Unit for the above programme.

2.3 Monitoring of coliform bacteria at public beaches

Monitoring of the levels of total coliform (TC) and faecal coliform (FC) in seawater at selected public beaches was continued on a monthly basis at 10 sites namely; Flic en Flac, Albion, Pointe aux Sables, Trou aux Biches, Mon Choisy, Le Goulet, Grand Baie, La Cuvette, Blue Bay, Pereybere and Belle Mare. The Blue Bay and Balaclava Marine Parks were also sampled on two occasions during the year.

Results of water analyses showed that the levels of TC and FC at the selected beaches and the two Marine Parks were within the *CWQG* limits for primary contact (TC<1000 colonies/100ml and FC<200 colonies/100ml).

Table 2.7 shows level of TC and FC at the various sites for the last three years.

Table 2.7: Results of coliform analysis at the monitoring sites

Beach	Station No.	Average colony count per 100ml					
		2004		2005		2006	
		TC	FC	TC	FC	TC	FC
Flic en Flac	1	25	9	35	13	42	13
	2	23	4	28	10	70	16
	3	17	8	36	13	27	6
	4	37	10	24	11	126	38
	5	44	12	39	12	119	46
Trou aux Biches	1	19	4	45	12	20	6
	2	44	6	17	4	19	7
Mon Choisy	1	15	3	36	10	21	6
	2	26	4	46	15	38	11
	3	23	3	58	13	24	10
	4	10	2	90	19	27	8
Blue Bay	1	17	2	20	7	148	39
	2	38	8	19	5	129	31
	3*	31	11	22	7	56	18
Albion	1	34	6	36	10	163	41
	2	-	-	-	-	558	136
Pointe aux Sables	1	834	150	951	182	61	11
	2	302	90	519	105	21	7
	3	71	25	79	13	30	8
	4	244	56	275	90	26	7

Grand Baie	1	14	3	46	12	49	22
	2	16	4	60	15	54	16
	3	29	7	66	16	34	11
	4	127	25	152	75	385	92
	5	110	21	228	86	499	90
Le Goulet	1	5	1	44	9	80	36
Belle Mare* <i>(started as from June 2005)</i>	1			19	4	66	9
	2			18	5	56	12
	3	-	-	25	8	92	29
	4			10	3	25	10
	5			11	4	67	13
Pereybere* <i>(started as from April 2005)</i>	1			70	25	61	11
	2	-	-	109	37	21	7
	3			343	134	30	8
	4			150	49	26	7
Blue Bay Marine Park	1	2	ND	0	0	ND	ND
	2	3	1	3	0	ND	ND
	4	5	ND	14	3	32	8
Balaclava Marine Park	2	ND	ND	ND	ND	ND	ND
	3	ND	ND	ND	ND	ND	ND
	4	ND	ND	ND	ND	10	2
	6	7	1	ND	ND	ND	ND
Coastal Water Quality Guideline limits (CWQG)	TC: 1000 CFU/100ml FC: 200 CFU/100ml						

(*): New monitoring station; ND: Not Detected

The data collected on the total and faecal coliforms were regularly provided to other organisations for various purposes such as the assessment of coastal development projects, public health aspects and issues related to pollution as shown below:

- Committee on Lagoonal Pollution in the Port Louis Region (Ministry of Environment and National Development Unit).
- Coordination committee for the implementation of the recommendations of the study. 'Environmental Risks Assessment in Grand Bay' (Ministry of Environment and National Development Unit).
- 'Level of Coliform Bacteria at selected Public Beaches' (Beach Authority).