



The River Rejuvenation Committee **Government of Goa**

**Name of the work: Preparation of Action Plan for
Rejuvenation of Polluted Stretches of Rivers in Goa**



Action Plan Report on Chapora River

March 2019

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Abbreviations:

BOD	Bio-Chemical Oxygen Demand
CPCB	Central Pollution Control Board, New Delhi
DO	Dissolved Oxygen Content
DMA	Directorate of Municipal Administration, Panjim Goa
GSPCB	Goa State Pollution Control Board, Panjim Goa
FC	Faecal Coliform
MBGL	Meters below ground levels
MLD	Million liters per Day
NEERI	National Environmental Engineering Research Institute Nagpur
NGT	National Green Tribunal
NWMP	National Water Quality Monitoring Programme.
PWD	Public Work Department of Goa State
SEAC	State Level Environment Expert Appraisal Committee
SEIAA	State level Environment Impact Assessment Authority.
SIDCGL	Sewerage Infrastructure Development Corporation of Goa Limited, Panjim Goa.
TC	Total Coliform
ULB	Urban Local Body
WRD	Water Resources Department of Goa

References

- Salinity report by GSPCB, Panjim Goa.
- Annual parameters monitoring by GSPCB (from 2015 till 2018).
- Integrated Coastal Zone Management of Coastal Zone in Goa – Council of Scientific & Industrial Research July 2013.

Executive Summary:

Chapora River, is one of the nine major rivers flowing from the east (Western Ghats) to the west (Arabian Sea) in the north of Goa. It is located between the latitudes (15 42' 42.3" and 15 35' 53.1") and longitudes (73 51' 31.5" and 73 42' 01.3"). The river originates in the Ramghat hills in Belgaum district of Karnataka, then flows through the Tilari Ghat, gushes out though the borders and enters into Goa at Ibrampur village. The total flowing distance of the river is 32 km in the State of Goa. It finally discharges into the Arabian Sea near the Chapora beach. The total basin area of the Chapora River is 255 Sq. Km and average runoff of 588. 4 MCM. Sal, Kalana Virnoda and Parshe are the tributaries of the Chapora River.

The Goa State Pollution Control Board (GSPCB) monitors the water quality of River Chapora at two locations, i.e. at Siolim Bridge & Alorna Fort respectively. The NGT / CPCB has declared this stretch of the River between Alorna Fort (Pernem Taluka) to Morjim as a polluted stretch. The length of the polluted stretch of the river is about 24km and the whole stretch is in saline zone. The said monitoring by GSPCB is carried out on a monthly basis throughout the year under the Central Pollution Control Board Programme National Water quality Monitoring Programme (NWMP). This Stretch of the River Chapora between Morjim and Alorna fort (Pernem Taluka) is classified as SW II (for bathing, contact water sports and commercial fishing). On the basis of GSPCB reports., Central Pollution Control Board (CPCB) has classified Chapora River (Stretch from Morjim to Pernem 32 km) under Priority V, having BOD level range between 3.5 -5.2 mg/lit.

The Report of Monitoring for the period April 2015 to December, 2018 at these two locations for the parameters of DO, BOD and Faecal Coliform have been taken into consideration for the preparation of Action Plan. The observed DO levels in the polluted river stretch between Alorna fort to Morjim as can be seen from the GSPCB monitoring reports and the two NIO reports are well above the desired level of 4 mg/l required for bathing water quality. The observed BOD levels in the polluted river stretch between Alorna fort to Morjim as can be seen from the GSPCB monitoring reports and the two NIO reports are well below the desired level of 3 mg/l required for bathing water quality. The observed FC levels in the polluted river stretch between Alorna fort to Morjim as can be seen from the GSPCB monitoring reports are above the desired levels of 500 MPN/ 100ML for bathing water quality. The reports of NIO of 2013 and 2018 also indicate pollutions source in the polluted stretch between Alorna Fort to Morjim.



Image 1 Chapora River

During the survey conducted for identification of pollution sources, it has been observed that the untreated domestic sewage outfalls mainly on southern bank of the river contribute to the values of faecal coliform in the polluted stretch.

The proposed action plan for Chapora River comprises of the following key issues and action necessary to be implemented:

A. Source Control: The source control includes the industrial pollution control and treatment and disposal of domestic sewage, as detailed below;

a) Industrial Pollution Control: The source identification studies were conducted during the month of January and February 2019. There are no industrial outfalls contributing the pollution in this stretch.

b) Channelization, treatment, utilisation and disposal of treated domestic sewage:

- The physical survey carried out during Jan / Feb. 2019, the domestic untreated sewage discharge is observed from the areas like Siolim, Oxel, Colvale, Camurlim and Vagale on the Southern bank of the River. The population density in these areas is very low.
- Discharges from individual house directly into the River and also into storm water drains/Nallahs leading to the River where observed on the Northern as well as Southern Bank during the physical survey. The Directorate of Panchayat and Directorate of health services will initiate the following action through village panchayat and the health officers after carrying out details survey.

- 1) Disconnection of the direct discharge into the river/storm water drain/Nallahs.
 - 2) Installation of Bio toilets
 - 3) Construction of septic tank and soak pits by residential houses
- There is fishing jetty at Chapora and is proposed to have a toilet facility at the fishing jetty.

B. River Catchment / Basin Management: Controlled ground water extraction and periodic quality assessment.

i. Periodic monitoring of ground water resources and regulation of ground water extraction by domestic / Agricultural industries particularly over explored and critical zones:

- a) The ground water table in the region is 2 to 5 MBGL in post monsoon and lowers by 3 m from the post monsoon ground water table. The decadal variation in the ground table is about 5 – 10 MBGL. The ground water table is high in the region. In view of this fact no further action is proposed in the action plan on this issue¹.
- b) The polluted stretch of the river Chapora, is in saline zone / tidal affected and not used for irrigation purpose.

C. Flood Plane Zone:

i. Regulating activity in flood plain zone:

During the physical survey, domestic untreated sewage disposal in the tributaries is observed near Siolim. The Directorate of Panchayat and Directorate of health services will initiate action through the village panchayat and Health Officer Concern to ensure that the domestic sewage is diverted to septic tank and soak pit.

ii. Management of Municipal, Plastic Hazardous Bio-Medical & Electrical and Electronic Waste:

The Local bodies are collecting segregated non bio degradable waste which is sent to the Goa Waste Management Corporation (GWMC) and subsequently transported to the baling station at Saligao within the state. The baled non-biodegradable waste is

¹ Aquifer System of Goa, Central Ground Water Board Sept. 2013

thereafter transported to cement plants in Karnataka for co incineration. However, the issue of treatment of biodegradable waste is limited to the Panchayat of Morjim, Oxel, Siolim, Asagao and Anjuna, as these are villages having commercial activity and residential complex. The solid waste generated from these Panchayat is treated at the Solid waste facility at Calangute/Saligao. The remaining panchayat are predominantly having single dwelling units and there is no major issue disposal of biodegradable waste.

However improvement in the house to house collection of segregated waste and necessary installation of transfer station for non-biodegradable waste would be completed within period of 6 months. Necessary direction for the same will be issued by the Directorate of Panchayat.

iii. **Greenery Development – Plantation Plan:**

The saline stretch of the river is about 32 km in the State of Goa. Along the 32 km saline stretch of Chapora River, Mangroves are observed in 90 hectares (2001) as per the NIO study of 2013. Whereas the EIA study of NIO of 2018 Mangrove forest observed in area of 220 hectares(2018) which indicates that the Mangrove forest have doubled in the period of 20 years with the highest density at Camurlim and Tuem villages. It was also observed during the Physical survey that there are extensive coconut orchards /plantation along both the bank of the River.

D. **Ecological / Environmental Flow (E-Flow):**

- i. **Issues relating to E- Flow:** The Polluted stretch of the Chapora River between Morjim & Alorna Fort (Pernem) out of 32 Km stretch which is under the influence of tides and hence there is no issue of E-flow in these River.
- ii. **Irrigation practices:** The entire polluted stretch of the river Chapora is in saline zone / tidal affected and water from River not used for irrigation purpose.

Action Plan Strategies:

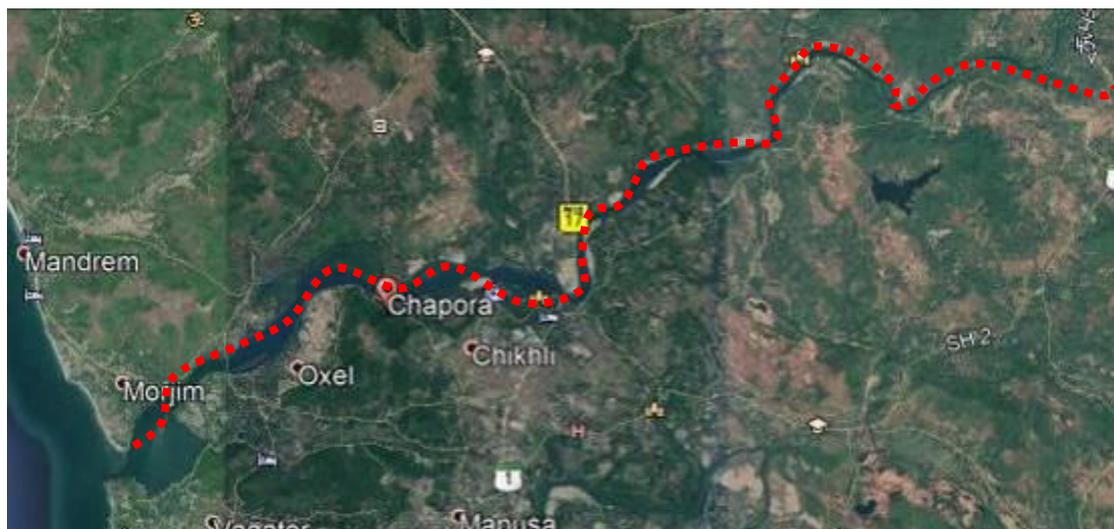
The action plan strategies based on the sampling analysis of the GSPCB and observation made in the NIO reports of 2013 and 2018, site survey and observations are listed below. These strategies are classified on the basis of the existing proposal in place, recommended up gradation in order to achieve the desired objective on short term and long term basis.

Sr. No.	Action Strategy	River Stretch	Agency	Time Frame
1.	<p>Disconnection of direct discharges of domestic sewage into the Chapora River/storm water drains/ Nallah.</p> <ul style="list-style-type: none"> ➤ Disconnection of the director discharge into the river/storm water drain/Nallah. ➤ Installation of Bio toilets ➤ Construction of septic tank and soak pits by residential houses 	Alorna fort to Morjim	Directorate of Panchayat and Directorate of Health	6 months
2.	Improvement to collection system, and erection of material recovery facilities / storage shed for non-biodegradable waste in the village panchayat areas along the banks of Chapora River	<ul style="list-style-type: none"> a) Alorna b) Casavere m c) Ozorim d) Dhargali m e) Tuem f) Parcem g) Agarwada h) Chopdem i) Morjim j) Menecuri m k) Pirna l) Nadora m) Rivora n) Colvale o) Camurlim 	Respective Village Panchayat and Directorate of Panchayat	12 months

Sr. No.	Action Strategy	River Stretch	Agency	Time Frame
		p) Oxel q) Siolim r) Assagao s) Anjuna		
3.	Expansion of Saligao Waste Management facility from 125 tons per day to 250 + 20% (300 tons per day). Project cost i.e. 82 cr.			9 months
4.	Providing toilet facilities at Chapora fishing jetty		Department of Fisheries	6 months
5.	The State of Goa has identified site for construction of Common Biomedical waste at Kundaim Industrial Estate. The National Environmental Engineering Research Institute (NEERI, Nagpur) has conducted the EIA study. The study report has been submitted to the SEIAA /SEAC seeking Environmental Clearance for the facility. The facility expected to be commissioned and operation within next 18 months. In the meanwhile the Healthcare facilities have their own treatment facilities such as Autoclave, Deep burial pit and encapsulation pit, needle burners etc.		Goa Waste Management corporation	18 months
6.	The Goa Waste Management Corporation and Producer Responsibility organisation are collecting the E-waste generated throughout the State and the E waste is there after transported to authorised recyclers in other states.		Goa Waste Management Corporation	ongoing

Introduction:

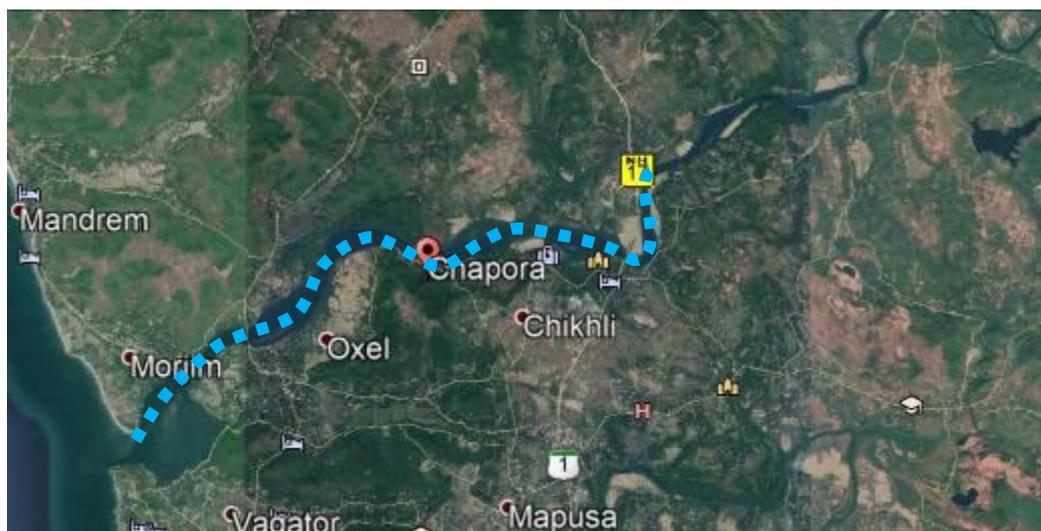
The state is having 9 major rivers with tributaries. The Chapora River originates in east side in Ramghat hills in Belgaum District of Karnataka, then flows through Tillari Ghat, gushes out through the borders and enters into the State near Ibrampur village, Pernem Taluka of North Goa district. It is located between latitudes $15^{\circ} 42' 42.3''$ N & $15^{\circ} 35' 53.1''$ N and longitude $73^{\circ} 51' 31.5''$ and $73^{\circ} 42' 1.3''$. The total flowing distance of the river is 32 km from its origin to the estuarine region wherein discharges into the Arabian Sea at Morjim beach².



Map 1 Map showing the Chapora River Stretch in State.

The Goa State Pollution Control Board (GSPCB) monitors the water quality on a monthly basis throughout the year in Chapora River under the Central Pollution Control Board Programme at two locations, namely, Alorna Fort and Morjim. On the basis of GSPCB reports, Central Pollution Control Board (CPCB) has classified Chapora River (from Stretch Alorna Fort to Morjim) under priority V, having BOD level range between 3.5 -5.2 mg/lit.

² NIO studies ICZM July 2013. P. No. 125



Map 2 Chapora –Polluted Stretch from Alorna Fort (Pernem) to Morjim

During the Physical Survey it has been observed that there are Coconut & Cashew plantations along the bank of the River. There are residential houses located on the bank of the River on the Northern Bank and Southern Bank. Direct discharge of untreated domestic sewage into the River and storm water drains / nallah leading to the river were observed during the Physical Survey. There is traditional activity of Sand Extraction through manual method in these River which is presently stopped as the Permits have not been renewed by the State Government.

a) Objectives:

The Hon'ble National Green Tribunal in the Original Application No 673 of 2018, vide its Order dated 20th September, 2018 directed the State Governments to prepare an Action Plan within two months for bringing all the polluted river stretches to be fit at least for bathing purposes (i. e. BOD < 3 mg/L and FC < 500 MPN/100 ml) within 6 months from the date of finalisation of the action plans.

In the said order the Hon'ble National Green Tribunal has directed that the Action Plan should cover aspects pertaining to Source control, Industrial Pollution Control, Channelization treatment, utilisation and disposal of treated domestic sewage, river catchment/ basin management /control, ground water extraction and periodic quality assessment, flood plain zone , ecological / environmental flow (e-flow) and such other issues may be found relevant for restoring water quality to the prescribed standards. The Hon'ble National Green Tribunal in their order has further directed to take into account the Model Action Plan for Hindon River, already prepared by CPCB while preparing the Action plans for other polluted river stretches.

Vide the said order the Hon'ble NGT directed that the four member committee comprising of Director Environment, Director Urban Development, Director Industries and Member Secretary, State Pollution Control Board shall be the Monitoring Committee for the execution of the Action Plan. The Committee shall be called "River rejuvenation Committee (RRC)" and will function under the overall supervision & co-ordination of the principal Secretary of the concern state. The action plan shall include components like identification of polluting sources including functioning / status of STP's, ETP's CETP, and solid wastes management processing facilities, quantification and characterisation of solid waste, trade & sewage generated in the catchment areas of polluted river stretch. The action plan should address issues related to, ground water extraction, adopting good irrigation practices, protection and management of flood plain zones, rain water harvesting, ground water charging, maintaining minimum environmental flow of rivers & plantation on both sides of the river.

The Hon. NGT has directed that setting of bio-diversity Park on flood plains by removing encroachments shall be considered as an important component of river rejuvenation. The action plan is expected to focus on proper interception and diversion of sewage carrying drains to the sewage treatment plant and emphasis should be on utilisation of treated sewage so as to minimise extraction of ground or surface water.

The Hon'ble NGT has directed to ensure that the action plan should have definite or specific timelines for execution steps. The State Government is required to set up a special environment surveillance task force in terms of this order. The said task force has to ensure that no illegal mining takes place in river bed of such polluted stretches. The river rejuvenation committee is directed to have web site inviting public participation from educational, religious institutions and commercial establishment. The achievement and failure may also be published on such website. The Committee may consider suitably rewarding those contributing significantly to the success of the project.

The RRC's will have the authority to recover the cost rejuvenation in Polluter pays Principal from those whose may be responsible for the pollution, to the extent found necessary. In this case principal laid down by this tribunal in the said order. Voluntary donations, CSR contribution voluntary services and private participation may be considered in consultation with the RRC.

1. Brief about Chapora River:

1.1. River Chapora:

The Chapora River in North Goa, is the river, originating on the western slopes in hilly region of Ramghat areas eastern side of Belgaum District of Karnataka. After traveling the distance of 32km in the state of Goa, it opens up into Arabian Sea, at Morjim.



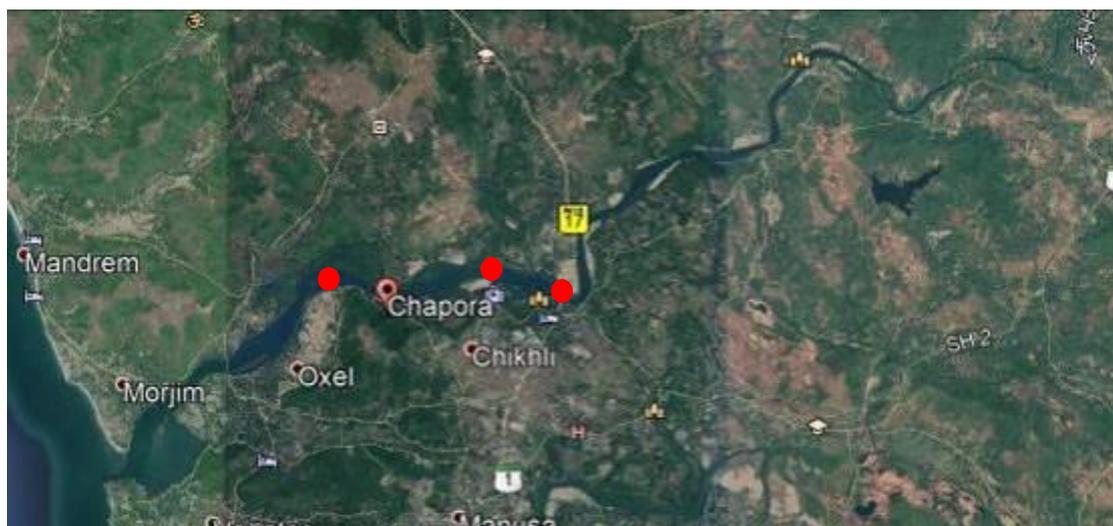
Map 3 Map showing the saline stretch of Chapora River

The salinity mapping was carried out by GSPCB under NWMP, for the Chapora River and the saline stretch is observed with a length of 32Km upstream of Arabian Sea (mouth of the sea). The table below indicates the salinity levels in the river.

Table 1 Water Sample Testing on Chapora River³

Location	Co-ordinates	Salinity in ppt
Khalchawada Menkure (Downstream)	15° 41' 55.5" N 73° 53' 28.2" E	8.73
Sal Dumashe near Chapel Christianwado.	15° 41' 28.7" N 73° 54' 38.20" E	5.25
Sal Dumashe near temple (upstream)	15° 41' 22.5" N 73° 54' 46.5" E	3.13

³ Salinity Report by GSPCB



Map 4 Map showing Salinity points on Chapora River

Nomenclature

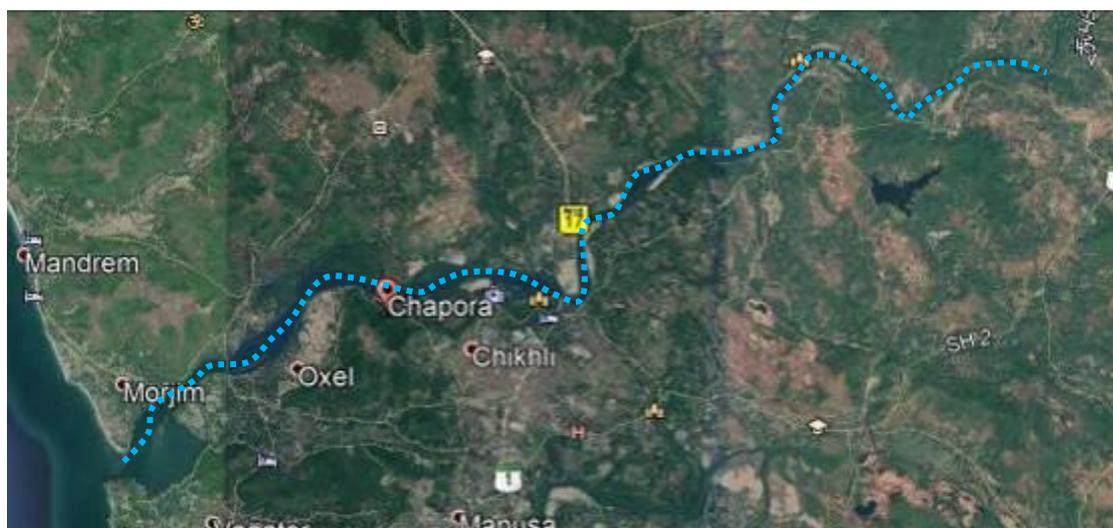
Identification



Chapora river stretch



Salinity point on the river



Map 5 Tidal Stretch of Chapora River (32 Km)

1.2. Water Quality of River Chapora:

For the purpose of conceptualising the plan of action for the polluted river stretch of Chapora River the data of water quality monitoring carried out by GSPCB for three seasons was considered from year 2015 to 2018 as under

- a) Pre monsoon (January - May)
- b) Monsoon (June – September)

c) Post Monsoon (October - December)

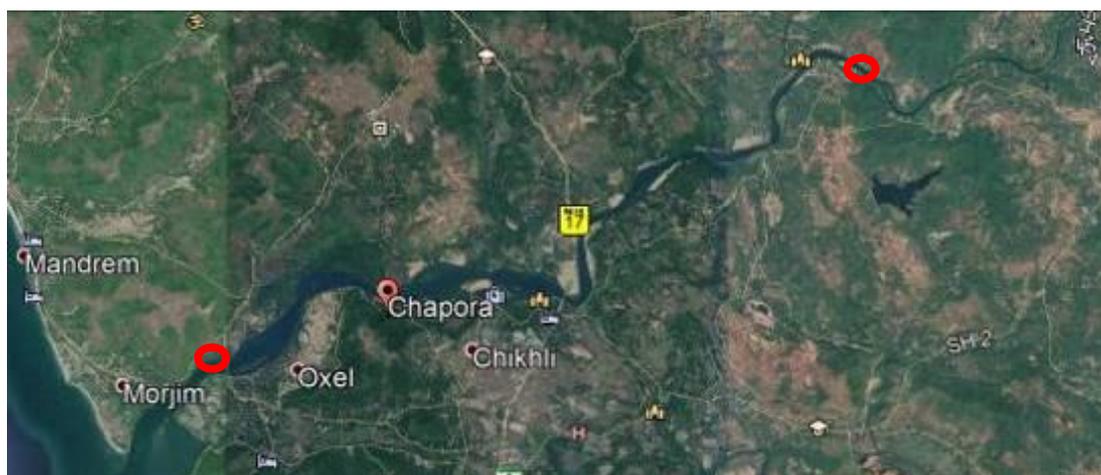
The Water Quality Monitoring Reports in the ICZMP Study of NIO, July 2013 and the EIA Study of NIO, 2018 were also considered for conceptualisation of the Action Plan.

The sampling results of GSPCB at locations mentioned in the table below have been considered.

Table 2 NWMP locations along the Chapora River⁴

Location	Co-ordinates	
	Latitude	Longitude
Alorna Fort	15° 42' 0.58" N	73° 54' 19.62" E
Siolim Bridge	15° 37' 54.26" N	73° 45' 37.33" E

The map showing the locations of the sampling point is attached herewith.



Map 6 Water Sampling Points on Chapora River

⁴ Annual Sampling Stations by GSPCB



Image 2 Domestic untreated sewage disposal in Chapora River.

1.3. Water Sampling Results:

The sampling results of the GSPCB for the period 2015 to 2018 was analysed to decide the Action plan strategies.

Table 3 Chapora River parameters near Alorna Fort⁵

Sr. No.	Year Parameters	2015	2016	2017	2018	Average
Pre - Monsoon (January to May)						
1.	DO (mg/l)	6.2 - 7.0	7.1 - 8	6 - 7.3	6.8 - 7.8	6-8
2.	BOD (mg/l)	0.4 - 0.9	0.5 - 1.7	0.4 - 3.5	0.9 - 1.5	0.4-3.5
3.	Faecal Coliform (MPN/100ml)	1300 - 2300	780 - 2300	780 - 2300	1300 - 4900	780-4900
Monsoon (June to September)						
1.	DO (mg/l)	5.9 - 7.3	6.9 - 7.3	7 - 7.6	SNC	5.9-7.6
2.	BOD (mg/l)	0.6 - 2.3	0.5 - 2.0	0.4 - 1.5	SNC	0.4-2.3
3.	Faecal Coliform (MPN/100ml)	2300 - 4900	1300 - 4900	780 - 4900	SNC	780-4900
Post - Monsoon (October to December)						
1.	DO (mg/l)	6.6 - 7.3	7.4 - 7.6	7.4 - 7.8	SNC	6.6-7.8

⁵ GSPCB Sampling under NWMP

Sr. No.	Year Parameters	2015	2016	2017	2018	Average
2.	BOD (mg/l)	0.9 - 1.7	0.65 - 1.2	1 - 1.6	SNC	0.65-1.7
3.	Faecal Coliform (MPN/100ml)	1300 - 2300	1300 - 2300	450 - 4900	SNC	450-4900

The DO in Chapora River at Alorna fort during pre-monsoon season varies from 5.7 mg/l to 8 mg/l and 5.9 mg/l to 7.9 mg/l during monsoon and 4.8 mg/l to 7.8 mg/l in post monsoon.

The BOD in Chapora River at Alorna fort during pre-monsoon season varies from 0.4 mg/l to 2.1 mg/l and 0.4 mg/l to 2.3 mg/l during monsoon and 0.65 mg/l to 2 mg/l in post monsoon.

The FC in Chapora River at Alorna fort during pre-monsoon season varies from 780 MPN/ 100ml to 4900 MPN/ 100ml and 780 MPN/ 100ml to 13000 MPN/ 100ml during monsoon and 450 MPN/ 100ml to 7900 MPN/ 100ml in post monsoon.

Table 4 Chapora River parameters near Siolim Bridge

Sr. No.	Year Parameters	2015	2016	2017	2018	Average
Pre - Monsoon (January to May)						
1.	DO (mg/l)	4.5 - 6.0	5.3 - 6.1	5.9 - 6.3	4.2 - 6.4	4.2 – 6.4
2.	BOD (mg/l)	0.6 - 3.2	2.1 - 2.1	1.9 - 2.0	1 - 4.5	0.6 – 4.5
3.	Faecal Coliform (MPN/100ml)	2700 - 3300	1300-1300	1300 - 1300	130 - 1300	130 -3300
Monsoon (June to September)						
1.	DO (mg/l)	4.4 - 6.4	4 - 7.6	5.7 - 7.8	6 - 7.4	4 – 7.8
2.	BOD (mg/l)	0.6 - 3.3	0.9 - 1.7	1.4 - 4.5	0.5 - 2.8	0.5 – 4.5
3.	Faecal Coliform (MPN/100ml)	180 - 7000	1300-7900	2300 - 7900	7900 - 7900	180 -7900
Post - Monsoon (October to December)						
1.	DO (mg/l)	6.1 - 7.1	5 - 6.1	3.7 - 6.7	4.2 - 6.2	3.7 - 7.1
2.	BOD (mg/l)	1.8 - 3.9	1 - 2.4	1.9 - 4.2	1.9 - 2.9	1 – 4.2
3.	Faecal Coliform (MPN/100ml)	3300 - 7900	7900- 13000	2300 - 7900	2300 - 4900	2300- 7900

The DO in Chapora River near Siolim Bridge during pre-monsoon season varies from 4.2 mg/l to 7.2 mg/l and 4 mg/l to 7.8 mg/l during monsoon and 3.7 mg/l to 7.1 mg/l in post monsoon.

The BOD in Chapora River near Siolim Bridge during pre-monsoon season varies from 0.6 mg/l to 5.2 mg/l and 0.5 mg/l to 4.5 mg/l during monsoon and 1 mg/l to 4.2 mg/l in post monsoon.

The FC in Chapora River near Siolim Bridge during pre-monsoon season varies from 130 MPN/ 100ml to 13000 MPN/ 100ml and 780 MPN/ 100ml to 13000 MPN/ 100ml during monsoon and 1300 MPN/ 100ml to 7900 MPN/ 100ml in post monsoon.

Summary of the ICZM study report of NIO July 2013

The results for the Water Quality Monitoring as a part of the ICZM study report of NIO commissioned by Department of Science Technology and Environment of Goa dated July 2013 in respect of Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Faecal Coliform are as listed below

- **Dissolved Oxygen (DO)**

All the observed Dissolved Oxygen values are normal and indicate well oxygenated water during all the three season i.e. Pre-monsoon, Monsoon and Post - monsoon.

- **Biochemical Oxygen Demand (BOD)**

All the observed values of BOD are less than 3 mg/l and indicate low organic matter addition to the Chapora River.

- **Faecal Coliform**

The observed values of Faecal coliform indicate pollution sources in the estuarine region. The extract of the relevant portion of NIO report is annexed as annex. 1.

Summary of the EIA report of NIO May, 2018

The results of the Water Quality Monitoring carried out by the National Institute of Oceanography (NIO) as a part of the EIA Study for desilting the River Chapora by Captain of Ports between Morjim to Siolim, in respect of DO, BOD and Faecal coliform are listed below

- **Dissolved Oxygen (DO)**

All the observed Dissolved Oxygen values are normal and indicate well oxygenated water during all the three season i.e. Pre-monsoon, Monsoon and Post - monsoon.

- **Biochemical Oxygen Demand (BOD)**

All the observed values of BOD are less than 3 mg/l and indicate low organic matter addition to the Chapora River.

- **Faecal Coliform**

The observed values of Faecal coliform indicate pollution sources in the estuarine region. The extract of the relevant portion of NIO report is annexed as annex. 2.

1.4. Data Analysis and interpretation:

The results of the water sampling carried out by Goa state Pollution Control Board at two locations in the Chapora River i.e. At Alorna fort and near Siolim bridge from April 2015 to December 2018, the summary of the analysis of water quality parameters of the ICZM study carried out by NIO for Department of Science technology and environment Government of Goa and the summary of the water quality monitoring of the EIA study carried out by NIO for the captain of ports in 2018 in respect of DO, BOD and Faecal coliform have been considered for preparation of action plan.

The Report of Monitoring for the period April 2015 to December, 2018 of GSPCB at two locations for the parameters of DO, BOD and Faecal Coliform have been taken into consideration for the preparation of Action Plan.

- **Dissolved Oxygen (DO)**

The observed DO levels in the polluted river stretch between Alorna fort to Morjim as can be seen from the GSPCB monitoring reports and the two NIO reports are well above the desired level of 4 mg/l required for bathing water quality.

- **Biochemical Oxygen Demand (BOD)**

The observed BOD levels in the polluted river stretch between Alorna fort to Morjim as can be seen from the GSPCB monitoring reports and the two NIO reports are well below the desired level of 3 mg/l required for bathing water quality.

- **Coliforms**

The observed FC levels in the polluted river stretch between Alorna fort to Morjim as can be seen from the GSPCB monitoring reports are above the desired levels of 500 MPN/100ML for bathing water quality. The reports of NIO of 2013 and 2018 also indicate

pollutions source in the polluted stretch between Alorna fort to Morjim in view of the presence of Fecal Coliform levels observed during these Studies.

1.5. Action Plan Strategies:

This Chapora river stretch is polluted stretch **under Priority V** as identified by the CPCB. The action plan is limited to the Regulatory interventions proposed in order to restore the Water Quality to the desired bathing water quality standards notified by the CPCB. The Action Plan has been prepared to achieve Faecal coliform < 500 MPN/ 100 ml in the River Chapora in the identified polluted stretch.as other parameters of DO and BOD are within the desired limits.

1.6. Major Concerns:

The polluted river stretches in Goa, Chapora River falls under priority V. The parameters like dissolved oxygen and bio-chemical oxygen demand is meeting prescribed statutory requirement but the levels of Faecal Coliforms (FC) exceeds the prescribed limits.

2. Source Control:

The reconnaissance survey was conducted along with the GSPCB officials for the polluted stretch as well as along the upstream side (till bridge on Dharglim Road) during the month of Jan. & Feb. 2019. The objective of this study is to analyse the sources of pollutants.

a) Industrial Pollution Control

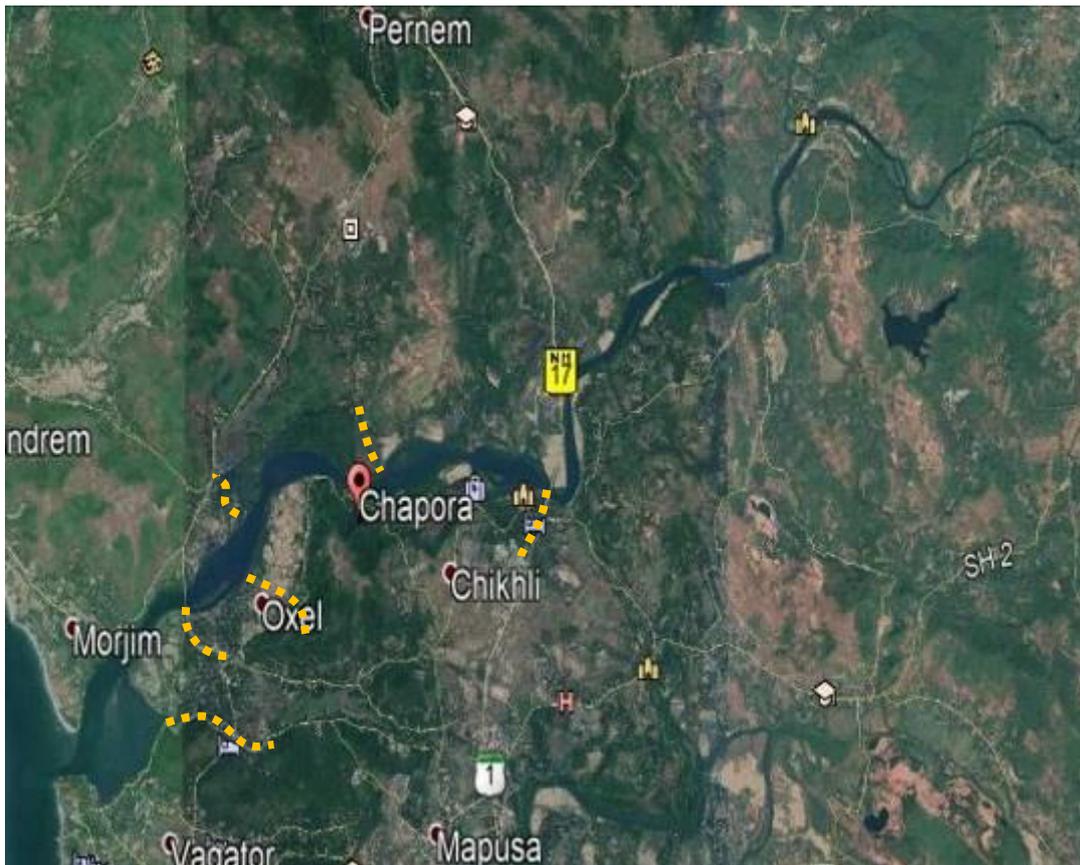
During the physical survey carried out in the month of January, February 2019 it has been observed there is no discharge from industrial units into the River Chapora.

b) Channelization, treatment, utilisation and disposal of treated domestic sewage:

The reconnaissance survey was carried out during the month of January, February 2019, for identification of the sources of pollution of River Chapora.

i. Sources of Pollutants:

The polluted river stretch (Pernem to Morjim) was physically surveyed along both the banks of river during month of January and February for identification of sources of pollution. The survey was extended till Arabo i.e. upstream of Alorna Fort. During the physical survey the discharge of untreated domestic sewage through nallah/ storm water drains was observed mainly on the Southern bank of the River at Siolim, Oxel, Colvale, Camurlim and Vagale. It was also observed during the Survey that, there are discharges from individual houses directly into the river and in some cases storm water drains leading to the River. The main challenge in this River Stretch is to control the levels of Faecal Coliforms.



Map 7 Tributaries in Chapora River



Map 8 Natural Treatment of tributaries on Chapora River

3. River Catchment Management:

The river Chapora has the catchment area of 255 sq. Kms. with an average runoff of 588.4 MCM⁶. 32 km stretch of the river is in the saline zone out of which 24 Kms stretch is under polluted stretch between Alorna Fort & Morjim. There are pre-dominantly agricultural fields and orchards along both the banks of the River Chapora and sub urban areas and also 220 hectares of Mangrove Forests.

i. Periodic monitoring of ground water resources and regulation of ground water extraction by industries particularly over exploited and critical zones:

The ground water table in the region is 2 to 5 MBGL in post monsoon and lowers by 3 m from the post monsoon. The decadal variation in the ground table is about 5 – 10 MBGL. The ground water table is high in the region. In view of this fact no further action is proposed in the action plan on this issue. This catchment /basin has not been identified as over exploited / critical zone as far as ground water is concerned. There is also no industrial exploitation of Ground water in this catchment area⁷.

ii. The major portion of the polluted stretch is under tidal influence and not suitable to use for irrigation.

4. Flood Plane Zone:

i. Regulating activity in flood plain zone:

During the physical survey conducted in Jan. & Feb. 2019, no encroachments have been identified. The Health department/ Village Panchayat will address the issue of direct sewage discharge into the river in case of individual houses by ensuring construction of septic tanks and soak pits and disconnection of direct discharge.

ii. Management of Municipal, Plastic, Hazardous, Bio-Medical & Electrical and Electronic Waste:

The Local bodies are collecting segregated non bio degradable waste which is sent to the Goa Waste Management Corporation (GWMC) and subsequently transported to the baling station at Saligao within the state. The baled non-biodegradable waste is thereafter transported to cement plants in Karnataka for co incineration. However, the issue of treatment of biodegradable waste is limited to the Panchayat of Morjim, Oxel,

⁶ NIO studies ICZM July 2013. P. No. 125

⁷ Aquifer System of Goa, Central Ground Water Board Sept. 2013

Siolim, Asagao and Anjuna, as these are villages having commercial activity and residential complex. The solid waste generated from these Panchayat is treated at the Solid waste facility at Calangute/Saligao. The remaining panchayat are predominantly having single dwelling units and there is no major issue disposal of biodegradable waste.

However improvement in the house to house collection of segregated waste and necessary installation of transfer station for non-biodegradable waste would be completed within period of 6 months. Necessary direction for the same will be issued by the Directorate of Panchayat.

The State of Goa has identified site for construction of Common Biomedical waste at Kundaim Industrial Estate. The National Environmental Engineering Research Institute (NEERI, Nagpur) has conducted the EIA study. The study report has been submitted to the SEIAA /SEAC seeking Environmental Clearance for the facility. The facility expected to be commissioned and operation within next 18 months. In the meanwhile the Healthcare facilities have their own treatment facilities such as Autoclave, Deep burial pit and encapsulation pit, needle burners etc.

There are no hospital waste observed in the stretch of the Chapora River however for futuristic provision the state Govt. is taking appropriate action in order to avoid further pollution due to hospital waste management.

The Goa Waste Management Corporation and Producer Responsibility organisation are collecting the E-waste generated throughout the State and the E waste is there after transported to authorised recyclers in other states.

5. Greenery Development- Plantation Plan:

The 32 km stretch of the Chapora River is under salinity zone wherein the Mangroves are observed in area of 90 Ha in 2001 which has further increased to 220 ha in 2018 as per the NIO study. There are agricultural fields and orchards located on both banks of the River.

6. Ecological / Environmental Flow (E-Flow):

- i. **Issues relating to E- Flow:** The Polluted stretch of the Chapora river is having length of 32 Kms & the total stretch of 32 Km stretch is under the influence of tides. There is no issue of E-Flow in the polluted stretch of river Chapora. Further the Captain of Ports Department has already carried out dredging of river at the mouth of the River for removal of sand bar and maintaining the channel for fishing boat
- ii. **Irrigation practices:** The complete portion of the Chapora River is in saline zone / tidal affected and not used for irrigation purpose.

7. Action Plan Strategies:

The action plan strategies based on the sampling analysis of the GSPCB and observation made in the NIO reports of 2013 and 2018 are as listed in the table below,

Sr. No.	Action Strategy	River Stretch	Agency	Time Frame
1.	<p>Disconnection of direct discharges of domestic sewage into the Chapora River/storm water drains/ Nallahs.</p> <ul style="list-style-type: none"> ➤ Disconnection of the director discharge into the river/storm water drain/Nallahs. ➤ Installation of Bio toilets ➤ Construction of septic tank and soak pits by residential houses. 	Alorna fort to Morjim	Directorate of Panchayat and Directorate of Health	6 months
2.	Improvement to collection system, and erection of material recovery facilities / storage shed for non-biodegradable waste in the village panchayat areas along the banks of Chapora River	a) Alorna b) Casaverem c) Ozorim d) Dhargalim e) Tuem f) Parcem g) Agarwada h) Chopdem i) Morjim j) Menecurim k) Pirna l) Nadora m) Rivora n) Colvale o) Camurlim p) Oxel q) Siolim r) Assagao s) Anjuna	Respective Village Panchayat and Directorate of Panchayat	12 months

Sr. No.	Action Strategy	River Stretch	Agency	Time Frame
3.	Expansion of Saligao Waste Management facility from 125 tons per day to 250 + 20% (300 tons per day). Project cost i.e. 82 cr.			9 months
4.	Providing toilet facilities at Chapora fishing jetty		Department of Fisheries	6 months
5.	The State of Goa has identified site for construction of Common Biomedical waste at Kundaim Industrial Estate. The National Environmental Engineering Research Institute (NEERI, Nagpur) has conducted the EIA study. The study report has been submitted to the SEIAA /SEAC seeking Environmental Clearance for the facility. The facility expected to be commissioned and operation within next 18 months. In the meanwhile the Healthcare facilities have their own treatment facilities such as Autoclave, Deep burial pit and encapsulation pit, needle burners etc.		Goa Waste Management corporation	18 months
6.	The Goa Waste Management Corporation and Producer Responsibility organisation are collecting the E-waste generated throughout the State and the E waste is there after transported to authorised recyclers in other states.		Goa Waste Management Corporation	ongoing

7.1. Conclusion & Remark:

- i. The stretch of River Chapora from Pernem and Morjim having length of 32 Kms is categorized as Priority V. The parameters such as DO and BOD are well within the CPCB prescribed standards. The only cause of concern is high levels of Fecal Coliform which is mostly due to the discharge of domestic sewage through nallah, storm water drains including direct discharge from residential houses into the River.
- ii. The action plan strategies have been elaborated above and will be implemented by concerned stake holder departments/ corporations by taking necessary action for disconnection of direct discharges of domestic sewage and improvement in the collection and storage of the Solid Waste in the concerned Panchayat.
- iii. The implementation and execution of the proposed action plan will be monitored by the River Rejuvenation Committee constituted by the order of the Hon'ble National Green Tribunal.

Annexure 1

Summary of the ICZM study report of NIO July 2013

The results for the Water Quality Monitoring as a part of the ICZM study report of NIO commissioned by Department of Science Technology and Environment of Goa dated July 2013 in respect of Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Faecal Coliform are as listed below

i) Dissolved Oxygen (DO)

- **Monsoon:** During high tide, the DO in Chapora River varies from 6.39 to 7.67 mg/l, with an average of 7.13 mg/l and thereby indicates higher DO in the river (Table 5a). The vertical distribution shows higher DO in surface relative to bottom due to higher dissolution of atmospheric DO in the surface water. Whereas, the spatial variation shows increasing DO from mouth towards upstream region. The observed DO is normal. During low tide, the DO shows a variation from 7.07 to 7.77 mg/l, with an average of 7.36 mg/l, indicating much higher DO than that of the high tide (Table 5b). The vertical distribution shows higher DO in surface at the mouth and near mouth station and a reverse trend at rest of the stations towards upstream. This shows a relatively low DO in the out flowing riverine water. The spatial variation shows increasing DO towards upstream region. The observed DO is normal.
- **Post-monsoon:** Chapora River shows well oxygenated water with all the stations showing DO values above 4.5 mg/l, with DO varying from 4.74 to 8.15 mg/l, with an average of 6.70 mg/l during the high tide (Table 5.1a). Higher values of DO are observed in the surface layer relative to bottom water and is due to more dissolution of atmospheric oxygen due to its direct contact with the surface layer. The spatial variation shows increasing DO towards upstream. During low tide, well oxygenated water within the study region was observed with all the stations showing DO values above 5 mg/l. The observed DO showed a range of variation from 5.26 to 8.15 mg/l, with an average of 6.80 mg/l (Table 5.1b). High values of DO are observed in the surface layer relative to bottom water layer and is due to more dissolution of atmospheric oxygen due to its direct contact with the surface layer. The spatial variation also shows increasing DO towards upstream. All the observed DO values are normal and indicate well oxygenated water.
- **Pre-monsoon:** Chapora River shows well oxygenated water with all the stations showing DO values above 5 mg/l, with DO varying from 5.07 to 9.91 mg/l, with an

average of 7.99 mg/l during the high tide (Table 5.2a). Higher values of DO are observed in the surface layer relative to bottom water and is due to more dissolution of atmospheric oxygen due to its direct contact with the surface layer. The spatial variation shows increasing DO towards upstream. During low tide, well oxygenated water within the study region was observed with all the stations showing DO values above 4.5 mg/l. The observed DO showed a range of variation from 4.82 to 9.47 mg/l, with an average of 7.68 mg/l (Table 5.2b). High values of DO are observed in the surface layer relative to bottom water layer and is due to more dissolution of atmospheric oxygen due to its direct contact with the surface layer. The spatial variation also shows increasing DO towards upstream. All the observed DO values are normal and indicate well oxygenated water.

ii) Biochemical Oxygen Demand (BOD)

- **Monsoon:** The BOD in Chapora River water remains low and varies from 0.35 to 2.18 mg/l, with an average of 1.13 mg/l (Table 5a). The vertical distribution shows distinct higher BOD in the surface layer relative to bottom layer indicating external additions to the river. The spatial variation shows increasing BOD towards upstream. The observed BOD values are low and are normal. During low tide, the BOD ranges much lower and varies from 0.25 to 1.75 mg/l, with an average of 0.72 mg/l (Table 5b). The vertical distribution largely shows higher surface values in surface at some stations and a reverse at others, while the spatial variation shows an apparent increase towards upstream. The observed values are normal for the river and indicate low organic matter addition to Chapora River.
- **Post-monsoon:** During high tide, the BOD values range from 0.14 to 4.80 mg/l, with an average of 1.01 mg/l (Table 5.1a). The range shows low BOD values except for one high value of 4.8 mg/l, indicating localised external addition in the surface layer at stn. C1 (Mouth). The vertical distribution shows overall higher BOD values in surface, indicating external additions, with an increase towards upstream. During low tide, the BOD still remains low and varies from 0.14 to 1.53 mg/l, with an average of 0.80 mg/l (Table 5.1b). The vertical distribution shows apparent higher values in the surface, increasing up to the estuarine region and decreasing thereafter in the upstream indicating external additions in the estuarine part. The observed BOD is normal.
- **Pre-monsoon:** During high tide, the BOD remains low and the values range from 0.85 to 2.91 mg/l, with an average of 2.13 mg/l (Table 5.2a). The range shows high BOD values in surface and low in bottom water layer, indicating localised external additions in the surface layer. The spatial distribution shows increases in BOD values towards

upstream. The observed BOD values are low. During low tide, the BOD shows a slight increase and varies from 0.93 to 3.39mg/l, with an average of 2.32 mg/l (Table 5.2b). The vertical distribution shows higher values in the surface increasing in the upstream, indicating external additions. The observed BOD is acceptable.

iii) Faecal Coliform

- **Monsoon:** The FC shows much lower values in Chapora River during the monsoonal high tide and varies from 0.00 to 160, with a mean of 36 (Table 5g). The vertical distribution does not show any high or low in surface and bottom but the values are consistent in surface and bottom at the mouth station. However, the spatial variation shows significant decrease in upstream. FC at the mouth station indicates some kind of pollution source. During low tide, the FC increase slightly higher in the mouth and near mouth station while rest of the stations do not show any FC, the values remaining zero in the upstream. The FC shows a variation from 0.00 to 390, with a mean of 94.17 (Table 5h). This indicates a pollution source at the mouth and near mouth station.
- **Post – Monsoon:** The FC varies from 0.00 to 8880, with a mean of 755.87 in Chapora River during the high tide (Table 5.1g). The vertical distribution shows an alternate low and high in surface relative to bottom from mouth to upper estuarine region, with upstream region showing nil FC. Spatially, the FC values show a gradual decrease from mouth towards the upstream and the values reach to zero. During low tide, the FC varies from 0.00 to 2440, with an average of 225 (Table 5.1h). The vertical distribution shows high values in surface and low in the bottom water layer, with mouth station showing the highest values. Similarly, the values decrease in the estuarine region spatially, and increase again slightly in the upstream. The FC indicates a kind of pollution source at the mouth station.
- **Pre – Monsoon:** The FC varies from 1.00 to 56, with a mean of 12.64 in Chapora River during the high tide (Table 5.2g). The vertical distribution shows high in surface relative to bottom, with higher values in the estuarine stations, indicating external additions. The spatial distribution shows apparent increase from mid of estuary to upstream. During low tide, the FC remains low and varies from 0.00 to 34, with an average of 6.25 (Table 5.2h). The vertical distribution largely shows high in surface and low in the bottom water layer, with estuarine stations showing the highest values of the range. Similarly, the spatial distribution shows an apparent increase in values towards the upstream. The FC indicates a kind of pollution source at the estuarine station.

The above conclusion has been arrived based on the samples collected at 6 locations of the Chapora River.

Annexure 2

Summary of the EIA report of NIO May, 2018

The results of the Water Quality Monitoring carried out by the National Institute of Oceanography (NIO) as a part of the EIA Study for desilting the River Chapora by Captain of Ports between Morjim to Siolim, in respect of DO, BOD and Faecal coliform are listed below

i) Dissolved Oxygen (DO)

Concentrations of DO in inshore zone ranged from 6.69 to 7.77 (mean, 7.23) at surface and from 6.76 to 7.00 (mean, 6.89) at bottom. In inner estuarine zone, the concentrations of DO varied from 6.44 to 7.62 (mean, 7.09) at surface and from 6.08 to 7.46 (Mean, 6.77) at bottom. Concentrations of DO in the upper estuarine zone of the Study area ranged from 7.35 to 7.97 (mean, 7.57) at surface and from 6.73 to 7.57 (mean, 7.09) at bottom. Insignificant variation between the surface and Bottom values of DO might reflect on the nearly well-mixed conditions of the Coastal waters off Chapora. The observed DO levels in the study region are well within the normal limits of seawater DO.

ii) Biochemical Oxygen Demand (BOD)

Concentrations of BOD in inshore zone (ranged from 0.13 to 2.15 (mean, 0.92) at surface and from 0.49 to 3.03 (mean, 1.83) at bottom. In inner estuarine zone, the concentrations of BOD varied from 1.08 to 2.32 at surface (mean, 1.71) and from 1.17 to 2.62 (mean, 1.85) at bottom. Concentrations of BOD values in the upper estuarine zone of the study area ranged from 0.40 to 1.20 (mean, 0.77) at surface and from 1.52 to 2.13 (mean, 1.82) at bottom. A higher mean BOD values observed at surface and bottom waters of DP and offshore zone indicate higher amount of organic matter addition to the inshore and estuarine zones. The mean BOD values are marginally elevated (>1.0 mg/l) except at surface water of inshore and upper estuary zone which indicate localised anthropogenic inputs into the waters of River Chapora.

iii) Coliforms

Counts of total coliforms (TC) in the study region ranged from 0.3 to 47.5 x10² CFU/ml (mean, 34.34 x 10² CFU/ml) and from 0.55 to 92 x 10² CFU/ml (mean, 17.18 x 10² CFU/ml), respectively in surface and bottom waters. Mean counts in surface waters

were higher than bottom waters. The abundance of specific functional groups of pathogenic bacteria in surface waters were in the range, 0.25–71.5 $\times 10^2$ CFU/ml for ECLO, ND–9.7 $\times 10^2$ CFU/ml for VLO, ND–10.55 $\times 10^2$ CFU/ml for SALO, ND–55.0 $\times 10^2$ CFU/ml for SHLO, ND–0.35 $\times 10^2$ CFU/ml for PKLO. In bottom waters, counts ranged from ND–69.5 $\times 10$ CFU/ml for ECLO, ND–68.0 $\times 10^2$ CFU/ml for VLO, ND–0.95 $\times 10^2$ CFU/ml for SALO, ND–37.5 $\times 10^2$ CFU/ml for SHLO, ND–12.0 $\times 10^2$ CFU/ml for PKLO. However, PALO were not detected in both surface and bottom waters. The counts recorded in the present study are within the normal values recorded for similar coastal waters along the west coast of India.