The River Rejuvenation Committee (RRC), Government of Goa

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

Action Plan Report on Sal River

February 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 litters per Day
NGT	National Green Tribunal
PWD	Public Work Department of Goa State
SIDCGL	Sewerage Infrastructure Development Corporation of Goa Limited, Panjim Goa.
TC	Total Coliform
ULB	Urban Local Body
WRD	Water Resources Department of Goa
GWMC	Goa Waste Management Corporation

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 – NIO, D'paula, Council of Scientific & Industrial Research July 2013.

Executive Summary

Sal River in the State of Goa originates in the hilly region of Verna Village in South Goa and after traversing 40 Km opens up into the Arabian Sea at Mobor (Near Betul Beach). The river flows through urban areas like Verna, Madgaon, Navelim and Benalulim before it discharges into Arabian Sea. 14 kms stretch of the River is affected by tides.

The Goa State Pollution Control Board (GSPCB) monitors the water quality of River Sal at three locations between Khareband and Mobor and at fourth location at Panzorconi on the tributary of River Sal of which 14 kms stretch is effected by tides and 8 Kms is non saline/ not effected by tides. The said monitoring is carried out on a monthly basis throughout the year under the Central Pollution Control Board Programme, National Water Quality Monitoring Programme. This Stretch of the River Sal between Khareband and Mobor as well as the tributary at Panzorconi 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 Sal River (from Stretch Khareband to Mobor 22 km) under Priority III, having BOD level range between 4.2 -16.8 mg/lit. The River Sal has in all five tributaries which join the River in this stretch between Khareband and Mobor. The total basin area of River Sal 301 Sq. km with average runoff of 694.4 MCM.

The Report of Monitoring for the period April 2015 to November, 2018 at the four locations above mentioned for the parameters of DO, BOD and Fecal Coliform have been taken into consideration for the preparation of this Action Plan. At Khareband, the DO ranges from 0.1 mg/l to 8.2 mg/l , BOD ranges from 0.6 mg/l to 32 mg/l and Faecal Coliform ranges from 7900 to 54,000 MPN/100ml which is in the non tidal area of the River . The values of DO ranges from 3.8 to 8.4 mg/l , BOD ranges from 0.2 to 6.4mg/l and FC ranges from 130 to 4900 MPN/100 ml at Orlim. The values of DO ranges from 2.7 to 7.2 mg/l, BOD ranges from 0.4 to 3.9 mg/l and FC ranges from 790 to 17000 MPN/100 ml at Panzorconi (Tributary). The values of DO ranges from 2.7 to 8.0 mg/l , BOD ranges from 0.2 to 5.1 mg/l and FC ranges from 200 to 4900 MPN/100 ml at Mobor. The National Institute of Oceanography has provided the reports of the water quality monitoring carried out for the Month of May, 2018 as a part of EIA report for desilting the River Sal by Captain of Ports between Telaulim to Varca where in the DO rangesto3.1 to 4.5 mg/l , BOD ranges from 0.5 to 1.9 mg/l and . The desired value of DO is 4.0 mg/l , BOD < than 3.0 mg/l and FC < 500 MPN/ 100ml for SWII River Water Quality and to be fit for bathing purposes.

The proposed action plan for Sal 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 disposal of untreated domestic sewage is observed in the urbanised areas of Madgaon & Navelim towns. The underground sewerage scheme is in place in some part of the town and the execution of the North trunk main is in progress and expected to be completed in next 2 years. The estimated cost of the work is 87.00 Cr.

- The South trunk main is already completed but the house service connection is not completed so far resulting in to the discharge of the sewage in the natural outfalls. The ULB, Health Department and SIDCGL will take appropriate action and ensure connection of the entire house / residential complexes service connections to the sewerage network in next 6 months.

- The sewage treatment facility for Madgaon, Navelim & surrounding area at Navelim are in operation and meets the standards prescribed as per the report of the Goa State Pollution Control Board. The total treatment facility is 27.50 MLD (20.00 + 7.50 MLD) and the treated waste water is been discharged in to the river at natural outfall.

- The natural outfall from Navelim town is polluted due to the sewage discharge. The Sewerage system work is in progress for the Navelim and expected to be completed in next 2 years. The estimated cost of the work is 283.00 Cr.

- The Tributary near Telaulim and Sirlim are polluted due to the domestic sewage discharge. There is no proposal for the underground sewerage scheme for these areas. It is proposed to have in stream treatment with Phytorid beds for these outfalls. Similarly the outfall at Kankanmoddi Village on tributary of River Sal is polluted due to domestic sewage discharge and the in stream treatment of Phytorid beds is proposed. The projects are proposed to be implemented in eighteen months for total estimated cost of 9.8 Cr.

- The Fisheries Department has proposed to construct additional 50 seater toilet blocks with Sewage Treatment Plant at Cutbona Jetty for the fisherman and also make arrangements for collection and disposal of waste fish as well as solid waste at

the jetty within the next six months. At a proposed estimated cost of Rs. 50.29 Lakhs + 62.21 Lakhs respectively.

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 industries particularly over exploded and critical zones:**

The ground water table in the region is 5 to 10 MBGL in post monsoon and lower downs by 4 m from the post monsoon ground water table. The decadal variation in the ground table is about 10 – 20 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 area.

ii. The major portion of the river 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 encroachments has been identified at Khareband, Navelim, Kakarmoddi including the domestic sewage disposal in the river / tributaries. The ULB/ Health department/ Village Panchayat /DMA/ SIDCGL will address the issue of sewage discharge and open defecation observed by construction of toilets. Diversion of the sewage discharge and provision of connection to the nearby sewerage network within the period of Six months.

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 and subsequently transported to the baling station at Verna. The baled non biodegradable waste is thereafter transported to cement plants in Karnataka for co incineration. The semi urban Village Panchayats along the river bank will install and make operational composting facilities within 6 months for estimated cost of 3 crores. Margao Municipal Council has also initiated house to house collection of segregated waste and the non bio degradable waste is being baled and transported to cement plants in Karnataka for

co incineration. The Margao Municipal Council is carrying out windrows composting of bio degradable waste at the existing treatment facility at Sonsodo. Further improvement in collection and treatment of waste will be carried out in six months.

iii. **Greenery Development – Plantation Plan:** The 14 km stretch of the Sal River is under salinity zone wherein the Mangrove plantation is observed in and areas of 11 Ha. ***(Source: ICZM studies for Goa, National institute of Oceanography July 2013).***

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

i. **Issues relating to E- Flow:** The Polluted stretch of the Sal river is having length of 22 Kms out of which the 14 Km stretch is under the influence of tidal effect. There is no issue of E-Flow in the 14 km saline stretch of river Sal. The stretch between Khareband to Navelim (8.00 Km) is under non-tidal effects and the river becomes dry in the month of Jan every year. It is proposed to rejuvenate this stretch by discharging the treated water from the STP at Navelim, to ensure the E-Flow and frequent flushing this stretch of the river. Further the Captain of Ports Department has already carried out desilting of river Sal in the six km stretch from Khareband to Telaulim in the year 2016. Now the Captain of Ports is carrying out EIA Study for desilting of the river stretch from Telaulim to Varca and the study is expected to be completed by April, 2019. The Work of desiliting is expected to commence in November , 2019 and completed by March, 2020 after obtaining all necessary permissions and following all codal formalities.

iii. **Irrigation practices:** The major portion of the river is in saline zone / tidal affected and not used for irrigation purpose.

The budgetary provisions worked out on the basis of Schedule of rates. The table below gives the summarised statement of the estimation.

The proposed works in brief are provided in the table below.

Sr. No	Action Strategy	Amount in Rs.
1	Natural treatment (SIBF/ Phytorid Beds) will be installed **immediately in eighteen months** along the banks in order to avoid the pollution	9,80,00,000
2	Improvement and upgradation of the existing Solid Waste Management Facility including collection system, composting facilities and erection of material recovery facilities / storage shed for non-biodegradable waste at Sonsoddo Margao	4,25,00,000
3	De weeding	2,60,00,000
4	Recycling and Reuse of treated sewage from the Sewage treatment plant at Navelim for flushing and maintaining E-flow during dry season.	25,12,50,000
5	Installation of DO control measures	59,51,500
	Total Estimated Cost in Rs.	**42,37,01,500**
	Total Estimated Cost in Cr.	**42.37**

1. Introduction

The state is having 9 major rivers and the tributaries. The Sal River originates in Verna in South Goa and travels 40 Km stretch till it discharges in to Arabian Sea at Mobor (Near Betul Beach). There are urbanised areas developed along the river. The River Sal has two tributaries which join the River in this stretch between Khareband and Mobor. The total basin area of River sal 301 Sq. km with average runoff of 694.4 MCM ***(Source: ICZM studies for Goa, National institute of Oceanography July 2013.)***

Sewage discharge by urban population and solid waste dumping are major causes for pollution in the river. The Goa State Pollution Control Board (GSPCB) monitors the water quality on a monthly basis throughout the year in all the rivers in the State including this river under the Central Pollution Control Board Programme. On the basis of GSPCB reports, Central Pollution Control Board (CPCB) has classified Sal River (from Stretch Khareband to Mobor 22 kms) under priority III, having BOD level range between 4.2 -16.8 mg/lit.

The Hon'ble National Green Tribunal in the Original Application No 673 of 2018 in its Order dated 20th September, 2018 directed the State Governments to prepare and 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 EETP'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.

The Goa State Pollution Control Board (GSPCB) monitors the water quality throughout the year in all the rivers. The results of water quality monitoring of River Sal at four locations indicate that the water quality is presently not meeting the standard for bathing. The presence of faecal coliform in excedance of the standard is the major cause of concern. The CPCB has categorised the River Sal as priority III based on the water quality monitoring reports of the GSPCB.

Map Showing the Major Rivers in the State.

The State has constituted the River rejuvenation Committee (RRC), under the Chairmanship of The Secretary Environment, with Director, Department of Environment, The Director Urban Development, Director Industries and The Member Secretary of GSPCB. The Chief Engineer, WRD Goa, The Directorate of Health services, The Managing Director SIDCGL have been co-opted as other members of the committee. Accordingly the said report has been prepared based on the Hindon river action plan.

Water Quality of River Sal

The Length of the River Sal in Salinity zone is 14 km from mouth of the river at Mobor,

Map showing Salinity stretch of Sal River

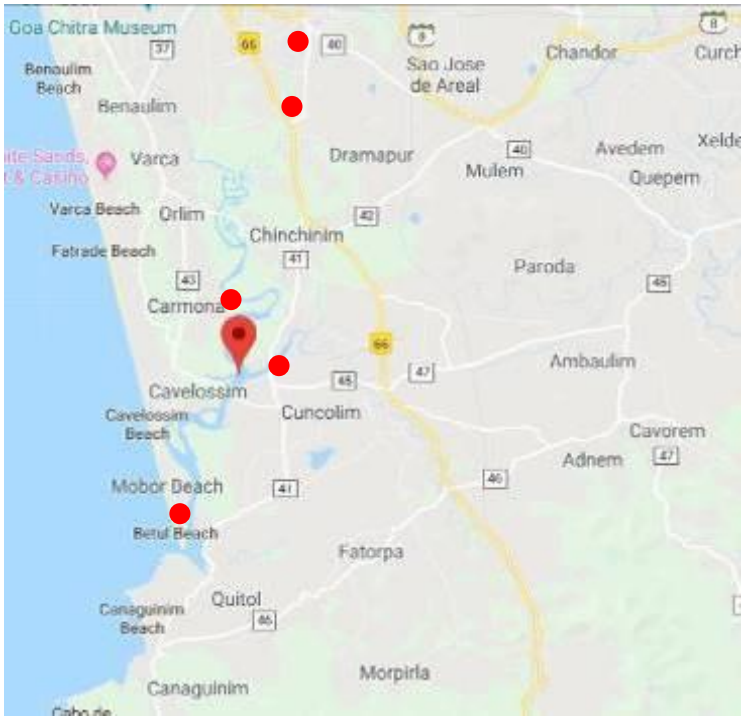
Nomenclature	Identification
	Sal river stretch
	Salinity Stretch on the river
	Tributaries of the Sal river

Monitoring Locations

The GSPCB collects samples at below mention four locations under the National Water-quality Monitoring Program (NWMP) of the CPCB on monthly basis.

Location	Co-ordinates	
	Latitude	Longitude
Khareband Bridge Madgaon	$15^0$16’ 8.91” N	$73^0$57’ 11.22” E
Orlim Bridge Orlim	15^0 13’ 10.43” N	$73^0$57’ 31.87” E
Pazarconi near culvert	15^0 10’ 54.61” N	$73^0$59’ 52.62” E
Near Hotel Leela, Mobor	$15^0$9’ 25.08” N	$73^0$57’ 8.11” E

The map showing the locations of the sampling is referred in map below.



Water Sampling Results (April 2015 to November 2018)

For the purpose of conceptualising the plan of action for the polluted river stretch of Sal River the data pertaining to three season were consider from year 2015 to 2018 as under

1. Pre monsoon (March - April)
2. Monsoon (July – September)
3. Post Monsoon (November – January)

The sampling results are studied since April 15 onwards and are mentioned in the table below.

Sal river parameters near Khareband Bridge (Pre- Monsoon)

Duration	D.O	BOD	Faecal Coliform	Total Coliform
March - 2018	SNC*	SNC	SNC	SNC
May- 2018	SNC	SNC	SNC	SNC
March - 2017	1.3	1.3	24,000	35,000
May- 2017	SNC	SNC	SNC	SNC
March - 2016	SNC	SNC	SNC	SNC
May- 2016	SNC	SNC	SNC	SNC
March - 2015	1.1	0.9	17,000	35,000
May- 2015	0.8	2.3	22,000	54,000

***SNC- Sampling not conducted.**

****During the pre-monsoon season the above mentioned stretch of the river is dry.**

Sal river parameters near Orlim Bridge (Pre- Monsoon)

Duration	D.O	BOD	Faecal Coliform	Total Coliform
March - 2018	4.6	1.0	780	1300
May- 2018	6.7	2.3	1100	1400
March - 2017	8.4	6.4	230	490
May- 2017	5.5	2.1	130	170
March - 2016	6.0	3.1	130	230
May- 2016	7.0	6.2	130	230
March - 2015	5.5	3	1300	3300
May- 2015	8.1	5.1	4900	7900

Sal river parameters near Panzorconi (Pre- Monsoon)

Duration	D.O	BOD	Faecal Coliform	Total Coliform
March - 2018	5.3	1.4	1,300	2,300
May- 2018	6.5	0.6	4,900	7,900
March - 2017	5.8	2.5	790	1,400
May- 2017	7.03	2.9	7,900	11,000
March - 2016	7.2	2.8	2,300	4,900
May- 2016	5.3	2.2	7,900	11,000
March - 2015	5.5	1.4	3,300	4,900
May- 2015	6.3	2.2	7,000	11,000

Sal river parameters near Hotel Leela (Pre- Monsoon)

Duration	D.O	BOD	Faecal Coliform	Total Coliform
March - 2018	5.8	0.5	1300	2300
May- 2018	6.4	0.8	200	450
March - 2017	6.2	2.8	1300	1700
May- 2017	9.6	5.1	1300	1700
March - 2016	6.8	1.1	490	790
May- 2016	5.9	1.5	230	490
March - 2015	6.2	1.8	330	460
May- 2015	5.4	0.8	1100	1700

Sal river parameters near Khareband Bridge (Monsoon)

Duration	D.O	BOD	Faecal Coliform	Total Coliform
July - 2018	2.7	0.6	17000	11000
Sept.- 2018	2.2	1.4	35000	92000
July - 2017	1.9	5.0	11000	17000
Sept - 2017	1.8	SNC	24000	35000
July - 2016	2.9	2.2	13000	17000
Sept - 2016	3.3	1.7	54000	92000
July - 2015	2.5	2.3	7900	14000
Sept. - 2015	1.6	1.2	24000	35000

Sal river parameters near Orlim Bridge (Monsoon)

Duration	D.O	BOD	Faecal Coliform	Total Coliform
July - 2018	3.8	2	13000	22000
Sept.- 2018	6.0	5.0	450	780
July - 2017	5.2	4.5	1700	3300
Sept - 2017	4.8	3.6	1300	2300
July - 2016	4.5	3.9	3300	4900
Sept - 2016	6.5	3.2	1300	1700
July - 2015	5.1	3.7	3300	4900
Sept. - 2015	4.8	2.4	1300	2300

Sal river parameters near Panzorconi (Monsoon)

Duration	D.O	BOD	Faecal Coliform	Total Coliform
July - 2018	2.7	0.6	17000	11000
Sept.- 2018	6.9	1	3300	4900
July - 2017	6.8	0.5	1300	1700
Sept - 2017	6.5	0.6	3300	7000
July - 2016	6.5	1.1	2300	3300
Sept - 2016	7.1	0.9	3300	7000
July - 2015	6.5	1.7	1100	1400
Sept. - 2015	7.0	0.4	3300	4900

Sal river parameters near Mobor (Monsoon)

Duration	D.O	BOD	Faecal Coliform	Total Coliform
July - 2018	6.3	0.5	4900	7900
Sept.- 2018	5.5	4.8	780	1300
July - 2017	6.0	5.1	1700	2200
Sept - 2017	2.8	1.3	3300	4900
July - 2016	6.5	0.9	1300	2400
Sept - 2016	4.8	1.2	2300	4900
July - 2015	6.4	2.5	2300	4900
Sept. - 2015	4.6	1.2	2300	4900

Sal river parameters near Khareband Bridge (Post Monsoon)

Duration	D.O	BOD	Faecal Coliform	Total Coliform
Nov. - 2018	1.9	1.7	35000	54000
Jan.- 2018	2.0	5.8	24000	54000
Nov. - 2017	7.6	1.7	54000	92000
Jan. - 2017	7.2	4.2	54000	92000
Nov. - 2016	8.2	8.9	54000	92000
Jan. - 2016	SNC	SNC	SNC	SNC
Nov. - 2015	0.10	10.20	54000	92000
Jan. - 2015	1.4	32.00	24000	35000

Sal river parameters near Orlim Bridge (Post Monsoon)

Duration	D.O	BOD	Faecal Coliform	Total Coliform
Nov. - 2018	4.1	1.1	2300	4900
Jan.- 2018	4.5	2.6	780	1100
Nov. - 2017	3.9	1.8	450	680
Jan. - 2017	6.2	3.5	170	220
Nov. - 2016	4.3	2.1	230	330
Jan. - 2016	4.8	1.8	230	330
Nov. - 2015	3.9	0.2	1100	1700
Jan. - 2015	5.7	2.5	2300	3300

Sal river parameters near Panzorconi (winter)

Duration	D.O	BOD	Faecal Coliform	Total Coliform
Nov. - 2018	7.1	1.2	2300	3300
Jan.- 2018	6.0	2.2	7900	24000
Nov. - 2017	6.9	3.9	2300	3300
Jan. - 2017	6.2	2.3	2300	4600
Nov. - 2016	6.4	0.8	2300	3300
Jan. - 2016	5.3	1.9	2300	3300
Nov. - 2015	7.2	2.2	1700	3300
Jan. - 2015	5.2	1.5	4900	7900

Sal river parameters near Mobor (Post Monsoon)

Duration	D.O	BOD	Faecal Coliform	Total Coliform
Nov. - 2018	8.0	3.0	1300	2300
Jan.- 2018	6.2	1.2	200	450
Nov. - 2017	4.7	3.2	2200	2700
Jan. - 2017	5.2	0.9	790	1100
Nov. - 2016	2.7	1.0	230	490
Jan. - 2016	6.2	0.5	780	1300
Nov. - 2015	5.3	1.3	1300	2300
Jan. - 2015	6.9	0.2	490	790

Data Analysis and Interpretation

The results of the water sampling are observed from various perspective in order to define the action plan strategies.

The Report of Monitoring for the period April 2015 to November, 2018 at the four locations above mentioned for the parameters of DO, BOD and Faecal Coliform have been taken into consideration for the preparation of these Action Plan. At Khareband the DO ranges from 0.1 mg/l to 8.2 mg/l , BOD ranges from 0.6 mg/l to 32 mg/l and Faecal Coliform ranges from 7900 to 54,000 MPN/100ml which is in the non tidal area of the River . The values of DO ranges from 3.8 to 8.4 mg/l , BOD ranges from 0.2 to 6.4mg/l and FC ranges from 130 to 4900 MPN/100 ml at Orlim. The values of DO ranges from 2.7 to 7.2 mg/l, BOD ranges from 0.4 to 3.9 mg/l and FC ranges from 790 to 17000 MPN/100 ml at Panzorconi (Tributary). The values of DO ranges from 2.7 to 8.0 mg/l , BOD ranges from 0.2 to 5.1 mg/l and FC ranges from 200 to 4900 MPN/100 ml at Mobor. The National Institute of Oceanography has provided the reports of the water quality monitoring carried out for the Month of May, 2018 as a part of EIA report for desilting the River Sal by Captain of Ports between Telaulim to Varca where in the DO rangesto3.1 to 4.5 mg/l , BOD ranges from 0.5 to 1.9 mg/l and .

The desired value of DO is 4.0 mg/l , BOD < than 3.0 mg/l and FC < 500 MPN/ 100ml for SWII River Water Quality to be fit for bathing purposes.

- It was not possible to conduct the test for specific time fame / month, the same as mentioned as Sampling Not Conducted (SNC) in the table above as during the pre-monsoon season the stretch of the river is dry at Khareband Bridge.
- The seasonal variations are observed in the values of faecal coliforms and the total coliforms, the values are higher in monsoon and are lower in other season.

Action Plan Strategies

The Sal River is the one of the major river stretch in the state. This river stretch is the most polluted stretch and the only stretch falls under priority III. It is essential to plan for the multi-stakeholder tributary approach for river rejuvenation.

The action plan strategy has been defined based on the present status of the river, the results obtained during the monitoring and long term sustainability of the project in order to achieve the desired standards.

This chapter deals with the observations recorded during the recent reconnaissance survey, analysis of the water sampling carried out by GSPCB and overall strategies/innervations proposed for Rejuvenation of river stretch.

Major Concerns:

At the backdrop of the above referred possible multiple sources of the pollutant and as per the NGT directions to address the pollution in above stretch of the River Sal ir ia observed that parameters like dissolved oxygen and bio-chemical oxygen demand, are within the prescribed standards on majority of the occasions but the other requirements like Faecal Coliforms (FC)) are exceeding the prescribed limits. The FC are relatively very high near Khareband.

The FC count shows relative increase in trend during the monsoon period due to surface runoff. The DO & BOD could not be analysed during the pre-monsoon season at Khareband as the river is dry during this period of the year at this location.

Being a non-perennial river, it is sluggish throughout the year except during high flow periods during the monsoon season in the non saline stretch of the River Sal. This seasonal variation reflects that river water composition is influenced by annual cycles. The river flows are disturbed at many locations in the non saline portion due to on going road works . T

The seepage and overflow from soak pits which are not properly maintained lead to release of untreated sewage into the nallahs leading to River Sal.

A. Source Control:

The reconnaissance survey was conducted along with the GSPCB officials and the ULB officials for the polluted stretch as well as on the upstream side (till bridge on Colva Road) during the month of Dec. 2018 & Jan. 2019. The objective of this study is to analyze the sources of pollutants and other site related issues. The issues observed along with the present proposals are discussed in the subsequent paras.

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 Sal.

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

The reconnaissance survey was carried out during the month of January, February 2019, and for identification of the sources of pollution of River Sal and the existing treatment facility for domestic sewage/discharge and present remedial measures are in place.

Sources of the pollutants:

The entire stretch (Khareband to Mobor) was physically surveyed both the bank of river during month of January and February for identification of sources of pollution. There are two STP's are located at Navelim along the bank of the river having capacity 20 MLD & 7.5 MLD respectively for treatment of sewage from Madgao and sub urban areas. Both the STP's are functioning efficiently and the outlet parameter are meeting the prescribed limits.

The sewerage system in Madgao and sub urban areas along the River Sal is more than 30 years old and having leakages at several locations. Part of the Madgao city and sub urban areas has been connected to this sewerage system. During the physical survey the discharge of untreated sewage through nallahs and tributary of River Sal were observed at Khareband, Navelim, Sirlim and Kakarmoddi into River Sal. It is also observed in physical survey that there is slaughter house in operation on the bank of the River Sal which is directly disposing waste and influent into the River Sal. This outfall contributes to the pollution load in River Sal. It was noted that SIDCGL has laid sewerage network across the said urbanised zone however it was observed that the many dwelling units and residential complex have not connected there sewer to this sewer line of the SIDCGL. In addition Open defecation from the residents at Khareband along the bank is also the major source of the pollutants.

Information regarding the existing and proposed sewerage scheme provided by the SIDCGL is as follows:-

Scheme for Navelim, Talaulim, Sequetim, Rumdamol, Davorlim, Aquem Baixo and other surrounding areas was taken up in year 2012-13. The EFC is accorded for the sewerage scheme is amounting to Rs. 293.00 Cr. The Work is taken up for abatement of pollution of River Sal

At present Sewerage network in Rumdamol and Davorlim areas are completed and release of House sewer connections are in progress. The work of laying sewer network in Navelim, Talaulim, Sequetim, Aquem Baixo and other surrounding areas is in progress and 70 % work is completed. Total around 80 Kms network is laid with 2510 Nos. of manholes. 7 pumping stations are proposed to be constructed in Navelim area to connect the low lying areas.

The entire flow of Navelim will be catered by 20 MLD STP at Shirvodem in Navelim . The Flow will be conveyed to South Trunk Main to STP. The Sewage of Margao City and Fatorda are also being treated in 20 MLD STP and additional 6.7 MLD STP at Shirvodem is also commissioned by JICA/ PWD. Sewerage Network in Margao is completed and at present House Sewer connections are in progress. All the authorized establishments, buildings, houses, apartments etc will be connected after receiving applications from the consumers for House sewer connections. However the Sewage flow from unauthorized / illegal development along the river banks in Margao, Navelim, Fatorda, khareband etc. cannot be ascertained.

Rehabilitation of North trunk main which was laid in the year 1988-90’s is in progress. The alignment passes through the areas Ambaji, behind District Hospital, Kadamba Bus Stand, Colva Circle, Comba, Damodar College, Khareband, & along the bank of River Sal to the STP with various diameters ranging 350-1200mm dia.

Concrete pipes with collar joints at an interval of 2 mts length (average) were used. The alignment is in water logged area and saturated conditions. The salinity has affected the concrete pipes.

The Rehabilitation includes laying of 7.50 Km Trunk main along with branch sewer lines in Shirvodem, Comba, Fatorda, Davondem and Khareband. The Project is expected to be completed by Dec 2019. This project on completion will help in abatement of Pollution of River Sal in Khareband and surrounding areas.

Natural outfall downstream of Khareband Bridge.

Solid waste dumping near Khareband Bridge.

Solid waste dumping near Orlim Bridge.

Fishermen's at Cutbona.

Utensils cleaning by Fishermen's.

Fish transportation near Mobor.

B. River Catchment / Basin Management

The river Sal has the catchment area of 301sq. kms with an average runoff of 694.4 mcm. 14 km stretch of the river is in the saline zone and the remaining 8 km stretch is in non saline zone (From Khareband to Mobor). The river in this stretch has in all 3 outfalls and 2 tributaries. There are pre-dominant agricultural fields along both the banks of the River Sal except Margao and sub urban areas.

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

The ground water table in the region is 5 to 10 MBGL in post monsoon and lower downs by 4 m from the post monsoon ground water table. The decadal variation in the ground table is about 10 – 20 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 area.

C. Flood Plane Zone:

i. **Regulating activity in flood plain zone:** During the physical survey encroachments has been identified at Khareband, Navelim, Kakarmoddi including the domestic sewage disposal in the river / tributaries. The ULB/ Health department/ Village Panchayat /DMA/ SIDCGL will address the issue of sewage discharge and open defecation observed by construction of toilets. Diversion of the sewage discharge and provision of connection to the nearby sewerage network within the period of Six months.

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 and subsequently transported to the baling station at Verna. The baled non biodegradable waste is thereafter transported to cement plants in Karnataka for co incineration. However, the issue of treatment of biodegradable waste in the local panchayat is required to be addressed. The semi urban Village Panchayats along the river bank will install and make operational composting facilities within 6 months for estimated cost of 3 crores including transfer station / storage facilities for non biodegradable waste. Margao Municipal Council has also initiated house to house collection of segregated waste and the non bio degradable waste is being baled and transported to cement plants in

Karnataka for co incineration. The Margao Municipal Council is carrying out windrows composting of bio degradable waste at the existing treatment facility at Sonsoddo.

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 commissioned and operation in the 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.

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.

D. Greenery Development – Plantation Plan

: The 14 km stretch of the Sal River is under salinity zone wherein the Mangroves vegetation is observed in area of 11 Ha. ***(Source: ICZM studies for Goa, National Institute of Oceanography July 2013).***

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

i. **Issues relating to E- Flow:** The Polluted stretch of the Sal river is having length of 22 Kms out of which the 14 Km stretch is under the influence of tidal effect. There is no issue of E-Flow in the 14 km saline stretch of river Sal. The stretch between Khareband to Navelim (8.00 Km) is under non-tidal effects and the river becomes dry in the month of Jan every year. It is proposed to rejuvenate this stretch by discharging the treated water from the STP at Navelim, to ensure the E-Flow and frequent flushing this stretch of the river. Further the Captain of Ports Department has already carried out desilting of river Sal in the six km stretch from Khareband to Telaulim in the year 2016. Now the Captain of Ports is carrying out EIA Study for desilting of the river stretch from Telaulim to Varca and the study is expected to be completed by April, 2019. The Work of desiliting is expected to commence in November, 2019 and completed by March, 2020 after obtaining all necessary permissions and following all codal formalities.

ii. **Irrigation practices:** The major portion of the river is in saline zone / tidal affected and not used for irrigation purpose.

Action Plan Strategies

The action plan strategies based on the sampling analysis, 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.	Natural treatment (SIBF/ Phytorid Beds) will be installed **immediately in Eighteen months** along the banks in order to avoid the pollution	a. Khareband b. Sirvodem c. Sirlim (Telaulim) d. Kankanmoddi (Panzorconi)	SIDCGL, WRD	18 months
2.	Replacement of the Old Sewerage Network system, laying of new sewerage system providing House connections to the existing sewerage system.	Margao town, Navelim and other sub urban areas around Margao	SIDCGL	18 months
3.	Improvement and upgradation of the existing Solid Waste Management Facility including collection system, composting facilities and erection of	a. Margao Municipal Council b. Cuncolim Municipal Council c. Navelim d. Telaulim e. Cana Benaulim	GSUDA, Marga Municipal Council, Cuncolim Municipal Council and concerned Village Panchayats	6 months

Sr. No	Action Strategy	River Stretch	Agency	Time Frame
	material recovery facilities / storage shed for non biodegradable waste at Sonsoddo Margao	f. Varca g. Orlim h. Carmona i. Assolna j. Cavelossim k. Velim l. Mobor		
4.	Desilting of River Sal	Telaulim to Varca	Captain of Ports	12 months
5.	Deweeding	Khareband to Navelim	SIDCGL, Water Resources Department	6 months
6.	Recycling and Reuse of treated sewage from the Sewage treatment plant at Navelim for flushing and maintaining E-flow during dry season.	Khareband to Navelim	SIDCGL	12 months
7.	Installation of DO control measures	Khareband to Navelim	WRD	6 months
8.	Training and Capacity Building, Awareness Programme	River Sal (Polluted Stretch)	GSPCB	6 months

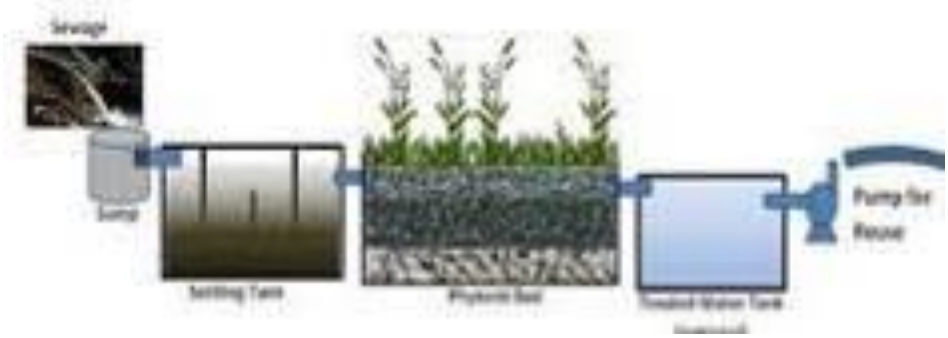
Decentralised Treatment facility.

Decentralised Treatment facility.

Floating Aerators with Cutter.

Natural treatment in the form Phytorid Beds.

Di-silting.



Treatment for the Natural Outfalls.

Conclusion & Remark:

The stretch of River Sal from Khareband and Mobor having al length of 22 kms is categorized as Priority III by the Central Pollution Control Board. The main cause of concern is high levels of Fecal Coliform, while other parameters such as DO and BOD are well within the CPCB prescribed standards on majority of occasions. The cause of pollution is mostly due to the urbanization on the either bank & inefficient collection conveyance & treatment mechanism of sewage and solid waste.

The action plan strategies have been elaborated in chapters above and will be implemented by concerned stake holder departments/ corporations by making necessary provision in their budgets.

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. The estimation and the items considered for the Action Plan are tentative and there could be variations during preparation of detailed estimates and execution of work. .

The proposed works in brief are provided in the table below.

Sr. No	Action Strategy	Unit	Qty.	Amount in Rs.
1	Natural treatment (SIBF/ Phytorid Beds) will be installed **immediately in Eighteen months** along the banks in order to avoid the pollution	Nos.	7	9,80,00,000
2	Improvement and upgradation of the existing Solid Waste Management Facility including collection system, composting facilities and erection of material recovery facilities / storage shed for non-biodegradable waste at Sonsoddo Margao	Lump Sum		4,25,00,000
3	DE weeding	Km	8	2,60,00,000
4	Recycling and Reuse of treated sewage from the Sewage treatment plant at Navelim for flushing and maintaining E-flow during dry season.	Km	8	25,12,50,000
5	Installation of DO control measures	No's	2	59,51,500
	Total Estimated Cost in Rs.			**42,37,01,500**
	Total Estimated Cost in Cr.			**42.37**