APPENDIX-17

Baseline Survey (Birds and Their Habitat Survey)

The Preparatory Survey on the Project for Construction of Mumbai Trans Harbor Link

Baseline Survey (Birds and their Habitat Survey)

Report

(Final Report)

5th July 2016

CONTENTS

1. Objectives

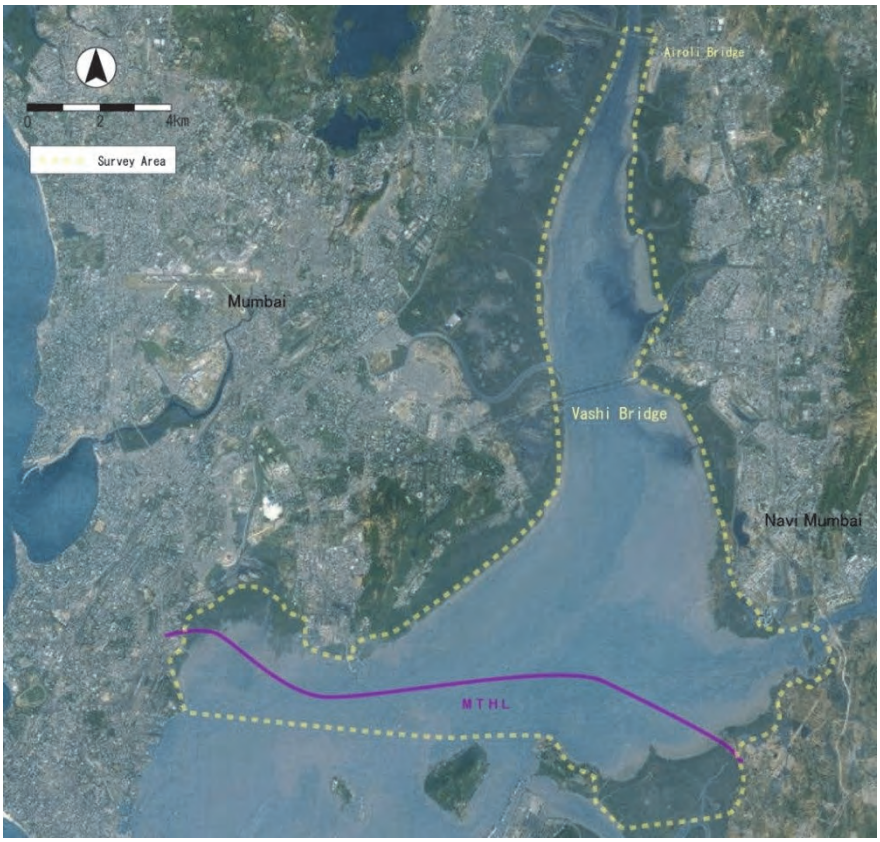
This survey was intended to collect basic information which contributes to appropriate implementation of monitoring and environmental mitigation measures during and after the construction by field surveys about inhabiting situation and habitat environment of flamingos before the construction around the planning route of Mumbai Trans Harbor Link.

- Grasp habitat situation of migratory birds (mainly flamingos) to contribute to appropriate implementation of the environmental mitigation measures (install range of sound barrio).
- Grasp feeding site and incoming population of migratory birds (especially flamingos). This result will be compared with results of monitoring survey during and after the construction.
- Grasp inhabiting/growth situation of benthos, plankton and algae and range of mangrove forests and mudflats as feeding environments before the construction. This result will be compared with surroundings during and after the construction.

2. Overview of the Survey

2.1 Survey Area

The survey is implemented in and around the project site (Sewri mudflats, Shivaji Nagar mudflats, surrounding forests and surrounding sea) (Shown in Figure 2-1).



Source: JICA Study Team

Figure 2-1 Survey Area

2.2 Survey Items

Items of this survey are shown below.

(1) Birds Survey

1) Flamingo Survey

2) Migratory Birds Survey

(2) Inhabiting Environments (Physical Surroundings) Survey

1) Mudflats Survey

2) Noise Survey

(3) Inhabiting Environments (Biota) Survey

1) Flora Survey

a) Mangrove Distribution Survey

b) Mangrove Flora Survey

2) Fauna Survey

a) Fishes Fauna Survey

b) Benthos Fauna Survey

c) Plankton Survey

2.3 Date of Survey

This survey was implemented with the schedule shown in Table 2-1.

Table 2-1 Status of the Survey Implementation

Items		Outline	First	Second	Third
1. Birds	1-1Flamingos	Grasp of Population of Flamingos, Flying Routes and Roosting Area	2/27, 2/28, 3/2, 3/3	3/31, 4/2, 4/5	5/11, 5/13, 5/14
	1-2 Migratory Birds	Grasp of Species of Migratory Birds			
2. Habitat Environments (Physical Habitat)	2-1 Mudflats	Grasp of Distribution of Mudflats	4/11		
	2-2 Noise	Grasp of Noise Generation in Habitats	3/2 - 3/3	4/4 - 4/5	5/12 - 5/13
3. Habitat Environments (Biota)	3-1Flora	Grasp of Mangrove Flora and Distribution of Mangrove Forests	4/11, 4/12		
	3-2Fauna	Grasp of Fishes and Benthos Fauna and Plankton Fauna and Flora	4/6(high tide), 4/13(low tide) and 4/14(low tide)		

Source: JICA Study Team

3. Field Survey

The methods and the results of each item that were conducted field surveys are shown below.

3.1 Birds Survey

3.1.1 Flamingo Survey

(1) Methods

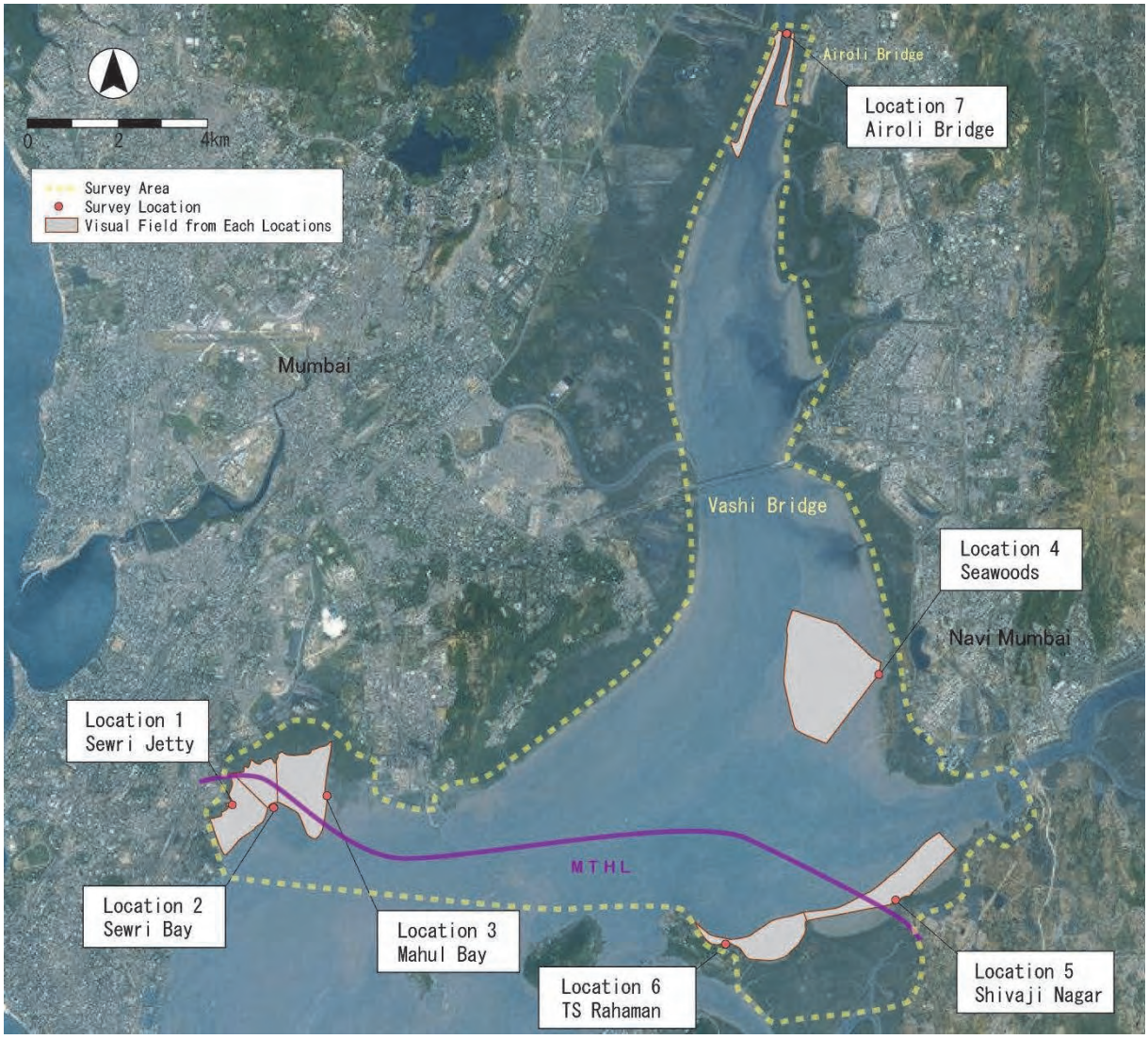
1) Survey of Counting their Population

Population of flamingos inhabit on mudflats was counted at 7 points shown in Figure 3-1 to get to know distribution and the number of individuals of flamingos within Mumbai Bay. Details of the survey methods are shown in Table 3-1.

Table 3-1 Methods of the Survey (Counting their Population)

Objective	- Distribution and the number of individuals of flamingos within whole Mumbai Bay before the construction are grasped. - Data of feeding sites which are important at dry season are obtained.
Target	Lesser Flamingo (*Phoenicopterus minor*), Greater Flamingo (*Phoenicopterus roseus*)
Frequency	3 times in all on approximately a monthly basis from February to May when the population of flamingos in Mumbai Bay is the most.
Time	For about 1 hour around the time of ebb
Method	The number of individuals of flamingos on the mudflats was counted by using binoculars of 8-10 magnifications at each fixed point.
Location	7 points shown in Figure 3-1 *Location 2 (Sewri Bay) and 3 (Mahul Bay) are observed from ships, and other points are observed from land.
Notes	- The survey at Location 6 (TS.Rahaman) was carried out in the same way as the surveys at other points in the second and the third observations. - Location 7 (Airoli Bridge) is an additional survey point. The survey at Location 7 was carried out only one day each in the second and the third observations.

Source: JICA Study Team



Source: JICA Study Team

Figure 3-1 Location of the Survey Points and their Visible Area (Counting the Population)

2) Flying Routes Survey

Fixed-point observations were carried out to get to know flamingos' traveling condition within the mudflat before construction. Details of the survey methods are shown in Table 3-2.

Table 3-2 Methods of the Survey (Flying Routes)

Objective	Flying routes of lesser flamingos over whole Mumbai Bay before the construction are grasped.
Target	Lesser Flamingo (*Phoenicopterus minor*)
Frequency	3 times in all on approximately a monthly basis from February to May when the population of flamingos in Mumbai Bay is the most.
Time	Times when the tide rises and the mudflats which are flamingos' feeding fields are submerged, after the survey to count the population.
Method	The number of the individuals, flying routes and flying altitudes were recorded by using binoculars of 8-10 magnifications and telescope of 20-60 magnifications at each fixed point.
Location	Same points as the counting survey
Notes	Flying routes from roosting area to feeding fields were optionally observed.

Source: JICA Study Team

3) Roosting Areas Survey

Flamingos living in Mumbai Bay feed themselves on mudflats at low tide and move in a group to other locations when the tide is up and the mudflats are submerged. In this survey, the waiting places when the flamingos cannot feed because the mudflats are submerged are defined as roosts. Field surveys within the survey area were carried out to get to know distribution of the roosts. Details of the survey methods are shown in Table 3-3.

Table 3-3 Methods of the Survey (Roosting Areas)

Objective	Roosts and resting sites of flamingos around Sewri mudflat before the construction are grasped.
Target	Lesser Flamingo (*Phoenicopterus minor*), Greater Flamingo (*Phoenicopterus roseus*)
Frequency	From February to May when the population of flamingos in Mumbai Bay is the most.
Time	Times when the tide is high and the mudflats which are flamingos' feeding fields are submerged.
Method	- Roosts were extrapolated from the flying direction of flamingos in the flying routes survey. And Roosts were identified by field observations. - Locations of roosts, the number of the individuals and others were recorded by using binoculars of 8-10 magnifications and telescope of 20-60 magnifications at each fixed point.
Location	At sea sections which were estimated to be roosting areas based on the flying routes survey.

Source: JICA Study Team

(2) Results

1) Survey of Counting the Population

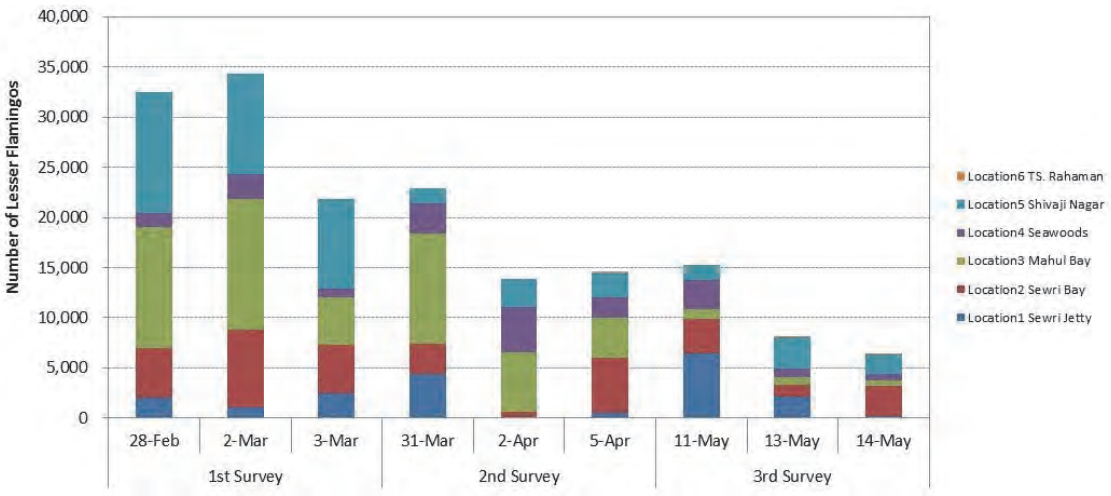
A list of the results of the survey of counting the population is shown in Table 3-4. Summaries of each survey point and inhabiting situation of flamingos are shown in Table 3-5. The following describes status of confirmation in each observation and population density at each survey point.

a) Status of Confirmation

① Lesser Flamingos

The number of identified lesser flamingos in each observation is shown in Figure 3-2. The number of identified lesser flamingos tends to be large in the first observation. On the second day of the first observation when the largest population was confirmed, 34,360 individuals of flamingos have been identified in total (Location 1 Sewri Jetty: 1,030 individuals, Location 2 Sewri Bay: 7,830 individuals, Location 3 Mahul Bay: 13,000 individuals, Location 4 Seawoods: 2,500 individuals, Location 5 Shivaji Nagar: 10,000 individuals).

After the first observation, the identified number is decrease with increase in the number of observation. In the second and the third observations, the confirmed number tends to decrease in comparison with the first observation, especially at Location 3 (Mahul Bay) and 5 (Shivaji Nagar).



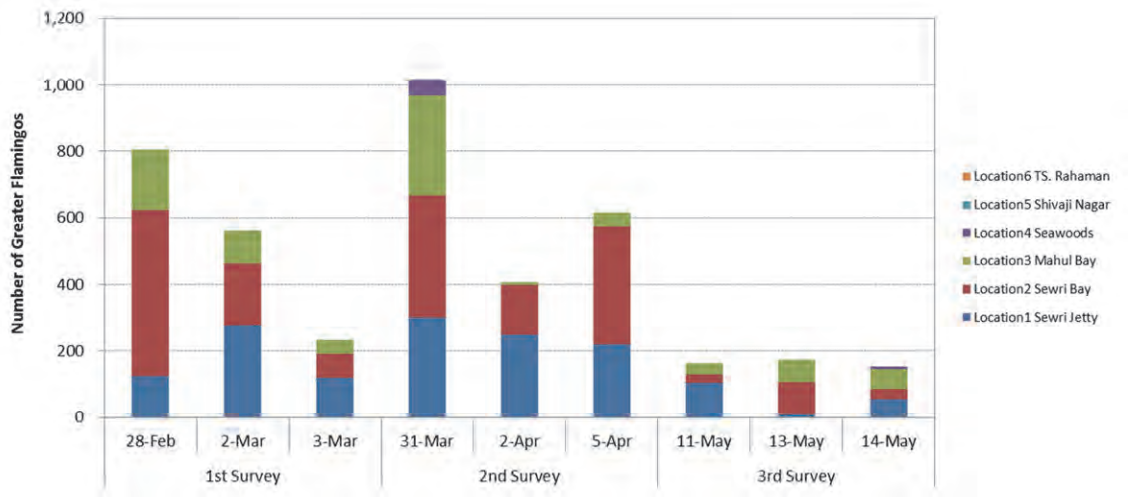
Source: JICA Study Team

Figure 3-2 Results of the Survey in Each Observation (Counting the Population: Lesser flamingos)

Note 1: The first observation was not implemented at Location 6 TS. Rahaman.
Note 2: Since the observations at Location 7 Airoli Bridge were carried out on different days, the results are not included.

② Greater Flamingos

The number of identified greater flamingos in each observation is shown in Figure 3-3. The number of identified greater flamingos tends to be smaller in the third observation in comparison with the first and the second observations. Most of greater flamingos were confirmed at the points in Sewri-Mahul mudflats (Location 1–3), and there were few flamingos identified at Location 4–6.



Source: JICA Study Team

Figure 3-3 Results of the Survey in Each Observation (Counting the Population: Greater flamingos)

Note 1: The first observation was not implemented at Location 6 TS. Rahaman.
Note 2: Since the observations at Location 7 Airoli Bridge were carried out on different days, the results are not included.

b) Habitat Density

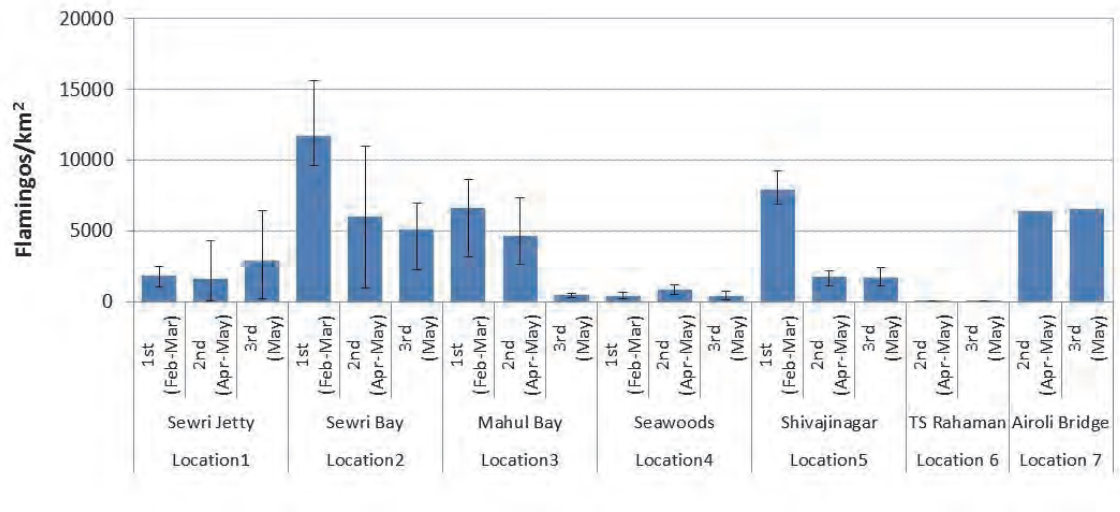
① Lesser Flamingos

Habitat density of lesser flamingos at each location in each observation is shown in Figure 3-4.

The density within Sewri-Mahul mudflats tends to be high at Location 2 (Sewri Bay) and 3 (Mahul Bay).

About the other locations, the densities at Location 5 (Shivaji Nagar) and 7 (Airoli Bridge) which is an additional location are as high as at Location 2 and 3. And lesser flamingos were rarely confirmed at Location 6 (TS. Rahaman).

Additionally, the densities at 2nd March in the first observation when the identified population is the most are 1,030 individuals/km^2 at Location 1(Sewri Jetty), 15,660 individuals/km^2 at Location 2(Sewri Bay), 8,667 individuals/km^2 at Location 3 (Mahul Bay), 658 individuals/km^2 at Location 4 (Seawoods) and 7,692 individuals/km^2 at Location 5(Shivaji Nagar).



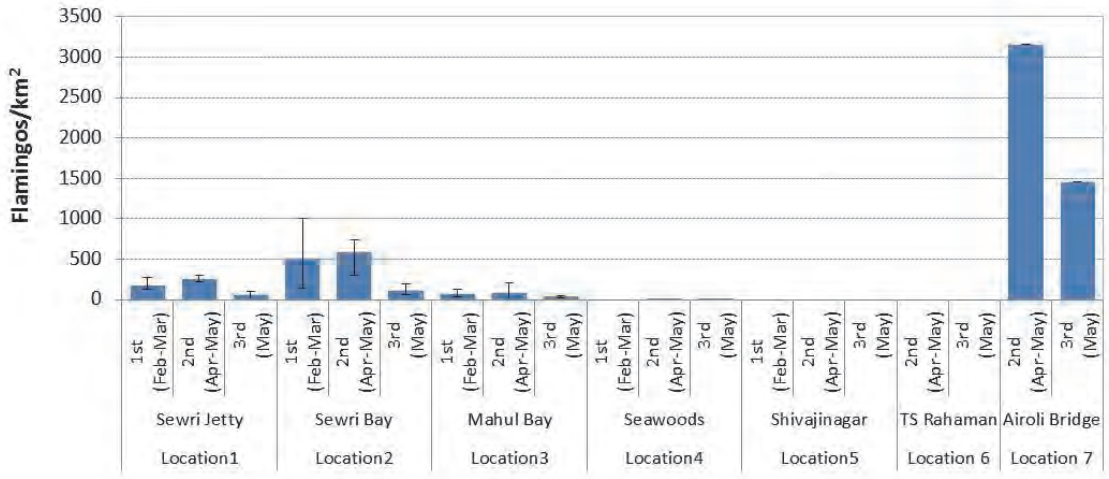
Source: JICA Study Team

Figure 3-4 Habitat Density at Each Location (Lesser Flamingos)

Note 1: Habitat density means the number of identified flamingos per visible area at each location.
Note 2: Bar charts show average, error lines show maximum and minimum.
Note 3: The first observation was not implemented at Location 6 (TS. Rahaman) and 7 (Airoli Bridge).
Note 4: The observations at Location 7 (Airoli Bridge) were implemented only one day each time.

② Greater Flamingos

Habitat density of lesser flamingos at each location in each observation is shown in Figure 3-5. Greater flamingos were intensively identified at 3 locations in Sewri-Mahul mudflats and Location 7 (Airoli Bridge) which is an additional location, especially the habitat density at Location 7 (Airoli Bridge) was high. In addition, most of the identified greater flamingos at Location 7 (Airoli Bridge) were young birds. Moreover, for the 3 locations in Sewri-Mahul mudflats, the population density in Location 2 (Sewri Bay) was higher.



Source: JICA Study Team

Figure 3-5 Habitat Density at Each Location (Greater Flamingos)

Note 1: Habitat density means the number of identified flamingos per visible area at each location.
Note 2: Bar charts show average, error lines show maximum and minimum.
Note 3: The first observation was not implemented at Location 6 (TS. Rahaman) and 7 (Airoli Bridge).
Note 4: The observations at Location 7 (Airoli Bridge) were implemented only one day each time.

Table 3-4 Results of the Survey (Counting their Population)

Survey Category	Location		Date	Visual Area (km^2)	Population		Habitat Density (Birds/km2)	
	No.	Name			Lesser Flamingo	Greater Flamingo	Lesser Flamingo	Greater Flamingo
1st Survey	Location1	Sewri Jetty	28 February 2016	1.0	2,000	125	2,000	125
			02 March 2016		1,030	278	1,030	278
			03 March 2016		2,500	120	2,500	120
	Location2	Sewri Bay	28 February 2016	0.5	5,000	500	10,000	1,000
			02 March 2016		7,830	185	15,660	370
			03 March 2016		4,800	72	9,600	144
	Location3	Mahul Bay	28 February 2016	1.5	12,000	181	8,000	121
			02 March 2016		13,000	100	8,667	67
			03 March 2016		4,800	42	3,200	28
	Location4	Seawoods	28 February 2016	3.8	1,500	0	395	0
			02 March 2016		2,500	0	658	0
			03 March 2016		803	0	211	0
	Location5	Shivaji Nagar	28 February 2016	1.3	12,000	0	9,231	0
			02 March 2016		10,000	0	7,692	0
			03 March 2016		9,000	0	6,923	0
2nd Survey	Location1	Sewri Jetty	31 March 2016	1.0	4,350	300	4,350	300
			02 April 2016		100	250	100	250
			05 April 2016		518	220	518	220
	Location2	Sewri Bay	31 March 2016	0.5	3,035	367	6,070	734
			02 April 2016		500	150	1,000	300
			05 April 2016		5,480	355	10,960	710
	Location3	Mahul Bay	31 March 2016	1.5	11,000	300	7,333	200
			02 April 2016		6,000	6	4,000	4
			05 April 2016		4,000	40	2,667	27
	Location4	Seawoods	31 March 2016	3.8	3,000	50	789	13
			02 April 2016		4,500	0	1,184	0
			05 April 2016		2,000	0	526	0
	Location5	Shivaji Nagar	31 March 2016	1.3	1,500	0	1,154	0
			02 April 2016		2,813	0	2,164	0
			05 April 2016		2,500	0	1,923	0
	Location6	TS. Rahaman	31 March 2016	1.0	0	0	0	0
			02 April 2016		0	0	0	0
			05 April 2016		106	0	106	0
	Location7	Airoli Bridge	29 March 2016	0.3	1,912	947	6,373	3,157
3rd Survey	Location1	Sewri Jetty	11 May 2016	1.0	6,416	103	6,416	103
			13 May 2016		2,167	9	2,167	9
			14 May 2016		230	55	230	55
	Location2	Sewri Bay	11 May 2016	0.5	3,500	27	7,000	54
			13 May 2016		1,120	98	2,240	196
			14 May 2016		3,000	30	6,000	60
	Location3	Mahul Bay	11 May 2016	1.5	900	34	600	23
			13 May 2016		800	68	533	45
			14 May 2016		500	60	333	40
	Location4	Seawoods	11 May 2016	3.8	3,000	0	789	0
			13 May 2016		850	0	224	0
			14 May 2016		650	7	171	2
	Location5	Shivaji Nagar	11 May 2016	1.3	1,445	0	1,112	0
			13 May 2016		3,131	0	2,408	0
			14 May 2016		2,000	0	1,538	0
	Location6	TS. Rahaman	11 May 2016	1.0	0	0	0	0
			13 May 2016		50	0	50	0
			14 May 2016		50	0	50	0
	Location7	Airoli Bridge	17 May 2016	0.3	1,978	435	6,593	1,450

Source: JICA Study Team

Table 3-5(1) Overview of the Survey Points and Inhabiting Situation of Flamingos

Location 1 Sewri Jetty	
This survey point is at a jetty located on the west side of Sewri-Mahul mudflats and is a land survey point. It is repair yards of ships, and besides many ordinary people visit here to observe flamingos. Density of flamingos is low compared to Location 2 (Sewri Bay) and 3 (Mahul Bay).	
	
View from the Point	Inhabiting Situation of Flamingos
Location 2 Sewri Bay (Shipboard Survey Point)	
This survey point is in order to observe the central part of Sewri-Mahul mudflats and is a shipboard survey point. Although it is located on the south side of the mudflats, the distance to the mudflats is far because of shallow water depth. The density of flamingos is high as well as Location 3 (Mahul Bay).	
	
View from the Point	Inhabiting Situation of Flamingos

Source: JICA Study Team

Table 3-5(2) Overview of the Survey Points and Inhabiting Situation of Flamingos

Location 3 Mahul Bay (Shipboard Survey Point)	
This survey point is in order to observe the east part of Sewri-Mahul mudflats and is a shipboard survey point. It is located near the mudflats exit in Mahul Creek, and is in contiguity with the mudflats. The density of flamingos is high as well as Location 2 (Sewri Bay).	
	
View from the Point	Inhabiting Situation of Flamingos
Location 4 Seawoods	
This survey point is at a jetty located on the left bank side of the mouth of Thane Creek, and is a land survey point. It has spread extensive mudflats on the front of the point. Flamingos often are feeding along the edge of water. Since the mudflats are wide for the number of flamingos, the habitat density is low compared to the other points.	
	
View from the Point	Inhabiting Situation of Flamingos

Source: JICA Study Team

Table 3-5(3) Overview of the Survey Points and Inhabiting Situation of Flamingos

Location 5 Shivaji Nagar	
This survey point is at a jetty located on the south side of the survey area and is located on the central part of mudflats which spread from the mouth of Panvel Creek to TS. Rahaman University. Flamingos often are feeding along the edge of water. Habitats of the flamingos were confirmed with the same degree of density with Location 2 (Sewri Bay) and 3 (Mahul Bay) from February to March. From April to May, the density was reduced and is as well as Location 1 (Sewri Jetty).	
	
View from the Point	Inhabiting Situation of Flamingos
Location 6 TS. Rahaman	
This survey point is at a jetty in TS. Rahaman University on the south side of the survey area. The mudflats area is small compared to the other points. The population of flamingos is small compared to the others. Flamingos were seen slightly to the seat side of the mudflat.	
	
View from the Point	Inhabiting Situation of Flamingos

Source: JICA Study Team

Table 3-5(4) Overview of the Survey Points and Inhabiting Situation of Flamingos

Location 7 Airoli Bridge	
This survey point is set on the Airoli Bridge over Thane Creek. It is possible to observe the mudflats that spread in both side of Thane Creek from the point. Flamingos inhabit mainly the edge of water. The habitat density is slightly less than Location 2 (Sewri Bay) and 3 (Mahul Bay). Moreover, there are a lot of greater flamingos; especially the number of the young birds is large.	
	
View from the Point (Left Bank)	View from the Point (Right Bank)

Source: JICA Study Team

2) Flying Routes Survey

The results of the flying routes survey is shown in Table 3-6 , and a flying routes map is shown in Figure 3-6.

The following describes the flying routes of flamingos at each survey point.

a) Sewri-Mahul Mudflats (Location 1-3)

About the lesser flamingos identified at Location 1-3, every individuals flying with the submergence of mudflats which are their feeding fields were flying in the southeast direction where their roosts near TATA power plant. At the time, flying altitude was often 5-20m.

Every individuals flying from their roosts to the mudflats before the mudflats appear were coming from the direction of their roosts near TATA power plant. The flying altitude was mainly 20-40m.

Flying to their roosts (Sewri mudflat)

Flying from the roosts to Sewri mudflat

Source: JICA Study Team

b) Location 4 (Seawoods)

About the lesser flamingos identified at Location 4, Individuals flying with the submergence of mudflats which are their feeding fields were flying in the northwest direction or in the southwest direction. Compared the flying routes with locations of roosts, individuals toward the northwest direction are considered to be likely headed to their roosts in Trombay area. In the meanwhile, since their roosts in the southeast direction have not been identified, the individuals flying to the southeast direction are likely to change the courses and move to the lake in Seawoods area which is an adjacent roost.

With regard to individuals flying from their roosts to the mudflats before the mudflats appear, flying from Seawoods area is observed. The flying altitude was mainly 20-40m.

Flying from their roosts in Seawoods to the direction of the mudflat

Source: JICA Study Team

c) Location 5 (Shivaji-Nagar)

About the lesser flamingos identified at Location 5, Most of individuals flying with the submergence of mudflats which are their feeding fields were flying to the mouth of Panvel Creek in the east direction. All the altitude was 20m or less.

With regard to flying from the direction of their roosts, flying from the northwest direction to the mouth of Panvel Creek was observed. It was observed that the individuals coming here increase the distribution toward Location 5 by walking or low-altitude and short flying from the mouth of Panvel Creek thereafter.

Walking from Panvel Creek

Flying from their roosts to the direction of Panvel Creek

Source: JICA Study Team

d) Location 7 (Airoli Bridge)

As the flying from feeding fields to the direction of their roosts, flying at the altitude of 5-20m to the south direction was observed. However, moving over Vashi Bridge in the south of Airoli Bridge was not observed. In addition, it was observed that some of the individuals were flying from north to south over Airoli Bridge (flying altitude is 20-40m).

With regard to flying from the direction of their roosts, the flamingos which have been waiting with swimming during high tide swam to the river banks with appearance of the mudflats since the major roosts around this location are in water section of Thane Creek. Therefore, a significant movement by flying was not observed at this location. But low-altitude and short flying and moving of some individuals to north over Airoli Bridge (flying altitude was 20-40m) were observed.

Low-altitude flying from the feeding field (Location 7)

Flying over Airoli Bridge (the altitude is more than 20m)

Source: JICA Study Team

Table 3-6(1) Results of the Survey (Flying Routes)

No.	Date	Low tide time	Location	Observed time	the number of individuals in a group	Flying altitude	Flying type
1	27 February 2016	8:28	Seawoods	10:35	25	5-20m	To Roosting Area
2				10:35	15	5-20m	To Roosting Area
3				10:41	25	5-20m	To Roosting Area
4				10:41	10	5-20m	To Roosting Area
5				10:42	25	5-20m	To Roosting Area
6				10:42	30	5-20m	To Roosting Area
7				10:43	35	5-20m	To Roosting Area
8	02 March 2016	11:07	Seawoods	13:20	2321	5-20m	To Roosting Area
9			Shivaji Nagar	14:33	43	5-20m	To Roosting Area
10				15:35	60	5-20m	To Roosting Area
11				15:40	30	5-20m	To Roosting Area
12				15:40	30	5-20m	To Roosting Area
13				16:04	100	5-20m	To Roosting Area
14	28 March 2016	8:16	Shivaji Nagar	11:32	28	5-20m	To Roosting Area
15	29 March 2016	9:15	Airoli Bridge	13:17	100	5-20m	To Roosting Area
16				13:20	100	0-5m	To Roosting Area
17				13:23	100	0-5m	To Roosting Area
18	31 March 2016	10:14	Sewri Jetty	12:25	35	5-20m	To Roosting Area
19				12:30	6	5-20m	To Roosting Area
20				13:54	48	5-20m	To Roosting Area
21				13:50	50	5-20m	To Roosting Area
22				13:55	6	5-20m	To Roosting Area
23				14:05	29	5-20m	To Roosting Area
24			Sewri Bay	13:51	27	5-20m	To Roosting Area
25				13:52	8	5-20m	To Roosting Area
26				14:15	26	5-20m	To Roosting Area
27				14:16	6	5-20m	To Roosting Area
28				14:19	7	5-20m	To Roosting Area
29			Seawoods	12:10	180	5-20m	To Roosting Area
30				12:10	40	5-20m	To Roosting Area
31				12:35	290	20-40m	To Roosting Area
32				13:00	300	5-20m	To Roosting Area
33				13:30	5	5-20m	To Roosting Area
34				14:00	5	5-20m	To Roosting Area
35	02 April 2016	12:59	Sewri Jetty	16:35	23	0-5m	To Roosting Area
36				16:40	17	5-20m	To Roosting Area
37				17:20	300	20-40m	To Roosting Area
38				17:30	300	40m<	To Roosting Area
39			Sewri Bay	16:30	600	5-20m	To Roosting Area
40				16:35	210	5-20m	To Roosting Area
41			Mahul Bay	15:02	390	5-20m	To Roosting Area
42				16:00	200	5-20m	To Roosting Area
43				16:15	100	5-20m	To Roosting Area
44				16:30	50	5-20m	To Roosting Area
45				16:32	200	5-20m	To Roosting Area
46				16:35	200	5-20m	To Roosting Area
47				16:40	150	5-20m	To Roosting Area
48				16:40	50	0-5m	To Roosting Area
49				16:45	300	5-20m	To Roosting Area
50				16:55	200	5-20m	To Roosting Area
51				16:55	50	5-20m	To Roosting Area
52				17:00	100	5-20m	To Roosting Area
53			Seawoods	14:01	53	20-40m	To Roosting Area
54				14:01	33	20-40m	To Roosting Area
55				14:02	27	20-40m	To Roosting Area
56				14:05	104	20-40m	To Roosting Area
57				14:07	150	40m<	To Roosting Area
58				14:09	12	20-40m	To Roosting Area
59				14:09	40	40m<	To Roosting Area
60				14:10	150	40m<	To Roosting Area
61				14:10	40	20-40m	To Roosting Area
62				14:13	20	20-40m	To Roosting Area
63				14:14	25	20-40m	To Roosting Area
64				14:16	10	40m<	To Roosting Area
65				14:16	30	20-40m	To Roosting Area
66				14:18	150	20-40m	To Roosting Area
67				14:20	60	20-40m	To Roosting Area
68				14:23	37	20-40m	To Roosting Area
69				14:26	85	40m<	To Roosting Area
70				14:30	25	40m<	To Roosting Area
71				14:40	25	20-40m	To Roosting Area
72				14:50	33	20-40m	To Roosting Area
73				14:50	6	20-40m	To Roosting Area
74				14:51	8	5-20m	To Roosting Area
75				15:08	17	5-20m	To Roosting Area
76			Shivaji Nagar	14:42	22	5-20m	To Roosting Area
77				15:06	18	5-20m	To Roosting Area

Source: JICA Study Team

Table 3-6(2) Results of the Survey (Flying Routes)

No.	Date	Low tide time	Location	Observed time	the number of individuals in a group	Flying altitude	Flying type
78	05 April 2016	16:24	Sewri Jetty	18:05	33	20-40m	To Roosting Area
79				18:31	29	20-40m	To Roosting Area
80			Sewri Bay	17:30	980	5-20m	To Roosting Area
81				17:30	500	5-20m	To Roosting Area
82			Seawoods	18:10	1000	5-20m	To Roosting Area
83				18:15	1000	5-20m	To Roosting Area
84			Shivaji Nagar	18:20	20	5-20m	To Roosting Area
85			Seawoods Roosting Area	16:08	2000	20-40m	To Feeding Area
86	07 April 2016	18:00	Shivaji Nagar	14:33	2000<	20-40m	To Feeding Area
87	08 April 2016	18:45	Mahul Bay	15:30	2000<	20-40m	To Feeding Area
88				15:34	250	5-20m	To Feeding Area
89	11 May 2016	8:50	Sewri Jetty	12:10	400	5-20m	To Roosting Area
90				12:20	550	5-20m	To Roosting Area
91				12:23	14	5-20m	To Roosting Area
92				12:30	500	5-20m	To Roosting Area
93				12:35	750	5-20m	To Roosting Area
94			Sewri Bay	12:10	120	5-20m	To Roosting Area
95				12:12	80	5-20m	To Roosting Area
96				12:20	100	5-20m	To Roosting Area
97				12:40	80	5-20m	To Roosting Area
98				12:42	80	5-20m	To Roosting Area
99				12:44	40	5-20m	To Roosting Area
100				12:45	100	5-20m	To Roosting Area
101				12:46	120	5-20m	To Roosting Area
102				12:50	100	5-20m	To Roosting Area
103				12:51	150	5-20m	To Roosting Area
104				12:52	50	5-20m	To Roosting Area
105				13:00	250	5-20m	To Roosting Area
106				13:05	200	5-20m	To Roosting Area
107			Mahul Bay	10:50	36	0-5m	To Roosting Area
108				10:55	132	0-5m	To Roosting Area
109				11:00	71	0-5m	To Roosting Area
110				11:01	95	0-5m	To Roosting Area
111				11:11	52	0-5m	To Roosting Area
112				11:12	61	0-5m	To Roosting Area
113				11:18	27	0-5m	To Roosting Area
114				11:30	15	0-5m	To Roosting Area
115				11:30	110	0-5m	To Roosting Area
116				11:30	30	0-5m	To Roosting Area
117				11:35	69	0-5m	To Roosting Area
118				11:40	56	0-5m	To Roosting Area
119				11:42	200	0-5m	To Roosting Area
120				11:50	124	0-5m	To Roosting Area
121				11:55	250	0-5m	To Roosting Area
122				11:58	152	0-5m	To Roosting Area
123				12:00	175	0-5m	To Roosting Area
124				12:08	110	0-5m	To Roosting Area
125				12:10	24	0-5m	To Roosting Area
126				12:13	113	0-5m	To Roosting Area
127				12:16	150	0-5m	To Roosting Area
128				12:40	160	0-5m	To Roosting Area
129				12:50	120	0-5m	To Roosting Area
130				13:00	150	0-5m	To Roosting Area
131			Seawoods	11:25	20	5-20m	To Roosting Area
132				11:33	20	5-20m	To Roosting Area
133				11:40	7	5-20m	To Roosting Area
134				13:10	350	30-40m	To Roosting Area
135				13:20	40	30-40m	To Roosting Area
136				13:20	250	30-40m	To Roosting Area
137	13 May 2016	10:44	Sewri Jetty	12:51	8	5-20m	To Roosting Area
138				13:15	20	20-40m	To Roosting Area
139				13:45	70	20-40m	To Roosting Area
140				13:46	48	20-40m	To Roosting Area
141				13:55	100	20-40m	To Roosting Area
142				14:15	100	20-40m	To Roosting Area
143				14:30	100	20-40m	To Roosting Area
144				15:00	250	20-40m	To Roosting Area
145				15:12	250	20-40m	To Roosting Area

Source: JICA Study Team

Table 3-6(3) Results of the Survey (Flying Routes)

No.	Date	Low tide time	Location	Observed time	the number of individuals in a group	Flying altitude	Flying type
146	13 May 2016	10:44	Sewri Bay	12:44	10	5-20m	To Roosting Area
147				12:50	2	5-20m	To Roosting Area
148				13:02	11	5-20m	To Roosting Area
149				13:06	11	5-20m	To Roosting Area
150				13:15	9	5-20m	To Roosting Area
151				13:16	13	5-20m	To Roosting Area
152				13:25	16	5-20m	To Roosting Area
153				13:35	4	5-20m	To Roosting Area
154				13:42	51	5-20m	To Roosting Area
155				13:46	15	5-20m	To Roosting Area
156				13:55	8	5-20m	To Roosting Area
157				13:57	29	5-20m	To Roosting Area
158				14:00	79	5-20m	To Roosting Area
159				14:00	137	5-20m	To Roosting Area
160			Mahul Bay	12:45	12	5-20m	To Roosting Area
161				12:47	165	5-20m	To Roosting Area
162				13:00	170	5-20m	To Roosting Area
163				13:03	50	5-20m	To Roosting Area
164				13:10	183	5-20m	To Roosting Area
165				13:16	150	5-20m	To Roosting Area
166				13:23	160	5-20m	To Roosting Area
167				13:26	100	5-20m	To Roosting Area
168				13:32	77	5-20m	To Roosting Area
169				13:37	180	5-20m	To Roosting Area
170				13:42	140	5-20m	To Roosting Area
171				13:53	128	5-20m	To Roosting Area
172				13:54	21	5-20m	To Roosting Area
173				13:55	31	5-20m	To Roosting Area
174				14:01	193	5-20m	To Roosting Area
175				14:05	5	5-20m	To Roosting Area
176				14:06	70	5-20m	To Roosting Area
177				14:09	213	5-20m	To Roosting Area
178				14:15	165	5-20m	To Roosting Area
179				14:20	100	5-20m	To Roosting Area
180				14:22	27	5-20m	To Roosting Area
181				14:50	1000	5-20m	To Roosting Area
182				14:55	200	5-20m	To Roosting Area
183				15:03	48	5-20m	To Roosting Area
184			Seawoods	12:50	100	5-20m	To Roosting Area
185				12:52	12	5-20m	To Roosting Area
186				13:51	40	0-5m	To Roosting Area
187				14:40	20	0-5m	To Roosting Area
188				15:00	150	20-40m	To Roosting Area
189				15:05	14	20-40m	To Roosting Area
190				15:15	150	40m<	To Roosting Area
191				15:15	350	40m<	To Roosting Area
192				15:16	42		To Roosting Area
193			Shivaji Nagar	14:20	37	0-5m	To Roosting Area
194				14:30	30	0-5m	To Roosting Area
195				14:30	84	5-20m	To Roosting Area
196				14:45	62	5-20m	To Roosting Area
197				14:45	30	5-20m	To Roosting Area
198	14 May 2016	12:19	Sewri Jetty	15:00	120	5-20m	To Roosting Area
199				15:30	150	5-20m	To Roosting Area
200				15:38	120	5-20m	To Roosting Area
201				15:42	200	5-20m	To Roosting Area
202				15:52	200	5-20m	To Roosting Area
203				16:00	50	5-20m	To Roosting Area
204				16:15	50	5-20m	To Roosting Area
205				16:20	30	5-20m	To Roosting Area
206			Sewri Bay	14:35	38	5-20m	To Roosting Area
207				14:45	31	20-40m	To Roosting Area
208				15:00	34	5-20m	To Roosting Area
209				15:01	50	5-20m	To Roosting Area
210				15:01	6	5-20m	To Roosting Area
211				15:06	22	5-20m	To Roosting Area
212				15:07	7	20-40m	To Roosting Area
213				15:09	56	5-20m	To Roosting Area
214				15:10	50	5-20m	To Roosting Area
215				15:10	50	5-20m	To Roosting Area

Source: JICA Study Team

Table 3-6(4) Results of the Survey (Flying Routes)

No.	Date	Low tide time	Location	Observed time	the number of individuals in a group	Flying altitude	Flying type
216	14 May 2016	12:19	Sewri Bay	15:13	50	5-20m	To Roosting Area
217				15:15	100	5-20m	To Roosting Area
218				15:22	20	5-20m	To Roosting Area
219				15:22	150	5-20m	To Roosting Area
220				15:23	64	5-20m	To Roosting Area
221				15:23	65	0-5m	To Roosting Area
222				15:20	15	0-5m	To Roosting Area
223				15:28	100	5-20m	To Roosting Area
224				15:30	500	5-20m	To Roosting Area
225				15:33	300	5-20m	To Roosting Area
226				15:34	160	5-20m	To Roosting Area
227				15:40	500	5-20m	To Roosting Area
228				15:41	300	5-20m	To Roosting Area
229				15:45	100	5-20m	To Roosting Area
230				15:46	45	5-20m	To Roosting Area
231				15:46	40	5-20m	To Roosting Area
232			Mahul Bay	15:21	83	20-40m	To Roosting Area
233				15:30	22	20-40m	To Roosting Area
234				15:32	250	20-40m	To Roosting Area
235				15:35	315	20-40m	To Roosting Area
236				15:37	55	20-40m	To Roosting Area
237				15:46	500	20-40m	To Roosting Area
238				15:52	400	20-40m	To Roosting Area
239				15:58	500	20-40m	To Roosting Area
240			Shivaji Nagar	15:00	20	5-20m	To Roosting Area
241				15:15	150-200	5-20m	To Roosting Area
242				15:25	1250	5-20m	To Roosting Area
243				16:00	300	5-20m	To Roosting Area
244				16:00	56	5-20m	To Roosting Area
245	17 May 2016	15:30	Airoli Bridge	13:50	30	20-40m	To Feeding Area
246	19 May 2016	16:55	Airoli Bridge	15:48	20	20-40m	To Feeding Area
247	20 May 2016	17:30	Seawoods Roosting Area	13:12	2000<	20-40m	To Feeding Area
248			Seawoods Roosting Area	13:50	2000<	20-40m	To Feeding Area

Source: JICA Study Team

Source: JICA Study Team

Figure 3-6 Results of the Survey (Flying Routes)

3) Roosting Area Survey

In this survey, “waiting fields during the times of a day for flamingos not to be foraging since mudflats are submerged” are defined as roosts. As a result of the field observations, 7 roosts have been identified. Overviews of the identified roosts are shown in Table 3-7, and the details of each roost are shown in Table 3-8.

In 2 points, which are 1.Sewri Bay-Mahul Bay and 7.Panvel Creek, of the identified roosts, flamingos fly from their roosts before the mudflats appearance and wait while swimming. Use time was as short as about 30 minutes. In addition, about 7.Panvel Creek, it has been observed that the individuals of Shivaji Nagar mudflat temporary fly there after the mudflat was submerged. The point was also used as a waiting field before moving their roosts.

Although the other roosts have been utilized as permanent roosts in mudflats flooding, the water forms are different. 2. TATA Pond, 4.Bandap and 6.Seawoods are ponds close to the mudflats, 3.Trombay is the mudflat which leaves mud environment at high tide, and 5.Thane Creek is the water of the river.

Table 3-7 Overviews of the Identified Roosts

No.	Name	Date	The Number Identified		Water Environment	Condition of Flamingo	Notes
			Lesser Flamingo	Greater Flamingo			
1	Sewri Bay, Mahul Bay	8 Apr	10,000<	Unclear	Marine area	Swimming	Waiting field before flying to feeding fields
2	TATA Pond	5 Apr	16,000	600	Pond	Walking	
		13 May	18,000	400			
3	Trombay	2 Mar	10,000<	100<	Mudflat	Walking	
4	Bhandap	10 May	22	40	Pond	Walking	
5	Thane Creek	19 May	4,000	1,000	River zone	Swimming	
6	Seawoods	19 May	2,300	20	Pond	Walking	
7	Panvel Creek	7 Apr	10,000<	Unclear	Marine area	Swimming	- Waiting field before flying to feeding fields - Waiting field before flying to roosting area

Source: JICA Study Team

Table 3-8(1) The Identified Roosts

1. Sewri Bay, Mahul Bay <Environmental Compartment> Marine Area <the number of identified individuals> - Lesser Flamingo 10,000 - Greater Flamingo Unclear <Condition of Flamingo> Swimming <Status of Utilization> It is a temporary roost to be used for about 30 minutes until the mudflats appear. It considered that flamingos have been flying here from the other roosts, such as TATA Pond and Trombay.	 
2. TATA Pond <Environmental Compartment> Pond <the number of identified individuals> - Lesser Flamingo 16,000 - Greater Flamingo 600 <Condition of Flamingo> Walking <Status of Utilization> It is used as a roost after the mudflats submerged. It has been observed the individuals of Sewri-Mahul mudflats are flying here.	

Source: JICA Study Team

Table 3-8 (2)　The Identified Roosts

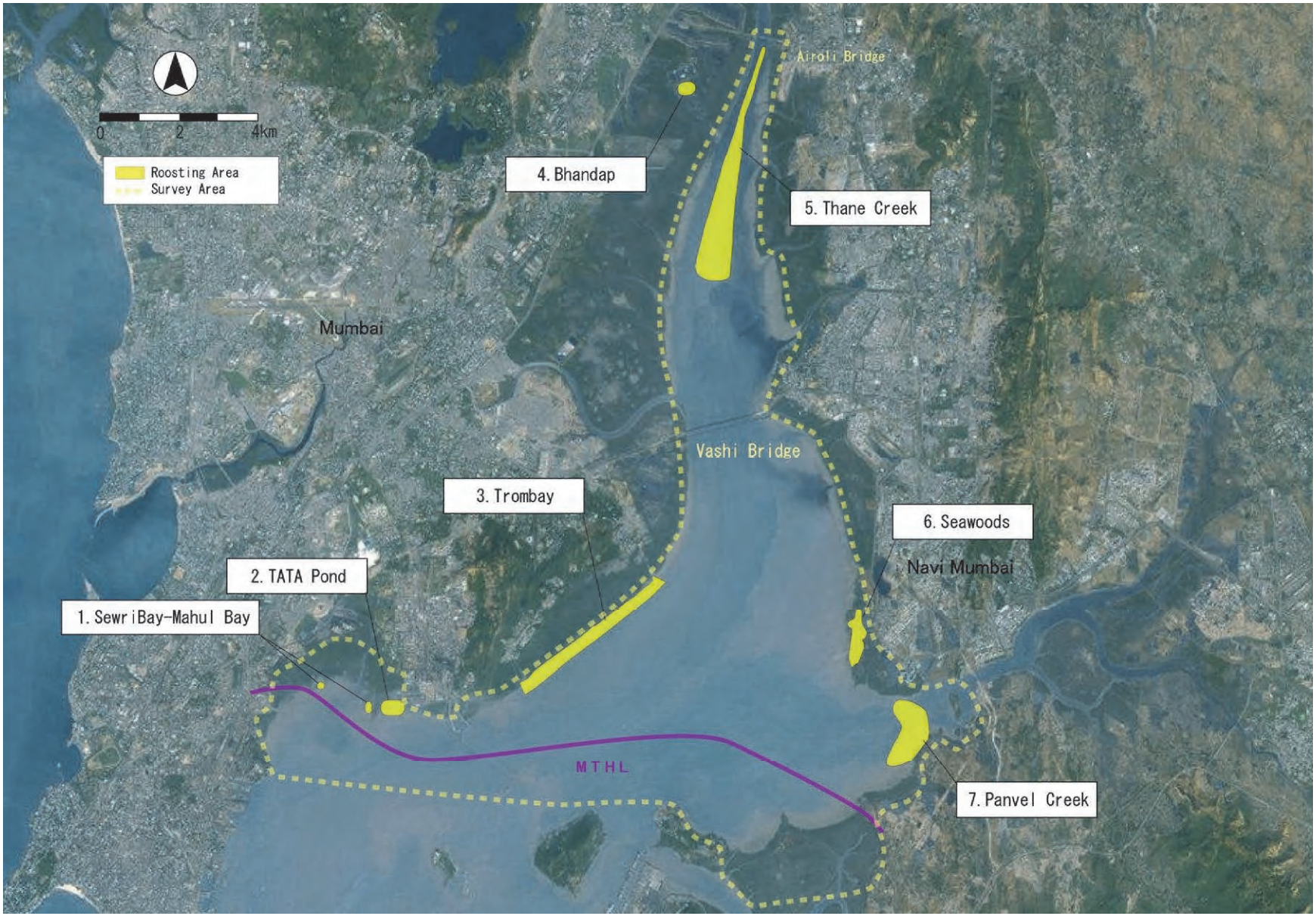
3. Trombay <Environmental Compartment> Mudflat <the number of identified individuals> - Lesser Flamingo　10,000< - Greater Flamingo　500< < Condition of Flamingo> Walking <Status of Utilization> It is a mudflat in Trombay. Part of the mudflat remains of land even the time of high tide. A large number of flamingos have been observed. Not only the individuals of the mudflats in Trombay area, there is a possibility that the individuals which are feeding in Seawoods and Shivaji Nagar use here as a roost.	
4. Bhandap <Environmental Compartment> Pond <the number of identified individuals> - Lesser Flamingo　22 - Greater Flamingo　40 (39 individuals of them are young.) < Condition of Flamingo> Walking <Status of Utilization> It is a pond of fresh water in a mangrove forest. Identified population is about 60 individuals, and small in comparison with the other points. It is considered that part of individuals around Airoli Bridge fly here.	
5. Thane Creek <Environmental Compartment> River <the number of identified individuals> - Lesser Flamingo　4,000 - Greater Flamingo　1,000 < Condition of Flamingo> Swimming <Status of Utilization> It is on the water surface of a river. Flamingos are used as a roost while swimming. The individuals feeding in the mudflats around Airoli Bridge start swimming with the submersion of the mudflat and utilize this point.	

Source: JICA Study Team

Table 3-8 (3)　The Identified Roosts

6. Seawoods <Environmental Compartment> Pond <the number of identified individuals> - Lesser Flamingo　2,300 - Greater Flamingo　20 < Condition of Flamingo> Walking <Status of Utilization> It is a pond of flooding in a mangrove forest. The identified population is about 2000 individuals. The individuals here are considered to be mainly fling from Seawoods mudflat.	
7. Panvel Creek <Environmental Compartment> Marine Area <the number of identified individuals> - Lesser Flamingo　10,000< - Greater Flamingo　Unclear < Condition of Flamingo> Swimming <Status of Utilization> It is a temporary roost to be used for about 30 minutes until the mudflats appear. It is observed that flamingos have been flying from Seawoods direction. In addition, the individuals flying from Shivaji Nagar area temporarily use this point after the mudflat is submerged.	

Source: JICA Study Team



Source: JICA Study Team

Figure 3-7 Result of the Survey (Roosting Area)

3.1.2 Migratory Birds Survey

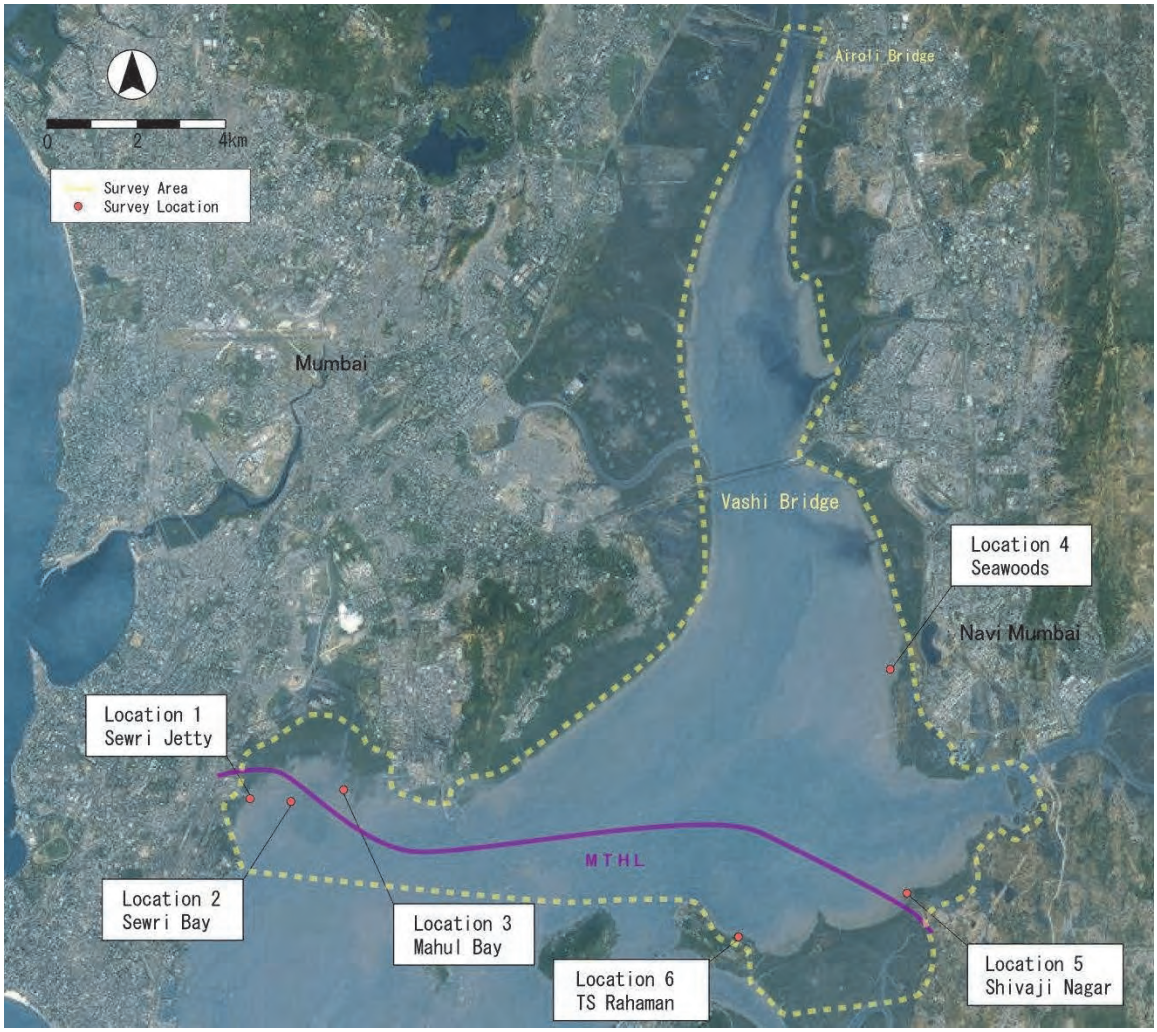
(1) Methods

The birds survey was carried out intended to get to know avifauna in Mumbai Bay, especially the inhabiting situation of migratory birds which use the mudflats. Details of the survey methods are shown in Table 3-9.

Table 3-9 Methods of the Survey (Migratory Birds)

Objective	Avifauna around the project site before the construction is grasped.
Target	General Birds
Frequency	3 times in all on approximately a monthly basis from February to May when the population of flamingos is expected to be the most.
Time	Basically during the occurrence of mudflats
Methods	Their species (avifauna), population, situation when identified and others were recorded by using binoculars of 8-10 magnifications and telescope of 20-60 magnifications at the fixed survey point and on the census routes on ships.
Location	6 points shown in Figure 3-8.

Source: JICA Study Team



Source: JICA Study Team

Figure 3-8 Location of the Survey Points (Migratory Birds)

(2) Results

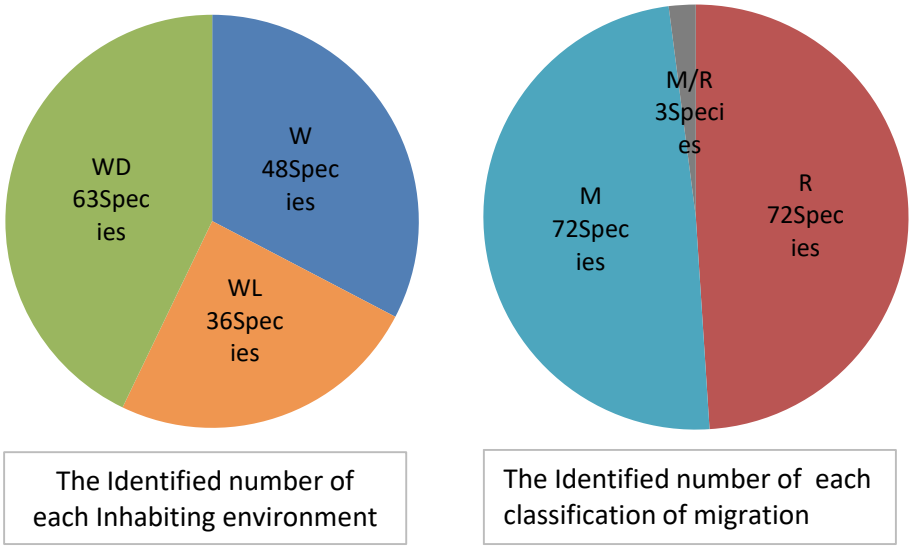
1) Overview of identified species

A list of birds identified in the field observation is shown in Table 3-10, and an outline of the identified species is shown in Figure 3-9.

147 species of birds have been observed through 3 times of the field observation. 48 species of them are waders such as snipes and plovers which are foraging with walking in mudflats and others, 36 species are other aquatic-dependent species, and 63 species are forest dependent species. In addition, about classification of migration of the identified species, 72 species of both migratory birds and resident birds were identified, and 3 species were species that take both movement forms of migratory birds and resident birds.

The identified populations of each observation are 110 species in the first observation, 130 species in the second, and 92 species in the third. The identified population in the third observation was small. It is thought to be a result of reflection the fact that many species already went to the breeding area at the time of the third observation since winter birds are abundant in snipes and plovers.

Besides, the total of 81 species was identified in previous studies by MMRDA (Rapid EIA 2012 and Migratory Birds Study 2008).



Source: JICA Study Team

Figure 3-9 Overview of Species of the Identified Birds

Note 1: The symbols in the identified number of each inhabiting environment; W means waders, WL means other aquatic-dependent species, and WD means forest dependent species

Note 2: The symbols in the identified number of each classification of migration; R means resident birds, M means migratory birds, and M/R means the species which take both movement forms of migratory birds and resident birds.

Table 3-10(1) Lists of the Identified Species

No.	Order	English Name	Scientific Name	1st Survey	2nd Survey	3rd Survey	Inhabiting Environment	Classification of migration	IUCN RL
1	Phoenicopteriformes	Greater Flamingo	*Phoenicopterus roseus*	○	○	○	W	M	LC
2		Lesser Flamingo	*Phoeniconaias minor*	○	○	○	W	M	NT
3	Pelecaniformes	Little Cormorant	*Microcarbo niger*	○	○	○	WL	R	LC
4		Indian Cormorant	*Phalacrocorax fuscicollis*	○	○	○	WL	R	LC
5	Ciconiiformes	Black-crowned Night Heron	*Nycticorax nycticorax*		○	○	W	R	LC
6		Striated Heron	*Butorides striata*	○	○	○	W	R	LC
7		Indian Pond-Heron	*Ardeola grayii*	○	○	○	W	M/R	LC
8		Cattle Egret	*Bubulcus ibis*	○	○	○	WD	R	LC
9		Little Egret	*Egretta garzetta*	○	○	○	W	R	LC
10		Western Reef-Heron	*Egretta gularis*	○	○	○	W	R	LC
11		Great Egret	*Ardea alba*	○	○	○	W	R	LC
12		Grey Heron	*Ardea cinerea*	○	○	○	W	M	LC
13		Intermediate Egret	*Ardea intermedia*	○	○	○	W	R	LC
14		Purple Heron	*Ardea purpurea*	○	○	○	W	R	LC
15		Asian Openbill	*Anastomus oscitans*		○	○	W	R	LC
16		Woolly-necked stork	*Ciconia episcopus*		○		W	R	VU
17		Painted Stork	*Mycteria leucocephala*	○	○	○	W	M/R	NT
18		Eurasian Spoonbill	*Platalea leucorodia*	○			WL	M	LC
19		Black-headed Ibis	*Threskiornis melanocephalus*	○	○	○	W	R	NT
20		Glossy Ibis	*Plegadis falcinellus*	○	○		W	R	LC
21	Anseriformes	Lesser Whistling Duck	*Dendrocygna javanica*			○	WL	R	LC
22		Common Teal	*Anas crecca*	○			WL	M	LC
23		Garganey	*Anas querquedula*	○	○		WL	M	LC
24	Falconiformes	Osprey	*Pandion haliaetus*	○	○		WL	R	LC
25		Black Kite	*Milvus migrans*	○	○	○	WD	R	LC
26		Black-eared Kite	*Milvus migrans lineatus/formosanus*	○	○		WD	M	LC
27		Shikra	*Accipiter badius*	○	○	○	WD	R	LC
28		Eurasian Sparrow-Hawk	*Accipiter nisus*	○			WD	M	LC
29		Greater Spotted Eagle	*Aquila clanga*		○		WD	M	VU
30		Indian Spotted Eagle	*Aquila hastata*		○		WD	M	VU
31		Marsh Harrier	*Circus aeruginosus*	○	○	○	WL	M	LC
32		Pallid Harrier	*Circus macrourus*		○		WL	M	NT
33		Brahminy Kite	*Haliastur indus*	○	○	○	WD	R	LC
34	Galliformes	Grey Francolin(Call)	*Francolinus pondicerianus*	○			WL	M	LC
35	Gruiformes	Baillon's Crake	*Zapornia pusilla*		○		WL	M	LC
36		White-breasted Waterhen	*Amaurornis phoenicurus*	○	○	○	WL	R	LC
37	Charadriiformes	Greater Painted-snipe	*Rostratula benghalensis*		○		W	R	LC
38		Common Ringed Plover	*Charadrius hiaticula*		○		W	M	LC
39		Little Ringed Plover	*Charadrius dubius*	○	○		W	R	LC
40		Kentish Plover	*Charadrius alexandrinus*	○	○	○	W	M	LC
41		Lesser Sand-Plover	*Charadrius mongolus*	○	○	○	W	M	LC
42		Greater Sand-Plover	*Charadrius leschenaultii*	○	○	○	W	M	LC
43		Pacific Golden Plover	*Pluvialis apricaria*	○	○		W	M	LC
44		Grey Plover/Black-bellied Plover	*Pluvialis squatarola*	○	○	○	W	M	LC
45		Red-wattled Lapwing	*Vanellus indicus*	○	○	○	WL	R	LC
46		Ruddy Turnstone	*Arenaria interpres*	○	○	○	W	M	LC
47		Little Stint	*Calidris minuta*	○	○	○	W	M	LC
48		Temminck's Stint	*Calidris temminckii*	○	○		W	M	LC
49		Dunlin	*Calidris alpina*	○	○		W	M	LC
50		Curlew Sandpiper	*Calidris ferruginea*	○	○	○	W	M	LC
51		Great Knot	*Calidris tenuirostris*		○	○	W	M	EN
52		Broad-billed Sandpiper	*Calidris falcinellus*	○	○		W	M	LC
53		Sanderling	*Calidris alba*		○		W	M	LC
54		Spotted Redshank	*Tringa erythropus*	○			W	M	LC
55		Common Redshank	*Tringa totanus*	○	○	○	W	M	LC
56		Marsh Sandpiper	*Tringa stagnatilis*	○	○		W	M	LC
57		Common Greenshank	*Tringa nebularia*	○	○	○	W	M	LC
58		Green Sandpiper	*Tringa ochropus*	○	○		W	M	LC
59		Wood Sandpiper	*Tringa glareola*	○	○	○	W	M	LC
60		Common Sandpiper	*Actitis hypoleucos*	○	○	○	W	M	LC
61		Terek Sandpiper	*Xenus cinereus*	○	○	○	W	M	LC
62		Black-tailed Godwit	*Limosa limosa*	○	○	○	W	M	NT
63		Bar-tailed Godwit	*Limosa lapponica*		○	○	W	M	NT
64		Eurasian Curlew	*Numenius arquata*	○	○	○	W	M	NT
65		Whimbrel	*Numenius phaeopus*	○	○	○	W	M	LC
66		Common Snipe	*Gallinago gallinago*		○		W	M	LC
67		Jack Snipe	*Lymnocryptes minimus*		○		W	M	LC
68		Black-winged Stilt	*Himantopus himantopus*	○	○		W	M	LC
69		Crab-Plover	*Dromas ardeola*		○		W	M	LC
70		Lesser Black-backed Gull	*Larus fuscus*	○			WL	M	LC
71		Heuglin's Gull	*Larus heuglini*	○	○	○	WL	M	LC
72		Steppe Gull	*Larus heuglini barabensis*		○		WL	M	LC
73		Pallas's Gull	*Ichthyaetus ichthyaetus*	○	○	○	WL	M	LC
74		Brown-headed Gull	*Chroicocephalus brunnicephalus*	○	○	○	WL	M	LC

Source: JICA Study Team

Table 3-10 (2) Lists of the Identified Species

No.	Order	English Name	Scientific Name	1st Survey	2nd Survey	3rd Survey	Inhabiting Environment	Classification of migration	IUCN RL
75	Charadriiformes	Slender-billed Gull	*Chroicocephalus genei*	○	○	○	WL	M	LC
76		Black-headed Gull	*Chroicocephalus ridibundus*	○	○	○	WL	M	LC
77		Whiskered Tern	*Chlidonias hybrida*	○	○	○	WL	M	LC
78		Caspian Tern	*Hydroprogne caspia*	○	○	○	WL	M	LC
79		Gull-billed Tern	*Gelochelidon nilotica*	○	○	○	WL	M	LC
80		Common Tern	*Sterna hirundo*	○	○		WL	M	LC
81		Little Tern	*Sternula albifrons*	○	○	○	WL	M	LC
82		Saunders's Tern	*Sternula saundersi*		○		WL	M	LC
83	Columbiformes	Rock Pigeon(Feral Pigeon)	*Columba livia*	○	○	○	WD	R	LC
84		Spotted Dove	*Streptopelia chinensis*	○	○	○	WD	R	LC
85		Laughing Dove	*Spilopelia senegalensis*	○	○	○	WD	R	LC
86	Psittaciformes	Alexandrine Parakeet	*Psittacula eupatria*	○	○	○	WD	R	NT
87		Rose-ringed Parakeet	*Psittacula krameri*	○	○	○	WD	R	LC
88	Cuculiformes	Southern Coucal	*Centropus sinensis parroti*	○	○	○	WD	R	LC
89		Asian Koel	*Eudynamys scolopaceus*	○	○	○	WD	R	LC
90	Apodiformes	Little Swift	*Apus affinis*			○	WD	R	LC
91		Asian Palm-Swift	*Cypsiurus balasiensis*	○	○	○	WD	R	LC
92	Coraciiformes	Pied Kingfisher	*Ceryle rudis*		○	○	WL	R	LC
93		Black-capped Kingfisher	*Halcyon pileata*	○	○		WL	R	LC
94		White-throated Kingfisher	*Halcyon smyrnensis*	○	○	○	WL	R	LC
95		Common Kingfisher	*Alcedo atthis*	○	○	○	WL	R	LC
96		Green Bee-eater	*Merops orientalis*	○	○	○	WD	R	LC
97		Blue-tailed Bee-eater	*Merops philippinus*	○	○		WD	M	LC
98		Indian Roller	*Coracias benghalensis*		○		WD	R	LC
99	Piciformes	Coppersmith Barbet	*Psilopogon haemacephalus*	○	○	○	WD	R	LC
100	Passeriformes	Plain/Sand Martin(?)	*Riparia paludicola/Riparia riparia(?)*		○		WD	M/R	LC
101		Barn Swallow	*Hirundo rustica*	○	○	○	WL	M	LC
102		Wire-tailed Swallow	*Hirundo smithii*	○	○	○	WL	R	LC
103		Red-rumped Swallow	*Cecropis daurica*	○		○	WD	R	LC
104		Dusky Crag Martin	*Ptyonoprogne concolor*	○	○		WD	R	LC
105		Yellow Wagtail	*Motacilla flava*	○	○		WL	M	LC
106		Grey Wagtail	*Motacilla cinerea*	○			WL	M	LC
107		White Wagtail	*Motacilla alba*	○			WL	R	LC
108		White-browed Wagtail	*Motacilla maderaspatensis*	○	○		WL	M	LC
109		Common Iora	*Aegithina tiphia*		○	○	WD	R	LC
110		Red-vented Bulbul	*Pycnonotus cafer*	○	○	○	WD	R	LC
111		Red-whiskered Bulbul	*Pycnonotus jocosus*	○	○	○	WD	R	LC
112		White-eared Bulbul	*Pycnonotus leucotis*	○	○	○	WD	R	LC
113		Long-tailed Shrike	*Lanius schach*	○	○		WD	R	LC
114		Bluethroat	*Luscinia svecica*		○		WD	M	LC
115		Pied Bushchat	*Saxicola caprata*		○		WD	R	LC
116		Oriental Magpie-Robin	*Copsychus saularis*	○	○	○	WD	R	LC
117		Jungle Babbler	*Turdoides striata*		○		WD	R	LC
118		Yellow-eyed Babbler	*Chrysomma sinense*		○		WD	R	LC
119		Blyth's Reed-Warbler	*Acrocephalus dumetorum*	○	○		WD	M	LC
120		Clamorous Reed-Warbler	*Acrocephalus stentoreus*	○	○	○	WD	M	LC
121		Common Chiffchaff	*Phylloscopus collybita*	○			WD	M	LC
122		Lesser Whitethroat	*Sylvia curruca*	○			WD	M	LC
123		Common Tailorbird	*Orthotomus sutorius*	○	○	○	WD	R	LC
124		Plain Prinia	*Prinia inornata*	○	○	○	WD	M	LC
125		Ashy Prinia	*Prinia socialis*	○	○	○	WD	R	LC
126		Red-breasted/Taiga Flycatcher	*Ficedula parva/Ficedula albicilla*	○			WD	M	LC
127		Indian Robin	*Saxicoloides fulicatus*	○	○	○	WD	R	LC
128		Tickell's Blue Flycather	*Cyornis tickelliae*			○	WD	R	LC
129		Common Rosefinch	*Carpodacus erythrinus*		○		WD	M	LC
130		Indian Silverbill	*Euodice malabarica*		○		WD	R	LC
131		Red Avadavat	*Amandava amandava*		○	○	WD	R	LC
132		Scaly-breasted Munia	*Lonchura punctulata*	○	○		WD	R	LC
133		House Sparrow	*Passer domesticus*		○	○	WD	R	LC
134		Baya Weaver	*Ploceus philippinus*		○	○	WD	R	LC
135		Brahminy Starling	*Sturnus pagodarum*		○		WD	R	LC
136		Common Myna	*Acridotheres tristis*	○	○	○	WD	R	LC
137		Pied Starling	*Gracupica contra*	○	○	○	WD	R	LC
138		Rosy Starling	*Pastor roseus*	○	○		WD	M	LC
139		Chestnut-tailed Starling	*Sturnia malabarica*			○	WD	M	LC
140		Indian Golden Oriole	*Oriolus kundoo*	○	○	○	WD	R	LC
141		House Crow	*Corvus splendens*	○	○	○	WD	R	LC
142		Indian(Large-billed) Jungle Crow	*Corvus macrorhynchos culminatus*	○	○	○	WD	R	LC
143		Purple Sunbird	*Cinnyris asiaticus*	○	○	○	WD	R	LC
144		Purple-rumped Sunbird	*Leptocoma zeylonica*	○	○	○	WD	R	LC
145		Vigor's Sunbird	*Aethopyga siparaja vigorsii*			○	WD	R	LC
146		White-spotted Fantail	*Rhipidura albicollis albogularis*		○	○	WD	R	NE
147		White-browed Fantail	*Rhipidura aureola*	○	○	○	WD	R	LC
Total	15 orders	147 Species		110 sp.	130 sp.	92 sp.	W : 48 sp. WL : 36 sp. WD : 63 sp.	R : 72 sp. M : 72 sp. M/R : 3 sp.	EN : 1 sp. VU : 3 sp. NT : 8 sp. LC : 134 sp. NE : 1 sp.

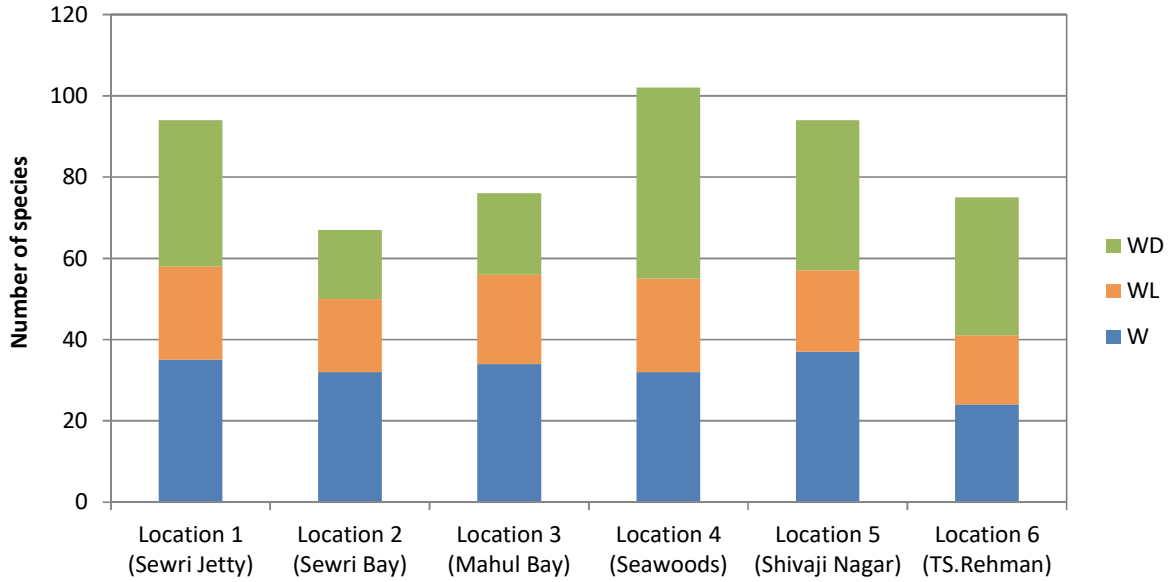
Source: JICA Study Team

2) Identified Condition of each observation point

The number of the identified bird species in each observation point is shown in Figure 3-10, and Shannon-Weiner Diversity Index is shown in Figure 3-11.

The number of identified species in each observation point was fluctuating between 67 species and 102 species. The number in Location 4 (Seawoods) was the most, and the numbers in Location 2 (Sewri Bay) and 3 (Mahul Bay) which are the observation points on ships were slightly less. This is a result that reflects the difference in the surrounding environments. Whereas a lot of both forest dependent species and aquatic-dependent species were identified at Location 4 (Seawoods) which there is abundantly both mudflats and forests around, it is considered that the forest dependent species were less identified at the observation points on ships which there is no forest around.

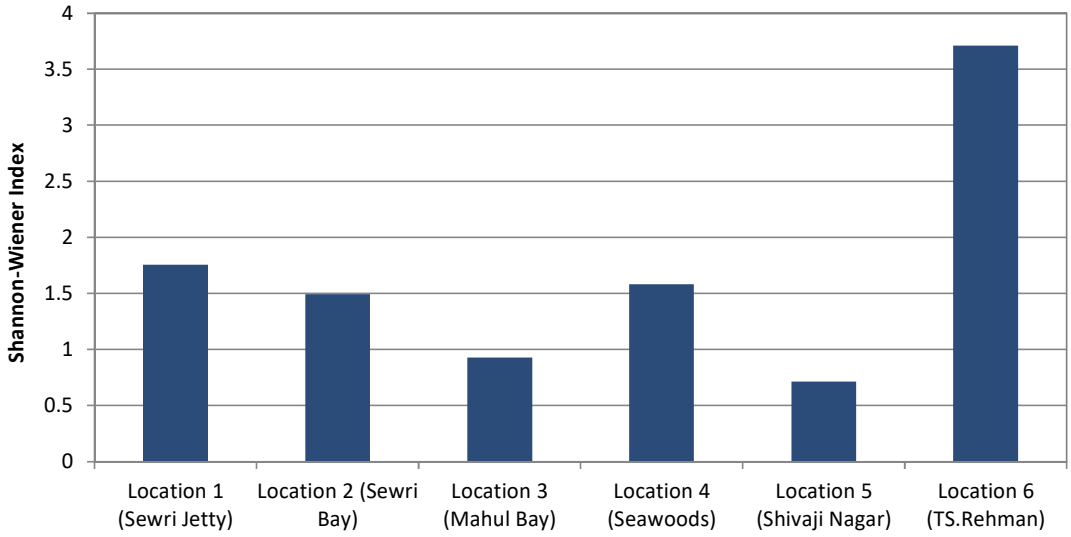
With regard to the diversity index at each observation point, whereas the values up to 2 were shown in a lot of points, an outstanding high value of 3.7 was shown at Location 6 (TS. Rahaman). Diversity index is used as a measure of the diversity of biota. The value becomes higher, where the number of species is larger and the uniformity degree of the population of each species is higher. That is, even the number of the identified species is the same at different points, the value becomes low at a point where the population of particular species is significantly large. Since the numbers of flamingos which live much in the other points and plovers such as *Charadrius mongolus* are small at Location 6 (TS. Rahaman), the uniformity degree of the populations of marshy species and forest dependent species is high. Therefore, the value at Location 6 (TS. Rahaman) becomes high.



Source: JICA Study Team

Figure 3-10 The Number of the Identified Species (Migratory Birds)

Note 1: W: Waders, WL: Other aquatic-dependent species, WD: forest dependent species



Source: JICA Study Team

Figure 3-11 Diversity Index at Each Observation Point (Shannon-Weiner Index)

Table 3-11(1) Lists of the Identified Species at each point (Migratory Birds)

No.	Order	English Name	Location 1 (Sewri Jetty)	Location 2 (Sewri Bay)	Location 3 (Mahul Bay)	Location 4 (Seawoods)	Location 5 (Shivaji Nagar)	Location 6 (TS.Rehman)	Inhabiting Environment	Classification of migration	IUCN RL
1	Phoenicopteriformes	Greater Flamingo	○	○	○	○			W	M	LC
2		Lesser Flamingo	○	○	○	○	○	○	W	M	NT
3	Pelecaniformes	Little Cormorant	○	○	○	○	○	○	WL	R	LC
4		Indian Cormorant				○	○	○	WL	R	LC
5	Ciconiiformes	Black-crowned Night Heron	○			○	○		W	R	LC
6		Striated Heron	○	○	○	○	○	○	W	R	LC
7		Indian Pond-Heron	○	○	○	○	○	○	W	M/R	LC
8		Cattle Egret		○	○		○	○	WD	R	LC
9		Little Egret	○	○	○	○	○	○	W	R	LC
10		Western Reef-Heron	○	○	○	○	○	○	W	R	LC
11		Great Egret	○	○	○	○	○	○	W	R	LC
12		Grey Heron	○	○	○	○	○	○	W	M	LC
13		Intermediate Egret	○	○	○	○	○	○	W	R	LC
14		Purple Heron	○		○		○	○	W	R	LC
15		Asian Openbill					○	○	W	R	LC
16		Woolly-necked stork						○	W	R	VU
17		Painted Stork	○	○	○	○	○	○	W	M/R	NT
18		Eurasian Spoonbill				○			WL	M	LC
19		Black-headed Ibis	○	○	○	○	○	○	W	R	NT
20		Glossy Ibis		○	○				W	R	LC
21	Anseriformes	Lesser Whistling Duck	○	○	○				WL	R	LC
22		Common Teal		○	○				WL	M	LC
23		Garganey		○	○				WL	M	LC
24	Falconiformes	Osprey	○	○	○	○		○	WL	R	LC
25		Black Kite	○	○	○	○	○	○	WD	R	LC
26		Black-eared Kite		○	○		○		WD	M	LC
27		Shikra	○						WD	R	LC
28		Eurasian Sparrow-Hawk				○			WD	M	LC
29		Greater Spotted Eagle		○	○				WD	M	VU
30		Indian Spotted Eagle			○				WD	M	VU
31		Marsh Harrier	○	○		○	○		WL	M	LC
32		Pallid Harrier				○	○		WL	M	NT
33		Brahminy Kite	○	○	○	○	○	○	WD	R	LC
34	Galliformes	Grey Francolin(Call)				○			WL	M	LC
35	Gruiformes	Baillon's Crake				○			WL	M	LC
36		White-breasted Waterhen	○		○		○	○	WL	R	LC
37	Charadriiformes	Greater Painted-snipe					○		W	R	LC
38		Common Ringed Plover					○		W	M	LC
39		Little Ringed Plover	○	○			○		W	R	LC
40		Kentish Plover	○	○	○	○	○		W	M	LC
41		Lesser Sand-Plover	○	○	○	○	○	○	W	M	LC
42		Greater Sand-Plover	○	○	○	○	○		W	M	LC
43		Pacific Golden Plover	○	○	○		○		W	M	LC
44		Grey Plover/Black-bellied Plover	○	○	○	○		○	W	M	LC
45		Red-wattled Lapwing				○	○		WL	R	LC
46		Ruddy Turnstone	○	○	○	○	○	○	W	M	LC
47		Little Stint	○	○	○	○	○	○	W	M	LC
48		Temminck's Stint				○	○		W	M	LC
49		Dunlin	○		○				W	M	LC
50		Curlew Sandpiper	○	○	○	○	○		W	M	LC
51		Great Knot		○	○				W	M	EN
52		Broad-billed Sandpiper	○	○	○	○	○	○	W	M	LC
53		Sanderling						○	W	M	LC
54		Spotted Redshank	○	○					W	M	LC
55		Common Redshank	○	○	○	○	○	○	W	M	LC
56		Marsh Sandpiper	○	○	○	○	○		W	M	LC
57		Common Greenshank	○	○	○	○	○	○	W	M	LC
58		Green Sandpiper	○			○	○	○	W	M	LC
59		Wood Sandpiper				○	○		W	M	LC
60		Common Sandpiper	○	○	○	○	○	○	W	M	LC
61		Terek Sandpiper	○		○	○	○		W	M	LC
62		Black-tailed Godwit	○	○	○		○		W	M	NT
63		Bar-tailed Godwit		○	○				W	M	NT
64		Eurasian Curlew	○	○	○	○	○		W	M	NT
65		Whimbrel	○	○	○	○	○	○	W	M	LC
66		Common Snipe					○		W	M	LC
67		Jack Snipe					○		W	M	LC
68		Black-winged Stilt	○		○	○			W	M	LC
69		Crab-Plover				○			W	M	LC
70		Lesser Black-backed Gull	○	○	○				WL	M	LC
71		Heuglin's Gull			○		○		WL	M	LC
72		Steppe Gull	○						WL	M	LC
73		Pallas's Gull	○	○	○	○			WL	M	LC
74		Brown-headed Gull	○	○	○	○	○	○	WL	M	LC
75		Slender-billed Gull	○	○		○	○		WL	M	LC
76		Black-headed Gull	○	○	○	○	○	○	WL	M	LC
77		Whiskered Tern	○	○	○	○	○	○	WL	M	LC
78		Caspian Tern	○	○	○	○	○	○	WL	M	LC
79		Gull-billed Tern	○	○	○	○	○	○	WL	M	LC
80		Common Tern	○	○	○			○	WL	M	LC
81		Little Tern	○	○	○	○	○	○	WL	M	LC
82		Saunders's Tern			○				WL	M	LC

Source: JICA Study Team

Table 3-11(2) Lists of the Identified Species at each point (Migratory Birds)

No.	Order	English Name	Location 1 (Sewri Jetty)	Location 2 (Sewri Bay)	Location 3 (Mahul Bay)	Location 4 (Seawoods)	Location 5 (Shivaji Nagar)	Location 6 (TS.Rehman)	Inhabiting Environment	Classification of migration	IUCN RL
83	Columbiformes	Rock Pigeon(Feral Pigeon)	○	○	○	○	○	○	WD	R	LC
84		Spotted Dove	○			○	○		WD	R	LC
85		Laughing Dove				○	○		WD	R	LC
86	Psittaciformes	Alexandrine Parakeet	○			○		○	WD	R	NT
87		Rose-ringed Parakeet	○	○	○	○		○	WD	R	LC
88	Cuculiformes	Southern Coucal	○			○		○	WD	R	LC
89		Asian Koel	○	○		○	○	○	WD	R	LC
90	Apodiformes	Little Swift			○				WD	R	LC
91		Asian Palm-Swift	○	○		○	○	○	WD	R	LC
92	Coraciiformes	Pied Kingfisher					○	○	WL	R	LC
93		Black-capped Kingfisher	○		○	○	○	○	WL	R	LC
94		White-throated Kingfisher	○	○	○	○	○	○	WL	R	LC
95		Common Kingfisher	○		○	○	○	○	WL	R	LC
96		Green Bee-eater	○	○		○	○	○	WD	R	LC
97		Blue-tailed Bee-eater				○	○		WD	M	LC
98		Indian Roller				○			WD	R	LC
99	Piciformes	Coppersmith Barbet	○	○		○		○	WD	R	LC
100	Passeriformes	Plain/Sand Martin(?)			○				WD	M/R	LC
101		Barn Swallow	○	○	○	○	○		WL	M	LC
102		Wire-tailed Swallow			○	○			WL	R	LC
103		Red-rumped Swallow				○	○		WD	R	LC
104		Dusky Crag Martin	○				○		WD	R	LC
105		Yellow Wagtail	○					○	WL	M	LC
106		Grey Wagtail	○						WL	M	LC
107		White Wagtail	○				○		WL	R	LC
108		White-browed Wagtail				○		○	WL	M	LC
109		Common Iora				○		○	WD	R	LC
110		Red-vented Bulbul	○		○	○	○	○	WD	R	LC
111		Red-whiskered Bulbul	○		○	○	○	○	WD	R	LC
112		White-eared Bulbul	○		○	○	○	○	WD	R	LC
113		Long-tailed Shrike	○			○	○		WD	R	LC
114		Bluethroat				○			WD	M	LC
115		Pied Bushchat				○			WD	R	LC
116		Oriental Magpie-Robin	○			○	○	○	WD	R	LC
117		Jungle Babbler					○		WD	R	LC
118		Yellow-eyed Babbler				○	○		WD	R	LC
119		Blyth's Reed-Warbler	○			○	○	○	WD	M	LC
120		Clamorous Reed-Warbler			○	○	○	○	WD	M	LC
121		Common Chiffchaff				○			WD	M	LC
122		Lesser Whitethroat	○						WD	M	LC
123		Common Tailorbird	○	○		○		○	WD	R	LC
124		Plain Prinia	○			○	○	○	WD	M	LC
125		Ashy Prinia	○		○	○	○	○	WD	R	LC
126		Red-breasted/Taiga Flycatcher				○			WD	M	LC
127		Indian Robin	○			○	○		WD	R	LC
128		Tickell's Blue Flycather						○	WD	R	LC
129		Common Rosefinch				○			WD	M	LC
130		Indian Silverbill	○						WD	R	LC
131		Red Avadavat					○		WD	R	LC
132		Scaly-breasted Munia	○			○			WD	R	LC
133		House Sparrow	○	○			○	○	WD	R	LC
134		Baya Weaver				○	○	○	WD	R	LC
135		Brahminy Starling					○		WD	R	LC
136		Common Myna	○	○		○	○	○	WD	R	LC
137		Pied Starling	○		○	○	○	○	WD	R	LC
138		Rosy Starling	○			○	○		WD	M	LC
139		Chestnut-tailed Starling				○			WD	M	LC
140		Indian Golden Oriole	○		○	○	○	○	WD	R	LC
141		House Crow	○	○	○	○	○	○	WD	R	LC
142		Indian(Large-billed) Jungle Crow	○	○	○	○	○	○	WD	R	LC
143		Purple Sunbird	○		○	○	○	○	WD	R	LC
144		Purple-rumped Sunbird	○	○		○	○	○	WD	R	LC
145		Vigor's Sunbird						○	WD	R	LC
146		White-spotted Fantail	○			○		○	WD	R	NE
147		White-browed Fantail				○		○	WD	R	LC
合計	15 Orders	147 Species	94 sp.	67 sp.	76 sp.	102 sp.	94 sp.	75 sp.	W : 48 sp. WL : 36 sp. WD : 63 sp.	R : 72 sp. M : 72 sp. M/R : 3 sp.	EN : 1 sp. VU : 3 sp. NT : 8 sp. LC : 134 sp. NE : 1 sp.

Source: JICA Study Team

3) Identified Condition of Principal Species

12 species (Lesser Flamingo, Woolly-necked stork, Painted Stork, Black-headed Ibis, Greater Spotted Eagle, Indian Spotted Eagle, Pallid Harrier, Great Knot, Black-tailed Godwit, Bar-tailed Godwit, Eurasian Curlew and Alexandrine Parakeet) of 147 species of birds identified in the field observations have been classified as NT or higher categories (EN: 1 sp., VU: 3 sp., NT: 8 sp.) in the IUCN Red List[1]. The other 135 species have been classified LC or NE which concerned degree of conservation is low.

About 11 species except for the lesser flamingos of the principal species2 identified in this survey, general biology and inhabiting situation within the survey area are shown in Table 3-12. And, Photographs of major principal species are shown in Table 3-13.

Table 3-12(1) General Biology and Inhabiting Situation of Principal Species

No.	Name	IUCN RL	Inhabiting Environment and General Biology	Inhabiting Situation within the Survey Area
1	Woolly-necked stork (Ciconia episcopus)	VU	It is a resident bird that belongs to the stork family. Wetlands including mudflats are main habitats. It is nesting in trees more than 10m height. Its principal foods are frogs, snakes, crabs and others.	1 individual was observed in Location 6 (TS. Rahaman) which is out of impact range of the project. Since there are colonies of storks including this species in the location, there is a possibility that the area around the location is used as a breeding field. Incidentally, inhabitation within the impact range of the project is not identified.
2	Painted Stork (Mycteria leucocephala)	NT	It belongs to the stork family. There are both individuals who migrate in the breeding season and individuals who breed here around Mumbai Bay. Wetlands including mudflats are main habitats. It breeds building a colony with other species in a forest close to the water. Its principal foods are frogs, snakes, crabs and others.	It is thought to use mudflats in the wide area of Mumbai Bay as feeding fields since individuals who have been foraging in the mudflats of all locations was observed. In Location 6 (TS. Rahaman) which is out of impact range of the project, there is a possibility that the area around is used as a breeding field because there are colonies of storks including this species. Incidentally, inhabitation within the impact range of the project is not identified.
3	Black-headed Ibis (Threskiornis melanocephalus)	NT	It is a resident bird that belongs to the ibis family. Wetlands including mudflats are main habitats. It gathers in groups in the breeding season, and nest on top of a high waterside tree. Its principal foods are small fishes and aquatic small animals.	As it was observed in the wide area of mudflats, it is thought to use mudflats in the wide area of the survey area as feeding fields. The individuals who act in groups at northern edge of Sewri mudflat and mangrove forest edge near the mouth of Mahul Creek were identified in the observation of May. Therefore, it is a possibility that mangrove forest around there is used as a breeding field. Incidentally, the individuals who act in a group were not observed within the impact range of the project.

Source: JICA Study Team

[1] It is a list of endangered wildlife by International Union for Conservation of Nature (IUCN). Depending on the endangered degree of the species, it has been classified into the following ranks in the high extinction risk order.
EX: Extinct, EW: Extinct in the Wild, CR: Critically Endangered, EN: Endangered, VU: Vulnerable,
NT: Near Threatened, LC: Least Concern, DD: Data Deficient

[2] The species classified as NT (Near Threatened) or higher categories in IUCN Red List are shown.

Table 3-12(2) General Biology and Inhabiting Situation of Principal Species

No.	Name	IUCN RL	Inhabiting Environment and General Biology	Inhabiting Situation within the Survey Area
4	Greater Spotted Eagle (Aquila clanga)	VU	It is a bird of prey that belongs to the hawk family, and migrates toward north in the breeding season. Forests in lowlands clos to wetlands are main habitats. It nests on high trees. It feeds on small mammals, birds in wetlands, frogs, snake and others.	Their flying the sky was observed in Location 2 (Sewri Bay) and 3 (Mahul Bay). It is considered to have been used the areas around Mumbai Bay as feeding fields during non-breeding season as it is a migratory bird.
5	Indian Spotted Eagle (Aquila hastata)	VU	It is a bird of prey that belongs to the hawk family, and migrates toward north in the breeding season. Cultivated lands and dry forests are main habitats. It nests on high trees. Although it mainly preys on mammals, it feeds on birds, frogs, snakes and others.	Their flying the sky was identified in Location 3(Mahul Bay). It is considered to have been used the area within the survey area as feeding fields during non-breeding season as it is a migratory bird.
6	Pallid Harrier (Circus macrourus)	NT	It is a bird of prey that belongs to the hawk family, and migrates toward north in the breeding season. Semi-dry areas grasslands are main habitats. It nests in the grass. It feeds on small mammals, birds, frogs, snake and others.	1 individual each was observed in Location 4 (Seawoods) and 5 (Shivaji Nagar).It is considered to have been used the area within the survey area as feeding fields during non-breeding season as it is a migratory bird.
7	Great Knot (Calidris tenuirostris)	EN	It is a wader that belongs to the snipe family, and migrates toward north in the breeding season. It inhabits mudflats, river mouths, sea coasts, riverbanks and paddy fields near sea coasts. It prey shellfishes, crustaceans, insects and others at sand mud, especially it is likely to eat shellfishes.	Their feeding at mudflats was observed in Location 2 (Sewri Bay) and 3 (Mahul Bay). It has been used the area within the survey area as feeding fields during non-breeding season as it is a migratory bird.
8	Black-tailed Godwit (Limosa limosa)	NT	It is a wader that belongs to the snipe family, and migrates toward north in the breeding season. It inhabits paddy fields, wetlands, mudflats, river mouths. It mainly feeds on insects, shellfishes, earthworms, sandworms and others.	Their feeding at mudflats was observed in Location 1 (Sewri Jetty), 2 (Sewri Bay), and 3 (Mahul Bay). It has been used the area around Sewri mudflat as feeding fields during non-breeding season as it is a migratory bird.
9	Bar-tailed Godwit (Limosa lapponica)	NT	It is a wader that belongs to the snipe family, and migrates toward north in the breeding season. It inhabits mudflats, sandbar of river mouths and sand beaches. It preys on crustaceans, sandworms, shellfishes and insects.	Their feeding at mudflats was observed in Location 2 (Sewri Bay) and 3 (Mahul Bay). It has been used the area around Sewri mudflat as feeding fields during non-breeding season as it is a migratory bird.
10	Eurasian Curlew (Numenius arquata)	NT	It is a wader that belongs to the snipe family, and migrates toward north in the breeding season. It inhabits river mouths and seaside mudflats. It preys on crabs, sandworms and others.	Their feeding at mudflats was observed in all locations except Location 6 (TS.Rahaman). It has been used the mudflats widely within the survey area as feeding fields during non-breeding season as it is a migratory bird.
11	Alexandrine Parakeet (Psittacula eupatria)	NT	It is a resident bird that belongs to the parrot family. It mainly inhabits lowland forests including mangrove forests, and nesting in hollows in a tree. It eats seeds, flowers, flower buds, fruits and vegetables.	It is a resident bird whose main habitats are woodlands. It is thought that it widely inhabits mangrove forests within the survey area as the individuals were observed in Location 1 (Sewri Jetty), 4 (Seawoods) and 6 (TS. Rahaman)

Source: JICA Study Team

Table 3-13 Identified major principal species

	
Painted Stork	Black-headed
	
Indian Spotted Eagle	Black-tailed Godwit
	
Great Knot	Eurasian Curlew

Source: JICA Study Team

3.2 Inhabiting Environments (Physical Surroundings) Survey

3.2.1 Mudflats Survey

(1) Methods

The survey of mudflats distribution was carried out by deciphering aerial photographs and field works to get to know the current situation of mudflats in Mumbai Bay. Details of the survey methods are shown in Table 3-14.

Table 3-14 Methods of the Survey (Mudflats)

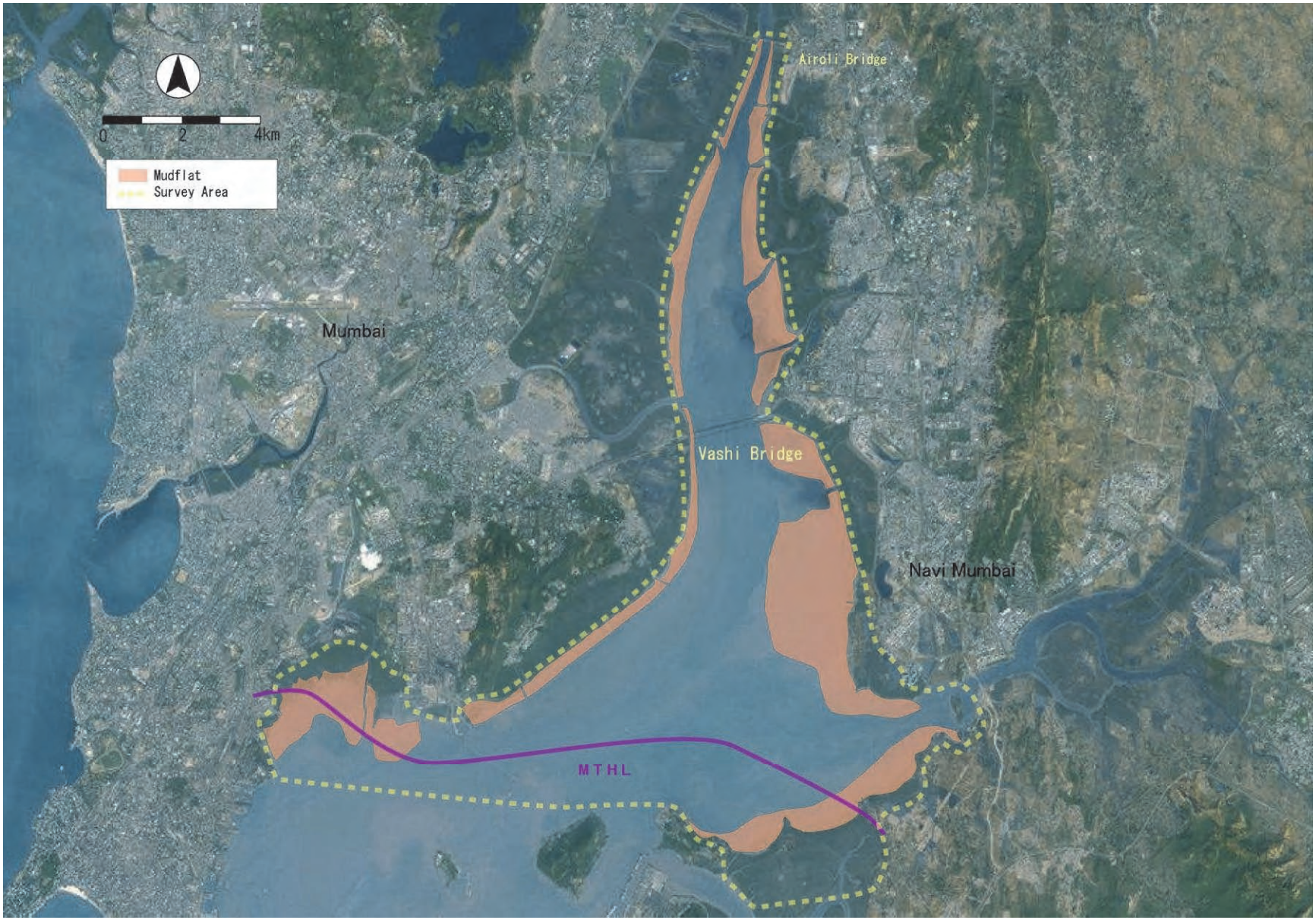
Objective	Situation of mudflat area in Mumbai Bay is grasped.
Target	Distribution of mudflats
Frequency	Once from February to May
Time	Basically daylight hours (for about 2 hours around the time of ebb)
Method	- Based on the latest aerial photographs, "interpretation manuscript map" was produced by hypostatizing the mudflats. - "The interpretation manuscript map" and aerial photographs (close-up photographs of the photographs computerized as needed) were carried, and distribution boundaries of the mudflats in the manuscript map were added or modified.
Location	The whole survey area, mainly in and around the project site (Sewri mudflat and Shivaji Nagar mudflat)

Source: JICA Study Team

(2) Results

Distribution of the mudflats confirmed through the survey is shown in Figure 3-12.

There are mudflats in the entire coastal zone within the survey area. In particular, it has spread to Seawoods area of Navi-Mumbai side.



Source: JICA Study Team

Figure 3-12 Result of the Survey (Mudflats)

3.2.2 Noise Survey

(1) Methods

Noise survey was carried out to get to know actual situation of noise around the project site and around the habitats of flamingos. Details of the survey methods are shown in Table 3-15.

Table 3-15 Methods of the Survey (Noise)

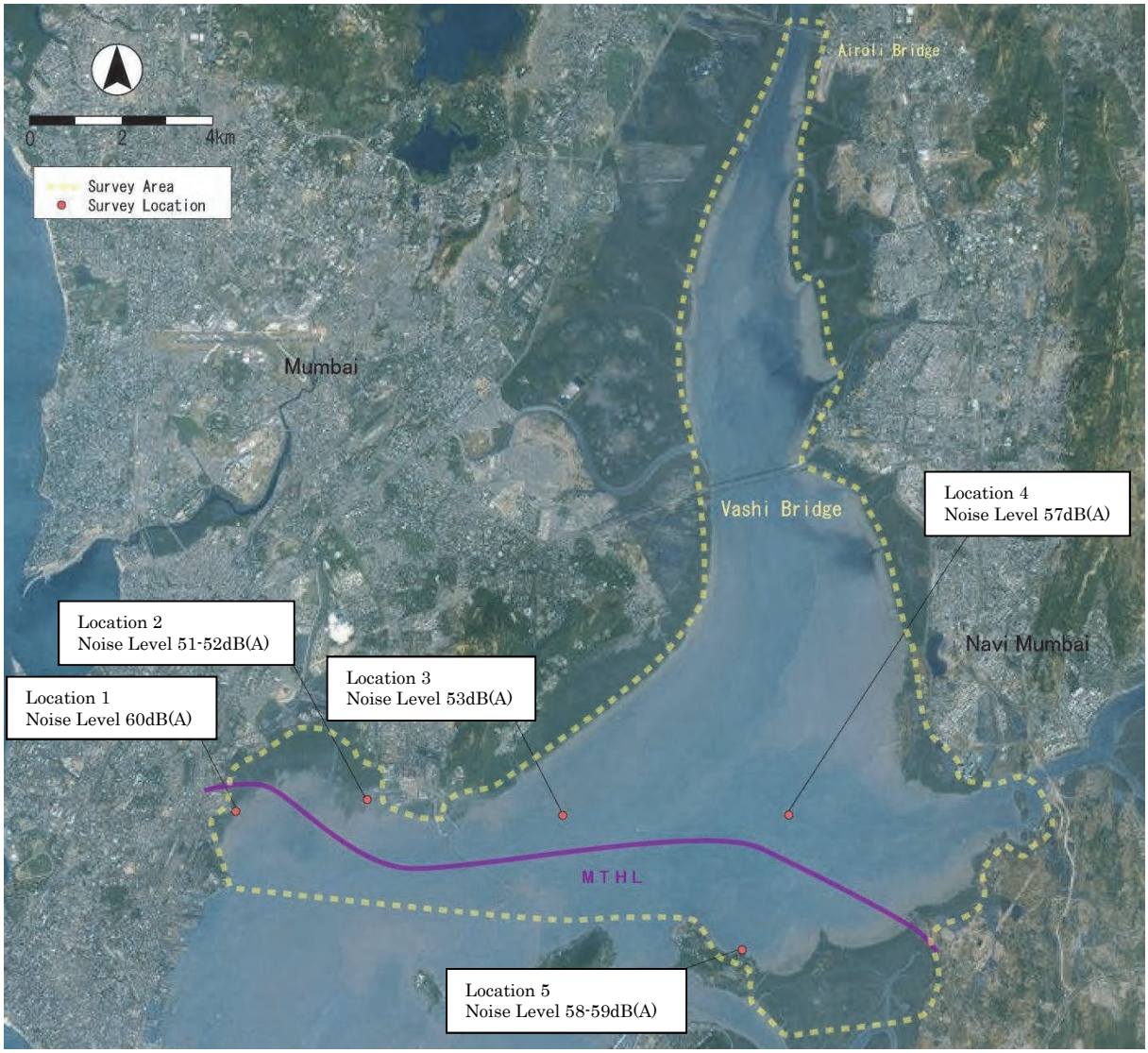
Objective	Actual situation of noise around the project site and around the habitats of flamingos is grasped.
Target	Background noise
Frequency	3 times in all on approximately a monthly basis from February to May with the counting survey.
Time	For 24 hours
Method	The measurements were carried out at 1.2m above the ground of the site boundary. Integration normal noise level meters were used and measure consecutively for 24 hours.
Location	5 points shown in Table 3-16

Source: JICA Study Team

Table 3-16 Overview of the Survey Points

Point No.	Latitude and Longitude	Measurement Date	Overview of the Point
Location 1 Sewri Jetty	18° 59' 48.20"N 72° 51' 59.33"E	4/3-4/4	It is located in a mudflat in Sewri area. The mudflat is feeding fields and roosts of flamingos at the moment.
Location 2 TATA Jetty	18° 59' 57.21"N 72° 53' 57.02"E	4/3-4/4 5/3-5/4	It is located near a cooling pond of TATA and near the current roosts of flamingos.
Location 3 Trombay	19° 01' 14.20"N 72° 57' 09.60"E	3/2-3/3	It is located nearby Trombay area which is feeding fields and roosts of flamingos at the moment.
Location 4 Seawoods	19° 01' 17.74"N 72° 57' 1.85" E	3/2-3/3	It is located nearby Seawoods area which is current feeding fields of flamingos.
Location 5 TS. Rahaman	18° 58' 2.29" N 72° 58' 4.96" E	4/3/4/4 5/12-5/13	It is located at a jetty in TS. Rahaman university. There is a possibility to be a habitat of flamingos in the future.

Source: JICA Study Team



Source: JICA Study Team

Figure 3-13 Location of the Survey Points (Noise)

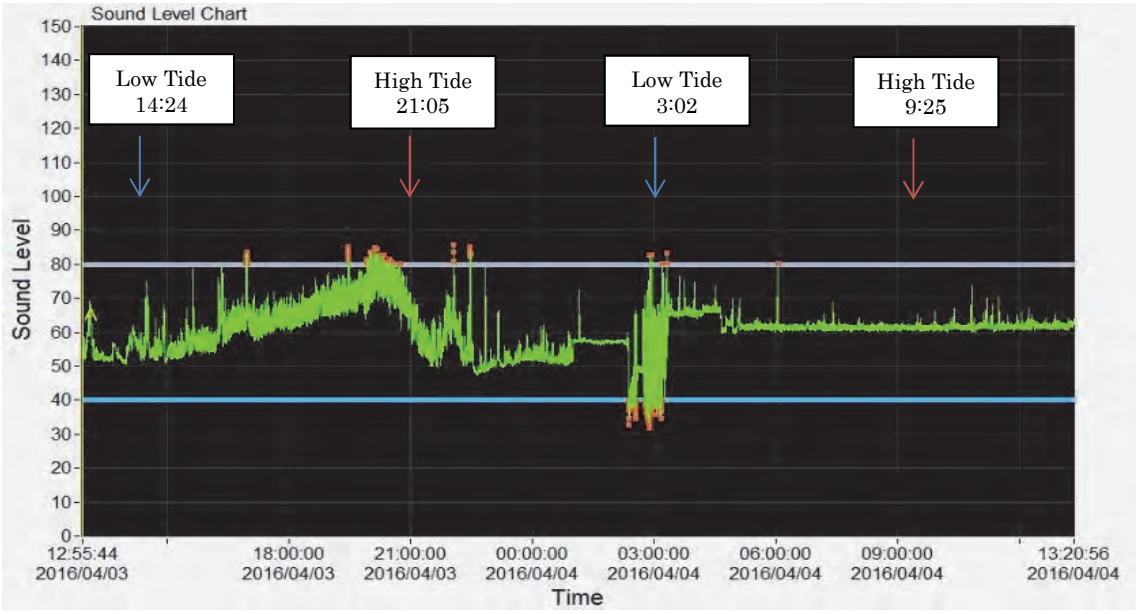
(2) Results

The results of noise measurements are shown in Figure 3-14 - Figure 3-18. Overviews of the results at each survey point are shown in Table 3-17.

Table 3-17 Results of the Survey (Noise)

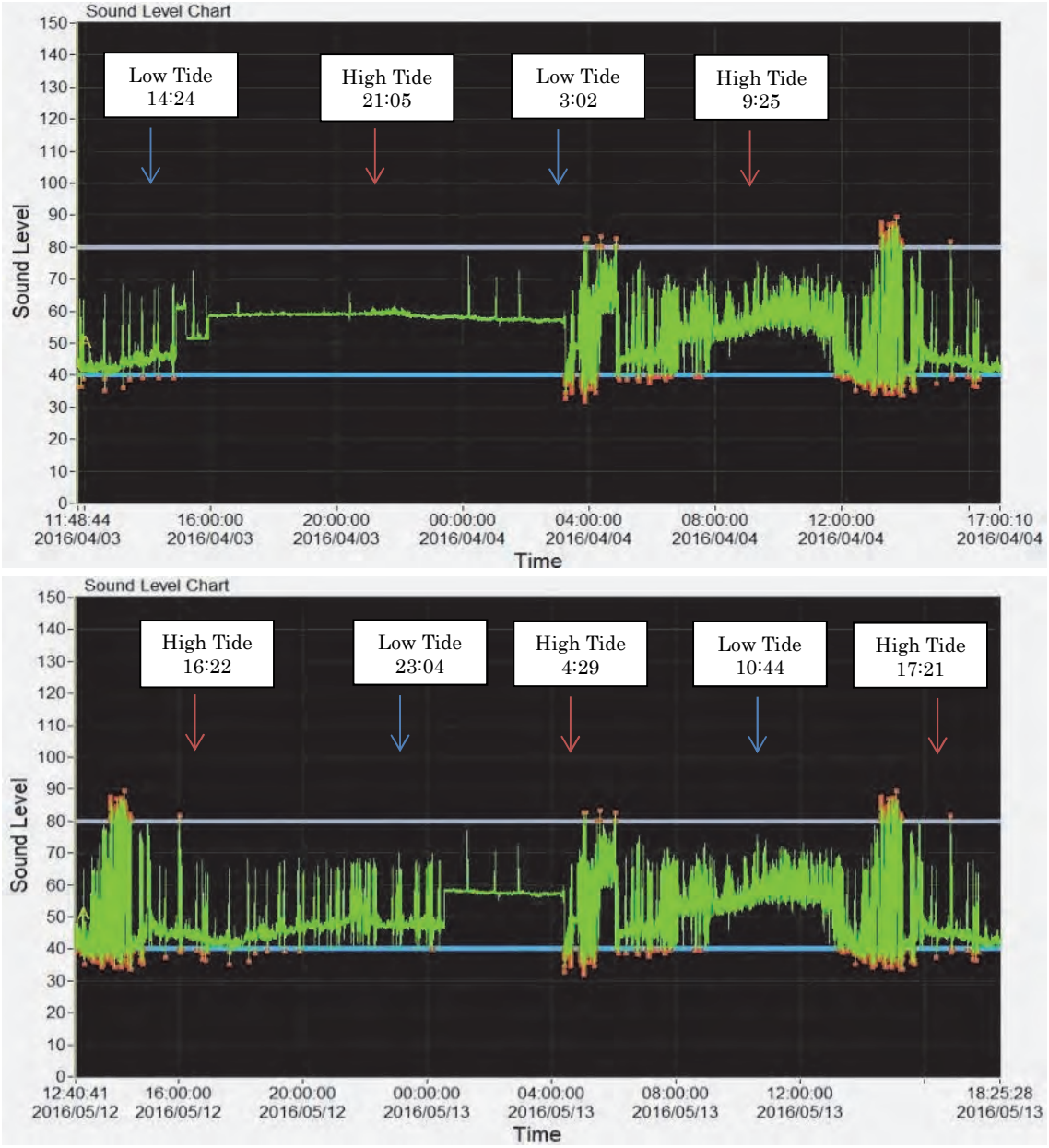
No.	Name	Date	Average Noise Level	Overview of the Results
Location 1	Sewri Jetty	4/2-4/3	60dB(A)	At the high tide on 2nd April, the noise exceeding 80 dB(A) was measured. It is considered that source of the noise were the passing of ships and others.
Location 2	TATA Jetty	4/2-4/3	52dB(A)	The noise fluctuates finely. In particular, at the measurement on May, the fluctuation tends to become large around the time of high tide. As this point is close to the roosts of flamingos, source of the sound is likely to be the flamingos flying to use the roosts.
		5/12-5/13	51dB(A)	
Location 3	Trombay	3/2-3/3	53dB(A)	The noise level is thought to always fluctuate between 40 dB(A) and 60 dB(A) because of wave sounds. It sometimes exceeds 80 dB(A) due to the passing of ships.
Location 4	Seawoods	3/2-3/3	57dB(A)	The noise level is stable at around 60 dB(A). No significant fluctuation was measured.
Location 5	TS.Rahaman	4/2-4/3	59dB(A)	The noise level is stable at around 60 dB(A). No significant fluctuation was measured.
		5/12-5/13	58dB(A)	

Source: JICA Study Team



Source: JICA Study Team

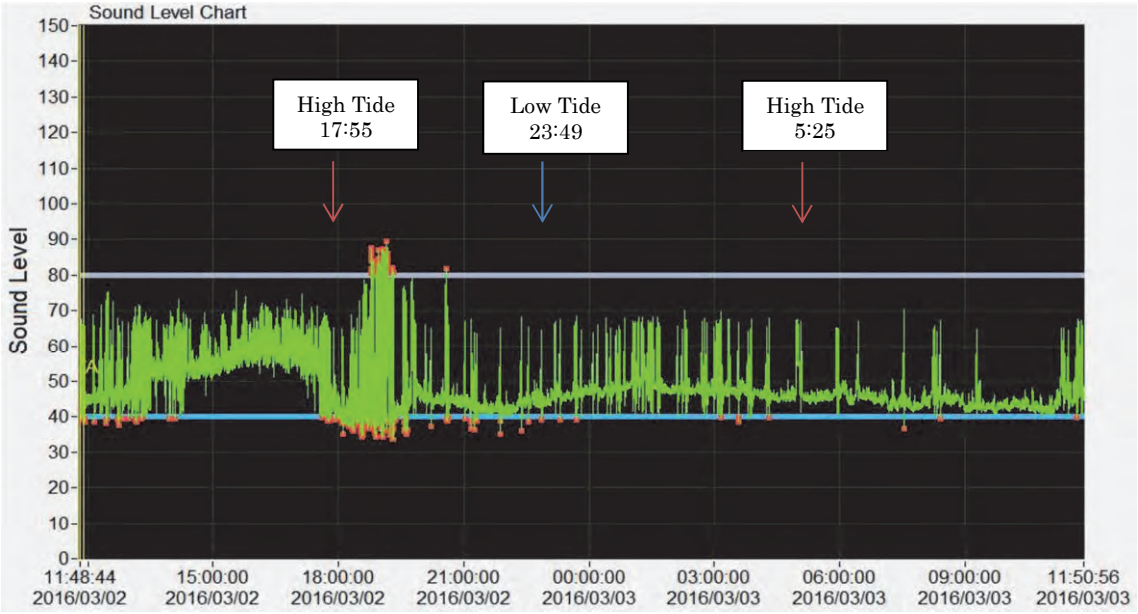
Figure 3-14 Results of the Noise Measurement at Location 1 Sewri Jetty (4/3-4/4)



Source: JICA Study Team

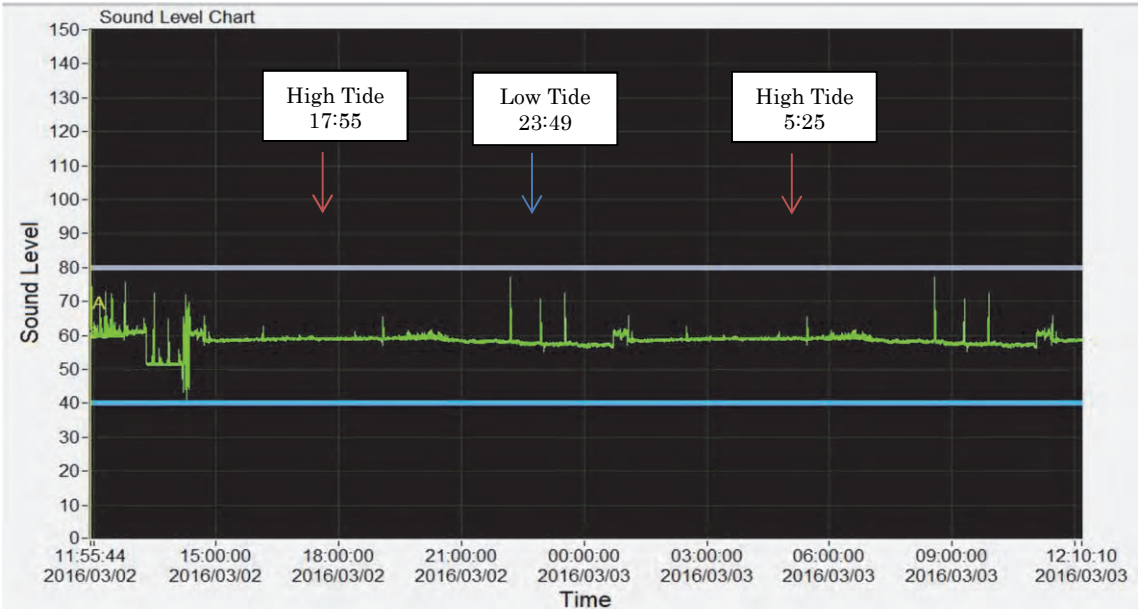
Figure 3-15 Results of the Noise Measurement at Location 2 TATA Jetty

(Upper Figure 4/3-4/4, Lower Figure 5/12-13)



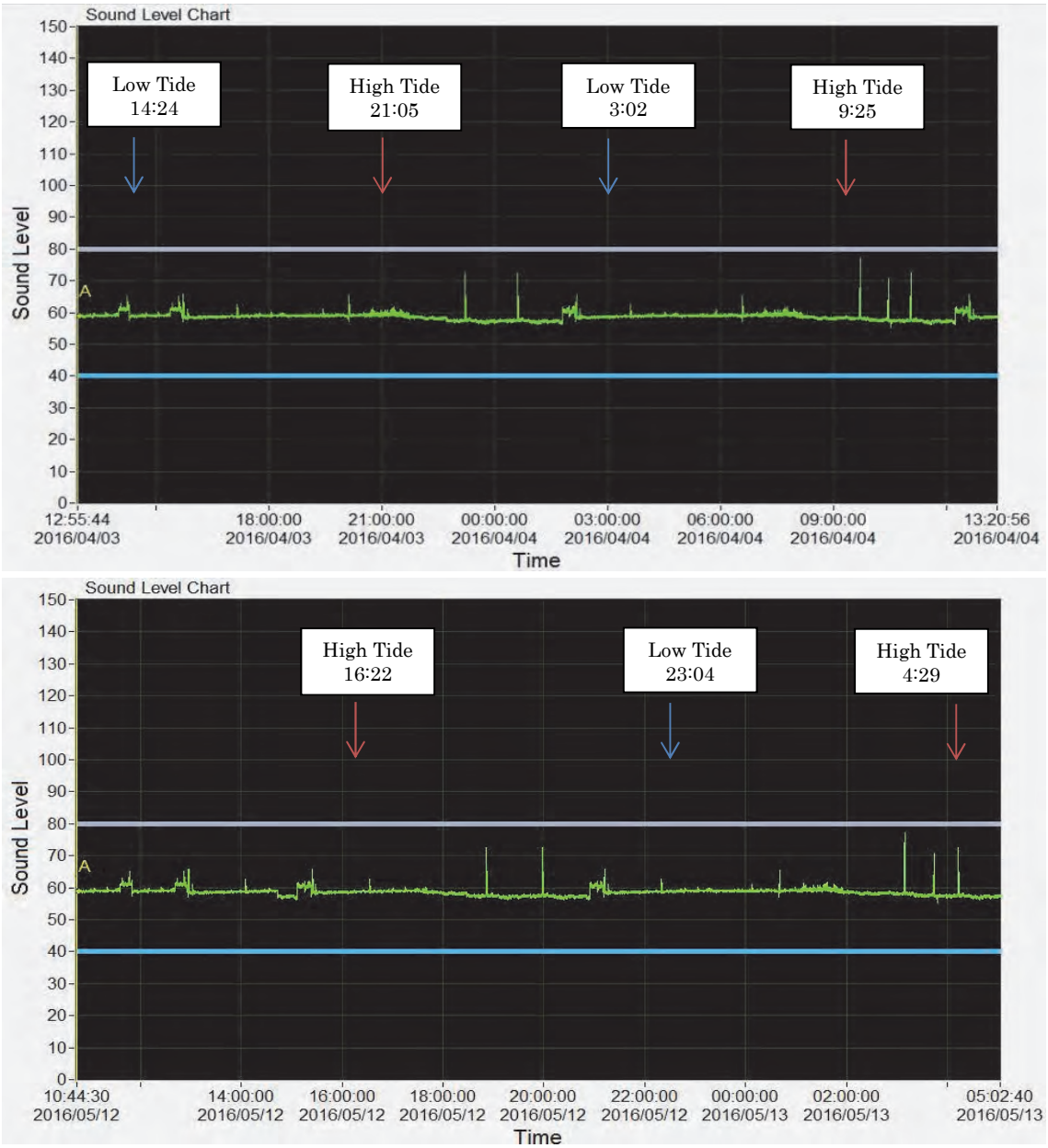
Source: JICA Study Team

Figure 3-16 Results of the Noise Measurement at Location 3 Trombay (3/2-3/3)



Source: JICA Study Team

Figure 3-17 Results of the Noise Measurement at Location 4 Seawoods Mudflat (3/2-3/3)



Source: JICA Study Team

Figure 3-18 Results of the Noise Measurement at Location 5 TS.Rahaman

(Upper Figure 4/3-4/4, Lower Figure 5/12-13)

3.3 Inhabiting Environments (Biota) Survey

3.3.1 Flora Survey

(1) Mangrove Distribution Survey

1) Methods

The survey of mangrove forest distribution was carried out by deciphering aerial photographs to get to know the current situation of mangrove forests in Mumbai Bay. Details of the survey methods are shown in Table 3-18.

Table 3-18 Methods of the Survey (Distribution of Mangrove Forests)

Objective	Distributional range of mangrove forests before the construction is grasped.
Target	Distribution of mangrove forests
Frequency	Once from February to May
Time	Basically daylight hours
Method	- Based on the latest aerial photographs, “interpretation manuscript map” was produced by hypostatizing the gathering of mangrove forests according to physiognomy of vegetation such as color, texture, height, density and others. - “The interpretation manuscript map” and aerial photographs (close-up photographs of the photographs computerized as needed) were carried, and distribution boundaries of the mangrove forests in the manuscript map were added or modified.
Location	Whole Mumbai Bay, mainly in and around the project site (Sewri mudflat and Shivaji Nagar mudflat)

Source: JICA Study Team

2) Results

The results of the survey of mangrove forest distribution are shown in Figure 3-19.

Mangrove forests in the survey area are mainly found around Sewri-Mahul mudflats, around Seawoods and around Shivaji Nagar.

Source: JICA Study Team

Figure 3-19 Result of the Survey (Distribution of Mangrove Forests)

(2) Mangrove Flora Survey

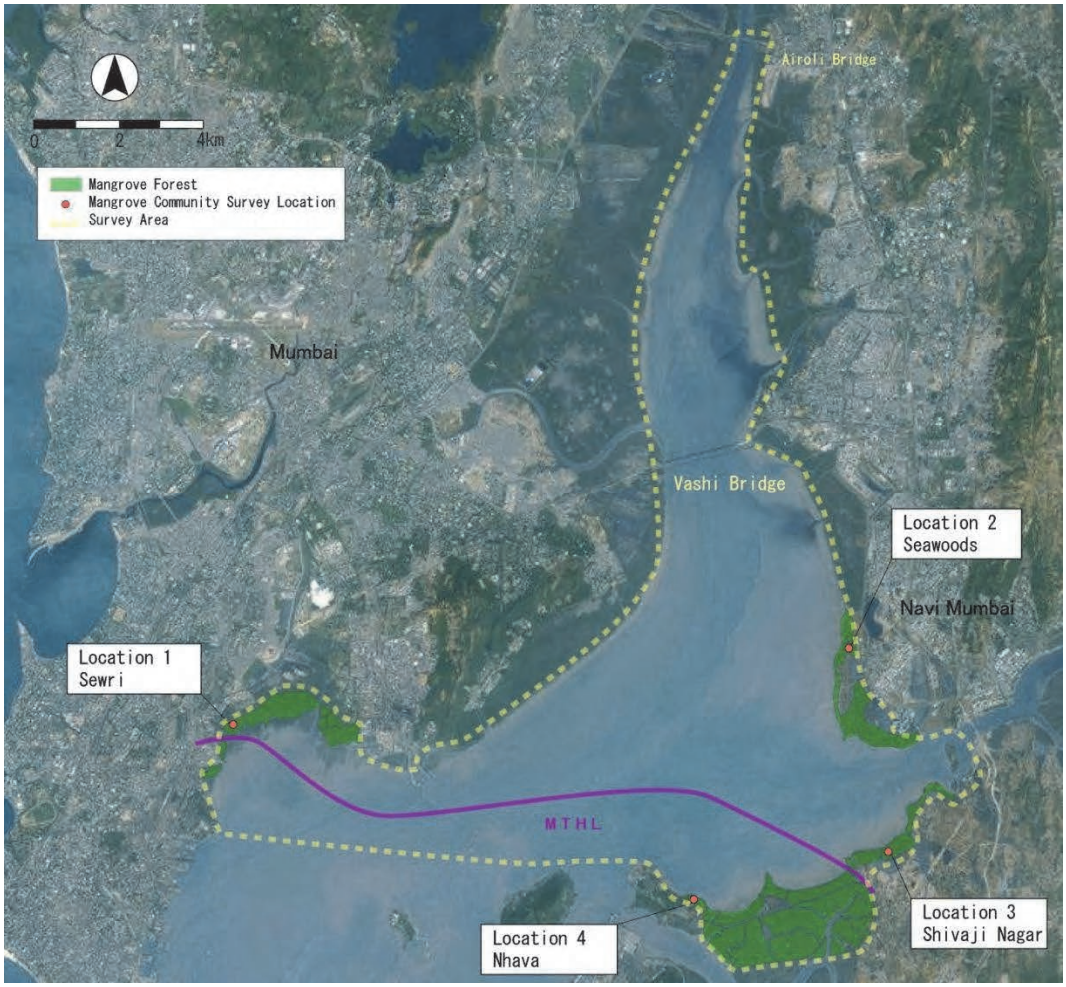
1) Methods

The survey of growth situation of mangrove forests was carried out by field observation to get to know the current situation of mangrove forest in Mumbai Bay. Details of the survey methods are shown in Table 3-19.

Table 3-19 Methods of the Survey (Mangrove Flora)

Objective	Growth situation of mangrove forests before the construction is grasped.
Target	Growth situation of mangrove forests
Frequency	Once from February to May
Time	Basically daylight hours
Method	The species were identified by field observations in the ranges of about 100m * 100m which represent each area.
Location	4 points shown in Figure 3-20.

Source: JICA Study Team



Source: JICA Study Team

Figure 3-20 Location of the Survey Points (Mangrove Flora)

2) Results

A list of the identified species of Mangrove in the survey of growth situation of mangrove forests is shown in Table 3-20.

The identified mangrove at 4 survey points was 12 species. Looking at each point, the most diverse mangrove species as 12 species were observed in Location 2 (Seawoods). On the other hand, mangrove forests in Location 1 (Sewri) take on simple mangrove flora consisting of 1 species of *Avicennia Marina*.

Table 3-20 A List of the Identified Species of Mangrove

No.	Order	Scientific Name	Location 1 Sewri	Location 2 Seawoods	Location 3 Shivaji Nagar	Location 4 Nhava	IUCN RL
1	Acanthaceae	*Acanthus Ilicifolius*		○	○	○	LC
2		*Avicennia Marina*	○	○	○		LC
3	Myrsinaceae	*Aegiceras Corniculatum*		○			LC
4	Lythraceae	*Sonneratia Alba*		○	○	○	LC
5		*Sonneratia Apetala*		○		○	LC
6	Euphorbiaceae	*Excoecaria Agallocha*		○	○	○	LC
7	Salvadoraceae	*Salvadora Persica*		○	○		NE
8	Amaranthaceae	*Suaeda Maritima*		○	○		NE
9	Aizoaceae	*Sesuvium Portulacastrum*		○	○		LC
10	Poaceae	*Aeluropus Lagopoides*		○	○		LC
11	Fabaceae	*Derris Heterophyla*		○	○		LC
12	Lamiaceae	*Clerodendron Inerme*		○	○		LC
Total	10 orders	12 species	1 species	12 species	10 species	4 species	LC:10sp. NE:2sp.

Source: JICA Study Team

3.3.2 Fauna Survey

(1) Fishes Fauna Survey

1) Methods

Fishes Survey by field works was carried out to get to know current situation of inhabitation of fishes in Mumbai Bay before the construction. Details of the survey methods are shown in Table 3-21.

Table 3-21 Methods of the Survey (Fishes)

Objective	Fishes fauna in marine area in and around the project site before the construction is grasped.
Target	General fishes
Frequency	Once from February to May
Time	Basically daylight hours
Method	- Caught fishes by seine nets using ships were identified their species. - Mudskippers which are on the mud surface of the mudflat at low tide were verified.
Location	2 points around the project site shown in Figure 3-21

Source: JICA Study Team

Source: JICA Study Team

Figure 3-21 Location of the Survey Points (Fishes)

2) Results

A list of the identified species in the fish survey is shown in Table 3-22.

35 species of fishes were identified in the field works. All identified fishes were the species which live in brackish water or marine water. As the species whose habitats depend on mudflats, Goggle-eyed goby (*Boleophthalmus* genus), Mudskipper (*Periophthalmus variablis* and *Scartelaos histophorus*) and others were observed. 3 species as *Scoliodon laticaudus* (spadenose shark), *Himantura bleekeri* and *Himantura gerrardi* fall into NT (Near Threatened) or higher categories in IUCN Red List. All of these species are cartilaginous fishes whose habitats are mainly marine area.

Table 3-22 A List of the Identified Fishes

No.	Class	Order	Family	Scientific Name	IUCN RL
1	Chondrichthyes	Carcharhiniformes	Carcharhinidae	*Scoliodon laticaudus*	NT
2		Rajiformes	Dasyatidae	*Himantura bleekeri*	VU
3				*Himantura gerrardi*	VU
4	Actinopterygii	Elopiformes	Elopidae	*Elops saurus*	LC
5		Anguilliformes	Congridae	*Conger cinereus*	NE
6			Muraenidae	*Gymnothorax pseudothyrsoideus*	NE
7		Clupeiformes	Clupeidae	*Tenualosa ilisha*	LC
8			Engraulidae	*Coilia dussumieri*	NE
9				*Thryssa mystax*	LC
10		Siluriformes	Bagridae	*Mystus seenghala*	NE
11		Aulopiformes	Synodontidae	*Harpadon nehereus*	NE
12		Mugiliformes	Mugilidae	*Chelon macrolepis*	LC
13				*Mugil cephalus*	LC
14		Perciformes	Latidae	*Lates calcarifer*	NE
15			Terapontidae	*Terapon jarbua*	LC
16			Carangidae	*Megalaspis cordyla*	NE
17				*Parastromateus niger*	NE
18			Gerreidae	*Gerres filamentosus*	LC
19			Sparidae	*Argyrops spinifer*	LC
20			Sciaenidae	*Johnius soldado*	NE
21				*Sciaena dussumierii*	NE
22			Scatophagidae	*Scatophagus argus*	LC
23			Cichlidae	*Tilapia mosambica*	NE
24			Polynemidae	*Polynemus tetradactylus*	NE
25			Gobiidae	*Boleophthalmus boddarti*	LC
26				*Boleophthalmus dussumieri*	NE
27				*Periophthalmus variablis*	NE
28				*Scartelaos histophorus*	NE
29			Trichiuridae	*Lepturacanthus savala*	NE
30			Scombridae	*Euthynnus affinis*	LC
31				*Rastrelliger kanagurta*	DD
32			Stromateidae	*Stromateus argenteus*	NE
33			Priacanthidae	*Priacanthus hamrur*	NE
34		Pleuronectiformes	Cynoglossidae	*Cynoglossus macropepidotus*	NE
35		Tetraodontiformes	Tetraodontidae	*Tetraodon nigroviridis*	NE
Total	2 classes	11 orders	26 families	35 species	VU :2 sp. NT :1 sp. DD :1 sp.

Source: JICA Study Team

(2) Benthos Fauna Survey

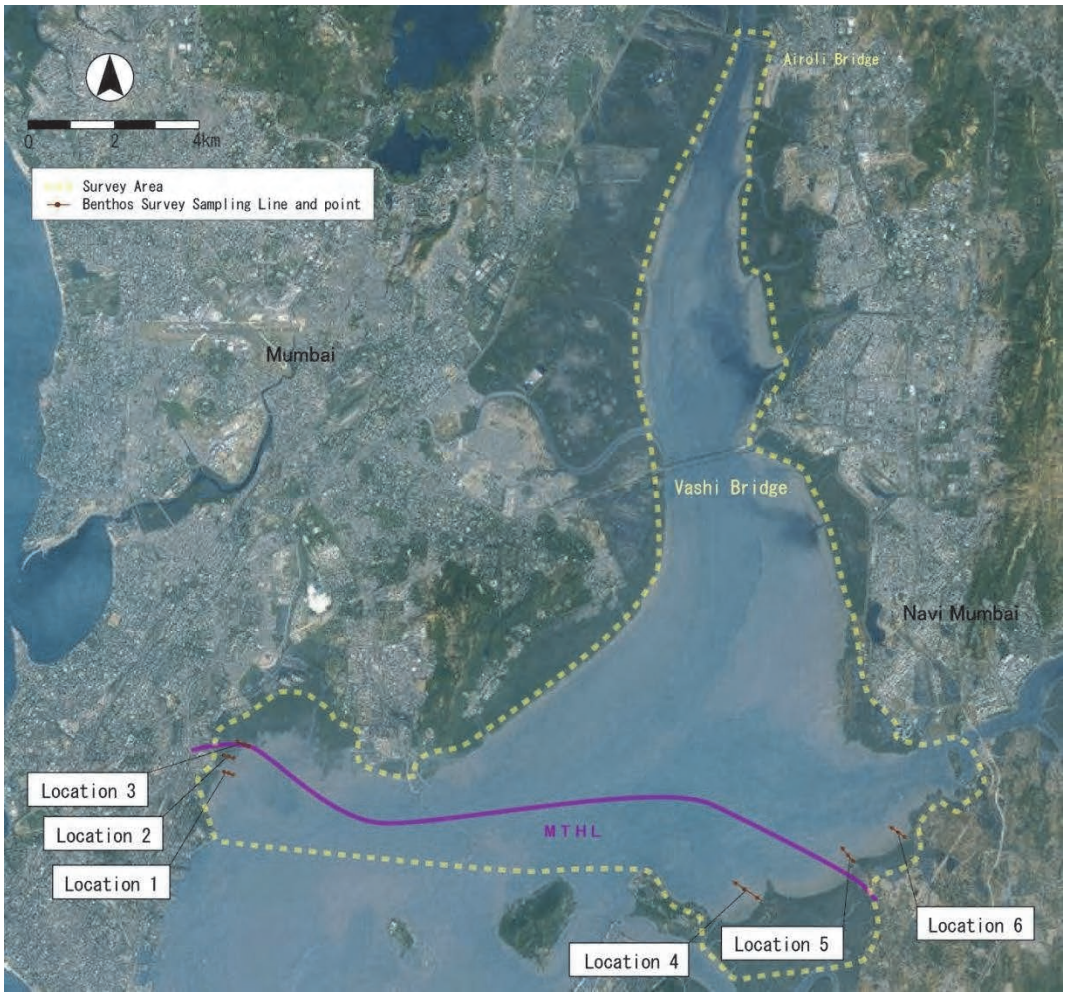
1) Methods

Benthos Survey by field works was carried out to get to know current situation of inhabitation of benthos in mudflats before the construction. Details of the survey methods are shown in Table 3-23.

Table 3-23 Methods of the Survey (Benthos)

Objective	Benthos fauna and the volume of inhabitation in marine waters in and around the project site before the construction are grasped.
Target	General Benthos
Frequency	Once from February to May
Time	At low tide
Method	- 25-square-cm patch of quadrates were set up. Crabs and other benthic animals that live in the mud of the surface layer (within 10cm depth) were collected with the mud. The collected mud was strained sand and mud through a 0.5mm-eyes sieve to extract macrobenthos. - Core samples of mud (diameter 3.5cm* depth 5cm) were collected to understand meiobenthos communities. - Collected samples were fixed with 8% Rose Bengal formalin solution.
Location	3 lines each in Sewri mudflat side and Shivaji Nagar mudflat side (shown in Figure 3-22) Samplings were conducted at 3 points (1 point each in high, middle and low tide area) on each line.

Source: JICA Study Team



Source: JICA Study Team

Figure 3-22 Location of the Survey Points (Benthos)

2) Results

a) Macrobenthos

The results of analysis of macrobenthos are shown in Table 3-24.

Macrobenthos fauna at each point is largely consisting of Polychaetes such as sandworm and Gastropods such as snails mainly.

Table 3-24 Inhabiting Density of Macrobenthos (Population/10cm^2)

No.	Taxon	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6	Average	Composition Ratio (%)
1	Polychaetes	44	23	62	89	78	71	61	22
2	Gastropods	567	244	73	88	89	159	203	72
3	Cumceans	0	1	0	0	0	0	0	0
4	Bivalves	9	7	12	0	6	18	9	3
6	Cnidarians	0	1	0	2	0	4	1	0
7	Oligochaetes	0	0	1	4	0	1	1	0
8	Mysids	6	1	0	2	0	1	2	1
9	Others	0	0	22	0	4	0	4	2
	Total	626	277	170	185	177	254	282	100

Source: JICA Study Team

b) Meiobenthos

The results of analysis of meiobenthos are shown in Table 3-25.

About meiobenthos fauna, nematodes were dominant in all of the survey points. In addition, taxon identified the most next to nematodes was copepods which are major food of greater flamingos. In particular, the inhabiting density at Location 2 and 5 were higher.

Table 3-25 Inhabiting Density of Meiobenthos (Population/10cm^2)

No.	Taxon	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6	Average	Composition Ratio (%)
1	Nematodes	1102	211	56	321	1527	137	559	83
2	Copepods	23	125	44	0	327	54	96	14
3	Polychaetes	0	2	12	0	5	0	3	0
4	Turbellarians	0	3	11	0	0	0	2	0
5	Nemertins	0	1	0	0	0	0	0	0
6	Foraminifera	7	0	21	0	9	15	9	1
7	Kinorynchs	0	1	0	0	0	2	1	0
8	Halacarids	1	0	0	0	0	1	0	0
9	Others	0	2	0	2	0	0	1	0
	Total	1133	345	144	323	1868	209	670	100

Source: JICA Study Team

(3) Plankton Survey

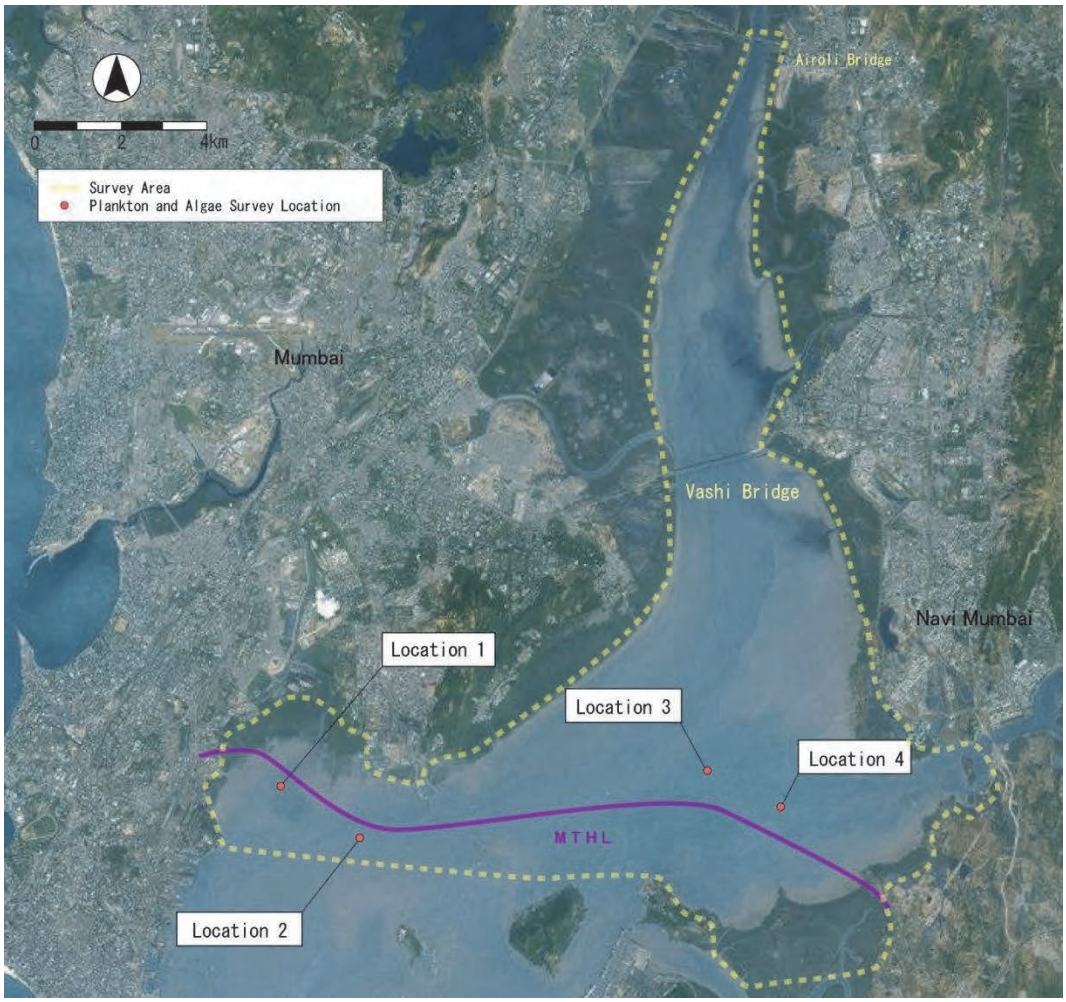
1) Methods

Plankton Survey by field works was carried out to get to know current situation of zooplankton and phytoplankton in Mumbai Bay before the construction. Details of the survey methods are shown in Table 3-26.

Table 3-26 Methods of the Survey (Plankton)

Objective	The situation of feeding environments of migratory birds such as flamingos before the construction is grasped.
Target	Phytoplankton, Zooplankton and Algae
Frequency	Once from February to May
Time	Basically daylight hours
Method	(1) Zooplankton - MARUKAWA's quantitative plankton nets or equivalent plankton nets were used for samplings. - The plankton nets were pulled horizontally about 3 times at approximately 0.5m/s speed. Flow meters were installed in the nets, and the volume of filtered water was recorded. - Neutral formalin or alcohols were used for fixing in the fields. (2) Phytoplankton - Sampling was from one layer of surface layer (0.5m). 1 liter of water was sampled and held in polyethylene bottles. - Neutral formalin or acid/neutral Lugol's solution were used for fixing in the fields. Additive amount of neutral Lugol's solution became approximately 1% of density. The samples which were not fixed at the fields were kept cold and taken to the laboratory.
Location	4 points around the project site (Shown in Figure 3-23)

Source: JICA Study Team



Source: JICA Study Team

Figure 3-23 Location of the Survey Points (Plankton)

2) Results

a) Zooplankton

The results of analysis of zooplankton are shown in Table 3-27.

In regard of composition ratio of zooplankton, copepods which are major foods of greater flamingos were dominant at all of the survey points. Especially, the inhabiting density was higher at Location 1 and 3.

Table 3-27 Inhabiting Density of Plankton (Population/ml)

No.	Taxon	Location1	Location2	Location 3	Location 4	Average	Composition Ratio (%)
1	Copepods	530	123	835	290	445	64
2	Cladocerans	25	11	0	36	18	3
3	Amphipods	26	0	0	5	8	1
4	Zoea Larvae	8	17	29	0	14	2
5	Ostracodes	0	124	36	43	51	7
6	Foraminifera	44	0	7	21	18	3
7	Appendicularians	2	0	1	0	1	0
8	Nauplii	2	0	0	0	1	0
9	Veliger Larvae	36	233	8	61	85	12
10	Ctenophora	21	0	0	7	7	1
11	Mysid	75	31	0	8	29	4
12	Fish eggs	0	19	64	0	21	3
	Total	769	558	980	471	695	100

Source: JICA Study Team

b) Phytoplankton

The results of analysis of phytoplankton are shown in Table 3-28.

In regard of composition ratio of phytoplankton, dominant species differed depending on the points. The dominant species were centric diatoms at Location 1, centric diatoms and blue-green algae at Location 2 and 3, and pinnate diatoms and dinoflagellates at Location 4.

Of the algae, spirulina which is major food resource of lesser flamingos belongs to blue-green algae. As regards blue-green algae, growth density was slightly higher at Location 2 and 3.

Table 3-28 Results of Analysis of Phytoplankton (the Number of Cells/L)

No.	Taxon	Location1	Location2	Location 3	Location 4	Average	Composition Ratio (%)
1	Centric Diatoms	782	534	346	185	462	33
2	Pinnate Diatoms	172	108	370	660	328	24
3	Dinoflagellates	384	174	103	441	276	20
4	Blue-green algae	211	536	377	167	323	23
	Total	1549	1352	1196	1453	1388	100

Source: JICA Study Team

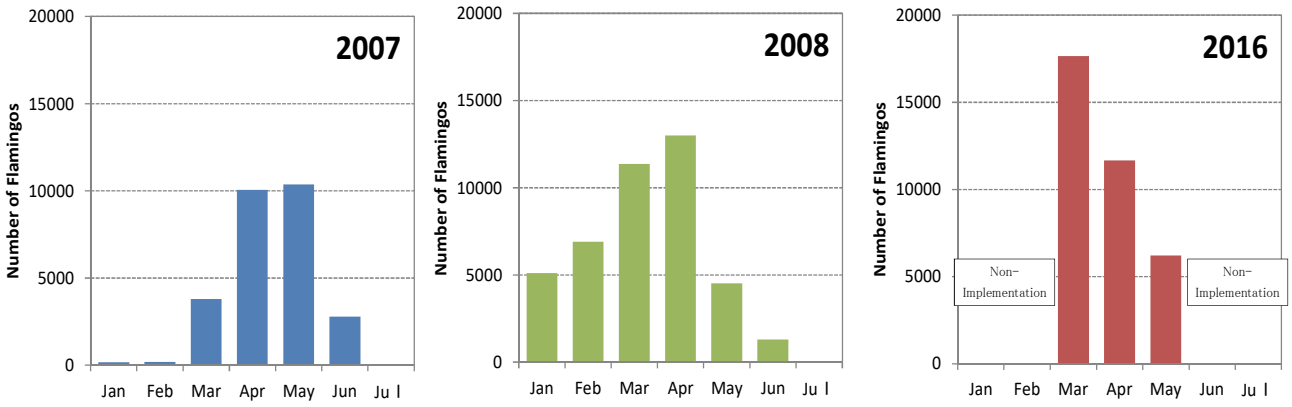
4. Summary of the Survey Results

4.1 Inhabitation of Flamingos and Impacts of the Project

(1) Interannual Inhabiting Situation

Figure 4-1 shows the identified statuses over time of lesser flamingos in Sewri mudflat where the most number of individuals were identified.

According to a previous study (Mumbai Trans Harbour Link Project Study of Flamingo and Migratory Birds Final Report 2008 December (Salim Ali Centre for Ornithology and Natural History), flying peak of flamingos was from April to May in 2007 and 2008. In contrast, the number of identified individuals in this survey became maximum from February to March (implemented in 2/29 - 3/3). There is a possibility that flying peak of this year was early in comparison with usual years. On the other hand, the identified number at peak period is 10,000 to 20,000 which is in common with the previous study. For this reason, it is considered that there is no significant change in the population.



Source: JICA Study Team

Figure 4-1 Identified Statuses Over Time of Lesser Flamingos in Sewri Mudflat

Note 1: The results of a previous study were quoted from Mumbai Trans Harbour Link Project Study of Flamingo and Migratory Birds Final Report 2008 December (Salim Ali Centre for Ornithology and Natural History).
Note 2: Although the number of flamingos in whole Sewri mudflat has been counted in both the previous study and this survey, the observation points are different.
Note 3: The observations were carried out in several days of each month in both the previous study and this survey. The value indicates the average value of the day in the month.

(2) Reaction to Human Activities and Characteristic Behavior

In this survey, not only the populations of flamingos, their flying routes and their roosts were investigated, but also avoidance behavior to human activities and mating behavior of flamingos were supplementary recorded. Details of these behaviors are shown below.

1) Avoidance Behavior to Human Activities

Simple measurements of noise, observation of reaction to the noise and observation of avoidance behavior against the presence of the observer were implemented at Airoli Bridge which is adjacent to the habitats of flamingos and where road traffic noise is generated, to get to know their avoidance behavior against noise and human activities.

a) Reaction to Noise

On Airoli Bridge, the noise of more than 80 dB(A) was measured due to the passage of vehicles. However, the lesser flamingos were foraging at the point of a distance of about 20m from the bridge regardless of the presence/absence of vehicles passing. Their behavior changes were not observed.

Lesser Flamingos foraging around Airoli Bridge

Source: JICA Study Team

b) Reaction to the Presence of the Observers

Although there is a sidewalk on Airoli Bridge, the passage of pedestrians is rare as 1 person per 1 hour. In the timing when there is no passerby for about 1 hour, the observers walked on the bridge so that the flamingos can see them. As a result, the flamingos showed actions away from the bridge by walking, and started feeding again at 100m away from the bridge.

Similar avoidance behaviors were observed at the roosts in Seawoods and Location 3 (Mahul Creek) of the counting survey. At the roosts in Seawoods, when the individuals waiting at the roost recognized the observers, they moved to 100m away. In addition, although the flamingos were foraging in entire area of mudflats at Location 3 (Mahul Creek), they were not feeding in the range of 100m from the range that they can visually recognize personnel of boring survey works.

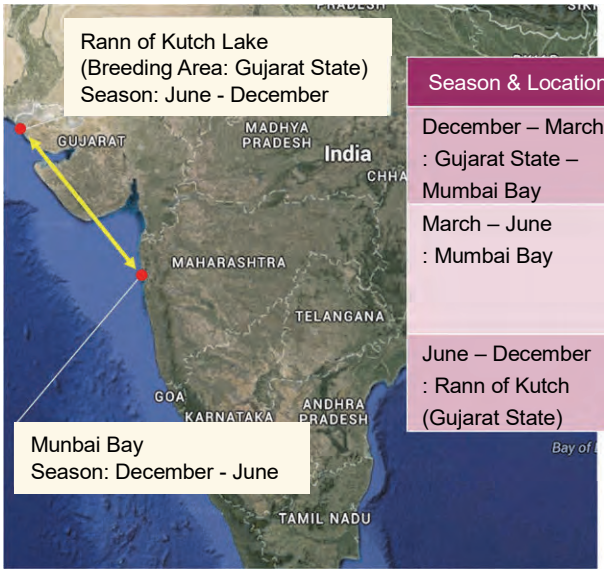
Action away from the observer to the radius 100 circular observed at the roosts in Seawoods

Avoidance behavior against boring works observed in Location 3 (Mahul Creek)

Source: JICA Study Team

2) Mating Behavior

It is known that the lesser flamingos in Mumbai Bay are flying from a breeding area between December to March, stay until May or June, and then flying to the breeding area again (Figure 4-2). The breeding area has been estimated to be Rann of Kutch in Gujarat State[3]. From May to June when they are towards the breeding area, the mating behavior to pair up male with female is observed. This behavior is that the male becomes in a group and marches with raising the heads. In this survey, the mating behaviors of the lesser flamingos were observed in the counting survey on May at 3 points of Location 2 (Sewri Bay), 3 (Mahul Bay) and 7 (Airoli Bridge).



Season & Location	Behavior
December – March : Gujarat State – Mumbai Bay	- Flying from the Breeding Area - Foraging
March – June : Mumbai Bay	- Foraging - Mating Behabior (May) - Moving to the Breeding Area (June)
June – December : Rann of Kutch (Gujarat State)	- Breeding

Source: JICA Study Team

Figure 4-2 Annual Movement of the Lesser Flamingos in Mumbai Bay

The Mating Behavior observed in Location 2 (Sewri Bay)

The Mating Behavior observed in Location 3(Mahul Bay)

Source: JICA Study Team

[3] Reference from Vijayan, L., Somasundaram, S., Zaibin, A. P., and Nandan, B. 2009 Population and habitat of the Lesser Flamingo Phoeniconaias minor in Thane Creek, Mumbai, India. Flamingo 18:58-61.

(3) Summary of the Inhabiting Situation of Lesser Flamingos in the Survey Area

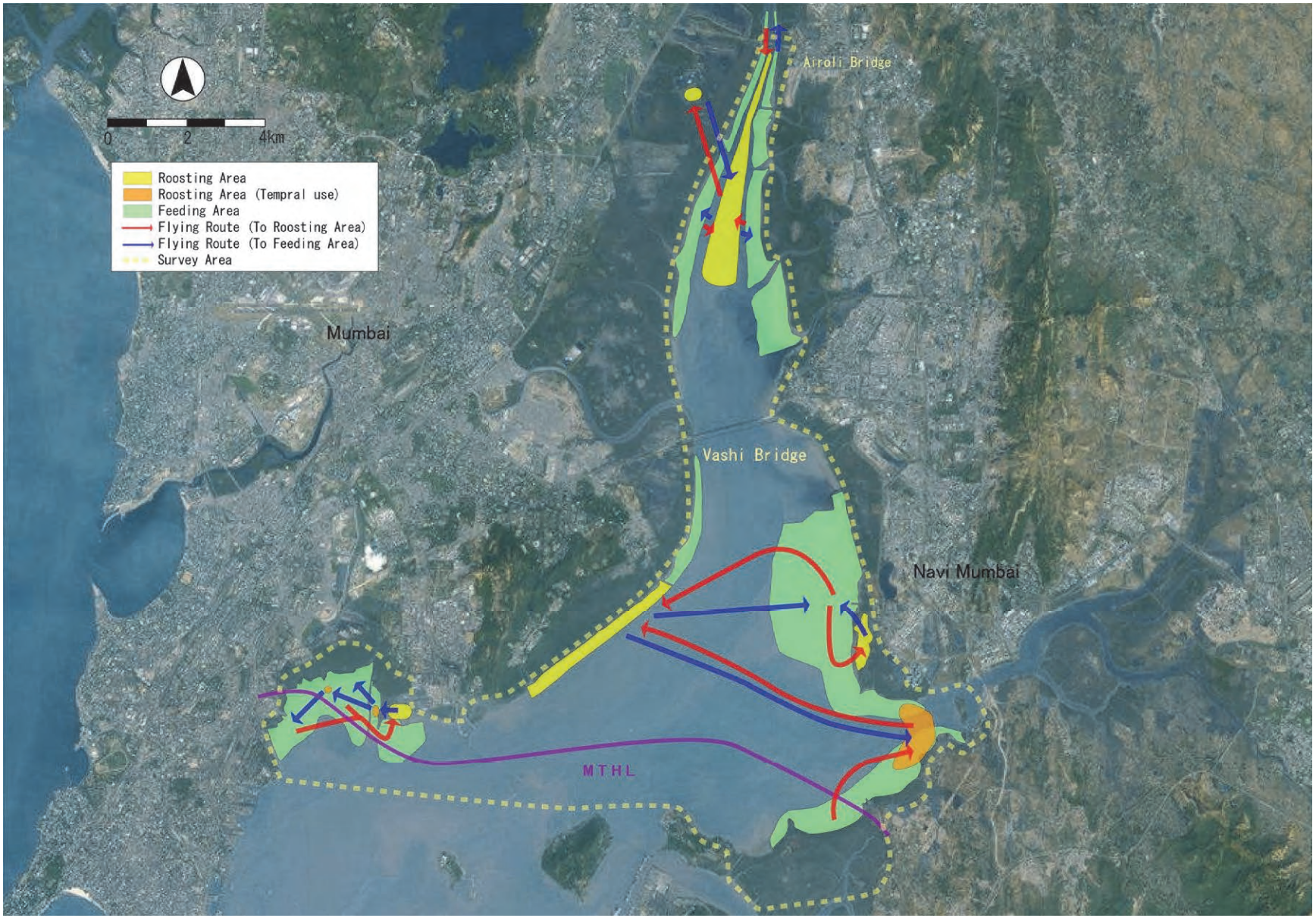
As a result of the survey, it became clear that lesser flamingos living in Mumbai Bay perform daily movement. The flamingos take their feeds when mudflats appeared on the water at low tide depending on the habitats. Then, they move to particular roosts when the mudflats are submerged becoming high tide.

Moving routes of lesser flamingos in the survey area are different depending on mudflats where they use as feeding fields. The population is separated into the following three large groups, 1) a group using Sewri-Mahul mudflats, 2) a group using mudflats in wide area around Trombay - Shivaji Nagar, and 3) a group using mudflats between Vashi Bridge and Airoli Bridge. Relating to these 3 groups, inhabiting situation of the lesser flamingos is shown in Table 4-1, and diagram of using pattern of their habitats is shown in Figure 4-3.

Table 4-1 Overviews of Inhabiting Situation of Flamingos in Mumbai Bay

No.	Group	Feeding Field (Habitat when the mudflat have appeared)	Roost (Habitat when the mudflat are submerged)	Population and Density
1	Sewri-Mahul	Sewri-Mahul mudflats	Pond in TATA power plant	There are high density areas more than 5,000 individuals/km^2 . In the area where the flamingos have been identified over time, it is thought that the population of the flamingos is equal to or slightly larger than it in 2008 when the past study was carried out. In this point, mating behavior has been observed at the third observation (in May).
2	Trombay - Shivaji Nagar	- Trombay mudflat - Seawoods mudflat - Shivaji Nagar mudflat	- Trombay mudflat - Pond in Seawoods	Population density is low compared to the other two groups. However, there is a high possibility that the density is high in mudflats in Trombay area where the survey was not implemented.
3	Vashi Bridge - Airoli Bridge	- Mudflat at the riverbank of Thane Creek	- Within Thane Creek - Pond in Bandap	There are high density areas more than 5,000 individuals/km^2 . The roost is on the water surface. The flamingos are swimming while the mudflat is submerged. In this point, mating behavior has been observed at the third observation (in May).

Source: JICA Study Team



Source: JICA Study Team

Figure 4-3 Using Pattern of Habitats by Flamingos in Mumbai Bay

4.2 Impacts on the Flamingos

In view of the inhabiting situation of the flamingos and activities to human shown already, impacts on the flamingos in the project area are expected as follows based on this survey.

(1) During the Construction

a) Forecasting and Assessing Described in Preparatory Survey Report

Construction of MTHL increases the noise generation and human activities. Therefore, there is a possibility that some groups of migratory birds avoid the adjacent area and move to other areas of Mumbai Bay temporarily.

b) Forecasting and Assessing Based on Results of the Baseline Survey

- ✓ Piers for the construction are installed in the mudflats. It is assumed that the flamingos avoid using areas where main body of the bridge is constructed and 100m or more around as their feeding fields. Avoided individuals from the construction area may shift to other nearest feeding areas such as Shivaji Nagar, Seawood and upstream of Vashi bridge in Thane Creek as shown in Figure 4-4.
- ✓ During the construction works are not carried out, it is assumed that the areas are used as feeding fields for the flamingos except where the physical buildings are occupied.

(2) After the Construction

a) Forecasting and Assessing Described in Preparatory Survey Report

Driving of the automobile, generation of noise and presence of the bridge beams are likely to affect migratory birds. In order to minimize these impacts, not only CRZ approval, but also additional mitigation measures such as the adoption of a lighting system that does not affect the roosts of the flamingos are planned.

b) Forecasting and Assessing Based on Results of the Baseline Survey

- ✓ Feeding fields of the flamingos were observed not only in Sewri but also in Shivaji Nagar. In addition, their roosts were found in TATA power plant around the project area. Therefore, the impacts on the feeding fields and the roosts are concerns in CH500-5,500 (Sewri region, about 5,000m section) and CH14,700 -17,900 (Shivaji Nagar region, about 3,200m section).
- ✓ According to the observations in Airoli Bridge, it is considered that impacts of road traffic noise on using feeding fields of the flamingos are low. For this reason, it is assumed that the flamingos come back and are foraging around the project area although they temporarily avoid the area at the beginning of the project.
- ✓ Also according to the observations in Airoli Bridge, the presence of the bridge girders has given no small impact on their flying movement. However, it is not assumed that the flamingos collide with the bridge girders since they raise the flying altitude and pass over the bridge girders.

Based on the results of the baseline survey, above predictions have been done. Of these predictions, the feeding fields and the roosting areas have changed from the results of the study in 2008. Consequently, new mitigation measures such as the following are required to cope with them.

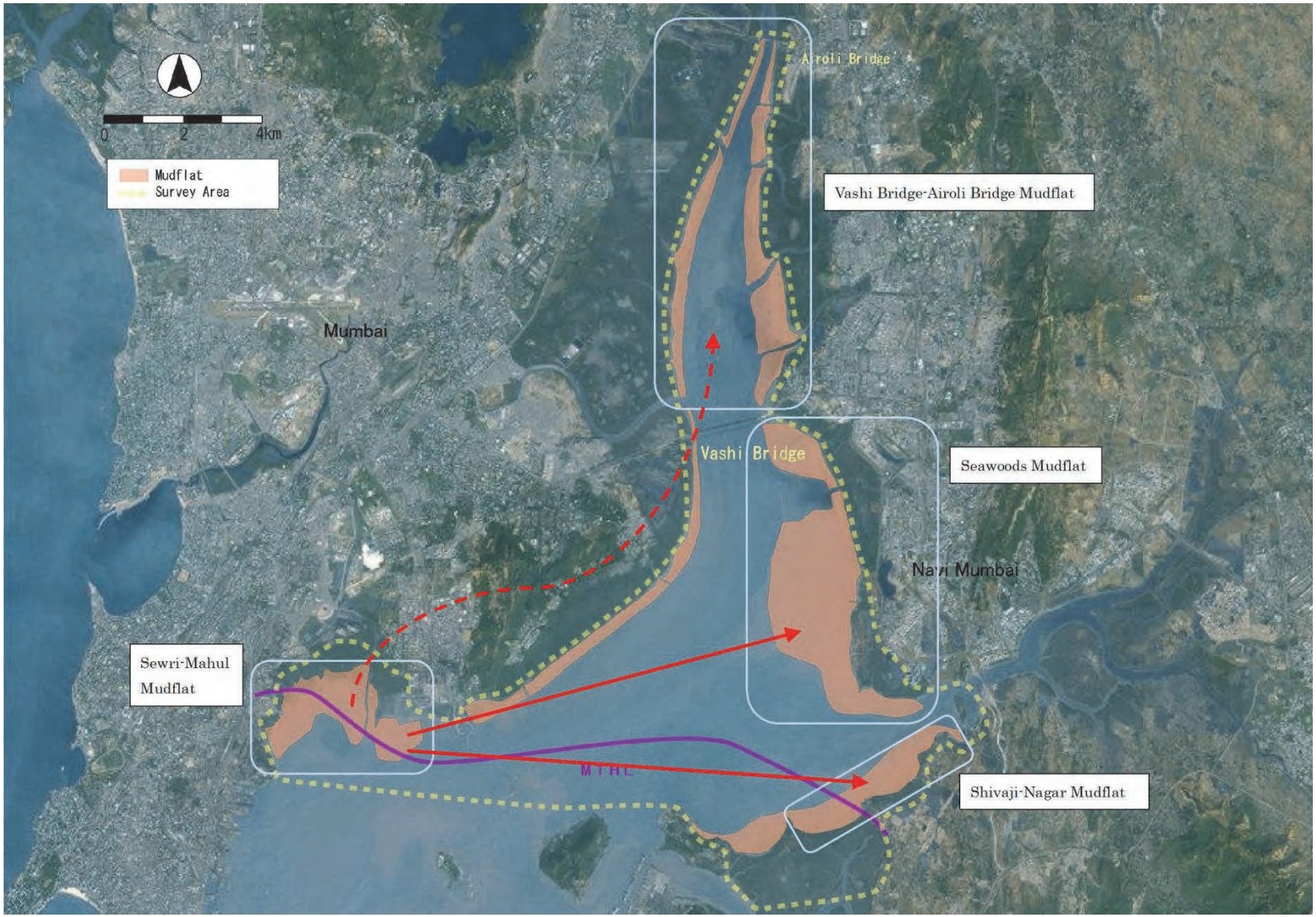


Figure 4-4 Candidate Substitutional Feeding Sites during Construction

4.3 Change of Environmental Mitigation Measures Based on the Baseline Survey

From the viewpoint of mitigating the impacts on the flamingos, sound barriers and bridge railing luminaire in consideration of the feeding fields and there roosts are planning to be installed in the supplementary EIA (2015, MMRDA/JICA) as the structural measures based on the incidental conditions of the CRZ approval (2013 and 2016).

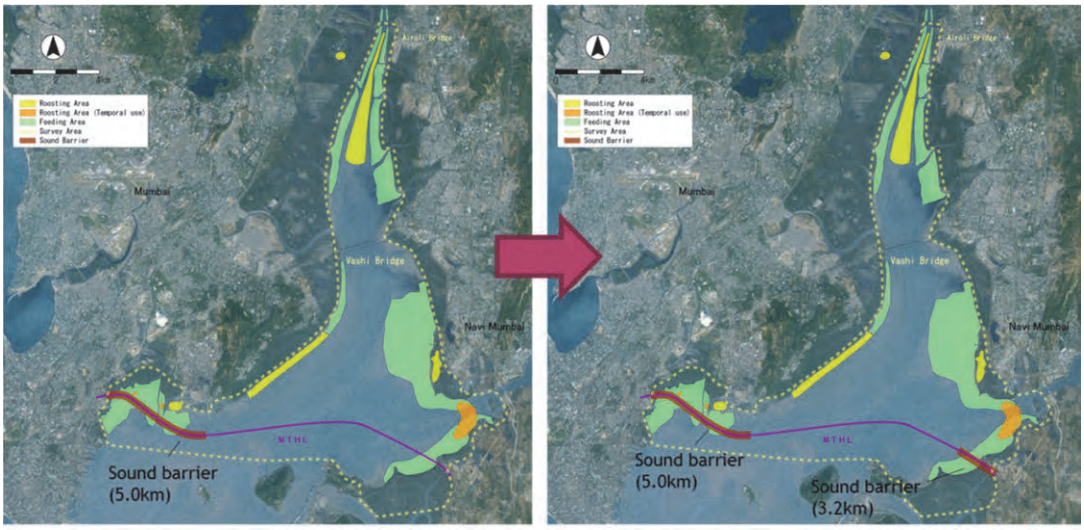
Although it was planned that section to install these mitigation measures is only Sewri section based on the results of a migratory birds survey implemented by MMRDA at 2008, it is considered that the same measures are necessary to install not only in Sewri but also in mudflat area of Shivaji Nagar since the distribution range has extended.

The following shows the current and the revised range of the mitigation measures (sound barriers and bridge railing luminaire).

Table 4-2 Installation Section of Noise Barriers

	Sewri Region	Shivaji Nagar Region	Total
Current	CH500－5,500 Approx. 5,000m	None	Approx. 5,000m
Revised	CH500－5,500 Approx. 5,000m	CH14,700－17,900 Approx. 3,200m	Approx. 8,200m

Source: JICA Study Team



Source: JICA Study Team

Source: Panasonic

Figure 4-5 Sound Barriers with Railing LED Lights

4.4 Inhabiting Situation of Other Migratory Birds and Impacts of the Project

(1) Comparison with the Previous Study

Table 4-3 shows a list of identified birds in the previous study[4] and in this survey.

Through all of the surveys, 161 species of birds have been identified around the project site. Of these, 81 species were identified in the previous study and 147 species were identified in this survey. The species which are identified in the previous study and are not identified in this survey are 14 species. There is no rare species ranked higher in IUCN Red List of these 14 species. It is more likely that they are not observed since the main habitats are out of the project area.

[4] The results of the previous study was quoted from Mumbai Trans Harbor Link Project Supplemental Environmental Impact Assessment 2015 November (MMRDA).

Table 4-3(1) Lists of the Identified Birds in the Studies of the Past

No.	Family	English Name	Scientific Name	Classification of migration	IUCN RL	2008		2012		2016					
						Sewri Mahul Creek	Shivaji Nagar Nhava	Sewri	Shivaji Nagar	Location 1 Sewri Jetty	Location 2 Sewri Bay	Location 3 Mahul Bay	Location 4 Seawoods	Location 5 Shivaji Nagar	Location 6 TS.Rehman
1	Phoenicopteridae	Greater Flamingo	*Phoenicopterus roseus*	M	LC	○				○	○	○	○		
2		Lesser Flamingo	*Phoeniconaias minor*	M	NT	○				○	○	○	○	○	○
3	Phalacrocoracidae	Little Cormorant	*Microcarbo niger*	R	LC					○	○	○	○	○	○
4		Indian Cormorant	*Phalacrocorax fusicollis*	R	LC								○	○	○
5	Ardeidae	Black-crowned Night Heron	*Nycticorax nycticorax*	R	LC					○			○	○	
6		Striated Heron	*Butorides striata*	R	LC	○	○			○	○	○	○	○	○
7		Indian Pond-Heron	*Ardeola grayii*	M/R	LC	○	○		○	○	○	○	○	○	○
8		Cattle Egret	*Bubulcus ibis*	R	LC						○	○		○	○
9		Little Egret	*Egretta garzetta*	R	LC	○	○	○		○	○	○	○	○	○
10		Western Reef-Heron	*Egretta gularis*	R	LC					○	○	○	○	○	○
11		Western reef Egret	*Egretta sacra*	R	LC	○	○	○							
12		Great Egret	*Ardea alba*	R	LC	○	○			○	○	○	○	○	○
13		Grey Heron	*Ardea cinerea*	M	LC	○				○	○	○	○	○	○
14		Intermediate Egret	*Ardea intermedia*	R	LC	○	○	○	○	○	○	○	○	○	○
15		Purple Heron	*Ardea purpurea*	R	LC					○		○		○	○
16	Ciconiidae	Asian Openbill	*Anastomus oscitans*	R	LC									○	○
17		Woolly-necked stork	*Ciconia episcopus*	R	VU										○
18		Painted Stork	*Mycteria leucocephala*	M/R	NT	○				○	○	○	○	○	○
19	Threskiornithidae	Eurasian Spoonbill	*Platalea leucorodia*	M	LC								○		
20		Black-headed Ibis	*Threskiornis melanocephalus*	R	NT	○	○	○	○	○	○	○	○	○	○
21		Glossy Ibis	*Plegadis falcinellus*	R	LC						○	○			
22	Anatidae	Lesser Whistling Duck	*Dendrocygna javanica*	R	LC	○				○	○	○			
23		Spot-billed Duck	*Anas poecilorhyncha*	R	LC		○								
24		Common Teal	*Anas crecca*	M	LC						○	○			
25		Garganey	*Anas querquedula*	M	LC						○	○			
26		Comb Duck	*Sarkidiornis melanotos*	R	LC	○									
27	Accipitridae	Osprey	*Pandion haliaetus*	R	LC	○	○			○	○	○	○		○
28		Black Kite	*Milvus migrans*	R	LC	○			○	○	○	○	○	○	○
29		Black-eared Kite	*Milvus migrans lineatus/formosanus*	M	LC						○	○		○	
30		Shikra	*Accipiter badius*	R	LC	○			○	○					
31		Eurasian Sparrow-Hawk	*Accipiter nisus*	M	LC								○		
32		Greater Spotted Eagle	*Aquila clanga*	M	VU	○					○	○			
33		Indian Spotted Eagle	*Aquila hastata*	M	VU							○			
34		Marsh Harrier	*Circus aeruginosus*	M	LC	○	○			○	○		○	○	
35		Pallid Harrier	*Circus macrourus*	M	NT								○	○	
36		Brahminy Kite	*Haliastur indus*	R	LC	○	○			○	○	○	○	○	○
37	Phasianidae	Grey Francolin(Call)	*Francolinus pondicerianus*	M	LC								○		
38	Rallidae	Baillon's Crake	*Zapornia pusilla*	M	LC								○		
39		White-breasted Waterhen	*Amaurornis phoenicurus*	R	LC					○		○		○	○
40	Rostratulidae	Greater Painted-snipe	*Rostratula benghalensis*	R	LC									○	
41	Charadriidae	Common Ringed Plover	*Charadrius hiaticula*	M	LC									○	
42		Little Ringed Plover	*Charadrius dubius*	R	LC	○				○	○			○	
43		Kentish Plover	*Charadrius alexandrinus*	M	LC					○	○	○	○	○	
44		Lesser Sand-Plover	*Charadrius mongolus*	M	LC	○	○			○	○	○	○	○	○
45		Greater Sand-Plover	*Charadrius leschenaultii*	M	LC					○	○	○	○	○	
46		Pacific Golden Plover	*Pluvialis apricaria*	M	LC					○	○	○		○	
47		Grey Plover/Black-bellied Plover	*Pluvialis squatarola*	M	LC	○	○			○	○	○	○		○
48		Red-wattled Lapwing	*Vanellus indicus*	R	LC	○			○				○	○	
49	Scolopacidae	Ruddy Turnstone	*Arenaria interpres*	M	LC	○				○	○	○	○	○	○
50		Little Stint	*Calidris minuta*	M	LC	○	○		○	○	○	○	○	○	○
51		Temminck's Stint	*Calidris temminckii*	M	LC	○							○	○	
52		Dunlin	*Calidris alpina*	M	LC	○				○		○			
53		Curlew Sandpiper	*Calidris ferruginea*	M	LC	○				○	○	○	○	○	
54		Great Knot	*Calidris tenuirostris*	M	EN						○	○			
55		Broad-billed Sandpiper	*Calidris falcinellus*	M	LC					○	○	○	○	○	○
56		Sanderling	*Calidris alba*	M	LC										○
57		Spotted Redshank	*Tringa erythropus*	M	LC	○	○			○	○				
58		Common Redshank	*Tringa totanus*	M	LC					○	○	○	○	○	○
59		Marsh Sandpiper	*Tringa stagnatilis*	M	LC	○				○	○	○	○	○	
60		Common Greenshank	*Tringa nebularia*	M	LC	○	○			○	○	○	○	○	○
61		Green Sandpiper	*Tringa ochropus*	M	LC					○			○	○	○
62		Wood Sandpiper	*Tringa glareola*	M	LC								○	○	
63		Common Sandpiper	*Actitis hypoleucos*	M	LC	○	○	○	○	○	○	○	○	○	○
64		Terek Sandpiper	*Xenus cinereus*	M	LC	○				○		○	○	○	
65		Black-tailed Godwit	*Limosa limosa*	M	NT	○				○	○	○		○	
66		Bar-tailed Godwit	*Limosa lapponica*	M	NT						○	○			
67		Eurasian Curlew	*Numenius arquata*	M	NT	○	○			○	○	○	○	○	
68		Whimbrel	*Numenius phaeopus*	M	LC	○				○	○	○	○	○	○
69		Common Snipe	*Gallinago gallinago*	M	LC									○	
70		Jack Snipe	*Lymnocryptes minimus*	M	LC									○	
71	Recurvirostridae	Black-winged Stilt	*Himantopus himantopus*	M	LC	○				○		○	○		
72		Pied Avocet	*Recurvirostra avosetta*	M	LC	○									
73	Dromadidae	Crab-Plover	*Dromas ardeola*	M	LC								○		
74	Laridae	Lesser Black-backed Gull	*Larus fuscus*	M	LC					○	○	○			
75		Heuglin's Gull	*Larus heuglini*	M	LC		○					○		○	
76		Steppe Gull	*Larus heuglini barabensis*	M	LC					○					
77		Pallas's Gull	*Ichthyaetus ichthyaetus*	M	LC					○	○	○	○		
78		Brown-headed Gull	*Chroicocephalus brunnicephalus*	M	LC	○				○	○	○	○	○	○
79		Slender-billed Gull	*Chroicocephalus genei*	M	LC					○	○		○	○	
80		Black-headed Gull	*Chroicocephalus ridibundus*	M	LC	○		○	○	○	○	○	○	○	○
81		Whiskered Tern	*Chlidonias hybrida*	M	LC	○				○	○	○	○	○	○
82		Caspian Tern	*Hydroprogne caspia*	M	LC	○	○			○	○	○	○	○	○
83		Gull-billed Tern	*Gelochelidon nilotica*	M	LC	○	○			○	○	○	○	○	○
84		Common Tern	*Sterna hirundo*	M	LC					○	○	○			○
85		Little Tern	*Sternula albifrons*	M	LC	○				○	○	○	○	○	○
86		Saunders's Tern	*Sternula saundersi*	M	LC							○			
87	Columbidae	Rock Pigeon(Feral Pigeon,Blue Rock Pigeon)	*Columba livia*	R	LC	○		○		○	○	○	○	○	○
88		Spotted Dove	*Streptopelia chinensis*	R	LC		○			○			○	○	
89		Laughing Dove	*Spilopelia senegalensis*	R	LC								○	○	
90	Psittacidae	Alexandrine Parakeet	*Psittacula eupatria*	R	NT					○			○		○
91		Rose-ringed Parakeet	*Psittacula krameri*	R	LC	○				○	○	○	○		○

Source: JICA Study Team

Table 4-3(2) Lists of the Identified Birds in the Studies of the Past

No.	Family	English Name	Scientific Name	Classification of migration	IUCN RL	2008		2012		2016					
						Sewri Mahul Creek	Shivaji Nagar Nhava	Sewri	Shivaji Nagar	Location 1 Sewri Jetty	Location 2 Sewri Bay	Location 3 Mahul Bay	Location 4 Seawoods	Location 5 Shivaji Nagar	Location 6 TS.Rehman
92	Cuculidae	Greater Coucal	*Centropus sinensis*	R	LC	○									
93		Southern Coucal	*Centropus sinensis parroti*	R	LC					○			○		○
94		Asian Koel	*Eudynamys scolopaceus*	R	LC	○				○	○		○	○	○
95	Tytonidae	Barn Owl	*Tyto alba*	R	LC	○									
96	Apodidae	Little Swift	*Apus affinis*	R	LC							○			
97		Asian Palm-Swift	*Cypsiurus balasiensis*	R	LC	○				○	○		○	○	○
98	Alcedinidae	Pied Kingfisher	*Ceryle rudis*	R	LC									○	○
99		Black-capped Kingfisher	*Halcyon pileata*	R	LC	○				○		○	○	○	○
100		White-throated Kingfisher	*Halcyon smyrnensis*	R	LC	○	○	○		○	○	○	○	○	○
101		Common Kingfisher	*Alcedo atthis*	R	LC	○	○			○		○	○	○	○
102		Small blue Kingfisher	*Alcedo coerulescens*	R	LC			○							
103	Meropidae	Green Bee-eater	*Merops orientalis*	R	LC		○		○	○	○		○	○	○
104		Blue-tailed Bee-eater	*Merops philippinus*	M	LC								○	○	
105	Coraciidae	Indian Roller	*Coracias benghalensis*	R	LC		○						○		
106	Megalaimidae	Coppersmith Barbet	*Psilopogon haemacephalus*	R	LC					○	○		○		○
107	Alaudidae	Bush lark	*Mirafra erythroptera*	R	LC				○						
108	Hirundinidae	Plain/Sand Martin(?)	*Riparia paludicola/Riparia riparia(?)*	M/R	LC							○			
109		Barn Swallow	*Hirundo rustica*	M	LC	○	○			○	○	○	○	○	
110		Wire-tailed Swallow	*Hirundo smithii*	R	LC							○	○		
111		Red-rumped Swallow	*Cecropis daurica*	R	LC								○	○	
112		Dusky Crag Martin	*Ptyonoprogne concolor*	R	LC					○				○	
113	Motacillidae	Yellow Wagtail	*Motacilla flava*	M	LC	○				○					○
114		Citrine Wagtail	*Motacilla citreola*	R	LC	○									
115		Grey Wagtail	*Motacilla cinerea*	M	LC					○					
116		White Wagtail	*Motacilla alba*	R	LC	○				○				○	
117		White-browed Wagtail	*Motacilla maderaspatensis*	M	LC								○		○
118	Aegithinidae	Common Iora	*Aegithina tiphia*	R	LC								○		○
119	Pycnonotidae	Red-vented Bulbul	*Pycnonotus cafer*	R	LC	○			○	○		○	○	○	○
120		Red-whiskered Bulbul	*Pycnonotus jocosus*	R	LC					○		○	○	○	○
121		White-eared Bulbul	*Pycnonotus leucotis*	R	LC	○	○			○		○	○	○	○
122	Laniidae	Long-tailed Shrike	*Lanius schach*	R	LC					○			○	○	
123		Rufous tailed Shrike	*Lanius isabellinus*	M	LC		○								
124	Turdidae	Bluethroat	*Luscinia svecica*	M	LC								○		
125		Pied Bushchat	*Saxicola caprata*	R	LC								○		
126		Oriental Magpie-Robin	*Copsychus saularis*	R	LC	○				○			○	○	○
127	Timaliidae	Jungle Babbler	*Turdoides striata*	R	LC									○	
128		Yellow-eyed Babbler	*Chrysomma sinense*	R	LC								○	○	
129	Sylviidae	Blyth's Reed-Warbler	*Acrocephalus dumetorum*	M	LC	○				○			○	○	○
130		Clamorous Reed-Warbler	*Acrocephalus stentoreus*	M	LC		○					○	○	○	○
131		Common Chiffchaff	*Phylloscopus collybita*	M	LC								○		
132		Lesser Whitethroat	*Sylvia curruca*	M	LC					○					
133		Common Tailorbird	*Orthotomus sutorius*	R	LC	○				○	○		○		○
134		Plain Prinia	*Prinia inornata*	M	LC					○			○	○	○
135		Ashy Prinia	*Prinia socialis*	R	LC	○				○		○	○	○	○
136	Muscicapidae	Red-breasted/Taiga Flycatcher	*Ficedula parva/Ficedula albicilla*	M	LC								○		
137		Indian Robin	*Saxicoloides fulicatus*	R	LC		○			○			○	○	
138		Tickell's Blue Flycather	*Cyornis tickelliae*	R	LC										○
139	Fringillidae	Common Rosefinch	*Carpodacus erythrinus*	M	LC								○		
140	Estrildidae	Indian Silverbill	*Euodice malabarica*	R	LC					○					
141		Red Avadavat	*Amandava amandava*	R	LC									○	
142		Scaly-breasted Munia	*Lonchura punctulata*	R	LC					○			○		
143	Ploceidae	House Sparrow	*Passer domesticus*	R	LC	○	○			○	○			○	○
144		Baya Weaver	*Ploceus philippinus*	R	LC								○	○	○
145	Sturnidae	Asian Pied Starling	*Sturnus contra*	R	LC	○									
146		Brahminy Starling	*Sturnus pagodarum*	R	LC									○	
147		Common Myna	*Acridotheres tristis*	R	LC					○	○		○	○	○
148		Pied Starling	*Gracupica contra*	R	LC					○		○	○	○	○
149		Rosy Starling	*Pastor roseus*	M	LC					○			○	○	
150		Chestnut-tailed Starling	*Sturnia malabarica*	M	LC								○		
151	Oriolidae	Golden Oriole	*Oriolus oriolus*	M	LC	○									
152		Indian Golden Oriole	*Oriolus kundoo*	R	LC					○		○	○	○	○
153	Corvidae	House Crow	*Corvus splendens*	R	LC	○	○			○	○	○	○	○	○
154		Large-billed (Jungle) crow	*Corvus macrorhynchos*	R	LC	○	○								
155		Indian(Large-billed) Jungle Crow	*Corvus macrorhynchos culminatus*	R	LC					○	○	○	○	○	○
156	Nectariniidae	Purple Sunbird	*Cinnyris asiaticus*	R	LC					○		○	○	○	○
157		Purple-rumped Sunbird	*Leptocoma zeylonica*	R	LC	○				○	○		○	○	○
158		Vigor's Sunbird	*Aethopyga siparaja vigorsii*	R	LC										○
159	Rhipiduridae	White throated Fantail	*Rhipidura albicollis*	R	LC	○									
160		White-spotted Fantail	*Rhipidura albicollis albogularis*	R	NE					○			○		○
161		White-browed Fantail	*Rhipidura aureola*	R	LC								○		○
合計	42 families	161 species		M:75 sp. M/R:3 sp.	EN:1 sp. VU:3 sp.	70 sp.	34 sp.	9 sp.	12 sp.	94 sp.	67 sp.	76 sp.	102 sp.	94 sp.	75 sp.
						81 sp.				147 sp.					

Source: JICA Study Team

(2) Inhabiting Situation of Principal Species and Impacts of the Project

In the surveys until now, the species classified NT or more categories in IUCN ranks have been identified 12 species. In regard to11 species of them except the lesser flamingos, the inhabiting situation and the impacts of the MTHL project are summarized in Table 4-4.

Table 4-4(1) Assessment of the impacts of MTHL project to Inhabitation of the Principal Bird Species

No.	Species Name	IUCN RL	Impact of the MTHL Project on the Inhabitation
1	Woolly-necked stork (Ciconia episcopus)	VU	There is a possibility of breeding in Location 6 (TS.Rahaman) which is out of the impact range of the project. On the other hand, it has not observed in the impact range of the project. Thus, it is considered that implementation of the project will not have significant impacts on inhabitation of this species.
2	Painted Stork (Mycteria leucocephala)	NT	This species uses mudflats in a wide range of the survey area as feeding fields during non-breeding season. In the observation in May, its colonies were found in Location 6 (TS. Rahaman) which is out of impact range of the project. This species uses the area around Location 6 as a breeding field. Although the signs of breeding within impact range of the project have not been observed, it is desirable to monitor its inhabiting situation during and after the construction since a part of mudflats which are its feeding fields is located within impact range.
3	Black-headed Ibis (Threskiornis melanocephalus)	NT	Activities in a group have been observed at the northern edge of Sewri mudflat and the edge of mangrove forest in Seawoods. There is a possibility that this species uses these areas as breeding fields. However, both areas are out of impact range of the project. It is considered that implementation of the project will not have significant impacts on breeding of this species. On the other hand, it is desirable to monitor its inhabiting situation during and after the construction since a part of mudflats which are its feeding fields is located within impact range.
4	Greater Spotted Eagle (Aquila clanga)	VU	This species is a migratory bird and moves to the north in the breeding season. And it uses the survey area as feeding fields during non-breeding season. It is considered that the project will not have significant impacts on its inhabitation as this species is a bird of prey whose activity range is wide and the impact range of the project is a part of the activity range.
5	Indian Spotted Eagle (Aquila hastata)	VU	This species is a migratory bird and moves to the north in the breeding season. And it uses the survey area as feeding fields during non-breeding season. It is considered that the project will not have significant impacts on its inhabitation as this species is a bird of prey whose activity range is wide and the impact range of the project is a part of the activity range.
6	Pallid Harrier (Circus macrourus)	NT	This species is a migratory bird and moves to the north in the breeding season. And it uses the survey area as feeding fields during non-breeding season. It is considered that the project will not have significant impacts on its inhabitation as this species is a bird of prey whose activity range is wide and the impact range of the project is a part of the activity range.

Source: JICA Study Team

Table 4-4(2) Assessment of the impacts of MTHL project to Inhabitation of the Principal Bird Species

No.	Species Name	IUCN RL	Impact of the MTHL Project on the Inhabitation
7	Great Knot (Calidris tenuirostris)	EN	This species is a migratory bird, and uses Sewri mudflat as a feeding field in non-breeding season. It is desirable to monitor its inhabiting situation during and after the construction since a part of its feeding fields is affected by the project.
8	Black-tailed Godwit (Limosa limosa)	NT	This species is a migratory bird, and uses Sewri mudflat as a feeding field in non-breeding season. It is desirable to monitor its inhabiting situation during and after the construction since a part of its feeding fields is affected by the project.
9	Bar-tailed Godwit (Limosa lapponica)	NT	This species is a migratory bird, and uses Sewri mudflat as a feeding field in non-breeding season. It is desirable to monitor its inhabiting situation during and after the construction since a part of its feeding fields is affected by the project.
10	Eurasian Curlew (Numenius arquata)	NT	This species is a migratory bird, and uses mudflats in a wide range of the survey area as a feeding field in non-breeding season. It is desirable to monitor its inhabiting situation during and after the construction since a part of its feeding fields is affected by the project.
11	Alexandrine Parakeet (Psittacula eupatria)	NT	This species is a resident bird, and mainly inhabit forest land. It is considered to widely inhabit mangrove forests within the survey area since it has been identified in more than one point. Although the signs of nesting and others have not been observed within impact range of the project, it is desirable to monitor its inhabiting situation during and after the construction since a part of the mangrove forests is modified by the project.

Source: JICA Study Team

Appendix 1 (1) Number of the Identified Birds at each point (Migratory Birds)

No.	英名	学名	Location 1 (Sewri Jetty)									
			1st Survey				2nd Survey			3rd Survey		
			2016/2/27	2016/2/28	2016/3/2	2016/3/3	2016/3/31	2016/4/3	2016/4/5	2016/5/11	2016/5/13	2016/5/14
1	Greater Flamingo	*Phoenicopterus roseus*	16	125	278	120	300	250	220	103	9	55
2	Lesser Flamingo	*Phoeniconaias minor*	921	2000	1030	2500	4350	100	518	6416	2167	230
3	Little Cormorant	*Microcarbo niger*				1		2		1		
4	Indian Cormorant	*Phalacrocorax fuscicollis*										
5	Black-crowned Night Heron	*Nycticorax nycticorax*							1			
6	Striated Heron	*Butorides striata*	1		11	2	1	1	1	6	2	
7	Indian Pond-Heron	*Ardeola grayii*	8	10		15	8	4	5	13	10	6
8	Cattle Egret	*Bubulcus ibis*										
9	Little Egret	*Egretta garzetta*	15	2		5	12	4	2	6	9	7
10	Western Reef-Heron	*Egretta gularis*	3	9	5	15	6	6	1	9	6	3
11	Great Egret	*Ardea alba*	3	2	32	20	39	6	1	7	38	5
12	Grey Heron	*Ardea cinerea*	10	1		3	5		1	4	3	2
13	Intermediate Egret	*Ardea intermedia*		1	7		3	6			4	
14	Purple Heron	*Ardea purpurea*	2									
15	Asian Openbill	*Anastomus oscitans*										
16	Woolly-necked stork	*Ciconia episcopus*										
17	Painted Stork	*Mycteria leucocephala*	6	3	7	3	2		2	5	10	1
18	Eurasian Spoonbill	*Platalea leucorodia*										
19	Black-headed Ibis	*Threskiornis melanocephalus*	5	5	3	5	23	70	3	7	12	3
20	Glossy Ibis	*Plegadis falcinellus*										
21	Lesser Whistling Duck	*Dendrocygna javanica*									99	100
22	Common Teal	*Anas crecca*										
23	Garganey	*Anas querquedula*										
24	Osprey	*Pandion haliaetus*				1						
25	Black Kite	*Milvus migrans*	20	20	1	15	16	10	3		9	3
26	Black-eared Kite	*Milvus migrans lineatus/formosanus*										
27	Shikra	*Accipiter badius*	1				1				8	
28	Eurasian Sparrow-Hawk	*Accipiter nisus*										
29	Greater Spotted Eagle	*Aquila clanga*										
30	Indian Spotted Eagle	*Aquila hastata*										
31	Marsh Harrier	*Circus aeruginosus*				1						
32	Pallid Harrier	*Circus macrourus*										
33	Brahminy Kite	*Haliastur indus*		3	1	2	3	5	3	4		
34	Grey Francolin(Call)	*Francolinus pondicerianus*										
35	Baillon's Crake	*Zapornia pusilla*										
36	White-breasted Waterhen	*Amaurornis phoenicurus*	1									
37	Greater Painted-snipe	*Rostratula benghalensis*										
38	Common Ringed Plover	*Charadrius hiaticula*										
39	Little Ringed Plover	*Charadrius dubius*	3	3			1	5				
40	Kentish Plover	*Charadrius alexandrinus*	50							5		
41	Lesser Sand-Plover	*Charadrius mongolus*	200	50	100	200	73		15	62	17	40
42	Greater Sand-Plover	*Charadrius leschenaultii*	50	70			5		15			
43	Pacific Golden Plover	*Pluvialis apricaria*							3			
44	Grey Plover/Black-bellied Plover	*Pluvialis squatarola*		7		15	6		3			
45	Red-wattled Lapwing	*Vanellus indicus*										
46	Ruddy Turnstone	*Arenaria interpres*		3		1	6	2	2			
47	Little Stint	*Calidris minuta*	30	50	40	50	20		25	1		
48	Temminck's Stint	*Calidris temminckii*										
49	Dunlin	*Calidris alpina*		2		1						
50	Curlew Sandpiper	*Calidris ferruginea*	3	15	80	200	79	1	130			
51	Great Knot	*Calidris tenuirostris*										
52	Broad-billed Sandpiper	*Calidris falcinellus*	1	8	40	20	12		10			
53	Sanderling	*Calidris alba*										
54	Spotted Redshank	*Tringa erythropus*		1								
55	Common Redshank	*Tringa totanus*	30	3	10	20	4	4	2	1		
56	Marsh Sandpiper	*Tringa stagnatilis*							1			
57	Common Greenshank	*Tringa nebularia*	1			4	1	3	1			
58	Green Sandpiper	*Tringa ochropus*	1									
59	Wood Sandpiper	*Tringa glareola*										
60	Common Sandpiper	*Actitis hypoleucos*	10	10	23	5		3	3	7		
61	Terek Sandpiper	*Xenus cinereus*	2	3		2	8					
62	Black-tailed Godwit	*Limosa limosa*	20	50	34	80	1					
63	Bar-tailed Godwit	*Limosa lapponica*										
64	Eurasian Curlew	*Numenius arquata*	1	6	5	8	3	3	1			
65	Whimbrel	*Numenius phaeopus*		1		2		2				
66	Common Snipe	*Gallinago gallinago*										
67	Jack Snipe	*Lymnocryptes minimus*										
68	Black-winged Stilt	*Himantopus himantopus*			3							
69	Crab-Plover	*Dromas ardeola*										
70	Lesser Black-backed Gull	*Larus fuscus*	2	12								
71	Heuglin's Gull	*Larus heuglini*										
72	Steppe Gull	*Larus heuglini barabensis*					1					
73	Pallas's Gull	*Ichthyaetus ichthyaetus*		1		3						
74	Brown-headed Gull	*Chroicocephalus brunnicephalus*	10	20	89	100	7	40	10	2	45	
75	Slender-billed Gull	*Chroicocephalus genei*			1	5			1			
76	Black-headed Gull	*Chroicocephalus ridibundus*	10	10	6	10		3	2	2		
77	Whiskered Tern	*Chlidonias hybrida*	6	6	25	5	27	10	20	3	14	
78	Caspian Tern	*Hydroprogne caspia*	1	15	5	21			1	6	13	
79	Gull-billed Tern	*Gelochelidon nilotica*	1	15	3	25	7		6	5	1	1
80	Common Tern	*Sterna hirundo*	2	15								
81	Little Tern	*Sternula albifrons*		30	3	15	4	2	1		9	
82	Saunders's Tern	*Sternula saundersi*										
83	Rock Pigeon(Feral Pigeon)	*Columba livia*	40	50	50		28	15	3	61	6	15
84	Spotted Dove	*Streptopelia chinensis*	3									
85	Laughing Dove	*Spilopelia senegalensis*										
86	Alexandrine Parakeet	*Psittacula eupatria*	5									
87	Rose-ringed Parakeet	*Psittacula krameri*	15		2		4			1		
88	Southern Coucal	*Centropus sinensis parroti*					1					
89	Asian Koel	*Eudynamys scolopaceus*				1	2	5	2		2	3
90	Little Swift	*Apus affinis*										

Appendix 1 (2) Number of the Identified Birds at each point (Migratory Birds)

No.	英名	学名	Location 1 (Sewri Jetty)									
			1st Survey				2nd Survey			3rd Survey		
			2016/2/27	2016/2/28	2016/3/2	2016/3/3	2016/3/31	2016/4/3	2016/4/5	2016/5/11	2016/5/13	2016/5/14
91	Asian Palm-Swift	*Cypsiurus balasiensis*	25			3	1	5	3		3	
92	Pied Kingfisher	*Ceryle rudis*										
93	Black-capped Kingfisher	*Halcyon pileata*	1						1			
94	White-throated Kingfisher	*Halcyon smyrnensis*	2	1		1	2		1	1		2
95	Common Kingfisher	*Alcedo atthis*		1	2	1						
96	Green Bee-eater	*Merops orientalis*	4				9	3	2	2	2	4
97	Blue-tailed Bee-eater	*Merops philippinus*										
98	Indian Roller	*Coracias benghalensis*										
99	Coppersmith Barbet	*Psilopogon haemacephalus*	3		10		1	2	1	2		3
100	Plain/Sand Martin(?)	*Riparia paludicola/Riparia riparia(?)*										
101	Barn Swallow	*Hirundo rustica*	4	1	2	2	18		3			
102	Wire-tailed Swallow	*Hirundo smithii*										
103	Red-rumped Swallow	*Cecropis daurica*										
104	Dusky Crag Martin	*Ptyonoprogne concolor*						3				
105	Yellow Wagtail	*Motacilla flava*				3						
106	Grey Wagtail	*Motacilla cinerea*			2							
107	White Wagtail	*Motacilla alba*	3									
108	White-browed Wagtail	*Motacilla maderaspatensis*										
109	Common Iora	*Aegithina tiphia*										
110	Red-vented Bulbul	*Pycnonotus cafer*	3		1	2	1	2	1		2	4
111	Red-whiskered Bulbul	*Pycnonotus jocosus*	5		1	2	1	3			3	3
112	White-eared Bulbul	*Pycnonotus leucotis*			1							
113	Long-tailed Shrike	*Lanius schach*							1			
114	Bluethroat	*Luscinia svecica*										
115	Pied Bushchat	*Saxicola caprata*										
116	Oriental Magpie-Robin	*Copsychus saularis*	1		1		1		2	1		2
117	Jungle Babbler	*Turdoides striata*										
118	Yellow-eyed Babbler	*Chrysomma sinense*										
119	Blyth's Reed-Warbler	*Acrocephalus dumetorum*	2		1				1			
120	Clamorous Reed-Warbler	*Acrocephalus stentoreus*										
121	Common Chiffchaff	*Phylloscopus collybita*										
122	Lesser Whitethroat	*Sylvia curruca*	1									
123	Common Tailorbird	*Orthotomus sutorius*	1		1		1	2		5	1	2
124	Plain Prinia	*Prinia inornata*						1		1		
125	Ashy Prinia	*Prinia socialis*	1		1		1	2	2	2	2	2
126	Red-breasted/Taiga Flycatcher	*Ficedula parva/Ficedula albicilla*										
127	Indian Robin	*Saxicoloides fulicatus*			1							
128	Tickell's Blue Flycather	*Cyornis tickelliae*										
129	Common Rosefinch	*Carpodacus erythrinus*										
130	Indian Silverbill	*Euodice malabarica*							1			
131	Red Avadavat	*Amandava amandava*										
132	Scaly-breasted Munia	*Lonchura punctulata*			3							
133	House Sparrow	*Passer domesticus*					1		3	4	40	12
134	Baya Weaver	*Ploceus philippinus*										
135	Brahminy Starling	*Sturnus pagodarum*										
136	Common Myna	*Acridotheres tristis*	4				1	5		6	2	6
137	Pied Starling	*Gracupica contra*						1				
138	Rosy Starling	*Pastor roseus*				15						
139	Chestnut-tailed Starling	*Sturnia malabarica*										
140	Indian Golden Oriole	*Oriolus kundoo*				1			1			
141	House Crow	*Corvus splendens*	10		7	50	43	20	15	11	19	30
142	Indian(Large-billed) Jungle Crow	*Corvus macrorhynchos culminatus*					1	4	1	3		
143	Purple Sunbird	*Cinnyris asiaticus*	1				1				2	1
144	Purple-rumped Sunbird	*Leptocoma zeylonica*	1		1		1		1	2		2
145	Vigor's Sunbird	*Aethopyga siparaja vigorsii*										
146	White-spotted Fantail	*Rhipidura albicollis albogularis*								3		
147	White-browed Fantail	*Rhipidura aureola*										
Total	147Species	Individual Number	1581	2640	1929	3581	5153	615	1058	6780	2569	547
		Number of Species	57	41	43	48	52	39	52	37	32	28
			80				69			47		
			94									

Appendix 1 (3) Number of the Identified Birds at each point (Migratory Birds)

No.	英名	学名	Location 2 (Sewri Bay)									
			1st Survey				2nd Survey			3rd Survey		
			2016/2/27	2016/2/28	2016/3/2	2016/3/3	2016/3/31	2016/4/3	2016/4/5	2016/5/11	2016/5/13	2016/5/14
1	Greater Flamingo	*Phoenicopterus roseus*	50	500	185	72	367	150	355	27	98	30
2	Lesser Flamingo	*Phoeniconaias minor*	3000	5000	7830	4800	3035	500	5480	3500	1120	3000
3	Little Cormorant	*Microcarbo niger*						1				
4	Indian Cormorant	*Phalacrocorax fuscicollis*										
5	Black-crowned Night Heron	*Nycticorax nycticorax*										
6	Striated Heron	*Butorides striata*						1				
7	Indian Pond-Heron	*Ardeola grayii*		1			12	5	15	5		
8	Cattle Egret	*Bubulcus ibis*								15		
9	Little Egret	*Egretta garzetta*		16	2		2	8	22		12	
10	Western Reef-Heron	*Egretta gularis*			1	2	9	1	5	20	5	5
11	Great Egret	*Ardea alba*		6		30	15	23	33	50		70
12	Grey Heron	*Ardea cinerea*			1	3	5	1	2	1		
13	Intermediate Egret	*Ardea intermedia*		13				8	7		5	
14	Purple Heron	*Ardea purpurea*										
15	Asian Openbill	*Anastomus oscitans*										
16	Woolly-necked stork	*Ciconia episcopus*										
17	Painted Stork	*Mycteria leucocephala*	12	1	10	6	4	7	4			
18	Eurasian Spoonbill	*Platalea leucorodia*										
19	Black-headed Ibis	*Threskiornis melanocephalus*	1	3	3		3	7	8	3	4	6
20	Glossy Ibis	*Plegadis falcinellus*						70				
21	Lesser Whistling Duck	*Dendrocygna javanica*								250	45	100
22	Common Teal	*Anas crecca*			9							
23	Garganey	*Anas querquedula*			7		35					
24	Osprey	*Pandion haliaetus*							1			
25	Black Kite	*Milvus migrans*		1	2	20	11	41	11	15	2	6
26	Black-eared Kite	*Milvus migrans lineatus/formosanus*				4						
27	Shikra	*Accipiter badius*										
28	Eurasian Sparrow-Hawk	*Accipiter nisus*										
29	Greater Spotted Eagle	*Aquila clanga*					1					
30	Indian Spotted Eagle	*Aquila hastata*										
31	Marsh Harrier	*Circus aeruginosus*			1							
32	Pallid Harrier	*Circus macrourus*										
33	Brahminy Kite	*Haliastur indus*	1	1	2		1	3	3	4	1	
34	Grey Francolin(Call)	*Francolinus pondicerianus*										
35	Baillon's Crake	*Zapornia pusilla*										
36	White-breasted Waterhen	*Amaurornis phoenicurus*										
37	Greater Painted-snipe	*Rostratula benghalensis*										
38	Common Ringed Plover	*Charadrius hiaticula*										
39	Little Ringed Plover	*Charadrius dubius*		150								
40	Kentish Plover	*Charadrius alexandrinus*		50								
41	Lesser Sand-Plover	*Charadrius mongolus*	200	750		50	6	3	50			
42	Greater Sand-Plover	*Charadrius leschenaultii*						1	20			
43	Pacific Golden Plover	*Pluvialis apricaria*			1	6			1			
44	Grey Plover/Black-bellied Plover	*Pluvialis squatarola*		6	1		2	4	3			
45	Red-wattled Lapwing	*Vanellus indicus*										
46	Ruddy Turnstone	*Arenaria interpres*		40				4	4			
47	Little Stint	*Calidris minuta*		800	200		10	7				
48	Temminck's Stint	*Calidris temminckii*										
49	Dunlin	*Calidris alpina*										
50	Curlew Sandpiper	*Calidris ferruginea*		210	6	6	50	1	50			
51	Great Knot	*Calidris tenuirostris*					1	4	4			
52	Broad-billed Sandpiper	*Calidris falcinellus*		62								
53	Sanderling	*Calidris alba*										
54	Spotted Redshank	*Tringa erythropus*		1								
55	Common Redshank	*Tringa totanus*	2	40		3	8	5	1			
56	Marsh Sandpiper	*Tringa stagnatilis*							2			
57	Common Greenshank	*Tringa nebularia*							1			
58	Green Sandpiper	*Tringa ochropus*										
59	Wood Sandpiper	*Tringa glareola*										
60	Common Sandpiper	*Actitis hypoleucos*					3					
61	Terek Sandpiper	*Xenus cinereus*										
62	Black-tailed Godwit	*Limosa limosa*	6	30	19	13	28	1	2			
63	Bar-tailed Godwit	*Limosa lapponica*						1				
64	Eurasian Curlew	*Numenius arquata*					9	1	3	1		
65	Whimbrel	*Numenius phaeopus*	1						2			
66	Common Snipe	*Gallinago gallinago*										
67	Jack Snipe	*Lymnocryptes minimus*										
68	Black-winged Stilt	*Himantopus himantopus*										
69	Crab-Plover	*Dromas ardeola*										
70	Lesser Black-backed Gull	*Larus fuscus*				13						
71	Heuglin's Gull	*Larus heuglini*										
72	Steppe Gull	*Larus heuglini barabensis*										
73	Pallas's Gull	*Ichthyaetus ichthyaetus*			1	8		2	1		1	
74	Brown-headed Gull	*Chroicocephalus brunnicephalus*				30	110	5	34			5
75	Slender-billed Gull	*Chroicocephalus genei*				1						
76	Black-headed Gull	*Chroicocephalus ridibundus*				20	10	8	50	15	2	
77	Whiskered Tern	*Chlidonias hybrida*			2	7	2	1	57	6	18	6
78	Caspian Tern	*Hydroprogne caspia*	1		1		5	7	10	15	15	12
79	Gull-billed Tern	*Gelochelidon nilotica*			1	5	14	17	6	25	2	20
80	Common Tern	*Sterna hirundo*				27		15	40			
81	Little Tern	*Sternula albifrons*				30	9	10			20	4
82	Saunders's Tern	*Sternula saundersi*										
83	Rock Pigeon(Feral Pigeon)	*Columba livia*					1	4				
84	Spotted Dove	*Streptopelia chinensis*										
85	Laughing Dove	*Spilopelia senegalensis*										
86	Alexandrine Parakeet	*Psittacula eupatria*										
87	Rose-ringed Parakeet	*Psittacula krameri*					10	4				
88	Southern Coucal	*Centropus sinensis parroti*										
89	Asian Koel	*Eudynamys scolopaceus*						1				
90	Little Swift	*Apus affinis*										

Appendix 1 (4) Number of the Identified Birds at each point (Migratory Birds)

No.	英名	学名	Location 2 (Sewri Bay)									
			1st Survey				2nd Survey			3rd Survey		
			2016/2/27	2016/2/28	2016/3/2	2016/3/3	2016/3/31	2016/4/3	2016/4/5	2016/5/11	2016/5/13	2016/5/14
91	Asian Palm-Swift	*Cypsiurus balasiensis*					1	3				
92	Pied Kingfisher	*Ceryle rudis*										
93	Black-capped Kingfisher	*Halcyon pileata*										
94	White-throated Kingfisher	*Halcyon smyrnensis*					1	1				
95	Common Kingfisher	*Alcedo atthis*										
96	Green Bee-eater	*Merops orientalis*						1				
97	Blue-tailed Bee-eater	*Merops philippinus*										
98	Indian Roller	*Coracias benghalensis*										
99	Coppersmith Barbet	*Psilopogon haemacephalus*					1	1				
100	Plain/Sand Martin(?)	*Riparia paludicola/Riparia riparia(?)*										
101	Barn Swallow	*Hirundo rustica*					20					
102	Wire-tailed Swallow	*Hirundo smithii*										
103	Red-rumped Swallow	*Cecropis daurica*										
104	Dusky Crag Martin	*Ptyonoprogne concolor*										
105	Yellow Wagtail	*Motacilla flava*										
106	Grey Wagtail	*Motacilla cinerea*										
107	White Wagtail	*Motacilla alba*										
108	White-browed Wagtail	*Motacilla maderaspatensis*										
109	Common Iora	*Aegithina tiphia*										
110	Red-vented Bulbul	*Pycnonotus cafer*										
111	Red-whiskered Bulbul	*Pycnonotus jocosus*										
112	White-eared Bulbul	*Pycnonotus leucotis*										
113	Long-tailed Shrike	*Lanius schach*										
114	Bluethroat	*Luscinia svecica*										
115	Pied Bushchat	*Saxicola caprata*										
116	Oriental Magpie-Robin	*Copsychus saularis*										
117	Jungle Babbler	*Turdoides striata*										
118	Yellow-eyed Babbler	*Chrysomma sinense*										
119	Blyth's Reed-Warbler	*Acrocephalus dumetorum*										
120	Clamorous Reed-Warbler	*Acrocephalus stentoreus*										
121	Common Chiffchaff	*Phylloscopus collybita*										
122	Lesser Whitethroat	*Sylvia curruca*										
123	Common Tailorbird	*Orthotomus sutorius*					1					
124	Plain Prinia	*Prinia inornata*										
125	Ashy Prinia	*Prinia socialis*										
126	Red-breasted/Taiga Flycatcher	*Ficedula parva/Ficedula albicilla*										
127	Indian Robin	*Saxicoloides fulicatus*										
128	Tickell's Blue Flycather	*Cyornis tickelliae*										
129	Common Rosefinch	*Carpodacus erythrinus*										
130	Indian Silverbill	*Euodice malabarica*										
131	Red Avadavat	*Amandava amandava*										
132	Scaly-breasted Munia	*Lonchura punctulata*										
133	House Sparrow	*Passer domesticus*						1				
134	Baya Weaver	*Ploceus philippinus*										
135	Brahminy Starling	*Sturnus pagodarum*										
136	Common Myna	*Acridotheres tristis*						4				
137	Pied Starling	*Gracupica contra*										
138	Rosy Starling	*Pastor roseus*										
139	Chestnut-tailed Starling	*Sturnia malabarica*										
140	Indian Golden Oriole	*Oriolus kundoo*										
141	House Crow	*Corvus splendens*					10	1				1
142	Indian(Large-billed) Jungle Crow	*Corvus macrorhynchos culminatus*						3				
143	Purple Sunbird	*Cinnyris asiaticus*										
144	Purple-rumped Sunbird	*Leptocoma zeylonica*						2				
145	Vigor's Sunbird	*Aethopyga siparaja vigorsii*										
146	White-spotted Fantail	*Rhipidura albicollis albogularis*										
147	White-browed Fantail	*Rhipidura aureola*										
Total	147Species	Individual Number	3274	7681	8285	5156	3812	949	6287	3952	1350	3265
		Number of Species	10	21	21	22	36	46	33	16	15	13
			39				56			22		
			67									

Appendix 1 (5) Number of the Identified Birds at each point (Migratory Birds)

No.	英名	学名	Location 3 (Mahul Bay)									
			1st Survey				2nd Survey			3rd Survey		
			2016/2/27	2016/2/28	2016/3/2	2016/3/3	2016/3/31	2016/4/3	2016/4/5	2016/5/11	2016/5/13	2016/5/14
1	Greater Flamingo	*Phoenicopterus roseus*	55	181	100	42	300	6	40	34	68	60
2	Lesser Flamingo	*Phoeniconaias minor*	8289	12000	13000	4800	11000	6000	4000	900	800	500
3	Little Cormorant	*Microcarbo niger*								1	1	
4	Indian Cormorant	*Phalacrocorax fuscicollis*										
5	Black-crowned Night Heron	*Nycticorax nycticorax*										
6	Striated Heron	*Butorides striata*					1	1		6	5	
7	Indian Pond-Heron	*Ardeola grayii*	1				13	7	16	7	21	25
8	Cattle Egret	*Bubulcus ibis*								4		
9	Little Egret	*Egretta garzetta*	15				10	3	10	16		15
10	Western Reef-Heron	*Egretta gularis*	5	6	3	2	9	6	10	15	16	13
11	Great Egret	*Ardea alba*	25		10	2	15	6	41	28	70	28
12	Grey Heron	*Ardea cinerea*	15	37	2	2	2	2	2	2	2	2
13	Intermediate Egret	*Ardea intermedia*		13			8		5			
14	Purple Heron	*Ardea purpurea*									1	
15	Asian Openbill	*Anastomus oscitans*										
16	Woolly-necked stork	*Ciconia episcopus*										
17	Painted Stork	*Mycteria leucocephala*	2	15			9	11	9	7	8	21
18	Eurasian Spoonbill	*Platalea leucorodia*										
19	Black-headed Ibis	*Threskiornis melanocephalus*	12	50	2	10	11	11	13	20	22	15
20	Glossy Ibis	*Plegadis falcinellus*	30									
21	Lesser Whistling Duck	*Dendrocygna javanica*								100		280
22	Common Teal	*Anas crecca*	9	4								
23	Garganey	*Anas querquedula*					50					
24	Osprey	*Pandion haliaetus*	6	4	5	1						
25	Black Kite	*Milvus migrans*	15	20	10	5	19	15	7	7	23	11
26	Black-eared Kite	*Milvus migrans lineatus/formosanus*			20		4	2				
27	Shikra	*Accipiter badius*										
28	Eurasian Sparrow-Hawk	*Accipiter nisus*										
29	Greater Spotted Eagle	*Aquila clanga*					1					
30	Indian Spotted Eagle	*Aquila hastata*					2					
31	Marsh Harrier	*Circus aeruginosus*										
32	Pallid Harrier	*Circus macrourus*										
33	Brahminy Kite	*Haliastur indus*	2	15	4	2	5	3	1	2	1	2
34	Grey Francolin(Call)	*Francolinus pondicerianus*										
35	Baillon's Crake	*Zapornia pusilla*										
36	White-breasted Waterhen	*Amaurornis phoenicurus*						3	1	2		
37	Greater Painted-snipe	*Rostratula benghalensis*										
38	Common Ringed Plover	*Charadrius hiaticula*										
39	Little Ringed Plover	*Charadrius dubius*										
40	Kentish Plover	*Charadrius alexandrinus*							25	1		1
41	Lesser Sand-Plover	*Charadrius mongolus*			500		2		25		22	17
42	Greater Sand-Plover	*Charadrius leschenaultii*	2					20				
43	Pacific Golden Plover	*Pluvialis apricaria*		2				25				
44	Grey Plover/Black-bellied Plover	*Pluvialis squatarola*		11	1	2	4	1	10	1		
45	Red-wattled Lapwing	*Vanellus indicus*										
46	Ruddy Turnstone	*Arenaria interpres*		3				7	1	31	1	
47	Little Stint	*Calidris minuta*				104	7	13	9		6	
48	Temminck's Stint	*Calidris temminckii*										
49	Dunlin	*Calidris alpina*						1				
50	Curlew Sandpiper	*Calidris ferruginea*	30		200	88	35	16	90		5	
51	Great Knot	*Calidris tenuirostris*							2		13	
52	Broad-billed Sandpiper	*Calidris falcinellus*				16	2		1			
53	Sanderling	*Calidris alba*										
54	Spotted Redshank	*Tringa erythropus*										
55	Common Redshank	*Tringa totanus*	1			11	2	1	15		1	3
56	Marsh Sandpiper	*Tringa stagnatilis*				2		3	1			
57	Common Greenshank	*Tringa nebularia*			2		1	1	3			
58	Green Sandpiper	*Tringa ochropus*										
59	Wood Sandpiper	*Tringa glareola*										
60	Common Sandpiper	*Actitis hypoleucos*	5		15	6	7	4	7	1		
61	Terek Sandpiper	*Xenus cinereus*						1	1			6
62	Black-tailed Godwit	*Limosa limosa*	50	89	30	15	22	23	4	34	18	14
63	Bar-tailed Godwit	*Limosa lapponica*									27	
64	Eurasian Curlew	*Numenius arquata*	1	3			7	3	3		5	
65	Whimbrel	*Numenius phaeopus*	3	11	15	4	8	1				1
66	Common Snipe	*Gallinago gallinago*										
67	Jack Snipe	*Lymnocryptes minimus*										
68	Black-winged Stilt	*Himantopus himantopus*				1	7	11				
69	Crab-Plover	*Dromas ardeola*										
70	Lesser Black-backed Gull	*Larus fuscus*			2							
71	Heuglin's Gull	*Larus heuglini*	1						1		1	
72	Steppe Gull	*Larus heuglini barabensis*										
73	Pallas's Gull	*Ichthyaetus ichthyaetus*	2	5	3		1	1	3			
74	Brown-headed Gull	*Chroicocephalus brunnicephalus*	30	12	40		16	110	250	5	6	1
75	Slender-billed Gull	*Chroicocephalus genei*										
76	Black-headed Gull	*Chroicocephalus ridibundus*		1	10		1	4	4			
77	Whiskered Tern	*Chlidonias hybrida*	15	10	5		26	13	80	6	10	10
78	Caspian Tern	*Hydroprogne caspia*	8	3	20	1	3	3	4	1	2	
79	Gull-billed Tern	*Gelochelidon nilotica*	15		20		7	20	20	3	19	2
80	Common Tern	*Sterna hirundo*			3			6				
81	Little Tern	*Sternula albifrons*			60		21	1		1	6	
82	Saunders's Tern	*Sternula saundersi*						1				
83	Rock Pigeon(Feral Pigeon)	*Columba livia*		1						25		
84	Spotted Dove	*Streptopelia chinensis*										
85	Laughing Dove	*Spilopelia senegalensis*										
86	Alexandrine Parakeet	*Psittacula eupatria*										
87	Rose-ringed Parakeet	*Psittacula krameri*	2									
88	Southern Coucal	*Centropus sinensis parroti*										
89	Asian Koel	*Eudynamys scolopaceus*										
90	Little Swift	*Apus affinis*								20		

Appendix 1 (6) Number of the Identified Birds at each point (Migratory Birds)

No.	英名	学名	Location 3 (Mahul Bay)									
			1st Survey				2nd Survey			3rd Survey		
			2016/2/27	2016/2/28	2016/3/2	2016/3/3	2016/3/31	2016/4/3	2016/4/5	2016/5/11	2016/5/13	2016/5/14
91	Asian Palm-Swift	*Cypsiurus balasiensis*										
92	Pied Kingfisher	*Ceryle rudis*										
93	Black-capped Kingfisher	*Halcyon pileata*						1				
94	White-throated Kingfisher	*Halcyon smyrnensis*					1					
95	Common Kingfisher	*Alcedo atthis*						1				
96	Green Bee-eater	*Merops orientalis*										
97	Blue-tailed Bee-eater	*Merops philippinus*										
98	Indian Roller	*Coracias benghalensis*										
99	Coppersmith Barbet	*Psilopogon haemacephalus*										
100	Plain/Sand Martin(?)	*Riparia palundicola/Riparia riparia(?)*						3				
101	Barn Swallow	*Hirundo rustica*	2	5		2	7	7	3		3	
102	Wire-tailed Swallow	*Hirundo smithii*								3	3	
103	Red-rumped Swallow	*Cecropis daurica*										
104	Dusky Crag Martin	*Ptyonoprogne concolor*										
105	Yellow Wagtail	*Motacilla flava*										
106	Grey Wagtail	*Motacilla cinerea*										
107	White Wagtail	*Motacilla alba*										
108	White-browed Wagtail	*Motacilla maderaspatensis*										
109	Common Iora	*Aegithina tiphia*										
110	Red-vented Bulbul	*Pycnonotus cafer*					3			4		
111	Red-whiskered Bulbul	*Pycnonotus jocosus*								6		
112	White-eared Bulbul	*Pycnonotus leucotis*								2		
113	Long-tailed Shrike	*Lanius schach*										
114	Bluethroat	*Luscinia svecica*										
115	Pied Bushchat	*Saxicola caprata*										
116	Oriental Magpie-Robin	*Copsychus saularis*										
117	Jungle Babbler	*Turdoides striata*										
118	Yellow-eyed Babbler	*Chrysomma sinense*										
119	Blyth's Reed-Warbler	*Acrocephalus dumetorum*										
120	Clamorous Reed-Warbler	*Acrocephalus stentoreus*								2		
121	Common Chiffchaff	*Phylloscopus collybita*										
122	Lesser Whitethroat	*Sylvia curruca*										
123	Common Tailorbird	*Orthotomus sutorius*										
124	Plain Prinia	*Prinia inornata*										
125	Ashy Prinia	*Prinia socialis*					2					
126	Red-breasted/Taiga Flycatcher	*Ficedula parva/Ficedula albicilla*										
127	Indian Robin	*Saxicoloides fulicatus*										
128	Tickell's Blue Flycather	*Cyornis tickelliae*										
129	Common Rosefinch	*Carpodacus erythrinus*										
130	Indian Silverbill	*Euodice malabarica*										
131	Red Avadavat	*Amandava amandava*										
132	Scaly-breasted Munia	*Lonchura punctulata*										
133	House Sparrow	*Passer domesticus*										
134	Baya Weaver	*Ploceus philippinus*										
135	Brahminy Starling	*Sturnus pagodarum*										
136	Common Myna	*Acridotheres tristis*										
137	Pied Starling	*Gracupica contra*								4		
138	Rosy Starling	*Pastor roseus*										
139	Chestnut-tailed Starling	*Sturnia malabarica*										
140	Indian Golden Oriole	*Oriolus kundoo*						1		1		
141	House Crow	*Corvus splendens*					9	6	10	7		
142	Indian(Large-billed) Jungle Crow	*Corvus macrorhynchos culminatus*					2					
143	Purple Sunbird	*Cinnyris asiaticus*					1					
144	Purple-rumped Sunbird	*Leptocoma zeylonica*										
145	Vigor's Sunbird	*Aethopyga siparaja vigorsii*										
146	White-spotted Fantail	*Rhipidura albicollis albogularis*										
147	White-browed Fantail	*Rhipidura aureola*										
Total	147Species	Individual Number	8648	12501	14082	5118	11663	6385	4727	1309	1186	1027
		Number of Species	29	24	26	21	43	45	37	36	30	21
			45				59			48		
			76									

Appendix 1 (7) Number of the Identified Birds at each point (Migratory Birds)

No.	英名	学名	Location 4 (Seawoods)									
			1st Survey				2nd Survey			3rd Survey		
			2016/2/27	2016/2/28	2016/3/2	2016/3/3	2016/3/31	2016/4/3	2016/4/5	2016/5/11	2016/5/13	2016/5/14
1	Greater Flamingo	*Phoenicopterus roseus*					50					7
2	Lesser Flamingo	*Phoeniconaias minor*	2000	1500	2500	803	3000	4500	2000	3000	850	650
3	Little Cormorant	*Microcarbo niger*	5	1			1		1		19	11
4	Indian Cormorant	*Phalacrocorax fuscicollis*	24					6		4	10	
5	Black-crowned Night Heron	*Nycticorax nycticorax*						1	2			
6	Striated Heron	*Butorides striata*		2	1	1		2	2	12	3	5
7	Indian Pond-Heron	*Ardeola grayii*	4	8	15	8	3		7	3		40
8	Cattle Egret	*Bubulcus ibis*										
9	Little Egret	*Egretta garzetta*	3		6	2	3	2	3		26	12
10	Western Reef-Heron	*Egretta gularis*				1			1	1		4
11	Great Egret	*Ardea alba*	2		3		6	13	7		11	100
12	Grey Heron	*Ardea cinerea*	2	1	3		1					
13	Intermediate Egret	*Ardea intermedia*	2	1								
14	Purple Heron	*Ardea purpurea*										
15	Asian Openbill	*Anastomus oscitans*										
16	Woolly-necked stork	*Ciconia episcopus*										
17	Painted Stork	*Mycteria leucocephala*	2		5	1	3	6	6	23	100	50
18	Eurasian Spoonbill	*Platalea leucorodia*	3									
19	Black-headed Ibis	*Threskiornis melanocephalus*		7	3	40	12	13	210	10	5	8
20	Glossy Ibis	*Plegadis falcinellus*										
21	Lesser Whistling Duck	*Dendrocygna javanica*										
22	Common Teal	*Anas crecca*										
23	Garganey	*Anas querquedula*										
24	Osprey	*Pandion haliaetus*			1	1		2				
25	Black Kite	*Milvus migrans*	1	2			2		3	12	1	8
26	Black-eared Kite	*Milvus migrans lineatus/formosanus*										
27	Shikra	*Accipiter badius*										
28	Eurasian Sparrow-Hawk	*Accipiter nisus*			1							
29	Greater Spotted Eagle	*Aquila clanga*										
30	Indian Spotted Eagle	*Aquila hastata*										
31	Marsh Harrier	*Circus aeruginosus*				1	1					
32	Pallid Harrier	*Circus macrourus*						1				
33	Brahminy Kite	*Haliastur indus*				1						
34	Grey Francolin(Call)	*Francolinus pondicerianus*	1									
35	Baillon's Crake	*Zapornia pusilla*					1					
36	White-breasted Waterhen	*Amaurornis phoenicurus*										
37	Greater Painted-snipe	*Rostratula benghalensis*										
38	Common Ringed Plover	*Charadrius hiaticula*										
39	Little Ringed Plover	*Charadrius dubius*										
40	Kentish Plover	*Charadrius alexandrinus*				1	11					
41	Lesser Sand-Plover	*Charadrius mongolus*		60	100	20	25	130	15	7	200	450
42	Greater Sand-Plover	*Charadrius leschenaultii*					25			2		
43	Pacific Golden Plover	*Pluvialis apricaria*										
44	Grey Plover/Black-bellied Plover	*Pluvialis squatarola*			25			45				
45	Red-wattled Lapwing	*Vanellus indicus*	2									2
46	Ruddy Turnstone	*Arenaria interpres*										2
47	Little Stint	*Calidris minuta*		60	100	500	5	15	11	5	4	1
48	Temminck's Stint	*Calidris temminckii*				1						
49	Dunlin	*Calidris alpina*										
50	Curlew Sandpiper	*Calidris ferruginea*		50		40		230	15	1	3	2
51	Great Knot	*Calidris tenuirostris*										
52	Broad-billed Sandpiper	*Calidris falcinellus*		10		25						
53	Sanderling	*Calidris alba*										
54	Spotted Redshank	*Tringa erythropus*										
55	Common Redshank	*Tringa totanus*	1	4	30	2	2		5	1		3
56	Marsh Sandpiper	*Tringa stagnatilis*	15									
57	Common Greenshank	*Tringa nebularia*		2		1	4	2	3			
58	Green Sandpiper	*Tringa ochropus*						2				
59	Wood Sandpiper	*Tringa glareola*	3	1								
60	Common Sandpiper	*Actitis hypoleucos*	5	5	15	2	3	20	8			
61	Terek Sandpiper	*Xenus cinereus*			1		1					5
62	Black-tailed Godwit	*Limosa limosa*										
63	Bar-tailed Godwit	*Limosa lapponica*										
64	Eurasian Curlew	*Numenius arquata*			4	1		3		1		
65	Whimbrel	*Numenius phaeopus*			3	1						
66	Common Snipe	*Gallinago gallinago*										
67	Jack Snipe	*Lymnocryptes minimus*										
68	Black-winged Stilt	*Himantopus himantopus*					9					
69	Crab-Plover	*Dromas ardeola*					1					
70	Lesser Black-backed Gull	*Larus fuscus*										
71	Heuglin's Gull	*Larus heuglini*										
72	Steppe Gull	*Larus heuglini barabensis*										
73	Pallas's Gull	*Ichthyaetus ichthyaetus*					2					
74	Brown-headed Gull	*Chroicocephalus brunnicephalus*		16	10	10			6		10	8
75	Slender-billed Gull	*Chroicocephalus genei*				5				1	8	9
76	Black-headed Gull	*Chroicocephalus ridibundus*	2			9	3	4		15		
77	Whiskered Tern	*Chlidonias hybrida*			40	4				3	40	8
78	Caspian Tern	*Hydroprogne caspia*					1	1		11	2	3
79	Gull-billed Tern	*Gelochelidon nilotica*	1			1	1	5	6		1	2
80	Common Tern	*Sterna hirundo*										
81	Little Tern	*Sternula albifrons*								1		
82	Saunders's Tern	*Sternula saundersi*										
83	Rock Pigeon(Feral Pigeon)	*Columba livia*						4		13		50
84	Spotted Dove	*Streptopelia chinensis*						1				
85	Laughing Dove	*Spilopelia senegalensis*										1
86	Alexandrine Parakeet	*Psittacula eupatria*		1								
87	Rose-ringed Parakeet	*Psittacula krameri*		3								2
88	Southern Coucal	*Centropus sinensis parroti*	1				1				1	
89	Asian Koel	*Eudynamys scolopaceus*	3				1	4	4	1	2	3
90	Little Swift	*Apus affinis*										

Appendix 1 (8)　Number of the Identified Birds at each point (Migratory Birds)

No.	英名	学名	Location 4 (Seawoods)									
			1st Survey				2nd Survey			3rd Survey		
			2016/2/27	2016/2/28	2016/3/2	2016/3/3	2016/3/31	2016/4/3	2016/4/5	2016/5/11	2016/5/13	2016/5/14
91	Asian Palm-Swift	*Cypsiurus balasiensis*			2	3		2	4			
92	Pied Kingfisher	*Ceryle rudis*										
93	Black-capped Kingfisher	*Halcyon pileata*		2		1		2	1			
94	White-throated Kingfisher	*Halcyon smyrnensis*	2	1	1	3	1	2	3	2	2	1
95	Common Kingfisher	*Alcedo atthis*	1	1		2			3	1	2	1
96	Green Bee-eater	*Merops orientalis*					3	2	4	4	7	4
97	Blue-tailed Bee-eater	*Merops philippinus*				4						
98	Indian Roller	*Coracias benghalensis*					1					
99	Coppersmith Barbet	*Psilopogon haemacephalus*	2						1			1
100	Plain/Sand Martin(?)	*Riparia palundicola/Riparia riparia(?)*										
101	Barn Swallow	*Hirundo rustica*		20			3	4	6			
102	Wire-tailed Swallow	*Hirundo smithii*	5			8		4	10			
103	Red-rumped Swallow	*Cecropis daurica*			1							
104	Dusky Crag Martin	*Ptyonoprogne concolor*										
105	Yellow Wagtail	*Motacilla flava*										
106	Grey Wagtail	*Motacilla cinerea*										
107	White Wagtail	*Motacilla alba*										
108	White-browed Wagtail	*Motacilla maderaspatensis*				1						
109	Common Iora	*Aegithina tiphia*							1			
110	Red-vented Bulbul	*Pycnonotus cafer*					2	2	2			2
111	Red-whiskered Bulbul	*Pycnonotus jocosus*							4			4
112	White-eared Bulbul	*Pycnonotus leucotis*					3	4	15			
113	Long-tailed Shrike	*Lanius schach*					1		2			
114	Bluethroat	*Luscinia svecica*							1			
115	Pied Bushchat	*Saxicola caprata*					2					
116	Oriental Magpie-Robin	*Copsychus saularis*				1		1	2	2		2
117	Jungle Babbler	*Turdoides striata*										
118	Yellow-eyed Babbler	*Chrysomma sinense*					1	2				
119	Blyth's Reed-Warbler	*Acrocephalus dumetorum*						2	3			
120	Clamorous Reed-Warbler	*Acrocephalus stentoreus*			1	4		4			1	1
121	Common Chiffchaff	*Phylloscopus collybita*		1								
122	Lesser Whitethroat	*Sylvia curruca*										
123	Common Tailorbird	*Orthotomus sutorius*					2	1	1		1	5
124	Plain Prinia	*Prinia inornata*	2				1					
125	Ashy Prinia	*Prinia socialis*	1			1	1	4	2	1	3	15
126	Red-breasted/Taiga Flycatcher	*Ficedula parva/Ficedula albicilla*		1	1							
127	Indian Robin	*Saxicoloides fulicatus*							2			1
128	Tickell's Blue Flycather	*Cyornis tickelliae*										
129	Common Rosefinch	*Carpodacus erythrinus*					1					
130	Indian Silverbill	*Euodice malabarica*										
131	Red Avadavat	*Amandava amandava*										
132	Scaly-breasted Munia	*Lonchura punctulata*							4			
133	House Sparrow	*Passer domesticus*										
134	Baya Weaver	*Ploceus philippinus*							2			
135	Brahminy Starling	*Sturnus pagodarum*										
136	Common Myna	*Acridotheres tristis*					2	4	4	2		2
137	Pied Starling	*Gracupica contra*							10			6
138	Rosy Starling	*Pastor roseus*					25	25	50			
139	Chestnut-tailed Starling	*Sturnia malabarica*									11	1
140	Indian Golden Oriole	*Oriolus kundoo*					1	1	5		2	1
141	House Crow	*Corvus splendens*				1		25	50	20		40
142	Indian(Large-billed) Jungle Crow	*Corvus macrorhynchos culminatus*				1			2	2		
143	Purple Sunbird	*Cinnyris asiaticus*		1			2		2		1	6
144	Purple-rumped Sunbird	*Leptocoma zeylonica*						4	2		1	
145	Vigor's Sunbird	*Aethopyga siparaja vigorsii*										
146	White-spotted Fantail	*Rhipidura albicollis albogularis*								1	4	
147	White-browed Fantail	*Rhipidura aureola*				4			2			2
Total	147Species	Individual Number	2095	1761	2872	1516	3230	5107	2515	3162	1331	1541
		Number of Species	27	26	25	39	45	43	50	30	30	45
			65				77			54		
			102									

Appendix 1 (9) Number of the Identified Birds at each point (Migratory Birds)

No.	英名	学名	Location 5 (Shivaji Nagar)									
			1st Survey				2nd Survey			3rd Survey		
			2016/2/27	2016/2/28	2016/3/2	2016/3/3	2016/3/31	2016/4/3	2016/4/5	2016/5/11	2016/5/13	2016/5/14
1	Greater Flamingo	*Phoenicopterus roseus*										
2	Lesser Flamingo	*Phoeniconaias minor*	1500	12000	10000	10000	1500	2813	2500	1445	3131	2000
3	Little Cormorant	*Microcarbo niger*			3	4	1	2			1	
4	Indian Cormorant	*Phalacrocorax fuscicollis*										1
5	Black-crowned Night Heron	*Nycticorax nycticorax*							1		1	
6	Striated Heron	*Butorides striata*		1						3		
7	Indian Pond-Heron	*Ardeola grayii*	15	60	28	3	21	16	3	3	8	4
8	Cattle Egret	*Bubulcus ibis*				2					1	
9	Little Egret	*Egretta garzetta*	6		60	4	10	27	10		1	25
10	Western Reef-Heron	*Egretta gularis*	1	1	2	4	1	1			1	
11	Great Egret	*Ardea alba*	7	2		15	9	2	15		4	1
12	Grey Heron	*Ardea cinerea*	2						2			
13	Intermediate Egret	*Ardea intermedia*	2	6						2		
14	Purple Heron	*Ardea purpurea*					1					
15	Asian Openbill	*Anastomus oscitans*					1			5		
16	Woolly-necked stork	*Ciconia episcopus*										
17	Painted Stork	*Mycteria leucocephala*	6	6	2	1	1		8		10	20
18	Eurasian Spoonbill	*Platalea leucorodia*										
19	Black-headed Ibis	*Threskiornis melanocephalus*	2	6	5	2	7	4	4	4	4	5
20	Glossy Ibis	*Plegadis falcinellus*										
21	Lesser Whistling Duck	*Dendrocygna javanica*										
22	Common Teal	*Anas crecca*										
23	Garganey	*Anas querquedula*										
24	Osprey	*Pandion haliaetus*										
25	Black Kite	*Milvus migrans*	2		2		2	3	2	1		2
26	Black-eared Kite	*Milvus migrans lineatus/formosanus*						1				
27	Shikra	*Accipiter badius*										
28	Eurasian Sparrow-Hawk	*Accipiter nisus*										
29	Greater Spotted Eagle	*Aquila clanga*										
30	Indian Spotted Eagle	*Aquila hastata*										
31	Marsh Harrier	*Circus aeruginosus*				1					1	
32	Pallid Harrier	*Circus macrourus*					1					
33	Brahminy Kite	*Haliastur indus*							1	1		
34	Grey Francolin(Call)	*Francolinus pondicerianus*										
35	Baillon's Crake	*Zapornia pusilla*										
36	White-breasted Waterhen	*Amaurornis phoenicurus*										1
37	Greater Painted-snipe	*Rostratula benghalensis*							2			
38	Common Ringed Plover	*Charadrius hiaticula*						1				
39	Little Ringed Plover	*Charadrius dubius*	3	1	1	2	1	1	5			
40	Kentish Plover	*Charadrius alexandrinus*	4				1	2				
41	Lesser Sand-Plover	*Charadrius mongolus*	16	261		100	36	4	20	8	5	303
42	Greater Sand-Plover	*Charadrius leschenaultii*										1
43	Pacific Golden Plover	*Pluvialis apricaria*					20	12	17			
44	Grey Plover/Black-bellied Plover	*Pluvialis squatarola*										
45	Red-wattled Lapwing	*Vanellus indicus*				2	6	2	2	1	1	2
46	Ruddy Turnstone	*Arenaria interpres*					5		3			
47	Little Stint	*Calidris minuta*	25	107	2	5	9		2			
48	Temminck's Stint	*Calidris temminckii*					3	13				
49	Dunlin	*Calidris alpina*										
50	Curlew Sandpiper	*Calidris ferruginea*			10	12	7	15	11			
51	Great Knot	*Calidris tenuirostris*										
52	Broad-billed Sandpiper	*Calidris falcinellus*			3		2		7			
53	Sanderling	*Calidris alba*										
54	Spotted Redshank	*Tringa erythropus*										
55	Common Redshank	*Tringa totanus*	5	1	3	4	4	1	5		3	2
56	Marsh Sandpiper	*Tringa stagnatilis*	1									
57	Common Greenshank	*Tringa nebularia*		2	1	1			2			1
58	Green Sandpiper	*Tringa ochropus*						1				
59	Wood Sandpiper	*Tringa glareola*						1	1		1	
60	Common Sandpiper	*Actitis hypoleucos*	2	2	1	2	7	2	1		2	1
61	Terek Sandpiper	*Xenus cinereus*		1			2					
62	Black-tailed Godwit	*Limosa limosa*			1							
63	Bar-tailed Godwit	*Limosa lapponica*										
64	Eurasian Curlew	*Numenius arquata*	1	1	1	1	2	1	2		1	3
65	Whimbrel	*Numenius phaeopus*			5	1	2					
66	Common Snipe	*Gallinago gallinago*						1				
67	Jack Snipe	*Lymnocryptes minimus*					1	1	1			
68	Black-winged Stilt	*Himantopus himantopus*										
69	Crab-Plover	*Dromas ardeola*										
70	Lesser Black-backed Gull	*Larus fuscus*										
71	Heuglin's Gull	*Larus heuglini*				1						
72	Steppe Gull	*Larus heuglini barabensis*										
73	Pallas's Gull	*Ichthyaetus ichthyaetus*										
74	Brown-headed Gull	*Chroicocephalus brunnicephalus*	7	10		40	5	9	5	4	5	2
75	Slender-billed Gull	*Chroicocephalus genei*			8			5				
76	Black-headed Gull	*Chroicocephalus ridibundus*										1
77	Whiskered Tern	*Chlidonias hybrida*	24	10			3		4	1	3	
78	Caspian Tern	*Hydroprogne caspia*			1							
79	Gull-billed Tern	*Gelochelidon nilotica*			1	2	5	5	1	4		3
80	Common Tern	*Sterna hirundo*										
81	Little Tern	*Sternula albifrons*					3	13			1	1
82	Saunders's Tern	*Sternula saundersi*										
83	Rock Pigeon(Feral Pigeon)	*Columba livia*		1			6	45	50			5
84	Spotted Dove	*Streptopelia chinensis*										2
85	Laughing Dove	*Spilopelia senegalensis*		11		1	2		2	1		
86	Alexandrine Parakeet	*Psittacula eupatria*										
87	Rose-ringed Parakeet	*Psittacula krameri*										
88	Southern Coucal	*Centropus sinensis parroti*										
89	Asian Koel	*Eudynamys scolopaceus*						1				3
90	Little Swift	*Apus affinis*										

Appendix 1 (10)　Number of the Identified Birds at each point (Migratory Birds)

No.	英名	学名	Location 5 (Shivaji Nagar)									
			1st Survey				2nd Survey			3rd Survey		
			2016/2/27	2016/2/28	2016/3/2	2016/3/3	2016/3/31	2016/4/3	2016/4/5	2016/5/11	2016/5/13	2016/5/14
91	Asian Palm-Swift	*Cypsiurus balasiensis*				6						
92	Pied Kingfisher	*Ceryle rudis*							1			
93	Black-capped Kingfisher	*Halcyon pileata*		2	2			1				
94	White-throated Kingfisher	*Halcyon smyrnensis*	2	4	1	1	1	2	3		1	1
95	Common Kingfisher	*Alcedo atthis*		4		2	3					1
96	Green Bee-eater	*Merops orientalis*					3				2	2
97	Blue-tailed Bee-eater	*Merops philippinus*							30			
98	Indian Roller	*Coracias benghalensis*										
99	Coppersmith Barbet	*Psilopogon haemacephalus*										
100	Plain/Sand Martin(?)	*Riparia palundicola/Riparia riparia(?)*										
101	Barn Swallow	*Hirundo rustica*				4	1		3			5
102	Wire-tailed Swallow	*Hirundo smithii*										
103	Red-rumped Swallow	*Cecropis daurica*										10
104	Dusky Crag Martin	*Ptyonoprogne concolor*	4	5								
105	Yellow Wagtail	*Motacilla flava*										
106	Grey Wagtail	*Motacilla cinerea*										
107	White Wagtail	*Motacilla alba*	1									
108	White-browed Wagtail	*Motacilla maderaspatensis*										
109	Common Iora	*Aegithina tiphia*										
110	Red-vented Bulbul	*Pycnonotus cafer*				1	9	1	6		2	5
111	Red-whiskered Bulbul	*Pycnonotus jocosus*				2	1				4	
112	White-eared Bulbul	*Pycnonotus leucotis*					1		3	3		2
113	Long-tailed Shrike	*Lanius schach*				3	1	1	1			
114	Bluethroat	*Luscinia svecica*										
115	Pied Bushchat	*Saxicola caprata*										
116	Oriental Magpie-Robin	*Copsychus saularis*										1
117	Jungle Babbler	*Turdoides striata*						2				
118	Yellow-eyed Babbler	*Chrysomma sinense*					2					
119	Blyth's Reed-Warbler	*Acrocephalus dumetorum*					1					
120	Clamorous Reed-Warbler	*Acrocephalus stentoreus*					7	1	7	1		
121	Common Chiffchaff	*Phylloscopus collybita*										
122	Lesser Whitethroat	*Sylvia curruca*										
123	Common Tailorbird	*Orthotomus sutorius*										
124	Plain Prinia	*Prinia inornata*					3					
125	Ashy Prinia	*Prinia socialis*		1			4	1	2	4	1	
126	Red-breasted/Taiga Flycatcher	*Ficedula parva/Ficedula albicilla*										
127	Indian Robin	*Saxicoloides fulicatus*					2		1	1	1	2
128	Tickell's Blue Flycather	*Cyornis tickelliae*										
129	Common Rosefinch	*Carpodacus erythrinus*										
130	Indian Silverbill	*Euodice malabarica*										
131	Red Avadavat	*Amandava amandava*						10	50			47
132	Scaly-breasted Munia	*Lonchura punctulata*										
133	House Sparrow	*Passer domesticus*					3					4
134	Baya Weaver	*Ploceus philippinus*							6			10
135	Brahminy Starling	*Sturnus pagodarum*						1				
136	Common Myna	*Acridotheres tristis*					2				2	
137	Pied Starling	*Gracupica contra*		2				8	16			4
138	Rosy Starling	*Pastor roseus*					13	6	120			
139	Chestnut-tailed Starling	*Sturnia malabarica*										
140	Indian Golden Oriole	*Oriolus kundoo*							1			
141	House Crow	*Corvus splendens*	17	50			6	20	5	10	14	17
142	Indian(Large-billed) Jungle Crow	*Corvus macrorhynchos culminatus*					6		3		2	
143	Purple Sunbird	*Cinnyris asiaticus*				1			3			
144	Purple-rumped Sunbird	*Leptocoma zeylonica*					1					
145	Vigor's Sunbird	*Aethopyga siparaja vigorsii*										
146	White-spotted Fantail	*Rhipidura albicollis albogularis*										
147	White-browed Fantail	*Rhipidura aureola*										
Total	147Species	Individual Number	1655	12558	10143	10230	1757	3059	2950	1502	3214	2500
		Number of Species	24	27	23	32	54	42	48	19	29	37
			52				77			55		
			94									

Appendix 1 (11) Number of the Identified Birds at each point (Migratory Birds)

No.	英名	学名	Location 6 (TS. Rehman)					
			2nd Survey			3rd Survey		
			2016/3/31	2016/4/3	2016/4/5	2016/5/11	2016/5/13	2016/5/14
1	Greater Flamingo	*Phoenicopterus roseus*						
2	Lesser Flamingo	*Phoeniconaias minor*			106		50	50
3	Little Cormorant	*Microcarbo niger*		3	1	1		
4	Indian Cormorant	*Phalacrocorax fuscicollis*			5		2	
5	Black-crowned Night Heron	*Nycticorax nycticorax*						
6	Striated Heron	*Butorides striata*		1	1	2	5	
7	Indian Pond-Heron	*Ardeola grayii*	20	5	20	4	15	
8	Cattle Egret	*Bubulcus ibis*		1				
9	Little Egret	*Egretta garzetta*	3	8	20	20	7	4
10	Western Reef-Heron	*Egretta gularis*	3	3	3	2	8	3
11	Great Egret	*Ardea alba*	3	5	12		100	
12	Grey Heron	*Ardea cinerea*		1	1			
13	Intermediate Egret	*Ardea intermedia*	7	1	2		7	
14	Purple Heron	*Ardea purpurea*	1				2	
15	Asian Openbill	*Anastomus oscitans*		1		15	20	
16	Woolly-necked stork	*Ciconia episcopus*		1				
17	Painted Stork	*Mycteria leucocephala*	4	20	6	15	12	8
18	Eurasian Spoonbill	*Platalea leucorodia*						
19	Black-headed Ibis	*Threskiornis melanocephalus*	4	8	7	6	10	3
20	Glossy Ibis	*Plegadis falcinellus*						
21	Lesser Whistling Duck	*Dendrocygna javanica*						
22	Common Teal	*Anas crecca*						
23	Garganey	*Anas querquedula*						
24	Osprey	*Pandion haliaetus*		1	1			
25	Black Kite	*Milvus migrans*		3	4	2		
26	Black-eared Kite	*Milvus migrans lineatus/formosanus*						
27	Shikra	*Accipiter badius*						
28	Eurasian Sparrow-Hawk	*Accipiter nisus*						
29	Greater Spotted Eagle	*Aquila clanga*						
30	Indian Spotted Eagle	*Aquila hastata*						
31	Marsh Harrier	*Circus aeruginosus*						
32	Pallid Harrier	*Circus macrourus*						
33	Brahminy Kite	*Haliastur indus*	1		2	1		
34	Grey Francolin(Call)	*Francolinus pondicerianus*						
35	Baillon's Crake	*Zapornia pusilla*						
36	White-breasted Waterhen	*Amaurornis phoenicurus*			1		1	
37	Greater Painted-snipe	*Rostratula benghalensis*						
38	Common Ringed Plover	*Charadrius hiaticula*						
39	Little Ringed Plover	*Charadrius dubius*						
40	Kentish Plover	*Charadrius alexandrinus*						
41	Lesser Sand-Plover	*Charadrius mongolus*	2	2	3			
42	Greater Sand-Plover	*Charadrius leschenaultii*						
43	Pacific Golden Plover	*Pluvialis apricaria*						
44	Grey Plover/Black-bellied Plover	*Pluvialis squatarola*	1	1	1			
45	Red-wattled Lapwing	*Vanellus indicus*						
46	Ruddy Turnstone	*Arenaria interpres*	4	3	1			
47	Little Stint	*Calidris minuta*	5		1			
48	Temminck's Stint	*Calidris temminckii*						
49	Dunlin	*Calidris alpina*						
50	Curlew Sandpiper	*Calidris ferruginea*						
51	Great Knot	*Calidris tenuirostris*						
52	Broad-billed Sandpiper	*Calidris falcinellus*	1	2				
53	Sanderling	*Calidris alba*		2				
54	Spotted Redshank	*Tringa erythropus*						
55	Common Redshank	*Tringa totanus*		4	2			
56	Marsh Sandpiper	*Tringa stagnatilis*						
57	Common Greenshank	*Tringa nebularia*		4	1			
58	Green Sandpiper	*Tringa ochropus*	2					
59	Wood Sandpiper	*Tringa glareola*						
60	Common Sandpiper	*Actitis hypoleucos*			1			
61	Terek Sandpiper	*Xenus cinereus*						
62	Black-tailed Godwit	*Limosa limosa*						
63	Bar-tailed Godwit	*Limosa lapponica*						
64	Eurasian Curlew	*Numenius arquata*						
65	Whimbrel	*Numenius phaeopus*	1					
66	Common Snipe	*Gallinago gallinago*						
67	Jack Snipe	*Lymnocryptes minimus*						
68	Black-winged Stilt	*Himantopus himantopus*						
69	Crab-Plover	*Dromas ardeola*						
70	Lesser Black-backed Gull	*Larus fuscus*						
71	Heuglin's Gull	*Larus heuglini*						
72	Steppe Gull	*Larus heuglini barabensis*						
73	Pallas's Gull	*Ichthyaetus ichthyaetus*						
74	Brown-headed Gull	*Chroicocephalus brunnicephalus*		20	60	16	1	
75	Slender-billed Gull	*Chroicocephalus genei*						
76	Black-headed Gull	*Chroicocephalus ridibundus*						7
77	Whiskered Tern	*Chlidonias hybrida*		7	3		2	
78	Caspian Tern	*Hydroprogne caspia*	1					
79	Gull-billed Tern	*Gelochelidon nilotica*	1	13	5		4	4
80	Common Tern	*Sterna hirundo*		2				
81	Little Tern	*Sternula albifrons*	2					
82	Saunders's Tern	*Sternula saundersi*						
83	Rock Pigeon(Feral Pigeon)	*Columba livia*		12				
84	Spotted Dove	*Streptopelia chinensis*						
85	Laughing Dove	*Spilopelia senegalensis*						
86	Alexandrine Parakeet	*Psittacula eupatria*			1			2
87	Rose-ringed Parakeet	*Psittacula krameri*			2			
88	Southern Coucal	*Centropus sinensis parroti*		1	2		1	
89	Asian Koel	*Eudynamys scolopaceus*	1	2	2	1	2	1
90	Little Swift	*Apus affinis*						

Appendix 1 (12)　Number of the Identified Birds at each point (Migratory Birds)

No.	英名	学名	Location 6 (TS. Rehman)					
			2nd Survey			3rd Survey		
			2016/3/31	2016/4/3	2016/4/5	2016/5/11	2016/5/13	2016/5/14
91	Asian Palm-Swift	*Cypsiurus balasiensis*	1	8	2	3	3	3
92	Pied Kingfisher	*Ceryle rudis*					1	
93	Black-capped Kingfisher	*Halcyon pileata*	1	1				
94	White-throated Kingfisher	*Halcyon smyrnensis*	3	1	3	1		2
95	Common Kingfisher	*Alcedo atthis*	2		1			
96	Green Bee-eater	*Merops orientalis*	5	4	3	2	10	5
97	Blue-tailed Bee-eater	*Merops philippinus*						
98	Indian Roller	*Coracias benghalensis*						
99	Coppersmith Barbet	*Psilopogon haemacephalus*		1	1	1	2	1
100	Plain/Sand Martin(?)	*Riparia paludicola/Riparia riparia(?)*						
101	Barn Swallow	*Hirundo rustica*						
102	Wire-tailed Swallow	*Hirundo smithii*						
103	Red-rumped Swallow	*Cecropis daurica*						
104	Dusky Crag Martin	*Ptyonoprogne concolor*						
105	Yellow Wagtail	*Motacilla flava*			2			
106	Grey Wagtail	*Motacilla cinerea*						
107	White Wagtail	*Motacilla alba*						
108	White-browed Wagtail	*Motacilla maderaspatensis*		1				
109	Common Iora	*Aegithina tiphia*			1		1	
110	Red-vented Bulbul	*Pycnonotus cafer*					3	
111	Red-whiskered Bulbul	*Pycnonotus jocosus*			1	2	4	2
112	White-eared Bulbul	*Pycnonotus leucotis*	2	5				
113	Long-tailed Shrike	*Lanius schach*						
114	Bluethroat	*Luscinia svecica*						
115	Pied Bushchat	*Saxicola caprata*						
116	Oriental Magpie-Robin	*Copsychus saularis*		6	1	3	1	1
117	Jungle Babbler	*Turdoides striata*						
118	Yellow-eyed Babbler	*Chrysomma sinense*						
119	Blyth's Reed-Warbler	*Acrocephalus dumetorum*			3			
120	Clamorous Reed-Warbler	*Acrocephalus stentoreus*			1			
121	Common Chiffchaff	*Phylloscopus collybita*						
122	Lesser Whitethroat	*Sylvia curruca*						
123	Common Tailorbird	*Orthotomus sutorius*		1	1		4	2
124	Plain Prinia	*Prinia inornata*		1				
125	Ashy Prinia	*Prinia socialis*		4	1	1	5	2
126	Red-breasted/Taiga Flycatcher	*Ficedula parva/Ficedula albicilla*						
127	Indian Robin	*Saxicoloides fulicatus*						
128	Tickell's Blue Flycather	*Cyornis tickelliae*					1	
129	Common Rosefinch	*Carpodacus erythrinus*						
130	Indian Silverbill	*Euodice malabarica*						
131	Red Avadavat	*Amandava amandava*						
132	Scaly-breasted Munia	*Lonchura punctulata*						
133	House Sparrow	*Passer domesticus*		2				
134	Baya Weaver	*Ploceus philippinus*					1	
135	Brahminy Starling	*Sturnus pagodarum*						
136	Common Myna	*Acridotheres tristis*				2		4
137	Pied Starling	*Gracupica contra*				1	2	1
138	Rosy Starling	*Pastor roseus*						
139	Chestnut-tailed Starling	*Sturnia malabarica*						
140	Indian Golden Oriole	*Oriolus kundoo*					2	
141	House Crow	*Corvus splendens*	4	15	15		15	5
142	Indian(Large-billed) Jungle Crow	*Corvus macrorhynchos culminatus*		4	2			2
143	Purple Sunbird	*Cinnyris asiaticus*		2				1
144	Purple-rumped Sunbird	*Leptocoma zeylonica*		1			4	2
145	Vigor's Sunbird	*Aethopyga siparaja vigorsii*					1	
146	White-spotted Fantail	*Rhipidura albicollis albogularis*			1			
147	White-browed Fantail	*Rhipidura aureola*					1	1
Total	147Species	Individual Number	85	194	316	101	310	116
			27	45	46	21	36	24
		Number of Species	66			46		
			75					

Appendix 2 (1)　Lists of the Identified Species (Benthos)

No.	Class	Order	Family	Scientific Name
1	Malacostraca	Decapoda	Penaeidae	*Penaeus monodon*
2				*Penaeus penicillatus*
3				*Penaeus semisulcatus*
4				*Penaeus merguiensis*
5				*Metapenaeus affinis*
6				*Metapenaeus dobsoni*
7				*Metapenaeus stridulans*
8				*Parapenaeopsis sculptilis*
9				*Parapenaeopsis stylifera*
10			Sergestidae	*Acetes indicus*
11			Palinuridae	*Panulirus polyphagus*
12			Portunidae	*Scylla serrata*
13				*Portunus sanguinolentus*
14				*Charybdis cruciata*
15			Matutidae	*Matuta lunaris*
16			Xanthidae	*Leptodius exaratus*
17			Eriphiidae	*Eriphia smithii*
18			Ocypodidae	*Uca annulipes*
19			Paguridae	*Pagurus prideauxi*
20		Stomatopoda	Squillidae	*Squilla mantis*
21	Gastropoda	Vetigastropoda	Trochidae	*Trochus stellatus*
22				*Trochus radiatus*
23				*Trochus tentorium*
24				*Clancules ceylonicus*
25			Turbinidae	*Astrea stellata*
26		(Not assigned)	Chilodontidae	*Euchelus asper*
27		Neritimorpha	Neritidae	*Nerita oryzarum*
28				*Nerita crepidularia*
29				*Nerita albicilla*
30		Discopoda	Ficidae	*Ficus gracilis*
31			Rostellariidae	*Tibia curta*
32			Bursidae	*Bursa lissostroma*
33				*Bursa spinosa*
34				*Bursa elegans*
35				*Bursa tuberculata*
36			Naticidae	*Natica picta*
37				*Natica maculosa*
38			Planaxidae	*Planaxis sulcatus*
39		Sorbeoconcha	Potamididae	*Telescopium telescopium*
40				*Potamides cingulatus*
41			Cypraeidae	*Erosaria lamarckii*
42		Neogastropoda	Babyloniidae	*Babylonia spirata*
43			Buccinidae	*Cantharus spiralis*
44			Cancellariidae	*Cancellaria costifera*
45			Conidae	*Conus mutabilis*
46			Muricidae	*Murex adustus*
47				*Murex tribulus*
48				*Murex brunneus*
49				*Ocinebra bombayana*
50				*Thais carinifera*

Appendix (2) Lists of the Identified Species (Benthos)

No.	Class	Order	Family	Scientific Name
51	Gastropoda			*Thais sacellum*
52			Clavatulidae	*Surcula javana*
53			Turridae	*Surcula amicta*
54			Drilliidae	*Clavus crassa*
55			Melongenidae	*Hemifuus pugilinus*
56				*Hemifuus cochlidium*
57		Systellommatophora	Onchidiidae	*Onchidium damelii*
58		Basommatophora	Siphonariidae	*Siphonaria laciniosa*
59	Bivalvia	Pectinoida	Pectinidae	*Chlamys singaporina*
60			Placunidae	*Placuna placenta*
61		Arcoida	Arcidae	*Arca granosa*
62		Veneroida	Cardiidae	*Cardium flavum*
63			Cyrenidae	*Villorita cyprinoides*
64			Mesodesmatidae	*Mactra cornea*
65			Veneridae	*Meretrix meretrix*
66				*Meretrix casta*
67				*Meretrix lyrata*
68				*Callista erycina*
69				*Dosinia cretacea*
70				*Dosinia gibba*
71				*Katelysia opima*
72	Cephalopoda	Octopoda	Octopodidae	*Octopus herdmani*
73			Amphitretidae	*Amphitretus pelagicus*
74		Sepiida	Sepiidae	*Sepia officinalis*
75		Teuthida	Loliginidae	*Loligo vulgaris*
Total	4	16	43	75

APPENDIX-18

Birds Long-term Monitoring Plan

The Project for Construction of Mumbai Trans Harbor Link

Birds Long-term Monitoring Plan

(Draft)

20th June, 2016

Table of Contents

1. Objectives

The surveys are carried out for the purpose of collecting the basic data in order to grasp impacts of the construction and to examine the need of conservation measures and the appropriate conservation measures approach by investigating inhabitation and habitat situation (feeding environments and physical surroundings) of migratory birds (mainly Flamingos) during and after the constructions.

2. Survey Area

The survey area is in and around the planning project area (Sewri mudflat, Shivaji Nagar mudflat, neighboring forests and surrounding marine waters) shown in Figure 2-1.

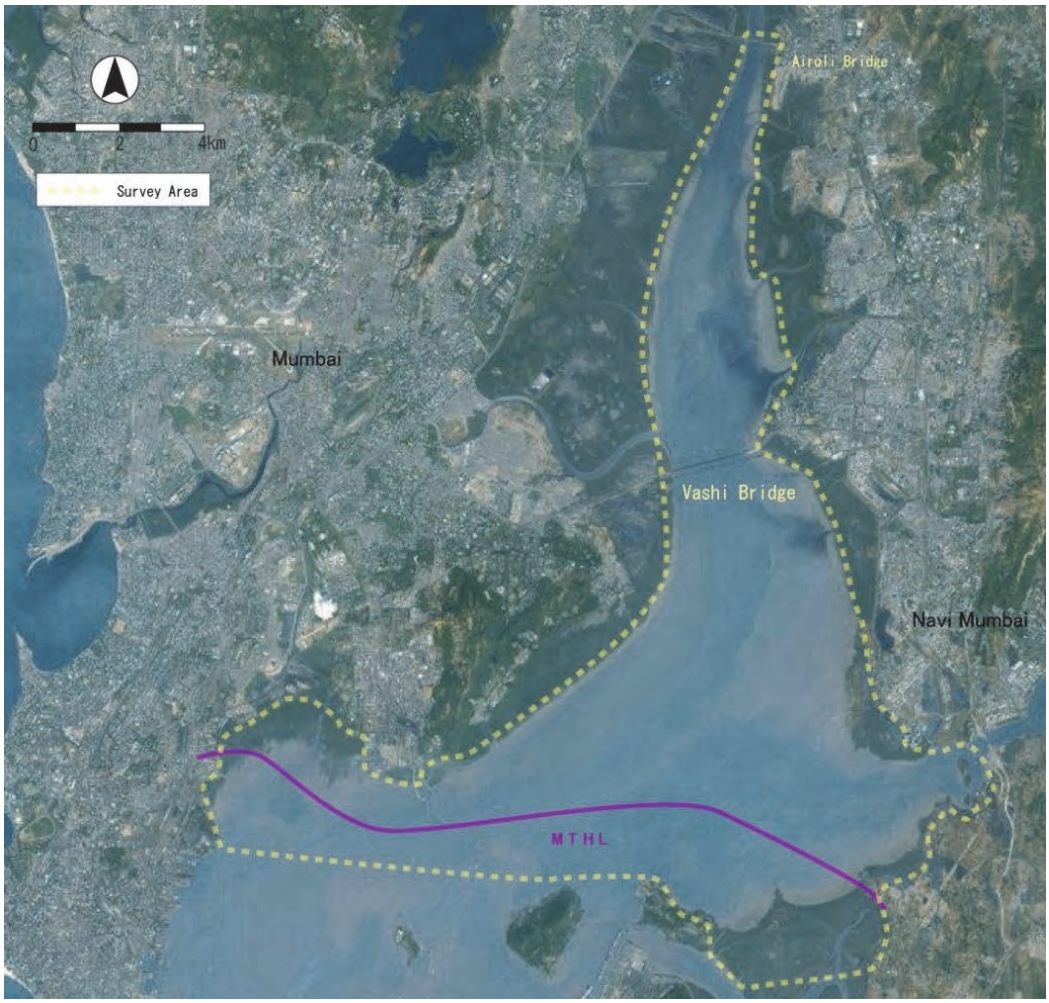


Figure 2-1 Survey Area

3. Survey Methods

3.1 Birds Survey

3.1.1 Flamingo Survey

(1) Survey to count the population

A survey to count the population of flamingos in the mudflats will be implemented to grasp flamingos' habitat distribution and the number of individuals in Mumbai Bay. Details of the survey methods are shown in Table 3-1.

Table 3-1 Outline of the survey (Count the population)

Objective	Habitat distribution and the population of flamingos during and after the construction are grasped.
Target	Lesser Flamingo (*Phoenicopterus minor*), Greater Flamingo (*Phoenicopterus roseus*)
Frequency	3 times in all on approximately a monthly basis from February to May when the population of flamingos is expected to be the most.
Time	For about 1 hour around the time of ebb
Method	The number of individuals of flamingos is counted by using binoculars of 8-10 magnifications at each fixed point.
Location	7 points shown in Table 3-2 and Figure 3-1 * Location 2 (Sewri Bay) and Location3 (Mahul Bay) are survey points on ships.

Table 3-2 Outline of the survey points

No.	Name	Visible Area (km^2)	Outline
Location1	Sewri Jetty	1.0	At a jetty in Sewri mudflat Western part of Sewri mudflat is observed.
Location2	Sewri Bay	0.5	On a ship Central part of Sewri mudflat is observed from marine waters.
Location3	Mahul Bay	1.5	On a ship Eastern part of Sewri mudflat is observed from Mahul Creek.
Location4	Seawoods	3.8	At a jetty in Seawoods section Seawoods mudflat is observed.
Location5	Shivaji Nagar	1.3	At a jetty in Shivaji-Nagar section Mudflats in Shivaji-Nagar section are observed.
Location6	TS. Rahaman	1.0	At a jetty in TS.Rahaman university Mudflats in TS.Rahaman section are observed.
Location7	Airoli Bridge	0.3	On Airoli bridge Mudflats on the south of Airoli bridge are observed.

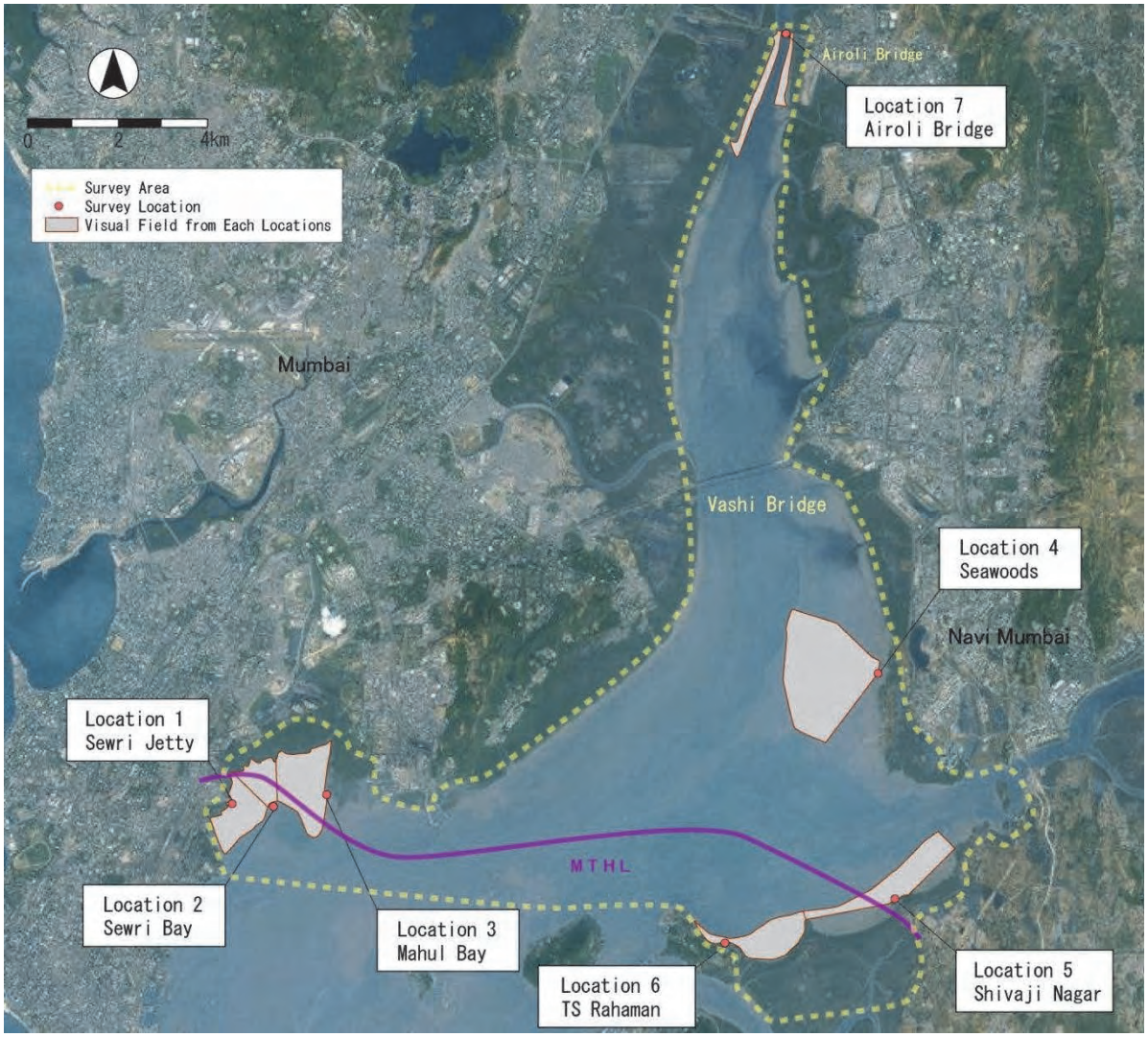


Figure 3-1 Location of the survey points and their visible Area (Count the population)

(2) Flying Routes Survey

A fixed-point observation to confirm flying routes of flamingos will be implemented to grasp flamingos' traveling condition within the mudflat during and after the construction. Details of the survey methods are shown in Table 3-3.

Table 3-3 Outline of the survey (Flying Routes)

Objective	Flying routes of flamingos over whole Mumbai Bay during and after the construction are grasped.
Target	Lesser Flamingo (*Phoenicopterus minor*)
Frequency	3 times in all on approximately a monthly basis from February to May when the population of flamingos is expected to be the most.
Time	Times when the tide rises and the mudflats which are flamingos' feeding fields are submerged, after the survey to count the population.
Method	The number of the individuals, flying routes and flying altitudes are recorded by using binoculars of 8-10 magnifications and telescope of 20-60 magnifications at each fixed point.
Location	7 points similar to the survey to count the population
Notes	Flying routes from roosting area to feeding fields are optionally observed.

(3) Roosting Areas Survey

This survey will be carried out to grasp inhabiting situation of flamingos at roosts identified in the baseline survey during and after the construction. Details of the survey methods are shown in Table 3-4.

Table 3-4 Outline of the survey (Roosting Areas)

Objective	Roosts and resting sites of flamingos around Sewri mudflat during and after the construction are grasped.
Target	Lesser Flamingo (*Phoenicopterus minor*), Greater Flamingo (*Phoenicopterus roseus*)
Frequency	From February to May when the population of flamingos in Mumbai Bay is expected to be the most
Time	Times when the tide is high and the mudflats which are flamingos' feeding fields are submerged
Method	- About 7 roosts identified in the baseline survey, species, population and flying direction are recorded. - When it is assumed that new roosts exist as a result of the flying routes survey, the roosts will be identified by appropriate surveys. - In case that the new roosts are identified, their location, species, population and flying direction are recorded.
Location	- 7 roosts identified in the baseline survey (Shown in Figure 3-2) - When it is determined that new roosts exist, optional survey will be carried out.

Figure 3-2 The survey points (Roosting Areas)

3.1.2 Migratory Birds Survey

This survey will be carried out to grasp avifauna, especially inhabiting situation of migratory birds which use mudflats, during and after the construction. Details of the survey methods are shown in Table 3-5.

Table 3-5 Outline of the survey (Migratory Birds)

Objective	Avifauna around the project site during and after the construction is grasped.
Target	General birds
Frequency	3 times in all on approximately a monthly basis from February to May when the population of flamingos is expected to be the most.
Time	Basically during the occurrence of mudflats
Method	Their species (avifauna), population and condition when they are identified are recorded by using binoculars of 8-10 magnifications and telescope of 20-60 magnifications at the fixed survey points and from the census routes on ships.
Location	6 points shown in Figure 3-3

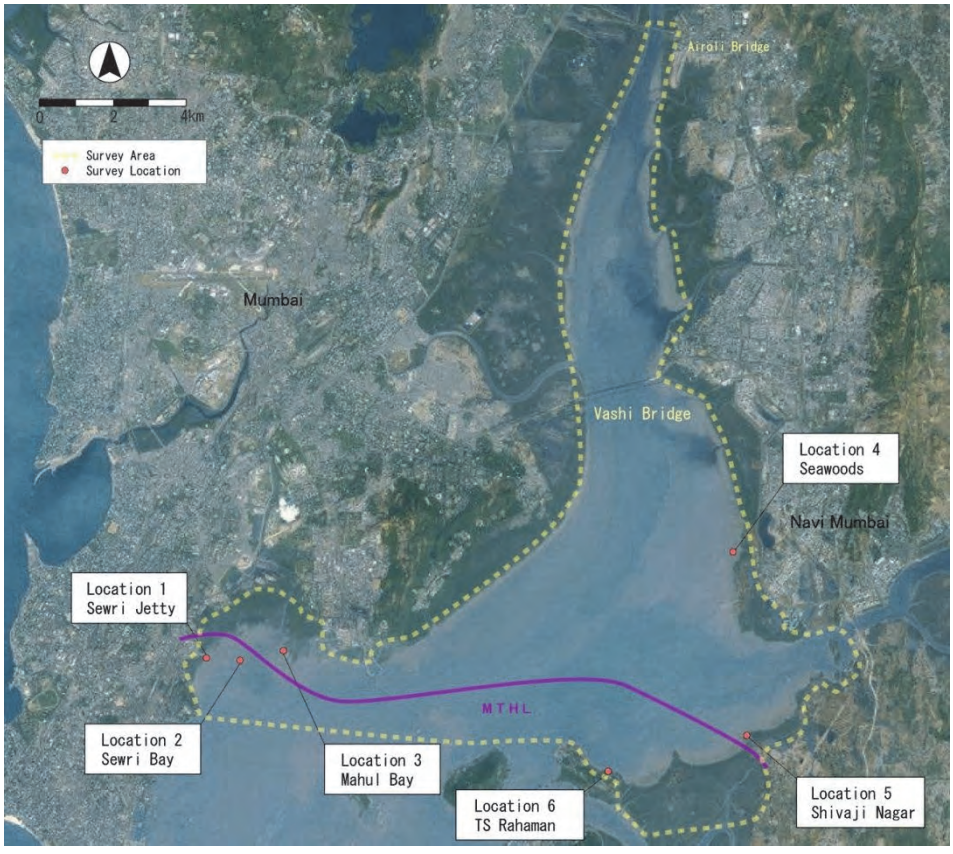


Figure 3-3 The survey points (Migratory Birds)

3.2 Physical Habitat Survey

3.2.1 Mudflats survey

This survey will be carried out to grasp distribution of mudflats during and after the construction by deciphering aerial photographs and field surveys. Details of the survey methods are shown in Table 3-6.

Table 3-6 Outline of the survey (Mudflats)

Objective	Situation of mudflat area during and after the construction is grasped.
Target	Distribution of mudflat
Frequency	Once from February to May
Time	Basically daylight hours (for about 2 hours around the time of ebb)
Method	- Mudflat distribution map based on the results of the baseline survey (Figure 3-4) is compared to the latest aerial photographs. In case that mudflat distribution has changed, the map will be revised. - Field surveys will be implemented with the revised map and the aerial photographs (close-up photographs of the photographs computerized as needed). In case that mudflat distribution has changed by the construction, the map will be revised.
Location	The whole survey area, mainly in and around the project site (Sewri mudflat and Shivaji Nagar mudflat)

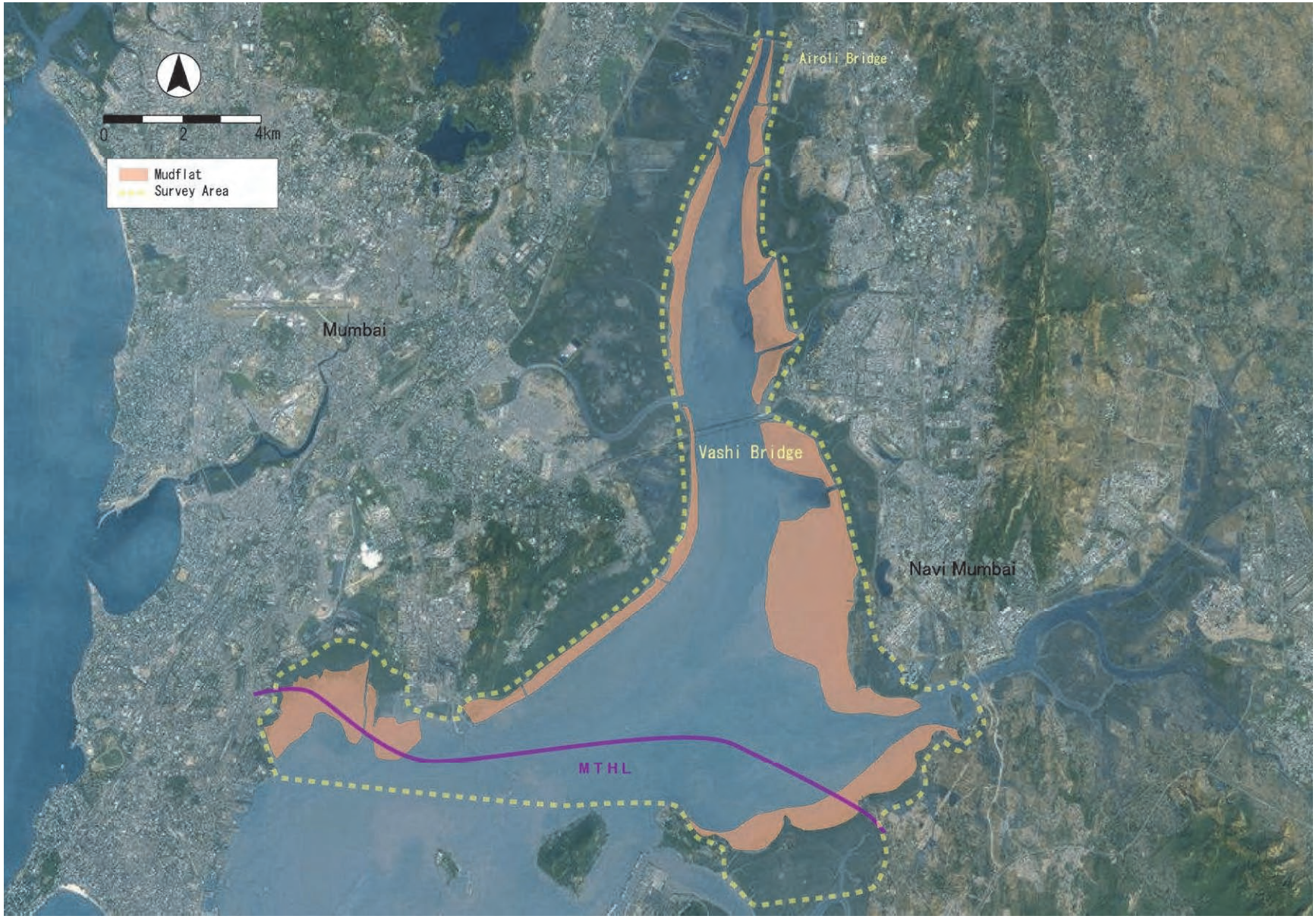


Figure 3-4 The result of the baseline survey (Mudflats)

3.2.2 Noise Survey

This survey will be carried out to grasp situation of noise around habitats of flamingos and the project site during and after the construction. Details of the survey methods are shown in Table 3-7.

Table 3-7 Outline of the survey (Noise)

Objective	Actual situation of noise around the project site and habitats of flamingos during and after the construction is grasped.
Target	Background noise
Frequency	3 times in all on approximately a monthly basis from February to May with the counting survey.
Time	For 24 hours
Method	The measurements are carried out consecutively for 24 hours at 1.2m above the ground of the site boundary. Integration normal noise level meters are used.
Location	5 points shown in Table 3-8 and Figure 3-5.

Table 3-8 Outline of the survey points

Point No.	Latitude and Longitude	Outline of the point
Location 1 Sewri Jetty	18° 59' 48.20"N 72° 51' 59.33"E	In a mudflat in Sewri area Currently, the mudflat is feeding field and roosting area of flamingos.
Location 2 TATA Jetty	18° 59' 57.21"N 72° 53' 57.02"E	Near a cooling pond of TATA Currently, the point is near roosts of flamingos.
Location 3 Trombay	19° 01' 14.20"N 72° 57' 09.60"E	Nearby Trombay area Currently, the area is feeding field and roosting area of flamingos.
Location 4 Seawoods	19° 01' 17.74"N 72° 57' 1.85" E	Nearby a mudflat in Seawoods area Currently, the area is feeding field of flamingos.
Location 5 TS. Rahaman	18° 58' 2.29" N 72° 58' 4.96" E	At a jetty in TS.Rahaman university There is a possibility to be a habitat of flamingos in the future.

Figure 3-5 The survey points (Noise)

3.3 Habitat Environments Survey

3.3.1 Flora Survey

(1) Mangrove Distribution Survey

This survey will be carried out to grasp current situation of mangrove forests during and after the construction by deciphering aerial photographs and field surveys. Details of the survey methods are shown in Table 3-9.

Table 3-9 Outline of the survey (Mangrove Distribution)

Objective	Distribution range of mangrove forests during and after the construction is grasped.
Target	Distribution of mangrove forests
Frequency	Once from February to May
Time	Basically daylight hours
Method	- Mangrove distribution map based on the results of the baseline survey (Figure 3-6) is compared to the latest aerial photographs. In case that mangrove distribution has changed, the map will be revised. - Field surveys will be implemented with the revised map and the aerial photographs (close-up photographs of the photographs computerized as needed). In case that mangrove distribution has changed by the construction, the map will be revised.
Location	Whole Mumbai Bay, mainly in and around the project site (Sewri mudflat and Shivaji Nagar mudflat)

Figure 3-6 The result of the baseline survey (Mangrove Distribution)

(2) Mangrove Growth Situation Survey

This survey will be carried out to grasp growth situation of mangrove forests during and after the construction by field surveys. Details of the survey methods are shown in Table 3-10.

Table 3-10 Outline of the survey (Mangrove Growth Situation)

Objective	Growth situation of mangrove forests during and after the construction is grasped.
Target	Growth situation of mangrove forests
Frequency	Once from February to May
Time	Basically daylight hours
Method	- Field surveys in the range of 100m * 100m which represent each survey area are implemented. And Species there are identified.
Location	4 points shown in Figure 3-7

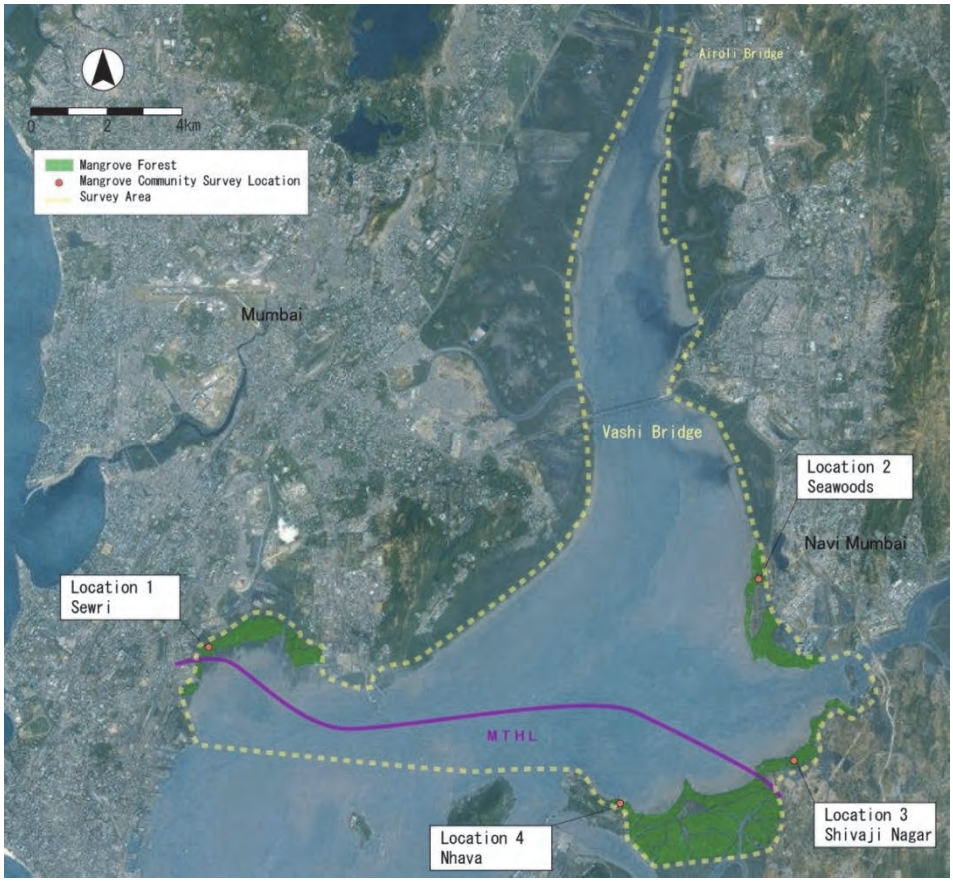


Figure 3-7 The survey points (Mangrove Growth Situation)

3.3.2 Aquatic Fauna Survey

(1) Fishes Survey

This survey will be carried out to grasp growth situation of fishes during and after the construction by field surveys. Details of the survey methods are shown in Table 3-11.

Table 3-11 Outline of the survey (Fishes)

Objective	Piscifauna and the volume of inhabitation in marine waters in and around the project site during and after the construction are grasped.
Target	General fish
Frequency	Once from February to May
Time	Basically daylight hours
Method	- Caught fishes by seine nets using ships are identified their species. - Mudskippers which are on the mud surface of the mudflat at low tide are verified.
Location	- Targets of checking the caught fishes are fishes caught at 2 points shown in Figure 3-8 - Arbitrary visual observations for mudskippers on the mudflat are implemented.

Figure 3-8 The survey points (Fishes)

(2) Benthos Survey

This survey will be carried out to grasp growth situation of benthos during and after the construction by field surveys. Details of the survey methods are shown in Table 3-12.

Table 3-12 Outline of the survey (Benthos)

Objective	Benthos aspects and the volume of inhabitation in marine waters in and around the project site during and after the construction are grasped.
Target	General benthos
Frequency	Once from February to May
Time	At low tide
Method	- 25-square-cm patch of quadrates are set up. Crabs and other benthic animals that live in the mud of the surface layer (within 10cm depth) are collected with the mud. The collected mud is strained sand and mud through a 0.5mm-eyes sieve to extract macrobenthos. - Core samples of mud (diameter 3.5cm* depth 5cm) are collected to understand Meiobenthos Communities. - Collected samples are fixed with 8% Rose Bengal formalin solution.
Location	3 lines in Sewri mudflat side and 3 lines in Shivaji Nagar mudflat side (Figure 3-9) Samplings are at 3 points (1 point each in high, middle and low tide area) on each line.

Figure 3-9 The survey points (Benthos)

(3) Planktons Survey

This survey will be carried out to grasp current situation of planktons during and after the construction by field surveys. Details of the survey methods are shown in Table 3-13.

Table 3-13 Outline of the survey (Planktons)

Objective	The situation of feeding environments of migratory birds such as flamingos during and after the construction.
Target	Phytoplankton, Zooplankton, Algae
Frequency	Once from February to May
Time	Basically daylight hours
Method	(1) Zooplankton - MARUKAWA's quantitative plankton nets or equivalent plankton nets are used for samplings. - The plankton nets are pulled horizontally about 3 times at approximately 0.5m/s speed. Flow meters are installed in the nets, and the volume of filtered water is recorded. - Neutral formalin or alcohols are used for fixing in the fields. Analysis is carried out indoors. (2) Phytoplankton - Sampling is from one layer of surface layer (0.5m). 1 liter of water is sampled and held in polyethylene bottles. - Neutral formalin or acid/neutral Lugol's solution are used for fixing in the fields. Additive amount of neutral Lugol's solution becomes approximately 1% of density. The samples are kept cold and taken to the laboratory. Analysis is carried out indoors.
Location	4 points around the project site shown in Figure 3-10.

Figure 3-10 The survey points (Planktons)

4. Implementation Schedule

This survey is carried out continuously for 10 years from 2017 to 2026.

Schedule of the survey items is shown in Table 4-1.

Table 4-1 Survey Schedule

Items		2017～2026			
		Feb.	Mar.	Apr.	May
Birds Survey	Flamingos - Counting the population - Flying Routes - Roosting Area				
	Migratory Birds				
Physical Surroundings Survey	Mudflats distribution				
	Noise				
Habitat Environments Survey	Flora - Mangrove Distribution - Mangrove Growth Situation				
	Aquatic Fauna - Fishes - Benthos - Planktons				

APPENDIX-19

2nd Stakeholder Meeting for Draft Fisheries Compensation Plan

1.1 2nd Stakeholder meeting summary

1.1.1 2nd Stage Stakeholder Meeting For MAHUL, SEWRI & TROMBAY

The second Stakeholder's meeting was organized with all fishers on 11th August 2016 in Mahul Gram Samiti hall, nearby vicinity of the PAPs. This second stakeholder's meeting was chaired by Deputy Engineer of MMRDA Mr Ganesh Deshpande along with the JICA study team members. The number of participants in the consultation session were approximately 125, as the meeting was held in between 3 villages for the convenience of the fishers. The details of the issues raised and discussed with the response provided by MMRDA official & consultation team is presented below.

Details of Second Consultation with PAPs at Affected Area

Sr. No	Organization	Attendance
1.	MMRDA	One officer in charge
2.	BEIPL Team (JICA Study Team Consultant)	six consultant in charge
3.	Mahul Fishing Business and Other Works Community Service Organization Ltd. (Mahul Matsyavyavasay Vividh Karyakari Sahakari Seva Sanstha Maryadit)	Mr. Koli and about 45 project affected fishermen of Mahul and Sewri village
4.	Turbhe Fishers and Other works Community Service Organization Ltd. (Turbhe Macchimar Vivisdh Karyakari Sahakari Sanstha Maryadit)	Mr Chandrakanth Vaity (chairman) and about 60 project affected fishermen from Trombay village.

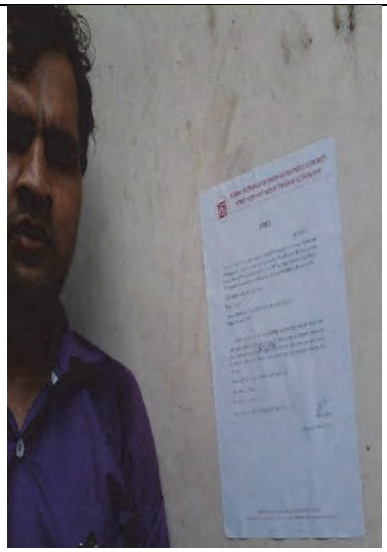
Table 1.1: Issues Discussed And Response Provided By MMMRDA & JICA Study Team

Sr. No.	Issues Discussed	MMRDA & BEIPL Team
1	Mr Sakharam Koli, from Mahul pointed out that the 750 meters impact zone on both sides is not enough. Activities like drilling and construction will create vibrations that will affect the fish of that particular area.	BEIPL Team explained that the category C4, C5 and C6 of the compensation policy have been designed keeping in mind these issues including accidents or mishaps that may take place during the construction.
2	Mr Chandrakant Vaity, from Trombay complained that the compensation money Rs 5,84,000 wasn't enough and this compensation should be increased. He further said that the compensation promised instead of incase of any grave accidents hasn't been declared yet. This amount should be declared beforehand. He also requested that the Trombay fishing community should be given a letter by the revenue department officiating the process of this survey. He also mentioned that they have not been offered any jobs until now. He also requested that all the areas of fishing along with the position of the boats should be marked again using GPS. Mr Koli from Mahul, mentioned that all fishing committees should be given the	Points were noted by MMRDA.

	meetings of every meeting that is being held to discuss the compensation policy.	
3	Mr Surayakant Vaity said that even if they were using drag nets and SUS nets, there was going to be a change in the current of the water which would mean decreasing the population of fish available.	BEIPL Team replied by explaining the report that was generated by Central Water and Power Research Station (CWPRS), Pune (CWPRS) has created a report in which they studied the area in the proposed alignment. They have mentioned that the change in the current would be minimal approximately about 10 % and care will be taken during construction that the turbidity of water is kept to bare minimum as there will be constant water samples analyzed.
4	Mr Narendra Patil requested that no restrictions should be kept for travelling like we have restrictions to travel near Bhabha Atomic Research Centre (BARC) and the TATA jetty.	Point was noted by MMRDA.

Sewri

Mahul



Trombay

Figure 1.1: Invitation Notice Displayed in Sewri and Mahul

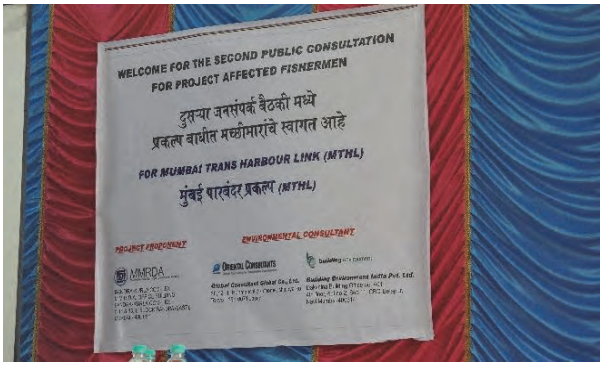


Figure 1.2: Members Present for The Meeting Along with The Stakeholders

1.1.2 2nd Stage Stakeholder Meeting For Draft Fisheries Compensation Plan at NHAVA

The second Stakeholder's meeting was organized with all fishers on 12th August 2016 in Shankar Mandir, Near Nhava Public School, nearby vicinity of the PAPs. This second stakeholder's meeting was chaired by Deputy Engineer of MMRDA Mr Ganesh Deshpande along with the JICA study team members. The number of participants in the consultation session were approximately 25. The details of the issues raised and discussed with the response provided by MMRDA official & consultation team is presented in Table 1.34 & Table 1.35. Whereas the Figure 1.54 presents the members present for the meeting as well as the issues addressed by the Stakeholders present during the meeting.

Table 1.2: Details Of Second Consultation With Paps At Affected Area

Sr. No	Organization	Attendance
1.	MMRDA	One officer in charge
2.	BEIPL Team (JICA Study Team Consultant)	four consultant in charge
3.	Fishers	Mr Mahendra Gharat (Chairman of Nhava fishing society) along with Mrs Sangeeta Boir (Sarpanch (village head) They were accompanied by fishermen of both the villages.

Table 1.3: Issues Discussed And Response Provided By MMRDA

No.	Issues Discussed	MMRDA & JICA Study Team Response
1	Mr Harishchandra Mhatre requested all the officials to increase the compensation for all categories.	MMRDA mentioned that he will put forth this request during the next meeting.
2	Mr Ganesh Gharat that people with drag nets should be considered as well. He informed everyone of the interviews that were conducted by ONGC and the results of those interviews was that they never got a job. Lastly, he raised his concern about subsistence fishermen not getting enough compensation.	MMRDA responded by saying that all fishermen who were going to be impacted were to be compensated according the severity of the impact including the subsistence fishermen and the fishermen who had nets. He also mentioned that he will put the request of the fishermen for creating more jobs to his superiors.
3	Mr Sanjay Mokal mentioned that the boats are available for rental during the construction and he also mentioned that there are a lot of educated people in the village. So the Government should try and create more jobs.	MMRDA said that they will consider giving more jobs and also according to the education we will try and appoint more jobs, if and when the need for the same arises.

Pictures from 2nd SHM at Nhava

Figure 1.3: Members present for the Second Stakeholders meeting

1.1.3 2nd Stage Stakeholder Meeting for Draft Fisheries Compensation Plan at MOHA

The second Stakeholder's meeting was organized with all fishers on 8th August 2016 in Moha, in the nearby vicinity of the PAPs. This second stakeholder's meeting was chaired by Deputy Engineer of MMRDA Mr Ganesh Deshpande. The details of the issues raised and discussed with the response provided by MMRDA official & consultation team is presented in Table 1.36 & Table 1.37. Whereas the Figure 1.55 presents the members present for the meeting as well as the issues addressed by the Stakeholders present during the meeting.

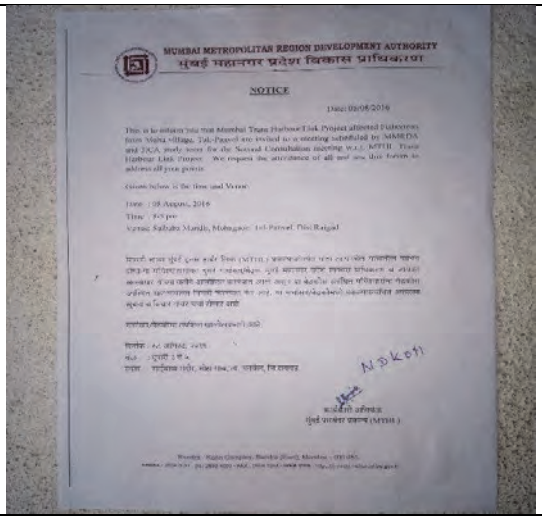
Table 1.4: Details of Second Consultation with PAPs at Affected Area

No	Organization	Attendance
1.	MMRDA	One officer in charge
2.	BEIPL Team (JICA Study Team Consultant)	six consultant in charge
3.	Fishers	Mr Pandharinath Patil (Chairman of Moha fishing society) along with Mrs Suman Koli (Chairwoman of Kombadbhuja fishing Society) They were accompanied by 48 fishermen of both the villages.

Table 1.5: Issues Discussed and Response Provided by MMRDA

No.	Issues Discussed	MMRDA & JICA Study Team Response
1	Mr Narayan Koli raised his concern about subsistence fishermen not getting enough compensation.	MMRDA responded by saying that all fishermen who were going to be impacted were to be compensated according the severity of the impact.
2	Mr Pandhrinath Patil expressed his concerns regarding the process of approaching the redressal committee if any fishermen had to go through the process.	MMRDA addressed him by saying that the process was fairly easy for all fishermen to follow and all the officials were available for any concerns that the fishermen would have for the process of compensation.

Moha



Kombadbhuja

Figure 1.1: Invitation Notice Displayed in Moha and Kombadbhuja

Figure 1.2: Members present for the Second Stakeholders meeting

1.1.4 2nd Stage Stakeholder Meeting For GAVHAN

The second Stakeholder's meeting was organized with all fishers on 13th October 2016 in Gavhan Gram Panchayat office, nearby vicinity of the PAPs. Figure 1.52 indicates the Invitation Notice displayed in Gavhan. This second stakeholder's meeting was chaired by Mr Ram Seth Thakur (ex-MP), Mr Prashant Thakur (local political leader), Mrs Ratnaprabha Gharat (Sarpanch), Superintendent Engineer Mr Nagargoje and Deputy Engineer Mr Ganesh Deshpande from MMRDA along with the JICA study team members. The number of participants in the consultation session were approximately 57. The details of the issues raised and discussed with the response provided by MMRDA official & consultation team is presented in Table 1.32 & Table 1.33. Whereas the Figure 1.53 presents the members present for the meeting as well as the issues addressed by the Stakeholders present during the meeting.

Table 1.6: Details of Second Consultation with PAPs at Affected Area

No	Organization	Attendance
1.	MMRDA	Two officers in charge
2.	BEIPL Team (JICA Study Team Consultant)	Three consultant in charge
3.	Representatives of Gavhan	Mr Ram Seth Thakur (ex-MP) Mr Prashant Thakur (local political leader) Mrs Ratnaprabha Gharat (Sarpanch) Mr Mahendra Seth Gharat (local political leader) Mr Arun Seth Bhagat (local political leader) Mr Suresh Patil (local political leader)
4.	Representatives from Gavhan Fishing Committee	Mr Vishwanath Koli And other fishermen from Gavhan village

Table 1.7: Issues Discussed And Response Provided By MMMRDA & JICA Study Team

No.	Issues Discussed	MMRDA & JICA Study Team Response
1	Mr Thakur enquired why the category C3 was receiving lesser compensation?	MMRDA mentioned that fishermen who fall in the C3 category won't be affected gravely, which is why the compensation given to them is lesser.
2	Mr Thakur fishermen who go handpicking for fish are more affected because their fishing grounds will get disturbed. He also mentioned that all affected fishermen should get equal amounts of money. There should be no categorization. He also requested to increase the buffer zone from 750 to atleast upto 2 kms on either side.	MMRDA noted all the points. He also mentioned that he will inform the Commissioner of these demands put forth.
3	Mr Gopinath Koli enquired what does one family unit mean in the compensation mean. Please explain it to us.	MMRDA mentioned that all people in the family, the wife and kids who are dependent on the man of the house will be counted as one unit. Families having children who are earning and have families of their own will be counted as different family unit.
4	Mr Thakur requested the MMRDA officials to give the explanation for definition of family unit in writing to them.	MMRDA noted the point.
5	Mr Vishwanathan Koli enquired why Gill nets are not considered in C1 category.	BEIPL Team : as the compensation plan was already finalized by the Government, they are rightfully the only people who can take this decision along with Fisheries Compensation Committee.
6	Mr Amar Mhatre requested the MMRDA	MMRDA noted the point.

	officials to circulate minutes of all earlier	

Figure 1.3: Invitation Notice Displayed in Gavhan

Figure 1.4: Members Present for The Meeting Along with The Stakeholders

APPENDIX-20

Cost Estimate Results for MoUD and MoRTH

1.1 Introduction

Since the MTHL project is a large scale of the 6 lane sea link with 21.8 km in length including approximately 17km long bridge over the Mumbai Bai, which requires the large amount of investment, The Ministry of Urban Development (MoUD), which MMRDA is under his jurisdiction, established a committee to examine the project cost prepared by the JICA Study Team for the approval of the Project at the central level. Two times of the official meeting were held on September 1st, 2016 and October 14th, 2016, and the JICA Study Team responded to inquiries from the committee during the two meetings. As a result of the two meetings, the committee finally requested the JICA Study Team to provide the update of the construction cost but not project cost by reflecting the latest information such as the detailed geo-technical investigation supervised by MMRDA, and added and updated requirements/ specifications for the Project during the preparation of the draft bid documents/ Employer's Requirements because the project cost was formulated at the appraisal stage of the Project in January, 2016.

Since the following Appendix-20 contains a result of the updated construction cost and its breakdown for the MTHL project based on the latest geotechnical information and the Employers Requirements/Specifications, this construction cost does not affect the amount of Loan Agreement for MTHL project.

1.2 Total Construction Cost

The total construction cost estimated is shown in Table 3.1.1 and Table 3.1.2.,including the cost breakdown of each package.

Table 1.2.1 Total Construction Cost – Summary

	Total Cost (INR Cr.)
Package 1 (Western Off-Shore)	6,293.1
Package 2 (Eastern Off-Shore)	4,425.8
Package 3 (Navi Mumbai)	811.8
Package 4 (ITS)	152.6
Total	**11,683.1**

Table 1.2.2 Total Construction Cost – Breakdown

Estimated Total Construction Cost	Unit	Quantity	Total (Cr. INR)	
(01) Investigation & Tests	L. Sum	1	53.5	Package 1 to 3
(02) Detailed Design (Superstructure)	L. Sum	1	48.1	Package 1 to 3
(03) Existing Utilities Relocation	L. Sum	1	96.2	Package 1 to 3
(04) Temp. Yard & Temporary Jetty	L. Sum	1	949.0	Package 1 to 3
(05) Earthworks	L. Sum	1	105.8	Package 1 to 3
(06) Foundation	m	66,121	1,183.8	Package 1 to 3
(07) Substructure	m³	367,208	1,366.0	Package 1 to 3
(08) Superstructure (Concrete)	m²	604,198	2,733.1	Package 1 to 3
(09) Superstructure (Steel)	t	107,034	4,569.9	Package 1 to 3
(10) Dolphins	No	52	180.6	Package 1 to 3
(11) Pavement	m²	701,379	93.5	Package 1 to 3
(12) Road Furniture	L. Sum	1	151.0	Package 1 to 3
(13) ITS	L. Sum	1	152.6	Package 4
Total			**11,683.1**	

1.3 Package 1

The cost estimation for Package 1 is shown in Table 3.2.1 to Table 3.2.3.

Table 1.3.1 Cost Estimation – Package 1 – Summary

Package 1 (0+000 To 10+380)	Unit	Quantity	Total (Cr. INR)	
(01) Investigation & Tests	L. Sum	1	28.1	
(02) Detailed Design (Superstructure)	L. Sum	1	25.3	
(03) Existing Utilities Relocation	L. Sum	1	50.6	
(04) Temp. Yard & Temporary Jetty	L. Sum	1	496.5	
(05) Earthworks	L. Sum	1	3.2	
(06) Foundation	m	44,103	765.3	
(07) Substructure	m³	179,274	675.7	
(08) Superstructure (Concrete)	m²	314,250	1,448.0	
(09) Superstructure (Steel)	t	58,792	2,528.1	
(10) Dolphins	No	36	126.8	
(11) Pavement	m²	338,560	43.6	
(12) Road Furniture	L. Sum	1	102.0	
Total			**6,293.1**	

Table 1.3.2 Cost Estimation – Package 1 – Breakdown (1/2)

(01) Investigation & Tests	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Investigation & Tests	L. Sum	1	280,852,000	280,852,000	0.50% of construction cost without O.H
Subtotal	**L. Sum**	**1**		**280,852,000**	

(02) Detailed Design (Superstructure)	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Detailed Design (Superstructure)	L. Sum	1	252,767,000	252,767,000	0.45% of construction cost without O.H
Subtotal	**L. Sum**	**1**		**252,767,000**	

(03) Existing Utilities Relocation	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Existing Utilities Relocation	L. Sum	1	506,453,000	506,453,000	1% of direct construction cost
Subtotal	**L. Sum**	**1**		**506,453,000**	

(04) Temp. Yard & Temporary Jetty	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Temporary Yard	m²	163,068	1,500	244,602,000	Yard size: 508x321m
b) Temporary Jetty	m²	72,625	65,000	4,720,625,000	
Subtotal	**L. Sum**	**1**		**4,965,227,000**	

(05) Earthworks	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Excavation (Softsoil)	m³	104	350	36,400	
b) Backfill	m³	49,420	650	32,123,000	
Subtotal	**L. Sum**	**1**		**32,159,400**	

(06) Foundation	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Pile Ø1000mm (cast in situ)	m	1,736	80,000	138,880,000	Land zone
b) Pile Ø1200mm (cast in situ)	m	11,286	100,000	1,128,600,000	Land zone
c) Pile Ø1500mm (cast in situ)	m	1,023	130,000	132,990,000	Land zone
d) Pile Ø2000mm (cast in situ)	m	11,970	185,000	2,214,450,000	T. Jetty zone
	m	15,096	210,000	3,170,160,000	Marine zone
e) Pile Ø2400mm (cast in situ)	m	2,992	290,000	867,680,000	Marine zone
Subtotal	**m**	**44,103**		**7,652,760,000**	

Table 1.3.3 Cost Estimation – Package 1 – Breakdown (2/2)

(07) Substructure	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) Ramp Piers	m³	25,670	35,000	898,450,000	Land zone
b) Main Alignment Piers	m³	57,179	35,000	2,001,265,000	T. Jetty zone
	m³	96,425	40,000	3,857,000,000	Marine zone
Subtotal	**m³**	**179,274**		**6,756,715,000**	

(08) Superstructure (Concrete)	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) PC Box (50 m Span)	m²	139,445	45,000	6,275,025,000	Temp. Jetty & Land zone
	m²	121,241	50,000	6,062,050,000	Marine zone
b) PC Box (30 m Span)	m²	53,564	40,000	2,142,560,000	Land zone
Subtotal	**m²**	**314,250**		**14,479,635,000**	

(09) Superstructure (Steel)	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) Steel Deck Slab Box Girder	t	58,792	430,000	25,280,560,000	
Subtotal	**t**	**58,792**		**25,280,560,000**	

(10) Dolphins	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) 6 Piles Type	No	16	48,000,000	768,000,000	
b) 3 Piles Type	No	20	25,000,000	500,000,000	
Subtotal	**No**	**36**		**1,268,000,000**	

(11) Pavement	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) Concrete Bridge Section	m²	270,800	1,250	338,500,000	SMA 1 layer and DGA 1 layer
b) Steel Bridge Section	m²	64,160	1,400	89,824,000	SMA 2 layers
c) Road Section	m²	3,600	2,000	7,200,000	SMA 1 layer / DGA 1 layer / Subbase 2 layers
Subtotal	**m²**	**338,560**		**435,524,000**	

(12) Road Furniture	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) RCC Crash Barrier	m	52,512	4,000	210,048,000	
b) Noise Barrier	m²	25,500	6,000	153,000,000	
c) Opaque Barrier	m²	18,000	18,000	324,000,000	
d) Anti Falling Object Barrier	m²	2,814	4,000	11,256,000	
e) Drainage 100mm	m	57,860	300	17,358,000	
f) Line Mark	m	71,661	250	17,915,167	
g) Retro-Reflectorised Traffic Sign	No	78	15,000	1,170,000	
h) Inspection Platform	No	77	2,200,000	169,400,000	
j) Road Illumination Installation Works	No	773	150,000	115,950,000	Main Align.: 3 per 50m / Ramp: 1 per 50m
Subtotal	**L. Sum**	**1**		**1,020,097,167**	

1.4 Package 2

The cost estimation for Package 2 is shown in Table 3.3.1 to Table 3.3.3.

Table 1.4.1 Cost Estimation – Package 2 – Summary

Package 2 (10+380 To 18+187)	Unit	Quantity	Total (Cr. INR)
(01) Investigation & Tests	L. Sum	1	20.7
(02) Detailed Design (Superstructure)	L. Sum	1	18.6
(03) Existing Utilities Relocation	L. Sum	1	36.4
(04) Temp. Yard & Temporary Jetty	L. Sum	1	447.1
(05) Earthworks	L. Sum	1	64.8
(06) Foundation	m	18,394	383.7
(07) Substructure	m³	132,874	497.7
(08) Superstructure (Concrete)	m²	210,203	961.5
(09) Superstructure (Steel)	t	43,596	1,874.6
(10) Dolphins	No	16	53.8
(11) Pavement	m²	233,788	30.3
(12) Road Furniture	L. Sum	1	36.7
Total			**4,425.8**

Table 1.4.2 Cost Estimation – Package 2 – Breakdown (1/2)

(01) Investigation & Tests	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Investigation & Tests	L. Sum	1	206,697,000	206,697,000	0.50% of construction cost without O.H
Subtotal	**L. Sum**	**1**		**206,697,000**	

(02) Detailed Design (Superstructure)	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Detailed Design (Superstructure)	L. Sum	1	186,027,000	186,027,000	0.45% of construction cost without O.H
Subtotal	**L. Sum**	**1**		**186,027,000**	

(03) Existing Utilities Relocation	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Existing Utilities Relocation	L. Sum	1	363,749,000	363,749,000	1% of direct construction cost
Subtotal	**L. Sum**	**1**		**363,749,000**	

(04) Temp. Yard & Temporary Jetty	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Temporary Yard	m²	130,900	1,500	196,350,000	Yard size: 340x385m
b) Temporary Jetty	m²	65,761	65,000	4,274,465,000	
Subtotal	**L. Sum**	**1**		**4,470,815,000**	

(05) Earthworks	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Backfill	m³	104,160	650	67,704,000	
b) Soil Reinforcement	m³	580,540	1,000	580,540,000	Average depth 3.5m
Subtotal	**L. Sum**	**1**		**648,244,000**	

(06) Foundation	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Pile Ø1000mm (cast in situ)	m	680	80,000	54,400,000	Land zone
b) Pile Ø1200mm (cast in situ)	m	414	100,000	41,400,000	Land zone
c) Pile Ø2000mm (cast in situ)	m	4,692	185,000	868,020,000	T. Jetty / Land zone
	m	9,792	210,000	2,056,320,000	Marine zone
d) Pile Ø2400mm (cast in situ)	m	2,816	290,000	816,640,000	Marine zone
Subtotal	**m**	**18,394**		**3,836,780,000**	

Table 1.4.3 Cost Estimation – Package 2 – Breakdown (2/2)

(07) Substructure	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) Ramp Piers	m³	10,544	35,000	369,040,000	Land zone
b) Main Alignment Piers	m³	29,627	35,000	1,036,945,000	Land zone
	m³	27,505	35,000	962,675,000	T. Jetty zone
	m³	65,198	40,000	2,607,920,000	Marine zone
Subtotal	**m³**	**132,874**		**4,976,580,000**	

(08) Superstructure (Concrete)	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) PC Box (50 m Span)	m²	89,457	45,000	4,025,565,000	Temp. Jetty & Land zone
	m²	84,240	50,000	4,212,000,000	Marine zone
b) PC Box (30 m Span)	m²	19,965	40,000	798,600,000	Land zone
c) RC Hollow Slab (15m Span)	m²	16,541	35,000	578,935,000	Land zone
Subtotal	**m²**	**210,203**		**9,615,100,000**	

(09) Superstructure (Steel)	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) Steel Deck Slab Box Girder	t	43,596	430,000	18,746,280,000	
Subtotal	**t**	**43,596**		**18,746,280,000**	

(10) Dolphins	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) 6 Piles Type	No	6	48,000,000	288,000,000	
b) 3 Piles Type	No	10	25,000,000	250,000,000	
Subtotal	**No**	**16**		**538,000,000**	

(11) Pavement	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) Concrete Bridge Section	m²	181,713	1,250	227,141,250	SMA 1 layer and DGA 1 layer
b) Steel Bridge Section	m²	47,575	1,400	66,605,000	SMA 2 layers
c) Road Section	m²	4,500	2,000	9,000,000	SMA 1 layer / DGA 1 layer / Subbase 2 layers
Subtotal	**m²**	**233,788**		**302,746,250**	

(12) Road Furniture	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) RCC Crash Barrier	m	35,034	4,000	140,136,000	
b) Noise Barrier	m²	3,600	6,000	21,600,000	
c) Anti Falling Object Barrier	m²	5,376	4,000	21,504,000	
d) Drainage 600mm	m	37,820	300	11,346,000	
e) Line Mark	m	46,178	250	11,544,500	
f) Retro-Reflectorised Traffic Sign	No	51	15,000	765,000	
g) Inspection Platform	No	38	2,200,000	83,600,000	
h) Road Illumination Installation Works	No	507	150,000	76,050,000	Main Align.: 3 per 50m / Ramp: 1 per 50m
Subtotal	**L. Sum**	**1**		**366,545,500**	

1.5 Package 3

The cost estimation for Package 3 is shown in Table 3.4.1 to Table 3.4.3.

Table 1.5.1 Cost Estimation – Package 3 – Summary

Package 3 (18+187 To 21+800)	Unit	Quantity	Total (Cr. INR)	
(01) Investigation & Tests	L. Sum	1	4.7	
(02) Detailed Design (Superstructure)	L. Sum	1	4.3	
(03) Existing Utilities Relocation	L. Sum	1	9.2	
(04) Temp. Yard & Temporary Jetty	L. Sum	1	5.4	
(05) Earthworks	L. Sum	1	37.8	
(06) Foundation	m	3,624	34.8	
(07) Substructure	m³	55,060	192.7	
(08) Superstructure (Concrete)	m²	79,745	323.6	
(09) Superstructure (Steel)	t	4,646	167.3	
(10) Dolphins	No	- -	- -	
(11) Pavement	m²	129,031	19.6	
(12) Road Furniture	L. Sum	1	12.3	
Total			**811.8**	

Table 1.5.2 Cost Estimation – Package 3 – Breakdown (1/2)

(01) Investigation & Tests	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Investigation & Tests	L. Sum	1	47,263,000	47,263,000	0.50% of construction cost without O.H
Subtotal	**L. Sum**	**1**		**47,263,000**	

(02) Detailed Design (Superstructure)	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Detailed Design (Superstructure)	L. Sum	1	42,536,000	42,536,000	0.45% of construction cost without O.H
Subtotal	**L. Sum**	**1**		**42,536,000**	

(03) Existing Utilities Relocation	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Existing Utilities Relocation	L. Sum	1	92,092,000	92,092,000	1% of direct construction cost
Subtotal	**L. Sum**	**1**		**92,092,000**	

(04) Temp. Yard & Temporary Jetty	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Temporary Yard	m²	36,080	1,500	54,120,000	Yard size: 300x66m and 185x88m
Subtotal	**L. Sum**	**1**		**54,120,000**	

(05) Earthworks	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Excavation (Hard Soil)	m³	344,000	350	120,400,000	
b) Backfill	m³	396,300	650	257,595,000	
Subtotal	**L. Sum**	**1**		**377,995,000**	

(06) Foundation	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Pile Ø1000mm (cast in situ)	m	720	80,000	57,600,000	Land zone
b) Pile Ø1200mm (cast in situ)	m	2,904	100,000	290,400,000	Land zone
Subtotal	**m**	**3,624**		**348,000,000**	

Table 1.5.3 Cost Estimation – Package 3 – Breakdown (2/2)

(07) Substructure	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) Ramp Piers	m³	9,650	35,000	337,750,000	Land zone
b) Main Alignment Piers	m³	45,410	35,000	1,589,350,000	Land zone
Subtotal	**m³**	**55,060**		**1,927,100,000**	

(08) Superstructure (Concrete)	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) PC Box (50 m Span)	m²	19,265	45,000	866,925,000	Land zone
b) PC Box (30 m Span)	m²	50,535	40,000	2,021,400,000	Land zone
c) RC Hollow Slab (15m Span)	m²	9,945	35,000	348,075,000	Land zone
Subtotal	**m²**	**79,745**		**3,236,400,000**	

(09) Superstructure (Steel)	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) Steel Truss	t	4,646	360,000	1,672,650,000	
Subtotal	**t**	**4,646**		**1,672,650,000**	

(10) Dolphins	Unit	Quantity	Unit Cost (INR)	Total	Conditions
Subtotal	**No**	**- -**		**- -**	

(11) Pavement	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) Concrete Bridge Section	m²	72,578	1,250	90,722,500	SMA 1 layer and DGA 1 layer
b) Steel Bridge Section	m²	12,055	1,400	16,877,000	SMA 2 layers
c) Road Section	m²	44,398	2,000	88,796,000	SMA 1 layer / DGA 1 layer / Subbase 2 layers
Subtotal	**m²**	**129,031**		**196,395,500**	

(12) Road Furniture	Unit	Quantity	Unit Cost (INR)	Total	Conditions
a) RCC Crash Barrier	m	14,242	4,000	56,968,000	
b) Anti Falling Object Barrier	m²	3,738	4,000	14,952,000	
c) Drainage 600mm	m	18,340	300	5,502,000	
d) Line Mark	m	24,415	250	6,103,667	
e) Retro-Reflectorised Traffic Sign	No	27	15,000	405,000	
f) Road Illumination Installation Works	No	261	150,000	39,150,000	Main Align.: 3 per 50m / Ramp: 1 per 50m
Subtotal	**L. Sum**	**1**		**123,080,667**	

1.6 Package 4

The cost estimation for Package 4 is shown in Table 3.5.1 and Table 3.5.2.

Table 1.6.1 Cost Estimation – Package 4 – Summary

Package 4 (ITS)	Unit	Quantity	Total (Cr. INR)
(01) Investigation & Tests	L. Sum	1	0.8
(02) Detailed Design	L. Sum	1	0.7
(03) Existing Utilities Relocation / Temp. Yard	L. Sum	1	1.5
(04) Buildings	L. Sum	1	36.5
(05) Systems	L. Sum	1	95.0
(06) Vehicles	L. Sum	1	18.1
Total			**152.6**

Table 1.6.2 Cost Estimation – Package 4 – Breakdown

(01) Investigation & Tests	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Investigation & Tests	L. Sum	1	7,596,487	7,596,487	0.50% of construction cost without O.H
Subtotal	**L. Sum**	**1**		**7,596,487**	

(02) Detailed Design	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Detailed Design	L. Sum	1	6,836,838	6,836,838	0.45% of construction cost without O.H
Subtotal	**L. Sum**	**1**		**6,836,838**	

(03) Existing Utilities Relocation / Temp. Yard	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Existing Utilities Relocation & Temp. Yard	L. Sum	1	15,042,548	15,042,548	1% of direct construction cost
Subtotal	**L. Sum**	**1**		**15,042,548**	

(04) Buildings	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Maintenance Office	m²	1,531	180,000	275,580,000	
b) Shivaji Nagar Toll Office	m²	497	180,000	89,460,000	
Subtotal	**m²**	**2,028**		**365,040,000**	

(05) Systems	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Highway Traffic Management System	L. Sum	1	657,000,000	657,000,000	
b) Toll Management System	L. Sum	1	293,000,000	293,000,000	
Subtotal	**L. Sum**	**1**		**950,000,000**	

(06) Vehicles	Unit	Quantity	Unit Cost (INR)	Total (INR)	Conditions
a) Patrol Vehicle	No	9	4,500,000	40,500,000	
b) Towing Vehicle	No	2	43,000,000	86,000,000	
c) Vehicle Mounted Crane	No	1	7,500,000	7,500,000	
d) Ambulance	No	1	3,000,000	3,000,000	
e) Bridge Inspection Vehicle	No	1	25,000,000	25,000,000	
f) Motorized Patrol Boat	No	1	8,000,000	8,000,000	
g) Road Sweeper	No	1	11,000,000	11,000,000	
Subtotal	**L. Sum**	**1**		**181,000,000**	