

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE BENCH AT CHENNAI
APPLICATION NO 14 OF 2022

IN THE MATTER OF:
M. Yuvadeeban

... Applicant

Versus

Department of Fisheries & 4 Ors.

...Respondents

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BEFORE THE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE BENCH AT CHENNAI
APPLICATION NO 14 OF 2022

M. Yuvadeeban
S/o Maragret Lawrence,
Aged about 26 Years,
B2, Ramaniyam Marvel, Seshdripuram, 1st Main Road,
Velacherry,
Chennai - 600 042.

... Applicant

-AND-

1. Department of Fisheries

Government of Tamilnadu
Rep by its Executive Engineer
Fishing Harbour Project Division
Nandanam, Chennai - 600 035
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12/1/2024

4. Tamilnadu State Coastal Zone Management Authority,
Through the Member Secretary,
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5. Ministry of Environment, Forest and Climate Change,
Through the Principal Secretary,
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Chennai-600 032.
Tel: 044-24336594
mstnsc2ma@yahoo.com

... Respondents

COUNTER AFFIDAVIT OF 1st RESPONDENT

I, M.Murugesan, S/o C.Muthian aged about 59 years, do hereby solemnly affirm and sincerely state as follows.

1. I am the 1st respondent herein, and discharging my duty as the Executive Engineer, 2nd Floor, Integrated Office Complex for Animal Husbandry and Fisheries Department, Nandanam, Chennai - 600 035, as such I am well acquainted with the facts and circumstances of this case from the available records. I have perused the affidavit filed by the applicant in support of documents. I deny all the averments. I am filing this application for myself and on behalf of the respondent 1.

Further report of 1st Respondent

1. The Hon'ble Tribunal in its order dated 14.11.2022, directed to file report that the Fisheries Department may consider whether the design of the present project can be modified. In so far as the same is

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concerned, It is submitted that the Barmouth opening of Kaluveli estuary is historically shifted 500m from south to north and viceversa due to tidal influences and rainflow. Based on the Field Visit and Studies by reputed institutions like Ocean Engineering of IIT Madras, the proposed training wall can be shifted within 500m range of Barmouth opening.

2. It is submitted that as a part of Mitigation for erosion control measures is proposed with series of 3 groynes in the north of northern Training wall. The EIA Report (Section 4.9.1.4) states that, the dredged material from the navigation channel between the two training walls will be deposited in the groin field area. The material later will be transported within the sediment cell makes nullify the erosion impacts on the northern part of the coastline. As far as the beach nourishment is considered the nourishment with groin field will give better results as the sediments are trapped between the groins. Thus, beach nourishment alone will not suffice the problem but groin with beach nourishment will be a technically sound option. The periodical monitoring of shoreline change will be assessed by reputed Shoreline experts in time to time and beach nourishment will be done by Fisheries Department.

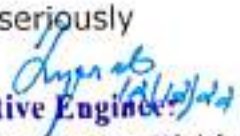
3. It is submitted that the Olive Ridley Turtle nesting and breeding season occurs every year during the end of November to March. The studies regarding monitoring of Marine turtles were conducted by Sálím Ali Centre for Ornithology and Natural History, shows the stretch between Mamallapuram and Puducherry (50 Km) experiences a very low nesting site frequency of 1.2 per day per 10 Km. Eventhough, the Nesting Numbers are meager, to ensure the protection of Olive Ridley Populations in long term, during nesting and breeding season of turtles, the lighting in the Harbour area will be strictly restricted with Standard Operating Procedure norms with time limit (night to morning hours)


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required for laying of eggs from November to march. For the mitigation measure on conservation of sea-turtles, based on the experts opinion from reputed organization, the Specific guidelines for the Harbour's lighting plan and mitigation measure will be adopted at the cost of Tamilnadu Fisheries and Fishermen Welfare Department.

4. The Hon'ble Tribunal directed to request the Forest Department to furnish required particulars with respect to the olive ridley turtle nesting sites in the villages where the project is proposed on 21.03.2022. It is submitted that the Forest Department report containing details of Sea turtle (olive ridley) egg collection and nest relocated into hatchery in Tindivanam forest ranger, Villupuram Forest Division during 2021-22, the egg collecting watcher Mr.ponnivel was never accompanied by Forest Guard or any other official during egg collection from Azhagankuppam village. The forest department for the past years never recorded GPS Co-ordinates of nesting site, only for the year 2022 collected with GPS Co-ordinates using mobile phone GPS app. It is clearly evident that Forest Department is not well acquainted with GPS Measuring tools and devices. GPS in commercial phones are not accurate. Date of egg collection was also not mentioned in the report. Based on the submissions of report from Forest ranger, near the proposed training wall site is not a permanent nesting site from the various year maps is enclosed in the Annexure-1. Moreover, the egg collecting watchers Mr.Ponnivel and Mr.Umapathi have made a statement that, they never collected eggs in the barmouth area and proposed training wall site in the Annexure-2.

5. In the civil appeal nos.2407-2412 of 2021 in the Annexure-3 , The State of Uttar Pradesh & Ors. etc etc., versus Uday Education and Welfare Trust. The Hon'ble Supreme Court of India said that "we would request NGT that when the credentials and bonafides of litigations are seriously


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raised, while entertaining such grievancies of such litigations which is likely to adversely affect the rights of many, it should ensure the credentials of such litigations ". The Vikatan newspaper published on 29.11.2022 is enclosed in Annexure-4, reported that some resort is functioning in the Kaluveli and they are the reason for the above appeal. So, I kindly request the Hon'ble Tribunal to check the credentials and motive of the Petitioner and it is the case of the Department that petitioner does not have the expertise nor his intention are not genuine and is questionable.

6. It is submitted that the shore berthing of boats involves lot of fishermen lives at risk. About 6-8 fishermen are required for stopping of boats against the wave currents and actions at offshore and then using tractors the boats are tied up and dragged above HTL for berthing. During nesting and non-nesting season i.e., throughout the year the fishermen berth their boats in the beach above HTL. Generally, it is observed by experts that the turtle nesting happens 30 meters from the high tide line. As far as concerned, the number of boats increases monthly and annually. It can be seen the difference in number of boats during the Detailed Project Report study and now is enclosed in the Annexure-5. In future, the number of boats increases and all berthed in shore. Inturn, the Sea turtles finding difficulties in finding their nesting grounds due to shore berthing. If all the boats shifted from shore and to be berthed in fishing harbour area, then the area for turtle nesting may proportionately increase.

7. It is submitted that the EIA (Environmental Impact Assessment) Report in Annexure 14 of Marine Biology study by Annamalai University were reported 3 seagrass species patches in coastal survey points KW-1, KW-2 and KW-3 which is very near to the estuary mouth. Due to dynamic nature of estuary mouth, the seagrass patches are not permanent, gets washed and of temporary nature. Annamalai university have not

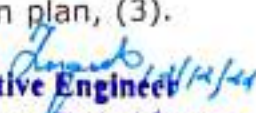
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Identified any Seagrass beds during the study. The survey points KW-1, KW-2 and KW-3 locations are shown in the map of Annexure-7. Any developmental project may pose a certain level of impact on the ecology and environment and also positive impacts on the economy and society. By adopting the applicable regulations and standards prescribed by MOEFCC, CZMA, and PCBs, the negative impacts on the environment are avoided and reduced to acceptable levels.

8. It is submitted that the Dhamra Port Case Study by Ann Moey, International Union for Conservation of Nature (IUCN) Published on 12 January 2021 is annexed in the Annexure-8 is an demonstrative of Development and Conservation can co-exist and that there are ways to develop in a responsible manner that meets the needs of people and needs of nature. The Story of Dhamra Port is the story of a major corporation and a global environmental organization working together to ensure that the construction of a large deep sea industrial port in India would not harm a significant population of endangered sea turtles. From a development perspective, the Site was perfect. But from a conservation perspective there were questions about its location close to one of the world's largest nesting site of the Olive Ridley turtle, protected under Indian law. The collaboration between DPCL-Dhamra Port Company Limited (then a joint venture between Tata Steel and L&T) and IUCN Shows that development and conservation can co-exist, and that there are ways to develop in a responsible manner that meets both the needs of people and the needs of nature. Lessons learned from this partnership can be applied to other projects that will have similar positive outcomes for people and for nature.

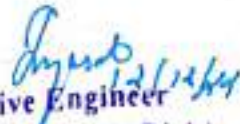
9. The following environmental management programs are widely recommended by MOEFCC for various large ports and harbor projects in India that are located in sensitive zones:

1. Construction of roads and pipelines on trusses without disturbing mangrove areas, (2). Compensatory mangrove afforestation plan, (3).


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In order to avoid any erosion and accretion from trailing wall or breakwater structures of ports, and jetty projects, beach nourishment during the non-nesting season is a common practice (excavation of deposited silt on the accretion side and scientifically distributing the silt on the erosion side), (4). Roust oil spill contingency plan, (5). Robust ecological and marine environmental monitoring during the operational phase,

- II. Large ports such as Tuticorin port which is handling very large ships with a capacity of 30,000 to 100,000 Tons (dead-weight), and very large vessel number of ships landing at the port, has fragile ecosystem such as large mats of seagrass within a 5km radius and the Gulf of Mannar national wildlife sanctuary with rich corals is located within 8Km from the project sites. The port is operating for a long period and the ecological scenario is continuously monitored by various reputed agencies in the region the facility has been adopting approved EMPs suggested by MOEFCC/CZMA from time to time to ensure environmentally friendly operations.
- III. Although Odisha experiences very high turtle nesting sites (refer to the paper shared with you), several large ports such as Dhamra are operating for a longer time and also are granted EC based on the EMPs suggested by MOEFCC. The research paper (Salim Ali Centre for Ornithology and Natural History), the stretch between Mamallapuram and Puducherry experiences a very low nesting site frequency of 1.2 per day per 10 Km,
- IV. Justification for suitability of grant of EC/CRZ for the proposed two fishing harbor projects:


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1. The proposed fishing harbour is not a commercial port, and it is intended to enhance the livelihood of the fishermen, hence the socioeconomic benefit is the paramount objective of the project,
2. The magnitude of the proposed fishing harbour operations is insignificant when compared with large ports due to the following reasons:
3. The volume of inventory (cargo/fish) handled will be less than 0.025 million TPA as against 50 to 100 million TPA of cargo handled by large ports located in ecologically sensitive areas in Odisha and Gujarat regions,
4. The typical propulsion capacity of the fishing boards will be in the range of 0.1 to 0.3 MW as against 5 to 10 MW of large ships landing at large ports. Hence the amount of turbulence created in the water will be insignificant and hence impact on the marine ecosystem such as seagrass or turtles will be insignificant,
5. The number of vessels operating in a day will be very less when compared with large ports, hence this will further reduce the impact on the marine environment,
6. The fishing harbours are operated only during day time when compared with large ports that are operating 24 hr x 7 days x 365 days, hence the envisaged impacts will be insignificant,
7. Fishing boats require a small quantity of fuel oil (less than 5 to 10 KL) when compared with 300 to 500 tons of fuel oil stored on each ship by the large ports, hence the impacts due to accidental oil spills is insignificant and the spill quantities if any can be easily treated by skimmers and bio-dispersants in the case of fishing harbours,
8. The maintenance dredging and beach nourishment requirements for the proposed project is less than 0.05 million m³ as against 1 to 3 million m³ for large port operations, hence the impacts due to the

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deposition of sand on the accretion due to the proposed project will be insignificant

The main harbour and backup activities are 100% compliant with applicable CRZ Regulations,

i. Shoreline change and management response:

a. As per published authentic reports, the shoreline of the harbour area falls under stable coast, however, the small patch of the sand bar (1.5km) at the mouth of the estuary is subjected to natural morphological changes. Due to its lesser economic importance and also sporadic turtle nesting occurrences on this sand bar, the proposed training wall will have limited influence on the shoreline phenomenon.

b. This has been reconfirmed through a hydrodynamic modelling exercise. The quantity of additional sand deposition on the southern side could be as high as 0.075 Million m^3 PA as against the natural phenomena of 0.014 million m^3 PA. It is tentatively estimated that the 0.075 million m^3 PA of sand may be deposited in an area of about 300 to 400 m on the southern side, which might contribute to an insignificant increase in shoreline change. Hence the impact of the accretion on the turtle nesting activities will be insignificant.

c. EIA/EMP recommends beach nourishment activities, which is an acceptable method by MoEF&CC, based on which several ECs were granted earlier. Although the quantity of accredited sand (annual depiction of 0.075 million m^3 PA) is very small, as a part of a proactive approach, EMP recommends undertaking maintenance dredging during the non-nesting seasons (May to Nov) and distributing the same on the northern side of the training wall to compensate 0.014 million m^3 PA eroded sand.

11. Seagrass ecology and management response:


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- a. Annamalai University report on ecology and biodiversity study indicates that only sporadic occurrence of seagrass was observed at a few patches of the creek. These patches are nowhere comparable with that of the large grass mats observed near Tuticorin areas. There is no evidence of a large seagrass mat that can support wider fish breeding and colonization. This is further corroborated by very low zooplankton density of 6000 to 7000 Nos per m³ as against typical biologically rich marine ecosystems such as Tuticorin with about 2,00,000 to 3,00,000 Nos per m³.
 - b. The propulsion used by the fishing boat will be infinitesimally small (<0.3 MW) when compared with large vessels operated in ports such as 5 to 10 MW, hence the net mechanical turbulence due to operation of the fishing hours on the marine ecosystem especially seagrass will be less significant. In addition, the number of boats operating at the harbour also will be very less when compared with large ports.
12. Salinity ingress due to creek opening (160m) and management response
- a. Hydrodynamic modeling studies indicated that the flushing in the creek will increase from the current level of 0.25Km to 1.5 to 2km during the high tide and high-high tide scenarios, which will happen only once in 15 days for about few hours, hence the osmotic affects on the marine benthic population will be less significant.
 - b. Based on the marine baseline studies data, it can be noted that there is no major difference in the biodiversity indices including diversity of Phytoplankton and benthos in the samples collected from the creek and also the open sea. This confirms that the


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marine biological species are very well acclimatized to a wider range of salinity.

13. Environmental management budget of Rs. 4.9 Cr
 - a. Mangrove afforestation plan in consultation with the state forest department,
 - b. Beach nourishment activities,
 - c. Turtle diversion buoys during the nesting season,
 - d. Marine environmental and ecological monitoring by reputed institutions,
 - e. Shoreline change status monitoring once in five years,
 - f. Conducting awareness training programs for fishermen availing the harbour facilities

14. Corporate social responsibility stewardship
 - a. Although the fisheries harbour is not a commercial port, the Fisheries department is committed to spending about Rs. 6.35 Cr of funds towards community development just like water supply, road, lighting etc..
 - b. Environmental management cell will be established to implement ISO 14001:2015 and ISO 26000 social accountability standards,
 - c. Communicating the overall environmental status of the project and its environs as per the SEIAA recommendations,
 - d. Periodical public consultations through appropriate methods to get feedback from the local people and other interested stakeholders on environmental management programs adopted,

In the light of above facts and circumstances, it is most respectfully prayed that this Honourable Tribunal may please to


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1. Dismiss this application under grounds that the facts stated by the applicant is totally false, against truth, baseless and motivated.
2. May be allowed to continue the work, as the fisheries department has followed all the procedures and norms in obtaining CRZ and environmental clearances.
3. Being the public welfare scheme and Government project, delay in execution affects the general public in getting their basic rights in time and also escalation in project cost, which is again the public money will be spent for creating this Fishing Harbour.

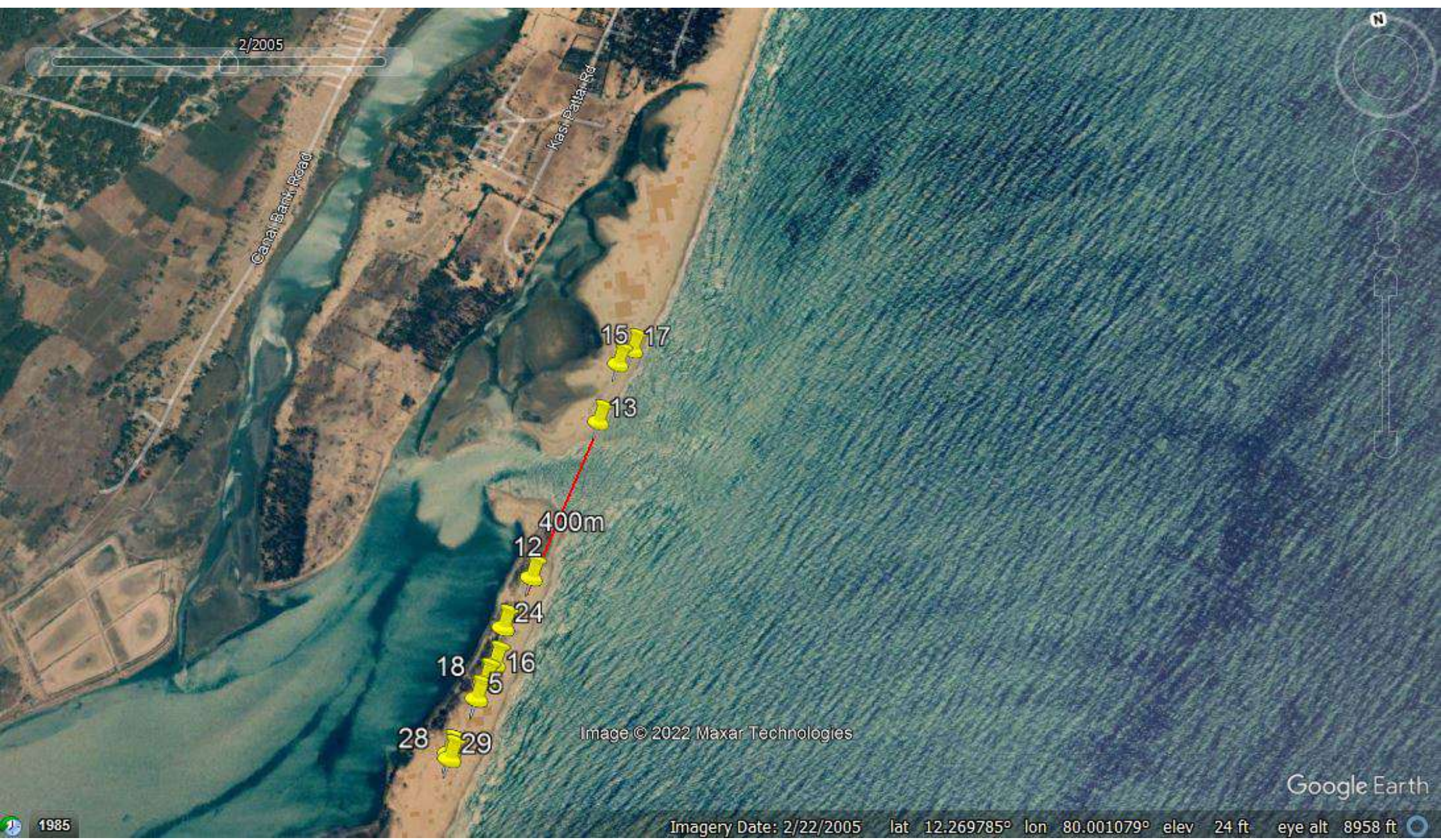
solemnly affirmed at Chennai on
this day of December 2022 and signed
in my presence.

T. Periyasamy
Before me 4/6/2021

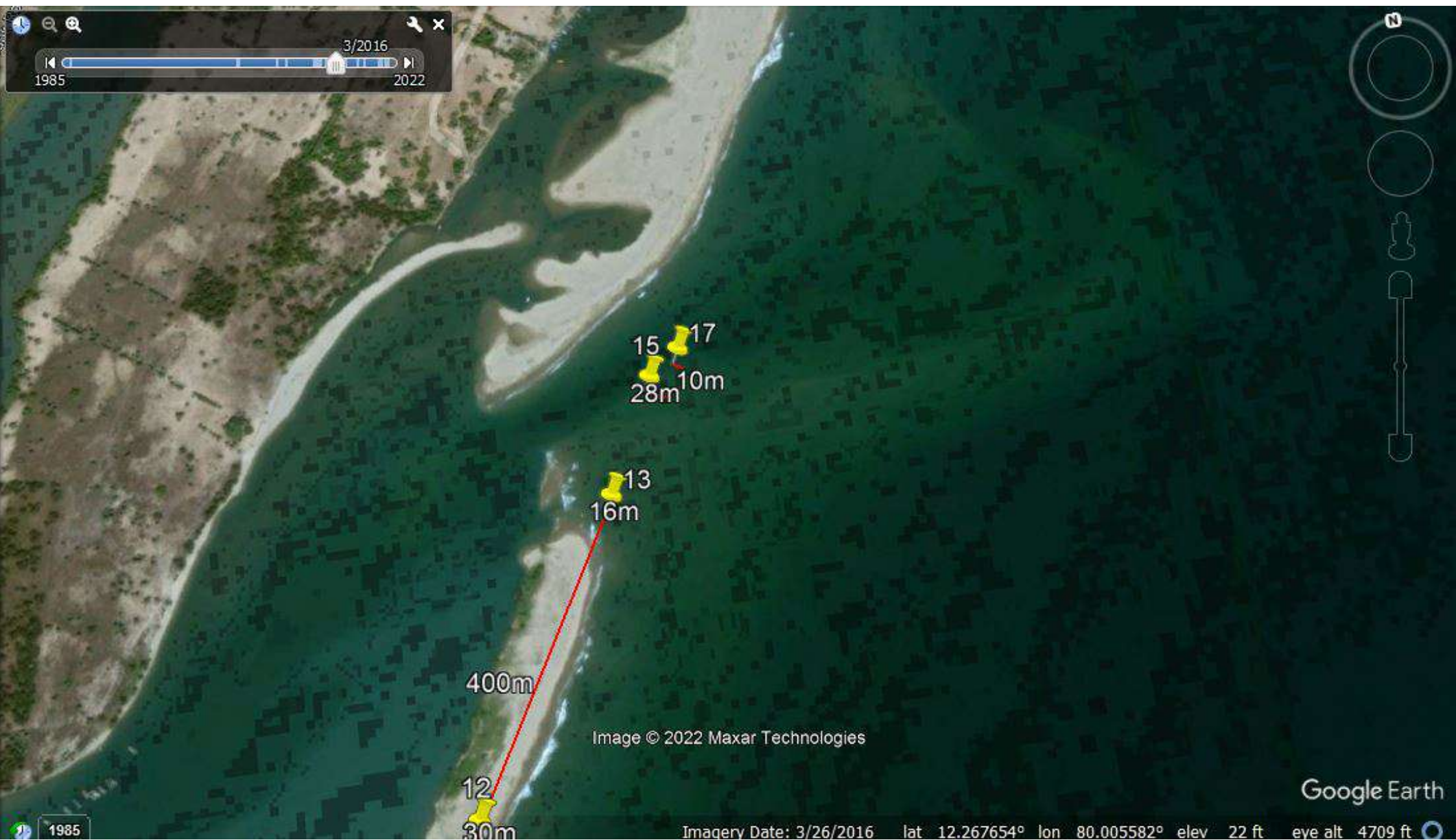
Advocate: Chennai


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Fishing Harbour Project Division
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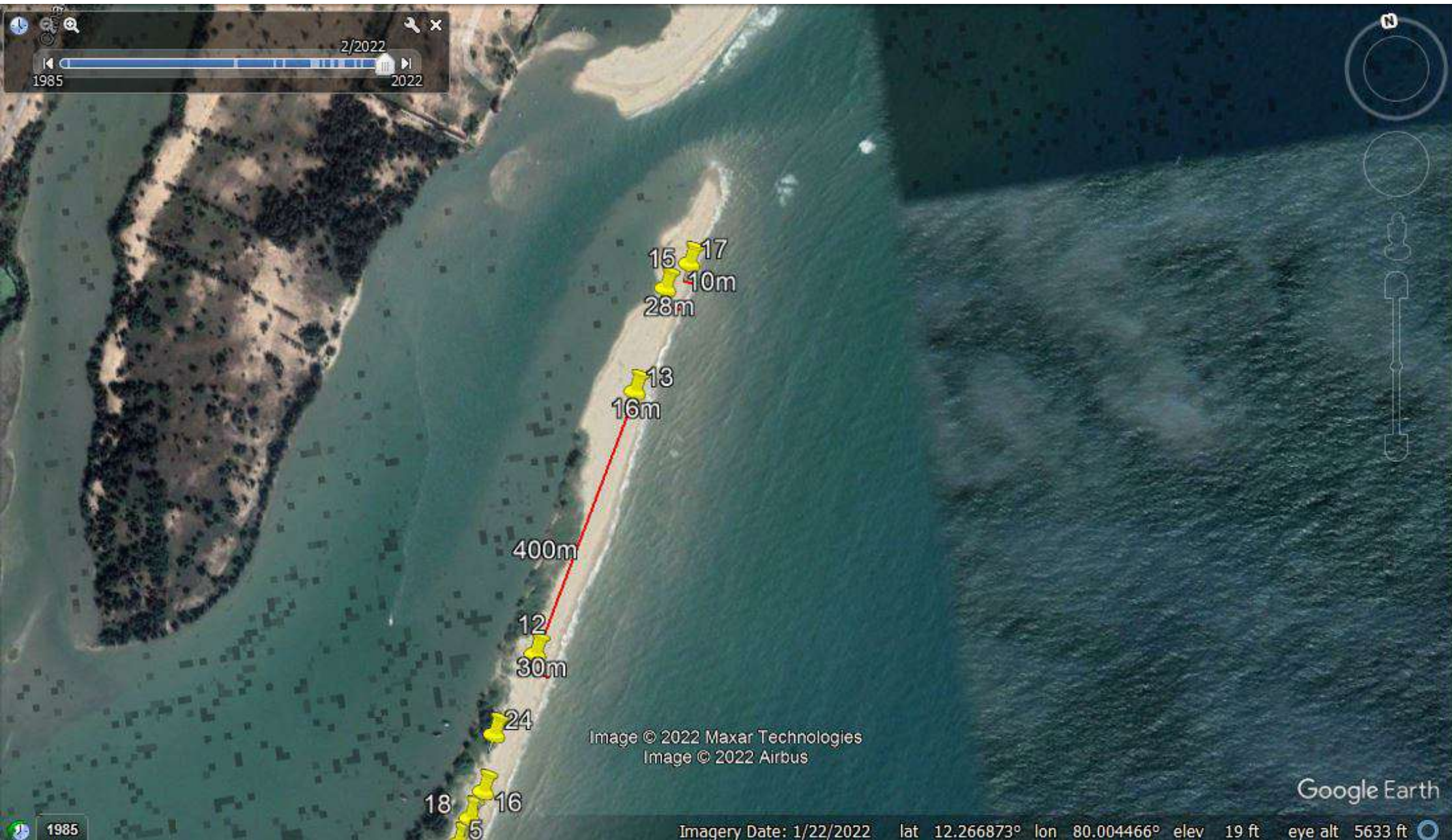


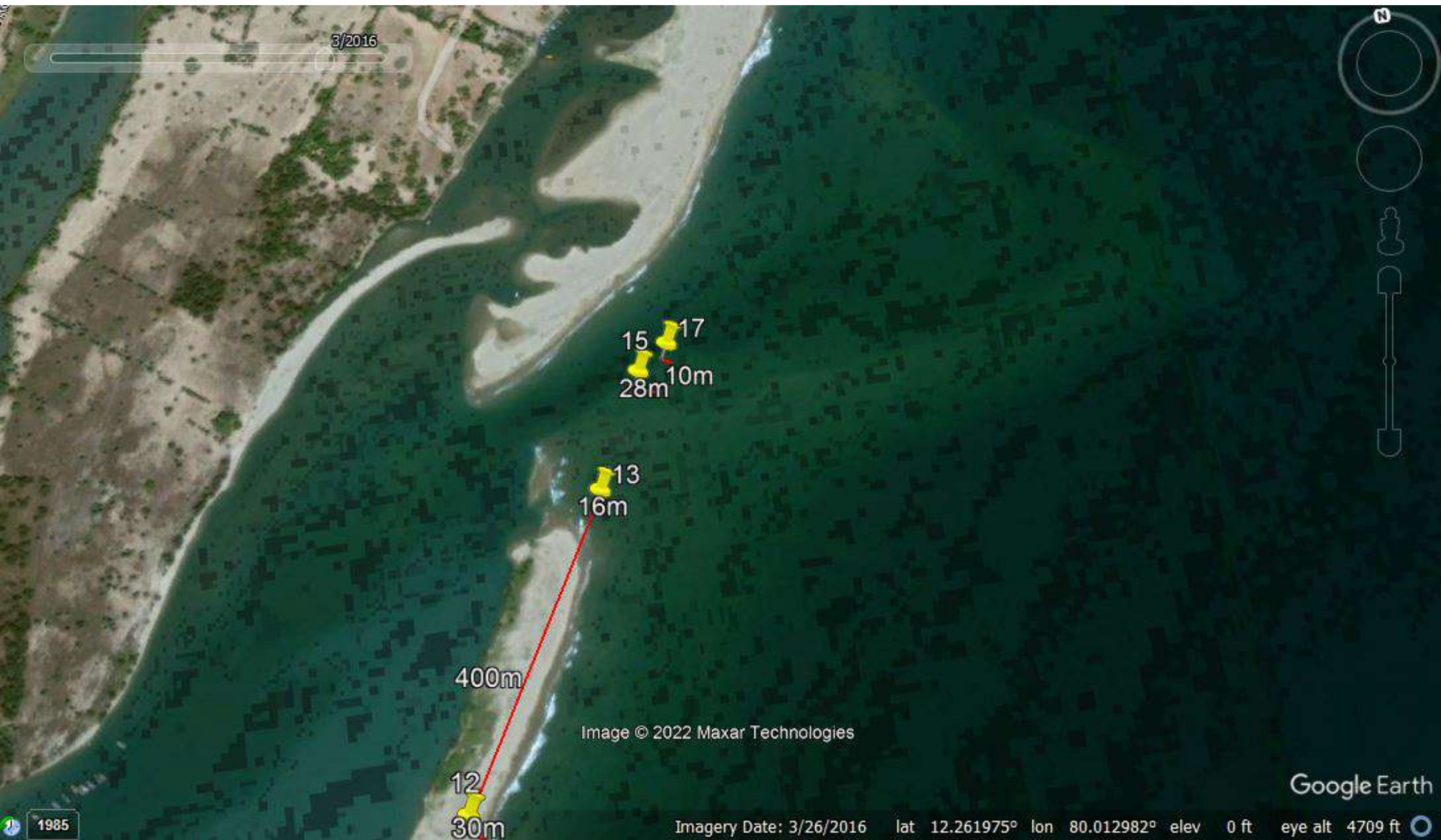














இங்கு

தேவதாஸ் உண்ணைய்யர்

P. 9517 என் னி டெயர்

TAMIL NADU FOREST DEPARTMENT

**TAMIL NADU BIODIVERSITY AND
GREENING PROJECT - SEA TURTLE CONSERVATION**



Name : K.UMAPATHI

Designation : PROTECTION WATCHER

District : VILLUPURAM.



K. R. [Signature]

Signature of Holder

[Signature]
FOREST RANGE OFFICER
THINDIVANAM RANGE
Issuing Officer.
THINDIVANAM.

Address of Holder

K.UMAPATHI
S/O. KALLAPAN,
VASAVANKUPPAM,
THINDIVANAM T.K.,
VILLUPURAM Dist.,

- * This ID is not Transferable
- * This ID is not for Avail any Dept., Previlages
- * If this card lost or misplaced
pls. be give it to the mentioned address

Valid upto 31.03.2015



TAMILNADU FOREST DEPARTMENT
**TAMILNADU BIODIVERSITY AND
 GREENING PROJECT - SEA CONSERVATION**



IDENTITY CARD



NAME : P.PONNIVEL
 DESIGN. : PROTECTION WATCHER
 DISTRICT : VILLUPURAM

10-03-2017

Signature of Holder

Issuing Officer

Address of Holder

P.Ponnivel,
 S/o. Palani,
 No.100, Vasavankuppam,
 Thindivanam T.K.
 Villupuram Dt.

- This ID is not Transferable
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Supreme Court of India

The State Of Uttar Pradesh vs Uday Education And Welfare Trust on 21 October, 2022

Author: B.R. Gavai

Bench: B.R. Gavai, B.V. Nagarathna

REPORTABLE

IN THE SUPREME COURT OF INDIA

CIVIL APPELLATE JURISDICTION

CIVIL APPEAL NOS.2407-2412 OF 2021

THE STATE OF UTTAR PRADESH
& ORS. ETC. ETC.

...APPELLANT (S)

VERSUS

UDAY EDUCATION AND WELFARE
TRUST AND ANR. ETC. ETC.

...RESPONDENT(S)

WITH

CIVIL APPEAL NOS. 3144-3146 OF 2022

CIVIL APPEAL NOS.3132-3134 OF 2022

CIVIL APPEAL NOS.3135-3137 OF 2022

CIVIL APPEAL NO.3138 OF 2022

CIVIL APPEAL NOS.4061-4062 OF 2022

CIVIL APPEAL NO.3141 OF 2022

CIVIL APPEAL NOS.2547-2548 OF 2020

CIVIL APPEAL NOS.3142-3143 OF 2022

CIVIL APPEAL NOS.3147-3149 OF 2022

JUDGMENT

B.R. GAVAI, J.

1. For the reasons stated in the applications for Signature Not Verified Digitally signed by GEETA AHUJA Date: 2022.10.21 impleadment/intervention, the same are allowed. 13:20:33 IST Reason:

2. This bunch of appeals challenges the order dated 18th February 2020, passed by the learned National Green Tribunal, Principal Bench, New Delhi (hereinafter referred to as "the learned NGT") in Original Application Nos.313, 335 and 396 of 2019, thereby quashing and setting aside the notice dated 1st March 2019 issued by the State of Uttar Pradesh for establishing new wood based industries (hereinafter referred to as "WBIs") and also setting aside all the provisional licenses given in pursuance thereof.

3. The appeals also challenge the orders dated 18th March 2020, 2nd December 2020, and 21st

December 2020 vide which the review applications filed by the State of Uttar Pradesh and the provisional license holders have been rejected.

4. Civil Appeal Nos.2407-2412 of 2021 are filed by the State of Uttar Pradesh. The rest of the Civil Appeals are filed by the provisional license holders, who were granted licenses in pursuance of the notice dated 1st March 2019, issued by the State of Uttar Pradesh.

FACTUAL BACKGROUND

5. For the sake of convenience, we will refer to the facts as found in Civil Appeal Nos. 2407-2412 of 2021 filed by the State of Uttar Pradesh.

6. There are series of orders passed by this Court and the Central Empowered Committee (hereinafter referred to as “CEC”) appointed by this Court, issuing various directions for prohibiting/regulating the felling of trees as well as the establishment of WBIs. We will refer to them extensively in the subsequent paragraphs.

7. In pursuance of the order passed by this Court dated 5th October 2015 in Writ Petition (Civil) No.202 of 1995 (T.N. Godavarman Thirumalpad vs. Union of India), the Ministry of Environment and Forest and Climate Change (“MOEFCC” for short) issued Wood Based Industries (Establishment and Regulation) Guidelines 2016 (hereinafter referred to as “2016 Guidelines”) vide Notification No. S.O. 3456 (E) dated 11th November 2016.

8. Subsequent to the 2016 Guidelines, timber assessment for Trees Outside Forest (“TOF” for short) in the State of Uttar Pradesh for WBIs was done for the period between February 2017 and December 2017 by the Forest Survey of India (“FSI” for short). The FSI thereafter submitted its report, which contains district wise, species wise and diameter class wise number of stems (trees), volume and annual potential production of timber from TOF in rural areas of all the districts of the State.

9. In pursuance of the 2016 Guidelines, the matter was placed before the State Level Committee (“SLC” for short) for grant of licenses to various WBIs. The SLC in its meeting held on 4th May 2018, considered the matter about the grant of licenses to various WBIs after taking into consideration the availability of wood in the State of Uttar Pradesh for determining the amount of timber available for new WBIs. In the said meeting, it was also decided that, in order to determine the correct number of new licenses to be issued to WBIs under different categories against the timber available in the State, a reassessment may be done by the Indian Plywood Industries Research and Training Institute (“IPIRTI” for short).

10. In the meeting of the SLC, held on 7th September 2018, since it was found that the capacity of plywood units is taken as fixed by the 2016 Guidelines, which, in turn, was based on the assessment of IPIRTI, a decision was taken that there was no need for the fresh assessment of the capacity by IPIRTI.

11. In pursuance of the aforesaid decision, E-lottery was held on 12th December 2018 for grant of licenses to various WBIs for the establishment of WBIs in 8 categories. Between 12th December 2018 and 31st December 2018, online letters of offer were issued to 1348 successful applicants. Subsequently, in the months of February and March 2019, provisional licenses were issued to 1215 successful applicants in the 8 categories to set up their WBIs. Subsequent thereto, on 1st March 2019, a notice was issued by the Government of Uttar Pradesh communicating the grant of provisional licenses to the newly selected WBIs.

12. Being aggrieved thereby, Original Application No. 313 of 2019 came to be filed by Uday Education and Welfare Trust before the learned NGT in March 2019. Vide order dated 28th March 2019, the learned NGT directed the State Government to submit a report from the Joint Committee comprising of the representative of Principal Secretary (Forest), U.P. and the Principal Chief Conservator of Forest, U.P. to examine the issues.

13. Being aggrieved by the notice dated 1st March 2019 issued by the State Government, Original Application Nos. 335 and 396 of 2019 also came to be filed by Samvit Foundation and U.P. Timber Association respectively before the learned NGT.

14. In pursuance of the directions issued by the learned NGT, the Joint Committee Report came to be submitted on 3rd August 2019. Vide order dated 6th August 2019 passed in Original Application nos. 313, 335 and 396 of 2019, the learned NGT directed the State Government to review the notice dated 1st March 2019 with regard to the establishment of new WBIs by 1350 units strictly in terms of the judgment of this Court in the case of T.N. Godavarman vs. Union of India. Vide order dated 1st October 2019, the learned NGT directed the status quo to be maintained.

15. The State of Uttar Pradesh filed an Interlocutory Application No.732 of 2019 in O.A. Nos. 313, 335 and 396 of 2019, seeking modification of the order dated 6th August 2019 and the order dated 1st October 2019. Vide order dated 18th December 2019, the learned NGT issued directions to the State Government to provide certain data. Subsequently, vide the impugned order dated 18th February 2020, the learned NGT allowed the said Original Applications and quashed and set aside the notice dated 1st March 2019 issued by the State Government for establishing new WBIs and all the provisional licenses given.

16. Being aggrieved thereby, Civil Appeal (Diary) No.12004 of 2020 was filed before this Court. Vide order dated 26th October 2020, this Court dismissed the said appeals as withdrawn with a liberty to file review application before the learned NGT. Vide orders dated 18th March 2020, 2nd December 2020, and 21st December 2020, the learned NGT rejected the Review Applications.

17. The appellants, therefore, approached this Court being aggrieved by the orders passed by the learned NGT in the Original Applications as well as in the Review Petitions. SUBMISSIONS

18. We have heard Shri Vikas Singh, Shri P.S. Patwalia and Mr. Rana Mukherjee, learned Senior Counsel appearing on behalf of the State of Uttar Pradesh, Shri V. Giri, Shri Syed Waseem Qadri, Shri V.K. Uniyal, Shri Vinay Navare, Shri V.K. Shukla, learned Senior Counsels, Ms. Prerna Singh,

and Mr. Rudraksh Gupta, learned counsels appearing on behalf of the appellants, who were granted provisional licenses. We have also heard Shri Dhruv Mehta and Shri Brijender Chahar, learned Senior Counsels appearing on behalf of the respondent No.1.

19. Shri Vikas Singh, learned Senior Counsel, submitted that the decision of the State Government to establish WBIs is in accordance with the 2016 Guidelines issued by the MOEFCC. He submits that the timber requirement by 1215 new WBIs, which were issued provisional licenses is only 12.35 lakh cubic meters per year, whereas the total timber available in the State is 80.30 lakh cubic meters per year. It is, therefore, submitted that, as such, the requirement is not even 20% of the total availability of timber. Learned Senior Counsel submitted that the only authorized agency in the country to conduct a survey of the forest as well as TOF is FSI. It is submitted that the object of IPIRTI is not to conduct a survey of either forest or TOF. It is submitted that, as a matter of fact, the learned NGT itself has directed such a study to be conducted by FSI, who has already undertaken similar studies for many States like Punjab, Maharashtra and others. It is submitted that when the survey with regard to availability of timber in the State of Uttar Pradesh was done by the very same agency, the learned NGT fell in gross error in again directing the State Government to conduct such a survey through the FSI.

20. It is submitted that even the MOEFCC had supported the stand taken by the State of Uttar Pradesh and, therefore, the learned NGT ought not to have interfered with the decision of the State Government.

21. Shri P.S. Patwalia, learned Senior Counsel also submitted that the decision of the State Government was in tune with the decision of this Court dated 18th May 2007 and 5th October 2015 passed in Writ Petition (Civil) No.202 of 1995 (T.N. Godavarman Thirumulpad vs. Union of India). It is submitted that when an expert body like the FSI had done an elaborate study, there was no reason for the learned NGT to have sat in appeal over the same. He further submits that though a detailed affidavit has been filed on behalf of the State of Uttar Pradesh in compliance with the order of the learned NGT dated 18th December 2019, regarding the availability of timber, the learned NGT has totally ignored the same.

22. Shri V. Giri, learned Senior Counsel, submits that the learned NGT erred in passing orders which have vitally affected the rights of the citizens who were granted provisional licenses. He submits that the order impugned is totally in breach of the principles of natural justice. It is submitted that, from the perusal of the record, it is clear that the State of Haryana while calculating its requirement for wood also takes into consideration the import from the State of Uttar Pradesh. It is submitted that when there is excess wood available in the State of Uttar Pradesh, there is no reason why the same should be permitted to be exported to the State of Haryana at the cost of entrepreneurs in the State of Uttar Pradesh.

23. Shri Vinay Navare, learned Senior Counsel, submitted that the timber used in the WBIs is from the trees which are agro-based. He submits that though the State of Uttar Pradesh had adopted an elaborate procedure right from June 2018 till the grant of licenses, the applicants before the learned NGT had taken no steps. Shri Navare submits that only after the provisional licenses were issued

and 632 out of 1215 WBIs provisional license holders had already been established and commenced operations, the applications were entertained and the orders were passed to the prejudice of the WBIs. It is submitted that Section 19(1) of the National Green Tribunal Act, 2010 (hereinafter referred to as “the NGT Act”) mandates following of the principles of natural justice. It is submitted that though the applications for impleadment were made by the WBIs, the applicants were not granted an opportunity of being heard.

24. Shri V.K. Uniyal, learned Senior Counsel submitted that the learned NGT had erred in using the word “allotted”. It is submitted that there is no question of allotment of timber to the WBIs and they are required to purchase the same from the open market.

25. Shri V.K. Shukla, learned Senior Counsel submitted that the State Government decided to grant provisional licenses for 8 different categories of WBIs. The requirement of raw material for different categories of WBIs is different. It is submitted that the learned NGT has grossly erred in considering all categories of WBIs together and setting aside the licenses granted to all of them. It is submitted that the said industries are established in pursuance of the National Agro Forestry Policy of 2014 and as such the learned NGT ought not to have interfered.

26. Ms. Prerna Singh, learned counsel appears for the appellants, who have been granted provisional licenses for plywood (press only) category. She submits that for plywood (press only) industries, there is no requirement of consumption of timber directly. It is submitted that initially veneer is manufactured out of round/fresh timber. Veneer then so manufactured is glued and pressed together to manufacture plywood. It is submitted that the learned NGT has considered the requirement of timber as twice the actual requirement. She submits that in the State of Uttar Pradesh, veneer is manufactured in surplus, which is exported to the State of Haryana.

27. Shri Rudraksh Gupta, learned counsel, submits that the learned NGT has failed to take into consideration the report of the National Poplar Commission of India.

28. All the learned counsel appearing on behalf of the appellants, in unison, submit that the original applicants before the Court were not bonafide litigants. It is submitted that there are reasons to believe that the proceedings were initiated at the instance of either the existing WBIs in the State of Uttar Pradesh to prevent competition or they were filed at the instance of the WBIs in the State of Haryana who were importing timber from the State of Uttar Pradesh at cheaper rates.

29. Shri Dhruv Mehta, learned Senior Counsel appearing on behalf of the respondent No.1, on the contrary, submits that this Court has repeatedly held that the principles of sustainable development, the precautionary principle and the polluter pays principle are to be followed consistently. He raised a preliminary objection on the ground that in view of Section 22 of the NGT Act, the scope of an appeal before this Court could be limited to that of Section 100 of the Code of Civil Procedure, 1908. It is, therefore, submitted that unless a substantial question of law is raised, the appeal could not be tenable.

30. Shri Dhruv Mehta submits that this Court vide order dated 12th December 1996 has specifically prohibited the felling of trees in any forest, public or private. He further relies on the report of CEC dated 15th March 2005 to buttress his submission that WBIs can be permitted only if they exclusively use timber derived from poplar and eucalyptus species or agriculture waste products. It is submitted that the said guidelines also specifically provided that if the unit is found to have used any timber other than poplar and eucalyptus whether from a legal source or otherwise, the license granted to the unit shall be liable to be cancelled. He further relies on the report of CEC dated 12th October 2006. He submits that an assessment has to be done on the basis of the district-wise survey about timber availability from the TOF category. He submits that the said report of CEC itself would reveal that the assessment of the State is much less than what was initially projected by the State Government. He submits that unless the timber availability for the new WBIs is assessed and the SLC examines and recommends its approval, it is not permissible to establish new WBIs.

31. Shri Mehta further submits that the report of CEC dated 18th April 2007, accepted by this Court vide its order dated 18th May 2007, would show that the availability of timber for WBIs in the State of Uttar Pradesh is only 45.70 lakh cubic meters per year. Learned Senior Counsel submits that taking into consideration the fact that presently many imported machines from China are being used, the capacity of the existing units has gone much higher and, therefore, the timber which is available in the State of Uttar Pradesh would not be sufficient to meet the demand of the existing industries.

32. Shri Mehta submits that when SLC in its meeting dated 4th May 2018 had decided to get a report from IPIRTI, there was no occasion for it to review its decision in its subsequent meeting dated 7th September 2018. He submits that the Senior Officer of the Forest Department of the rank of Chief Conservator of Forest, Kanpur Division, Kanpur recommended that the report from IPIRTI should be obtained before deciding to issue the new licenses. It is submitted that the letters of the said officer dated 11th September 2019 and 20th April 2018 have been ignored by the SLC.

33. Shri Dhruv Mehta further submits that Annexure-I to the 2016 Guidelines is in contravention of the recommendations of CEC, which takes the requirement of timber for plywood unit as "NIL".

34. The learned Senior Counsel submits that vide Notification dated 20th July 2012, the State of Uttar Pradesh had notified 7 species of trees in the prohibited category. However, vide another Notification dated 31st October 2017, the said trees were taken out of the prohibited category. The learned NGT had set aside the said Notification of 2017 by order dated 11th September 2018. It is submitted that the said order of the learned NGT has been accepted by the State of Uttar Pradesh and a fresh notification has been issued on 7th January 2020, again bringing the said trees in the prohibited category. The learned Senior Counsel submits that while assessing the availability of timber, the trees under the said prohibited category have also been taken into consideration. He submits that if 20.75 lakh cubic meters is deducted from the availability of the timber, then the timber available in the State would be much less.

35. The learned Senior Counsel further submits that the survey has not been conducted for all the districts and has been conducted only for 30 districts and, therefore, the survey itself is erroneous.

36. The learned Senior Counsel further submits that FSI, while conducting the survey, has not taken into consideration the rotation period and, therefore, the survey is erroneous on the said count also. Learned Senior Counsel, in support of his submissions, relies on the judgment of this Court in the cases of Common Cause vs. Union of India and others¹, Mantri Techzone Private Limited vs. Forward Foundation and others², Municipal Corporation of Greater Mumbai vs. Ankita Sinha and Others³ and Pragnesh Shah vs. Dr. Arun Kumar Sharma and others⁴.

37. Shri Dhruv Mehta, relying on the judgment of this Court in the case of Ankita Sinha and Others (supra), submits that this Court itself has considered the learned NGT to be a special Tribunal and held that it will even have jurisdiction to take suo motu cognizance of the environmental issues. He, therefore, submits that the (2017) 9 SCC 499 (2019) 18 SCC 494 2021 SCC OnLine SC 897 2022 SCC OnLine SC 79 arguments made on behalf of the appellants with regard to locus are without substance.

38. Shri Vikas Singh, learned Senior Counsel, in rejoinder, submits that the only distinction between the prohibited trees and non-prohibited trees is that the non-prohibited trees can be felled without permission, whereas prohibited trees can be felled only in certain circumstances and only after the requisite permission is granted. He submits that the perusal of the FSI survey would reveal that even after the timber requirement for 1215 new units is taken into count, the State, still, will have 26.36 lakh cubic meters in reserve. He submits that if the new WBIs are permitted, it would result in more farmers going in for agro forestry in the State, which, in turn, will increase the forest cover. It is submitted that said 1215 units are likely to give employment to around 80000 people. Learned Senior Counsel, therefore, submits that the impugned orders deserve to be quashed and set aside.

EARLIER ORDERS OF THIS COURT

39. For appreciating the rival submissions, it will be apposite to refer to certain orders passed by this Court.

40. This Court in the case of T.N. Godavarman (supra) passed an order on 12th December 1996. The relevant part thereof is as under:

“6. Each State Government should within two months, file a report regarding –

(i) the number of saw mills, veneer and plywood mills actually operating within the State, with particulars of their real ownership;

(ii) the licenced and actual capacity of these mills for stock and sawing;

(iii) their proximity to the nearest forest;

(iv) their source of timber.

7. Each State Government should constitute within one month, an Expert Committee to assess:

(i) the sustainable capacity of the forests of the State qua saw mills and timber based industry;

(ii) The number of existing saw mills which can safely be sustained in the State;

(iii) The optimum distance from the forest, qua that State, at which the saw mill should be located.”

41. Vide subsequent order dated 4th March 19975, this Court directed thus:

“6. All unlicensed saw mills, veneer and plywood industries in the State of Maharashtra and the State of Uttar Pradesh are to be closed forthwith and the State Government would not remove or relax the condition for grant of permission/licence for the opening of any such saw mill, veneer and plywood industry and it shall also not grant any fresh permission/licence for this purpose. The Chief Secretary of the State will ensure strict compliance of this direction and file a compliance report within two weeks.”

42. Vide order dated 9th May 2002, this Court constituted CEC for monitoring of the implementation of the orders passed by this Court and for placing non-compliances of the cases before it.

(1997) 3 SCC 312

43. Vide order dated 29th October 20026, this Court further directed thus:

“44. No State or Union Territory shall permit any unlicensed sawmills, veneer, plywood industry to operate and they are directed to close all such unlicensed unit forthwith. No State Government or Union Territory will permit the opening of any sawmills, veneer or plywood industry without prior permission of the Central Empowered Committee. The Chief Secretary of each State will ensure strict compliance with this direction. There shall also be no relaxation of rules with regard to the grant of licence without previous concurrence of the Central Empowered Committee.

45. It shall be open to apply to this Court for relaxation and or appropriate modification or orders qua plantations or grant of licences.”

44. Vide order dated 1st September 2006, this Court allowed licenses to be issued to the closed sawmills, Veneer and Plywood units as per availability of timber and eligibility and seniority as per CEC recommendation. (2008) 16 SCC 337

45. In pursuance of the orders passed by this Court, SLC was constituted by the State of Uttar Pradesh for verification and compilation of information about closed WBIs.

46. The FSI conducted its assessment and assessed the annual availability of wood from TOF in the State of Uttar Pradesh at 55.61 lakh cubic meters vide report dated 3rd April 2007.

47. On the basis of the report of the FSI, the SLC assessed the annual availability of timber for WBIs from TOF at 53.01 lakh cubic meters. CEC further reduced the same to 43.70 lakh cubic meters. However, it added 2.00 lakh cubic meters per year as timber available from government forests, and, therefore, assessed the annual availability of timber at 45.70 lakh cubic meters.

48. It is to be seen that in its report itself, the CEC included 17.77 lakh cubic meters of timber from the prohibited species. This Court considered the report of CEC and passed the following order on 18th May 2007:

“The matters relate to Saw Mills, Plywood and Veneer Units.

The CEC has considered the availability of wood for the industries, which was assessed as 43.70 lakh cu. mt from trees outside forests and 02.00 lakh cu. mt from Government Forests.

It has also assessed the units into four categories.

We accept the CEC's recommendations.

The Saw Mills, Plywood and Veneer Units may be permitted, on the basis of the recommendations made by the CEC.

Licences may be given by the State Level Committees.

If there are any objections regarding grant of licences, the parties would be at liberty to submit their applications before the CEC for consideration.”

49. It could thus be seen that in 2007 itself, this Court had accepted the recommendations of the CEC wherein the CEC had computed the total availability of timber and had also taken into consideration the availability of timber from the prohibited category.

50. Vide order dated 29th February 2008, this court considered the issue regarding the manufacturing of Medium Density Fiber board (MDF) and Particle board in the States of Punjab, Uttarakhand and Karnataka. While considering the same, this Court passed the following order:

“The matter relates to the manufacturing of Medium Density Fiber board (MDF) and Particle Board in the States of Punjab, Uttarakhand and Karnataka. CEC has filed its report and stated that there is a growing trend to use more and more MDF / Particle Board in place of industrial timber. The MDF/Particle Board help in reducing the

pressure on natural forests. The lops and tops and small wood available from the plantations of eucalyptus, poplar, etc. raised on the non-forest can be used by MDF/Particle Board plants.”

51. In view of the permissions granted by this Court, the licenses were granted to the unlicensed sawmills which were closed on account of the orders passed by this Court taking into consideration the availability of timber between 2007 and 2010. However, it is to be noted that the said licenses were granted only to the units which were closed and not to the new units.

52. The matter again came up for consideration before this Court on 30th April 2010, when this Court passed the following order:

“(II) after meeting the requirement of the licensed wood based industry, the units permitted by this Hon'ble Court and the units whose category is yet to be finalised, the plywood/veneer units falling in category IV may be considered for grant of license to the extent of timber availability and strictly in the order of seniority, subject to the one-time payment of Rs.9 lakhs per press in respect of the veneer units and compliance of the other conditions that have been stipulated. The one-time payment of penalty will be in addition to the normal licence fee and the other charges, if any, payable to the U.P. Forest Department. As decided earlier, the above said amount should be kept in a designated interest bearing bank account and should be utilized only after the scheme in this regard is approved by this Hon'ble Court;”

53. It could thus be seen that this Court permitted granting of additional licenses if additional timber was found to be available.

54. The CEC in its meeting held on 26th May 2010 with the SLC and representatives of WBIs Associations in the State of Uttar Pradesh, after taking into consideration the capacity of timber for Vertical Band Saw (VBS) sawmill, modified/reduced the value of capacity of timber for VBS sawmills upto 10 Horse Power from 540 to 270 cubic meters per year for the State of Uttar Pradesh in line with other States. As such, additional 9,58,230 cubic meters of timber became available for licenses from 3,549 such VBS units. In view of this position between 2010 and 2015, licenses came to be issued by the State of Uttar Pradesh to unlicensed WBIs, which were closed earlier by the order of this Court, as per the criteria recommended by the CEC and accepted by this Court.

55. The matter again came up for consideration before this Court on 5th October 2015 with regard to WBIs, when this Court passed the following order:

“CATEGORY I - MATTERS RELATING TO WOOD BASED INDUSTRIES:

We have heard Shri Harish Salve, learned amicus curiae, Shri Ranjit Kumar, learned Solicitor General of India, Shri K.K. Venugopal, learned senior counsel and other learned senior counsel/counsels. Accordingly, we pass the following orders:

(i) The State Level Committees for Wood-Based Industries ("SLCs") are, subject to the compliance of the prescribed guidelines and procedure, authorized to take decisions regarding the grant of license/permission to the wood-based industries;

(ii) In each State/UT for which the SLC has so far not been constituted, the SLC under the Chairmanship of the Principal Chief Conservator of Forests with a representative of the Ministry of Environment and Forest and Climate Change ("MoEFCC") and an officer of the State Forest Department/Industries Department not below the rank of the Chief Conservator of Forests/ equivalent rank will immediately be constituted;

(iii) The MoEF is authorized to issue appropriate guidelines in conformation with the orders and

directions issued by this Court and also the existing guidelines to the SLCs relating to assessment of timber availability for wood-based industries and grant of license/permission to the wood-based industries including addition of new machineries and also utilization of amounts recovered from the wood-based industries and connected matters;

(iv) Any person aggrieved by the decision taken by the SLC may file an appeal before the MoEFCC seeking appropriate relief within 60 days' time. If, for any reason, any person is aggrieved by the orders so passed in the appeal, he may prefer an appropriate petition/application/appeal before the appropriate forum/Court for grant of appropriate relief(s).

We also permit the MoEFCC to condone the delay, if any, in filing an appeal, if sufficient cause is made out by the applicant(s)/appellant(s)"

56. It is thus seen that vide the said order, SLCs were authorized to take decisions regarding the grant of license/permission to the WBIs. Vide the said order, it was also directed to constitute SLC under the Chairmanship of the Principal Chief Conservator of Forest with a representative of MOEFCC and an officer of the State Forest Department/Industries Department not below the rank of the Chief Conservator of Forests/equivalent rank. This Court further directed the SLCs to be constituted in each State/Union Territory for which the SLC was not yet constituted. The MOEF was also authorized to issue appropriate guidelines in conformity with the orders and directions issued by this Court and also the existing guidelines to the SLCs relating to the assessment of timber availability for WBIs. Appeals could be filed before MOEFCC against the decision of the SLC.

MOEFCC GUIDELINES

57. In accordance with the directions issued by this Court vide order dated 5th October 2015, the MOEFCC issued 2016 Guidelines on 11th November 2016. The 2016 Guidelines provided for the constitution of the SLC as well as the powers and functions of SLC. Under clause 4 of the 2016

Guidelines, the SLC was authorised to assess the availability of timber for wood based industrial units in the State/UT every five years. The SLC was also authorised to approve appropriate locations for setting up of wood based industrial units. It was also authorized to approve the name of wood based industrial units which may be considered for grant of fresh license or enhancement of the existing licensed capacity.

58. Clause 5 of the 2016 Guidelines provides for the assessment of the availability of timber for wood based industrial units. It requires that the quantity of timber would be assessed by commissioning the study, preferably in collaboration with institutes/universities of repute, once in five years. Under clause 6 of the 2016 Guidelines, the timber requirement for various units as assessed by IPIRTI was given in Annexure I. The said Annexure I reads thus:

“The Indian Plywood Industry Research and Training Institute (IPIRTI), Bangalore an autonomous body under the Ministry of Environment, Forest and Climate Change has assessed the timber requirement per unit for peeling length of 4 feet and 8 feet size in the plywood/veneer units as 5 cu.mt and 11 cu.mt. respectively per day on an average of 8 working hours per day. By assuming that the peeling units work for 8 hours per day on an average for 300 days in a year the normal timber requirement of the peeling length of 4 feet size in veneer units is 1500 cu.mt.

The total timber requirement for the stand alone veneer units may be assessed by calculating the equivalent number of 4 feet length machines and by taking its normal installed capacity as 1500 cu.mt. per annum.

The timber requirement of a plywood unit may be taken as 'nil' on the ground that the round timber is used as timber in the veneer units only and that the plywood units are the secondary users which use the veneer as the raw material produced by the veneer units.

The plywood units use presses of various sizes such as 8x4x6, 8x4x12, 8x4x15, 4x4x7, 4x4x10. A 8x4x10 capacity press can produce upto 10 plywood pieces of 8'x4' size per hour whereas a 8x4x15 capacity press can produce upto 15 plywood pieces of 8'x4' size per hour and so on. The normative installed capacity of the plywood units will accordingly depend upon the number and the type of presses. This number and type of presses installed in each of the plywood unit may be assessed and thereafter equivalent number or presses of 8x4x10 capacity may be calculated. The normative annual timber requirement for a integrated plywood unit having a 8x4x10 capacity press may be taken as 2000 cu.mt. per annum, and accordingly the total requirement of timber for the plywood units should be calculated.”

59. It could thus be seen that even as per the assessment of the IPIRTI, the timber requirement of a plywood unit is required to be taken as 'NIL' on the ground that the round timber is used as timber in the veneer units only and that the plywood units are the secondary users which use the veneer as raw material. It could thus be seen that the plywood units use presses of various sizes.

60. In pursuance of the 2016 Guidelines, the SLC was reconstituted in the State of Uttar Pradesh under the Chairmanship of Principal Chief Conservator of Forest/Head of Forest Department on 17th May 2017. Vide Notification dated 11th September 2017, the MOEFCC amended the 2016 Guidelines.

61. Subsequently, in accordance with the 2016 Guidelines, the SLC assessed the availability of timber for WBIs in the State of Uttar Pradesh, through the FSI. For assessing the availability of timber, the FSI conducted a survey and arrived at the annual potential production of timber from TOF in rural areas of all the districts of the State. FSI assessed the annual potential production from TOF at 77.74 lakh cubic meters. Subsequent to the survey and assessment, the SLC in its meeting dated 4th May 2018 considered the matter for grant of license to various WBIs. The SLC decided to get the reassessment done by IPIRTI to determine the correct number of new licenses to be issued to WBIs under different categories against the available timber. However, subsequently, the SLC, in its meeting dated 7th September 2018, found that IPIRTI had not done any new study/assessment of the consumption of timber by various WBIs in any State/Union Territory. It was also found that the State of Haryana had adopted the timber consumption figures based on the CEC figures of 2007. It was therefore unanimously resolved by the SLC that there was no need for any fresh study/assessment for the consumption of timber by WBIs to be conducted by IPIRTI and to adopt the figures for WBIs as were referred to in the 2016 Guidelines. It further found that the CEC in its meeting dated 26th May 2010 had reduced the annual consumption of timber of sawmills upto 10 Horse Power or less HP to 270 cubic meters from 540 cubic meters.

62. On the basis of the decision of the SLC, e-lottery was held. After following the procedure, provisional licenses were issued to 1215 successful applicants in 8 categories of WBIs in February and March 2019. After the issuance of provisional licenses, on 1st March 2019, the State Government issued a Notice with regard to grant of provisional licenses to the newly selected WBIs which came to be challenged before the learned NGT by way of filing the aforesaid Original Applications by the respondents. The learned NGT after passing various interlocutory directions finally passed the impugned order and quashed and set aside the notice dated 1st March 2019 issued by the State Government and provisional licenses given in pursuance thereof. As such we are required to examine the correctness of the decision of the learned NGT.

CONSIDERATIONS

63. The learned NGT while passing the impugned order has set aside the notice of the State of Uttar Pradesh on the following grounds:

- (1) that the WBIs can be allowed to operate only after ensuring timber and raw material availability to sustain such industries and this has to be determined in actual terms and not on mere assumptions;
- (2) that it is difficult to accept the stand of the State of Uttar Pradesh that there was availability of timber/raw material to sustain the new WBIs;

(3) that it is the stand of the State of Uttar Pradesh that the total potential availability of timber per year in the State of Uttar Pradesh is 80.30 lakh cubic meters, which includes 2.56 lakh cubic meters from the Government forests and 77.74 lakh cubic meters from TOF. Out of 80.30 lakh cubic meters, 71.8 lakh cubic meters were stated to be available from 22 species and 8.50 lakh cubic meters from the other species. Out of 22 species, there are 10 species that are prohibited from felling and as such, 20.75 lakh cubic meters from these 10 species are liable to be excluded; (4) that the major contribution is from Eucalyptus (28 lakh cubic meters) and Poplar species (15 lakh cubic meters), a total of which is 43 lakh cubic meters. Thus, the figure is not actual but presumptive;

(5) that the standard error percentage adopted by the FSI is not correct and is much higher;

(6) that the total availability of timber for consumption including that from the government forests would not be more than 40-45 lakh cubic meters per year;

(7) that the potential availability of 77.74 lakh cubic meters from TOF as given in the affidavit has been overestimated.

64. It is to be noted that after this Court allowed the licenses to be issued to the closed sawmills vide order dated 1st September 2006, the SLCs were constituted. The permissions were to be granted on the recommendations of the CEC. Vide order dated 18th May 2007, this Court had also accepted the recommendation of the CEC. Vide another order dated 30th April 2010, this Court permitted additional licenses to be granted if additional timber was available. Accordingly, licenses were granted between 2010 and 2015. Vide subsequent order dated 5th October 2015, this Court allowed the grant of license/permission to unlicensed WBIs in the country. This Court had directed the reconstitution of the SLCs for WBIs. In pursuance of the directions issued by this Court, the 2016 Guidelines were issued by the MOEFCC. As per the 2016 Guidelines, the SLC was reconstituted in the State of Uttar Pradesh on 17th May 2017.

65. One of the duties which was cast upon the SLC was to assess the availability of timber for wood based industrial units in the State. The SLC was to assess the availability of timber by commissioning studies, preferably in collaboration with institutes/universities of repute, once in five years. In accordance with the 2016 Guidelines, the FSI conducted the survey and submitted its report in March 2018. It will be relevant to refer to the relevant part of the Foreword of the said report of the FSI.

“In the recent past, a number of requests were received for establishment of wood based industries in the state for which the raw material would come from outside the forest areas. Since accurate assessment of TOF is needed for effective planning & management, Uttar Pradesh Forest Department requested FSI to make Agro-Climatic zone wise assessment on the basis of inventory already done during its regular course of inventory conducted in the State. As per the final report, the total stems as estimated from the study is 299.43 million with a volume of 79.40 m. cum.

The total yield in the Uttar Pradesh is estimated 7.8 million cum.

The report gives an assessment of the growing stock existing outside state forest reserves. The report has also indicated district-wise, species-wise and girth class-wise number of stems and volume in each Agro-Climatic Zone wise of inventoried districts. I am confident that this report would provide useful data for arriving at informed policy and programme interventions to give a fillip to forestry sector in the state besides providing benchmark data for tree crop in non-forest area.”

66. After conducting the survey, the FSI has come to a finding that the State of Uttar Pradesh had an annual potential production of 77,74,521 cubic meters of timber. For conducting the survey, the FSI acquired satellite data for the inventoried districts of Uttar Pradesh State from National Remote Sensing Centre, Hyderabad. The entire gambit of scientific methodology was applied. The data processing was carried out independently for all the inventoried districts of Uttar Pradesh. It will be relevant to refer to the following part of the report of the FSI:

“The data processing was carried out independently for all the inventoried districts of Uttar Pradesh. Estimates of stems per ha and volume per ha were generated according to species and diameter class for block, linear and scattered stratum under each district.

Estimated stems and their volumes were generated according to species and diameter class by aggregating stem per hectare and volume per hectare over the entire Rural CNF Area of each stratum for each district by combining the estimated stems and volumes under block, linear and scattered stratum. By aggregating the estimates of stems and volume of all the three strata, the estimates of stems and volumes according to species and diameter class has been prepared for Rural area separately.”

67. The FSI had also divided the State of Uttar Pradesh into 9 Agro-climatic zones to generate the estimate of growing stock and annual potential production. District- wise production was estimated before concluding that 77,74,521 cubic meters of timber was the annual potential production. The contention of the respondents that the rotation method was not applied is totally incorrect. It will be relevant to refer to paragraph 5.4 of the said report, which reads thus:

“5.4 Estimates of Annual Potential Production of Wood from TOF (Rural) Yield of a forest depends on several factors such as its structure, growth, density, productive capacity of site etc. The estimate of yield been generated for rural area using growing stock estimates. The Uttar Pradesh Forest Department was supplied the complete list of tree species which were found in the survey. The Uttar Pradesh Forest Department was asked to indicate tree species being used as 'timber' and 'non timber' and rotation period of specified timber species. The Uttar Pradesh Forest Department informed that they do not have rotation period of all species and requested Forest Survey of India to use their rotation period used for estimation of annual potential production of wood. The species are arranged into two groups;

one containing the species having timber values and another containing rest by agro-climatic zone wise. The yield has been calculated using Von Mentel formula as given below:

Yield= $2GS/R$ Where GS: Growing Stock R: rotation period Using the information of timber value, growing stock and rotation period in the above mentioned formulae species wise yield were calculated. The Agro-

Climatic Zone wise yield has been given in Annexure-11.” [emphasis supplied]

68. The standard error was also determined by applying the appropriate scientific method.

69. The FSI, hence, considered various aspects before concluding and submitting its 101 page report.

70. It could thus be seen that the estimation as arrived at by the FSI was by applying a proper and adequate scientific method.

71. However, it is surprising that the learned NGT has brushed aside such a scientific exercise by merely observing that the figures arrived at were by estimation and not realistic.

72. The FSI has published a paper on “Trees Outside Forest Resources in India”. The contributors to the said paper are (1) Dr. Subhash Ashutosh, DG, FSI; (2) Prakash Lakhchaura, DDG, FI, (3) Kamal Pandey, DD, FI; (4) Dr. Sourav Ghose, Proj. Scientist D; (5) Sushila Tripathi; and (6) H.K. Tripathi. The paper shows that the timber and panel products of TOF origin have emerged as the major alternative to timber from forests and thus TOF have significantly obviated pressure from forests. The report shows that, the extent of TOF in the country has been assessed at 29.38 m hectare, which is around 8.94% of the total geographical area of the country. The report further shows that based on the recommendations of the National Commission on Agriculture (NCA, 1976), the Government of India launched a social forestry program in the late seventies on a large scale. The paper further shows that, these days satellite data in a wide range of spectral, spatial, radiometric and temporal resolutions are available from various Remote Sensing Agencies of several countries. It further shows that there has been a rapid advancement in the development of digital image processing software. It, therefore, observes that the desired mapping of natural resources with reasonable accuracy is possible. The report refers to the methodology of assessment of TOF in different countries of the world and refers to various authorities. It refers to different types of methodologies used for different periods; the first one being from 1991 to 2001; the second period being from 2001 to 2016; and the third period being from 2016 onwards. The report shows that the State of Maharashtra has the highest potential annual yield of timber in India followed by the States of Uttar Pradesh and Karnataka.

73. It will be relevant to refer to the conclusion of the said paper, which is as follows:

“5. Conclusion TOF play a significant role in the socio- economic lives of people both in rural and urban areas of the country by enriching the people and society at large economically as well as ecologically. The management of TOF assumes high significance in the country for realizing much higher potential which it offers in generating wood based economy and ecosystem services including carbon sequestration. Periodic assessment of TOF resources including its spatial distribution

is prerequisite for its scientific management in the country.

FSI is mandated with this task however there is need for continuous improvement in the methodology and inclusion of more number of variables in the assessment. The organization will have to be further strengthened particularly in terms of man power, to address the emerging information needs on TOF. There has been regular refinement in methodologies in the last three decades to quantify TOF resources using various statistical designs and estimates with better precision. The advancement of technologies in the field of remote sensing, satellite image processing and availability of high resolution satellite data made the methodology much precise and easier.

The progression of science may further refine the existing method of TOF assessment in near future.

TOF also act as an important source for timber and fuel wood to meet the demands of fast growing population of the country. There is a need to put focus on increasing the growing stock per hectare or yield of TOF by better management and planning. There is also a need for a separate policy on TOF to ensure its expansion and sustainable management for multiple ecological benefits, timber production, carbon sequestration and for obviating pressure from the natural forests.

Occupying nearly 9% of the geographical area of the country, TOF are significant natural, renewable resource which make vital contribution to the agro-ecology, socio-economy of the rural areas, environmental amelioration in the urban areas and feed wood based industries with the raw material and thus generate significant employment. TOF form a nearly 38% of the carbon sink in forest & tree cover of the country. TOF offers the path for achieving the national policy goal of 33% of forest & tree cover in the country. Through expansion of TOF, particularly in agro-forestry and on culturable waste lands, India can substantially increase its carbon sink to achieve its international commitments of NDC and LDN by 2030.”

74. It could thus be seen that the FSI has also emphasized the need of promoting TOF. It has been observed that TOF are significant natural, renewable resources which make vital contributions to the agro-ecology, socio-economy of the rural area, and environmental amelioration in the urban area and feed WBIs with raw material and thus generate significant employment.

75. It is our considered view that, when the estimation was done by the FSI by applying the scientific method and had arrived at the conclusion based on satellite data, such a report could not have been brushed aside by the learned NGT lightly.

76. Insofar as the finding of the learned NGT that the survey also takes into consideration the prohibited trees, the felling of which is not permissible, it will be relevant to note that the Notification dated 7th January 2020 issued by the Government of Uttar Pradesh provides that the prohibited trees shall not be felled till 31st December 2025 except under unavoidable circumstances, such as when a tree is dead or dying or it constitutes a danger to persons or property, or its felling is necessary for executing development work approved by the Government, or if the fruit bearing capacity of such tree has declined substantially. Such trees cannot be felled unless permission to fell such tree has been obtained in writing from the competent authority. The tree owners are also

required to maintain 10 trees in place of each tree felled. It is thus clear that there is no absolute prohibition for felling the trees which are in the prohibited category. However, the same can be done only in exceptional circumstances.

77. It is to be noted that the prohibited trees also include trees like Mango, Jamun, etc. which are fruit bearing trees. After a particular number of years, the fruit bearing capacity of such trees drastically reduces and as such, the farmers normally fell such trees and go in for replantation of the orchard. Apart from that, it is to be noted that the CEC itself approved the availability of timber for the State of Uttar Pradesh in its report dated 19th April 2007, which included 17.77 lakh cubic meters of prohibited trees. The said report of the CEC was approved by this Court vide its order dated 18th May 2007.

78. It is further to be noted that in pursuance of the order of the learned NGT dated 28th March 2019, a Committee of Experts [Joint Committee comprising of representative of Principal Secretary (Forest), U.P. and Principal Chief Conservator of Forest, U.P.] had submitted its report on 3rd August 2019. Not only this, but in pursuance of the directions issued by the learned NGT on 18th December 2019, another detailed affidavit was filed on behalf of the State Government on 21st January 2020, giving therein the details about the availability of timber. It was specifically stated in the said affidavit that eucalyptus and poplar are the main species of TOF and 80% of the wood is derived therefrom. It was further pointed out that the farmers in the State of Uttar Pradesh were not getting remunerative prices and are forced to sell their produce at a very cheap rate mainly to middlemen. It was also pointed out that there would be an expected investment of about Rs.3000 crore in the State with the establishment of new WBIs. The same would employ more than 80000 people, mostly in the rural areas of the State. However, all these factors have been ignored by the learned NGT.

79. As such, the learned NGT has grossly erred in deducting the availability of timber from the prohibited trees. By now, it is more than settled that the Courts should not enter into an area that is the domain of the experts. FSI, which is undisputedly an expert body, had arrived at its estimation based on the scientific method. The learned NGT could not have sat in appeal over the opinion of the expert.

80. It is relevant to note that MOEFCC, in pursuance of the directions issued by the learned NGT had filed its opinion on 18th December 2019. It will be relevant to refer to paragraph 8 of the said opinion.

“8. That based on the examination of available documents in light of the provisions of the Wood Based Industries (Establishment and Regulation) Rules, 2016, MoEFCC is of the opinion that the State of U.P. has followed the Wood Based Industries (Establishment and Regulation) Guidelines, 2016 (as amended in 2017) issued by MoEFCC.

The availability of wood in the State has also been assessed by the SLC through FSI. The Ministry is, therefore, of the view that the SLC may approve setting up of new industries in the State if it is satisfied that sufficient timber is available legally to run the new wood based industries.”

81. The learned NGT has failed to take into consideration the stand of the MOEFCC, which also supported the stand of the State that sufficient timber was available legally to run the new WBIs.

82. Insofar as the contention of the learned counsel for the respondents that, though in the meeting of the SLC dated 4th May 2018, it was decided to get the assessment done by IPIRTI, the SLC in its meeting dated 7th September 2018 did a volte-face and decided not to get the assessment done from IPIRTI, the perusal of the minutes of the meeting of the SLC dated 7th September 2018 would reveal that it was found that the IPIRTI had not done any new study/assessment of the consumption of timber by various WBIs in any State/Union Territory. It was noticed that, as per the report of the FSI, the TOF available was 77,74,522 cubic meters. Adding the timber available in the forest area of 2,57,273 cubic meters, the total quantity of availability of timber was 80,31,795 cubic meters. It is to be noted that the SLC had taken note of the letter dated 29th August 2018 issued by the Director, IPIRTI, where he had communicated that no assessment pertaining to the annual consumption of timber by Veneer and Plywood Industries was undertaken by the IPIRTI during the last two years in any State of the country. It was found that the 2016 Guidelines itself provided for annual consumption of timber based on the report of IPIRTI. In this premise, it was found that there was no need to conduct a fresh study/assessment for the consumption of timber by WBIs by IPIRTI. It was decided to accept the figures as provided in the 2016 Guidelines.

83. It can thus be seen that the decision of the SLC for not getting the assessment done by the IPIRTI is based on sound reasons. When the 2016 Guidelines itself provided for the consumption of timber by WBIs based on the report of the IPIRTI, there was no purpose to again get the assessment done by IPIRTI. The scope of judicial review has been succinctly explained by this court in the case of *Tata Cellular vs. Union of India*⁷, which has been consistently followed in a catena of cases. This Court, in the said case, observed thus:

“77. The duty of the court is to confine itself to the question of legality. Its concern should be:

(1994) 6 SCC 651

1. Whether a decision-making authority exceeded its powers?
2. Committed an error of law,
3. committed a breach of the rules of natural justice,
4. reached a decision which no reasonable tribunal would have reached or,
5. abused its powers.

Therefore, it is not for the court to determine whether a particular policy or particular decision taken in the fulfilment of that policy is fair. It is only concerned with the manner in which those decisions have been taken. The extent of the duty to act fairly will vary from case to case. Shortly put, the

grounds upon which an administrative action is subject to control by judicial review can be classified as under:

(i) Illegality : This means the decision-

maker must understand correctly the law that regulates his decision- making power and must give effect to it.

(ii) Irrationality, namely, Wednesbury unreasonableness.

(iii) Procedural impropriety.

The above are only the broad grounds but it does not rule out addition of further grounds in course of time. As a matter of fact, in *R. v. Secretary of State for the Home Department, ex Brind* [(1991) 1 AC 696] , Lord Diplock refers specifically to one development, namely, the possible recognition of the principle of proportionality. In all these cases the test to be adopted is that the court should, “consider whether something has gone wrong of a nature and degree which requires its intervention”.

84. Applying the aforesaid principle to the present case, it cannot be said that the decision-making process has been vitiated either on account of illegality, irrationality or procedural impropriety.

85. With regard to the contention of Shri Dhruv Mehta, learned Senior Counsel, that Annexure I to the 2016 Guidelines providing the timber requirement of a plywood unit to be taken as “NIL” is contrary to the CEC recommendations is concerned, we do not find any substance in the said submission. Firstly, 2016 Guidelines have been issued by the MOEFCC in pursuance of the directions issued by this Court dated 5th October 2015. In any case, the raw material for plywood industries is ‘Veneer’ and the raw material for veneer is ‘timber’. We find substance in the contention of the appellants that, if timber is to be considered again as a raw material for plywood, then it will amount to showing the consumption of the same timber more than once, which is, in fact, not consumed. It is not in dispute that veneer is a raw material for plywood, which is derived from timber. The same timber is used for deriving veneer and such veneer, which is used for manufacturing plywood, cannot be counted twice. In any case, as long as the 2016 Guidelines which are issued in pursuance of the directions issued by this Court are not set aside, the contention in that regard is without substance.

86. That leads us to consider the contention of the respondents that this Court has repeatedly emphasized the principles of sustainable development, the precautionary principle and the polluter pays principle. No doubt that the protection of the environment is of utmost importance. It is the duty of this generation to protect the environment for future generations.

CONCLUSION

87. It cannot be disputed that Section 20 of the NGT Act itself directs the learned Tribunal to apply the principles of sustainable development, the precautionary principle and the polluter pays principle. Undisputedly, it is the duty of the State as well as its citizens to safeguard the forest of the country. The resources of the present are to be preserved for the future generations. However, one principle cannot be applied in isolation of the other.

88. It is necessary that, while protecting the environment, the need for sustainable development has also to be taken into consideration and a proper balance between the two has to be struck.

89. A body having expertise in the field, i.e. the FSI, upon a scientific study, has concluded that there is sufficient timber available in the State of Uttar Pradesh. Not only that, but the respondents themselves have placed on record a project report on "Study to know the percentage and value of the raw material sourced through U.P. Forests by Plywood and Khair (Kattha) Industries in U.P.". The said report is prepared by RAK Management Consultants on the instructions of the Department of Planning, Economic and Statistics Division, Government of Uttar Pradesh. The said report itself shows that the consultants, during the field survey, observed resentment among the plywood manufacturers against the process of issuing new licenses to the WBIs by the State Government.

90. The report further goes on to show that on average 1500-1700 trucks/tractor trollies of the eucalyptus and popular wood from all over Haryana, Punjab, Himachal Pradesh and Uttar Pradesh go to Yamuna Nagar, Haryana daily. Out of the said trucks/trollies, approximately 300- 350 tractor trollies and some other small vehicles per day come from Uttar Pradesh. The report shows that approximately 5 to 6 lakh metric tons of timber per year is exported to Yamuna Nagar. The said material belongs to the western districts of Uttar Pradesh, i.e. Muzaffarnagar, Saharanpur, Shamli, Baghpat and Meerut. It is stated that there is no sufficient market for this produce in the said area. The report further finds that the western districts of Uttar Pradesh, i.e. Meerut, Muzaffarnagar, Saharanpur, Baghpat and Shamli, etc. do not have sufficient number of plywood and veneer units and as such, they are not sufficient for the entire farmers' produce available in the said area. The report itself shows that the western districts need around 80-85 plywood and veneer units. The report goes on further to show that there is dissatisfaction among the already existing industrialists about the assessment made by the FSI.

91. It is further to be noted that the State has specifically pointed out before the learned NGT that on the establishment of WBIs, an investment of about Rs.3000 crore was likely to be attracted in the State; employment opportunities to over 80000 people will be available and the farmers of the State would get a more remunerative price. This would result in more impetus for large-scale plantation and agro-forestry. The State also emphasized that this will reduce dependence on traditional/cash crops and also reduce migration of people to urban areas. It is also emphasized that if the new WBIs are permitted, it will reduce the import of WBIs produce. However, all these aspects have not been taken into consideration by the learned NGT.

92. It will be relevant to note that the Forest Research Institute, Dehradun, Uttarakhand has published 'Country Report of Poplars and Willows Period : 2012-2015'. The report states that the timber from poplar and willow is the backbone of vibrant plywood, board, match, paper and sports

goods industries. The report further states that in tune with Indian Agroforestry Policy 2014, the plantation of poplar has been promoted. It further states that the Planning Commission of India has given special grants to certain States for the diversification of agriculture where farmers are advised to move away from paddy cultivation to sustain agricultural production. Poplar and eucalyptus are among the few trees promoted under this diversification plan. The report states that Poplar plays a significant role in rural development by generating employment for many categories of skilled, semi-skilled and unskilled workers.

93. The paper on “Trees Outside Forest Resources in India” published by the FSI, cited supra, also emphasizes that TOF are significant natural, renewable resources which make vital contributions to the agro-ecology, socio-economic improvement of the rural areas, environmental amelioration in the urban areas and feed WBIs with raw material and thus generate significant employment. TOF form nearly 38% of the carbon sink in the forest and tree cover of the country. It states that TOF offers the path for achieving the national policy goal of 33% of forest and tree cover in the country. It states that through the expansion of TOF, particularly in agro-forestry and on culturable waste lands, India can substantially increase its carbon sink to achieve its international commitments of NDC and LDN by 2030.

94. As already discussed herein above, the majority of TOF is from two species, i.e. Poplar and Eucalyptus. These trees are fast growing. If a market is available for the said trees, there will be impetus to the farmers for large scale plantations. The rotation in these species is quite fast. This will, in turn, increase the green coverage. We are of the considered view that the learned NGT has taken a lopsided view. It has failed to take into consideration the concerns expressed by the State. The learned NGT has committed patent error in ignoring the expert’s report and sitting in appeal over the same. The learned NGT has also failed to take into consideration the stand taken by the MOEFCC, which supported the stand of the State. As already discussed herein above, the State had emphasized many advantages of granting new licenses to WBIs. It was also emphasized that the timber from the State of Uttar Pradesh was being exported to the State of Haryana. However, none of these aspects have been considered by the learned NGT. We are, therefore, of the considered view that the impugned orders of the learned NGT are not sustainable in law.

95. There is another reason, in our view, why the order of the learned NGT would not be sustainable. Though, on the date on which the review applications were rejected, 1215 provisional licenses were already granted and 633 units had already been established and commenced production, the learned NGT has passed the impugned order which adversely affects their interest. Either some of such industries ought to have been impleaded in their representative capacity or a public notice should have been given so that such license holders could have represented their case. However, the said contention is lightly brushed aside by the learned NGT by holding that, since the issue is related to the general decision of the State which is applicable uniformly to all the proposed provisional licensees, it is not necessary to consider the issue raised in the impleadment applications. It is more than a settled law that the principles of natural justice are required to be followed even in administrative actions when such actions adversely affect the rights of the citizens. When the learned NGT exercised its judicial powers, it could not have ignored the principles of natural justice, which, even under Section 19(1) of the NGT Act, it is bound to follow.

96. Another aspect that needs consideration is that a serious issue was raised before the learned NGT by the appellants herein with regard to the credentials and bonafides of the original applicants.

97. When the matter was heard by us, we too made pertinent queries to Shri Mehta and Shri Chahar with regard to the credentials of the applicants before the learned NGT. One applicant is Uday Education and Welfare Trust; the second applicant is Samvit Foundation and the third applicant is U.P. Timber Association. Undisputedly, the U.P. Timber Association was a litigant interested in the litigation. However, insofar as the other original applicants, i.e. Uday Education and Welfare Trust and Samvit Foundation, for whom Shri Dhruv Mehta and Shri Brijender Chahar, learned Senior Counsel are appearing, specific queries with regard to the activities undertaken by the said original applicants were made as to whether they were involved in any activity with regard to the protection of the environment; had they at least been engaged in promoting plantation; what were the aims and objectives of the said original applicants; and what are the sources of funding, etc. Shri Mehta and Shri Chahar, learned Senior counsel, fairly submitted that apart from the fact that they (original applicants) had previously filed some public interest litigations wherein orders were passed in their favour, they had no other information.

98. Shri Dhruv Mehta, learned Senior Counsel has rightly relied on the judgment of this Court in the case of Ankita Sinha and Others (supra) to submit that the learned NGT is empowered to take suo motu cognizance. This Court has held that, taking into consideration the nature of functions of the learned NGT, it cannot be equated with other Tribunals and in environmental matters, it will also have a power to take suo motu cognizance. However, when the credentials and bonafides of a litigant approaching the learned NGT are seriously raised, the same cannot be ignored.

99. We find that before a litigant is permitted to knock the doors of justice and seek orders which have far reaching effects of affecting the employment of thousands of persons, stopping investment in the State, prejudicing the interests of the farmers; the credentials and bonafides of the applicants must be tested. In the present case, there is scope to infer that the litigation could be at the behest of the existing WBIs who wanted to avoid competition and continue to get raw material at a cheaper rate. There is also scope to infer that it could be at the behest of the WBIs in the adjoining Yamuna Nagar district of Haryana where lakhs of tons of timber is exported from the State of Uttar Pradesh. There is scope to infer that it could be in the interest of middlemen who are engaged in exporting timber from Uttar Pradesh to Haryana. We would, therefore, only request the learned NGT that, when credentials and bonafides of such litigants are seriously raised and when entertaining the grievance of such litigants, which is likely to adversely affect the rights of many, it should ensure the bonafides and credentials of such litigants.

100. Though we are allowing the appeals, setting aside the orders of the learned NGT, and upholding the action of the State Government in granting licenses, we would like to remind the State and its authorities that it is their duty to protect the environment. The State and its authorities should ensure that necessary steps are taken for arresting the problem of declining forest and tree cover. The State and its authorities should make meaningful and concerted efforts to ensure that the green cover in the State of Uttar Pradesh is not reduced and to ensure that it increases.

101. The conservation of forest plays a vital role in maintaining the ecology. It acts as processors of the water cycle and soil and also as providers of livelihoods. As such, preservation and sustainable management of forests deserve to be given due importance in formulation of policies by the State. In this regard, it will be apposite to refer to certain earlier pronouncements of this Court.

(a) In the case of *Samatha vs. State of A.P. and Ors.*⁸, a three-Judge Bench of this Court after referring to the earlier judgment in the case of *State of H.P. and others vs. Ganesh Wood Products and others*⁹ observed that, even while considering the grant of renewal of mining leases, the provisions of the Forest (Conservation) Act, 1980 and the Environment (Protection) Act, 1986 would apply. This Court held that the MOEF and all the States have a duty to prevent mining operations affecting forests. It further observed that, whether mining operations are carried on within the reserved forest or other forest area, it is their duty to ensure that the industry or enterprise does not denude the forest to become a menace to human existence nor a source to destroy flora and fauna and biodiversity. It has further been held that if it becomes inevitable to disturb the existence of forests, there is a concomitant duty upon the State to AIR 1997 SC 3297 = (1997) 8 SCC 191 (1995) 6 SCC 363 reforest and restore the green cover and to ensure adequate measures to promote, protect and improve both man-made and natural environment, flora and fauna as well as biodiversity. It further held that there can be no distinction between government forests and private forests in the matter of forest wealth of the nation and in the matter of environment and ecology.

(b) In the case of *Essar Oil Ltd. vs. Halar Utkarsh Samiti and others*¹⁰, this Court discussed the need for a balance between the economic and social needs and development on the one hand and environment considerations on the other. It was observed that laws on environment should be to create harmony between the two since neither one can be sacrificed at the altar of the other. In this regard, the observations of this Court in the case of *Indian Council for Enviro-Legal (2004) 2 SCC 392 Action vs. Union of India and others*¹¹ were quoted as under:

“While economic development should not be allowed to take place at the cost of ecology or by causing widespread environment destruction and violation;

at the same time, the necessity to preserve ecology and environment should not hamper economic and other developments. Both development and environment must go hand in hand, in other words, there should not be development at the cost of environment.”

(c) In the case of *Maharashtra Land Development Corporation and others vs. State of Maharashtra and another*¹² reference was made to *Glanrock Estate Private Limited vs. State of Tamil Nadu*¹³ wherein it was observed as under:

“27. Forests in India are an important part of the environment. They constitute [a] national asset.

In various judgments of this Court delivered by the Forest Bench of this Court in *T.N. Godavarman (1996) 5 SCC 281 (2011) 15 SCC 616 (2010) 10 SCC 96 Thirumulpad v. Union of India (Writ Petition*

No. 202 of 1995), it has been held that ‘intergenerational equity’ is part of Article 21 of the Constitution.

28. What is intergenerational equity? The present generation is answerable to the next generation by giving to the next generation a good environment. We are answerable to the next generation and if deforestation takes place rampantly then intergenerational equity would stand violated.

29. The doctrine of sustainable development also forms part of Article 21 of the Constitution. The ‘precautionary principle’ and the ‘polluter pays principle’ flow from the core value in Article 21.

30. The important point to be noted is that in this case we are concerned with vesting of forests in the State. When we talk about intergenerational equity and sustainable development, we are elevating an ordinary principle of equality to the level of overarching principle.”

(d) Of course, one cannot ignore one of the several dicta of this Court in T.N. Godavarman Thirumulkpad vs. Union of India and others¹⁴ wherein this Court enunciated the definition of “forest” in the following words:

“4. The Forest Conservation Act, 1980 was enacted with a view to check further deforestation which ultimately results in ecological imbalance; and therefore, the provisions made therein for the conservation of forests and for matters connected therewith, must apply to all forests irrespective of the nature of ownership or classification thereof. The word “forest” must be understood according to its dictionary meaning. This description covers all statutorily recognised forests, whether designated as reserved, protected or otherwise for the purpose of Section 2(i) of the Forest Conservation Act. The term “forest land”, occurring in Section 2, will not only include “forest” as understood in the dictionary sense, but also any area recorded as forest in the Government record irrespective of the ownership. This is how it has to be understood for the purpose of Section 2 of the Act. The provisions enacted in the Forest Conservation Act, 1980 for the conservation of forests and the matters connected therewith must apply clearly to all forests so understood irrespective of the ownership or classification thereof...” AIR 1997 SC 1228

102. Though we find that for the sustainable development of the State and on account of the availability of the timber, sanction of granting licenses can be permitted to continue, however, as a responsible State, it needs to ensure that environmental concerns are duly attended to. We, therefore, direct the State Government to ensure that while granting permission for felling trees of the prohibited species, it should strictly ensure that the permission is granted only when the conditions specified in the Notification dated 7th January 2020 are satisfied. The State Government shall also ensure that when such permissions are granted to the applicants, the applicants scrupulously follow the mandate in the said notification of planting 10 trees against 1 and maintaining them for five years.

103. In the result, the appeals are allowed. The impugned orders passed by the learned National Green Tribunal, Principal Bench, New Delhi in Original Application Nos.313, 335 and 396 of 2019 as well as in the Review Applications are quashed and set aside.

104. Pending applications, if any, shall stand disposed of. No costs.

.....J.

[B.R. GAVAI] J.

[B.V. NAGARATHNA] NEW DELHI;

OCTOBER 21, 2022

Vikatan > General News > Tamilnadu

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‘ஆமையைக் கடவுளாக வழிபடுவோம்; எங்கள் வாழ்வாதாரம் உங்களுக்குத் தெரியாது’ - துறைமுகம் கோரும் மீனவர்கள்

✍ அ.கண்ணனாசன்

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துறைமுகம் அமைக்கும் பணியை உடனடியாகச் செயல்படுத்த கோரிக்கை விடுத்து விழுப்புரம், செங்கல்பட்டு மாவட்ட மீனவ சமூகத்தினர், இ.சி.ஆர் சாலையில் உண்ணாவிரதப் போராட்டத்தில் ஈடுபட்டிருந்தது அந்தப் பகுதியில் பரபரப்பை ஏற்படுத்தியிருக்கிறது.



விழுப்புரம் மாவட்டம், மரக்காணம் பகுதியில் 19 மீனவ கிராமங்களும்,

விழுப்புரம் மாவட்டம், மரக்காணம் பகுதியில் 19 மீனவ கிராமங்களும், செங்கல்பட்டு மாவட்டத்தில் சுமார் 44 மீனவ கிராமங்களும் இருக்கின்றன. இந்தப் பகுதிகளில், மீனவர்கள் தங்களுடைய மீன்பிடி விசைப்படகுகளைப் பாதுகாப்பாக நிறுத்துவதற்கு இதுவரையில் மீன்பிடித் துறைமுகங்கள் இல்லை. இதனால், மீனவர்கள் கடலில் விசைப்படகுகளை நிறுத்தும்போது காற்று, புயல், சூறாவளி ஏற்பட்டால் எதிர்பாராதவிதமாகக் கடலில் மூழ்கிவிடும் நிலை நீடித்துவருவதாகக் கூறப்படுகிறது. இதனால் **மீனவர்கள்** பெரும் சிரமத்துக்கு உள்ளாகிவருகின்றனர். எனவே, இந்தப் பகுதிகளில் மீனவர்களின் நலனை கருத்தில்கொண்டு மீன்பிடித் துறைமுகங்கள் அமைக்கப்பட வேண்டும் எனப் பல ஆண்டுகளாக கோரிக்கை இருந்துவந்தது. இந்த நிலையில், விழுப்புரம் மாவட்டத்தில் அழகன்குப்பம் பக்கிங்ஹாம் கால்வாயிலும்; செங்கல்பட்டு மாவட்டத்தில் ஆலம்பரா கோட்டை என்ற இடத்திலும் மீன்பிடித் துறைமுகங்கள் அமைக்க கடந்த இரண்டு ஆண்டுகளுக்கு முன்னர் அதிமுக ஆட்சியில் அறிவிக்கப்பட்டு, ரூ.236 கோடி நிதி ஒதுக்கப்பட்டது.



விழுப்புரம் மாவட்ட எஸ்.பி தலைமையில் போலீஸ்

தொடர்ந்து கடந்த ஆண்டு துறைமுகங்கள் அமைப்பதற்கான முதற்கட்டப் பணிகள்



வினிகடன்



செய்திகள் இதழ்கள் Blggboss Updates சினிமா ஆன்மிகம் Games விளையாட்டு FIFA V

விழுப்புரம் மாவட்ட எஸ்.பி தலைமையில் போலீஸ்

தொடர்ந்து கடந்த ஆண்டு துறைமுகங்கள் அமைப்பதற்கான முதற்கட்டப் பணிகள் சம்பந்தப்பட்ட ஒப்பந்ததாரர்கள் மூலம் மேற்கொள்ளப்பட்டன. அப்போது, 'இந்த மீன்பிடித் துறைமுகங்கள் இந்தப் பகுதிகளில் அமைந்தால், கடல் ஆமைகள் ஆண்டுதோறும் முட்டையிடவருவது பாதிக்கப்படும், சூழலுக்கும் பாதிப்பு உண்டாகும்' எனக் கூறி சில தொண்டு நிறுவனங்களின் சார்பில் சென்னை உயர் நீதிமன்றத்தில் வழக்கு தொடரப்பட்டது. இந்த வழக்கு நிலுவையில் இருப்பதால், துறைமுகங்கள் அமைப்பதற்கான முதற்கட்டப் பணிகளும் நிறுத்தப்பட்டுள்ளன. எனவே, 'மீனவர்களின் நலனைக் கருத்தில்கொண்டு இந்த இரண்டு மாவட்டங்களிலும் துறைமுகப் பணிகளை உடனடியாகச் செயல்படுத்த வேண்டும்' என்ற சில முக்கியக் கோரிக்கைகளை வலியுறுத்தி விழுப்புரம் மற்றும் செங்கல்பட்டு மாவட்ட மீனவ சமூகத்தினர் ஆயிரத்துக்கும் மேற்பட்டோர், ஈ.சி.ஆர் சாலையில், அனுமந்தை எனும் இடத்தில் அமர்ந்து நேற்று (28.11.2022) உண்ணாவிரதப் போராட்டத்தில் ஈடுபட்டனர்.

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இந்தப் பகுதியில், விழுப்புரம் மாவட்ட காவல் கண்காணிப்பாளர் ஸ்ரீநாதா தலைமையில் பலத்த போலீஸ் பாதுகாப்பு போடப்பட்டிருந்தது. மாலை சுமார் 3:30 மணிவரை உண்ணாவிரதப் போராட்டம் நடைபெற்ற நிலையில், திண்டிவனம் சார் ஆட்சியரின் பதிலை ஏற்று அனைவரும் கலைந்து சென்றனர்.


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இந்த உண்ணாவிரதப் போராட்டம் குறித்து, மீனவச் சமூகத்தைச் சேர்ந்தவரும், அழகன்குப்பம் ஊராட்சி மன்றத் தலைவருமான பழனி என்பவரிடம் பேசினோம். "மரக்காணம் பகுதியில் துறைமுகம் அமைக்கப்பட வேண்டும் என்பது 25 ஆண்டுக்கால கோரிக்கை. அந்தக் கோரிக்கையை ஏற்று மத்திய, மாநில அரசுகள் இணைந்து செங்கல்பட்டு, விழுப்புரம் மாவட்டங்களில் துறைமுகங்கள் அமைக்கும் பணியைத் தொடங்கினார்கள். அந்தத் துறைமுகத்தின் முகத்துவாரம் அமையும் இடத்துக்கு அருகில் தனியார் ரிசார்ட் ஒன்று இருக்கிறது. கூடுதலாக, குழுவெளி - கடல் பகுதியின் அருகே சுமார் 7 ஏக்கர் நிலம் வாங்கி வைத்திருக்கிறார்கள். துறைமுகம் அமைப்பதால் இதெல்லாம் பாதிக்கப்படும் என்றுதான், இந்தத் திட்டத்தைச் சீர்குலைக்கும் நோக்கத்தில் ஈடுபட்டுவருகின்றனர்.



விக்கடன்

செய்திகள் இதழ்கள் Bigg Boss Updates சினிமா ஆன்மீகம் Games விளையாட்டு FIFA V

அழகன்குப்பம் பழனி

முக்கியமாக, அந்த ரிசார்ட் விடுதிக்குத் தங்குவதற்கு வரும் சுற்றுலாப்பயணிகளை, பக்கிங்ஹாம் கால்வாய் பகுதிகளிலும், கடலின் முகத்துவாரப் பகுதிகளிலும் அரசு அனுமதி பெறாமல் படகு சவாரிக்கு அழைத்துச் செல்கிறார்கள். துறைமுகத்தால் இதெல்லாம் பாதிக்கப்பட்டுவிடுமோ என்பதால்தான், தனியார் தொண்டு நிறுவனங்களின் மூலமாக இந்தத் திட்டத்தைத் தடுக்கிறார்கள். "இந்தப் பகுதிகளில் பறவைகள் இருக்கின்றன, ஆமைகள் முட்டையிடுகின்றன, மாசு ஏற்பட்டுவிடும்" என்று அந்தத் தொண்டு நிறுவனத்தினர் வதந்தியைக் கிளப்பிவிட்டு, பசுமை தீர்ப்பாயத்தில் கேஸ் போட்டார்கள். அதன் அடிப்படையில் பசுமை தீர்ப்பாயத்தின் மூவர் ஆய்வுக்குழு இங்கு வந்து ஆய்வு மேற்கொண்டு, 'துறைமுகத்தால் பாதிப்பு வராது' என்று அறிக்கை சமர்ப்பித்திருக்கிறார்கள். அந்த அறிக்கை தவறு எனக் கூறும் தனியார் தொண்டு நிறுவனத்தினரால், இந்த வழக்கு தடைப்பட்டு நிற்கிறது. அதனால் துறைமுகங்கள் அமைக்கும் பணியும் தடைப்பட்டு நிற்கிறது.



VIDEO 000% OFF

இன்று (29.11.2022) அந்த வழக்கின் விசாரணை நீதிமன்றத்தில் நடக்கவிருக்கிறது. வழக்கை அவர்களுக்குச் சாதகமாக வாதாடி எடுத்துச் சென்றுவிட்டால் நாங்கள் என்ன செய்வது என்பதால்தான், மீனவர்களின் நிலையை அரசின் கவனத்துக்குக் கொண்டு செல்ல, நேற்று அடையாள உண்ணாவிரதம் இருந்தோம். பொதுமக்களின் வாழ்வாதாரம் முக்கியமா இல்லை, ரிசார்ட் உரிமையாளர்களின் வாழ்வாதாரம் முக்கியமா என்பதுதான் எங்களுடைய கேள்வி. எனவே, நீதிமன்றம் இந்த வழக்கைத் தாமாக முன்வந்து தள்ளுபடி செய்ய வேண்டும். மேலும், அரசும் இந்த வழக்கில் தலையிட வேண்டும். இந்த வழக்கு ஒரு தனியார் தொண்டு நிறுவனம் எனும் தனிநபரால் போடப்பட்டது. எங்களுடைய வாழ்வாதாரம் பற்றி அவர்களுக்குத் தெரியாது. எப்போது மழை வரும், புயல் வரும், வெள்ளம் வரும் என்பதும், ஆமை, டால்பின், திமிங்கலம் எப்போதெல்லாம் கரை ஒதுங்கும் என்பதும், இதனால் என்னென்ன பாதிப்புகள் வரும் என்பதும் மீனவர்களாகிய எங்களுக்குத் தெரியும். **ஆமையை கடவுளாக வழிபடுபவர்கள் நாங்கள்.**

யாதார்படய

ஆமை, வலையில் சிக்கிக்கொண்டால், வலையே போனாலும் பரவாயில்லையென, வலையை வெட்டி எடுத்துவிட்டு ஆமையை மீட்டு கடலில் விட்டுவிடுவோம். பிறகு வீட்டுக்கு வந்து, அதற்காகப் படையல் வைத்து வழிபட்டு, படையலைக் கடலில் விடுவோம். இப்படி ஆமைகளைப் பாதுகாக்கிறோம் நாங்கள். ஆனால், எங்களுக்காக அமைக்கப்படும் துறைமுகத்தால் ஆமை பாதிக்கப்படும் என்பது என்ன நியாயம்... அதேபோல், எங்களுக்குத் துறைமுகம் இல்லாததால் புதுவை, கடலூர், சென்னை போன்ற வெகு தூரத்திலுள்ள துறைமுகங்களுக்குச் செல்லவேண்டியிருக்கிறது.

Also Read



‘இந்தி தெரியாததால் தமிழக மீனவர்கள் மீது தாக்குதல்... ஒன்றிய அரசு மன்னிப்பு கேட்க வேண்டும்!’ - வைகோ

அதனால், எங்கள் பகுதியில் கடலிலேயே படகுகளை நிறுத்தினால், சில நேரங்களில் மூழ்கிப்போய்விடுகின்றன. நேற்று உண்ணாவிரதத்தின்போது எங்களிடம் பேசிய **கிண்டிவனம் சார் அப்சியூர்**, "உங்களின் கோரிக்கைகள்



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  Biggboss Updates
  சினிமா
  ஆன்மிகம்
  Games
  விளையாட்டு
  FIFA

அதனால், எங்கள் பகுதியில் கடலிலேயே படகுகளை நிறுத்தினால், சில நேரங்களில் மூழ்கிப்போய்விடுகின்றன. நேற்று உண்ணாவிரதத்தின்போது எங்களிடம் பேசிய **திண்டிவனம் சார் ஆட்சியர்**, "உங்களின் கோரிக்கைகள் அரசின் கவனத்துக்குக் கொண்டு செல்லப்பட்டிருக்கின்றன. அரசு, நீதியரசரின் கவனத்துக்கு இதைக் கொண்டு செல்லும். அதற்கான பணிகளை பார்த்துக்கொண்டிருக்கிறோம். தற்காலிகமாக இந்த உண்ணாவிரதத்தைக் கைவிடுங்கள்" என்றார். அதை நம்பி நாங்கள் உண்ணாவிரதத்தைக் கைவிட்டோம். ஆனால், இந்தத் துறைமுகம் அமைவது தடுக்கப்படும் என்று சொன்னால், மீனவர்கள் அனைவரும் எங்களுடைய அரசு அடையாள ஆவணங்களை மாவட்ட ஆட்சியரிடம் ஒப்படைத்துவிட்டு, கடலில் இறங்கிப் போராட்டத்தில் ஈடுபடுவோம்" என்றார்.

Logged on : 17-11-2022

Number of Fishing Vessels Registered in VILLUPURAM

Live Place of Registry VILLUPURAM				
me of Base of Operation	Deep Sea Fishing Vessel	Motorized non Mechanical	Motorized Mechanical	Non-motoriz
ttukadu Alagankuppam		43		
SAVANKUPPAM		91		
PANIKUPPAM		63	1	24
CIYARKUPPAM		197	7	30
NDAVAIPUDHUKUPPAM		80		6
MUTTICHA VADI		84		1
JMANDAIKUPPAM		167	26	3
ETTINAGAR		34		7
CHIKUPPAM		24		
ONIMEDU		93		
DHALIYARKUPPAM		50		1
ICHANKUPPAM		95		
OHUKUPPAM		30		22
LAICHAVADI		27		
MMIYARPALAYAM		66		1
nnamudaliyar chavadi		88		49
ANDHIRAYANKUPPAM		19		33
OUKUPPAM		94		
THANA KUPPAM		19		
TAL		1364	34	177

Logged on : 17-11-2022

Number of Fishing Vessels Registered in NEELANKARAI

Live Place of Registry NEELANKARAI				
me of Base of Operation	Deep Sea Fishing Vessel	Motorized non Mechanical	Motorized Mechanical	Non-motoriz
TTIVAKKAM		60	1	3
AVAKKAM		6		3
INNA NEELANKARAI		83		13
RIA NEELANKARAI		45		7
INNANDIKUPPAM		24		3
NCHAMBAKKAM		28		4
VAIYURKUPPAM		96		25
INARKUPPAM		52		11
NATHUR REDDI KUPPAM		84		13
ATTUR KARIKATTU KUPPAM		44		48
DUR				
VALAM		175		31
EMMANCHERI		54		7
DHUKALPAKKAM		31		15
MMELIKUPPAM		27		
OLERIKATTUKUPPAM		43		10
TIPULAM		30		1
AVANKUPPAM		18		2
EVANERI		110		1
MALLAPURAM		76		6
NPURUSAM		24		12
KILAMEDU		63		2
ARIKUPPAM		76		14
YYURKUPPAM		11		2
THURANGAPATTINAM		132	3	16
DHUPATTINAMKUPPAM		93		1
VALIKUPPAM		72		15
DDALORECHINNAKUPPAM		58		1
Idalore Periakuppam		99		19
Idalore Alikuppam		50		52
GALAMMANKUPPAM		25		10
ZHAYANADUKUPPAM		35		17
DHUNADUKUPPAM		28		
RUNTHURAIKUPPAM		53		2
RAMANKENI		115		7
DHALIYARKUPPAM		105		7

PANAIYURCHINNAKUPPAM		43		6	
Paraiyur Peria kuppam		105		5	
KADAPAKKAM		78	2	15	
ALAMBARAIKUPPAM		149	5	25	
VILAMBURKUPPAM					
THENPAKKAM					
KOTTAIKADU		12		8	
SOONAMBEDU					
THIRUVANMAIYUR					
TOTAL		2512	11	439	

Logged on : 17-11-2022

Number of Fishing Vessels Registered in NEELANKARAI

Live 		Place of Registry :	NEELANKARAI
Name of Base of Operation	Motorized non Mechanical	Motorized Mechanical	
KOTTIVAKKAM	60	1	
PALAVAKKAM	6		
CHINNA NEELANKARAI	83		
PERIA NEELANKARAI	45		
CHINNANDIKUPPAM	24		
EANCHAMBAKKAM	28		
PANAIYURKUPPAM	96		
NAINARKUPPAM	52		
KANATHUR REDDI KUPPAM	84		
EGATTUR KARIKATTU KUPPAM	44		
PADUR			
KOVALAM	175		
CHEMMANCHERI	54		
PUDHUKALPAKKAM	31		
NEMMELIKUPPAM	27		
SOOLERIKATTUKUPPAM	43		
PATTIPULAM	30		
SALAVANKUPPAM	18		
THEVANERI	110		
MAMALLAPURAM	76		
VENPURUSAM	24		
KOKILAMEDU	63		
UMARIKUPPAM	76		
MEYYURKUPPAM	11		
SATHURANGAPATTINAM	132	3	
PUDHUPATTINAMKUPPAM	93		
UYYALIKUPPAM	72		
CUDDALORECHINNAKUPPAM	58		
Cuddalore Periakuppam	99		
Cuddalore Alikuppam	50		
ANGALAMMANKUPPAM	25		
PAZHAYANADUKUPPAM	35		
PUDHUNADUKUPPAM	28		
PERUNTHURAIKUPPAM	53		
PARAMANKENI	115		
MUDHALIYARKUPPAM	105		
PANAIYURCHINNAKUPPAM	43		

Panaiyur Peria kuppam	105	
KADAPAKKAM	78	2
ALAMBARAIKUPPAM	149	5
VILAMBURKUPPAM		
THENPAKKAM		
KOTTAIKADU	12	
SOONAMBEDU		
THIRUVANMAIYUR		
TOTAL	2512	11

5
15
25
8
439

Number of Fishing Vessels Registered in VILLUPURAM

Live

Place of Registry :

VILLUPURAM

Name of Base of Operation	Motorized non Mechanical	Motorized Mechanical	Non-motorized
Muttukadu Alagankuppam	43		
VASAVANKUPPAM	91		
KAIPANIKUPPAM	63	1	24
EKKIYARKUPPAM	197	7	30
MANDAVAIPUDHUKUPPAM	80		6
KOMUTTICHAVADI	84		1
ANUMANDAIAKUPPAM	167	26	3
CHETTINAGAR	34		7
NOCHIKUPPAM	24		
KOONIMEDU	93		
MUDHALIYARKUPPAM	50		1
ANICHANKUPPAM	95		
PUDHUKUPPAM	30		22
PILLAICHAVADI	27		
BOMMIYARPALAYAM	66		1
Chinnamudaliyar chavadi	88		49
THANDHIRAYANKUPPAM	19		33
NADUKUPPAM	94		
SOTHANAIAKUPPAM	19		
TOTAL	1364	34	177

Images of Village wise Fishing boats berthed in Opensea



Muttukadu



Kaipanikuppam



Ekkiyarkuppam



Kaipanikuppam



Ekkiyarkuppam



Vasavankuppam



Muttukadu



Komuttichavadi



Anumandaikuppam



Chettynagar



Chettynagar



Anumandaikuppam



Chettynagar



Chettynagar



Nochikuppam



Nochikuppam



Koonimedu



Koonimedu



Mudhaliyarkuppam



Anichangkuppam



Mudhaliyarkuppam



Mudhaliyarkuppam



Pillaichavadi



Nadukuppam



Nadukuppam



Sothanaikuppam



Sothanaikuppam



Pudhukuppam



Thandhirayankuppam



Thandhirayankuppam



Nadukuppam



Chinnamudaliyarchavadi



Sothanaikuppam



Nadukuppam



Bommiyarpalayam



Summary

The story of Dhamra Port is the story of a major corporation and a global environmental organization working together to ensure that the construction of a large deep sea industrial port in India would not harm a significant population of endangered sea turtles. From a development perspective, the site was perfect. But from a conservation perspective there were questions about its location close to one of the world's largest nesting site of the Olive Ridley turtle, protected under Indian law. The collaboration between DPCL-Dhamra Port Company Limited (then a joint venture between Tata Steel and L&T) and IUCN shows that development and conservation can co-exist, and that there are ways to develop in a responsible manner that meets both the needs of people and the needs of nature. Lessons learned from this partnership can be applied to other projects that will have similar positive outcomes for people and for nature.

Classification

[to be provided]

Location



The location of the port is 15 kilometers crow fly towards north west from Turtle nesting beach Gahirmatha in District Bhadrak, Odisha, India.

Lat: 20°49'17.24"N, Long: 86°57'51.39"E

Desired behaviour change

The desired behaviour change was to make key stakeholders realise that development and conservation can happen simultaneously. This behaviour change was desired particularly in both private sector entities as well as NGOs. IUCN mobilised the best scientific expertise available on the subject and constituted a team of experts to showcase how this can happen with successful on the ground models.

Challenges

The major challenge to this project was ensuring the success and continuity of safeguards to protect turtles from being severely impacted by port construction and ensuing long-term port activities. However, there were other challenges related to the desired behavior change. These included:

- Resistance of concerned actors to the project; and
- Reputational risk for key stakeholders.

In terms of ensuring the protection of Olive Ridley populations in the long-term, enhancing community awareness about the importance of turtles was also important, including changing community fishing practices that contributed to turtle mortality.

Main stakeholders

- Olive Ridley Turtles

- DPCL
- Tata Steel
- IUCN (International Union for Conservation of Nature)
- Fishers and local communities

Building blocks

1. Strong partnerships and open communication
2. Science and technical expertise
3. Governance and community outreach

1. Strong partnerships and open communication

A major building block that led to the success of this project is the strong collaboration and trust between the partners and the open lines of communication established within the partnership and with the public.

This was a challenging project, and the partners needed to work through complex issues together and to understand each other's perspectives. It helped that the partnership facilitated the assembly of a multi-sectoral and multi-disciplinary team.

The private sector is commonly described as being blind to environmental issues. The reality, however, is that the private sector is heavily invested in biodiversity. The project was an opportunity for companies to deepen their understanding of environmental issues and to develop the corporate habit of thinking beyond the bottom line. Less obviously, it is an opportunity for environmental specialists to deepen their understanding of business and development dynamics and to acquire the habit of injecting bottom line analysis into their own evaluations.

Robust communication practices went hand in hand with the partnership. Because of the sensitivity around the issue among environmental organizations and other sectors, the approach toward the project was to make information transparent and publicly available. The partners described very clearly what they were doing and what they were not doing – and why. Information was made available through fact sheets and the project website, and by engaging in public discussions and meetings. A number of other efforts were made to ensure information was flowing freely between the key stakeholders. For example, in early 2009, IUCN held a Consultative Technical Workshop on Dhamra Port in Bhubaneswar, Odisha, followed by a trip to the port site. The interactive forum brought together a diverse mix of government representatives, the private sector, leading local and international scientists, technical experts, academics and local community representatives. Work with the press ensured that messages were disseminated at a national level. These efforts encouraged participation and helped to dispel confusion.

2. Science and technical expertise

At the outset, IUCN organized a scoping mission to review potential impacts of the proposed Dhamra Port development on the environment. The scoping mission found that the major environmental issues were dredging and lighting. However, these issues were not unique as there were a number of examples around the world where similar problems were effectively addressed.

Dredging, recognized as a serious threat to the marine turtles, was identified by IUCN as a priority. IUCN, with experts from the Species Survival Commission's Marine Turtle Specialist Group designed and developed a dredging protocol to be followed during port operations. These included installing turtle deflectors on all dredger drag-heads to help ensure turtles were not pulled into the dredger. Trained observers were assigned to all dredgers to monitor this process. These observers would check screens on inflow and overflow pipes on a 24/7 basis. These measures (deflectors, screens, and human observers) were put in place to ensure that the dredging was "turtle friendly". Such measures were the first to have been put in place in the history of dredging activities in India.

Lighting was the second major threat identified because excess glare is known to distract turtle hatchlings as they instinctively move towards brightly lit areas and away from the sea. For this, the IUCN Commission experts provided specific guidelines for the port's lighting plan, which was adopted by the port authorities. IUCN further supported

Tata Steel in identifying the right design for these lights. Today, Dhamra Port is the first and only port in India to have installed “turtle friendly” lighting.

To address other environmental impacts, IUCN supported DPCL in developing an Environment Management Plan (EMP). This plan was scientifically robust and practically implementable, going beyond the existing legal requirements. Most importantly EMP was designed in such a way that it becomes the integral part of the Standard Operating Procedures (SOPs) of DPCL. This makes it different from other EMPs.

3. Community outreach and governance

IUCN entered into the Dhamra port project because of concern about the port harming Olive Ridley turtles. As IUCN dug into the problems, however, it learned that the mortality rate of the turtles had already increased dramatically. A report prepared by the Wildlife Institute of India indicated that turtle mortality had increased from a few thousand a year in the early 1980s to more than 10,000 by the mid 1990s. Mechanized trawl fishing and gill net fishing were seen to be responsible for the mortalities.

Local community awareness regarding the value of the turtles was low. To address this, the IUCN team engaged in community sensitizing activities, including creative educational programs, as well as traditional outreach. DPCL also established a community training centre so that local villagers could develop skills which would prepare them for jobs arising at the new facility.

IUCN also identified that the use of Turtle Excluder Devices (TEDs) could be helpful in reducing turtle mortality due to trawl fishing, one of the biggest problems in the areas. The devices weren't new to fishers in the Dhamra area – Indian NGOs and scientists had tested them with the fishers in the past – but they weren't being used. The IUCN DPCL team consulted extensively with local fishing cooperative officers and communities to better understand the issues. A training workshop was organized and a number of practical trials of the TEDs for fishers in the area were facilitated. Changing the practices of local fishing communities remains a major priority, but will require long-term education programming combined with policy solutions.

The last obstacle to be tackled in this public arena was governance. In the beginning, local authorities seemed more concerned about fishers' rights than turtle safety. However, as understanding spread, government agencies became partner advocates for the holistic, long-term solutions. There were alternative livelihood trainings to provide income generating options to the community besides fishing.

How do the building blocks interact?

Through the three project building blocks, a holistic solution toward the challenge of balancing development with conservation was reached. While each block addressed a different aspect of the project, the combination of all these helped to consolidate mutual trust and collaboration among the stakeholders and actors, enabling engagement, dialogue and understanding for both the short term outcome and for long-term sustainability.

Impacts

Dhamra port is an example of a successful partnership between a private sector company and a conservation organization, in a project that deals with company core business and not just minor corporate social responsibility (CSR) initiatives.

As a result of the partnership and with assistance from IUCN, DPCL drafted an Environmental Management Plan (EMP). The EMP addresses regulations, policy, planning, implementation, operations and management as well as quality assurance and monitoring. It details the procedures needed for change management, and the development of a corporate culture that prioritizes safety, environmental protection and the promotion of positive community relations.

To fund ongoing research and intervention, a trust, proposed by IUCN, is being established to support long-term conservation in the area. DPCL and IUCN have now initiated the process of establishing the “Dhamra Conservation Trust”.

The Trust will focus on turtle conservation along the coastline of Odisha; improving the quality of life through alternative livelihoods; promoting opportunities for women; and empowering villagers.

On the broader scale, the project has led to a deeper understanding among private, public and civil society actors that much can be done to address both development and environment at the same time, in a sustainable manner, using good science. The outcomes of the project are changing perceptions not just on the business side on environmental sustainability, but also on the side of environmental organizations about the role they can play in enabling similar breakthroughs in sustainable business practices.

Story

The story of Dhamra Port is a story of misunderstandings, technical difficulties and conflict. But it is equally a story of determined individuals, enlightened companies, innovative approaches and mutual benefit. Despite the challenges, it is a story that resulted in a happy ending, both for the Olive Ridley turtle and for the people of Odisha.

Early on, a number of environmental organizations in India voiced strong opposition to the development of the port. Fortunately Tata Steel was committed to establishing whether a port could be built in this area without harming the turtles.

They asked IUCN, the International Union for Conservation of Nature, to advise on the project. IUCN brought in its global experts on sea turtles who worked with the company to help implement significant mitigation measures. IUCN accepted that this was a challenging engagement from the beginning. There was major resistance and debate within the environmental community about whether IUCN should be involved. And Tata Group knew that once they had engaged with IUCN, there could be significant cost associated with the organization's recommendations.

IUCN's participation in the Dhamra Port project sparked heated conflict among environmentalists. The issues were many and complex. There were many criticisms and misunderstandings, including accusations from external bodies and from NGO members within IUCN, which clouded the discussion. There were also factual gaps and misinformation about the potential impact of port development.

There was significant internal debate among IUCN members and even within the organization as to whether or not IUCN should be engaged in the project, and as to whether or not the port could be built without harming this important population of a vulnerable species.

"Many in the IUCN India National Committee felt that since the port was going to be built anyway it was important to provide scientific advice if possible. However several members did voice serious opposition to IUCN's engagement with the port at all," recalled Meena Gupta, IUCN Regional Councillor for South and East Asia.

For many, this was a project to save sea turtles. There was international evidence to show it was possible for ports and turtles to coexist, provided that standard operating procedures were followed. And by mobilizing its international network of experts, IUCN could bring much needed objective science and commitment to conservation to the table. "We have a golden opportunity to engage industry and help them get it right," said Nicolas Pilcher, co-chair IUCN Species Survival Commission - Marine Turtle Specialist Group.

IUCN is mandated by its Members to engage with the private sector. But as direct as the mandate is, it is porous enough for debate. In spite of the IUCN Council approved Business and Biodiversity Strategy mandating work with these "large footprint" industries, some IUCN Members still felt that industries – like mining – had such serious environmental consequences that IUCN should not engage with them. Some groups outside IUCN objected to the project loudly, and ran campaigns against IUCN. Others emphasized taking a long-term view, arguing that compromises were worth it, considering the potential for influencing a large-scale development project and mitigating its impact on a valued species, not to mention setting an international example.

The international science community by and large supported this position, concluding, on the basis of global best practices, that environmental damage could be adequately mitigated. In the end, the organization stood firm in its belief that it could act as a neutral and impartial partner in the project, using the best science to ensure that the best outcome was achieved for the turtles. IUCN also viewed the project as an important test case and learning opportunity around engaging with business in ways that provide the best results for nature and local communities.

Over a period of several years, the two organizations worked together through many challenges to demonstrate that development and conservation can co-exist, and that there are ways to develop in a responsible manner that meets both the needs of people and the needs of nature. Dhamra Port helped establish trust between IUCN and the Tata Group, and this led to other subsequent forms of engagement, all of which demonstrated that biodiversity protection can be a core principle of a large-footprint industry. Speaking about this partnership, Ratan Tata, Chairman Emeritus Tata Group said, “I am pleased that the Tata Group’s tradition of corporate social and environmental responsibility continued in the development of Dhamra Port. We have appreciated the partnership with IUCN in achieving this together.”

REVISED MASTER PLAN DEVELOPMENT OF DHAMRA PORT

AT BHADRAK DISTRICT, ODISHA



FINAL COMPREHENSIVE EIA/EMP Report

June 2018

Prepared By

L&T INFRASTRUCTURE ENGINEERING LIMITED

(S. No. 94 as on June 15, 2018 - List of QCI-NABET Accredited Consultant
Organizations)



Undertaking by the Project Proponent

- 1 The Dhamra Port Company Limited (DPCL) has carried out a Comprehensive Environmental Impact Assessment (CEIA/EMP) study for the Revised Master Plan Development of Dhamra Port at Bhadrak district, Odisha.
- 2 As per MoEF Office Memorandum No.J-11013/41/2006-IA.II (I) dated October 05, 2011, DPCL herewith declares the ownership of contents (information and data) of this CEIA/EMP Report.

For and on behalf of

M/s The Dhamra Port Company Limited (DPCL)


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Designation: CEO - DPCL

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Declaration by Experts contributing to the Comprehensive EIA/EMP Report for Revised Master Plan Development of Dhamra Port

I, hereby, certify that I was a part of the EIA team in the following capacity that developed the above EIA.

EIA Coordinator:

Name: C.V. Sundara Rajan (with support from other EIA Coordinators namely Ratheesh. B & Susruta Amirapu)

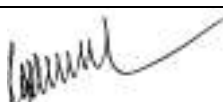
Signature: & Date: June 25, 2018

Period of Involvement: 2014 - Ongoing

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Functional Area Experts

S. No.	Functional Areas	Name of the Expert/s	Involvement (Period & Task)	Signature & Date
1	AP	Susruta Amirapu	Period: 2014 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018
		B. Ratheesh		 June 22, 2018
		Anshul Sanduja		 June 22, 2018
		With Support From: • Reji Baby Varghese (TM)		
2	WP	B. Ratheesh	Period: 2014 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018
		C.V. Sundara Rajan		 June 22, 2018

S. No.	Functional Areas	Name of the Expert/s	Involvement (Period & Task)	Signature & Date
		Reji Baby Varghese		 June 22, 2018
		<u>With Support From:</u> - Gorji Navya Tej (FAA) M. Uma Devi (FAA) - Anshul Sanduja (TM)		
3	SHW	Susruta Amirapu	Period: 2014 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018
		B. Ratheesh		 June 22, 2018
		Anshul Sanduja		 June 22, 2018
4	SE	Dr. Latha Bhaskar	Period: 2014 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018
		Aruditi Kaushik	September 2016 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018
5	EB	I. Siva Rama Krishna	Period: 2014 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018
		Varun Christopher Fernando		 June 22, 2018
		Dr. Subramanyam N. V. R. M.		 June 22, 2018
6	HG	C.V. Sundara Rajan	Period: 2014 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018

S. No.	Functional Areas	Name of the Expert/s	Involvement (Period & Task)	Signature & Date
7	GEO	C.V. Sundara Rajan	Period: 2014 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018
8	SC	Reji Baby Varghese	Period: 2014 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018
		<u>With Support From:</u> Dr. Subramanyam N. V. R. M. (TM)		
9	AQ	B. Ratheesh	Period: 2014 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018
		Susruta Amirapu		 June 22, 2018
		Anshul Sanduja		 June 22, 2018
		<u>With Support From:</u> - Gorji Navya Tej (FAA) M. Uma Devi (FAA)		
10	NV	Dr. Rajasekar Elangovan	Period: 2014 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018
		Reji Baby Varghese		 June 22, 2018
11	LU	C.V. Sundara Rajan	Period: 2014 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018
		Gorji Navya Tej	Period: October 2016 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018

S. No.	Functional Areas	Name of the Expert/s	Involvement (Period & Task)	Signature & Date
12	RH	Susruta Amirapu	Period: 2014 – Ongoing Task: Provided the required input for specific Functional Areas of Expertise during project period	 June 22, 2018

Declaration by the Head of the Accredited Consultant Organization

I, C.V. Sundara Rajan, hereby, confirm that the above mentioned experts prepared the Comprehensive EIA/EMP Report for Revised Master Plan Development of Dhamra Port. I also confirm that the Consultant Organization shall be fully accountable for any misleading information mentioned in this statement.



Signature:

Name: C.V. Sundara Rajan

Designation: City Office Manager & Head - Environment Section

Name of the EIA Consultant Organization: L&T Infrastructure Engineering Limited

NABET Certificate Number & Issue Date: RA-155th AC Meeting: December 28, 2017

**NATIONAL ACCREDITATION BOARD FOR EDUCATION & TRAINING
QUALITY COUNCIL OF INDIA**

QCI Office, 6th Floor, ITPI Building, Ring Road, I.P. Estate, New Delhi

Scheme for Accreditation of EIA Consultant Organizations

**Accreditation Committee Meeting for Re-Accreditation held on
December 28, 2017**

The following members were present during the meeting:

1. Prof. B.B. Dhar	- Chairman
2. Dr. G.K. Pandey	- Member
3. Dr. Nalini Bhat	- Member
4. Dr. S. P.Chakrabarti	- Member
5. Prof. C.P Kaushik	- Member
6. Prof. Umesh Kulshrestha	- Member

Dr. S.R. Wate and Prof. G.J Chakrapani expressed their inability to attend the meeting.

Mr. A.K. Jha – Senior Director, Dr. S.K Mishra – Joint Director, Dr. Pawan K. Singh – Assistant Director, Ms. Samra Khan – Accreditation Officer and Ms. Kritika Sharma – Executive Officer were present in the meeting.

1.0 Minutes of the Accreditation Committee meeting dt. December 13, 2017 were approved.

2.0 Case for Re-Accreditation

The following case was discussed and decisions were taken as noted below.

2.1 L&T Infrastructure Engineering Limited, Hyderabad

The ACO has been assessed as per Version 3 of the Scheme. Result of the Re-accreditation Assessment (RA) is given below:

2.1.1 Category of Approval :

The ACO has scored more than 60% marks hence it continues to be accredited with Cat. A.

2.1.2 Scope of Accreditation

Sl. No.	NABET Scheme Sectors	Sector Description	Cat.	Sector (MoEFCC Notification September 14,2006	No. dt. &

				Amendments)
1	3	River Valley projects	A	1 (c)
2	4	Thermal power plants	A	1 (d)
3	29	Air ports	A	7 (a)
4	31	Industrial estates/ parks/ complexes/areas, export processing Zones (EPZs), Special Economic Zones (SEZs), Biotech Parks, Leather Complexes	A	7 (c)
5	33	Ports, harbours, break waters and dredging	A	7 (e)
6	34	Highways	A	7 (f)
7	36	Common Effluent Treatment Plants (CETPs)	B	7 (h)
8	37	Common Municipal Solid Waste Management Facility (CMSWMF)	B	7 (i)
9	38	Building and construction projects	B	8 (a)
10	39	Townships and Area development projects	B	8 (b)

2.1.3 Sectors approved for EIA Coordinators (ECs)

a. Assessed as per RA norms – for ECs approved earlier:

S. No.	Name	Earlier approval status (SA/subsequently)		Current approval status (after RA)		Remarks
		Sector	Cat.	Status	Cat.	
In-house						
1.	C.V. Sundara Rajan	31	A	Renewed	A	None
		33	A	Renewed	A	None
		34	A	Renewed	A	None
2.	Susruta Amirapu	31	A	Renewed	A	None
		33	A	Renewed	A	None
3.	B. Ratheesh	31	A	Renewed	A	None
		33	A	Renewed	A	None

b. Assessed as per IA norms – for new Sectors of approved ECs and fresh ECs proposed:

Sl. No.	Name	Sectors			Cat.	Remarks
		Applied	Recommended	Approved		
In-house						
1	T.K.S. Sridhar Rajagopalachari	33	Yes	Yes	A	None
		29	Yes	Yes	A	None
2	C.V. Sundara Rajan	3	Yes	Yes	A	None
		4	Yes	Yes	A	None
3	Susruta Amirapu	4	Yes	Yes	A	None
4	B. Ratheesh	4	Yes	Yes	A	None
		34	Yes	Yes	A	None
Empanelled						
5	Haneesh K. R.	36	Yes	Yes	B	None
		37	Yes	Yes	B	None
		38	Yes	Yes	B	None
		39	Yes	Yes	B	None

 L&T Infra Engineering L&T Infrastructure Engineering Ltd.							
Client: The Dhamra Port Company Limited							
Project: Revised Master Plan Development of Dhamra Port						Project No.: C1141302	
Title: Final Comprehensive EIA/EMP Report						Document No.: RP010	Rev.: 0
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LIST OF ACCRONYMS

AADT	Annual Average Daily Traffic
AAQ	Ambient Air Quality
ADT	Average Daily Traffic
AE	Auxiliary Engine
BIS	Bureau of Indian Standards
BOD	Biochemical Oxygen Demand
BOG	Boil Off Gas
BOOST	Build, Own, Operate, Share and Transfer
BOXN	Bogie Open Top
BNP	Bhitarkanika National Park
BWLS	Bhitarkanika Wildlife Sanctuary
BWRO	Brackish Water Reverse osmosis
CEO	Chief Executive officer
CGWB	Central Ground Water Board
CHWIF	Common/Hazardous Waste Incineration Facility
CMO	Chief Medical Officer
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
COD	Chemical Oxygen Demand
CD	Chart Datum
CHWIF	Common Hazardous Waste Incineration facility
CMFRI	Central Marine Fisheries Research Institute
CNG	Compressed Natural Gas
CPCB	Central Pollution Control Board
CRV	Coastal Research Vessel
CRZ	Coastal Regulatory Zone
CSIR	Council For Scientific and Industrial Research
CSR	Corporate Social Responsibility
CWPRS	Central Water Power Research Station
CZMA	Coastal Zone Management Authority
CZMP	Coastal Zone Management Plan
CTE	Consent to Establish
CTO	Consent To Operate
dB(A)	Decibels-A Weighting
DG	Diesel Generator
DMP	Disaster Management Plan
DMF	Dual Media Filters
DO	Dissolved Oxygen
DPCL	Dhamra Port Company Limited
DPR	Detailed project Report
DRDO	Defence Research and Development Organization
DWT	Dead Weight Tonnage
EAC	Expert Appraisal Committee
EAL	Equivalent Axle Loads
EC/CRZ	Environmental & CRZ Clearance
EC	Electrical Conductivity
ECoR	East Coast Railway
ECR	The Emergency Control Room
ECT	Emergency Control Team
EHW	Extreme High Water
EIA	Environmental Impact Assessment
ELLW	Extreme Lower Low Water
EMC	Environment Management Cell
EMP	Environment Management Plan
ENVIS	Environmental Information Systems
EPZ	Export Processing Zone

ESD	Emergency shutdown system
ETP	Effluent Treatment Plant
FB	Fairway Buoy
FCC	Fertilizer Cargo Complex
FH	Fishing Hamlet
FOIS	Freight Operations Information System
FRP	Fibre Reinforced Plastic
GIS	Geographic Information System
GMS	Gahirmatha Marine Sanctuary
GDP	Gross Domestic Product
GoI	Government of India
GoO	Government Of Odisha
GRP	Glass Reinforced Plastic
GW	Groundwater
H ₂ SO ₄	Sulphuric Acid
Ha	Hectares
HoD	Head Of Department
HoS	Head Of Section
HSD	High Speed Diesel
HNO ₃	Nitric Acid
HPSV	High Pressure Sodium Vapour
HTL	High Tide Line
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA, previously known as International Association of Lighthouse Authorities)
IC	Incident Controller
ICEF	Indo-Canada Environmental Facility
IESNA	Illuminating Engineering Society of North America
IMO	International Maritime Organisation
IOCL	Indian Oil Corporation Limited
IR	Infra-Red
ISPL	International Seaports Private Limited
IUCN	International Union for Conservation Of Nature
IVI	Important Value Index
IWAI	Inland Waterways Authority Of India
LED	Light Emitting Diode
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LTL	Low Tide line
LLW	Lowest Low water
LNTIEL	L&T Infrastructure Engineering Limited
LSI	Langelier Saturation Index
MCM	Million Cubic Metres
ME	Main Engine
MHHW	Mean Higher High Water
MHU	Mobile Health Unit
MLD	Million Litres Per Day
MLLW	Mean Lower Low Water
MMTPA	Million Metric Tonnes Per Annum
MoEF & CC	Ministry of Environment, Forest And Climatic Change
MoST	Ministry of Surface Transport
MoU	Memorandum of Understanding
MSDS	Material Safety data Sheet
MSL	Mean Sea Level
MT	Metric Tons
MVA	Mega Volt Ampere
NAAQS	National Ambient Air Quality Standards
NABET	National Accreditation Board for Education and Training
NEAA	National Environmental Appellate Authority
NFPA	National Fire Protection Agency
NGL	Normal Ground Level

NGO	Non-Governmental Organization
NIO	National Institute of Oceanography
NO _x	Oxides Of Nitrogen
NH ₃	Ammonia
NOC	No Objection Certificate
NO ₂	Nitrogen Di Oxide
NO ₂ -	Nitrite
NO ₃ -	Nitrate
NPSH	Net Positive Suction Head
NRSC	National Remote Sensing Centre
NSDP	Net State Domestic Product
NTU	Nephelometric Turbidity Unit
OES	Occupational Exposure Standard
OHE	Overhead Equipment
OISD	Oil Industry Safety Directorate
OCZMA	Odisha Coastal Zone Management Authority
OSPCB	Odisha State Pollution Control Board
OSC	On Scene Commander
OPTCL	Odisha Power Transmission Corporation Limited
OUAT	Odisha University of Agriculture and Technology
OWS	Oil Water Separator
PCI	Per-Capita Income
PCPIR	Petrochemical & Petroleum Investment Region
PERC	Powered Emergency Release Coupling
PFR	Pre-Feasibility Report
PIA	Project Influenced Area
PIANC	Permanent International Association of Navigation Congresses
POL	Petroleum Oil Lubricants
PPE	Personal Protective Equipment
PPP	Private Public Partnership
PSF	Pressure Sand Filter
PUC	Pollution Under Control
PVC	Poly Vinyl Chloride
QCI	Quality Council Of India
RA	Risk Analysis
RH	Relative Humidity
R&R	Resettlement & Rehabilitation
RLNG	Re-gasified Liquefied Natural Gas
RO	Reverse Osmosis
RTG	Rubber Tyre Gantry
SAIL	Steel Authority of India Limited
SAL	Standard Axle Loads
SCV	Submerged Combustion Vaporizer
SDNP	Sustainable Development Network Partners
SDI	Silt Density Index
SEZ	Special Economic Zone
SIA	Social Impact Assessment
SO ₂	Sulphur Dioxide
SPT	Standard Penetration Test
STD	Standard
STP	Sewage Treatment Plant
STV	Shell & Tube Vaporizer
SWRO	Salt Water Reverse Osmosis
TCE	Tata Consulting Engineers
TDS	Total Dissolved Solids
TEU	Twenty foot Equivalent Units
TLF	Tanker Loading Facility
TOC	Total Organic Carbon
TPD	Tons Per Day
TSDF	Treatment, Storage and Disposal Facility

TSHD	Trailer Suction Hopper Dredger
TSS	Total Suspended Solids
TULF	Tanker unloading facility
UGC	University Grants Commission
UKC	Under Keel Clearance
UV	Ultraviolet
VDF	Vehicle Damage Factor
VTMS	Vessel Traffic Management Systems
VTs	Vehicle Traffic Service
WB	World Bank
WTP	Water Treatment Plant

Chapter 1 Introduction

1.1 Background

As a part of major initiative to propel the economic growth, the Government of Odisha (GoO) is aggressively working on the improvement of the import/export capabilities of the sea ports along the coast of the Odisha State.

Dhamra Port has been developed by “The Dhamra Port Company Limited” (DPCL) by means of Concession granted by Government of Odisha on BOOST basis. DPCL was originally incorporated under the Companies Act (CA), 1956 as a SPV as per Clause 2.4 of CA as a PPP project. By a deed of assignment of May 15, 1999, ISPL, the promoter of DPCL assigned and subrogated all its rights and obligations under the Concession Agreement to DPCL for implementation of the project. The DPCL now is a wholly owned subsidiary of M/s. Adani Ports and Special Economic Zone Limited, who has acquired the entire shareholding of the Company from M/s. Tata Steel Limited and M/s. L&T Infrastructure Development Projects Limited in June, 2014.

The first official notification defining the limits of Dhamra port was issued on March 28, 1881; (published on pages 379 & 380 of the Calcutta Gazette of March 30, 1881, by the Bengal Government). Subsequently Dhamra port limits were extended vide notification No. 1652-I-VP-12/Com dated June 09, 1931 by the Bihar and Odisha governments. This notification described port limits on the basis of physical ground features (land marks). However, Government of Odisha vide letter no. Env-I-11-98- 21564/F&E dated October 17, 1998 and GPP-20/98(pt)-1073/Com dated February 02, 1999 addressed to Government of India (GoI).

The Consent to establish (NOC) for Phase I development project was obtained from Odisha Pollution Control Board, under section 25 of Water (Prevention and Control of Pollution) Act, 1974 and section 21 of Air (Prevention and Control of Pollution) Act, 1981 vide OPCB Office Memorandum No. 12096 dated 17th September, 1998. Ministry of Surface Transport (MoST), Government of India accorded the environmental clearance (EC) for expansion of Dhamra port project vide their Office Memorandum No. PD/26017/8/98-PDZ (CRZ) dated 4th January, 2000. CTO was obtained from OPCB vide Letter No: 6441/ IND-I-CON-6348 of April 04, 2016 and is being renewed periodically. DPCL has implemented Phase I facility with two berths and 25 MMTPA capacity to handle Coal, Iron Ore and Lime Stone and has become operational wef May, 2011. Dhamra Port is one of the deepest ports of India with a draught of 18.0 m and can accommodate super cape-size vessels up to 180,000 DWT.

Further to the Phase I development; DPCL has obtained CRZ/EC for Phase II expansion. Phase II expansion includes development of 11 additional berths, 1 barge loading facility and one transloading facility to handle additional 71.3 MMTPA of dry bulk cargo, liquid and gas cargo including LNG, Other Break bulk (clean cargo) and 1 million TEUs of containerised cargo . The Consent to establish (NOC) for Phase II expansion was obtained from Odisha Pollution Control Board, vide order no. 2615-IND-II-NOC-5659 dated 19.02.2013. Odisha Coastal Zone Management Authority (OCZMA) recommended the proposal vide its Letter OCZMA-1/2012-13 dated December 20, 2012. Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India accorded the environmental and CRZ clearances for Phase II expansion vide their letter no. F. No. 11-104/2009-IA.III dated 1st January, 2014 and further amendment vide letter dated March 25, 2015. The EC/CRZ clearance letters for Phase I development, Phase II & amendment to Phase II, and compliance to the conditions

of EC/CRZ for the period April 2017 to September 2017 is given as **Appendix A** and Consent to Establish (CTE) & Consent to Operate (CTO) for Phase I and for Phase II is given as **Appendix B**.

With a view to optimize the waterfront area, utilize the maximum marine development potential, Increasing the backup area usage to accommodate future cargo projections and business requirement, DPCL proposes to revise the Master Plan based on Five (05) Years and Thirty (30) Years Development Plan.

1.2 Details of Project Proponent

The contact details of authorised person of DPCL are as below.

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1.3 Applicable Legal and Policy Framework

The proposed expansion of the Dhamra Port project attracts the provisions of Environmental Impact Assessment (EIA) Notification, 2006 (as amended) and Coastal Regulation Zone (CRZ) Notification, 2011 (as amended). The proposed project is categorised under Ports and Harbours included as Item 7(e) in the Schedule of the EIA Notification. Based on the cargo handling capacity planned in the Dhamra port Revised Master Plan (>5MMTPA), the proposed expansion of Dhamra Port is classified as Category “A”. The following rules and regulations are applicable to this development is given in **Table 1-1**.

Table 1-1: Applicable Environmental Regulation

Applicable Govt Policies & Regulations	Year	Objective	Reason for Applicability
Environmental (Protection) Act	1986	To protect and improve overall environment.	Environment in general.
Environmental Impact Assessment Notification (as amended)	2006	EIA notification for more effective Environmental clearance process.	Direct
Coastal Regulation Zone Notification (as amended)	2011	To protect the Coastal ecological resources and to prevent coastal pollution.	Direct
Air (prevention and control of pollution) Act	1981	To control air pollution by controlling emissions according to prescribed standards.	Control of Air pollution
Noise Pollution (Regulation and Control) (Amendment) rules	2000 & 2010	Noise pollution regulation and controls.	Control of Noise pollution
Water (Prevention and Control of Pollution) Act	1974	To control water pollution by controlling emission & Water pollutants as per the prescribed standards.	Control of Water pollution.
Solid Waste Management Rules	2016	Management of Solid Waste.	Appropriate handling of Solid Waste.
Hazardous and other Wastes (Management and Transboundary Movement) Rules and	2016	To store/handle hazardous waste and materials as per the provisions of the manufacturer, storage and import of Hazardous Chemical Rules, Hazardous Wastes (Management and Handling)	Appropriate handling of Hazardous and Other Waste.

Applicable GoI Policies & Regulations	Year	Objective	Reason for Applicability
amendment thereof		Rules and Amendments.	
E-Waste (Management) Rules and amendment thereof	2016	Consumer or bulk consumer of electrical and electronic equipments listed in Schedule I shall ensure that e-waste generated by them is channelized to authorized collection centre (s) or registered dismantler (s) or recycler or is returned back to the pick up or take back services provided by the producers.	Involvement of information technology and telecommunication equipment, electrical and electronics.
Batteries (Management and Handling) Rules	2001 (amended in 2010)	Consumer to ensure that used batteries are not disposed off in any manner other than depositing with the dealer, manufacturer, importer, assembler, registered recycler, reconditioner or at the designated collection centres.	Appropriate handling of used batteries.
Construction and Demolition Waste Management Rules and amendment thereof	2016	Generator shall prima-facie be responsible for collection, segregation of concrete, soil and others and storage of construction and demolition waste generated, as directed or notified by the concerned local authority in consonance with these rules. The generator shall ensure that other waste (such as solid waste) does not get mixed with this waste and is stored and disposed separately.	Appropriate handling of Construction and Demolition waste.
Bio-Medical Waste Management Rules	2016	Generator to take all necessary steps to ensure that bio-medical waste is handled without any adverse effect to human health and the environment.	Appropriate handling of Bio-Medical Waste.
The Manufacture, Storage and Import of Hazardous Chemical Rules (as amended)	1989	To prevent major chemical accidents arising from industrial activities; and to Limit the effects of chemical (industrial) accidents.	DPCL Revised Master Plan envisages handling and storage of LNG, Propane, Butane, LPG, CNG, NG and All Class A, B, C petroleum products, excluded petroleum products Including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos. Appropriate handling and storage of these cargos.

1.4 Project Site

The Dhamra port is located between 20° 48'N to 20° 56'N and Longitude 86° 55'E to 87° 16'E on the East Coast of India in Chandbali Tehsil of Bhadrak District in Odisha State. It is located at a distance of 220 km from Bhubaneswar and 360 km from Kolkata. The port is located to the north of Dhamra River mouth. The site provides natural protection for a tranquil harbour where no breakwater is required. The location map showing the project site is given as **Figure FD0101**.

1.4.1 Features of Project Site

Revision of master plan development will be carried in total area of 2013.4 ha comprises of Dry Barren Mud, Dry Mud with Giria Grass, Thorny scrub, Sea/Submerged land which falls in

inter tidal zone without any macro vegetation. This includes Existing Phase I (234 ha), approved Phase II (456 ha) area, proposed reclamation area of Sea/Submerged inter tidal land (1075.7 ha), proposed applied vacant government land (247.7 ha). Revised Master Plan area including Phase I and Phase II is falling in the villages namely Amarnagar, Balisahi, Dosinga, Pt. Nilakanthanagar, Rabindranagar, Kishoreprasad, Nilambarnagar, Gourprasad and Unsurveyed Area to the east of village Gourprasad and Hrudayaprasad. The Surveys Nos pertaining to Revised Master Plan including Phase I and Phase II is enclosed as **Appendix C**.

Some of the Site Photographs showing Proposed Expansion Site – Applied Land; Proposed Expansion Site – Area to be Reclaimed; Phase I and Phase II and Excluded Mangrove Area are given in **Exhibit 1-1 to Exhibit 1-5**.



Exhibit 1-1: View of the Proposed Expansion Site (247.7 ha – Applied Land)



Exhibit 1-2: View of the Proposed Expansion Site (1075.7 Ha) Area to be Reclaimed)



Exhibit 1-3: View of the Phase I Area



Exhibit 1-4: View of the Phase II Area (Under Construction) – New Stockyard Line Construction Work and New Silo Construction Work



Exhibit 1-5: View of the Scattered Mangroves (Excluded) towards Southern Boundary

The environment setting of the project site surroundings covering 15.0 km radius is as follows:

S. No.	Details	Description
1.	Sea	Abutting East
2.	River	- Dhamra River: 1.6 km South - Matai River: 8.0 km West
3.	Seismicity	Seismic Zone II (Low Risk Zone)
4.	Hills/Valleys	None
5.	Archeologically Important Places	None
6.	National Parks/Wildlife Sanctuaries	- Bhitarkanika National Park: 1.52 km South-South West ¹ - Bhitarkanika Sanctuary: 2.2 km South-South West - Gahirmata Marine Sanctuary is located at 11.0 km towards south of port site
7.	Reserved/Protected Forests	- Kalibhanjadian PF (3.0, SSW) - Garmal Forest (1.2, SW) - Kantiakhai PF (3.3, SE) - Sunirupi PF (10.0, S) - Katiakhai RF 3.1 km S - Bagulida RF (Proposed) 9.9 km S
8.	Mangroves	- Mangroves on northern side with buffer of 50 m - Excluded mangroves towards Southern Boundary - Kanika Island >1.5 km E
9.	Defence Installations	- Integrated Test Range (ITR) of DRDO is located at Wheeler Island which is at about 13.0 km towards south-south east of port site

1.4.2 Connectivity Aspects

Dhamra is connected by road with Bhadrak (85 km), the nearest major town on NH 5. The existing road connectivity from NH 5 to Dhamra is available at Jamujhadi, which is around 25 km from Bhadrak towards Balasore. The nearest railway stations are Bhadrak and Ranital which are 62 km away from Dhamra on the Chennai-Howrah line. The nearest airport is located at Bhubaneswar at 220 km, the state capital of Odisha.

Dhamra port has already constructed a rail link of 62.5 Km with single line track, connecting the port with the Indian Railway network near Bhadrak railway station. The port has acquired 125 m wide land corridor from Dhamra to Bhadrak for providing exclusive connectivity with the hinterland. Approval has already been obtained for 4 lane road and 2 rail tracks (as a part of Phase I & II Clearance).

1.4.3 Proposed Rail/Road Corridor

As a part of Revised Master Plan, it is to further develop additional 2 lane road and 1 rail tracks in the existing corridor.

In addition, for easy evacuation of cargo, a new rail, road and utilities corridor (12 km x 125 m wide) is proposed from Northern side development of Dhamra Port. This corridor will connect Dhamra port with existing rail-road corridor near Bansada, Bhadrak. Number of lanes and tracks will be finalised during detailed engineering by using the entire available width.

¹Revised Master Plan Layout is outside the Eco Sensitive Zone of Bhitarkanika Sanctuary & National Park which was declared as per Gazette Notification dated June 16, 2015

1.5 Project Status

DPCL has implemented Phase I activities. Presently Immediate Development Plan is under implementation inline to the Phase II expansion approval obtained by DPCL from MoEF&CC.

1.6 Need for Revision of Master Plan

1.6.1 National Scenario

Various sectors and new models of development have been adopted to address the basic infrastructure needed to match the growing GDP of the country. Among many sectors of infrastructure, Sea Port infrastructure are grossly inadequate for the nation to meet the growing challenges which in turn successfully integrate Indian Trade with the Global economy in terms of productivity, efficiency, state-of-art technology and surpass global developments in the Shipping sector.

Ports play a vital role in overall economic development of the country. About 90% by volume and 70% by Value of the country's international trade is carried on through maritime transport. Development of India's ports and trade related infrastructure will continue to be critical to sustain the success of accelerated growth in the Indian economy. Despite record growth rates, the merchandise trade intensity of India's GDP is still low. This indicates that there is still a lot of untapped potential for trade growth, and consequently the demands on the country's ports and trade infrastructure will continue to mount as trade diversifies and grows. Hence, there is a need to expand the Country's ports in a timely and efficient manner.

Realising this need, the Government of India has given adequate thrust to Sea Port infrastructure. In the Maritime Agenda (2010-2020) a target of ~3200 MT Port capacity to handle an expected traffic of ~2500 MT has been set for the year 2020. More than 50% of this capacity is to be created in the Non-Major Ports. The Non-Major Ports are expected to play an important role in achieving the target. The objective is not only creating more capacity but to bring out ports at par with the best international Ports in terms of performance.

The usage of LNG is expected to significantly grow in the country. As per "Vision 2030" Natural Gas Infrastructure in India Report by Industry Group for Petroleum & Natural Gas Regulatory Board, In future, the natural gas demand is all set to grow significantly at a CAGR of 6.8% from the consumption levels of 139 MMSCMD in 2014 to 746 MMSCMD in 2029-30.

1.6.2 State (Odisha) Scenario

The state of Odisha has a Coast line of 480 km from Andhra Pradesh border in Ganjam District to West Bengal border in Balasore District. It is endowed with conducive, unique, natural and strategic port locations which has bathymetric advantage and proximity to deep sea encouraging deep draught ports which is suitable for the development of modern ports. To facilitate developers for development of Minor Ports, Government of Odisha has framed the Port Policy during the year 2004. One of the main objective of the policy is to increase the handling capacity of cargo from the coast of Odisha as envisaged by Government of India. Also, as per Maritime agenda (2010 – 2020) released by Ministry of Shipping, GoI, Odisha state plan to achieve 200 million tons of cargo handling through different ports by 2020. The major chunk of the cargo will be the imports of crude oil, finished petroleum products, LPG, LNG cooking coal, edible oil, fertilizers and construction materials for commissioning of mega steel and other plants.

The advantages for development/expansion of sea ports in Odisha includes availability of naturally endowed and mineral rich vast hinterland of developing Eastern and Central Indian States that offers long term potential for cargo shipment. Besides the nearby industrial areas of Odisha and West Bengal, Odisha coast has to serve the land locked States of Jharkand, Chattisgarh, Bihar and Northeastern States. This region houses the largest mineral resource base of the country in terms of Iron Ore, Thermal Coal & Coking Coal, and other critical minerals such as Manganese, Copper etc. This region is housing nearly 80% of the country's Integrated Steel Plants both from Public Sector such as SAIL and Private Sectors such as TATA Steel, Jindals, Essars, Bhushan, etc. The region also has Fertiliser and other Agricultural input demands apart from Heavy Engineering and Automobiles etc. Gateway for containerized traffic and potential for container transshipment hub with spokes to NE states- Nepal-Bangladesh-Myanmar.

A close view of Steel Sector alone would bring out the enormity of the task at hand. The steel sector depends largely on infrastructure sector for transportation, generally 4 Tons of raw-material and finished goods has to be handled for every Ton of Steel production capacity (3 Tons of Raw material and 1 Ton of finished steel). As per the Government of India's National Steel Policy, the target steel production capacity by the year 2020 is 200 MT. This region (Odisha, Jharkand, Chattisgarh and West Bengal) is housing the largest mineral resource base of Iron Ore and Coal (critical inputs for Steel), maximum investments in terms of expansions of existing steel plants and new steel plants are under implementation/development. Considering that Indian Steel plants depend substantially on imported Coking Coal from Australia, New Zealand, Indonesia, South Africa, Canada and USA (nearly 1.0 ton per ton of Steel), the estimated imports are to be around 100 MT by the year 2020. Apart from this there are imports of Lime Stone from Gulf States.

A closer view of the Thermal Coal mine sector, this region houses the largest Coal Resource of the Nation with nearly 400 Billion Tons. With the growing energy demand of the country, the demand for coastal movement of Thermal Coal to the tune of nearly 200 MT of the production plan of 535 MT from Mahanadi Coal Fields Limited and Coal India Limited is expected by 2020.

The development of world class infrastructure in the Petroleum, Chemicals, Petrochemicals and allied sector (Odisha PCPIR) at Paradip with Indian Oil Corporation Limited (IOCL) as an Anchor industry will bring about a boom to the region. The other major industries present in the petroleum complex are IFFCO, Paradip Phosphate Limited, Goa Carbon Limited etc., The biggest advantage of this complex is very good raw material linkage in the vicinity. Paradip refinery itself has a plan to use natural gas as fuel as well as feed-stock (for its petrochemical units) and has a captive demand of about 5.50 MMSCMD. IOCL's captive consumption of gas in its own Refineries (Paradip, Haldia and Barauni) has a potential of 8 MMSCMD (2.5 MMTA), which would further increase in near future. In addition, IOCL would supply RLNG (Re-gasified Liquefied Natural Gas) to customers in state of Odisha, West Bengal & Jharkhand.

As a part of National Waterways - 5, a MoU (Memorandum of Understanding) with Government of Odisha, Paradip Port and Dhamra Port Company Limited was signed by IWAI on 30th June, 2014 for developing the commercially viable stretch of 332 km in two phases. During Phase-1, it is proposed to take up the development of 201 km stretches of Pankopal/Jakodia to Paradip and Dhamra. The 131 km stretch between Talcher and Pankopal/Jakodia and East Coast Canal stretch (Dhamra – Charbatia – Geonkhali) will be taken up in the 2nd Phase. Considering the above development of NW-5, there is enormous potential of movement of cargo.

1.6.3 Dhamra Port

Dhamra port has a significant strategic locational advantage over its counterparts on account of access to the Eastern hinterland consisting of steel industries and power plants. The mineral heartlands of the country (Odisha, Jharkhand, Chhattisgarh and West Bengal) are in close proximity to Dhamra port. Super cape size carriers can call on Dhamra port from where cargo can be shipped to Kolkata and Haldia by smaller vessels and barges.

1.6.3.1 Traffic Projections

Based on the available hinterland the revised traffic forecast for the Dhamra port has been worked out as given below:

- Existing - 24 MMTPA
- Immediate Phase - 96.8 MMTPA
- 5 Year Development – 150.1 MMTPA
- Long Term (30 Year) Development – 303 MMTPA

1.7 Revised Master Plan Development

The Revised Master Plan has been planned for 5 Years and 30 Years. The summary of development planned is given below:

- Immediate Development Plan (As per approved Phase II expansion which is under implementation) - The total quay length of 3693 m to handle dry bulk cargo, multipurpose cargo, Container, and PoL/Crude Oil/LNG / LPG, Cryogenic cargo, Liquid cargo etc and barge facilities along with backup facilities and independent port craft facilities, conveyor systems, drainage, water supply, electrical works, internal roads, railway works and other utilities and amenities is being developed. Total cargo handling capacity will increase from Existing 25 MMTPA to approximately 99.6 MMTPA.
- Revised master plan development (05 years) – Total quay length will be of 6032 m to handle Multi-Purpose including liquid cargo and Liquid/Gas/Cryogenic cargoes. Total cargo handling capacity will be approximately 169.5 MMTPA along with increased backup facilities. For easy evacuation of cargo, a new rail, road and utilities corridor (12 km x 125 m wide) is proposed from Northern side development of Dhamra Port. As a part of Revised Master Plan, it is to further develop additional 2 lane road and 1 rail track in the existing corridor.
- Revised master plan development (30 years) - Total quay length will be increased to 11750 m (cumulative) to handle Multi-Purpose including liquid cargo and Liquid/Gas/Cryogenic cargoes. Total cargo handling capacity will be approximately 314 MMTPA (Cumulative) by end of 30 years.

1.8 Consultants Appointed by DPCL

DPCL has prepared Pre-feasibility Report (PFR) for the revised master plan development and Detailed Project Report (DPR) for proposed LNG and LPG facilities at Dhamra port. In addition, DPCL appointed the following agencies/organization for conducting various studies:

- Tata Consulting Engineers (TCE) Limited, Mumbai for preparation of “Feasibility Report on Desalination Plant for water supply to Dhamra Port”
- Environ Software (P) Ltd, Bangalore for mathematical / hydraulic modelling / water quality modelling studies for proposed intake and outfall discharge system for LNG/LPG

processing facilities & dredge disposal studies and flow modelling/ wave modelling/ sediment transport modelling/ shoreline change prediction

- Department of Marine Sciences, Berhampur University, Odisha for marine Bio Diversity Studies
- National Institute of Oceanography (NIO), Visakapatnam Goa for Demarcation of HTL, LTL and Setback lines and also for preparation CRZ maps

In order to assess the potential environmental impacts due to the proposed port expansion, DPCL appointed L&T Infrastructure Engineering Limited (LNTIEL) to carry out the Comprehensive EIA study for the Revised Master Plan Development of Dhamra Port for seeking Environmental/Coastal Regulation Zone (CRZ) Clearances from Statutory Authorities.

1.9 Comprehensive Environmental Impact Assessment (CEIA) Study

The CEIA study for the revised master plan development of Dhamra Port covers both terrestrial and marine environmental assessment.

DPCL submitted the proposal (Form-1, Draft ToR and Prefeasibility Report) for consideration by the Expert Appraisal Committee (EAC, Infra 2) for obtaining Terms of Reference (ToR) for Environmental/CRZ Clearance in accordance with the provisions of the EIA Notification, 2006 (as amended) and CRZ Notification, 2011 (as amended).

The EAC (Infra-2), MoEF&CC has considered the project proposal in its meeting held on January 20, 2016 at New Delhi to determine the ToR and approved the ToR vide MoEF&CC letter No: F.No.11-104/2009-IA.III (Pt.), dated February 18, 2016 for Revised Master Plan Development of Dhamra port. A copy of the letter is enclosed as **Appendix D** for reference.

The EIA study has been carried out comprehensively based on the approved ToR covering both terrestrial and marine environments. The compliance to ToR prescribed by MoEF&CC and standard ToR for Ports and Harbour projects is enclosed as **Appendix E**.

1.10 Approach and Methodology

1.10.1 Project Influence Area (PIA)/Study Area

As per the Ports and Harbour EIA guidance manual issued by MoEF&CC, an area within 5 km radius from project boundary for primary data generation and 15 km radius as the general study area for secondary data generation is considered. A map showing the study area is given as **Figure FD0102**.

1.10.2 Study Period

The EIA study has been carried out as per MoEF&CC approved ToR for both terrestrial and marine environment. The baseline terrestrial and marine environmental surveys were carried out covering the following seasons:

- Summer season, 2014
- Post monsoon season, 2014
- Winter season, 2014-15
- Summer season, 2016

DPCL has also assessed the baseline conditions for both terrestrial and marine environment during post-monsoon season, 2017 and winter season, 2017-18 by engaging Centre of

Envotech and Management Consultancy Private Limited (CEMC), an MoEF&CC and NABL accredited laboratory and summary of the same is included in this final CEIA/EMP report.

1.10.3 Methodology

The CEIA study for the revised master plan has been carried out both for construction as well as operational phases. In each phase, the anticipated impacts due to the proposed project on terrestrial, marine environment and social components have been addressed. The methodology adopted for the study is discussed in the following sections.

1.10.3.1 Analysis of Alternatives

As the proposed project has already been established & operational, is being an Expansion/revision of Master Plan of existing Dhamra port, study of site alternatives has least significance. Various options for layout within the port limits were studied through hydrodynamic and other mathematical modelling with a view to optimise the port design with minimum coastal/environment impact (such as away from ESZ, no R&R and minimal sedimentation in the port) and other suitable operational Conditions.

1.10.3.2 Baseline Environmental Conditions

The baseline environmental status of the study area was established by carrying out the field surveys covering both the marine and terrestrial environmental components. In addition, authenticated earlier baseline data/secondary data was also collected, reviewed and presented.

Terrestrial Environment: The baseline environmental data for terrestrial environment was collected within the study area for following attributes.

- Meteorology; Ambient Air Quality; Noise; Water Quality and Soil – **By M/s Vison Labs for Summer 2016** (NABL and MoEF&CC accredited agency)/ **Vitro Labs, Hyderabad** for Summer 2014, Post Monsoon 2014 and Winter 2014-2015 (MoEF&CC/NABL accredited agency)
- Ecology
- Land use and Land Cover Mapping

Site specific hourly meteorological data was generated during the study period. In addition, project specific meteorological data for the complete year 2015 was obtained from LAKES Environment. Ambient air quality monitoring at the identified monitoring locations in the study area was carried out during the study period with twice a week frequency. Hourly noise levels were recorded at identified monitoring locations once during a season. Similarly, inland water quality (surface and groundwater) and soil quality sampling was carried out at identified monitoring locations once during a season.

Marine Biodiversity: **Department of Marine Sciences, Berhampur University**, a reputed academic and research institute, has been engaged to monitor the marine biodiversity during summer, 2016.

Marine Environment: **Centre for Advanced Studies in Marine Biology (CASMB), Annamalai University, Parangipettai, Tamil Nadu**, a reputed academic and research institute, has been engaged to monitor the marine environmental attributes in the project region during Summer 2014, Post Monsoon 2014 and Winter 2014-2015. The marine environment was monitored in terms of:

- Seawater quality
- Sediment quality
- Marine biology (plankton and benthos)

Centre of Envotech and Management Consultancy Private Limited (CEMC), an MoEF&CC/ and NABL accredited laboratory appointed by DPCL for terrestrial and marine environment during post-monsoon season, 2017 and winter season, 2017-18.

The baseline environmental conditions are described in **Chapter 4**.

HTL/LTL and CRZ Demarcation Survey

The physical demarcation of HTL and LTL was carried out by National Institute of Oceanography (**NIO**) which is an authorized agency by MoEF&CC. Based on the survey by NIO, the CRZ set back lines were demarcated. The Revised master Plan layout was superimposed on the HTL/LTL and CRZ map.

Socio-Economic Aspects

Data on population, literacy, occupation, amenities, and medical facilities was collected from District Statistical Handbook of Bhadrak and Kendrapara District and Primary Census Abstract (Census of India), 2011.

Fisheries data was collected from Marine Fisheries Census, 2010 from Department of Fisheries/CMFRI.

The details of the study are given in **Chapter 7**.

1.10.3.3 Anticipated Environmental Impacts and Mitigations Measures

Environmental attributes likely to be affected by project activities of the revised master plan of Dhamra Port were identified and impacts are assessed. Project activities of the revised master plan can be broadly classified into construction and operation phase activities.

Construction phase activities includes capital dredging, reclamation, construction of cargo berths, cargo storage areas, approach trestle, intake and outfall, rail /road connectivity, water treatment facilities, and installation of cargo handling equipment, development of internal infrastructure.

Operation phase activities includes maintenance dredging, cargo handling, movement of ships calling at port, movement of tugs and port crafts, cargo storage and inland cargo movement. Most appropriate and accepted methods are used to quantify impacts likely to arise due to development of Dhamra Port as per the revised master plan. The mitigation measures proposed to minimise/avoid each of the likely impacts that occur during construction and operation phases are presented in **Chapter 5**.

1.10.3.4 Environmental Monitoring Programme

Environmental Monitoring Programme for construction and operation phases of project has been formulated and presented in **Chapter 6** of this report. The Environmental Monitoring Programme covers the technical and network design of monitoring including measurement methodologies, frequency, location, etc.

1.10.3.5 Additional Studies

Risk Analysis and Disaster Management Plan: Risk analysis covering the Hazard Identification including potential release events and Failure Frequency and Consequence

modelling of release rate and damage distances was carried out. In this revised master plan development, the proposed cargos (Liquid/Gaseous/Cryogenic) are divided into different class i.e. (i) Class - A Petroleum (ii) Class - B Petroleum (iii) Class - C Petroleum (iv) Excluded Petroleum (v) Other Gaseous Cargos and (vi) Other liquid Cargos. In case of accident, all the above cargo likely to cause Fire & Explosion and Toxic effects except other cargos. **Among these cargo, representative items from each class which cause maximum damage distances based on NFPA hazard classification have been selected and risks associated were quantified.** Other cargos will have health hazard as the most probable hazard. The necessary measures will be taken during handling, transfer and storage of such cargos. The details of the same and measures to guard against fire hazards etc., have been provided in **Chapter 7**.

Traffic Studies: Traffic surveys were carried out for the road connectivity from NH-5 (near Bhadrak railway station) to Dhamra port for three days count at two locations i.e. at km 25.00 on SH Dhamra port road and at km 153.0 on NH-5 for Classified Traffic Volume Count to estimate the present traffic scenario in the project region. Also, traffic projections due to the proposed revised master plan development of Port have been made. The adequacies of existing corridor road provision (width and number of lanes) were analyzed and accordingly recommendations have been proposed in **Chapter 7**.

Social Impact Assessment: The likely social impacts associated with the project development are detailed out in **Chapter 7**.

Corporate Social Responsibility (CSR): The CSR activities proposed are discussed in **Chapter 7**. Also the CSR budgetary provision to be made for the activities proposed is discussed in **Chapter 7**.

1.10.3.6 Project Benefits

The project benefits in terms of improvements in the physical infrastructures and social infrastructure, employment potential and other tangible benefits are presented in **Chapter 8**.

1.10.3.7 Environmental Management Plan (EMP)

An Environmental Management Plan (EMP) was prepared and mitigation measures for the impacts during construction and operation phases and environmental monitoring programme are proposed. The mitigation measures have been discussed in **Chapter 5** under the respective sections. The Environmental Monitoring Programme has been discussed in **Chapter 6**. The institutional mechanism responsible for the implementation of the mitigation measures and Greenbelt development are presented in **Chapter 9**.

1.11 Structure of EIA Report

The report is structured as per Appendix III of EIA Notification, 2006 and also EIA Guidance Manual for Ports and Harbours, 2010 released by MoEF&CC.

- Chapter 1 : Introduction
- Chapter 2 : Project Description
- Chapter 3 : Analysis of Alternatives
- Chapter 4 : Description of Environment
- Chapter 5 : Anticipated Environmental Impacts and Mitigation Measures
- Chapter 6 : Environmental Monitoring Programme
- Chapter 7 : Additional Studies

- Chapter 8 : Project Benefits
- Chapter 9 : Environment Management Plan (EMP)
- Chapter 10: Summary and Conclusion
- Chapter 11: Disclosure of Consultants Engaged

Chapter 2 Project Description

2.1 General

In this chapter, Existing Dhamra Port facilities (EC approved Phase-I), Phase II approved facilities, revised master Plan Development 5 year and 30 year Plan is presented summarising the details of location, land, traffic potential, field surveys and mathematical model studies carried out for the revised master plan, layouts, Dredging and Reclamation, cargo handling, utilities and services, estimated cost for the development of project, environmental protection works, project implementation schedule and the proposed activity with respect to CRZ compatibility.

2.2 Port Location

The Dhamra port is located between 20° 48'N to 20° 56'N and Longitude 86° 55'E to 87° 16'E on the East Coast of India in Chandbali Tehsil, Bhadrak District of Odisha State. It is located at a distance of 220 km from Bhubaneswar and 360 km from Kolkata. The port is located to the north of Dhamra River mouth. The site provides natural protection for a tranquil harbour where no breakwater is required. The Port limits has been defined by Government of Odisha vide Commerce & Transport (Commerce) Department Notification No. 1691-G.P.P.-64/97-com dated the 11th March, 1998.

2.3 Dhamra Port Existing Facilities (Phase I Development)

The salient features of Phase I of Dhamra port have been tabulated in **Table 2-1**.

Table 2-1: Salient Features of Phase I Development

Features/Description			Unit	Phase 1
Cargo handled			-	Coal, Limestone and Iron ore
Cargo Handling Capacity/Annual Traffic			MMTPA	25
Land			Ha	234
Land for Rail, Road and Utility corridor			Ha	826.5
Design Vessel Size			DWT	180000 (Super Cape Size)
Breakwaters			m	No breakwaters due to natural tranquillity of the region
Diameter of Turning Circle			m	600
Depth at Turning Circle (Manoeuvring Areas)			below CD m	17
Number of Berths			-	Quay of 700m long with 2 berths, 19 m depth
One Way Approach Channel of 18.0 km (Outer + Inner)	Outer Channel	Width	-	240m
		Depth		18.3 m
	Inner Channel	Width		170m
		Depth		17.5 m to 17.0 m
Approach Trestle to berth		Length	m	126 m
		Width		12 m
Approach Bund		Length	m	186
Navigational Aids			-	Channel marker buoys : 21 no (8 fitted with GPRS); Fairway Buoy: 1 no.; Racon : 1 no.
Cargo Handling Equipment's				Ship loader, Ship un-loaders, Stacker cum reclaimer, Reclaimer, Wagon tippler complex, Covered Conveyor, Balloon loop type railway system, Silos and rail loading facilities etc.,
Cargo Storage Capacities			m ²	941000

Features/Description		Unit	Phase 1
Water		MLD	1.25; Source – Matai river
Raw Water Reservoir Capacity		m ³	6,71,400
Power		-	Dedicated 62.0 km long, 132 KV electric overhead transmission line with an outdoor 132 kV substation built within Dhamra Port limits 132KV/6.6KV HT transformers stepping down power and supplying to four secondary substations. Of the two 20 MVA transformers one is the main and the second one is a standby. The secondary substations at 6.6 KV voltage act as load centre distribution points.
Greenbelt development		-	43.0 Ha linear strip plantation along both sides of 62.5 km rail-road corridor from Bhadrak to Dhamra Port. DPCL has established a large nursery of multi species as a part of green belt development which is being continuously monitored.
Connectivity	Dedicated Corridor	-	DPCL acquired dedicated rail-road-utility corridor of 125m from Dhamra to Bhadrak and developed 62.5km rail connectivity from Dhamra to Bhadrak on the main Howrah-Chennai line, 132 KV overhead transmission line and 457mm cross country pipeline for supply of raw water from Matai river as a part of Phase I.
Environmental / Safety Aspects		-	• 5 MLD Water Treatment Plant • 140 KLD Sewage Treatment Plant • Dust Suppression System, Covered Conveyors, Wagon Tippers • Settling Ponds • Greenbelt development; Regular compliance monitoring • Mangrove conservation measures • Turtle conservation measures • Fire Fighting facilities including Fire Station, Fire Tender, Hydrant, Fire Extinguishers etc.,

Some of the Phase I development salient features pictorial representations are shown in **Exhibit 2-1 to Exhibit 2-11**.



Exhibit 2-1: Phase - I Berthing Facilities (Dolphin Type Jetties)



Exhibit 2-2: Stacker cum Reclaimer



Exhibit 2-3: Covered Conveyor Belt and Wagon Tippler



Exhibit 2-4: Dedicated Rail Corridor to Dhamra Port



Exhibit 2-5: Matai River Raw water Reservoir in Port



Exhibit 2-6: Substation at Port Site, Power Lines from Bhadrak Substation



Exhibit 2-7: Dust suppression System (Water Sprinklers) and Settling Ponds



Exhibit 2-8: Avenue Plantation and Nursery



Exhibit 2-9: Greenbelt Development along Rail/Road Corridor



Exhibit 2-10: Excluded Mangrove Area

**Exhibit 2-11: Fire Fighting Facilities in Dhamra Port**

2.4 Phase II Expansion Approved by MoEF&CC

DPCL is under process of implementing immediate development plan inline to the EC/CRZ clearance of Phase II expansion. The photographs of some of the facilities under construction are provided in **Exhibit 2-12** to **Exhibit 2-16**.

**Exhibit 2-12: New Jetty Expansion Area****Exhibit 2-13: Port Users Building****Exhibit 2-14: New MCC Building****Exhibit 2-15: New Container yard**

**Exhibit 2-16: Development of Backup Area through Reclamation**

Based on the available hinterland the traffic forecast for the Dhamra port has been worked out and same has been summarized in **Table 2-2**.

Table 2-2: Phase wise Traffic Forecast in MMTPA

Commodity	Existing	Immediate Phase	5 Year Development	Long Term (30 Year) Development
Dry Bulk Cargo	24.0	62.3	84.0	157.0
Container (MTEU) 1 TEU = 14 MT	-	1	2.15	4.5 (63MMT)
Multipurpose & General Cargo	-	8.5	15.0	43.0
Liquid & Gas	-	12.0	21.0	40.0
Total (MMTPA)	24.0	96.8	150.1	303

Bathymetry within an area of 25 km x 25 km near Dhamra River is very complex due to the presence of shoals and islands. In the offshore, these depth contours lie in a convex shape. All this show a reversal pattern of slope found along the transect off Gahirmatha indicating very gentle slope in the near shore up to 10m contour and steeper slope beyond. Along the northern end of Kanika Sand Island, the 10m depth contour lies about 13.3 km away from the northern part of Dhamra coast. The 15m contour lies about 20.3 km away from the coast and 7.0 km from the 10m contour. The 20m contour lies about 4.0 km from the 15m contour and 24 km from the coast. Here, the slope is gentle throughout the coast up to 20m contour. This bottom topography also indicates a nearly uniform depositional pattern in the near shore and offshore.

Based on the sub-soil information from available geotechnical investigation reports of the boreholes explored in the area, it is observed that the top soil in entire area is comprised of highly plastic soft to medium inorganic clay up to a depth of 15 to 18 m having SPT 'N'

values varying from 1 to 8. This clay layer is followed by medium to stiff silty clay layer having thickness of 5 to 10m with SPT 'N' values varying from 10 to 30. The soil beneath this is comprised of stiff to hard clay with silt having SPT > 30. Average ground water table is at 0.0 to 0.5 m below NGL.

2.6.3 Oceanography Investigations

The site specific oceanographic conditions such as tide, wave, current etc, are discussed in detail in Chapter 4.

2.7 Mathematical Model Studies

2.7.1 Flow Modelling

Flow modelling was carried out by M/s Environ Software for neap and spring tide conditions in the offshore region of Dhamra, Odisha considering existing conditions and proposed revised master plan development. The model generated tides and currents are comparable to actual observations at Dhamra. The currents are slightly increased (0.1 m/sec) in the northern part of Dhamra Port (Zone-A) and near Kanika Island and reduced the currents (0.2 m/sec) in the approach channel and mouth of Dhamra river mouth (Zone-B and Zone-C) during flooding tide condition. The currents are slightly reduced (0.2 m/sec) in the northern part of Dhamra Port (Zone-A) and approach channel, Kanika Island and increases the currents (0.1 m/sec) in the mouth of Dhamra river (Zone-B) during ebbing tide condition. Flow regime changes for various tidal conditions in the study domain after the proposed expansion development of the Port are predicted to be not of much significance. Variation in the flow regime (in the current speeds) after the expansion is limited to the development location mostly and found to be very much local in nature. No change in the flow regime of the rest of the domain is observed. It can be observed from the HD modelling studies that there was flow movement near the northern part of proposed reclamation since the flow velocity slightly increased after expansion and thus sufficient flow circulation will be available for north side mangrove area.

2.7.2 Wave Modelling

Wave modelling and tranquillity studies were carried out by M/s Environ Software to establish that tranquillity conditions prevail at the port facility for most of the time in a calendar year. The proposed expansion in the port basin have ensured that the currents and tides around the berths are well within threshold limits applicable for safe berthing of vessels most of the time thus enabling unhindered operations at the port through-out the year.

2.7.3 Sediment Transport Study

Sediment transport modelling studies were carried out by M/s Environ Software. The model was run continuously for six months before the proposed developments and predicted the sediment deposition, erosion and bed level changes at various time levels. From the model results, it can be seen that the changes in the sedimentation processes was localized due to proposed developments and no impact on the other than development area. The change in the bed levels due to the expansion development is not very significant and the change is limited to the basin, berth and approach channel only. The variation in the bed levels before and after development at the port basin location where the berths are located is of the order of 0.42 m over a period of six months & morphological changes around western side of

Kanika island is in the order of 0.3 m over a period of six months. The total maintenance dredged quantity was estimated about 16 Mm³ – 20 Mm³ annually based on the bed morphological studies due to the proposed expansion.

2.7.4 Dredge Spoil Disposal Study

Dredge disposal modeling studies were carried out by M/s Environ Software for dumping of about 20 MCM of dredged material for 8 months with continuous disposal of dredged material at location approved by MoEF&CC vide Phase II EC/CRZ Clearance i.e. DP Latitude 20°55.1' and Longitude 87°10.5' (**Figure 2-1**) and predicted the sediment plume dispersion and bed level changes at various time levels. At DP the sediment plume moves towards north and south side of the Dhamra and not reaching to the coast or any other eco-sensitive area. The maximum sediment concentration level varies in between 9,000 mg/l to 13,000 mg/l during disposal time at dump location.

The bed level change is limited to a small area and stretched in the North & South direction. The bed level variation over the period of 8 months dumping is of the order of 0.16 m. The model continued for 4 more months after stopping the disposal of dredge material and observed that the bed levels reduces to 0.011m at around the disposal location within 4 months which is insignificant.

The particle trajectory model studies also has been carried out covering period of 50 days to study the movement of sediment particle at dump locations i.e. DP. From the results, it can be concluded that the dumped sediment particles at site DP follow a movement in a circular axis initially in eastern direction and finally towards the southern part of dumped site and moves towards southern direction after 50 days. At any point of time, it remains far away from the western Coast of Dhamra region and other Eco-sensitive areas.

It can be concluded that DP location is suitable for disposal of dredged material dumping since the spread of the dump material seem to be confined to smaller area of ~ 3.5 sq Km.



Figure 2-1: Offshore Disposal Location for Dredge Material

2.7.5 Shoreline Changes Study

Shoreline changes modelling studies were carried out by M/s Environ Software to understand the changes in the nearby shoreline (North & South Side of proposed Expansion, South side of River Dhamra, Kanika Island, Gahirmatha beach, Wheeler Island) due to proposed development. The shoreline studies shows that mostly accretion in the stretches studied. Erosion was observed in north side of expansion area at the rates of -4.38m/ year and erosion at south side of River Dhamra at the rate of -2.71 m/ year. Suitable mitigation measures will be adopted to maintain the stability of coast

2.8 Development of Revised Master Plan

2.8.1 Planning Brief

For conceptualizing layout plans for the proposed facility, the requirements like navigation parameters, number of berths, cargo handling facilities, operational parameters, etc. has been identified. Based on above, suitable locations within the proposed port site have been identified where these facilities are to be developed.

The basic navigational needs for servicing the vessels are as given below.

- Sufficient water depths and widths in approach channel
- Harbour basin and jetty for the cargo handling operation
- Tranquillity conditions
- Adequate stopping distance for vessels of largest size
- Sufficient water area for easy manoeuvrability of vessels throughout the year
- Efficient fenders and mooring systems etc.
- The layout has been planned in such a way that to accommodate the future business scenario and cargo traffic fluctuations

2.8.1.1 Mooring Issues at Dhamra Port

It is evident from various studies of existing port that current velocity in the existing navigation channel in front of berth is very high and is in tune of 1.5 to 1.9 m/s. Studies also show that current velocity under and behind the berth are very less as compare to that in front of the berth during both flood and ebb tides.

Above phenomenon results into development of pressure head and difference in water level because of velocity gradient across the channel and berth pocket. Additional forces on the vessel, called stand-off forces, are being developed due to this, which creates heavy lateral forces on the vessel in addition to the regular mooring forces.

Because of above, numbers of occasions were recorded in the port in which the ropes of vessels subjected exponentially high forces and were broken during peak flood and peak ebb.

To take care of this situation and to ensure that this condition does not get repeated in future, the quay line of the bigger vessel berths need to be located away from the main channel.

This being an operational issue is already taken care while carrying out detailed engineering to implement the immediate development plan inline to Phase –II Environment/CRZ Clearance and the same is also integrated in the Revised master Plan.

2.8.2 Immediate Development Plan

Immediate Development is a part of Phase II Expansion for which Environmental/CRZ Clearance has been obtained. Total quay length will be 3693m to handle dry bulk cargo, multipurpose cargo, Container and LNG/LPG/PoL/Crude Oil/Cryogenic cargo, Liquid cargo and barge facilities along with backup facilities, transloading facility and independent port craft facilities, conveyor systems, drainage, water supply, electrical works, internal roads, railway works and other utilities and amenities will be developed to accommodate dry bulk cargo, multipurpose cargo and LNG/LPG/PoL cargo etc. Total cargo handling capacity will increase from Existing 25 MMTPA to approximately 99.6 MMTPA. Partial Transfer of Environmental Clearance (i.e LNG Terminal of 12 MMTPA) on the name of Dhamra LNG Terminal Private Limited is under Progress. Necessary application was made by DPCL to MoEF&CC for the same vide its letter number:DPCL/2018/ENV-02 dated November 02, 2018.

Presently DPCL is under process of implementing immediate development plan inline to Phase II Expansion for which EC/CRZ Clearances has been obtained. Detailed Engineering is carried out to ensure feasibility of layout and to overcome present operational issues if any that may result into minor modifications/changes in configuration during execution of project components.

The layout showing Immediate Development Plan is given as **Figure FD0201**.

2.8.3 Revised Master Plan (First 5 years)

Total quay length will be of 6032 m to handle Multi-Purpose, Liquid/Gas/Cryogenic cargoes as part of revised master plan for first five years. Marine structures of the port will be developed with the flexibility to handle various cargos. Type of berth and type of cargo is a commercial and business requirement. So master plan is revised with those flexibilities to accommodate berths as multi-purpose. Total cargo handling capacity will be approximately 169.5 MMTPA along with increased backup facilities. For easy evacuation of cargo, a new rail, road and utilities corridor (12 km x 125 m wide) is proposed from Northern side development of Dhamra Port. This corridor will connect Dhamra port with existing rail-road-corridor near Bansada, Bhadrak. As a part of Revised Master Plan, it is to further develop additional 2 lane road and 1 rail track in the existing corridor.

The layout showing Revised Master Plan (First 5 Years) is given as **Figure FD0202**.

2.8.4 Revised Master Plan (30 years)

Total quay length will be increased to 11750m to handle Multi-Purpose and Liquid/Gas/Cryogenic cargoes. Total cargo handling capacity will be approximately 314 MMTPA by the end of 30 years. The layout showing Revised Master Plan (30 Years) is given as **Figure FD0203**.

The following are the Cargos handling capacity and cargo type mentioned while obtaining ToR is given in **Table 2-3**.

Table 2-3: Cargo Handling Capacity as mentioned in ToR

Facility/ Component		Immediate Development (MoEF&CC Approved)	Revised Master Plan (First 5 Years)
Capacity (Cumulative)		99.6 MMTPA	169.5 MMTPA
Cargo Handling	Bulk Cargo	49 MMTPA	17 MMTPA

Capacity	LNG/ LPG/PoL/Crude Oil	(i) LNG 10 MMTPA (ii) PoL (including LPG) 2.5 MMTPA	7.5 MMTPA
	Container	10.08 MMTPA	33.32 MMTPA
	Multipurpose	-	9 MMTPA
	Barge	3 MMTPA	3 MMTPA

As the berths are proposed to be developed as Multipurpose, the various cargos are combined into TWO broad categories i.e Multi-Purpose (including Liquid) and Liquid/Gas/ Cryogenics as represented below.

The development of the project will be carried out in different phases and the details are given in **Table 2-4** and **Table 2-5**.

Table 2-4: Cargo Handling Capacity and Type for 5 Year and 30 Year

Facility/ Component		Immediate Development (MoEF&CC Approved)	Revised Master Plan (First 5 Years)	Revised Master Plan (30 Years)
Capacity (Cumulative)		99.6 MMTPA	169.5 MMTPA	314 MMTPA
Cargo Handling Capacity (Additional)	Multipurpose (including Liquid)	62.08	62.4	143.7
	Liquid/Cryogenic/ Gas	12.5	7.5	-

Table 2-5: Cargo Mix for 5 Year and 30 Year

S. No.	Cargo Type	Cargo Mix ²
1.	Multipurpose (Including Liquid)	Coal / Iron ore / limestone / Mines & Minerals & other dry bulk/Fertilizers and raw materials for manufacture of fertilizer / food grains / sugar / clinker / cement / Project cargo / timber & wood / machines/ Iron steel products / Break Bulk etc./Container (3.1 m TEUs for 5 year and 4.66 m TEUs for 30 years) All Class A, B, C petroleum products, excluded petroleum products Including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos), PoL Such as LPG, Motor Spirit, Naphtha, High Speed Diesel, Crude Oil, Aviation Fuel, Kerosene, Low Sulphur Heavy Stock/ Furnace oil, Carbon Black Feedstock (CBFS), Paraffin, Bitumen, Lube oil, Asphalt etc.
2.	Gas / Cryogenics/Liquid,	LNG, Propane, Butane, LPG, CNG, NG and All Class A, B, C petroleum products, excluded petroleum products Including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos
		Note: 1. Risk Assessment has been carried out for representative cargos of the above categories keeping in mind NFPA hazard classification to derive worst case scenario. 2. It is implied that any other cargo having lesser risk against the representative cargos considered for RA can be handled. 3. Class-A Petroleum: Liquids which have flash point below 23°C; Class-B Petroleum: Liquids which have flash point of 23°C and above but below 65°C; Class-C Petroleum: Liquids which have flash point of 65°C and above but below 93°C; Excluded Petroleum: Liquids which have flash point of 93°C and above 4. Hazardous & Toxic Chemicals means as referred in "The Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 (as amended)

² Storage of cargo in the CRZ area will be as per the CRZ Notification 2011 (as amended)

S. No.	Cargo Type	Cargo Mix ²
		5. Non Hazardous chemicals and other Liquid cargos means liquid cargo not covered under Hazardous and Toxic Category

2.8.5 Land and Proposed Land Use

2.8.5.1 Topographic Features

The project site is located at average (-) 1.0 m CD to (+) 3.5 m CD level. Project site is sloping towards East i.e. towards Sea side.

2.8.5.2 Existing Land use Pattern

Revision of master plan development will be carried in total area of 2013.4 ha. This includes Phase I - 234 ha, Phase II - 456 ha including basin area, proposed reclamation of Sea/Submerged intertidal area 1075.7 ha and proposed applied vacant government land 247.7 ha. Revised Master Plan area (including Phase I and II) is falling in the villages namely Amarnagar, Balisahi, Dosinga, Pt. Nilakanthanagar, Rabindranagar, Kishoreprasad, Nilambarnagar, Gourprasad and Unsurveyed Area to the east of village Gourprasad and Hrudayaprasad.

Present land uses of the expansion site are Dry Barren Mud, Dry Mud with Giria Grass, Thorny scrub, Sea/Submerged land which falls in inter tidal zone without any macro vegetation.

2.8.5.3 Proposed Land use

The proposed land use for 5 year development consist of Bulk Material Handling Area, Container Terminal Backup Area, Multipurpose Cargo Backup Area, Liquid Tank Farm, Godown Area, LPG / LNG Terminal, Gate Complex & Parking, Greenbelt, Internal Rail and Road Approaches and Corridors, Excluded Scattered Mangrove Area, Desalination plant + ETP + STP + WTP, Buildings + Workshops, Misc. (Open storage + recreation facilities + etc.) and planned in an area of 1229.2 ha. As the total reclamation will be carried out within a period of 5 year keeping a vision of 30 year, the remaining area of 761.72 ha has been earmarked for future development. During 30 year development plan the above mentioned land use plan will be extended based on the cargo storage requirement to use the 761.2 Ha.

2.8.6 Design Vessel Size & Parcel Size

The design vessel size details are as given in **Table 2-6**.

Table 2-6: Design Vessel Size

S. No.	Vessel Size	Type
1.	2,50,000 DWT	Bulk Carrier
2.	18,500 TEU	Container Ship
3.	1,50,000 DWT	Liquid Carrier
4.	2,65,000 m ³	LNG/Cryogenic Carrier
5.	85,660 m ³	LPG Carrier

The parcel size of the cargo is given in **Table 2-7**.

Table 2-7: Parcel Size

S. No.	Cargo Type	Average Parcel Size

S. No.	Cargo Type	Average Parcel Size
1.	Coal Import	1,00,000 MT
2.	Coal Export	1,00,000 MT
3.	Container	4500 TEU
4.	General & Break Bulk Cargo	40,000 MT
5.	Barge Loading	10,000 MT
6.	Fertilizer and FRM	50,000 MT
7.	Liquid	40,000 MT – 60,000 MT
8.	LNG/Cryogenic	1, 35,000 cu.m.
9.	LPG	44,000 MT

2.8.7 Berthing Facilities

Total quay length during 5 year and 30 year development are 6032 m and 11750 m respectively.

2.8.7.1 Transloading Facility

The transloading facility as approved under Phase II will be implemented as a part of immediate development plan. The facility will be either a kind of Ship to Ship Transfer (STS) or without the central platform with one mooring facility with a dredged depth of (-) 19.0 m CD to accommodate 180,000 DWT vessel will be developed.

2.8.7.2 Barge Loading Facility

The barge facility is proposed towards shore. All barge berths are proposed to be connected to land to handle cargo efficiently. Barge berth planned with adequate width and dredged depth to accommodate up to 10,000 DWT barges.

2.8.8 Navigation Facilities

The channel alignment will be oriented considering the following aspects:

- The channel is aligned in a straight line as far as possible
- The channel is oriented so as to reach the deep-water contours in shortest possible distance (this is to optimize the quantity of dredging)

The dimensions of the navigation channel are dependent on the vessel size, the behaviour of the vessel when sailing through the channel, the environmental conditions (winds, currents and waves) and the channel bottom conditions. Channel design primarily involves determination of the safe channel width and depth for the dimensions of the design vessel.

The widening & deepening of the approach channel will be required for the proposed revised Master Plan development. The proposed approach channel dimensions are as follows:

- Navigation Channel – 21.0 km long (total) at (-) 19.0 m CD dredged depth (5 Year) and 21.0 km long (total 2 – way) at (-) 19.0 m CD dredged depth and 24.0 km long (total) at (-) 22.0 m CD dredged depth (30 Year)
- Outer channel – 380m wide (one way) for 5 year; 500 m wide (two way) for 30 year
- Inner channel – 380m wide (one way) for 5 year; 500 m wide (two way) for 30 year
- Berth Pockets of all bulk & multipurpose berth (-) 20.5 m CD dredged depth

2.8.8.1 Channel Width

The width of the proposed navigational channel is 380 m one way movement for 5 year development and 500 m for 30 year development for two way movement simultaneously. The maximum beam of largest vessel is 55.0 m for 2, 50,000 DWT Bulk Cargo vessels and 60.0 m for 18,500 TEUs container vessel.

For the proposed revised master plan layout, widening & deepening of the existing channel has been envisaged to meet the requirement of the cargo volumes.

2.8.8.2 Channel Depth

The depth in the channel should be adequately greater than the static draft of the vessels using the waterway to ensure safe navigation. Generally, the depth in the channel is determined by following factors.

- Vessel's loaded draft
- Trim or tilt due to the loading within the holds
- Ship's motion due to waves, such as pitch, roll and heave
- Character of the sea bottom, soft or hard
- Wind influence of water level and tidal variations

Based on the PIANC guidelines, the following general recommendations on under keel clearances shall be adopted to determine the dredge depths:

- Open sea area (in outer approach channel): for those exposed to strong and long stern or quarter swell, where speed may be high, gross under keel clearance should be about 20% of the maximum draft of ships
- Channel: for sections exposed to strong and long swell, gross under keel clearance should be about 15% of the draft
- Channel: less exposed to swell, gross under keel clearance should be about 10% of the draft
- Manoeuvring and berthing areas for those exposed to swell (without full protection of breakwater): gross under keel clearance should be about 10 to 15% of the draft.
- Manoeuvring and berthing areas protected (full protection by breakwater): gross under keel clearance to be about 7% of the draft.

Considering the above factors and guidelines given in Permanent International Association of Navigation Congresses (PIANC), the under keel clearance is taken as 15% of the draft of the maximum size of the vessel in the channel and manoeuvring in existing and proposed approach channel has been considered as sheltered area. The maximum fully laden draft for design vessel is 19.0 m for bulk carrier and 16.0 m for 18,500 TEU container vessels.

Based on considerations, under keel clearance to be adopted in proposed crane roll-on facility development may be 15% of vessel draft in channel, 10% in basin area and 7% in the berth pocket. From the above considerations, the depths required in the navigation channel at the proposal port are worked out and presented below. However to optimize the dredging quantity in initial phase, tidal advantage up to 3.0 m has been considered to accommodate largest size vessels.

Description	Max. Draft of Vessel (m)	UKC (m)	Tidal Advantage	Water Depth Required (m)
Approach Channel	19	2.85 (15% UKC)	3.0	18.85
Basin Area	19	1.9 (10% UKC)	2.0	18.90
Berth Pocket	19	1.33 (7% UKC)	0.0	20.33

Hence, from the above table it can be seen that for safe maneuvering of the vessel with entering limiting tide in the approach channel and the basin area (-) 19.0 m CD dredge depth is required and for berth pocket (-) 20.5 m CD dredged depth is required.

However, for revised Master Plan (30 year) with the design vessel size of 2,50,000 DWT for bulk cargo, the dredged depth of the approach channel and basin area is required up to (-) 22.0 m CD as with increased frequency of largest vessel.

2.8.8.3 Manoeuvring Area

The location of the manoeuvring area or the turning basin, required to swing and berth the vessels, is very important and its design must provide the proper configuration, the proper dimensions and access. The size of the manoeuvring area is a function of the length and manoeuvrability of the vessels and the time available for executing the turning manoeuvre.

The optimum configuration of such basin would be circular. By considering environmental conditions and the fact that vessels will be assisted by tugs, the diameter of the turning circle is required to be kept as 1.8 to 2.0 times length of the vessel.

The dimensions and sizing of the manoeuvring and the basin area has been carried out in such a manner that 700 m diameter turning circle will be available.

2.8.8.4 Navigational Aids

The proposed development of berths as per the master plan and its related backup facility involves creating an approach channel of 500 m wide base width having (-) 19.0 m CD depth in approach channel and in turning circles. These areas will be delineated by appropriate navigational aids. Also, it will be quite useful to establish a well-marked navigation line, by installing two navigation marks / leading light towers, one in the front near the high water line and the other at the rear. These marks will distinctly demarcate the channel.

The height and spacing in between the towers must be designed suitably with adequate day marks and night leading lights, fulfilling the navigational needs of vessels approaching the port facility. The following navigational aids are available in existing approach channel.

- Channel marker buoys
- Fairway buoy and Turning circle buoys
- Front and rear leading light
- Berth corner lights

In existing approach channel the buoyage system follows International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) standards as applicable to Region A countries. One fairway buoy has been installed at the entrance of the channel. The channel is marked with 19 lateral buoys spaced at a distance of 1 NM. Turning circle is marked with 2 cardinal buoys. The visibility of the fairway buoy and navigational buoy is 10 NM and 5 NM respectively in fair weather. The navigational buoys are fitted with GPS system and fairway buoy is having a recon transmitting code letter "D".

However, the addition or change in the location of these buoys will be required once the entire channel widening as per the proposed master plan development get completed.

2.8.8.4.1 Fairway Buoy

Fairway buoy (FB) marks the entry to the approach channel and also indicates the location of the pilot boarding area. Hence the vessels calling at port should be able to detect the fairway buoy while approaching the port.

The characteristics of the fairway buoy will be as follows:

- Type - Fibre Reinforced Plastic (FRP) (3m dia)
- Radar Reflector - Fitted
- Light characteristics - Fl RW 105 10m LED 20W Halogen Lamps
- Power - Solar with backup battery for optimum autonomy.
- Anchoring arrangement - with 32mm diameter chain and 3.0 T anchor weight

2.8.8.4.2 Channel Marker Buoys

There will be a pair of Channel Marker Buoys at the beginning of the channel on either side. Thereafter two pairs of Channel Marker Buoys are provided along the channel at a uniform spacing. The channel marker buoys will have the following characteristics:

- Type - FRP (3m dia)
- Day mark - Single Green, Cone type (Starboard buoy) & Single Red, Can type (Port side buoy)
- Radar reflector - Fitted
- Light characteristics - Fl G 3s 2m (star board buoys)
- LED 20W Halogen Lamps
- Power - Solar plus backup battery for optimum autonomy.
- Anchoring arrangement - with 32mm diameter chain and 3.0 T anchor weight

2.8.8.4.3 Front and Rear Leading Light

It is necessary to mark the center line of the channel with leading lights to ensure safe day and night navigation of vessels visiting the port. The leading lines will be having following criteria:

- Visibility range - 20 nautical miles
- The Leading lines and Leading lights are designed in accordance with IALA Guidelines and recommendations and the details are as follows:
- Day mark - As per IALA Guidelines
- Light Characteristics - Front Light Fl Y 1s & Rear Light Occ. Y 3s

The leading lights will be controlled by a sun-switch to ensure that the lights operate only during darkness or bad visibility. Power supply will be provided by batteries, to be recharged by solar panel systems mounted on the supporting structure, and/ or by power supply from the port distribution system. The battery banks shall be sized to ensure 24 hours continuous operation of the lighting system.

2.8.9 Natural Tranquillity

Kanika Island in the nearby vicinity of the port provides full and natural protection for a tranquil harbour where no breakwater is required.

2.8.10 Cargo Handling Capacity

The cargo handling capacity along with the cargo mix of revised master plan (5 years and 30 years) is given in **Table 2-8**.

Table 2-8: Cargo Handling Capacity as per Revised Master Plan (upto 5 Years and 30 years)

S. No.	Cargo Type	Cargo Mix	Cargo Handling Capacity (MMTPA)	
			5 Years	30 Years
1.	Multipurpose (Including Liquid)	Coal / Iron ore / limestone / Mines & Minerals & other dry bulk/Fertilizers and raw materials for manufacture of fertilizer / food grains / sugar / clinker / cement / Project cargo / timber & wood / machines/ Iron steel products / Break Bulk etc./Container (3.1 m TEUs for 5 year and 4.66 m TEUs for 30 years) All Class A, B, C petroleum products, excluded petroleum products Including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos <u>Tentative list of hazardous liquid cargo but not limited to are as follows:</u> Ethylene, Propylene (Propene), Butadiene, Pentane, Ethyl Mercaptan Motor Spirit, Propylene Oxide, Hexane, Naphtha, Acetone, Methyl Chloride / Chloro Methane, Cyclohexane, Benzene, Ethyl Acetate, Acrylonitrile Acetonitrile, Methyl Methacrylate, Methacrylonitrile, Methanol (Methyl Alcohol), Isopropyl Alcohol, Ethyl Alcohol (Ethanol), Ethylene di chloride, Methyl Isobutyl Ketone, Ethyl Benzene, N-Butyl Acetate, Isobutyl Alcohol (Iso Butanol), N-Butyl Alcohol (N-Butanol), Epichlorohydrine, Styrene, O-Xylene, High Speed Diesel, Cumene, Crude Oil, Aviation Fuel, Kerosene, Acetic Acid, Acetic Anhydride, Non-edible/Mentha Oil Low Sulphur Heavy Stock/ Furnace oil, Carbon Black Feedstock (CBFS), Aniline, Methyl Ethyl Ketone Peroxide, Ethyl Hexanol-2, Vinyl Chloride, Phenol, Naphthalene, Ethylene Glycol, Mono Ethylene Glycol, Toluene 2.4 -di isocyanate, Diphenyl Methane Di-Isocynate, Edible oil/Palm Oil, Paraffin, Bitumen, Sulphur, Lube oil, Asphalt, Coal, CNG, NG, LPG, Ammonia (NH₃), Diammonium Phosphate, Muriate of Potash (MOP), Soda Ash (Sodium Carbonate), Urea, Limestone, Caustic Soda, Sulphuric acid, Phosphoric acid, Piperine/ Piperidine, Chloroform, Hydrochloric Acid (HCL) etc.,	149.48	293.18
2.	Gas / Cryogenics/Liquid	LNG, Propane, Butane, LPG, CNG, NG and All Class A, B, C petroleum products, excluded petroleum products Including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos	20*	20*
Total (Cumulative)			169.5	314

(Note: Partial Transfer of earlier Environmental Clearance (i.e for LNG Terminal of 12 MMTPA) on the name of Dhamra LNG Terminal Private Limited is under Progress. Necessary application was made by DPCL to MoEF&CC for the same vide its letter number:DPCL/2018/ENV-02 dated November 02, 2018.)

2.8.11 Cargo Handling Rates

The cargo handling rates are worked out for effective topside working hours of 21 to 24 hours per day and other factors that influence the berth and stockyard operation. The details are given **Table 2-9**.

Table 2-9: Cargo Handling Rates

S. No.	Cargo Type	Average Parcel Size
1.	Coal Import	63,500 – 95,250 TPD
2.	Coal Export	54,500 – 98,250 TPD
3.	Iron Ore Export	68,250 TPD
4.	General & Break Bulk Cargo	15,00 TPD – 22,000 TPD
5.	Barge Loading	12500 TPD – 19,800 TPD
6.	Fertilizer and FRM	15,000 TPD – 22,000 TPD
7.	Liquid/Other Chemicals	20,000 TPD – 35,750 TPD
8.	LNG/Other Cryogenics	94,000 TPD
9.	LPG/Other Cryogenics	13,650 TPD

2.8.12 Cargo Storage Capacities

The details of the storage areas and their capacities for Revised Master Plan (5 Years and 30 Years) are given estimated at about 710.88 Ha for 5 year plan and 1347.4 Ha (Cumulative) for 30 year plan. The storage area consists of Bulk Material Handling Area/ Container Terminal Backup Area/ Multipurpose Cargo Backup Area/ Liquid Tank Farm/ Godown Area/ LNG/LPG/Cryogenic Terminal/ Miscellaneous (Open Storage + recreational facilities + etc.)

2.8.13 Cargo Handling

2.8.13.1 Coal – Import

Unloading: Coal will be unloaded from ship through grab type unloader traveling on rail at Jetty. Grab will unload coal to belt feeder/ discharge gate through hopper. Further, coal will be conveyed to stock yard through series of conveyors.

Stockyard: Cargo will be stacked in coal yard by mechanized handling system. Coal cargo received by belt conveyor system from the jetty will be stacked in coal yard through yard conveyors along stockyard using stacker cum reclaimer. Each yard conveyor is equipped with one stacker cum reclaimer machine.

Evacuation: Coal is also being reclaimed from stockyard through stacker cum reclaimer and conveyed towards reclaiming conveyors which will discharge material in wagon loading silo. An In-motion wagon loading arrangement with conveyor connectivity has been planned. The rake consists of 59 wagons (maximum) of 68 MT capacities each subject to wagon carrying capacity & density of coal. However, to enhance the capacity of the exiting railway loop, additional lines and silo will be constructed to match the berth capacity.

2.8.13.2 Coal/Iron Ore – Export

In-loading Stream: Coal / Iron Ore trains of BOXN wagons will travel along the rail spurs and empty their wagons into train unloading stations i.e. tippler. Rail lines with dump station for unloading Coal / Iron Ore in BOBRN wagons have been proposed within the existing Marry-go-round (MGR) of Dharma Terminal. The thermal coal from various coal fields in Odisha is expected to be shipped through Dhamra port and the receipt of such coal will be through BOBRN/ BOXN wagons rakes would require a different type of facility in which the wagon contents is discharged through a track hopper or wagon tippler. The coal will be conveyed through the apron feeders or belt feeders or unloader below the hopper to the conveyor system and finally stacked into the stockyard through a stacker cum reclaimer.

Stockyard: Coal / Iron Ore would be transferred from the train unloading stations to the storage area for stockpiling via stacking conveyors. The combined stacker / reclaimers have a stacking and reclaiming capability. Coal / Iron Ore would be reclaimed from the storage area and conveyed to the wharf facilities and ship loaders, as required.

Evacuation: Out loading conveyors will discharge the Coal / Iron Ore into surge silo. Two surge silo bins will be installed near the berth facilities to allow coal conveyed from the coal storage area to be temporarily stored during hatch changes when loading ships. Further Coal / Iron Ore will be transferred on Jetty conveyor from the surge silo via conveyor. When vessel is not on the berth, stockpile area can be used for the storage of Coal / Iron Ore simultaneously. Tunnel Conveyor can discharge the Coal / Iron Ore on receiving conveyor which will transfer the Coal / Iron Ore on yard conveyor. For cargo reclaiming from stockyard, yard conveyor will reclaim the Coal / Iron Ore on dispatch conveyor which will discharge the Coal / Iron Ore in surge silo. From the surge silo it will discharge on berth conveyor. Berth conveyor will feed the ship loader through which Coal / Iron Ore will be exported in to vessels.

2.8.13.3 Multipurpose Cargo – Import/Export

The storage area is designed to handle all type of multi-purpose cargo such as fertilizer, FRM, steel other bulk cargo, etc. The choice of yard system is determined by the volume of material to be handled and its stacking heights, and the space available for storage.

Operation Modes in Yard: The internal transportation of cargo will be carried out using heavy-duty fork-lift, trucks and other smaller lifting plants, as per requirements. These will operate to and from railcars and trucks and the identified temporary storage / lifting area of the storage yard.

2.8.13.4 Container

The yard area has been worked out considering 7 wide container stacks with 1 truck lane. The RTG arrangement has been done back to back position with additional high-mast space after every 4 RTG modules. Each alternate module has been spaced for the truck passing lane for having flexibility of the container cargo movement in yard. The provision of reefer platforms has been also kept in the terminal.

2.8.14 Liquid Terminal: Storage and Handling

The Liquid Terminal for proposed master plan will be developed in line with business requirement of liquid cargo. Tanks would be used to store PoL, Crude oil, classified and non-classified hydrocarbons, edible and non-edible oils, and other specialty commodities like CBFS, Bitumen and other hazardous and non- hazardous chemicals etc. Storage of cargo in the CRZ area will be as per the CRZ Notification 2011 (as amended). Other facilities such as Pump House, Manifolds, TLF, TULF, Utility Blocks, Substation, Control Room, pavement, drainage, lighting and formation level, OWS, ETP is taken into account while designing the terminal. Necessary arrangements / accessories as per the standards would be provided at the storage tank for the safe containment of the products.

The pipelines connecting from jetty to storage tanks will be provided based on type of product and location within the project area. However, the exact alignment will be finalised during the detailed engineering. A cross- country pipe line for transportation of liquid will be provided as and when required.

2.8.14.1 General Layout

General layout of the Liquid terminal provides following facility.

- Storage Tank Facility
- Pump House
- Truck Loading & Unloading Facilities
- Access Road to Liquid Terminal

2.8.14.2 Operation Modes in Liquid Terminal

Import Operations: Vessel carriers will discharge their cargo, using the vessel's pumps, through the marine unloading arms or hoses of 16" diameter and 100 m length into the onshore pipeline system (Dock lines). The unloading arms or hoses are connected to the pipeline system through a pipeline manifold. Since the allocated space for the tank farm is close to the jetties, the cargo can be directly pumped to the tank farm without the need of booster pumps.

Export Operations: Road tankers will get unloaded at Tanker unloading facility (TULF) and fill Storage tanks in Liquid terminal with the help of unloading pumps at TULF. The Storage tanks contents will then be evacuated into vessel carriers via dock lines with the help of export pumps in the terminal.

Dock Line Cleaning: Pig launching/receiving station at both ends (Jetty and Tank farm) to be installed. Product will be imported in from various locations and discharged at terminal jetty to the storage tank; Product will be distributed in local market through truck loading facility at the enclosures. An empty tank truck will be pre-weighed on a weight bridge before proceeding to the TULF. The empty weight on the truck shall be entered into the tanker loading software. Further the required quantity to be filled into the tanker would be feed in from the control room. The field operator will check the alignment and line up prior to commencing of tank truck filling operation. The field operator or the control room will initiate the tanker filling operation as per pre-defined set-up. This need to be worked out in detailed engineering and incorporated in the design.

2.8.14.3 Tank Arrangement

- The type of the storage tank will be either fixed or floating type and capacity of the storage tank will be about 25000 KL.
- No dyke is required as full containment storage tank is proposed
- Tanks shall be arranged in maximum two rows so that each tank is approachable from the road surrounding the enclosure.
- The tank height shall not be exceeded one and half times the diameter of the tank or 20 m whichever is less. The minimum distance between a tank shell and the inside toe of the dyke wall shall not be less than half the height of the tank.

2.8.14.4 Metering

A metering facility shall be provided at the service platform for the following purposes.

- Continuous pressure recording of each pipeline, with alarm in case of surge pressures as a safety precaution
- Continuous temperature recording of each pipeline as a safety precaution
- Flow and density measurements

- The initial pressure in the pipeline will be in the range of 7-15 Kg/cm²g with a pressure drop of 1 Kg/cm²g and maximum liquid velocity of 3 m/s
- The average liquid temperature in the pipeline will be around 700C

2.8.14.5 Design Specification for Liquid Terminal

Design Criteria:

- Valve shall be selected for long lasting & leak proof service.
- Normal design conditions of temperature and pressure will be most severe conditions expected to co-exist under usual long term operation conditions. These usual conditions include all operation and control functions such as throttling, bypassing and blowing to be used for operation and control.
- Design Temperature is the most severe sustained fluid temperature. Design Temperature will be the maximum fluid operating temperature with safety margin (5 to 20%)

Applicable Codes and Standards

The design and construction shall be carried to ensure that the most stringent Indian or International Design Codes are applied. The design codes and standards, which shall be considered as minimum requirements. Latest version of there shall be followed.

Code	Description
ASME B 31.3	Chemical plant and Petroleum Refinery Piping
ASME B 31.4	Liquid transportation systems for Hydrocarbons, Liquid Petroleum Gas
ASME B 16.5	Steel pipe flanges and flanged fittings
ASME B 16.9	Factory Made Wrought Steel Butt Weld Fittings
ASME B 16.10	Face to Face & End to End Dimensions of Ferrous Valves
ASME B 16.11	Forged Steel Fittings Socket
ASME B 16.34	Steel Valves Flanged and Butt Welding Ends
ASME B 16.20	Ring Joint Gaskets and Grooved for Steel Pipes Flanges
ASME B 16.21	Non Metallic Flat Gaskets for Pipe Flanges
ASME B 16.25	Butt Welding Ends
ASME B 18.2	Square & Hex. Bolts and Screws
ASME B 36.10	Welded and Seamless Wrought Steel
ASME B 36.19	Stainless Steel Pipe
API 1102	Liquid Petroleum pipeline crossing rail, roads and Highways
API 650	Storage Tank design.
ASME Sec-VIII, Div 1	American Standard for Vessel Design
IS 803	Storage Tank Design (Indian STD)
OISD-STD-117	Fire Protection facilities for petroleum Depots and Terminals
OISD-STD-118	Layout for Oil and Gas installation.
OISD-STD-156	Fire Protection Facility for Ports Handling Hydrocarbons

2.8.14.6 Internal Road within Liquid Terminal

The main road approaching to the liquid terminal will have two lanes. The road network is planned so that it provides easy access for maintenance, fire-fighting, escape during emergency and dead end should be avoided. Single lane roads will have 4 m width, with minimum 0.5 m shoulder on each side. The width of double lane roads is 8 m. Intersections and corners shall be of sufficient width and radius to permit fire equipment, with a minimum turning radius of 15 m, to turn corners without reversing.

2.8.15 LNG Handling Storage and Regasification

2.8.15.1 LNG Scheme

LNG is stored in LNGC at cryogenic temperature of -162°C and pressure of around 0.13 barg (near to saturated condition). LNG is transferred through number of cargo pumps of LNGC to onshore Storage tanks using unloading arms and unloading lines.

LNG is unloaded from ship via Liquid unloading arms and Vapour is transferred to ship storage (to maintain pressure) via vapour return arm. These arms are equipped with flexible coupling which engages/disengages quickly as per requirement. These couplings are normally known as “Powered Emergency Released Coupling” (PERC) and have double block valve. These coupling disengage automatically upon detection in abnormal ship movement or activation of emergency shutdown system (ESD).

During no ship unloading (or Holding mode), arms are isolated, drained and purged with nitrogen. LNG in the arms (during holding mode) is drained to the Jetty drain drum. From unloading arms, LNG is transferred to onshore LNG tanks through two unloading lines (36” size each). In order to maintain the LNG unloading lines at cryogenic temperature when unloading operation is not taking place (i.e. in holding mode of Plant); LNG from the onshore storage In-tank pump discharge is circulated between the unloading lines. During circulation one line takes LNG from tanks to the jetty while the other returns it back to the unit. A minimal amount of LNG is send to the tank inlet lines (from In-Tank pump discharge) to maintain receiving lines cold during holding mode.

During ship tanker unloading, the LNG stream is sampled and analysed using the dedicated sampling Unit. The density of LNG in the tanker relative to that stored in the Tanks shall decide mode of filling (top/bottom) in the tanks. This implies that if the LNG is heavy, top filling shall be used and vice versa. This is to facilitate the mixing of LNG in the tanks to prevent the stratification in the tanks that can cause “Roll over phenomenon” thereby generating large amount of BOG.

A small LNG flow is always maintained to LNG tanks through LNG filling risers to keep the lines cold. The bypass valves of tank top/bottom filling valves are always kept open for this purpose.

2.8.15.2 Marine Side Facilities

The following marine side facilities shall be provided:

- LNG jetty berth (including but not limited to breasting dolphins, mooring dolphins, fenders and catwalks)
- LNG jetty head
- LNG jetty trestle accommodating pipe rack and access road to the jetty head
- The mooring hooks and mooring monitoring system
- Ship berthing system
- The monitoring of met ocean data needed to be available for the ship
- Any measures to secure the piling of the jetty head, trestle and flare trestle as cathode protection of piles, etc.

The jetty shall be designed to accommodate LNG carriers in the size range of $20,000\text{ m}^3$ to $265,000\text{ m}^3$. To accomplish this, the LNG berth will include breasting and mooring dolphins, fender systems, mooring hooks, mooring line tension monitoring system and a LNG carrier docking assistance system.

The LNG berth is to provide a platform to support the mechanical equipment required for unloading LNG carriers. The LNG trestle shall provide structural support from the terminal to the LNG unloading platform for the LNG unloading piping, auxiliary mechanical and utilities, control and electrical systems, and access roadway.

2.8.15.3 LNG Handling

The principal components of the ship-to-shore LNG transfer system are the ship's pumps, the marine unloading arms, pipeline manifolds and connected cryogenic pipelines to handle LNG in liquid form at particular temperature.

2.8.15.3.1 Marine Unloading/Loading Arms

Marine unloading / loading arms would be provided on the central unloading platform. Each such unloading arm has a sufficient capacity of pumping along with one vapour return arm. The unloading arms are moved with a remote controlled hydraulic system located on the berth. After connection is completed, the communication cable is connected to shore and the emergency shutdown system is tested. After the unloading arms are cooled, the LNG will be transferred from the carrier to the storage tanks using the carrier's pumps.

2.8.15.3.2 Pipelines

It is proposed to provide required numbers and sufficient diameter of pipelines for transfer of LNG from berth to tank farm area. To allow for expansion of these cryogenic pipelines, loops shall be provided at every regular interval along the length of the pipelines.

The pipelines connecting from jetty to storage tanks will be provided based on type of product and location within the project area. However, the exact alignment will be finalised during the detailed engineering. A cross- country pipe line for transportation of LNG will be provided as and when required.

2.8.15.4 Tankages

The LNG will be stored near atmospheric pressure and in full-containment LNG tanks that typically consist of the following facilities.

Part or type	Definition
Inner tank (or primary container)	A flat bottomed, self-supporting, vertical metallic 9% Ni steel cylinder with a suspended deck. During normal and accidental conditions, the inner tank is designed so as to retain the full liquid content. In the present note the inner tank (by opposition to "outer tank") is sometimes used as a global term for the whole of the inner tank, the cryogenic system, the suspended deck, internals and inner accessories outer tank (or secondary container).
Outer Tank (or Secondary Container)	A flat bottomed, vertical cylinder designed to content liquid from the inner tank in the event of leak or accidental event. A self-supporting reinforced/prestressed concrete tank equipped with a reinforced concrete dome and designed to achieve the following functional objectives : • In normal tank service, to provide the primary vapour containment of the tank, to retain the thermal insulation of the primary container and to prevent moisture ingress that may lead to the degradation of the insulation system • In case of leakage of the primary container, to contain all liquid product and to remain structurally vapour tight. Venting release is acceptable but shall be controlled. • Some other functions have to be provided, for defined accidental cases: • Resistance against a flying objects impact • Resistance against fire • Resistance against blast • Containment of liquid during an OBE

Part or type	Definition
Full Containment Tank	A container in which the inner container is surrounded by a secondary container designed to contain LNG in the event of a spill from the inner container and where the secondary container is enclosed by a concrete roof designed such that excess vapour caused by a spill of LNG from the primary container will discharge through the relief valves (or the definition given by the BS 7777 [superseded since 2006]: "A double tank designed and constructed so that both the inner tank and the outer tank are capable of independently containing the refrigerated liquid stored. The outer tank is intended to be capable of both containing the refrigerated liquid and controlled venting of the vapour resulting from product leakage after a credible event"). The inner tank contains the liquid under normal operating conditions. The outer dome is supported by the outer tank. The outer tank is intended to be capable of both containing the refrigerated liquid and controlled venting of the vapour resulting from product leakage after a credible event.

The LNG shall be contained in the tanks at its cryogenic temperature of approximately -162 °C near atmospheric pressure. Two full containment concrete roof LNG storage tanks shall be built for initial phase and another one tank in future in the next phase. The working capacity of each tank shall be 180000 m³.

The LNG storage tanks shall have a design pressure of 290m barg and a maximum boil-off rate of 0.05% per day of gross tank contents. All pipe works connections to the tank, including those for filling and emptying, shall be made through the tank roof.

The LNG storage tanks shall be equipped with density monitoring to indicate stratification and potential rollover problems and allow early operator action. The tanks shall be designed to be top or bottom loaded from a LNG carrier to avoid stratification. The bottom loading shall be accomplished using a standpipe inside the tank. The top loading shall be carried out using separate piping connections in the top of the tank. In addition, facilities shall be provided to circulate and mix the stored product in the event of stratification occurring. This shall be undertaken by pumping LNG from the bottom of the tank and reintroducing the LNG to the tank using either the top or bottom fill lines.

Temperature instruments shall be furnished in the wall and floor of the LNG storage tank to monitor the temperature profile. Automatic continuous tank level gauging, temperature monitoring, and density measurement shall be provided.

2.8.15.5 Boil off Gas Handling System

Excess vapour generated during LNG unloading into the LNG storage tanks and boil-off gas generated in normal operation are compressed by the boil-off compressors and condensed in sub-cooled LNG delivered by the low pressure LNG pumps in a vessel so-called BOG recondenser.

The BOG recondenser has two sections:

- The upper section is a packed tower for mixing gas and LNG resulting in the gas to be condensed.
- The lower section is as buffer vessel for feeding LNG to the high pressure LNG pumps with a net positive suction head (NPSH) above the minimum value required by the HP pump manufacturer.
- The LNG required for condensing the vapour is delivered into the upper section of the BOG recondenser while the balanced LNG send-out is flowing directly to the lower section of the BOG recondenser; the LNG coming out from the BOG recondenser is so sub-cooled and provides a medium suitable for being pumped by the high pressure LNG pumps (a safety margin of minimum 2°C below the saturation temperature of the BOG recondenser out-coming LNG shall be considered).

The BOG recondenser shall be designed on the following basis:

- Condensation of the BOG generated by three LNG storage tanks.
- Condensation of the BOG generated during a LNGC unloading process at the design rate of 15 000 m³/h.
- A provision of 3 000 m³ (n)/h additional boil-off gas to take into account the truck loading facilities.
- Floating pressure 1 barg - 4 barg.
- Hold-up of the lower section designed for 1 minute based on 12 MMTPA send-out.
- The BOG recondenser shall be protected by two pressure safety valves (2 X 100%) for on-line maintenance.
- Piping shall be arranged around the BOG recondenser for maintenance only (cold LNG circulation to HP pumps suction header).

2.8.15.6 Regasification Unit

Shell and Tube Vaporiser

High pressure LNG from LNG HP Pumps is vaporized in these shell & tube vaporizers (STV). The shell and tube vaporizers (STV) are made up of tubes assembly installed in a shell casing in which the glycol water will circulate. These STVs are specially designed heat exchanger for LNG service. 4 W + 1S configuration of STV (each of duty 38 MW) is envisaged for Dhamra LNG Plant.

Below Table shows plant send out capacity with variation in ambient temperature and number of STV in operation:

Ambient Temperature	Plant Capacity	STV	SCV
>21°C	120% (685.2 tons/hr)	4 Nos (1 Standby)	No SCV operation
13°C-21°C	102.8% (587 tons/hr)	5 Nos	No SCV operation
10°C-13°C	100% (571 tons/hr)	5 Nos (402 Tons/hr from STV)	One SCV (169 tons/Hr)

The vaporizers operating pressure is floating with the delivery gas pipeline network, which could vary between 50 to 90 barg.

The flow instrument in the downstream NG line, with pressure temperature compensation measures the flow rate through Shell & Tube Vaporizer, and controls it by manipulating LNG inlet flow control valve.

The heating medium for the vaporizer is 36% Glycol-Water mixture. The selection of heating medium is important to eliminate the chance of freezing of the medium, thereby affecting the performance of the vaporizer.

Process Control

Low temperature overrides on NG outlet side set at 0°C and on the glycol water side are provided for LNG inlet flow control valve. These temperature controllers provide low temperature override to LNG Flow controller, which controls the flow of LNG to STV. The ultimate protection against low temperature of NG outlet and hence against the freezing of glycol water mixture is provided by Low Low Temperature trip (set at -5°C) on NG outlet side, which will close LNG inlet shutoff valve. As mentioned earlier the operating pressure of the vaporizers on NG side is floating with the delivery gas pipeline network. High pressure override is provided by pressure controller on the downstream of Gas Metering Station, which will reduce the LNG flow in case of high pipeline pressure. The primary protection against high pressure is provided by High High Pressure trip set at 91 barg (hold) upstream of Gas Metering Station, which will shut off the gas send out by stopping all LNG HP Pumps

and closing all STV LNG inlet shut off valves Pressure Safety Valve for STV is set at 130 barg (hold), which is designed for relieving 110% of the rated throughout of the vaporizer, provides the ultimate protection against over pressure. The low-low pressure of the gas send out line is detected by Low Low pressure alarm (set at 65 barg) on the downstream of Gas metering Station, which will give an alarm on the control room board. On glycol-water side, full flow is always maintained through the STVs. The energy optimisation is achieved by controlling the number of operating fans for the air heaters. Low Low glycol-water inlet flow to the top and the bottom of STV will close LNG inlet shut off valve of STV to prevent the possibility of freezing.

Tube rupture of STV, if it happens, is detected by High High Pressure trip (set at 8 barg: hold) on STV shell side and High High Temperature trip (set at -5°C) in the outlet line of glycol-water, which will trip STV by closing STV LNG inlet shut off valve.

Rupture Disk (set at 10 barg) is for ultimate safety of the shell side, during tube rupture case. After detecting tube rupture NG outlet valve of STV, inlet MOV and/or manual isolation valve) shall not be closed until LNG inventory in the STV is fully vaporized. If it is closed immediately on detection, it could cause higher pressure on the tube side.

Glycol Water:

Glycol water circulation shall be through glycol water pumps (1W+1S). No flow control is envisaged for Glycol water. Low-Low temperature trip on Glycol water line (outlet of STV) shall initiate interlock to prevent GW freezing temperature.

Submerged Combustion Vaporiser

A Back-up LNG Vaporizer (Submerged Combustion Vaporizer) will be used as back up capacity to allow maintenance and to meet gas market peak requirements. The Back-up LNG vaporiser may also be used during period of exceptionally low ambient air temperature to meet the Send-out requirement. Back-up LNG Vaporizer is a fired water bath heater using Fuel Gas. The Back-up LNG vaporiser first water fill will be supplied from the fresh water system or by a road tanker if the fresh water quality is not suitable. But once in operation, the combustion water generated by the combustion of the fuel gas will make-up for any water loss and blowdown. Excess water will then be disposed to the waste water treatment. Since flue gas is in contact with the water bath, the water pH will decrease continuously. To keep the pH within acceptable limit, chemical have to be dosed regularly in the water bath, according to the Back-up LNG vaporiser vendor recommendation. LNG flow control scheme of SCV shall be similar to STV. Detail control scheme of SCV fuel gas and flue gas temperature to be developed in detailed engineering based on vendor input.

However, Selection of regasification unit will be carried out during detailed design stage. Use of Open Rack vaporiser (ORV) may also be explored.

2.8.15.7 LNG Metering System

The metering station, equipped with custody transfer meters, shall be implemented with several metering lines in parallel including, each one, one ultra-sonic type flow meter.

2.8.15.8 Flare and Blowdown System

The LNG storage and re-gasification does not involve combustion of any anthropogenic fuel. Thus, the ambient air quality is not likely to be affected due to the proposed project. The system shall include elevated flare and pilot burner. The flare design shall consider the heat

radiation to surrounding personnel and equipment so that safe distances are maintained. Emissions during LNG flaring are not expected to be significant. CO₂ in small quantities will be released to atmosphere during flaring; however, their contribution to ground level concentrations (GLCs) will be insignificant. Possibility of LNG coming out as fugitive emission is ruled out due to robust system design.

2.8.15.9 LNG Draining Facilities

In areas where LNG spill could occur, effluent shall be released by a network of open trenches into an impounding basin. In storage tank and process areas, buried pipes shall not be used in order to avoid hazard arising from gas confinement or gas spreading into an underground network.

2.8.15.10 Safety Systems

The regulatory framework identifies the regulatory requirements that are applicable for the project.

The expression « regulatory framework » encloses:

- The statutory i.e. legal requirements
- LNG project rules
- Industry codes and standards
- 3rd party rules (i.e. investment bank, assurance company etc.)
- Good practices to be applied

This framework is represented in a table in which the most relevant requirements are listed and is intended to provide a guide to the project phases to which each regulation may apply.

The table is meant to identify in a first step, the applicable regulatory requirements governing safety and is not exhaustive. During each step of the project the applicable list shall have to be further developed in parallel with the stepwise project development since as each new stage is reached the regulatory issues become more specific and are more and more detailed.

Regulatory Framework:
The following LEGISLATION, RULES, CODES AND STANDARDS are mandatory requirement during project phase; • NFPA 59A "Standard for the Production, Storage and Handling of Liquefied Natural Gas (LNG)" and all its annexes. • OHSAS 18001 - Occupational Health and Safety specification • Safety philosophy The following documents shall be followed; • ISO 9000 - quality management systems (including safety aspects)

2.8.15.11 LNG Spillage, Gas Leakage, Flame and Smoke Detection

These detection systems are intended to rapidly and reliably detect any LNG spillage or flammable gas leakage and any fire condition in the Terminal.

Continuously operating detection systems are installed at every location, outdoors and indoors, where leaks are credible. Flashing lights and loudspeakers are distributed on the field to warn the people on site of any abnormal situation.

The arrangement of detectors is such as to always provide redundancy and to prevent false and deceptive alarms. Voting technique and cross-zone arrangement is used where justified.

The detections system shall comply with NFPA 72 requirements.

The following detection devices are provided:

- LNG spillage detection LNG spills are detected by low temperature sensors (RTD's) which are protected against accidental damage.
- Flammable gas detection

The flammable gas detectors are of the infra-red type. Along critical fences, open path type gas detectors shall be installed.

Fire Detection:

Flame Detection:

The flame detectors are of the ultraviolet/infrared (UV/IR) type.

Heat Detection:

High temperature detectors are provided for protection of tank relief valves fires and activation of tailpipe extinguishing packages. The heat detectors are of high temperature thermistor strip type or of temperature-sensitive pneumatic type.

Smoke Detection:

Smoke detectors are of the double ionisation chamber type and are used in building technical rooms.

Manual Call Points:

The manual call points shall be of the break-glass type. They shall be provided in the plant areas covered by flame and/or combustible gas detectors and located along escape routes from these areas.

The three types of fire detectors shall be considered such as Optical fires detectors, smoke detectors and heat detectors. The Optical fires detectors consist of Infrared Fire detectors, UV Fire detectors, UV/IR Fire detectors, Triple IR Fire detectors and CCTV Flame detectors. The smoke detectors consist of Optical smoke detectors, Ionization-type smoke detectors and High sensitivity smoke detectors. The heat detectors shall be of the kind Fusible link detectors.

Loss of Containment Detection:

- Hydrocarbons gas detection
- Hydrogen gas detection
- Low temperature spill detection

The flammable gas detectors can be of different types such as Point Flammable Gas Detectors, Open path gas detectors, Ultrasonic Gas Detectors etc.

The Fire and Gas system shall alert operations personnel of a fire and/ or gas release situation. It shall include as a minimum:

- Early detection of flammable gases
- Early detection of fire
- Initiation of audible and visual alarms to warn of fire and gas hazards
- Initiation of the relevant automatic actions (extinguishing agent discharge where appropriate, closure of isolation dampers)
- Initiation of alarms at the CCR and display points geographically on the Fire and Gas system via custom graphics displays
- Initiation of emergency shutdown by automatic or manual operation.

LNG Spill Detectors:

Areas where cryogenic liquid spills can collect shall be equipped with spill point detectors at the outlet of the spill channel e.g. at the re-condenser and at the send-out pumps.

2.8.15.12 Truck Loading Facility

- A LNG truck loading station shall be implemented consisting of 1 truck loading bays having common weighbridge
- Each loading bay shall be designed to export 50m³/h LNG

2.8.15.13 NG compressor for conversion to CNG

Reciprocating compressor with minimum 3 stages giving discharge pressure of 255 Kg/cm²g with suction pressure of 19 kg/cm²g. Suction pressure may vary and regulator to limit the suction pressure to 26 kg/cm²g. The gas temperature after cooler shall not exceed 52⁰ C considering maximum ambient temperature of 45⁰ C for design. The compressors size shall be for Type A/Type B guaranteed flow with no negative tolerance for gas composition with suction pressure of 19 kg/cm²g, suction temperature of 35⁰C and discharge pressure of 255 kg/cm² g.

The priority fill system shall ensure the filling of vehicle, high bank of cascade, medium bank of cascade and low bank of cascade in correct order. The priority fill panel shall be designed to ensure filling of vehicle, storage cascade in correct order. Design of priority fill system shall be selected to achieve maximum flow rate through combined flow from compressor and 3 banks cascade (3000 water litres for Type A & 2025 water litres for Type B compressor) arrangement.

2.8.15.14 Floating Storage and Regasification Unit (FSRU)

DPCL has an approval to handle LNG of about 12 MMTA as per Phase II Environmental/CRZ Clearance and the details of LNG Onshore Terminal including Handling, Storage and Regasification were also given in PFR, ToR and Draft CEIA reports of revised master plan. However, during further review of the LNG Terminal Technical aspects and development Plan, it has been understood that, Dhamra LNG onshore terminal shall take few years and there is a need for a interim solution to serve the country by alleviating the immediate energy needs. For this purpose FSRU is planned with a maximum capacity of 2.5 MTPA (interim arrangement) as a part of Revised Master Plan. The same was presented during Public Consultation and also can be seen in the public hearing proceedings. This important interim requirement of handling LNG through FSRU is presented in this Final CEIA report for EAC, MoEF&CC kind consideration.

It is pertinent to mention that the impacts and Risks scenarios related to FSRU is much lesser than the impact and Risk predicted for Onshore LNG terminal (as the maximum inventory considered in Risk Assessment will not exceed 1,80,000 m³) and hence the measures considered for Onshore Terminal will holds good for FSRU.

The technical details of the FSRU are given below:

- Size of the vessel – Maximum LOA is 345 m
- Storage size – 1,25,000 m³ to 2,16,000 m³ (Average 1,70,000 m³)
- LNG Containment System – Moss or membrane
- Regasification method – Open Loop (using Seawater)
- Send out rate – 2 MTPA (nominal) with peak of 2.5 MTPA
- NG pipeline – 30 inch pipeline from metering station connecting to gas grid

- No buffer tank
- Boil off gas handling – BOG compressor
- NG Distribution Network – NG pipeline (dedicated pipelines) or Jagdishpur Haldia pipeline by GAIL.

The FSRU receives LNG feedstock from LNG Carriers (LNGCs), which unload the LNG feed stock via hose transfer. The unloading takes place with the LNG Carrier moored to the FSRU in a side by side configuration. The LNG imported is stored in the four on-board storage tanks within the FSRU. The feedstock is regasified on the FSRU and exported as high pressure gas to onshore facilities via HP gas unloading arm on LNG Berth.

The FSRU will be a self-contained unit with its own on-board crew of 27-30 persons. The FSRU will generate its own potable water through equipment installed on-board and shall have captive power generation facility. The LNG shall be unloaded through flexible hoses. The FSRU will have on-deck regasification facility. Sendout of high pressure NG to the jetty deck will be by DCMA type arms placed on the unloading platform of the LNG jetty. The FSRU and the Jetty will follow all applicable Indian and international design and operations codes and industry specific guidelines (e.g. IS/BIS, OISD, NFPA, SIGTTO, OCIMF, etc.) applicable to the LNG industry fitting and commensurate to LNG industry.

2.8.16 LPG Handling

The principal components of the ship-to-shore LPG transfer system are the ship pumps, the marine loading/unloading arms, pipeline manifolds and connected pipelines to handle butane, Propene and LPG.

2.8.16.1 Plant Throughput

LPG terminal will be operation in stage wise manner i.e. Stage 1A and Stage 1B. During Stage 1A LPG terminal shall be designed to send LPG/Butane/Propane via cross country pipeline and tanker loading facility with dispatch capacity of 440 MT/hr and during Stage 1B overall dispatch capacity will be 776 MT/hr.

2.8.16.2 Marine Unloading/Loading Arms

Marine unloading/loading arms would be provided on the central unloading platform. The loading / unloading arms are moved with a remote-controlled hydraulic system located on the berth. After connection is completed, the communication cable is connected to shore and the emergency shutdown system is tested.

2.8.16.3 Pipelines

It is proposed to provide required numbers and sufficient diameter of pipelines for transfer of LPG from berth to tank farm area. To allow for expansion of these pipelines, loops will be provided at every regular interval along the length of the pipelines. The pipelines shall also be insulated with adequate material to limit heat ingress through outside environment. However, the exact alignment will be finalised during the detailed engineering. A cross-country pipe line for transportation of LPG will be provided as and when required.

2.8.16.4 Storage Tanks for Propane/Butane

Storage tank is vertical flat bottom, double wall, full containment refrigerated storage tank, which is designed to store Propane/Butane/Propylene from jetty. The function of these tanks

is to store Propane/Butane/Propylene. Both these tanks are identical in all respect and Propane/Butane/Propylene can be stored in any of these tanks. The pumping capacity of each tank is 25000 MT.

Propane/Butane/Propylene is pumped by ship pump through marine unloading arm to storage tanks through two marine unloading arm at the rate of 600 MT/hr each.

The tank operating pressure is 700 mm WC (Holding mode) to 1200 mm WC (Unloading mode). Corresponding tank material temperature at this holding pressure of 700 mm WC are approximately -44.4°C in case of propane, -4.4°C in case of Butane and -46.4°C in case of Propylene.

The expected temperature of cargo ship inventory during unloading operation are -42.7°C in case of propane, -2.9°C in case of Butane and -44.9°C in case of Propylene. The temperature of cargo shall vary a little based on the composition/level of impurity. LPG is pumped to truck loading stations and cross country pipeline by pumping propane & butane by Propane/Butane Transfer Pumps followed by heating & then blending.

2.8.16.5 Transfer Pumps

There are submersible centrifugal pumps situated in the tank. These pumps are provided for following functions:

- Transfer of propane/butane for heating and then to blending plant for production of LPG for tanker loading.
- Pre-cooling of unloading lines prior to ship unloading.

Each tank is provided with automatic flow control valve meant for minimum flow return and designated flow return to facilitate production of LPG of different ratio of Propane & Butane. During phase 1A total three pumps will be installed with provision to install one more pump, which shall be installed during phase 1B.

2.8.16.6 Propane/Butane Heating Train

Propane and Butane/Propylene are heated in separate heating trains to 15°C in two steps. Preheating of refrigerated propane liquid at -44.4°C is performed in Propane Heater - I and preheating of refrigerated Butane at -4.4°C is done in Butane Heater - I by condensing hot propane vapors at 37°C to avoid freezing problems by direct heating with steam. The propane used for heating Propane and Butane/Propylene is vaporized in a kettle type Propane Vaporizer-I and Propane Vaporizer-II by condensing steam. The steam condensate is used to heat the Propane and Butane/Propylene to 15°C in Propane Heater - II and Butane Heater - II respectively.

2.8.16.6.1 LP Steam Heating

In the vaporizers, the liquid propane is vaporized at a pressure of 12.5 Kg/cm²G with L.P. steam at 3.5 Kg/cm²G. The condensate coming from the shell side of Propane Heater-II and Butane Heater -II are collected in steam condensate receiver. This condensate will be transferred to condensate polishing unit through steam condensate pumps.

2.8.16.6.2 Steam Blender and Blending Control

Butane is mixed with Mercaptan in Static Blender. Propane, Butane and Mercaptan are mixed in Static Blenders at a certain ratio in order to make LPG as per IS-4576, which

depends upon the composition of commercial propane and Butane stored in the storage tank. Provision is made to mix Propane and Butane from bullets.

Blending ratio depends on the composition of commercial propane & commercial butane stored in tanks and also composition of condensate from bullets Propane Heater-II and Butane Heater – I.

Online blending control system is provided to make LPG as per IS specifications. The vapor pressure of the mixture is supervised by continuous measurement at the downstream of static blender with the help of two online vapor pressure analyzer's.

Ethyl Mercaptan is injected for the odorization of liquid LPG/ Butane/Propane. The blended LPG is filled into the road tankers via loading arms. The ratio of blending streams is determined by processor & controlled by flow measurement and regulation on the propane & butane streams.

If the vapor pressure of the mixture exceeds the desired value, the flow ratio of Propane & Butane is corrected by the blending control system and the off specification product is returned back to Propane/Butane bullets.

2.8.16.7 Road Tanker Loading

The blended LPG as per the IS specification (IS-4576/IS-14861) is filled into road tankers via loading arms. There are two road tankers filling gantries, each gantry with 8 Nos. loading points. Bay allocation can be changed for simultaneous tanker loading of domestic LPG, Automotive LPG, Propane and Butane.

Facility for sick tanker unloading is provided at one bay in each gantry. Propane sick tanker will be unloaded in Propane bullet and Butane & LPG sick tankers will be unloaded in Butane bullet. In future during propylene send out case propylene will be routed via Domestic LPG path for tanker loading facility.

Sick tanker unloading is done by unloading pumps situated near TLF. The vapors of road tanker are either recovered by connecting the suction of BOG compressors or are evacuated to the flare header.

2.8.16.8 LPG Booster Pump

LPG booster pump is provided to pump domestic/Automotive LPG by cross country pipeline at maximum flow rate of 440 MT/hr.

2.8.16.9 Flash Compressor

These compressors are used to compress the vapors generated in the storage tank during ship unloading and during the precooling operation. Propane storage tanks are provided with compressor and Butane storage tanks are provided with compressor.

These are oil flooded screw type compressors. Each one is having two stages. For propane/propylene service both stages will be operating in series and for butane service, only first stage will be in operation. Start stop of these compressors depends on the tank pressures. From each tank the compressor suction line is running up to a suction separator.

Suction separators are provided for both Flash and BOG compressors.

2.8.16.10 Condensers and Receiver for Flash Compressors

Compressed vapors from both flash compressors are further condensed into Propane/Butane Flash condensers and then stored into Propane/Butane Flash Condensate Receivers. Propane/Butane from Propane/Butane Flash Condensate Receivers are pumped to Propane/Butane bullets by Propane/Butane Flash Condensate Pumps.

2.8.16.11 Boil-off Compressor

The normal boil-off vapors from the storage tanks are compressed separately through boil-off compressors. Propane & commercial butane storage tanks are provided with compressors.

Boil-off compressors are oil flooded screw type of compressors. Each one is having two stages. For propane service, both the stages of the compressors are in service.

For butane service first stage is in operation. Start-stop of these compressors depend on the tank pressures.

2.8.16.12 Condensers and Receivers for Boil-off Compressors

Compressed vapors from both boil-off compressors are further condensed into Propane /Butane BOG condenser and then stored into two separate receivers Propane/Butane BOG Condensate receiver.

Propane/Butane condensate from BOG Condensate receivers are pumped to bullets by Propane/Butane BOG condensate pumps and also it is routed to the Boiler to be used as boiler fuel.

2.8.16.13 Propane/Butane Bullets

Propane/ Butane Bullets are mounded bullets. Propane/Butane condensates received in BOG Condensate receivers and Flash Condensate receivers is transferred to Propane/Butane Bullets through BOG Condensate pumps and Flash condensate pumps.

Propane/Butane mounded bullets are emptied by Propane/Butane Bullet pumps discharging to the blending system. During zero send out Propane/ Butane condensate can be fed to Propane/Butane Storage tank-I and II.

2.8.16.14 Precooling Operation

The pre-cooling operation is one of the requirements prior to the ship unloading operation.

During precooling operation, cold Propane/Butane from the Storage Tank I & II is pumped into one of the unloading line going to the Jetty Area, from where it flows towards the Propane/Butane Storage Area and returns into the tank through the other unloading line. The flash gas generated during this operation will be catered by flash compressor.

For precooling during propylene/propane unloading scenario two additional lines shall be installed (in future) from storage tank till jetty to avoid any contamination of propylene and propane inventory.

2.8.16.15 Emptying Unloading Line

For emptying unloading line the contents in the unloading line will be transferred to the Storage Tank. After ship unloading operation is complete, field Operators should open all

isolation valves on the recently operated unloading lines. Hand-control valve on the recently operated unloading lines is to be kept 5 to 10% open for at least one or two days until temperature in the recently operated unloading lines rises. During this period, a portion of the hold-up liquid will get transferred to tank due to expansion.

DCS Operator shall close hand-control valve using hand controller. Field Operator shall open all isolation valves including ON/OFF valves.

Hot vapors from the Flash compressor discharge are introduced subsequently in unloading line by opening isolation valves. Hot vapors will enter line and push the liquid toward the jetty and then is pushed into the Storage Tank by other unloading line.

After the evacuation of liquid is completed, Field Operators shall close all ON/OFF valves in liquid evacuation loop and close Hand-control valve using hand controller.

During this period, DCS operator has to closely monitor the rise in tank pressure and carry out loading, unloading of the compressor based on tank pressure whenever required.

2.8.16.16 Sick Tanker Unloading

During filling of tanker if any tanker becomes sick the following procedure is to be followed to evacuate the tanker.

Butane/LPG Sick Tanker Unloading:

Field operator will ensure that Sick tanker is connected properly to Butane bullet through Vapor balancing line. Field operator will ensure that Sick tanker bottom is connected to pump which will transfer the liquid butane/LPG to Butane Bullet.

Sick tanker unloading is done by unloading pumps located near TLF. After sick tanker unloading is complete, close isolation valve on vapor line. The remaining vapors of road tanker are either recovered by connecting to the suction of BOG compressors or vented to the flare header. Remove coupling from sick tanker top. Drain the liquid propane/butane from sick tanker bottom to flare header.

Pure Propane and Propylene Sick Tanker Unloading:

Field operator will ensure that Sick tanker is connected properly to Propane/Propylene Bullet through Vapor balancing line. Since there is no pressure difference available in sick tanker and Bullet, Pump is required to transfer Sick Tanker Liquid to Propane/Propylene bullet.

Field operator will ensure that Sick tanker bottom is connected to pump which will transfer the liquid butane/LPG to Butane Bullet.

Sick tanker unloading is done by unloading pumps located near TLF. After sick tanker Unloading is complete, close isolation valve on vapor line. The remaining vapors of road Tanker are either recovered by connecting to the suction of BOG compressors or vented to the flare header. Remove coupling from sick tanker top. Drain the liquid propane/butane from sick tanker bottom to flare header. EPC contractor shall further develop the procedure for unloading of sick tanker based on Configuration of gantry and tanker.

2.8.16.17 LPG Barge (Pressurized) Loading for Export

The Barge size is expected to handle LPG will range from 1800 to 5000MT. The pressurized LPG loading rate will be about 220t/hr. LPG product will be diverted to ship loading line in-lieu of TLF. The process and the jetty system shall be designed to handle the pressurized LPG export system safely. The process conditions considered for the barge are (i) Operating

Pressure - 6 to 13 kg/cm²g (ii) Operating Temperature - 15 to 45deg C (iii) Design Pressure - 18 kg/cm²g (iv) PSV Set Pressure - 17.6 kg/cm²g. Also the terminal shall be designed to handle vapor from barge during emergency. The vapor from ship shall be routed to the terminal's flare system. The initial vapor load considered for designing the vapor line is 12t/hr.

2.8.16.18 Floating Storage and Offloading (FSO)

Similar to LNG, the details of LPG Onshore Terminal including Handling, Storage and Heating were given in PFR, ToR and Draft CEIA reports of revised master plan. However, during further review of the LPG Terminal Technical aspects and development Plan, it has been understood that, Dhamra LPG onshore terminal shall take few years and there is a need for a interim solution to serve the country by alleviating the immediate energy needs. For this purpose FSO is planned with a maximum storage capacity of the compartments of vessel not more than 25000 MT (interim arrangement) as a part of Revised Master Plan. This important interim requirement of handling LPG through FSO is presented in this Final CEIA report for EAC, MoEF&CC kind consideration.

It is pertinent to mention that most of the impacts and Risks scenarios predicted for Onshore LPG terminal will remain same or less compared to FSO and the measures suggested for Onshore LPG terminal will holds good for FSO.

The FSO is a permanently moored floating vessel for storage and offloading of LPG. It is permanently moored (stationed) for operation using a turret mooring system (tower like structure attached to the FSO. The FSO's mooring system will be installed at the forward end while the offloading platform will be installed at the rear end.

2.8.17 Dredging

Dredging quantity for the immediate phase, 5 year and 30 year development plan has been worked out and cumulative values are listed below.

- Immediate development Plan – 24.85 MCM (Already Approved)
- 5 Year development Plan – 110 MCM for (-) 19.0 m CD
- Revised Master Plan (30 year) – 140 MCM for (-) 19.0 m CD (Cumulative)
- Revised Master Plan (30 year) – 185 MCM for (-) 22.0 m CD (Cumulative)

As a preliminary estimate maintenance dredging requirement as per the master plan will be approximately 16 to 20 MCM/year. However, the same will depend upon type of the sediments and sea bed material.

2.8.18 Reclamation and Disposal

Approximately 110 MCM of the dredged material will be used for reclamation to the extent possible of proposed backup yard and level rising up to 5 to 7 m CD and remaining dredged material if any, will be disposed-off at the MoEF&CC approved disposal ground beyond (-) 20 m depth offshore.

During immediate development plan the most of the dredge material (from the approved dredging quantities) is being used for reclamation purpose by using ground improvement techniques and there by deep sea disposal is being avoided to the extent possible in order to minimise the impact on the environment.

2.8.18.1 Reclamation Philosophy

There are number of methods by which land reclamation can be carried out. The method of reclamation depends on following parameters.

- Availability and type of material for reclamation
- Availability of area for reclamation
- Availability and type of equipments
- Type and use of nearby area

Considering the above factors, the most suitable methodology of reclamation for the Dhamra Port is "Reclamation of land by dredged material".

Reclamation by this method is not only effective but also environment friendly. The method includes use of dredged material from the navigation area for development of land. Most of the soil material at Dhamra is clay. Hence, reclamation with this material can reduce the use of sand drastically and the same time most of dredged material can be utilised for reclamation. Use of sand for top 1 m will be required for easy access of the construction equipment. The option of utilizing identified offshore borrow area (which is identified as a part of Phase II Expansion) as a source will be explored to meet the sand requirement based on the feasibility studies.

To reclaim the area, protective bund will be prepared on the periphery of the area to be reclaimed. Different material can be used for preparation of the bund. The bund making material could be in form of good soil, rocks, sheet-piles, geo-bags, etc. Soil bund can be used in more protected intertidal area. The bund in deep water can be prepared considering geo-bags, rocks, sheet-piles or other suitable material. The bund is required to be constructed to avoid spreading of dredged material.

The dredged material will be pumped into the reclamation area enclosed by reclamation bunds wherein the dredged material will be allowed to settle and the supernatant water will be directed into sea through appropriate outfall pipelines. After completion of the reclamation, necessary development shall be carried out.

Once the area is reclaimed, levelling work on the ground will be carried out. The soil will remain exposed to the weather for few months so that excess water from the top layer of the soil is dried out. Further a thin compacted sand layer on the top will be laid off. The area will be further improved by suitable ground improvement method.

Further the sea face of the reclamation will be protected against wave and current by suitable shore protection method.

Additional material required for reclamation may be explored from nearby quarry sites, if need during the execution of the project for which necessary permission from local competent authority will be obtained. Ready mix concrete will be made out of the basic raw material on site itself. Batching plants of respective size and capacity as per requirement will be installed at the site. If required, temporary load out facilities with storage for transport of raw materials at suitable site, through barges will also be explored.

2.8.19 Operational Time

It is assumed that proposed master plan facilities will work round the clock, seven days a week. Allowing 15 days weather downtime, the effective number of working days will be 350 days/year, subject to limiting current and tide conditions.

2.8.20 Connectivity

Dhamra is connected by road with Bhadrak (85 km), the nearest major town on NH 5. Distance between Dhamra and Bhubaneswar is 220 km. The existing road connectivity from NH 5 to Dhamra is available at Jamujhadi, which is around 25 km from Bhadrak towards Balasore.

Dhamra port has already constructed a rail link of 62.5 Km with single line track, connecting the port with the Indian Railway network near Bhadrak railway station. The port has acquired 125 m wide land corridor from Dhamra to Bhadrak for providing exclusive connectivity with the hinterland. Approval has already been obtained for 4 lane road and 2 rail tracks (as a part of Phase I & II Clearance). As a part of Revised Master Plan, it is to develop further additional 2 lane road and 1 rail tracks in the existing corridor.

In addition, for easy evacuation of cargo, a new rail, road and utilities corridor (12 km x 125 m wide) is proposed from Northern side development of Dhamra Port. This corridor will connect Dhamra port with existing rail-road corridor near Bansada, Bhadrak. Number of lanes and tracks will be finalised during detailed engineering by using the entire available width.

2.8.21 Railway Works

Following facilities have been proposed in port bulb to handle the projected traffic of Dhamra Southern side of Port-

- Wagon Tippler – Additional 2 nos. with full rake length Pre & Post tippler line
- Track Hopper – 4 nos. with full rake length Pre & Post hopper line with each hopper
- Wagon Loading Silos – Additional 5 nos. with full rake length Pre & Post line with each silo
- Loading by Pay loader – Realignment of existing line for loading with pay loader
- Extension of existing bye-pass line
- One handling line for liquid cargo in tank wagons
- Fertilizer Godowns – 4 lines of full rake length with engine escape facility to serve FCC godowns
- Clinker loading silo - 1 silo with full rake length Pre & Post hopper line with engine escape facility combined with Fertilizer Cargo Complex (FCC).
- Container yard - 6 lines of full rake length with engine escape facility
- In-Motion weigh bridge - 3 additional In motion weigh bridges with associated FOIS building
- Locomotives – Additional 15 locomotives for shunting, placement & removal of rakes for loading & unloading inclusive stand by arrangement
- Locoshed - Augmentation of loco shed to cater to maintenance requirement of additional locomotives
- Sick wagon shed - For repair of unfit wagons
- Commercial Facilities – Suitable augmentation in existing facilities related to rail commercial
- To serve the above mentioned additional facilities in port bulb following additional facilities will be augmented in Dhamra Terminal yard for reception & dispatch of trains
- 6 additional lines at R&D yard with suitable augmentation in Signaling & OHE traction facilities
- Augmentation of Rail operation building
- Running Room - Suitable augmentation in existing crew & guard running room facilities

Following facilities has been proposed in port bulb to handle the projected traffic of Dhamra Northern side of Port-

- Wagon Tippler – 2 nos. with full rake length Pre & Post tippler line with each tippler
- Track Hopper – 2 nos. with full rake length Pre & Post hopper line with each hopper
- Wagon Loading Silos – 5 nos. with full rake length Pre & Post line with each silo
- One handling line for liquid cargo in tank wagons
- Fertilizer Godowns – 2 lines of full rake length with engine escape facility to serve FCC godowns
- Container yard - 6 lines of full rake length with engine escape facility
- In-Motion weigh bridge - 3 In motion weigh bridges with associated FOIS building
- Locomotives – 10 locomotives for shunting, placement & removal of rakes for loading & unloading inclusive stand by arrangement
- Commercial Facilities – Facilities related to rail commercial for FOIS & Railway commercial staff
- To serve the above mentioned additional facilities in northport a separate R&D yard with following facilities will be required for reception & dispatch of trains-
- 10 full rake length lines with suitable signalling and OHE facilities
- Rail operation building
- Running Room
- Store

2.8.22 Utilities and Services

2.8.22.1 Water Supply

Water supply planned for Phase – I will be extended to cater to proposed revised master plan development covering the following.

- Potable water for consumption of operating personnel
- Potable water for ships calling at the port
- Water for dust suppression system
- Water for fire fighting
- Water for greenbelt development

Water will be sourced from existing source for construction phase. 40 MLD capacity desalination plant will be constructed in modular basis to cater water requirements of operation phase of the revised master plan.

- Construction phase requirement for Revised Master Plan (5 Years and 30 Years): 1.95 MLD
- Operation phase requirement : Water required during operation phase of the Revised Master Plan of 5 years is 21.4 MLD and 30 years is 40 MLD respectively

2.8.22.1.1 Desalination Plant System

The various components of desalination plant are as follows:

Intake at Matai River

It is proposed to have Intake near Matai River, upgrading the existing intake system.

Proposed Pipelines

It is proposed to upgrade the existing pipelines and lay additional pipelines to accommodate the full capacity of plant to carry raw water. Treated water through MS pipeline from desalination plant to port and the reject water is disposed off at the same outfall location proposed for LNG/LPG Terminal using GRP pipelines.

Technological Consideration for Desalination Plant

Desalination Plant is proposed near the existing WTP. Treatment broadly would comprise following units:

Clarification + Oil & Dissolved gases removal + Depth Filtration + Fine Filtration + RO Membrane unit

Clarification

Various clarifier options are available such as Conventional Clarifiers, Solids re-circulation Clarifiers, Sludge Blanket Clarifiers, Dissolved Air Floatation, Lamella Clarifiers and Tube Settlers.

Lamella clarifiers and Tube Settlers require about half the foot print area of Conventional Clarifiers and Solids re-circulation Clarifiers. The power consumption of Lamella clarifiers and Tube Settlers is also less in comparison with Sludge Blanket Clarifiers and Dissolved Air Floatation units. However, tube settler clarifiers are selected over Lamella clarifiers for the desalination plant.

Oil & Dissolved gases removal

Chlorination, Aeration and Dual media filters options are available for Oil & gas removal. Dual Media filters are used commonly for this application in view of no power requirement and chlorine requirement. The same are proposed for Dhamra Desalination Plant.

Filtration

Pressure filters and Gravity filters are 2 commonly used methods of depth filtration. In case of Dhamra, Pressure Filters (DMF+PSF) are proposed to reduce the construction time, avoid re-pumping after filtration and in view of small capacity of the desalination plant.

Fine Filtration

The RO membranes require in feed water with Silt Density Index (SDI) < 3. Suspended solids of size above 5 micron are not allowed in RO system to avoid any damage to RO membrane/element. In order to remove the suspended solids of micron sizes in DMF, PSF and Micron Cartridge Filters are introduced before RO system as fine filtration.

The filtration and fine filtration units get combined in Ultra-Filtration membranes, however they are much higher in capital cost. Hence micron cartridge filtration (5 Micron size) is proposed for fine filtration. Following are the basic reasons of using Micron Cartridge Filter in RO System:

1. The ability of cartridge filters to remove suspended particulates, colloids and larger colour causing organics from the feed stream greatly impacts the performance and longevity of any RO equipment
2. Micron Cartridge Filter are designed to decrease SDI, Colour and turbidity which are the key factors that impacts on life of RO membrane.

3. In general, 5 to 10 micron bacteria in width or length for non-spherical species are found, hence the micron filter of 5 micron size will be able to remove most of the bacteria and cyst in water.

Reverse Osmosis Trains

There are several options available for treating water of fluctuating water TDS quality from 200 to max 25,000 mg/l.

Use of Brackish water RO membranes for treating water less than 10,000 mg/L and Sea water RO membranes for treating TDS higher than 10,000 mg/L. In this case separate set of pumps will be required. Eventually there will be 2 trains of BWRO and 2 trains of SWRO and cost of RO section of the plant will be substantially higher.

Recirculation of concentrated brine back to inlet to increase the salinity of the resultant feed to RO. However the operating cost will be higher in view of higher feed water TDS.

Presently SWRO membranes are available which work on varying TDS from 2000 to 45,000 mg/l. At Dhamra the scheme being proposed comprises varying the operating head of the RO system to match the TDS requirement. Hence common SWRO trains will be fed with 2 pumps in series, for pressures between 5 – 15 bar, the 1st High Pressure (HP) pump will become operational which will also be operated on variable speed and for pressures between 15 and 40 bar, the 2nd High Pressure pump shall be operated in series, this system will give higher recovery at lower TDS for the same pressure. The average operating pressure will be in the range 18-40 bar and hence the operating costs will also be much lower. Considering the overall advantages of lower capital & operating costs, this option of 2 SWRO trains with 2 High Pressure pumps in series operating at variable recovery is proposed for Dhamra Port.

Brackish Water train for Potable Water

SWRO trains will reduce the TDS in the range 250 – 1500 mg/L, however the water will be devoid of necessary minerals, hence it proposed to have 2 trains of BWRO only to cater to the requirement of potable water. The recovery shall be designed for 85%. Re-Mineralisation shall be provided for the product water so generated to make it suitable for potable use.

Outfall / Reject Disposal System

Reject from RO System (Brine) shall be conveyed to sea shore near jetty at the same outfall location proposed for LNG/LPG Terminal at a distance of approx 2 km from plant as TDS will be less than Sea water. Concentrated Brine which coming from RO, itself has pressure, so this pressurised brine can be transported to the disposal point through GRP Pipe of suitable diameter.

The entire treatment process is given below:

In the reverse osmosis process, SWRO would operate with dissolved solids of less than 1500 ppm. Water for potable purpose will pass into Brackish Water reverse osmosis (BWRO) membranes. BWRO Permeate water has only Na and Cl in the water and TDS is less than 50 ppm. This water cannot be consumed for potable purpose and requires remineralisation. So BWRO permeate will have to pass through re-mineralization process to add the ions in the BWRO permeate water which will add balance minerals up to acceptable limit of drinking water. In case Langelier Saturation Index (LSI) is negative, remineralization will be carried out to make LSI positive. The process flow diagram indicating the treatment stages is given in below.

Thus, the product water after blending with the pre-treated water has total dissolved solids of less than 1500 ppm from the SWRO plant and less than 500 ppm from the BWRO plant.

For the present study, blending of pre-treated water is being done. With the help of blending and use of degasser tower (reducing dissolved CO_2), the pH of water is being neutralized and also the chances of LSI being negative are less.

The desalinated BWRO water is corrosive in nature and devoid of minerals for human consumption. In order to make the water suitable for drinking, minerals are been added. This process of adding minerals is called as Remineralisation. The water is stabilized by adding a specified doze of chemicals. The most common process for remineralisation of desalinated water is as

- Lime Dissolution by carbon dioxide
 - Dosage of chemicals solutions based on calcium chloride and sodium bicarbonate.
- Generally, dosage of chemical solutions based on calcium chloride and sodium bicarbonate is most widely used process for remineralisation which helps to adjust pH in between 6.8 to 8.1 to meet the potable water requirements. The process flow of the treatment process is shown in **Figure 2-2**.

The reject TDS from the desalination plant will be less than the TDS value observed for the seawater in the region. Hence no impacts are envisaged due to discharge of reject brine from the outfall arrangement; therefore, no modelling studies were carried out for the outfall location of discharge from the desalination plant. The outfall for the desalination plant will be shore near jetty (same outfall location for LNG/LPG Terminal).



Figure 2-2: Process Flow of the Treatment Process

2.8.22.2 Power

The power distribution system planned is simple to operate and maintain high reliability, being accessible for inspection and repair with safety.

Designing of electrical distribution system ensures that voltage at the utilization equipment is maintained within the tolerance limits under all load conditions since poor voltage regulation is detrimental to the life and operation of the equipment.

Power requirement during Construction and Operation phases of the Revised Master Plan is given below:

- Construction Phase: 6075 kwh/day for 5 year development and 10125 kwh/day for 30 year development

- Operation Phase: 391000 kwh/day for 5 year development and 816000 kwh/day for 30 year development

Odisha Power Transmission Corporation Limited (OPTCL) will provide additional power supply from the Bhadrak substation to the existing substation in the port premises to meet the power demand for the port expansion.

The emergency backup of 12 MVA for 5 year development and 30 MVA for 30 year development will be provided by DG sets. Diesel consumption for the same for 5 year will be ~2500 L/h (12 MVA) and for 30 year will be ~5000 L/h (30 MVA).

2.8.22.3 Buildings

Buildings required for revised master plan development is planned in an area of about 92840 m² which consists of Administration Building, Port and Marine Operations Building, Port User Building, Electrical Buildings (approximately 22 no.), Main Gate House Complex, Rail Administration Building, Workshops, Fuelling Station, Transit Shed / Godowns, Stores and Miscellaneous buildings such as Water tank/pump house/ Toilet block etc.

2.8.23 Seawater Intake and Outfall System

To meet the sea water requirement for the LNG/LPG plant an intake is proposed. Also a marine outfall is planned to discharge the return cooling water from the LNG/LPG terminal proposed as a part of Revised Master Plan. The seawater intake quantity is 1, 20,000 m³/h. The discharge is through a pipeline with a diffuser system at the point of disposal. The disposal location is finalised based on the modelling studies carried out by M/s Environ Software. This location has been finalized as it is getting easily dispersed to achieve sea water ambient temperature and also it does not have any recirculation issue.

- Intake system – 20°50' 55.936" N, 86°58' 28.933" E at -19.5 m to -23.0 m CD depth
- Outfall system – 20°49' 59.823" N 86°58' 11.258" E

2.8.24 Environmental Management

2.8.24.1 Dust Suppression System

Dust suppression equipment will be provided for efficient control of dust pollution on environment during storage and handling of Coal, Iron ore and other dry bulk cargo berth and stockyard. An efficient dust suppression system will contain dust particles before it is airborne. A common system consisting of suitable pump, storage tank, nozzles for dust suppression at discharge/feeding points of belt conveyors have been proposed at each transfer tower for efficient dust control system. In addition to above suitable spray system shall also be provided at ship unloader, stockyards & wagon loading station. Dust control is envisaged at following locations.

- Ship unloader discharging in to hoppers
- Stockyards
- Discharge and feeding points of conveyors
- Rapid loading system
- Sprinklers/nozzles will be provided to control dust emission at various points or areas.

Dry Fog Dust Suppression System for Receipt and Discharge Points:

Dust Control System works on the principle of agglomeration. Dust particles released from a material handling plant which become air borne, are made to pass through a blanket of

extremely fine dry fog. Plain water is mixed with compressed air in a ratio through highly efficient acoustic nozzles which produces millions of minuscule water droplets which when kept entrapped within an enclosure in a dust generating transfer point, can efficiently contain and control even fine dust particle.

Each application point shall be provided with requisite number of Dual-fluid Dry Fog Acoustic oscillating type Nozzles. Flow Control Box is provided for a group of nozzles to regulate the pressure of compressed air and water as per requirement. Maximum moisture addition is within 0.1 %.

Dust Suppression (Plain Water) System for Stockpile Area and Track Hopper:

Wet suppression has proved to be the most effective means for controlling fugitive dust emissions from stockpiles. Moisture is added to capture the dust particles that are already airborne. It is basically designed to prevent lift off of dust from stockpile and road area. It also consists of a Plain water nozzle system for conveyor area and a Track hopper system. The nature and particle size of dust generated in the material handling system changes with change in size and characteristic of the material. In practice, the size of the dust particles has a very wide spectrum. A careful control of Air and Water Flow & Pressure is therefore necessary to obtain optimum dust suppression results. For this purpose, pressure regulators are provided in the system. Dust control is accomplished by spraying water on Mobile hopper & Truck receipt area discharge chute. Water is sprayed in at regular intervals depending on the site condition. The dust control is achieved by the agglomeration of dust particles with finely atomized water droplets equal to/close to/larger than the dust particles as the case may be, the Collision between the water droplets and dust particles plays an important role in the process of agglomeration and heavier mass thus formed settles down to the source. Plain water dust suppression has been considered for top of Mobile hopper & Truck receipt area discharge chute. The system has been designed to control dust nuisance of the working environment during un-loading of coal from Grab & at the peripheral location of discharge chute of belt feeder towards truck receipt.

In addition, Wind screens will be provided along stack yard as committed during public hearing

2.8.24.2 Wastewater Management

2.8.24.2.1 Storm Water Management and Treatment

Water used for dust suppression in the conveyor transfer points and the stockyards will get absorbed to the extent of the property of the material and remaining water will be collected through proper drainage. During rainy season the rain water over vast stockyard area will also to be collected. For this purpose the stockyard ground level will be provided with a slope in each stockyard from the centre to the sides. For collecting water draining out of the stockyards RCC toe drains will be constructed along the length of each row and interconnected to finally lead it to a settling pond. Settling ponds will be constructed out of concrete. Lime will be added in the settling pond to neutralize heavy metal, if any in the runoff from the stockyard. The settled materials will be retrieved and sent back to respective cargo stockyard. The supernatant water will be reused and excess water if any (during adverse situation) will be discharged into sea after ensuring the discharge standards.

The storm water runoff of remaining port area will be diverted through site grading into the storm water drainage system and will be discharged into sea with suitable outfall

arrangement. The details about the storm water management system are provided in **Section 7.6 of Chapter 7**.

2.8.24.2.2 Sewage and Effluent Treatment

Sewage generated from toilet blocks, canteens etc. and effluent generated from liquid tank washing etc. will be treated in Sewage Treatment Plant and Effluent Treatment Plant respectively. The domestic wastewater generation during 5 year and 30 year development are estimated to be 0.9 MLD and 2.0 MLD respectively and industrial wastewater generation are 2.4 MLD and 5.0 MLD respectively.

STP of 1 MLD capacity during 5 year development and 2 MLD (Cumulative) capacity during 30 year development and ETP of 3 MLD capacity during 5 year development and 5 MLD (Cumulative) capacity during 30 year development will be developed on modular basis in operation area. Treated Sewage and effluents shall be reused for dust suppression, irrigating greenbelt and other requirements.

Sea disposal of treated effluents will also be explored in future for which separate modelling studies will be conducted to identify appropriate outfall location for discharge of treated effluent as per marine discharge standards as prescribed by CPCB. Necessary approval shall be obtained.

2.8.24.3 Solid Waste Management/Bilge Water Reception Facility

Ships/vessels calling at Dhamra Port will not be permitted to dump the wastes /bilge water during the berthing period. However, during emergency, the reception facilities will be explored. The collected wastewater will be sent to the approved OSPCB vendors. Or the bilge water will be collected by authorised waste recyclers and taken for further treatment. Hold washing will not be permitted in the port and MARPOL regulations will be implemented.

Used oil/Spent oil & Used Battery, Containers/Barrels/liners Contaminated with HW/Chemicals and Sludge from oil water separator will be collected and disposed to OSPCB/CPCB approved vendors or CHWIF located at the nearest. Hazardous wastes, if any will be handled as per Hazardous Waste Management Rules (as amended). Hazardous wastes will be disposed through approved OSPCB vendors. The detail of Hazardous waste expected during Dhamra Port Operations is given in **Table 2-10**.

Table 2-10: List of Hazardous Wastes

S. No.	Details of Unit Process generating Hazardous Waste as listed in column 2 of Schedule -1	Details of waste stream as indicated in column 3 of Schedule -1	Solid/Semi solid/liquid oily Tarry Slurry Others	Quantity generated/handled/ year	Waste Management proposed	Possible Source
1.	5-Industrial operations using mineral or synthetic oil as lubricant in hydraulic systems or other applications	5.1 Used or spent Oil	Liquid/Oily	800 KL/Year	Collection, Storage, and sold out to registered recycler	From Lube Oil for Equipments, pumps, Vehicles other machineries
2.	5-Industrial operations using mineral or synthetic oil as lubricant in hydraulic systems or other applications	5.2 Wastes or residues containing Oil	Solid/Others	36 MT/year	Collection, Storage and Transport to OSPCB/CPCB approved TSDF/CHWIF	From Workshops and maintenance of equipments, pumps,

S. No.	Details of Unit Process generating Hazardous Waste as listed in column 2 of Schedule -1	Details of waste stream as indicated in column 3 of Schedule -1	Solid/Semi solid/liquid oily Tarry Slurry Others	Quantity generated/handled/year	Waste Management proposed	Possible Source
						conveyors, minor spill clean ups, rail line etc.,
3.	21-Production and / or Industrial use of paints, Pigments, Lacquers, varnishes, plastic and Inks.	21.1 Process wastes, residues and sludges	Solid Slurry &	3000 Kg/year	Collection, Storage and Transport to OSPCB/CPCB approved TSDF/CHWIF	From industrial structures paintings.
4.	33-Handling of hazardous chemicals and wastes	33.1 Empty barrels/containers /liners contaminated with hazardous chemicals /wastes	Solid	72000 Nos/Year	Collection, Storage and Transport to OSPCB/CPCB approved TSDF/CHWIF	From operational area
5.	3-Cleaning, emptying and maintenance of petroleum oil storage tanks including ships	3.1 cargo residue, washing water and sludge containing oil	Liquid	50 - 75 MT		From operational area
6.		3.2 cargo residue and sludge containing chemicals	Solid	2-5 MT		
7.		3.3 Sludge and filters contaminated with oil	Solid	25000 Nos.	Collection, Storage and Transport to OSPCB/CPCB approved TSDF/CHWIF	
		3.4 Ballast water containing oil from ships	Liquid	Based on Vessel's/ Ship's Request	Collection, Storage and Transport to OSPCB/CPCB approved TSDF/CHWIF	
8.	35-Purification and treatment of exhaust air/gases, water & waste water from the processes in this schedule and common industrial effluent treatment plants (CETP's)	35.3 Chemical sludge from waste water treatment	Solid/Semi Solid	25 MT	Collection, Storage and Transport to OSPCB/CPCB approved TSDF/CHWIF	Waste water treatment plant and sewage treatment plant
9.		35.4 Oil and grease skimming	Solid/Semi Solid	0.5 T		

The nearest TSDF is located at village Kanchichuan, PO Mangalpur, district Jajpur, at a distance ~150km by road. This TSDF has treatment, storage and disposal facility. The secured engineering landfill capacity is 25,000 TPA, waste treatment and storage facility of 12,000 TPA and storage facility for incinerable waste is 3000 TPA. The TSDF is developed by M/s Ramky Environ Engineer Limited and operating under the name of Odisha Waste Management project. The facility is in operation since 2010-11.

The details of E-waste is given in **Table 2-11**.

Table 2-11: List of E-Waste

S. No.	Details of E-Waste	Type of waste	Quantity generated/handled/year	Waste Management proposed	Possible Source
1.	E Waste such as Wiring/Electrical, CRT, LCD, Fluorescent Lamps, Incandescent Lamp, Batteries, LED, computer and its parts	Solid	LS	Collection, Storage and Transport to authorized Recyclers.	Industrial Use of E Waste Components

2.8.24.4 Summary of Environmental Aspects

Summary of potential types of pollution in Dhamra Port and measures to reduce the same are given in **Table 2-12**.

Table 2-12: Measures to Reduce Pollution

S. No.	Type	Remarks
1.	Air Pollution	- Covered Conveyor and Transfer Points - Dust Suppression System at stockyard, Transfer towers, at berth/Unloaders, at wagon (Un)loading, at track hoppers, at Truck loading Silos, Discharge and feeding points of Conveyors etc., - Use of Specialised Unloaders - Wind screens will be provided along stack yard - Proper house keeping - Trucks before leaving the loading area shall be covered with tarpaulin and also the railway wagons - Trucks Tyres and areas susceptible for coal dust before leaving premises shall be cleansed washed to remove coal particles. - Greenbelt
2.	Water Pollution	- STP - ETP - Settling Pond at Coal and Iron ore Stockyard - Storm Water Drainage System for Inside and some portion of outside port area
3.	Solid Waste	Proper Collection, handling and Transport System

2.8.25 Fire Fighting Facilities

2.8.25.1 Dry Bulk Berths and Stockyards

The fire fighting system at the port will be capable of both controlling and extinguishing fires. It is proposed to install Fire Hydrant System, which will be designed to give adequate fire protection for the facility based on Indian Standard or equivalent and conform to the provisions of the Tariff Advisory Committee's fire protection manual. Fire hydrant system is proposed at the following areas, which are classified as ordinary hazard areas.

- Proposed bulk import / Export berths
- Bulk import and bulk export stockyards
- All galleries of bulk import and bulk export conveyors

The fire hydrant system will be designed to ensure that adequate quantity of water is available at all times, at all areas of the facility where a potential fire hazard exists. Each hydrant connection will be provided with suitable length of hoses and nozzles to permit effective operation.

The hydrant service will consist of ring mains to cover the facility, with its pump, located in a common pump house. Adequate arrangement with jockey pumps, pressure switches, etc. will be provided to maintain the required pressure in the hydrant system. The operation of pumps provided for the system will be automatic.

2.8.25.2 Container Terminal

The fire-fighting system will be designed to give suitable fire protection for the containerized cargo and container handling facilities in the terminal and shall conform to the provision of Tariff Advisory Committee's fire protection manual. The fire-fighting system shall be a combination of water hydrants, fire alarm system and fire extinguishers.

The fire hydrant system will be sea water based and designed to ensure that an adequate quantity of water is available at all times, at all areas of the facility where a potential fire hazard exists. There will be provision for connecting the system to the potable water supply in order that the system can be flushed and rested on potable water after a fire-fighting event.

The fire-fighting system will consist of ring main with spur lines to cover the facilities in the yard. Hydrants will be provided at sufficient spacing. Each hydrant connection will be provided with a suitable length of hose and nozzle to permit effective operation. The main fire-fighting pumps will be provided in the pump house located at the western end of the berth.

2.8.25.3 Liquid Jetty and Tank Farm Area

2.8.25.3.1 Jetty

The liquid jetty will be provided with fixed fire-fighting facilities according to the requirements of OISD Guidelines. Sea water will be used for fire-fighting facilities. The facilities will include a pump house on trestle, tower mounted water/foam monitors as well as hydrants and water curtains. The proposed fire-fighting facility for the jetty broadly consists of following.

- A sea water pump house with a control room on top along the approach trestle at adequate safety distance from the loading platform / manifold.
- Two tower mounted foam/water monitors
- Monitors of stand pipe type at Jetty service platform
- Water curtain system at jetty service platform and on the two breasting dolphins.
- Fire hydrants on the jetty service platform, breasting and mooring dolphins and on the pile trestle
- Leak detection/ Alarm system

On the fire hydrant line standard double headed hydrants are proposed for installation one on each of the breasting and mooring dolphins and two nos. on the service platform. In addition it is proposed to provide similar fire hydrants on the pile trestle from the pump room to the jetty along with pipeline at a required spacing.

At any given point of time the fire hydrant pipe line will be capable of supplying water enough for feeding hydrants and the water curtains located on the service platform, breasting and mooring dolphins.

For the jetty and pipeline trestle it is proposed to have fire gas detector and an air sampling type detector. A sampling type detector consists of piping or tubing distribution from the detector unit to the areas to be protected. An air pump draws air from the protected area back to the detector through the air sampling ports and piping. At the detector the air is analysed for the fire products.

It is also proposed to have an alarm system which comes into operation automatically through the fire gas detector and the sampling type detector. This can also be manually operated for conveying fire alert message.

2.8.25.3.2 Tank Farms

The fire-fighting system inside the tank farms will be as per the norms of OISD. The fire fighting system will comprise of a jockey pump (electric driven), main pumps (diesel engine driven), fire water ring main with monitors & spray, foam system for storage Tanks. Besides,

the fire alarm system consisting of break glass type manual call points at field & Fire Alarm Panel in the Fire Pump-house/control room.

The fire water header is kept pressurized with the jockey pump and on loss of pressure due to opening of hydrants on the header, the pressure switches activate the pump contacts & main pump start in sequence to ensure adequate pressure and flow is maintained in the system.

The storage tanks have spray rings with nozzle on shell and foam chamber attached to foam nozzle of the Tank. The foam chamber is connected by foam water line to the fixed foam Tank outside the dyke. In the event of fire to the liquid in two of the storage Tanks, the foam system is activated & foam poured on the top of the burning liquid surface. For the other tanks in the vicinity of this affected tank, the spray system is activated and the tank surface kept cool.

Further the small water monitors, hydrants help in large quantity of water being poured onto the Tank roof / shell. Small fires are doused with portable wheeled extinguishers. The manual call points provided in the various areas are for fire warning. In the event of fire being noticed by any personnel, the break glass type call button if pressed activates the hooter & alarm at the fire alarm panel in Pump-house.

2.8.25.4 LNG/LPG Terminal

A centralized spill, fire and combustible gas alarm and control system provides input to an information management system. Automatic detection devices, manual alarms and audible and visual signalling devices are generally strategically located throughout the terminal. Automatic detection devices include flame, fire and heat, smoke, low temperature and combustible gas detectors. Emergency shutdown system (ESD) incorporates in the design of the terminal and provides the operators with the capability of remotely shutting down the entire or selective portions of the terminal. The unloading arms are generally equipped with Powered Emergency Release Couplers (PERCs). The PERC maintains containment integrity and prevents damage to the unloading arms in the event of an emergency. Fire-fighting facilities are provided in the LNG / LPG terminal which operates through centralized alarm & control system. Following fire fighting facilities are provided for the LNG / LPG terminal including jetty:

- A fire water supply system designed to provide water for the governing scenario
- A fire water distribution network
- Fixed spraying systems
- Monitors and hydrants
- Remote Operated HVLRM
- Water curtains where required
- Foam systems
- Dry chemical powder skids
- Inergen system
- Nitrogen snuffing system
- Mobile and portable firefighting equipment
- Appropriate buildings protection
- The fire truck and the first intervention pick-up.
- Fire detection and Alarm system
- Fire & Gas system

2.8.26 Greenbelt Development

Greenbelt will be developed in an area of about 129.0 ha during 5 year plan and about 258.90 ha during 30 year plan.

2.9 Coastal Regulation Zone (CRZ) Compatibility

National Institute of Oceanography (NIO) has carried out demarcation of High Tide Line (HTL), Low Tide Line (LTL) and Coastal Regulation Zone (CRZ) for the project site and its surrounding as per CRZ Notification 2011 (as amended). Based on the survey, CRZ set back lines were demarcated and the project layout was superimposed on CRZ map.

Dhamra Port "Revised Master Plan" facilities falls in CRZ I (B), CRZ III and CRZ IV (A) and the activities proposed in the CRZ area are permissible as per CRZ Notification, 2011, amended till date, as it requires waterfront and foreshore facilities.

The proposed evacuation corridor (Road/ Rail / Pipeline /utility) on the northern side is partly passing through sparse mangroves (CRZ IA). The design of corridor will be as per permissible norm.

Dense Mangroves were observed on the northern side outside the proposed project area and 50 m buffer is ensured. Scattered mangrove trees on the southern side over 9 ha area is being protected by M/s DPCL. Notified Eco sensitive zone of Bhitarkanika Sanctuary/ National park & Gahirmatha Sanctuary is located on southern side of the project boundary. The Revised Master Plan layout is outside the notified Eco Sensitive Zone of Bhitarkanika Sanctuary, Bhitarkanika National Park and Gahirmatha Marine Sanctuary.

The project layout superimposed on HTL, LTL and CRZ setbacks is given as **Figure FD0204**. The CRZ compatibility of the facilities falling with CRZ area with respect to CRZ Notification, 2011 is given in **Table 2-13**.

Table 2-13: CRZ Compatibility of Dhamra Port Revised Master Plan Facilities

S. No	Proposed Facilities	Falling in CRZ area with Classification	Permissible / Not permissible as per CRZ notification 2011, amended till date	Applicable Clause no. of CRZ Notification 2011, amended till date
1	Multipurpose Storage/ Liquid / Gas/Cryogenic Storages areas (With all Operation facilities)	CRZ I (B), CRZ III & CRZ IV A	Permissible	3(iv)(a); 4(i)(a)&(f); 8(I)(i)(b)&(c) 8(I)(ii)(f) 8(III)A(iii)(e)(f)(h) 8(III)B(ii)&(iii)&(iv) And Annexure II
2	Multipurpose/ Liquid / Gas/Cryogenic - Berths / barges	CRZ I (B) & CRZ IV	Permissible	3(iv)(a); 4(i)(a)(f); 8(I)(i)(c) And Annexure II
3	Common Operation Building and Other facilities	CRZ I (B) & CRZ III	Permissible	3(iv)(a) and 4(i)(a)(f)
4	Utility Corridor (Pipeline / Road / Rail/ transmission etc)	CRZ I (B) & CRZ III, CRZ I (A)	Permissible	3(iv)(a); 4(i)(a)(f) 8(I)(i)(b)(c); 8(I)(ii)(g)
5	Outfall pipeline and diffuser system	CRZ I (B) & CRZ III	Permissible	3(iv)(a); 4(i)(a)(f); 4(ii)(d)(f); 8(I)(i)(b)(c);
6	Seawater Intake Pipeline	CRZ I (B) & CRZ III	Permissible	3(iv)(a); 4(i)(a)(f); 4(ii)(d)(f) 8(I)(i)(b)(c);
7	Dredging /Reclamation	CRZ IV(A), CRZ III, CRZ I(B)	Permissible	3(i)(a); 3(iv)(a); 3(iv)(c); 4 (i) (f); 8(I)(i)(c)

2.10 Project Cost

Immediate development plan is being implemented at the estimated cost of INR 10016 Crore. The total project cost for the development of revised master plan includes Civil Construction, Onsite Infrastructure, Marine Facilities, Consultancy, Dredging, reclamation, ground development work, Environment Management Plan including Greenbelt development. The project cost for the 5 year and 30 year development plan is given below:

- Revised Master Plan (5 Years): INR 17518 crore
- Revised master plan (30 Year): INR 31415 Crore

2.11 Project Development Schedule

The revised master plan is prepared considering development in phase wise manner i.e. immediate development; 5 years development and 30 years development.

Chapter 3 Analysis of Alternatives

3.1 Site Alternatives

Dhamra Port is already been established & operational, and this being an Expansion/revision of Master Plan of existing Dhamra port, study of site alternatives has least significance.

3.2 Layout Analysis

Various options for layout within the port limits were studied through hydrodynamic and other mathematical modelling with a view to optimise the port design with minimum coastal/environment impact and other suitable operational Conditions.

The proposed expansion area is also selected on the basis of pre dominant wind direction and away from existing habitation areas/Notified ESZ of Bhitarkanika and Gahirmatha Sanctuary. Majority of areas under proposed expansion will be developed through reclamation of Sea/Submerged land (Inter Tidal Area) in order to avert Resettlement and Rehabilitation (R&R).

Revised Master Plan was finalised and considered to be the best, inline to positive impact on the coastal environment, with minimal sediment infiltration in the port, thus reducing the impacts associated with maintenance dredging and its disposal and also providing best suitable conditions for port operation, improving tranquil conditions in the port area.

Chapter 4 Description of Environment

4.1 Preamble

The baseline/existing environmental conditions in the Project Influenced Area (PIA) or general study area are established based on reconnaissance surveys, field surveys, investigations and review of data collected from various secondary sources. The baseline environmental surveys (both terrestrial and marine) were carried out to understand the all the seasonal variations and presented in this chapter.

This chapter details with the location of site, existing features, meteorological conditions, oceanographic conditions, environmental aspects, ecological aspects, social aspects, road & rail connectivity and other infrastructure facilities covering the terrestrial and marine environment baseline data and also the terrestrial and marine bio-diversity. Secondary data collected from various sources has also been included in this chapter.

Following are the various environmental attributes monitored for both terrestrial and marine environment.

Terrestrial Environmental Components	Marine Environmental Components
• Meteorology - o Temperature - o Relative Humidity - o Rainfall - o Wind Speed & Direction - o Solar Radiation	• Marine Water Quality - o Physico-Chemical Parameters • Sediment Quality - o Physico-Chemical Parameters
• Ambient Air Quality - o Particulate matter <10 micron size (PM₁₀) - o Particulate matter <2.5 micron size (PM_{2.5}) - o Sulphur Dioxide (SO₂) - o Nitrogen Dioxide (NO₂) - o Carbon Monoxide (CO) - o Ozone (O₃) - o Lead (Pb) - o Ammonia (NH₃) - o Benzene (C₆H₆) - o Benzo(a)Pyrene (BaP) - o Arsenic(As) - o Nickel (Ni)	• Biological Parameters - o Primary productivity - o Phytoplankton - o Zooplankton - o Macro benthos - o Meio benthos - o Microbial load
• Ambient Noise Levels - o Day equivalent noise levels - o Night equivalent noise levels	• Marine Biodiversity Survey • Marine Ecology
• Inland Water Quality - o Groundwater Quality - o Surface Water Quality	
• Soil Quality	
• Flora & Fauna (Terrestrial Ecology)	

4.2 Study Area/Study Period

Project Influence Area (PIA)/Study Area: As described in Chapter 1, an area within 15 km radius from project boundary has been earmarked for the study as the PIA/study area. Two districts are falling within the study area viz. Bhadrak and Kendrapara districts of Odisha state. Further, the study area is divided in to two major sub divisions namely the Project area

and General Study area. The PIA (general study area) map is given as **Figure FD0102**. The existing land use pattern in the proposed project area mainly consists of Dry Barren Mud, Dry Mud with Giria Grass, Thorny scrub, Sea/Submerged land which falls in inter tidal zone without any macro vegetation.

Description of Project Area: The proposed expansion is planned in an area abutting the existing Port. Project area is the area where the Project activities (including civil constructions activities) are confined with the project boundary. Project site falls outside the notified/declared ecologically sensitive areas of Bhitarkanika National Park/Sanctuary/Gahirmatha Sanctuary.

Description of General Study area (Core and Buffer Areas): General Study area is broadly sub-grouped as Core area and Buffer area.

As per the Ports and Harbour EIA guidance manual issued by MoEF&CC, an area within 5 km radius from project boundary for primary data generation and 15 km radius as the general study area for secondary data generation is considered.

Description of Core Area: An area within 5 km radius from proposed expansion boundary is designated as Core area. The Project area is outside the notified Eco-Sensitive Zone of Bhitarkanika Sanctuary and Gahirmatha Sanctuary. Core area includes a part of Bhitarkanika Sanctuary and Bhitarkanika National park including, mangroves, Kanika island, Dhamra River, Habitations, Crop land and parts of Forest area.

Description of Buffer Area: An area within 15 km radius from proposed expansion boundary is designated as buffer area. Buffer area is considered for secondary data assessment. Buffer area includes parts of Bhitarkanika Sanctuary and Bhitarkanika National park, parts of Forests area, Dhamra River, Maipura River, Habitations, Crop land and Gahirmatha Marine Sanctuary. Project Area, Core Area and Buffer Area as defined are shown in **Figure 4-1**.



Figure 4-1: Project Area, Core Area and Buffer Area of PIA

According to census 2011, the demographic profile of one kilometre area from the project boundary shows that maximum population in Kathikola (1510) village and minimum at Saratprasad (258) village and high sex ratio of 1077 was observed at Dosinga and low sex ratio at Saratprasad (856). There are total of 4415 numbers of workforce covering main and marginal workers. There are total of 8975 numbers of non-workers in one kilometre area including children and elder people out of which 3116 are males and 5859 are females. The demographic profile at project site and within one kilometre from the port boundary is given in **Table 4-1** and village wise demographic profile is shown in **Figure 4-2**.

Table 4-1: Demographic Profile within One Kilometre from Port Boundary

Particulars	Within the Project site (Nos)	Within 1.0 km from the port boundary (Nos)
Total number of villages	None	14 ³
Number of Households	None	2691
Population	None	13390
Sex Ratio	None	941
Literates	None	9578
Illiterates	None	3812
Total workforce (including main and marginal)	None	4415
Non Workers	None	8975
Main workforce	None	2863
Marginal Work Force	None	1552

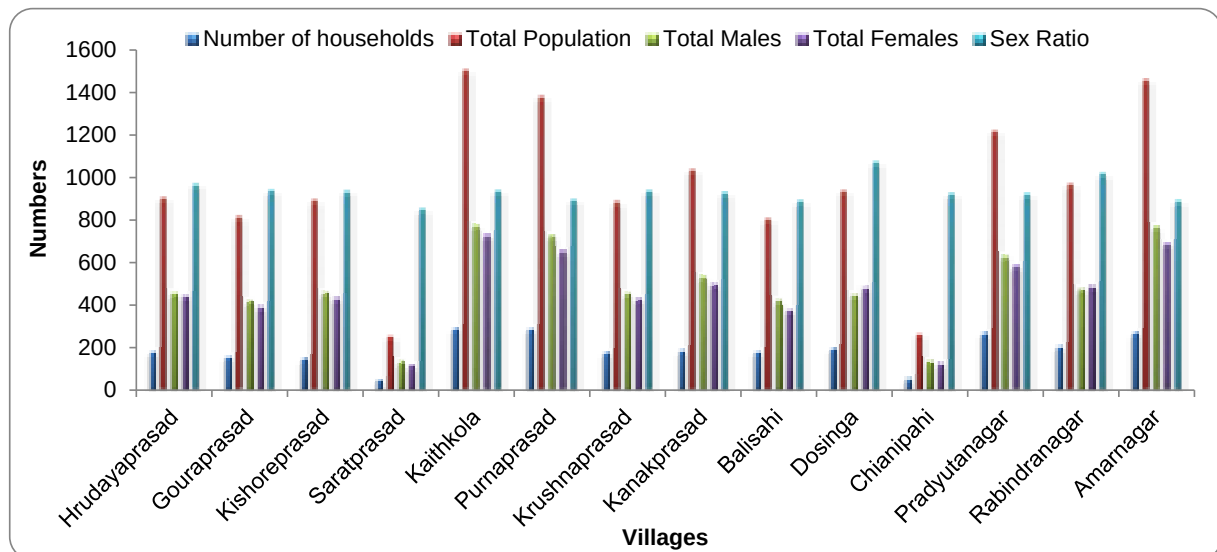


Figure 4-2: Demographic Profile within One Kilometre from Project Boundary

CRZ compatibility: The proposed development will be carried out in accordance/adhering to the regulation of permissible activities as per the CRZ Notification, 2011. The project development area falls in CRZ IB, CRZ III, CRZ IV and proposed Northern Corridor shall pass through sparse mangrove area (CRZ I(A)) on Trestle as per the HTL and LTL physical demarcation study carried out by Regional Centre of National Institute of Oceanography, Visakhapatnam, CSIR-National Institute of Oceanography, India.

³ All the villages are under the Chandbali P.S. of Bhadrak District

4.2.2 Study Period

The EIA study has been carried out as per MoEF&CC approved ToR for both terrestrial and marine environment. The baseline terrestrial and marine environmental surveys were carried out covering the following seasons:

- Summer season, 2014
- Post monsoon season, 2014
- Winter season, 2014-15
- Summer season, 2016

DPCL has also assessed the baseline conditions for both terrestrial and marine environment during post-monsoon season, 2017 and winter season, 2017-18.

4.2.3 Environmentally/Ecologically Sensitive Areas

The environmental sensitive areas covering an aerial distance of 15 km from project boundary is given in **Table 4-2**.

Table 4-2: Environmentally Sensitive Areas within 15 km Radius

S. No	Classification	Name/Identity	Aerial Distance (km) (within 15.0 km) Proposed project location boundary & Direction
1.	Areas protected under International conventions, National or local legislation for their ecological, landscape, cultural, heritage or other related value	Bhitarkanika Sanctuary ⁴	2.2 SSW
		Bhitarkanika National Park	1.52 SSW
		Gahirmatha Marine Sanctuary	11.0 S
2.	Areas which are important or sensitive for ecological reasons – wetlands, mangroves, watercourses or other water bodies, coastal zone, biospheres, mountains, forests	Dhamra River	1.6 S
		Matai River	8.0 W
		Maipura River	9.3 S
		Ranhansua River	12.3 S
		Bhitarkanika Sanctuary (Ramsar Wetland of International Significance from August 19, 2002)	2.2 SSW
		Mangroves	• More than 50m N • Within Project area (Excluded) S • Kanika Mangroves 1.5 km E
3.	Areas used by protected, important or sensitive species of flora or fauna for breeding, nesting, foraging, resting, over wintering, migration	Olive Ridley Nesting Beach in Gahirmatha (Nearest Nesting Point at wheeler Island)	12 SE
		Salt water Crocodiles in Bhitarkanika	1.52 SSW
4.	Inland, coastal, marine or under groundwaters	Bay of Bengal	Abutting E
		Dhamra River	1.6 km S
		Matai Nadi	8.0 km W
		Maipura Nadi	9.3 km S
		Ranahansua River	12.3 km S
		Baunsagarh Nadi	11.2 km S
		Satabhaya Nala	14 km S
		Bhitra Kanika Nadi	11.8 km SW
		Sanjoga Nadi	11.1 km SW
		Munda Jhor Nadi	6.6 km SSW

⁴ The revised Master plan layout is outside of the Eco-Sensitive Zone of Bhitarkanika Sanctuary & Bhitarkanika National Park and Gahirmatha Marine Sanctuary, declared as per Gazette Notification 16th June 2015

S. No	Classification	Name/Identity	Aerial Distance (km) (within 15.0 km) Proposed project location boundary & Direction
		Kanthiakai Nala	5.5km S
		Bhekta Nala	6.8 km SSW
		Mahul Jhor	3.5 km W
		Dosandhi Jhor	12.4 km NW
		Sotra Jhor	4.9 km WNW
		Galla Nadi	12.2 km W
5.	State, National and International boundaries	-	East Coast boundary of Odisha State
6.	Routes or facilities used by the public for access to recreation or other tourist, pilgrim areas	No	-
7.	Defence installations	Integrated Test Range (ITR) of DRDO (at Wheeler Island)	13.0 SSE
8.	Densely populated or built-up area	No	only scattered habitations near project site
9.	Areas occupied by sensitive man-made land uses (hospitals, schools, places of worship, community facilities)	Nearest Hospital & School at Dosinga	0.5 SSW
		Maa Dhamarai Temple at Dhamra	6.3 WSW
10.	Areas containing important, high quality or scarce resources (groundwater resources, surface resources, forestry, agriculture, fisheries, tourism, minerals)	Kalibhanjdian RF	3.0 SSW
		Garmal Forest	1.2 SW
		Kantiakhai PF	3.3 SE
		Kanika Sand Forest	1.7 E
		Bagulida RF (Proposed)	9.9 km S
		Fishing harbour	6.5 SW
		Suneirupei PF	10.0 S
		Barunei Gahirmata PF	11.4 S
		Katiakhai RF	3.1 S
11.	Areas already subjected to pollution or environmental damage (those where existing legal environmental standards are exceeded)	No	
12.	Areas susceptible to natural hazard, which could cause the project to present environmental problems (earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions)	Proposed project falls under Seismic Zone II (Low damage risk zone) as per IS 1893 (Part I) of Indian Seismic Map. It is a cyclone prone area. During the design stage, the effects from natural disasters will be considered and necessary precautionary measures would be built in/implemented.	

4.2.3.1 Ecologically Sensitive Areas

The project expansion area does not contain any Corals/coral reefs, Sand Dunes, National parks, marine parks, sanctuaries, wildlife habitats, Biosphere Reserves, Salt Marshes, Turtle nesting grounds, Horse shoe crabs habitats, Sea grass beds and areas or structures of archaeological importance.

The proposed evacuation corridor (Road/ Rail / Pipeline /utility) on the northern side is partly passing through sparse mangroves (CRZ IA). The design of corridor will be as per permissible norm. Dense Mangroves were observed on the northern side outside the proposed project area and 50 m buffer is ensured. Scattered mangrove trees on the southern side over 9 ha area is being protected by M/s DPCL. Notified Eco sensitive zone of Bhitarkanika Sanctuary/ National park & Gahirmatha Sanctuary is located on southern side of the project boundary. The Revised Master Plan layout is outside the notified Eco Sensitive Zone of Bhitarkanika Sanctuary, National Park and Gahirmatha Marine Sanctuary. Eco-

Located at latitude $20^{\circ}43'$ to $21^{\circ}13'N$ and longitude $86^{\circ}16'$ to $87^{\circ}00'E$. Bounded by Balasore District on the north, Jajpur District and Kendrapada District and river Baitarani on the south, Keonjhar District on the west and Bay of Bengal on the east, covers an area of 2505 km^2 (246529 ha). The coast line of the district is about 50 km which is concave to the Bay of Bengal in contrast to bulging out coast line in the centre and south.

There are a group of islands close to each other lying a few kilometres inside the Bay of Bengal off Dhamra Coast. Of the five islands, Outer Wheeler (Dr Abdul Kalam Island) is the biggest with an area of 263.13 Acres (Ac.)⁵ and the other islands are Coconut Island (97.50 Ac.), Long Wheeler (52.50 Ac.), Shortts (Batighara) Island (41.25 Ac.) and Small Wheeler (10.63 Ac.). These islands have been handed to Defence Research and Development Organization (DRDO) and the outer Wheeler Island has been developed as a Missile Launching Station and related research activities.

Kendrapara District:

Located at latitude $20^{\circ}20'$ to $20^{\circ}47' N$ and longitude $86^{\circ}14'$ to $87^{\circ}03' E$. The district is clearly delineated by 48 km shoreline of Bay of Bengal. The district constitutes coastal and delta areas in a transitional environment at the interface of terrestrial and unique marine and eco-systems. Bounded by Bhadrak district in north, in the north-east by Jajpur district and Cuttack district in the west, in the south by the Jagatsinghpur district and in the east by the Bay of Bengal. The entire geographical area of 2644 km^2 of the district extends from Mahanadi Mouth on the south to Dhamra on the north. The river Mahanadi, Brahmani and Baitarani along with their distributaries form the drainage system of the district with mostly anastomosing drainage pattern in nature.

The district has the distinction, among others, of having Gahirmatha, world's largest known rookery of Olive Ridley sea turtles, Bhitarkanika with its rich bio-diversity in its mangrove forest and district headquarters is located at Kendrapara, which is the oldest Municipality of Odisha, constituted in 1869⁶. The region is subject to inundation of seawater, which leaves deposits of salt on the surface of the low-lying land and in many parts renders cultivation impossible.

4.3.2 Climatic Conditions

Bhadrak District:

The climate of the district is generally hot and humid all the year around. The cold/winter season from December to February is followed by the hot season from March to May. The period from June to September constitutes the southwest monsoon season. October and November constitute the post-monsoon season. Being a coastal district winds are stronger during summer and South-west monsoon season. But there is light to moderate winds during post-monsoon and winter season. The district is directly on the track of most of the cyclonic storms and depression⁷.

Kendrapara District:

⁵ Odisha District Gazetteers – Bhadrak, Gopabandhu Academy of Administration (Gazetteers unit), General Administration Department Government of Odisha, 2016

⁶ Odisha District Gazetteers – Kendrapara, Gopabandhu Academy of Administration (Gazetteers unit), General Administration Department Government of Odisha, 2016

⁷ Odisha District Gazetteers – Bhadrak, Gopabandhu Academy of Administration (Gazetteers unit), General Administration Department Government of Odisha, 2016

The climate of this district is hot and humid in nature. The district experiences tropical hot and humid climate, with the summers being hot and the winter cold. The southwest monsoon is the principal source of rainfall in the district. The district is characterized by a tropical monsoon climate having three distinct seasons in a year viz. winter, summer and rainy seasons.

4.3.2.1 Temperature, Humidity and Rainfall

Bhadrak District: The highest maximum temperature ever recorded at Chandbali was 46.7°C on 12th June, 1942. The lowest minimum temperature ever recorded at Chandbali was 5.1°C on 14th January, 1989.

May is the hottest month with the mean maximum temperature of 37.7°C and mean minimum temperature of 25.5°C. The minimum temperature is recorded in the month of January with maximum of 28.6°C and minimum 13.5°C.

The Relative Humidity (RH) is generally high from July to December. RH recorded at 8.30 AM and 5.30 PM reveals that the RH ranges from 43 to 68% and 88 to 92% respectively. The potential evapotranspiration values vary from 5.67 cm to 31.5 cm.

An annual average rainfall of 1428 mm is received through 67 numbers of rainy days in the Bhadrak district. The distribution of rainfall across the block is not uniform. Bhadrak and Bhandaripokhari receive average annual rainfall of 1605 and 1532 mm respectively. However, Bonth receives less amount of rainfall i.e. 1140 mm. Two blocks namely Tihidi and Dhamnagar receive an annual average rainfall of 1221 mm with average 63 numbers of rainy days. Basudevpur receives highest amount of rainfall i.e. 2109 mm in the district however Chandbali gets only 1166 mm of average rainfall⁸. About 71% of the annual rainfall is received during southwest monsoon months, i.e. June to September. In the 90-year period 1901 to 1990, the highest annual rainfall was 159% of the normal occurred in 1973, and the lowest annual rainfall was 72% of the normal occurred in 1918. In the same period, there were 10 years when the annual rainfall of the district was less than 80% of the normal. There is one meteorological observatory in the district at Chandbali.

Kendrapara District: The maximum temperature is 42.04°C (during summers) and the minimum at 12.8°C (during winters). Summers generally last from March to May and winters, from October to February. May is the hottest month of the year and temperature gradually reduces to minimum in December which is the coldest month of the year.

The humidity remains high of 85% with the prevalence of southwest monsoon and gradually declines from September every year in summer season.

Average annual rainfall of Kendrapara is 1556 mm in 52.96 rainy days⁹, out of which 80% rainfall occurs in monsoon season (June to September). About 72% of rainfall is received during the monsoon season. Rainfall is generally heavy during the monsoons, which occur during the months of June to September. August is the rainiest month of the year with an average rainfall of 1340 mm. South West monsoon is primarily responsible for the rainfall in this District. In the period between April and May, three to four cyclonic rains generally occur in the district that causes a drop in the temperature.

⁸ District Irrigation Plan of Bhadrak (Odisha), Pradanmantri Krishi Sinchayee Yojana(PMKSY), March, 2016

⁹ District Irrigation Plan of Kendrapara (Odisha), Pradanmantri Krishi Sinchayee Yojana(PMKSY), March, 2016

4.4 Land Environment

4.4.1 Land Availability

Revision of master plan development will be carried in total area of 2013.4 ha. This includes Phase I - 234 ha, Phase II - 456 ha including basin area, proposed reclamation of Sea/Submerged intertidal area 1075.7 ha, and proposed applied vacant government land 247.7 ha.

4.4.2 Land Use-Land Cover

4.4.2.1 Land Use-Land Cover studies for PIA Districts

Bhadrak District: Land use pattern of the Bhadrak district including total geographical area, area under forest, wasteland and under other use¹⁰. Wastelands are mostly predominant in Basudevpur followed by Chandbali and Dhamnagar blocks. Maximum area under other uses is concentrated in Chandbali followed by Basudevpur while lowest area under other uses is found in Bhandaripokhari followed by Dhamnagar.

Kendrapara District: Land use pattern of the Kendrapara district including total geographical area, area under forest, wasteland and under other use¹¹.

4.4.2.2 Land Use-Land Cover studies for PIA

The land use/land cover for the study area is prepared in the form of a map by using Sentinel-II satellite imageries dated November 2016. Land Use/land Cover breakup (15 km radius) is given in **Table 4-3**. Land Use pattern is shown in **Figure 4-4** and Land Use/land Cover map is shown in **Figure 4-5**.

The satellite data for area and distance calculations is processed using Remote Sensing & Geographical Information System (GIS) software by classification algorithms and the data is interpreted with the help of Survey of India (Sol) Toposheets (scale 1:50,000).

Table 4-3: Land use Pattern of PIA

S. No	LULC	Area (sq. meters)	Area (acres)	Area (Hectares)	Percentage
1	Builtup - Rural/Urban	40862811.43	10097.41	4086.28	3.48%
2	Agriculture - Crop land	288006886.61	71167.94	28800.69	24.54%
3	Agriculture - Aquaculture/Pisciculture	46312506.22	11455.30	4635.80	3.95%
4	Forest - Scrub	3216192.84	794.74	321.62	0.27%
5	Land with/without Scrub	20569365.29	5082.79	2056.94	1.75%
6	Sandy area	3959029.09	967.06	391.56	0.33%
7	Water Bodies - Rivers/Streams/Canals	39888055.23	9856.54	3988.81	3.40%
8	Other – Sea (Bay of Bengal)	578029245.23	142833.92	57802.92	49.25%
9	Mangroves	152816782.40	37761.79	15281.68	13.02%
	Total Area	1173660874.34	290017.48	117366.29	100.00%

¹⁰ District Irrigation Plan of Bhadrak (Odisha), Pradhanmantri Krishi Sinchayee Yojana (PMKSY), March, 2016

¹¹ District Irrigation Plan of Kendrapara (Odisha), Pradhanmantri Krishi Sinchayee Yojana (PMKSY), March, 2016

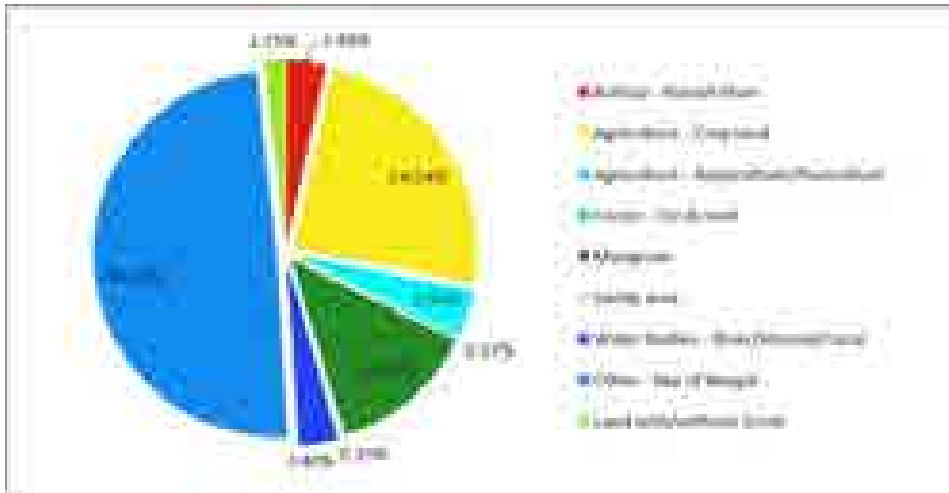
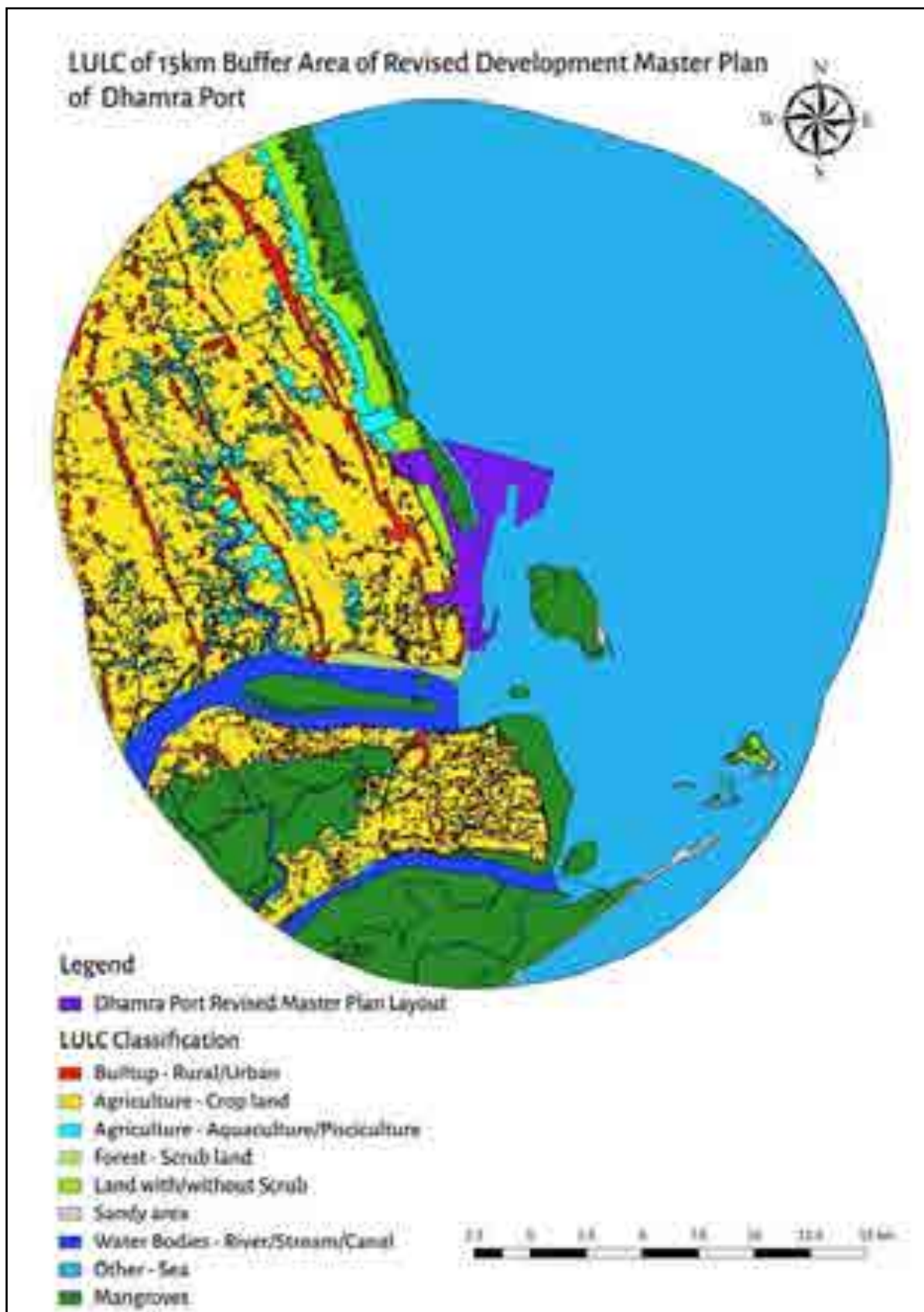


Figure 4-4: Land use pattern in PIA



13.02% by Mangroves, 3.95% by Aquaculture/Pisciculture, 3.48% by Builtup – Rural/Urban, 3.40% by Water bodies – Rivers/Streams/Canals, 1.75% by Land with/without Scrub and a minute percentage of area of 0.33% & 0.27% under Sandy area & Forest-Scrub lands.

Revision of master plan development will be carried in total area of 2013.4 ha. This includes Phase I - 234 ha, Phase II - 456 ha including basin area, proposed reclamation of Sea/Submerged intertidal area 1075.7 ha, and proposed applied vacant government land 247.7 ha. Total area covered by Phase – I of the Dhamra Port is 234 Ha. In addition to this, approximately 1747.4 Ha areas will be required for the revised master plan (30 year plan) within the existing port limits (excluding mangroves area and basin area). Present land uses of the expansion site are Dry Barren Mud, Dry Mud with Giria Grass, Thorny scrub, Sea/Submerged land which falls in inter tidal zone without any macro vegetation.

Preliminary land preparation works for plantations observed in part of the proposed applied land. The land use pattern and classification in the project area is shown in **Figure 4-6** and **Figure 4-7**.

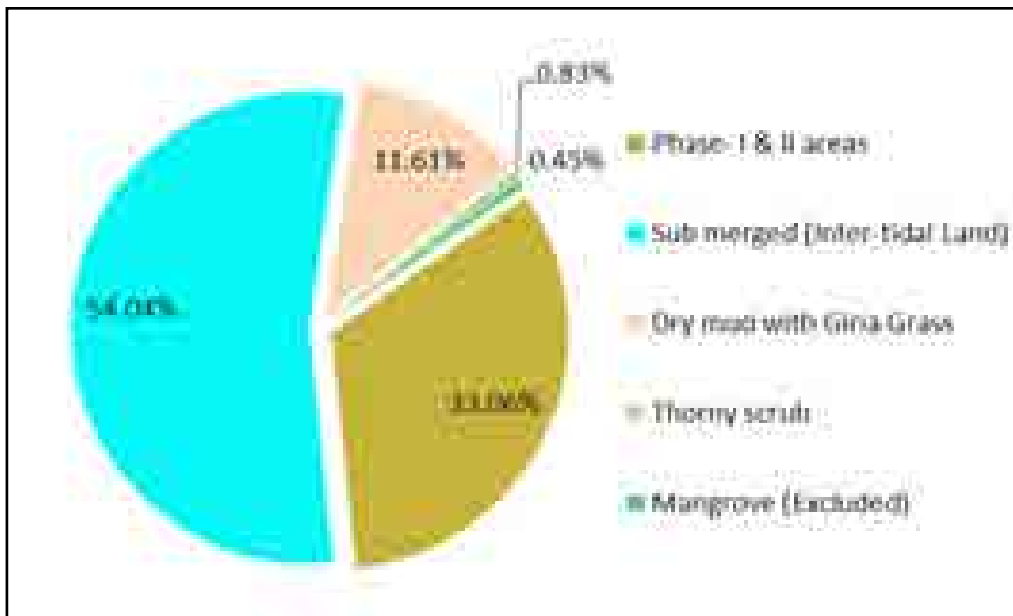


Figure 4-6: Land use pattern of Project Area

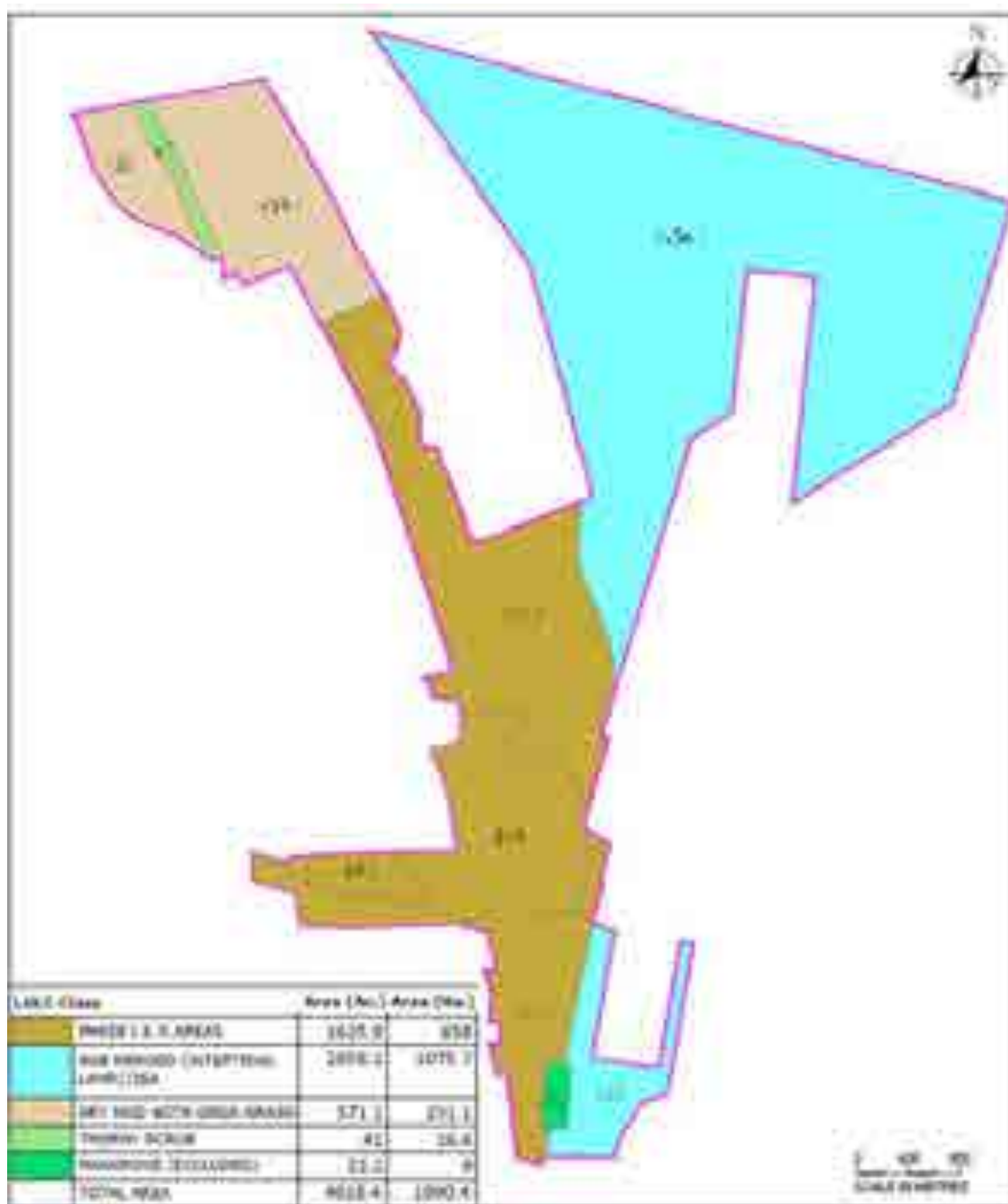


Figure 4-7: Classified LU/LC of the Project area

4.4.3 Natural Resources of PIA district

4.4.3.1 Forest and Forest Resources

Bhadrak District:

Bhadrak Wildlife division came into being with effect from 1st October, 2003 and Headquarters is at Chandabali. This Division was formed carving out a portion of Baripada Forest Division and a portion of Mangrove Forest Division (W.L), Rajnagar. The jurisdiction of

Bhadrak Wildlife Division is the entire geographical area of Bhadrak Revenue District¹². Bhadrak District has 97.07 km² forest area out of total geographical area of the Division is 2505 km² and forest area is 53.32 km². The area of the Division extends between 20°43' to 21°15' N Latitude and 86°14' to 87°05' E Longitude. Mangroves (Bani pahi) naturally exist along the Bay of Bengal Coast starting from Dhamra in South to Chudamani in north over a length of about 35 km and width of 2 km approximately. All these forest are under highly degraded state due to biotic interference. Maximum coverage of area under forest is seen in Tihidi block followed by Bonth block while in blocks like Basudevapur, Bhandaripokhari and Dhamnagar forest cover is absent.

The PIA falls in the Chandbali Range and it consists of four sections and eleven Beats. This Division forms a part of buffer area of Gahirmatha Sanctuary and Bhitarkanika National Park. The movement of Crocodiles in Baitarani and Matai River is monitored. During nesting period of turtles, regular patrolling is conducted by On-shore (4 no's) and Off-shore (1 no.) camps. Census of crocodiles, birds, elephants and dolphins are done every year in this Division. The coastal stretch is covered with mangrove vegetation of varying width. It is almost pure mangrove vegetation of *Avicennia marina* locally known as Bani.

Kendrapara District:

As per classification adopted by the Wildlife Institute of India, the entire forest division falls in the Eastern Plateau, Biotic Province under the Deccan Peninsula Bio-geographic Zone. There are wild stretches of jungle along the seacoast. Indigenous quail, hare and black partridge are found in the scrub jungle and migratory quail are found in the scrub jungle of Kalibhanja Dian, Bhitarkanika and Bagapatia forest blocks¹³. Both Bhitarkanika Wildlife Sanctuary (BWLS) and National Park (BNP) and Gahirmatha Marine Sanctuary (GMS) are located in this district. The BWLS, BNP and GMS are falling within 15 km of PIA.

Bhitarkanika Wildlife Sanctuary and National Park

Mangroves of Bramhani and Baitarani delta of Kendrapara district have been declared as Bhitarkanika Wildlife Sanctuary located between 20°35' to 20°38' N latitude and 86°50' to 87° E longitudes. It covers an area of 672 km² and has been designated as a Wildlife Sanctuary in 1975 as per the Wildlife (Protection) Act, 1972. There are 381 villages inhabited by 1.96 lakh people. Bhitarkanika is endowed with very complex sub-ecosystem of freshwater, marine and terrestrial, which intricately mixed with each other. Bhitarkanika was declared as "Ramsar Wetland Site" of International Significance on 19th August 2002¹⁴. Declared wetland Area is 65,000 Ha. The general elevation above mean sea level is between 1.5 to 2 metres. Higher ground extends to 3-4 metres. Apart from hosting the largest known sea turtle nesting beach in the world and the highest density of saltwater crocodile in the country, Bhitarkanika is a major breeding and wintering place for a multitude of resident and migratory water birds and is the east coast's major nursery for brackish water and estuarine fish fauna.

The area is influenced by heavy alluvial silt brought down by the rivers and deposited in the deltaic areas due to regular tidal inundation. The entire area is further influenced by high detrital content of the tidal material resulting from fallen mangrove leaves. The soil is clayey loam with sand, overlaid by rich humus layer. The climate of the area is tropical and the main rainy months are August and September. The area is prone to severe cyclonic storms twice

¹² Odisha District Gazetteers – Bhadrak, Gopabandhu Academy of Administration (Gazetteers unit), General Administration Department Government of Odisha, 2016

¹³ Odisha District Gazetteers – Kendrapara, Gopabandhu Academy of Administration (Gazetteers unit), General Administration Department Government of Odisha, 2016

¹⁴ <http://www.ramsar.org/sitelist.doc>

almost every year during April to May and October to November and also, there are occasional tidal bores.

Eco-Sensitive Zone of Bhitarkanika Sanctuary & Bhitarkanika National Park and Gahirmatha Marine Sanctuary, declared in the Gazette Notification dated 16th June 2015.

Flora of Bhitarkanika WLS: The flora of Bhitarkanika mainly includes mangroves and their associates. The mangroves are the salt marsh of the tropics covered by herbs, shrubs, and trees. Total 71 numbers of mangrove and their associates were found in Bhitarkanika along its fringe area¹⁵. The most predominant species are *Avicennia officinalis* (Badabani), *Avicennia alba* (Kalabani), *Excoecaria agallocha* (Guan), *Heritiera littoralis* (Sundari), *Sonneratia apetala* (Keoruan), *Rhizophora apiculata* (Rai), *Rhizophora mucronata* (Rai), *Kandelia candel* (Sindhuguan), *Ceriops decandra* (Garani), *Phoenix paludosa* (Hental), *Aegiceras corniculatum* (Kharasi). Some mangrove taxa like *Cerbera manghas*, *Acanthus volubilis*, *Xylocarpus granatum*, *Heritiera kanikensis* and *Bruguiera gymnorhiza* which are restricted to Bhitarkanika and are not found in other mangrove forests of Odisha. *Sonneratia apetala* is the dominant element found in abundance and in luxuriant state along the river banks of Bhitarkanika and its creeks.

The less frequent and rare (or) endangered plant include *Acanthus volubilis* (Harkanch), *Dolichandrone spathacea* (Gosinga), *Intsia bijuga* (Massitha), *Lumnitzera littorea* (Churanda), *Pandanus fascicularis* (Lunikia), *Rhizophora stylosa* (Rai), *Sapium indicum* (Batula), *Sonneratia caseolaris* (Orua), *Xylocarpus moluccensis* (Pitamari), *Xylocarpus mekongensis* (Pitakorua), *Heritiera kanikensis* (kanika sundari). These species are most common and found in the wet land and play an important role in building land mass, arresting soil erosion and controlling flood damage. Among the associated plant's Karanta (*Pongamia glabara*), kochila (*Strychnus nuxvomica*), Hintala (*Barringtonia racemosa*), Bania (*Hibiscus tilaceus*), Habali (*Thespesia populnea*), Miriga (*Salvadora persica*), etc. are conspicuous.

Notable herbs like *Bulbostylis barbata*, *Launaea sarmentosa*, *Spinifex littoreus*, *Cyperus arenarius*, *Finbribstylis sericea*, *Pedaliium murex*, *Trianthema portulacastrum* and *Gisekia pharnaceoides* etc. are found near Satavaya- Gahiramatha region.

In Bhitarkanika a variety of wild rice (*Potresia coarctata*) grows abundantly in tidal mud flats. Based on the genetic strain of this wild rice several saline and flood resistant varieties of rice have been developed.

Fauna of Bhitarkanika WLS: Bhitarkanika supports the highest density of endangered saltwater crocodile (*Crocodylus porosus*) in India. Nearly 1498 Saltwater Crocodile¹⁶ inhabit Bhitarkanika and its associated river systems. A crocodile project was operating at Dangamal since mid-1975 and it has a captive breeding and research centre for estuarine crocodile. Bhitarkanika is now boasts of a population of 1600 plus crocodiles with more than 200 breeding population. Population and trend of estuarine crocodile status is given in **Table 4-4**.

Table 4-4: Population and trend of Estuarine Crocodile

Year	Hatchling	Yearling	Juvenile	Sub-adult	Adult	Total
2010-11	531	377	304	166	276	1654
2011-12	489	320	423	154	260	1646
2012-13	486	356	395	128	284	1649
2013-14	504	387	307	142	304	1644
2014-15	511	380	317	149	308	1665

¹⁵ Behera and Nayak, 2013. *Floral Diversity of Bhitarkanika, East Coast of India and its potential uses*. J. Chem. Bio. Phy. Sci. Sec. B, Vol.3, No.3; 1863-1874

¹⁶ ENVIS Newsletter, Centre for Environmental Studies, Vol-11, No-1, Nov.-Jan.' 08

Year	Hatchling	Yearling	Juvenile	Sub-adult	Adult	Total
2015-16	597	342	269	164	299	1671

The wetland also supports Grey Pelican (*Pelecanus philippensis*) which is a vulnerable species according to IUCN Red List. The mangrove forests and its adjoining wetlands support large number of resident as well as migratory waterfowls.

Snakes of the area include the deadly poisonous Kingcobra (*Ophiophagus hannah*), Banded krait (*Bungarus fasciatus*) and the common krait (*B. caeruleus*). Non-poisonous snakes include Indian Rock python (*Python molurus*), Rat snake (*Ptyas mucosus*) and the water snake (*Natrix piscator*). Lizard species found in this area are India's largest lizard / Water monitor lizard (*Varanus salvator*) and Land monitor (*Varanus flavescens*); Chameleon (*Chameleo zeylanicus*), Garden lizard (*Calotes versicolour*), House gecko (*Hemindactylus* sp.) and the skink (*Mabuya* sp.)

Nearly 271 bird species were recorded in Bhitarkanika which include about 100 species of local and long distance migratory water birds. 82 species have been recorded to breed at Bhitarkanika¹⁷ and a total of 79 water bird species have been recorded from the area.

Some notable avifauna of the National Park are Grey heron (*Ardea cinerea*), Purple heron (*Ardea purpurea*), Darter (*Anhinga rufa*), Little cormorant (*Phalacrocorax niger*), Little egret (*Egretta gargetta*), Median egret (*Egretta intermedia*), Large egret (*Egretta alba*), Night heron (*Nycticorax nycticorax*), Lesser adjutant stork (*Leptoptilos javanicus*), Painted stork (*Mycteria leucocephala*), rare Black necked stork (*Ephippiorhynchus asiaticus*), Spoonbill (*Platalea leucorodia*), Brahminy kite (*Haliastur indus*), endangered White bellied sea eagle (*Haliaeetus leucogaster*), Pallas fishing eagle (*H. leucoryphus*), Osprey (*Pandion haliaetus*), Red jungle fowl (*Gallus gallus*), Red wattled lapwing (*Vanellus indicus*), Golden plover (*Pluvialis dominica*), Lesser sand plover (*Charadrius mongolus*), Curlew (*Numenius arquata*), Red shank (*Tringa totanus*), Little stint (*Calidris minutus*), Common Sandpiper (*Tringa hypoleucos*), Whimbrel (*Numenius phaeopus*), Indian river tern (*Sterna aurantia*), Rose-ringed parakeet (*Pstittacula krameri*), Koel (*Eudynamis scolopacea*), Spotted owlet (*Athene brama*), Rare white collared kingfisher (*Halcyon chloris*), Brown-winged storkbilled kingfisher (*Pelargopsis amauroptera*), Indian roller (*Coracias benghalensis*), Grey hornbill (*Tockus birostris*), Black-naped green woodpecker (*Picus canus*), Swallow (*Hirundo rustica*), Golden oriole (*Oriolus oriolus*), Indian tree pie (*Dendrocitta vagabunda*), Red whiskered bulbul (*Pycnonotus jacusus*), Paradise flycatcher (*Terpsisiphone paradisi*), Tailor bird (*Orthotornus sutorius*), Majpie robin (*Copsychus saularis*), Indian tree pipit (*Anthus hodgsoni*), Loten's sunbird (*Nectarinia asiatica*), Baya (*Ploceus philippinus*), and the common Rose finch (*Carpodacus erythrinus*). Bagagahana the heronry, provides nesting and living space to about 80,000 resident and local migratory birds. Also the numerous wetlands scattered throughout the sanctuary serve as a feeding and wintering ground for more than 50,000 migratory birds during the winter and early summer months. The population of rare birds is increasing in Bhitarkanika due to availability of sufficient fish and other aquatic food, besides calm and serene environment. Bhitarkanika Wildlife Sanctuary has been identified as an important bird area (IBA) of the country. Survey of Birds visiting the Heronry is given in **Table 4-5**.

¹⁷ Pandav, B. (1997). Birds of Bhitarkanika mangroves, eastern India. Forktail 12: 7-17.

Table 4-5: Birds of Heronry (Bagagahan)

Year	Total No. of Nests Counted	Number of Adults Counted	Number of Chicks	Total
2010-2011	7,026	14,056	28,112	42,168
2011-2012	12,826	25,652	34,321	59,973
2012-2013	15,422	30,844	39,261	70,105
2013-2014	17,547	35,094	44,458	79,548
2014-2015	19,784	39,568	51,977	91,545
2015-2016	20,501	41,014	55,423	96,437

Bhitarkanika mangroves are major breeding and nursery grounds for estuarine and brackish water fish, arthropod and mollusc fauna along the east coast of India. Some of the commercial fishes recorded in this area are Ilisha (*Hilsa Illisha*), Khainga (*Mullet* sp.), Bhekti (*Lates calcarifer*), Kantia (*Mystus gulio*), and Kokili (*Anchovella* sp.), Prawns such as *Penaeus indicus*, *Penaeus monodon*, *Metapenaeus affinis* and crabs mainly the Mud crab, *Scylla serrata* and Fiddler crab (*Uca* sp.).

Marine dolphin recorded from the area is Indo-pacific humpbacked dolphin (*Sousa chinensis*). Notable among the other mammalian fauna of Bhitarkanika are Fishing cats (*Felis viverrina*), the Jungle cat (*Felis chaus*), Hyaena (*Hyaena hyaena*), Wild boar (*Sus scrofa*), Rhesus macaque (*Macaca mulatta*), Indian percupine (*Hystrix indica*), Otter (*Lutra persipicillata*) and Rat (*Rattus rattus*). The Herbivores are represented by Chital or Spotted deer (*Axis axis*) and Sambar (*Cervus unicolor*).

Gahirmatha Marine Sanctuary

Gahirmatha Marine Wildlife Sanctuary is located at the mouth of the River Maipura, between the Dharma River and Paradeep, on the eastern boundary of Bhitarkanika Wildlife Sanctuary along the northern Odisha coast. It is notified on 27th September 1997 and published in the Odisha Gazette, extraordinary No. 1268 dated 17th October, 1997, located between 86°45'57" to 87°17' 36" E longitude and 20°17' 32" to 20°45'58" N latitude. The total area of the sanctuary is 1435.0 km² which includes 1408.0 km² of water body and 27.0 km² of land mass including reserve forests, mud flats and accreted sand bars. Core area of the sanctuary consists of 725.50 km² and the buffer zone accounts for 709.50 km². The entire sanctuary area comes within the revenue district of Kendrapara.

The Gahirmatha beach supports the largest known nesting beach of Olive Ridley Sea Turtle in the world. The Olive Ridley Sea turtle (*Lepidochelys olivacea*) arrive in thousands in the coastal waters during November - December. The mass nesting of olive ridley turtles at Gahirmatha takes place between December and March and the first arribada at Gahirmatha is sometimes followed by a second one of much lower intensity after a gap of 35 – 60 days. Olive Ridley Sea Turtle is an endangered species according to the IUCN Red List. Nearly half a million olive ridleys nest every year at Gahirmatha. Besides, the coastal waters off Gahirmatha are a major mating area for the olive ridley sea turtle that migrate to this coast every winter. A minimum of 1.5 lakh to maximum of 7.0 lakh with an average of 3.0 lakh female turtles visit the beach for nesting / egg laying during late December to April. Turtle nesting frequency at Arribada in Gahirmatha rookery area is shown in **Figure 4-8**.

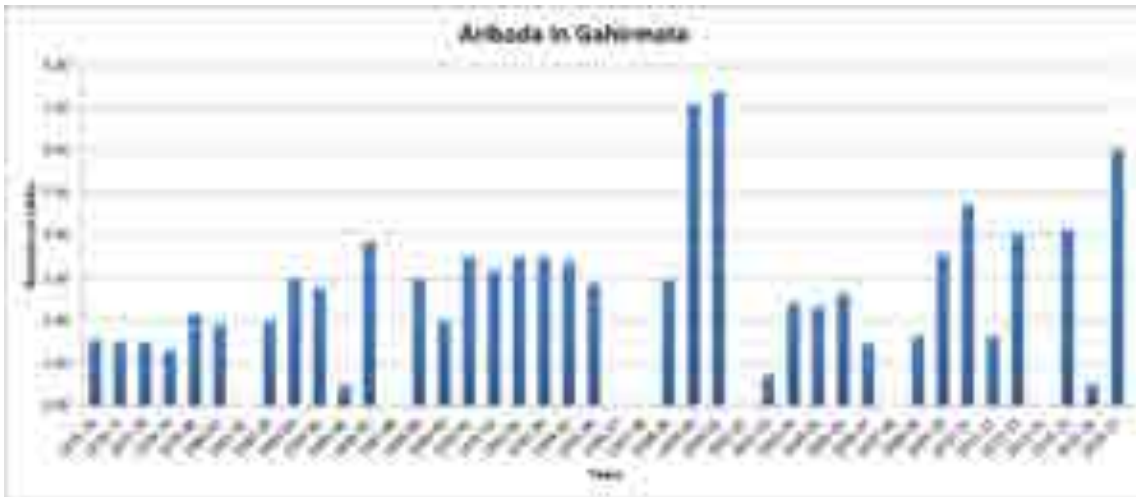


Figure 4-8: Olive Ridley nesting at Gahirmata Marine Sanctuary

The year 2016-2017 mass nesting numbers of 6,03,962 were reported in the “Times of India” dated March 05, 2017 Bhubaneswar Edition.

Periodic Status Survey of Wildlife is carried out to ascertain the population viability and impact of management inputs. Marine dolphins recorded from the Gahirmatha Marine Wildlife Sanctuary area are Irrawaddy dolphin (*Orcaella brevirostris*), Pantropical spotted dolphin, Common dolphin (*Delphinus delphis*) and Finless black porpoise (*Neophocaena phocaenoides*).

4.4.3.2 Wetlands (Lakes, Reservoirs, Marshy Lands, Ponds etc.)

The Bhadrak district wetland area is estimated to be 19017 Ha forming nearly three per cent of total geographic area of the district. The major wetland categories are River/Stream (4989 Ha) comprising of about 26% followed by Aquaculture ponds (~24%), Intertidal mud flats (~20%) and Mangroves (~15%). The extent of open water was estimated to be 9886 Ha in post monsoon season and has not shown any significant seasonal reduction¹⁸.

The Kendrapara district wetland area is estimated to be 49284 Ha forming nearly seven per cent of total geographic area of the district. The major wetland categories are Mangroves (19277 Ha) comprising of about 39% followed by River/Stream (~36.39%) and Intertidal mudflats (~10.65%). The extent of open water was estimated to be 21516 Ha in post monsoon season and 21412 Ha in pre-monsoon season.

4.4.3.3 PIA District Agricultural Profile

Bhadrak and Kendrapara Districts falls in North Eastern Coastal Plain (OR-3) of Agro Climatic Zone (NARP) and East coast plains and hills region (XI) of Agro-Climatic Region (Planning Commission) with Agro Ecological Sub Region (ICAR) characteristics of Eastern Ghats, hot moist sub humid eco sub region; Gangetic delta, hot moist sub humid eco sub region; Utkal plain and East Godavari delta, hot dry sub humid eco sub region (18.4)¹⁹.

Bhadrak District: Highest gross cropped area has been seen in Chandbali followed by Basudevpur block while lowest is recorded in Bonth followed by Bhandaripokhari blocks

¹⁸ Source: SAC/EPISA/AFEG/NWIA/ATLAS/28/2010- National Wetland Atlas: Odisha, (ISRO), Ahmedabad and Odisha State Remote Sensing Application Centre, Bhubaneswar, September 2010

¹⁹ Agriculture Contingency Plan District: Bhadrak, 2011

respectively. With respect to net sown area, highest value has been recorded in Chandbali block followed by Basudevapur block while lowest value has been recorded in Dhamnagar followed by Bhandaripokhari and Bonth Blocks. Maximum area in Chandabali has been recorded to be sown more than once. Maximum cropping intensity of 150.83% is seen in Dhamnagar block followed by Tihidi (142.2%) while in Chandabali block, minimum cropping intensity of 109.32 % is recorded among all the blocks in Bhadrak district.

Rice is the staple food of the people and paddy is the principal food crop followed by bajra, jowar and ragi crops. Tobacco, Groundnut, Chillies, Sesamum, Sugarcane are also cultivated.

Biomass and Livestock: Livestock density per km² is around 136 numbers, whereas the state average is 122 numbers. Bhadrak had been a traditional milk-surplus district. Milk and milk products were marketed in neighbouring districts and West Bengal²⁰.

The majority of livestock farming is centred on rearing of indigenous cows followed by poultry and goats. However, pigs, sheep's, ducks, hybrid cows and buffalos are being reared on very small scale. Total livestock population of the district is 689086.

Kendrapara District: The Staple crops of the district are Paddy, Jute, vegetable and Spices in Kharif and Paddy, Moong, Biri, Ground nut, Til, Mustard, Sun flower and Sugar cane in Rabi Season. The important horticultural crops are coconut, Mango, Banana are grown in the district. Main vegetables cultivated in the district are potato, sweet potato, brinjal, cow pea, lady's finger, pumpkin, spine gourd, Kundu, cauliflower, cabbage and arum.

As per the Livestock census 2012, the district has a livestock population of 623479 consisting 130975 poultry birds, 1439 ducks, 1200 pigs, 107829 goats, 14558 sheep, 367478 cows and 14012 buffalos.

4.4.4 Topography - PIA Districts

Bhadrak District: The area basically is comprised of deltas formed by two major rivers namely Salandi & Baitarani and half a dozen of rivers and rivulets. Thus the whole district is a fertile monotonous alluvial plain that slopes from West to East following the river gradients. The plain is usually intersected by its own set of rivers and marshland can be seen here and there prominently close to Sea line. Thus the district is devoid of upland and hills.

Kendrapara District: The topography of the coastal district is dominated by the fluvial actions of the meandering streams and littoral action of the tides, waves and currents.

Topography of the PIA shows that it is distributed in between 0 ft to 11 ft elevation with sloping toward east. Topographical map of PIA is shown in **Figure 4-9**.

²⁰ District Irrigation Plan of Bhadrak (Odisha), Pradhanmantri Krishi Sinchayee Yojana(PMKSY), March, 2016



(Source: en-in. topographic-map.com; Google web site)

Figure 4-9: Topographical map

Slope of the PIA:

The slope of the Project area is 0-3% with 0-1% slope considered as level to nearly level and 1-3% as very gently sloping. The 15km buffer of the Project area majorly in the slope range of 0-3% slope and specifically the slopes of Bhadrak district falling in the buffer area is having majority of 0-1% sloping and few areas with 3-8% (gently sloping category) specially the river area. In Kendrapara district falling under the buffer there is a majority of 1-3% sloping and few areas with 3-8% (gently sloping category). Slope map of the Project area with 15km buffer is given in **Figure 4-10**.



(Source: Bhuvan-NRSC)

Figure 4-10: Slope map of Project area with 15km buffer

4.4.5 Geology and Mineral Resources - PIA Districts

Bhadrak District: The area comes under the coastal plains of the east coast. More precisely this area is a part of the middle coastal plain of depositional landforms of recent origin and geologically belongs to post tertiary period. The area basically comprises deltas formed by several rivers. Thus the whole district is a fertile monotonous alluvial plain that slopes from West to East following the river gradients. The plain is usually intersected by its own set of rivers and marshland can be seen here and there prominently close to sea line. However, the land in a village would differ in characteristics such as the extent of alluvial soil and sand, which determines the cropping pattern, and other use such as water bodies and grassland. The district is devoid of upland and hills. The salt tract is a narrow belt which stretches just beyond the shore line for about 3 to 6 km inland. There are no mineral resources in Bhadrak district.

Kendrapara District: The area covered by soft quaternary sediment overlying Baripada beds of Tertiary age. A total of five Quaternary units are identified within the district, namely

(i) Older beach deposit (ii) Upper delta deposit (iv) Younger beach deposit and (v) Present day coastal deposit. Older beach deposit consisting of compact sand and silt of Late Pleistocene to Early Holocene age occurs as small patches (mainly small ridges) within Lower Delta deposit. Lower and Upper delta deposit consist of clay with fine sand and silt and altering layers of sandy silt and silty clay respectively. Both are of Middle to Late Holocene age. Major difference between is that lower Delta is a marine deposit whereas Upper Delta is typically fluvial deposit. Areas near the Bay of Bengal sea shore are mainly occupied by younger beach deposit consisting of very fine sand and silt. This is a marine-Aeolian deposit and occurs as small ridges. Present day coastal deposit occurs within narrow zone and consists of medium grained sand with heavy mineral. Both younger beach deposit and present day coastal deposit are of Late Holocene age. The beach and sand dune deposits along the coast contains heavy minerals like monazite, rutile, illeminite and zircon etc. Such deposit in theses sand bodies has been estimated as 1.8 Million Tonnes with a grade of 33.18% of heavies. The River Sand deposits have been reported around Tulasipur, Tradipal, Penthapal, Pakshata, Artamula, Mangalpur, Bhagabatpur, Basupur, Sathilo, Amrutamonohi, Naladia, Pandia, Gaudagaon, Korua, Akhuadakhini, Ramachandrapur, Talakusuma and Haridaspur area on the river bed of Luna, Brahmani, Chitroptala and Mahanadi. Clay of Upper deltaic deposit is used for brick kiln industry.

The project site is located at average (-) 1.0 m CD to (+) 3.5 m CD level. Project site is sloping towards East i.e., towards Sea side.

4.4.5.1 Geo morphological Observations of Project Area

The area between HTL and the LTL is plain and there are no rocky outcrops and this intertidal zone is silty and sandy area. The inter-tidal zone consists mainly of silty and sandy sediments²¹. Coastal geomorphology changes abruptly and dense to scattered mangrove patches are found along North and South side of the Port. The project boundary is falling out side notified Eco-Sensitive Zone of Bhitarkanika National Park.

4.4.6 Soil profile of PIA district

Bhadrak District: In general, three groups of soils are found in the district of Bhadrak. These soil groups are classified in to Matured, red and lateritic soil (alfisols), mixed grey soil (inceptisols), unaltered soils with coarse parent materials (entisols) and Unclassified soil (with mud flats) and seems to be heterogenous in colour, texture and exhibits other hysiochemical variations. Among all these, soil groups inceptisols are found to the most dominant group of soil in most of the blocks of district (Dhamnagar, Tihidi, Chandbali, Bonth, Bhadrak and Basudevapur) except Bhandaripokhari block where alfisols are the domiant soil group. Maximum area of inceptisols and entisols are found in Chandbali block while least is observed in Bhandaripokhari block. Unclassified soils with mud flats are concentrated in Basudevapur Block. Soils are mostly loamy and heavy clay type.

Kendrapara District: The district is predominately occupied by tertiary and recent alluvium brought down by distributaries of the rivers. The soil is divided into four categories viz. Matal or clay land, Dorasa or loamy soil, Balia or sandy soil and Patu or alluvial soil. Chikita is strong sticky clay, which is almost too stiff to be used for successful cultivation²². The soil of

²¹ Demarcation of HTL, LTL and Setback lines for the Revised Master Plan of the Dhamra Port Company Ltd., Dhamra, Odisha by NIO, Visakhapatnam, May 2016.

²² Odisha District Gazetteers – Kendrapara, Gopabandhu Academy of Administration (Gazetteers unit), General Administration Department Government of Odisha, 2016

One time soil sampling at *Ten (10)* locations within the study area during the study period carried out. At each location, soil samples were collected from three different depths below the surface and homogenized. The homogenized samples were analysed for physical and chemical characteristics. Soil analysis was carried as per IS: 2720 methods. Soil quality monitoring locations and analytical results are given in **Table 4-6** and **Table 4-7**. A map showing the soil sampling locations is given as **Figure FD0401**. The status of soil quality assessed during post-monsoon season, 2017 and winter season, 2017-18 are given as **Appendix G**.

Table 4-6: Soil sampling locations

S. No	Location	Code	Distance (KM)	Direction	Project area/ Study area	Environmental Setting
1	Prop. Expansion Site	S1	-	-	Project area	Open Land
2	Port Site	S2	-	-	Project area	Urban Area/Open Land
3	Rabindranagar	S3	0.1	W	Study area	Agricultural Area
4	Kishorprasad	S4	0.5	W	Study area	Agricultural Area
5	Kanakaprasad	S5	0.6	W	Study area	Residential Area
6	Bali Sahi	S6	1.4	W	Study area	Open Land
7	Sabitri Sarai	S7	1.5	W	Study area	Open Land
8	Narsinghprasad	S8	1.6	W	Study area	Agricultural Area
9	Tikaitnagar	S9	4.4	SSW	Study area	Agricultural Area
10	Dakshina Dhamra	S10	5.2	W	Study area	Open Land

Table 4-7: Soil Quality Monitoring Results

S. No	Parameters		Units	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1	Texture/ Particle size Distributions	Sand	%	12	14	15	18	15	18	15	13	15	12
		Silt	%	65	58	62	32	64	32	28	58	65	61
		Clay	%	23	28	23	50	21	50	57	29	20	27
2	Color		--	Light Brown	Light Brown	Brown	Brown	Brown	Brown	Light Brown	Brown	Brown	Brown
3	Soil Type		--	Silty Clay	Silty Clay	Silty Clay	Clay	Silty Clay	Clay	Clay	Silty Clay	Silty Clay	Silty Clay
4	pH (10% Slurry)		-	7.79	7.96	6.78	8.52	7.39	7.95	7.69	7.56	7.59	7.64
5	Conductivity		µmhos/cm	8690	8258	2230	1381	104	1407	1246	124	156	2664
6	Bulk density		gram/cc	1.18	1.2	1.21	1.24	1.16	1.18	1.23	1.18	1.24	1.23
7	Porosity		% v/v	72	68	70	72	58	64	60	64	65	63
8	Sodium Absorption Ratio S.A.R		%	12.3	10.5	3.6	1.24	0.24	2.8	1.9	0.18	1.05	0.86
9	Infiltration capacity		mm/h	24	26	24	22	26	28	32	24	28	26
10	Nitrogen as N		mg/100grm	358	324	316	289	325	298	305	316	279	304
11	Potassium as K		mg/100grm	125	136	142	81	134	115	131	148	76	93
12	Phosphorus as P		mg/100grm	68	78	89	69	96	91	81	78	69	72
13	Zinc as Zn		mg/kg	1.2	2.6	1.3	3.9	3.6	4.6	2.5	4.2	3.2	4.1
14	Cadmium as Cd		mg/kg	0.08	0.16	0.01	<0.01	<0.01	0.08	0.04	<0.01	<0.01	<0.01
15	Cation exchange Capacity		meq/100gr	0.25	0.32	0.89	0.66	1.24	1.24	2.14	1.06	0.45	0.54
16	Alkali Metals		mg/kg	25.3	32.6	12.2	12.6	1.6	5.6	6.2	2.5	2.2	14.8
17	Permeability		Cm/sec	3.6	2.5	4.6	3.9	3.6	3.2	2.9	4.5	1.3	4.1
18	Water holding capacity		%	68	72	65	65	68	56	51	72	69	76
19	Chromium as Cr		mg/kg	0.35	0.42	0.19	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	0.06
20	Copper as Cu		mg/kg	<0.01	<0.01	<0.01	0.09	0.24	<0.01	0.04	0.16	0.09	0.11
21	Iron as Fe		mg/kg	0.16	0.08	0.17	0.11	0.14	0.09	0.13	0.16	0.14	0.09
22	Manganese as Mn		mg/kg	<0.01	<0.01	<0.01	0.08	0.24	<0.01	<0.01	0.36	0.04	0.05
23	Lead as Pb		mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

S. No	Parameters	Units	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
24	Nickel as Ni	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

4.4.8.1 Results and Discussions

Inferences on soil quality are given below.

- Soil Texture varied from Silty Clay to Clay
- Sand ranged between 18% at Kishorprasad (S4) and Bali Sahi (S6) respectively to 12% at Prop. Expansion Site (S1) and Dakshina Dhamra (S10) respectively
- Silt ranged between 65% at Prop. Expansion Site (S1) and Tikaitnagar (S9) respectively to 28% at Sabitri Sarai (S7)
- Clay ranged between 57% at Sabitri Sarai (S7) to 20% at Tikaitnagar (S9)
- The bulk density of the soil ranged between 1.24 g/cc at Kishorprasad (S4) and Tikaitnagar (S9) respectively to 1.16 g/cc at Kanakaprasad (S5)
- Porosity ranged between 72%v/v at Prop. Expansion Site (S1) to 58%v/v at Kanakaprasad (S5)
- Infiltration capacity ranged between 32 mm/h at Sabitri Sarai (S7) to 22 mm/h at Kishorprasad (S4)
- Water holding capacity ranged between 76% at Dakshina Dhamra (S10) to 51% at Sabitri Sarai (S7)
- Permeability ranged between 4.6 cm/sec at Rabindranagar (S3) to 1.3 cm/sec at Tikaitnagar (S9)
- pH ranged between 8.52 at Kishorprasad (S4) and 6.78 at Rabindranagar (S3)
- Conductivity ranged between 8690 μ mohs/cm at Prop. Expansion Site (S1) and 104 μ mohs/cm at Kanakaprasad (S5)
- Sodium Absorption Ratio ranged between 12.3% at Prop. Expansion Site (S1) to 0.18% at Narsinghprasad (S8)
- Cation exchange Capacity ranged between 2.14 meq/100g at Sabitri Sarai (S7) to 0.25 meq/100g at Prop. Expansion Site (S1)
- Nitrogen (N) ranged between 358 mg/100g at Prop. Expansion Site (S1) and 279 mg/100g at Tikaitnagar (S9)
- Phosphorus (P) ranged between 96 mg/100g at Kanakaprasad (S5) and 68 mg/100g at Prop. Expansion Site (S1)
- Potassium (K) ranged between 148 mg/100g at Narsinghprasad (S8) and 76 mg/100g at Tikaitnagar (S9)
- Zinc ranged between 4.6 mg/kg at Bali Sahi (S6) and 1.2 mg/kg at Prop. Expansion Site (S1)
- Cadmium ranged between 0.01 mg/kg at Rabindranagar (S3) and 0.16 mg/kg at Port Site (S2) and below detectable at Kanakaprasad (S5), Bali Sahi (S6), Narsinghprasad (S8) and Tikaitnagar (S9)
- Chromium ranged between 0.42 mg/kg at Port Site (S2) and 0.06 mg/kg at Dakshina Dhamra (S10) and below detectable at Kanakaprasad (S5), Bali Sahi (S6), Narsinghprasad (S8) and Tikaitnagar (S9)
- Copper ranged between 0.24 mg/kg at Kanakaprasad (S5) and 0.04 mg/kg at Sabitri Sarai (S7)
- Iron ranged between 0.08 mg/kg at Port Site (S2) and 0.17 mg/kg at Rabindranagar (S3)
- Lead and Nickel are below detectable limits

4.4.8.2 Soil Quality Status Based on Data generated during 2014-2015

Apart from above, baseline environmental monitoring was carried out by DPCL envisaging the revised master plan proposal covering Three (03) Seasons (36 weeks or 9 months) was also reviewed with respect to soil.

In line with the suggestion given by EAC, MoEF&CC during ToR meeting and vide its MoM (2nd meeting of Expert Appraisal Committee (Infra-2), MoEF&CC) and to understand the environment in a comprehensive manner the collected data during Summer season, 2014, Post monsoon season, 2014 and Winter season, 2014-15 with respect to Soil has been reviewed and presented below.

Inferences on comprehensive soil quality assessment are given below.

- Sand ranged between 35.3% at Kishore Prasad and 23.9% at Narsingh Prasad both during summer season
- Silt ranged between 40.5% at Port Site during summer to 31.4% at Narsingh Prasad during winter season
- Clay ranged between 43.7% at Kanak Prasad during winter to 27.55% at Port Site during summer
- The bulk density of the soil ranged between 1.72 g/cc at Kishore Prasad during summer to 1.42 g/cc at Proposed Site and Rabindra Nagar during Post monsoon season and Winter season respectively
- Porosity ranged between 33.8%v/v at Rabindra Nagar and Sabitri Sarai during Post monsoon season and Winter season respectively to 27.1%v/v at both during Post monsoon season and Winter season respectively
- Infiltration capacity ranged between 3.6 cm/h at Proposed Site and Rabindra Nagar during Post monsoon season and Winter season respectively to 2.35 cm/h at Tikait Nagar and Proposed Site both during Post monsoon season and Winter season respectively
- Water holding capacity ranged between 39.4% at Bali Sahi and Narsingh Prasad to 28% at Tikait Nagar and Proposed Site both during Post monsoon season and Winter season respectively
- pH ranged between 8.13 at Sabitri Sarai during Winter season and 7.17 at Kanak Prasad during Post monsoon; soils are normal to alkaline in nature
- Sodium Absorption Ratio ranged between 16.4% at Kishore Prasad to 7.1% at Narsingh Prasad both during Summer season
- Cation exchange Capacity ranged between 26.55 meq/100g at Tikait Nagar, Kanak Prasad and Kishore Prasad during Summer, Post monsoon and winter seasons respectively to 20.15 meq/100g at Kanak Prasad during summer season
- Nitrates as NO₃ ranged between 11 mg/100g at Narsingh Prasad during summer and 3 mg/100g at Proposed Site and Rabindra Nagar during Post monsoon season and Winter season respectively
- Phosphates as PO₄-2 ranged between 9 mg/100g at Kanak Prasad and Narsingh Prasad during summer and 4 mg/100g at Proposed Site during summer, Sabitri Sarai during Post monsoon season and Port Site during winter seasons respectively
- Potassium (K) ranged between 7 mg/100g at Bali Sahi and Kishore Prasad during summer, Rabindra Nagar and Dakshin Dhamra during Post monsoon and Sabitri Sarai and Kanak Prasad respectively and 3 mg/100g at Proposed Site and during summer, Proposed Site and Sabitri Sarai during Post monsoon and Port Site and Rabindra Nagar during winter season respectively
- Zinc ranged between 0.48 mg/kg at Kishore Prasad and 0.25 mg/kg at Proposed Site both during summer season respectively

- Copper ranged between 0.45 mg/kg at Rabindra Nagar during Post monsoon and Sabitri Sarai during winter season respectively and 0.29 mg/kg at Proposed Site both during summer season
- Lead ranged between 0.08 mg/kg at Sabitri Sarai during summer and winter season and Rabindra Nagar during Post monsoon respectively to 0.03 mg/kg at Proposed Site during summer and winter and Tikait Nagar during summer, Kanak Prasad during Post monsoon and Rabindra Nagar and Kishore Prasad during winter seasons respectively
- Nickel ranged between 0.08 mg/kg at Kanak Prasad during summer to 0.05 mg/kg at most of the locations during all the three seasons
- Cadmium and Chromium are reported below detectable limits

4.5 Water Environment

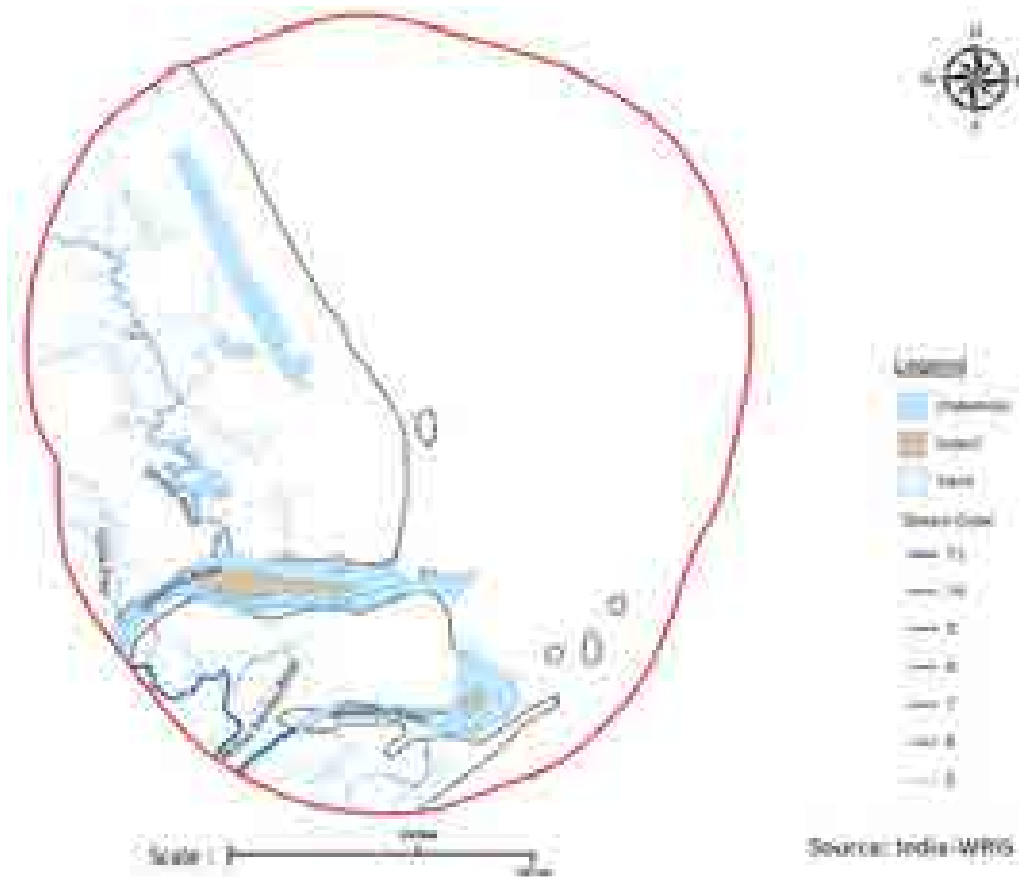
4.5.1 Hydrological Parameters - Drainage & Irrigation in PIA

4.5.1.1 Drainage

Bhadrak District: All the rivers have their source inside the State and thus they are mid streams and short streams. The main Rivers of the District are Baitarani, Salandi, Gamei, Kansbans, Matai, Kochila, Genguti, Reba, Kapali. The river systems in the district are classified mainly into two categories i.e. Baitarini River System and Salandi River System. The main tributary rivers of Baitarini are Genguti and Kochila but Reba. Kapali and Matai are the tributaries of Salandi.

Kendrapara District: There are three major river systems in this District viz. Mahanadi system, Bramhani system and the Baitarani system. Cultivable alluvial plains are formed from the deposits of these river systems and contribute to agricultural prosperity of the district. The district is bisected by rivers like the Mahanadi, the Brahmani and the Baitarini and many other streams and their tributaries like Luna, Chitrotpala, Karandia, Govari, Kharashuan, Dhamara, Meinpura, Kani and Birupa.

Drainage map of the project study area with 15km buffer is shown in **Figure 4-12**.



(Source: India-WRIS website)

Figure 4-12: Drainage map of 15km buffer area of Project site

4.5.1.2 Irrigation Resources

The surface irrigation sources of Bhadrak district primarily includes canal (Major & medium irrigation), various water-bodies including rainwater harvest.

4.5.2 Water Quality Assessment

The baseline status of water quality has been assessed through the identification of water resources and appropriate sampling locations for surface and groundwater in the study area. The sampling locations for both surface and groundwater are shown in **Figure FD0402**. The water samples were collected once during the study period and were analysed for physical, chemical and bacteriological parameters. Standard methods prescribed for sampling and analysis were adopted. Sampling protocol was based on the hydrogeological conditions of the region and also based on the competitive usage of the respective water source from which the sample has been collected.

The prevailing status of water quality has been assessed during the study period. The water samples were collected around 15 km radial distance where **Three (03)** sampling stations for surface water and **Seven (07)** sampling stations for groundwater were selected for the study area and analysed in accordance with standard test methods.

4.5.3 Surface Water Quality

Total **Three (03)** surface water monitoring locations were identified for assessment in different villages around the project site based on the usage of surface water by the settlements/ villages in the study area.

Water sample analysis with respect to physico-chemical, nutrient, demand and bacteriological parameters having relevance to public health and aesthetic significance are selected to assess the water quality status with special attention. Standard methods prescribed for surface sampling and analysis were adopted. Surface water quality monitoring locations and results are given in **Table 4-8** and **Table 4-9**. The status of surface water quality assessed during post-monsoon season, 2017 and winter season, 2017-18 are given as **Appendix G**.

Table 4-8: Description of Surface Water Locations

Station No.	Location	Distance from Project Boundary (km)	Azimuth Directions	Project Area/Study Area	Environmental Setting
SW1	Dhamra River	5.7	WSW	Study Area (Rivers)	Washing, Bathing and Agriculture
SW2	Matai Nadi near Harishpur	6.3	WSW		Washing, Bathing and Agriculture
SW3	Matai Nadi near DPCL Intake Point	7.3	WNW		Washing, Bathing and Agriculture

Table 4-9: Surface Water Quality Results

Parameters	Units	SW1	SW2	SW3	Tolerance Limits for Inland Surface Waters, Class – C
pH	-	8.25	8.20	8.18	6.5 to 8.5
Colour	Hazen units	200	200	200	300
Conductivity	μS/cm	50625	42600	35508	-
Turbidity	NTU	24.68	22.03	20.14	-
Taste	Agreeable	Unagreeable	Unagreeable	Unagreeable	-
Odour	Unobjectionable	Objectionable	Objectionable	Objectionable	-
Temperature	°C	28.7	27.6	29.3	-
Dissolved Oxygen	mg/L	5.4	5.2	5.50	4.0
BOD (3 days at 27°C)	mg/L	20	16	12	3.0
COD	mg/L	130	110	108	-
Total Dissolved Solids	mg/L	31356	26418	22015	1500
Total Solids	mg/L	31404	26470	22067	-
Total Hardness	mg/L	5000	4600	3800	-
Chloride as Cl	mg/L	14605.7	12604.2	10604.1	600
Fluorides as F ⁻	mg/L	1.80	1.60	1.50	1.5
Sulphate as SO ₄	mg/L	3549.2	2602.2	1996.4	400
Total Alkalinity	mg/L	1000	800	700	-
Nitrates as NO ₃	mg/L	27.1	25.2	23.9	50.0
Cyanides as CN	mg/L	<0.001	<0.001	<0.001	0.05
Calcium as Ca	mg/L	320	200	160	-
Magnesium as Mg	mg/L	1008	984	816	-
Sodium as Na	mg/L	9336.8	7677.8	6411.7	-
Potassium as K	mg/L	5.0	4.7	4.8	-
Iron as Fe	mg/L	0.42	0.36	0.30	50.0
Chromium Cr ⁶⁺	mg/L	0.068	0.051	0.042	0.05

Parameters	Units	SW1	SW2	SW3	Tolerance Limits for Inland Surface Waters, Class – C
Cadmium as Cd	mg/L	0.035	0.041	0.033	0.01
Lead as Pb	mg/L	<0.001	<0.001	<0.001	0.1
Copper as Cu	mg/L	0.071	0.055	0.043	1.5
Arsenic as As	mg/L	<0.001	<0.001	<0.001	0.2
Selenium as Se	mg/L	<0.001	<0.001	<0.001	0.05
Phenolics as C ₆ H ₅ Oh	mg/L	< 0.001	< 0.001	< 0.001	0.005
Zinc as Zn	mg/L	2.16	1.16	0.87	15
Mercury as Hg	mg/L	<0.0002	<0.0002	<0.0002	-
Salinity	psu	23.36	20.16	16.96	-
Anionic detergents as MBAS	mg/L	0.097	0.086	0.038	1.0
Residual Chlorine	mg/L	<0.02	<0.02	<0.02	-
Manganese as Mn	mg/L	0.093	0.084	0.062	-
Total Nitrogen	mg/L	2.64	1.40	0.98	-
Total phosphorus	mg/L	<0.02	<0.02	<0.02	-
Free Ammonia As NH ₄	mg/L	<01	<01	<01	-
Coliform Organisms	MPN/100 ml	230	150	120	5000
Faecal Coliform Organisms	MPN/100 ml	Nil	Nil	Nil	-

4.5.3.1 Results and Discussions

The following are the observations drawn from the results of surface water analysis;

- pH ranged between 8.18 to 8.25; surface waters are alkaline in nature
- Salinity ranged between 16.96 PSU at Matai Nadi near DPCL Intake Point (SW3) and 23.36 PSU at Dhamra River (SW1)
- Dissolved Oxygen (DO) ranged between 5.2 mg/l at Matai Nadi near Harishpur (SW2) and 5.5 mg/l at Matai Nadi near DPCL Intake Point (SW3)
- Chemical Oxygen Demand (COD) ranged between 108 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 130 mg/l at Dhamra River (SW1)
- Biochemical Oxygen Demand (BOD) ranged between 12 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 20 mg/l at Dhamra River (SW1)
- Electrical Conductivity (EC) ranged between 35508 µS/cm at Matai Nadi near DPCL Intake Point (SW3) and 50625 µS/cm at Dhamra River (SW1)
- Total Dissolved Solids (TDS) ranged between 22015 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 31356 mg/l at Dhamra River (SW1)
- Turbidity ranged between 20.14 NTU at Matai Nadi near DPCL Intake Point (SW3) and 24.68 NTU at Dhamra River (SW1)
- Total Hardness (as CaCO₃) ranged between 3800 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 5000 mg/l at Dhamra River (SW1)
- Total Alkalinity ranged between 700 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 1000 mg/l at Dhamra River (SW1)
- Chlorides (Cl) ranged between 10604.1 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 14605.7 mg/l at Dhamra River (SW1)
- Fluoride ranged between 1.5 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 1.8 mg/l at Dhamra River (SW1)
- Sulphates ranged between 1996.4 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 3549.2 mg/l at Dhamra River (SW1)
- Calcium ranged between 160 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 320 mg/l at Dhamra River (SW1)

- Magnesium ranged between 816 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 1008 mg/l at Dhamra River (SW1)
- Sodium (Na) ranged between 6411.7 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 9336.9 mg/l at Dhamra River (SW1)
- Potassium ranged between 4.7 mg/l at Matai Nadi near Harishpur (SW2) and 5.0 mg/l at Dhamra River (SW1)
- Manganese ranged between 0.062 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 0.093 mg/l at Dhamra River (SW1)
- Iron ranged between 0.3 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 0.42 mg/l at Dhamra River (SW1)
- Cadmium ranged between 0.033 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 0.041 mg/l at Matai Nadi near Harishpur (SW2)
- Chromium ranged between 0.042 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 0.068 mg/l at Dhamra River (SW1)
- Copper ranged between 0.043 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 0.071 mg/l at Dhamra River (SW1)
- Zinc ranged between 0.87 mg/l at Matai Nadi near DPCL Intake Point (SW3) and 2.16 mg/l at Dhamra River (SW1)
- Coli forms ranged between 120 MPN/100ml at Matai Nadi near DPCL Intake Point (SW3) and 230 MPN/100ml at Dhamra River (SW1)
- Lead, Arsenic, Selenium, Mercury, Residual Chlorine, Free Ammonia and Faecal coli forms are reported below detectable limits

Some of the parameters such as BOD, Fluorides, Cadmium, Chlorides, Chromium, TDS and Sulphates for surface water samples are exceeding the limits specified of Class C, Drinking water source after conventional treatment and disinfection, as Per limits specified in ISI-IS: 2296-1982. This might be due to tidal influx, surface drainage from land area and sewage discharges from nearby habitations. Higher values for Electrical Conductivity, TDS and chlorides in surface water were also recorded due to the tidal influx.

4.5.3.2 Surface Water Quality Status Based on Data generated during 2014-2015

In line with the suggestion given by EAC, MoEF&CC during ToR meeting and vide its MoM (2nd meeting of Expert Appraisal Committee (Infra-2), MoEF&CC) and to understand the environment in a comprehensive manner the collected data during Summer season, 2014, Post monsoon season, 2014 and Winter season, 2014-15 with respect to surface water has been reviewed for comparison and presented below.

Inferences on comprehensive surface water quality assessment are given below.

- pH ranged between 7.68 to 8.04; surface waters are neutral to alkaline in nature
- Dissolved Oxygen (DO) ranged between 2.8 mg/l at Dhamra River (SW1) during Post monsoon season and 3.8 mg/l at Matai Nadi Near DPCL Intake (SW3) during summer season
- Chemical Oxygen Demand (COD) ranged between 5 mg/l at Matai Nadi Near DPCL Intake (SW3) during Post monsoon season and 17 mg/l at Dhamra River (SW1) and Matai Nadi Near Harishpur (SW2) during Post monsoon and Winter seasons respectively
- Biochemical Oxygen Demand (BOD) ranged between 2 mg/l at Matai Nadi Near DPCL Intake (SW3) during Summer and Post monsoon seasons respectively and 5 mg/l at Dhamra River (SW1) during Summer and Post monsoon seasons and also at Matai Nadi Near Harishpur (SW2) during winter season respectively

- Electrical Conductivity (EC) ranged between 10200 $\mu\text{mhos/cm}$ at Matai Nadi Near DPCL Intake (SW3) during Post monsoon season and 21333 $\mu\text{mhos/cm}$ at Matai Nadi Near Harishpur (SW2) during summer season
- Total Dissolved Solids (TDS) ranged between 6840 mg/l at Matai Nadi Near DPCL Intake (SW3) during post monsoon season and 14490 mg/l at Matai Nadi Near Harishpur (SW2) during winter season
- Turbidity ranged between 3.2 NTU at Matai Nadi Near DPCL Intake (SW3) during summer season and 10.2 NTU at Dhamra River (SW1) during winter season
- Total Hardness (as CaCO_3) ranged between 1320 mg/l at Matai Nadi Near DPCL Intake (SW3) during post monsoon season and 2800 mg/l at Matai Nadi Near Harishpur (SW2) during summer season
- Total Alkalinity ranged between 200 mg/l at Dhamra River (SW1) and 600 mg/l at Matai Nadi Near Harishpur (SW2) both during summer season
- Chlorides (Cl) ranged between 3250 mg/l at Matai Nadi Near DPCL Intake (SW3) during winter season and 6450 mg/l at Matai Nadi Near Harishpur (SW2) during summer season
- Fluoride ranged between 1.27 mg/l at Matai Nadi Near DPCL Intake (SW3) during winter season and 1.71 mg/l at Dhamra River (SW1) during post monsoon season
- Sulphates ranged between 305 mg/l at Matai Nadi Near DPCL Intake (SW3) during post monsoon season and 1036 mg/l at Matai Nadi Near Harishpur (SW2) during winter season
- Calcium ranged between 226 mg/l at Dhamra River (SW1) during winter season and 321 mg/l at Matai Nadi Near Harishpur (SW2) during summer season
- Magnesium ranged between 151 mg/l at Matai Nadi Near DPCL Intake (SW3) during post monsoon season and 488 mg/l at Dhamra River (SW1) during summer season
- Sodium (Na) ranged between 1735 mg/l at Matai Nadi Near DPCL Intake (SW3) during post monsoon season and 3630 mg/l at Matai Nadi Near Harishpur (SW2)
- Potassium ranged between 14 mg/l at Matai Nadi Near DPCL Intake (SW3) during post monsoon season and 31 mg/l at Matai Nadi Near Harishpur (SW2) during summer season
- Manganese ranged between 0.035 mg/l at Matai Nadi Near DPCL Intake (SW3) during post monsoon season and 0.082 mg/l at Matai Nadi Near Harishpur (SW2) during winter season
- Iron ranged between 0.11 mg/l at Matai Nadi Near DPCL Intake (SW3) during post monsoon season and 0.36 mg/l at Dhamra River (SW1) during summer season
- Lead ranged between 0.018 mg/l at Matai Nadi Near DPCL Intake (SW3) during post monsoon season and 0.031 mg/l at Matai Nadi Near Harishpur (SW2) during winter season
- Arsenic ranged between 0.021 mg/l at Matai Nadi Near DPCL Intake (SW3) during post monsoon season and 0.037 mg/l at Dhamra River (SW1) during winter season
- Copper ranged between 0.021 mg/l at Matai Nadi Near DPCL Intake (SW3) and 0.055 mg/l at Dhamra River (SW1) both during winter season respectively
- Zinc ranged between 0.75 mg/l at Matai Nadi Near DPCL Intake (SW3) during post monsoon season and 1.27 mg/l at Matai Nadi Near Harishpur (SW2) during winter season
- Coli forms ranged between 5 MPN/100ml at Matai Nadi Near DPCL Intake (SW3) during post monsoon season and 24 MPN/100ml at Matai Nadi Near Harishpur (SW2) during winter season
- Cadmium, Chromium, Selenium, Mercury, Residual Chlorine, Free Ammonia, Phenolic compounds are reported below detectable limits and no Faecal coli forms were reported.

On comparison with the Class C, Drinking water source after conventional treatment and disinfection, as Per limits specified in ISI-IS: 2296-1982, and are within the limits except Chlorides, TDS, Sulphates, Fluorides and BOD.

Bhadrak District: Total ground water availability is primarily contributed through shallow tube wells (0.772 BCM per ha) followed by deep tube wells (0.312 BCM per ha) and medium tube well (0.075 BCM per ha). There is a total of 0.265 BCM per ha, 0.723 BCM per ha and 0.236 per ha of ground water available during kharif, rabi and summer season respectively in the Bhadrak district. There is a highest recharge and gap of ground water in Chandbali block followed by Basudevpur compared to other blocks. Hydrogeological Map of Bhadrak District is shown in **Figure 4-13**.



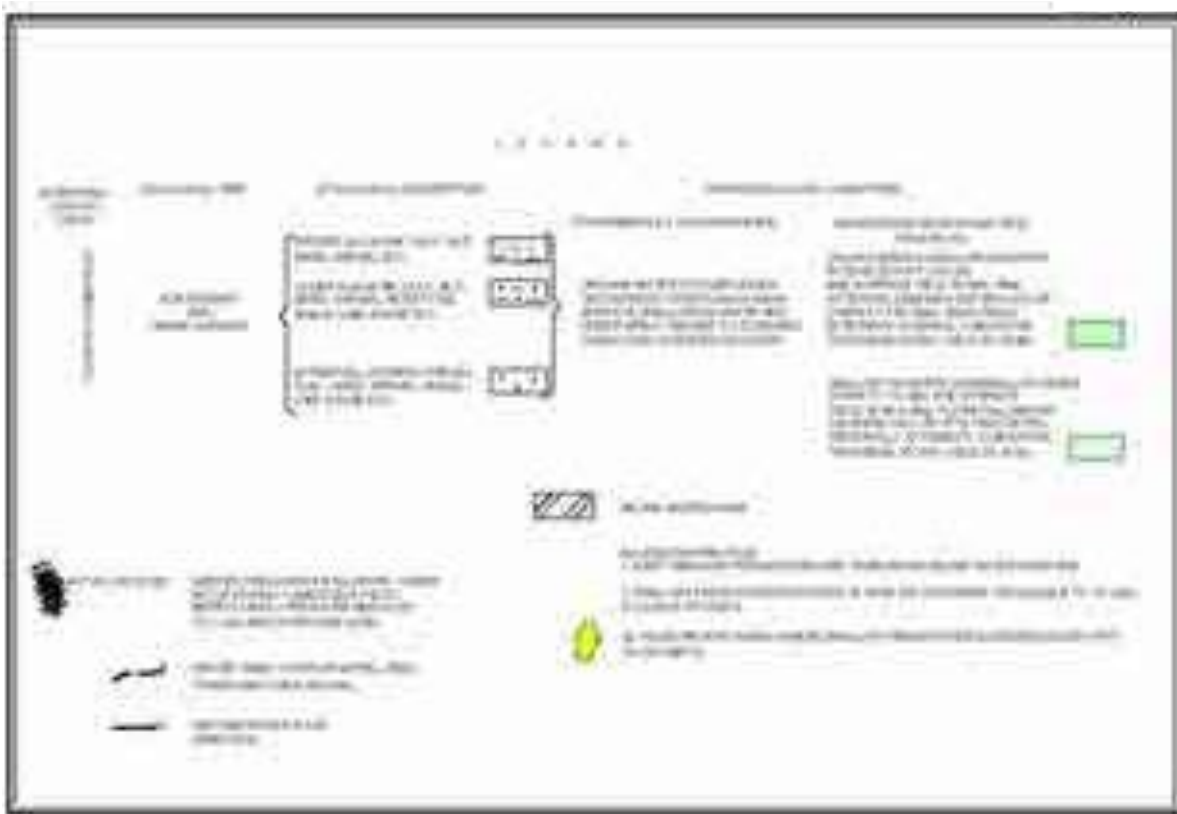


Figure 4-13: Hydrogeological Map of Bhadrak District

Kendrapara District: The aquifer system in the district may be broadly divided into (i) Shallow aquifer and (ii) Deeper aquifers. The thickness of shallow aquifers varies widely due to salinity problem²³. Normally the thickness of fresh shallow aquifers varies from 15 to 20m or more within the saline hazard tract lying west of Indipur-Kendrapara-Karliopatana section. The occurrence of fresh water bearing deeper aquifers is identified from available borehole data down to a maximum depth of 612m. In the major part of the district the depth of the boreholes are restricted to 300m. Hydrogeological Map of Kendrapara District is shown in **Figure 4-14**.

²³ Ground Water Information Booklet of Kendrapara District, Odisha, Central Ground Water Board Ministry of Water Resource South Eastern Region, Bhubaneswar, 2014

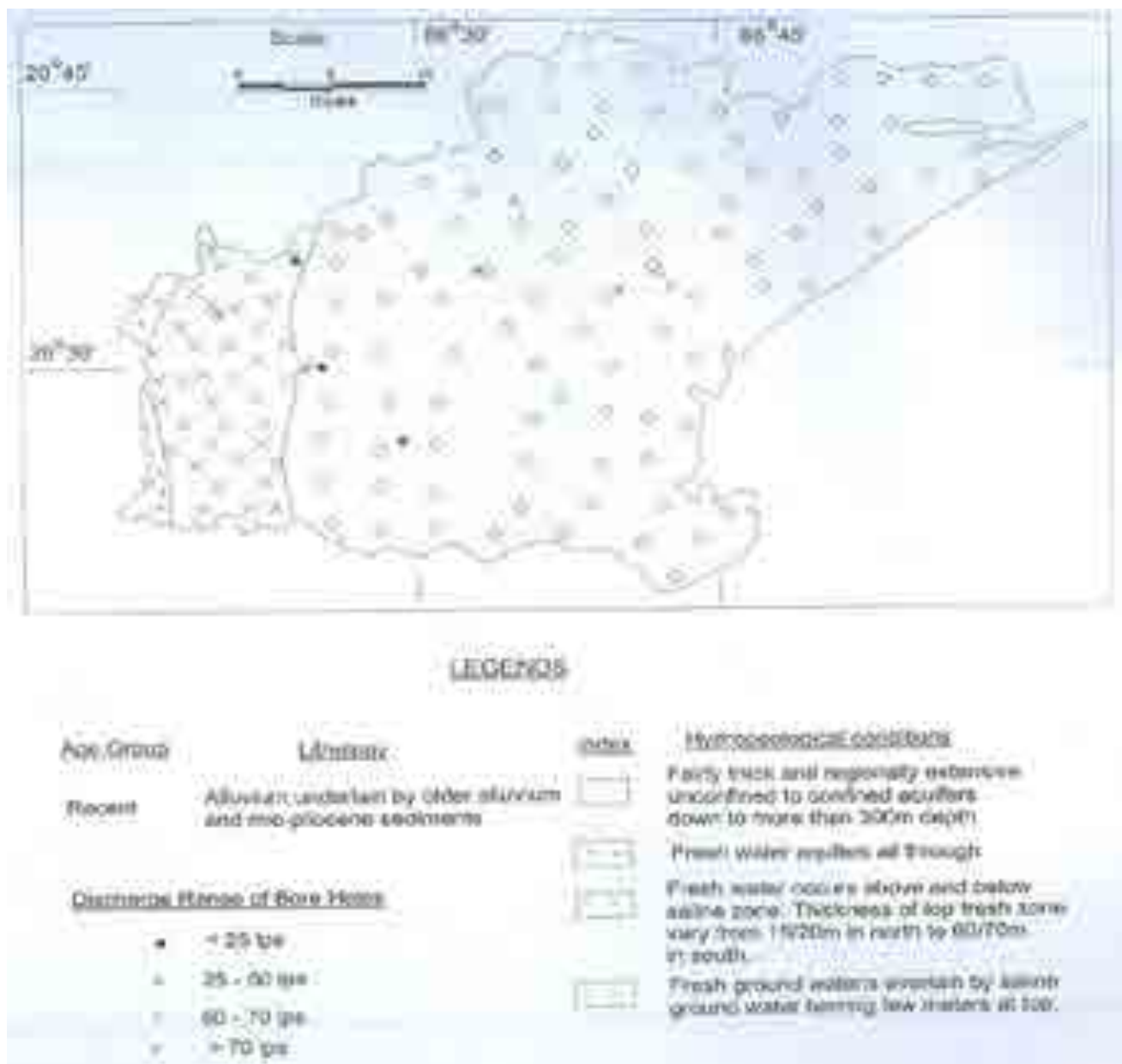


Figure 4-14: Hydrogeological Map of Kendrapara District

4.5.5 Groundwater Quality

The quality of groundwater is as important as quantity. As per Central Ground Water Board (CGWB) all the blocks are in the safe limits of ground water utilization in terms of quantity of groundwater resources available and amount of groundwater being exploited²⁴. Groundwater quality is saline in few blocks like Mahakalapada, Marshaghai, Rajkanika and Rajnagar. Hence groundwater structures are not feasible in those blocks. The details of groundwater draft, annual groundwater recharge and the gap in Bhadrak and Kendrapara blocks are given in **Table 4-10** and **Table 4-11**. The status of groundwater quality assessed during post-monsoon season, 2017 and winter season, 2017-18 are given as **Appendix G**.

²⁴ Ground Water Information Booklet of Bhadrak and Kendrapara Districts, Odisha, Central Ground Water Board Ministry of Water Resource South Eastern Region, Bhubaneswar, 2014

Table 4-10: Status of Ground Water Availability and Quality for Bhadrak District

Name of the Block	Status of Block as per CGWB			Ground Water (BCM)		
	Critical	Semi-Critical	Safe	Draft	Recharge	Gap
Basudevpur	-	-	Safe	0.0388	0.0779	0.0392
Bhadrak	-	-	Safe	0.0729	0.1082	0.0353
Bhandaripokhari	-	-	Safe	0.0629	0.096	0.0332
Bonth	-	-	Safe	0.0431	0.0772	0.0342
Chandabali	-	-	Safe	0	1.1006	1.1006
Tihidi	-	-	Safe	0.0222	0.0372	0.015
Dhamnagar	-	-	Safe	0.0268	0.0576	0.0308

Table 4-11: Status of Ground Water Availability and Quality for Kendrapara District

Name of the Block	Status of Block as per CGWB			Ground Water (BCM)		
	Critical	Semi-Critical	Safe	Draft	Recharge	Gap
Kendrapara	-	-	Safe	0.0133	0.0242	0.911
Derabish	-	-	Safe	0.0208	0.041	0.0202
Mahakalapara	-	-	Safe	0	0	0
Marshaghai	-	-	Safe	0	0	0
Garadpur	-	-	Safe	0.252	0.37	0.118
Pattamundai	-	-	Safe	0.0329	0.058	0.0251
Aul	-	-	Safe	0.038	0.0076	0.0038
Rajkanika	-	-	Safe	0	0	0
Rajnagar	-	-	Safe	0	0	0
Total	-	-	Safe	0.959	0.1678	0.0719

Total **Seven (07)** groundwater locations were identified for assessment in the study area. Description of ground water locations is given in **Table 4-12** and is shown in **Figure FD0402**. The Inland water quality results are presented in **Table 4-12**.

Table 4-12: Description of Groundwater Locations

Station No.	Location	Distance from Project Boundary (Km)	Azimuth Directions	Project Area/Study Area	Source	Environmental Setting
GW1	Port Site	-	-	Project Area	Hand Pump	Domestic Use
GW2	Kishorprasad	0.5	W	Study Area		
GW3	Kanakprasad	0.6	W			
GW4	Balisahi	1.4	W			
GW5	Sabitri Sarai	1.5	W			
GW6	Narsinghprasad	1.6	W			
GW7	Tikaitnagar	7.6	SSW			

Table 4-13: Groundwater Quality Results

Parameter	Unit	GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	Acceptable Limit as per IS10500:2012	Permissible Limit as per IS10500:2012
pH	-	7.27	7.48	7.53	7.73	7.57	7.58	7.52	6.5-8.5	No relaxation
Color	Hazen	<01	<01	<01	<01	<01	<01	<01	5	25
Taste	-	A	A	A	A	A	A	A	A	A
Odor	-	A	A	A	A	A	A	A	A	A
Conductivity	μS/cm	926	939	1262	995	912	963	1066	NS	NS
Turbidity	NTU	1.3	1.7	1.44	1.36	1.3	1.4	1.22	1	5
Temperature	°C	27.2	28.2	27.8	28.4	27.4	28	28.2	NS	NS

Parameter	Unit	GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	Acceptable Limit as per IS10500:2012	Permissible Limit as per IS10500:2012
Total Dissolved solids	mg/L	574	582	782	616	565	598	660	500	2000
Total Solids	mg/L	580	590	794	622	572	604	665	NS	NS
Total Hardness as CaCO ₃	mg/L	230	190	270	150	170	200	260	200	600
Total Alkalinity	mg/L	330	340	350	360	300	360	380	200	600
Calcium as Ca	mg/L	48	40	56	32	36	44	48	75	200
Magnesium as Mg	mg/L	26.4	21.6	31.2	16.8	19.2	21.6	33	30	100
Residual Chlorine	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.2 (min)	1
BOD (3) days at 27°C	mg/L	<01	<01	<01	<01	<01	<01	<01	-	-
COD	mg/L	<01	<01	<01	<01	<01	<01	<01	NS	NS
Chloride as Cl	mg/L	45	65	155	70	75	50	75	250	1000
Sulphate as SO ₄	mg/L	56.7	27.3	50.5	27.7	40.2	38.9	36.8	200	400
Fluorides as F ⁻	mg/L	0.6	0.5	0.6	0.5	0.5	0.6	0.7	1	1.5
Nitrates as NO ₃	mg/L	6	5.3	5.9	5.6	4.7	5.9	5	45	No relaxation
Sodium as Na	mg/L	101.8	123.5	160	154.5	127.4	123.9	120.9	NS	NS
Potassium as K	mg/L	3.7	3.5	4.3	3.7	2.7	3.9	3.1	NS	NS
Phenolic Compounds	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.002
Anionic Detergents	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.2	1
Cyanides as CN	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	No relaxation
Cadmium as Cd	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	No relaxation
Arsenic as As	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.05
Copper as Cu	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	1.5
Lead as Pb	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	No relaxation
Manganese as Mn	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.1	0.3
Iron as Fe	mg/L	0.14	0.1	0.08	0.08	0.08	0.12	0.1	0.3	No relaxation
Chromium as Cr ⁶⁺	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	No relaxation
Zinc as Zn	mg/L	0.06	0.12	0.01	0.08	0.06	0.1	0.12	5	15

Parameter	Unit	GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	Acceptable Limit as per IS10500:2012	Permissible Limit as per IS10500:2012
Salinity	psu	0.072	0.1	0.25	0.11	0.12	0.08	0.12	NS	NS
Mercury as Hg	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001	No relaxation

NS: No Standard; A: Agreeable

4.5.5.1 Results and Discussions on Groundwater Quality

The following are the observations drawn from the results of groundwater analysis;

- pH ranged between 7.27 to 7.73; ground waters are neutral in nature
- Electrical Conductivity (EC) ranged between 912 $\mu\text{S}/\text{cm}$ at Kishorprasad (GW2) and 1262 $\mu\text{S}/\text{cm}$ at Narsinghprasad (GW6)
- Total dissolved solids ranged between 565 mg/l at Kishorprasad (GW2) and 782 mg/l at Narsinghprasad (GW6)
- Turbidity ranged between 1.22 NTU at Tikaitnagar (GW7) and 1.7 NTU at Kanakprasad (GW3)
- Total hardness (as CaCO_3) ranged between 150 mg/l at Sabitri Sarai (GW5) to 270 mg/l at Narsinghprasad (GW6)
- Total Alkalinity ranged between 300 mg/l at Kishorprasad (GW2) and 380 mg/l at Tikaitnagar (GW7)
- Chlorides (Cl) ranged between 45 mg/l at Port Site (GW1) and 155 mg/l at Narsinghprasad (GW6)
- Fluoride ranged between 0.5 mg/l at Kishorprasad (GW2), Kanakprasad (GW3) and Sabitri Sarai (GW5) respectively and 0.7 mg/l at Tikaitnagar (GW7)
- Sulphates (as SO_4) ranged between 27.3 mg/l at Kanakprasad (GW3) and 56.7 mg/l at Port Site (GW1)
- Calcium ranged between 32 mg/l at Sabitri Sarai (GW5) and 56 mg/l at Narsinghprasad (GW6)
- Magnesium ranged between 16.8 mg/l at Sabitri Sarai (GW5) and 33.0 mg/l at Tikaitnagar (GW7)
- Sodium (Na) ranged between 101.8 mg/l at Port Site (GW1) and 160.0 mg/l at Narsinghprasad (GW6)
- Potassium ranged between 2.7 mg/l at Kishorprasad (GW2) and 4.3 mg/l at Narsinghprasad (GW6)
- Iron (Fe) ranged between 0.08 mg/l at Kishorprasad (GW2) and GW6 respectively to 0.14 mg/l at Port Site (GW1)
- Zinc (Zn) ranged between 0.01 mg/l at Narsinghprasad (GW6) to 0.12 mg/l at Kanakprasad (GW3) and Tikaitnagar (GW7) respectively
- Copper (Cu), Lead, Manganese (Mn), Arsenic (As), Cadmium (Cd) and Chromium (Cr^{6+}), Cyanides, COD, BOD, Phenolic Compounds, Anionic Detergents, Free Ammonia are reported below detectable limits and no Coli forms were reported.

It is inferred that all the parameters for groundwater are within the Permissible limits specified as per Drinking Water Quality Standards (IS 10500:2012).

4.5.5.2 Ground Water Quality Status Based on Data generated during 2014-2015

In line with the suggestion given by EAC, MoEF&CC during ToR meeting and vide its MoM (2nd meeting of Expert Appraisal Committee (Infra-2), MoEF&CC) and to understand the

environment in a comprehensive manner the collected data during Summer season, 2014, Post monsoon season, 2014 and Winter season, 2014-15 with respect to ground water has been reviewed for comparison and presented below.

Inferences on comprehensive ground water quality assessment are given below.

- pH ranged between 7.13 to 7.9; ground waters are neutral in nature
- Electrical Conductivity (EC) varied between 810 $\mu\text{mhos/cm}$ at Narsing Prasad (GW4) during Post monsoon season and 1124 $\mu\text{mhos/cm}$ at Kishore Prasad (GW7) during Summer season
- Total dissolved solids ranged between 526 mg/l at Narsing Prasad (GW4) during Post monsoon season and 691 mg/l at Kishore Prasad (GW7) during Summer
- Turbidity ranged between 1.4 NTU at Kishore Prasad (GW7) during Summer season and 3.5 NTU at Port Site (GW1) during winter season
- Total hardness (as CaCO_3) ranged between 144 mg/l at Sabitri Sarai (GW6) during Post monsoon season to 288 mg/l at Kishore Prasad (GW7) during Summer season
- Total Alkalinity ranged between 240 mg/l at Kishore Prasad (GW7) during winter season and 360 mg/l at Kanak Prasad (GW2) during Summer season
- Chlorides (Cl) ranged between 49 mg/l at Port Site (GW1) during winter and post monsoon seasons respectively and 103 mg/l at Kishore Prasad (GW7) during Summer season
- Fluoride ranged between 0.7 mg/l at Narsing Prasad (GW4) during winter season and 0.92 mg/l at Kanak Prasad (GW2) during Summer season
- Sulphates (as SO_4) ranged between 28 mg/l at Bali Sahi (GW3) during Post monsoon season and 135 mg/l at Kishore Prasad (GW7) during Summer season
- Calcium ranged between 32 mg/l at Kanak Prasad (GW2) and 72 mg/l at Tikait Nagar (GW5) both during Post monsoon season respectively
- Magnesium ranged between 14 mg/l at Tikait Nagar (GW5) and 28 mg/l at Kishore Prasad (GW7) both during Summer season respectively
- Sodium (Na) ranged between 88 mg/l at Narsing Prasad (GW4) during Post monsoon season and 142 mg/l at Sabitri Sarai (GW6) during Summer season
- Potassium ranged between 1.56 mg/l at Sabitri Sarai (GW6) during Summer season and 3.2 mg/l at Kanak Prasad (GW2) and Bali Sahi (GW3) both during winter season respectively
- Chemical Oxygen demand ranged between 1 mg/l at Tikait Nagar (GW5) during Summer season and 5 mg/l at Port Site (GW1) during Post monsoon season
- Iron (Fe) ranged between 0.01 mg/l at Tikait Nagar (GW5), Sabitri Sarai (GW6) and Kishore Prasad (GW7) during Post monsoon and at Sabitri Sarai (GW6) and Kishore Prasad (GW7) winter seasons respectively to 0.04 mg/l at Port Site (GW1) during Summer season
- Zinc (Zn) ranged between 0.33 mg/l at Port Site (GW1) during winter season to 0.53 mg/l at Kishore Prasad (GW7) during Summer season
- Lead ranged between 0.011 mg/l at Port Site (GW1) during winter season to 0.028 mg/l at Tikait Nagar (GW5) during Summer season
- Arsenic (As) ranged between 0.013 mg/l at Sabitri Sarai (GW6) during winter season to 0.025 mg/l at Kanak Prasad (GW2) during Summer season
- Mercury (Mg), Cadmium (Cd), Selenium and Chromium (Cr^{6+}), Cyanides, BOD, Residual free chlorine, Phenolic Compounds, Anionic Detergents, Free Ammonia are reported below detectable limits and no Coli forms were reported

It is inferred that all the parameters for groundwater are within the Permissible limits specified as per Drinking Water Quality Standards (IS 10500:2012) except Lead concentrations.

4.6 Marine Environment

4.6.1 Coastal Hydrology/Geomorphology²⁵

4.6.1.1 Tides

The tides near the Dhamra region are of the semi-diurnal type i.e., characterized by occurrence of two high and two low waters every day. Tide levels with respect to Chart Datum as given in Hydrographic Chart No. 3017 , Approaches to Dhamra (Latitude 20° 48' N, Longitude 86° 54' E) are given in **Table 4-14**.

Table 4-14: Tide Levels

Tide Levels at Chandbali (Dhamra River)	Height (m) above Chart Datum (CD)
Mean Lower Low Water Springs	+0.74
Mean Low Water Neaps	+1.28
Mean Sea Level	+1.77
Mean High Water Springs	+2.31

4.6.1.2 Waves

It is observed that offshore wave heights are higher during the SW and NW monsoon. During the months of June, July and August, more than 95% of waves are higher than 1.0 m, 35% of the waves are higher than 2.0 m and 5% of waves are greater than 3.0 m. While the wave heights during the months of November, December & January are in the range of 0.5 m to 2.0 m which accounts to 90% of the total occurrences. The predominant deep water wave directions during the pre-monsoon (Mar-May) are wind generated waves from SW, SSW and swells from S, during the NE-monsoon (Jun-Aug) are from NNE and NE and swells from S and SSE, during the transition (Feb, Oct) are swells from S and SSE.

The near shore maximum wave height at 20 m contour for 10 % and 0.1 % exceedance during the SW monsoon are 2.4 m and 4.97 m respectively. While during the NE monsoon, the near shore maximum wave height at the 20m contour for 10 % and 0.1 % exceedance are 1.53 m and 2.64 m respectively and given in **Table 4-15** and **Table 4-16**.

Table 4-15: Extracted wave height in m for 10% Exceedance

Location	NNE	NE	SSE	S	SSW	SW
Outer channel	0.84	0.68	1.53	1.71	0.67	1.04
Channel Bend	0.45	0.51	0.05	0.03	0.00	0.00
Turning Circle	0.44	0.44	0.04	0.02	0.00	0.00
Berth	0.33	0.38	0.00	0.00	0.00	0.00

Table 4-16: Extracted wave height in m for 1% Exceedance

Location	NNE	NE	SSE	S	SSW	SW
Outer channel	0.67	0.76	1.8	1.38	1.34	1.05
Channel Bend	0.44	0.58	0.11	0.00	0.00	0.00
Turning Circle	0.45	0.58	0.05	0.00	0.00	0.00
Berth	0.33	0.40	0.00	0.00	0.00	0.00

²⁵ PFR DPCL, 2016

4.6.1.3 Littoral Drift

Waves induce currents along the coast when they break, known as long shore currents (littoral currents). These currents resulting from oblique wave approach run parallel to the shore in the surf zone. These currents transport sediments disturbed by the waves in the direction of current known as littoral drift or long shore sediment transport.

During SW monsoon the waves approach the coast generally from south to SE. During this period, the associated littoral current and littoral drifts are directed up-coast in the northeast direction. Whereas, during the fair weather period including NE monsoon when the wave direction is northeast to east, the coast experiences down-coast drift.

Central Water Power Research Station (CWPRS) estimated the drift from south to north of the order of 0.9 Mm³/year during SW monsoon season and the southerly drift during NE monsoon season as 0.16 Mm³/year. Thus, the net northward littoral drift along the coast is of the order of 0.74 Mm³/year. It can be concluded that the northerly drift (March–September) is the most dominant for this coast and accounts for major sand movements and shoreline changes.

4.6.1.4 Storm Surges

Odisha coast is prone to frequent cyclones and associated storm surges and floods. About 90% of the damage along the coast is due to the inundation caused by the combined effects of tides, waves and storm surges, while remaining 10% of the damage is from the very strong winds.

4.6.1.5 Currents

The maximum measured and simulated currents speed at measured locations is 1.96 m/s. The cross and longitudinal current velocities vary along the channel alignment in space and time. Cross current velocities are insignificant in the inner channel and increase in amplitude toward the seaward end of the outer channel. Longitudinal velocities are strong in the inner channel and reduce seaward in the outer channel.

4.6.1.6 Seabed Bathymetry

Bathymetry within an area of 25 km x 25 km near Dhamra River is very complex due to the presence of shoals and islands. In the offshore, these depth contours lie in a convex shape. All this shows a reversal pattern of slope found along the transect off Gahirmatha indicating very gentle slope in the near shore up to 10m contour and steeper slope beyond. Along the northern end of Kanika Sand Island, the 10m depth contour lies about 13.3 km away from the northern part of Dhamra coast. The 15m contour lies about 20.3 km away from the coast and 7.0 km from the 10m contour. The 20m contour lies about 4.0 km from the 15m contour and 24 km from the coast. Here, the slope is gentle throughout from the coast up to 20m contour. This bottom topography also indicates a nearly uniform depositional pattern in the near shore and offshore.

4.6.2 Marine Environmental Parameters and Analysis

The existing marine environmental conditions around the site were established through collection and analysis of water and sediment samples marine biodiversity assessment in the project region.

The potential impacts due to the construction and operation of the proposed project components may be felt on the marine environment and biodiversity. Therefore existing marine environmental conditions were monitored. The locations in the marine monitoring network were selected such that the existing baseline conditions in the area likely to be affected by the effect of potential environmental impacts of the project activities can be effectively represented.

4.6.3 Marine Biodiversity Study

The MoEF&CC approved ToR (letter no. F.No.11-104/2009-IA.III (Pt.) dated 18th February, 2016) suggests that “The EIA should also include a marine biodiversity survey, impact assessment and a marine biodiversity management plan drawn up through the N.I.O. or any other Institute specializing in marine ecology and oceanography”.

In line with that, the Marine Biodiversity Study at Dhamra Port was undertaken by Department of Marine Sciences, Berhampur University, during Summer season, 2016.

4.6.3.1 Methodology and Assessment

Marine Biodiversity Study is undertaken for documentation of plankton and faunal diversity from different locations within the radius of 15 km from the Port boundary and Development of Biodiversity Management Plan for the sites outside Bhitarkanika Sanctuary/ National Park and Gahirmatha Marine Sanctuary. Benthic samples are sieved through mesh size of 500 μ for macro fauna and preserved for further identification by using standard identification manual. Both primary and secondary information used for the generation of biodiversity index of the region.

4.6.3.2 Sampling Locations

Benthic and Plankton samples were collected from **Ten (10)** locations around the port region and details are given in **Table 4-17** and shown in **Figure 4-15**.

Table 4-17: Benthic and Plankton sampling locations

Locations	Coordinate	Environmental Setting
1	N20°47'17" E86°56'28"	Estuarine (Near Fishing Jetty)
2	N20°48'17" E86°58'07"	Near Port
3	N20°51'19" E87°00'12"	Open ocean
4	N20°50'36" E87°04'16"	Open ocean
5	N20°47'35" E87°06'14"	Open ocean
6	N20°46'03" E87°05'05"	Near wheeler island
7	N20°48'03" E86°57'52"	Port reclamation area
8	N20°51'14" E86°58'01"	Northern mangrove
9	N20°48'14" E86°59'48"	Kanika mangrove
10	N20°48'07" E87°01'19"	Kanika beach



Figure 4-15: Marine Biodiversity Sampling Locations

The coastal stretch of the region includes diverse ecosystems such as mangrove, estuary, sandy beaches etc. The southern part of the PIA fall under the Bhitarkanika National Park and Gahirmatha Sanctuary. The Bhitarkanika National Park is an important breeding ground for salt water crocodiles. Gahirmatha Sanctuary is the largest nesting site for Olive Ridley turtles and also known as the habitat for endemic Horseshoe crabs which were known to distribute in West Bengal and Odisha Coast. The diverse mangrove habitat of the region provided shelter for large number of species including the coastal birds.

Phytoplankton: There are 16 species (5 species of Mediophyceae, 4 species each of Bacillariophyceae and Dinophyceae, 3 species of Coscinodiscophyceae) of phytoplankton were reported from Nine (09) locations.

Phytoplankton family composition shows that Coscinodiscophyceae is the most dominating family (74%) followed by Bacillariophyceae (11%), Dinophyceae (8%) and Mediophyceae (6%). Phytoplanktons of sampling locations 6, 7 and 9 were belongs to only family coscinodiscophyceae. Phytoplanktons of family Dinophyceae were reported from sampling location 3 (17%), sampling location 4 (25%), sampling location 5 (33%) and sampling location 8 (8%).

Phytoplankton species composition shows that *Coscinodiscus* sp. is the most dominant (1366 cells/l) followed by *Pleurosigma* sp (100 cells/l).

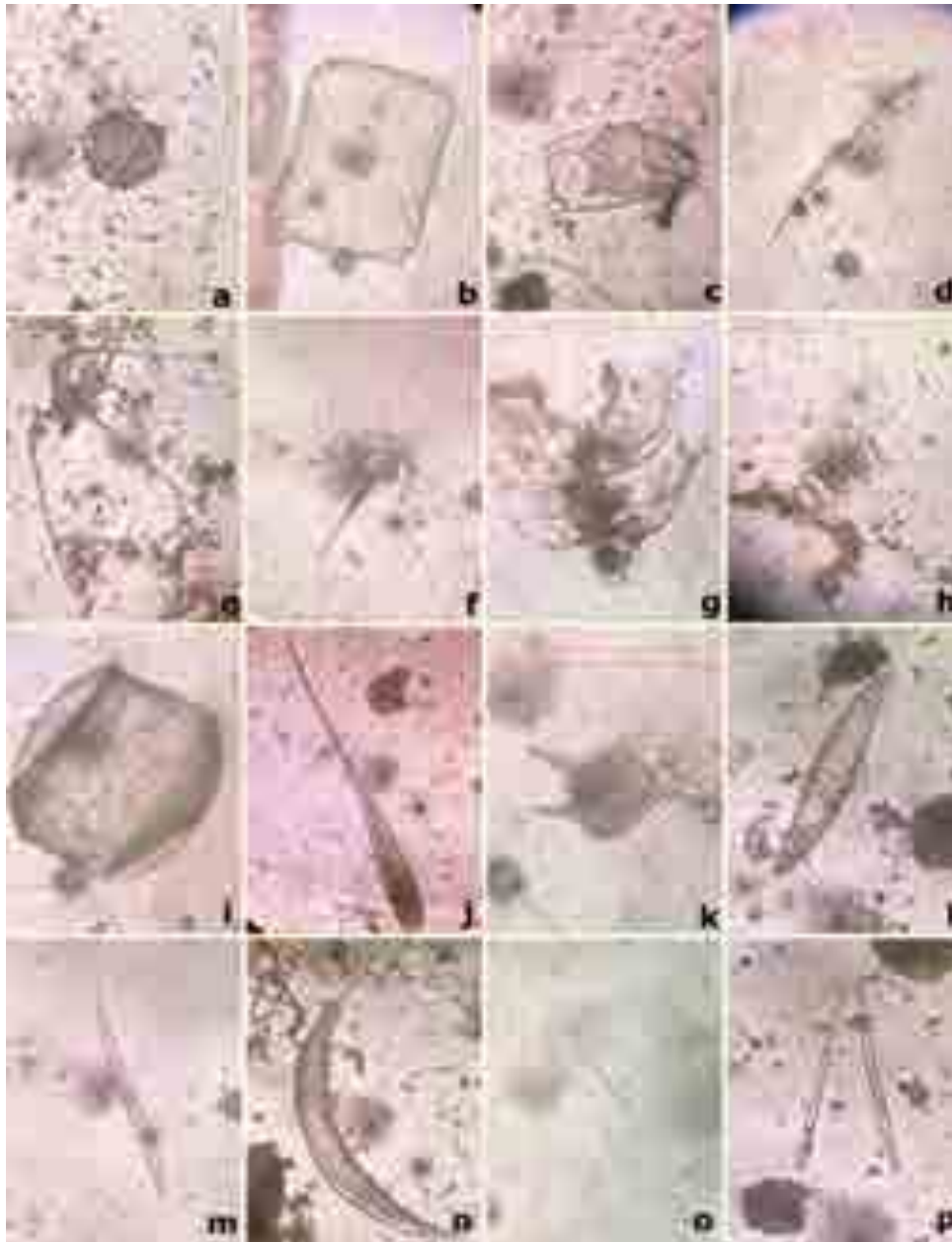
Diversity of phytoplankton was high in Location-1 (7 species) and low in sampling Locations 6, 7 and 9 (only 1 species).

The density of phytoplankton is high in sampling location-2 (495 cells/l) followed by sampling location 1 (450 cells/l). The density of phytoplankton is lowest in sampling location 6 (13 cells/ l) followed by sampling location 7 (25 cells/ l).

Phytoplankton density during the Biodiversity survey is given in **Table 4-18**. Phytoplankton recorded during the Biodiversity Survey is shown in **Exhibit 4-1**.

Table 4-18: Phytoplankton Density

Family	Species	Sampling Locations								
		1	2	3	4	5	6	7	8	9
Mediophyceae	<i>Biddulphia heteroceros</i>	40	-	-	-	-	-	-	-	-
	<i>Biddulphia mobiliensis</i>	-	-	-	25	-	-	-	-	-
	<i>Biddulphia sinensis</i>	-	15	-	-	15	-	-	-	-
	<i>Chaetoceros coarctatus</i>	-	-	-	13	-	-	-	-	-
	<i>Chaetoceros</i>	10	-	-	-	-	-	-	-	-
	<i>lorenzianus</i>									
Bacillariophyceae	<i>Licmophora sp</i>	30	15	-	-	-	-	-	-	-
	<i>Pleurosigma sp. 1</i>	-	15	-	-	-	-	-	30	-
	<i>Pleurosigma sp. 2</i>	30	30	40	-	-	-	-	-	-
	<i>Thalassiothrix</i>	10	-	-	-	-	-	-	-	-
Dinophyceae	<i>Ceratium fusus</i>	-	-	-	13	-	-	-	-	-
	<i>Ceratium macroceros</i>	-	-	-	-	30	-	-	-	-
	<i>Ceratium pulchellum</i>	-	-	20	50	15	-	-	-	-
	<i>Peridinium sp</i>	-	-	-	13	-	-	-	15	-
Coscinodiscophyceae	<i>Coscinodiscus sp.</i>	320	420	60	188	75	13	25	135	130
	<i>Rhizosolenia robusta</i>	10	-	-	-	-	-	-	-	-
	<i>Rhizosolenia sp</i>	-	-	-	-	-	-	-	15	-
Total Density (cells per liter)		450	495	120	300	135	13	25	195	130



a. *Biddulphia heteroceros*, b. *Biddulphia mobiliensis*, c. *Biddulphiasinensis*, d. *Ceratiumfusius*, e. *Ceratiummacroceros*, f. *Ceratiumpulchellum*, g. *Chaetoceroscoarctatus*, h. *Chaetoceros lorenzianus*, i. *Coscinodiscus* sp., j. *Licmophora* sp., k. *Peridinium* sp., l. *Pleurosigma* sp. 1, m. *Pleurosigma* sp. 2, n. *Rhizosoleniarobusta*, o. *Rhizosolenia* sp. and p. *Thalassiothrix* sp.

Exhibit 4-1: Phytoplankton recorded During the Biodiversity Survey

Zooplankton: Total of Nine (09) zooplankton forms are recorded during the study.

Lucifer found as the most dominating organism (64%) followed by Copepod (28%). The other organisms include Mysis (4%), Zoea (2%), Chaetognath (1%) and Coelenterate larva (1%).

Maximum density of zooplankton was reported from sampling location 6 (4120 organisms/m³) followed by sampling location 5 (2150 organisms/m³). Density was very low at sampling location 1 (160 organisms/m³) followed by sampling location 2 (270 organisms/m³).

Maximum diversity of zooplankton was observed in sampling location 3 and sampling location 6 (6 species each) followed by sampling locations stations 5, and 9 (5 species each).

Minimum diversity of zooplankton was recorded in sampling location 1, 2 and 8 (3 species each).

Lucifer was found available in all the stations with maximum density at sampling location 6 (3670 organisms/m³) followed by sampling location 5 (1180 organisms/m³).

Coelenterate larvae were reported only from sampling locations 3, 4 and 5.

Auricularia larva, veliger and ctenophore were reported only from sampling locations 3, 6 and 7 respectively.

Zooplankton Density during the Biodiversity survey is given in **Table 4-19**. Zooplankton recorded during the Biodiversity Survey is shown in **Exhibit 4-2**.

Table 4-19: Zooplankton Density

Species	Sampling Locations								
	1	2	3	4	5	6	7	8	9
Auricularia larva			10						
Cheatoagnath	20	10	10	30		20	30		10
Coelentereta larva			30	20	50				
Copepod	40	90	180	120	730	190	270	280	760
Ctenophore							10		
Lucifer	100	170	380	300	1180	3670	190	100	30
Mysis (Prawn larva)					140	200	10		10
Veliger larva						10			
Zoea			30		50	30		50	20
Total density per m³	160	270	640	70	2150	4120	510	430	830



a. Auricularia larva, b. Chaetognath, c. Coelenterate larva, d. Copepod, e. Ctenophore, f. Lucifer, g. Mysis, h. Veliger larva, i. Zoea larva

Exhibit 4-2: Zooplankton recorded During the Biodiversity Survey

Benthic Fauna: The benthic macrofauna were represented by polychaets and nematods only. No macrofauna were observed in benthic samples of sampling location 7, 8 and 10.

The polychaets found in the benthic samples were belongs to family Capitellidae, Cossuridae, Eunicidae, Maldanidae, Nereidae, Poecilochaetidae, Spionidae, Syllidae and Terebellidae. Benthic fauna recorded During the Biodiversity Survey is shown in **Exhibit 4-3**.



a. Capitellidae, b. Cossuridae, c. Eunicidae, d. Maldanidae, e. Nereidae, f. Poecilochaetidae, g. Spionidae, h. Syllidae and i. Terebellidae

Exhibit 4-3: Benthic fauna recorded During the Biodiversity Survey

In line with the suggestion given by EAC, MoEF&CC during ToR meeting and vide its MoM (2nd meeting of Expert Appraisal Committee (Infra-2), MoEF&CC) and to understand the environment in a comprehensive manner the collected data with respect to marine environment during 2014-2015 has been reviewed and presented below (Section 4.6.4 and 4.6.5).

4.6.4 Sea/Harbour Water Quality (Physico-Chemical and Biological Parameters)

4.6.4.1 Sampling Locations

The physico-chemical and biological samples were collected from **Ten (10)** locations both in high tide and low tide. The Coordinates of the Marine sampling locations are given in the **Table 4-20** and sampling locations are shown in **Figure FD0403**. In addition, inter tidal samples are also collected at **Two (02)** locations in and around the proposed reclamation area. The status of sea/harbour water quality assessed during post-monsoon season, 2017 and winter season, 2017-18 are given as **Appendix G**.

Table 4-20: Marine Sampling Locations

S. No.	Location Code	Latitude	Longitude
1.	MSL-1	20°46'50.79"	86°57'55.95"
2.	MSL-2	20°48'51.60"	86°58'17.03"
3.	MSL-3	20°51'25.73"	86°58'29.74"
4.	MSL-4	20°51'38.73"	87°00'27.36"
5.	MSL-5	20°46'58.03"	87°00'12.35"
6.	MSL-6	20°54'20.52"	87°05'07.56"
7.	MSL-7	20°55'38.00"	86°58'29.74"
8.	MSL-8	20°57'55.34"	87°07'43.93"
9.	MSL-9	20°53'52.96"	87°07'35.76"
10.	MSL-10	20°55'06.64"	87°10'31.21"
11.	Inter tidal area – Southern side (A)	20°48'02.63"	86°57'52.64"
12.	Inter tidal area – Northern side (B)	20°50'25.69"	86°58'04.51"

The primary objective of this investigation is to establish baseline data on seawater quality and marine ecology. Methodologies used for the study are therefore clearly aimed at obtaining information on the environmental conditions according to EIA governed protocols defined in standard manuals and reference material (e.g. UNESCO, 1978; Parsons *et al.*, 1984; Standard Methods of the American Public Health Association APHA, 1989, 1998; Grasshoff *et al.*, 1999).

Physico- chemical parameters such as Temperature, Salinity, Transparency, DO, BOD, Nitrate, Nitrite, Ammonical Nitrogen, Total Nitrogen, Total Phosphorous and Inorganic Phosphate were monitored. All parameters were estimated by using following standard methods. Biological variables have also been studied and this includes Primary productivity, Chlorophyll- a and Planktons (both Phytoplankton and Zooplankton), etc.

Seasonal variations in Marine water Physico-Chemical and Biological parameters were given in the **Table 4-21** and graphically presented from **Figure 4-16** to **Figure 4-24**.

Table 4-21: Seasonal Variations in Marine Water Physico-chemical parameters

Parameters	Unit	Summer		Post Monsoon		Winter	
		Min.	Max.	Min.	Max.	Min.	Max.
Water Temperature	°C	28.0	31.0	26.0	29.4	26.0	29.0
Salinity	PPT	20.0	34.0	20.4	27.0	30.0	35.0
pH		7.3	8.4	7.5	8.2	7.6	8.5
DO	mg/L	4.0	6.0	5.7	6.9	4.2	6.7
BOD		0.10	0.68	0.19	0.78	0.70	3.00
TSS	ppm	67.43	172.80	110.43	254.40	100.30	200.30
Turbidity	NTU	7.0	20.0	10.4	35.7	9.0	15.0
Nitrite	μmol/l	0.11	0.54	0.12	0.27	0.14	2.18
Nitrate		3.76	7.65	4.60	8.50	2.90	8.20
Ammonia		0.02	0.13	0.02	0.09	0.02	0.45

Parameters	Unit	Summer		Post Monsoon		Winter	
		Min.	Max.	Min.	Max.	Min.	Max.
Total Nitrogen		12.46	24.56	20.32	24.43	16.40	22.90
IP		0.25	1.89	2.03	4.23	1.10	3.50
TP		1.64	3.54	0.39	1.32	0.23	1.70
SiO ₂		28.98	56.63	30.42	57.40	30.50	62.40
POC	µgC/l	50.34	90.43	89.32	107.54	89.30	125.43
PHC	µg/l	0.04	0.32	0.04	0.94	0.04	0.96
Cadmium (Cd)		0.21	5.32	1.05	3.56	0.36	1.49
Chromium (Cr)		2.09	8.32	2.1	6.2	1.1	5.1
Iron (Fe)		4.32	24.54	4.9	21.3	10.31	26.78
Lead (Pb)		1.43	7.6	2.2	7.5	1.4	5.2
Nickel (Ni)	µg/l	0.6	9.3	0.9	5.0	0.3	1.5
Zinc (Zn)		10.21	38.43	12.45	36.43	10.3	33.6
Manganese (Mn)		15.67	42.45	20.32	37.65	20.3	50.2
Copper (Cu)		8.32	15.43	9.3	15.7	9.3	21.24
Mercury (Hg)		0.09	0.35	0.084	0.43	0.02	1.39
Chlorophyll a	mg/m ²	0.43	1.55	0.20	3.40	1.37	3.46
Phaeo pigments		0.22	0.622	0.3	2.07	0.1	3.07
Total Biomass	ml/100m ³	10.21	26.65	11.32	37.88	18.69	45.54
Primary Productivity	mg C/m ³ /hr	105.75	507.59	105.50	260.40	119.23	289.32
Phytoplankton density	No/l	4030	8283	3415	7140	2865	7960
Phytoplankton diversity	No of Species	28	42	19	27	15	20
Zooplankton	No/m ³	4257	8283	2495	5720	2505	5310
Zooplankton diversity	No of Species	17	26	12	20	13	19

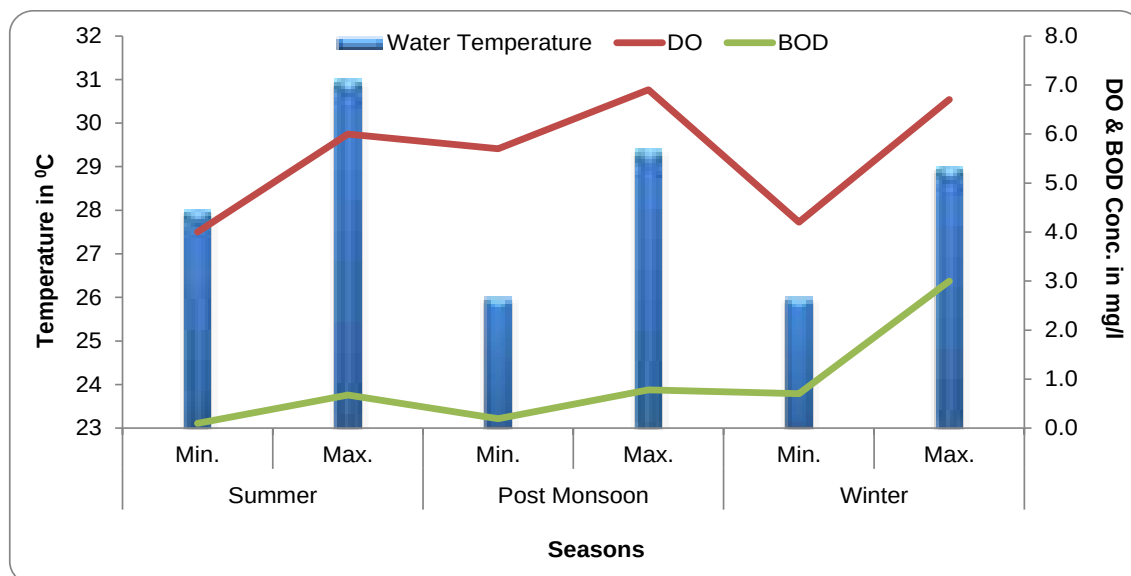


Figure 4-16: Variations in Water temperature, DO and BOD

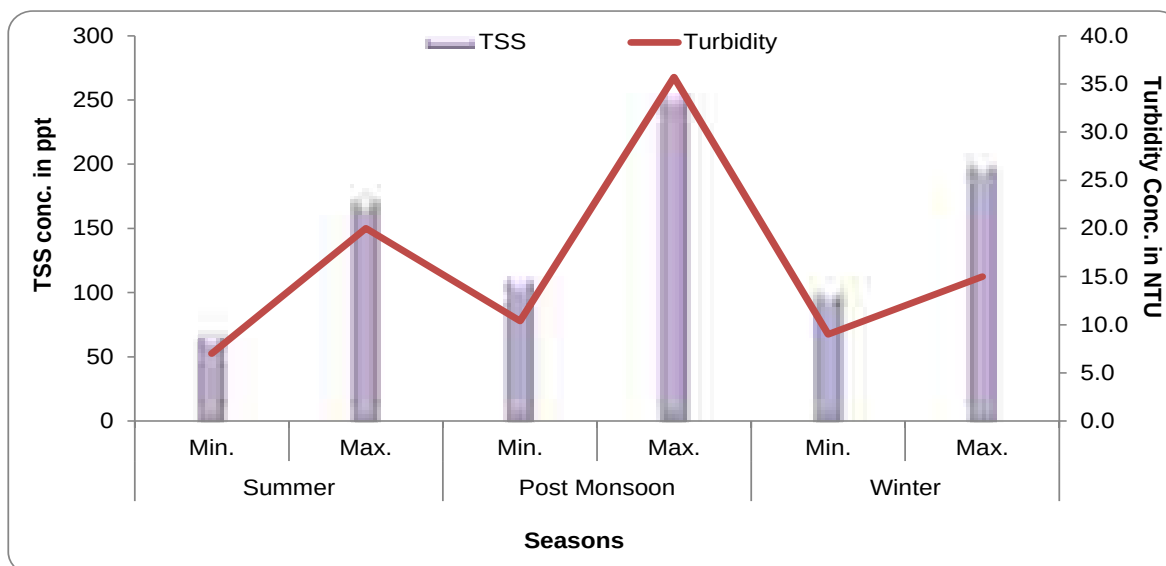


Figure 4-17: Variations in TSS and Turbidity

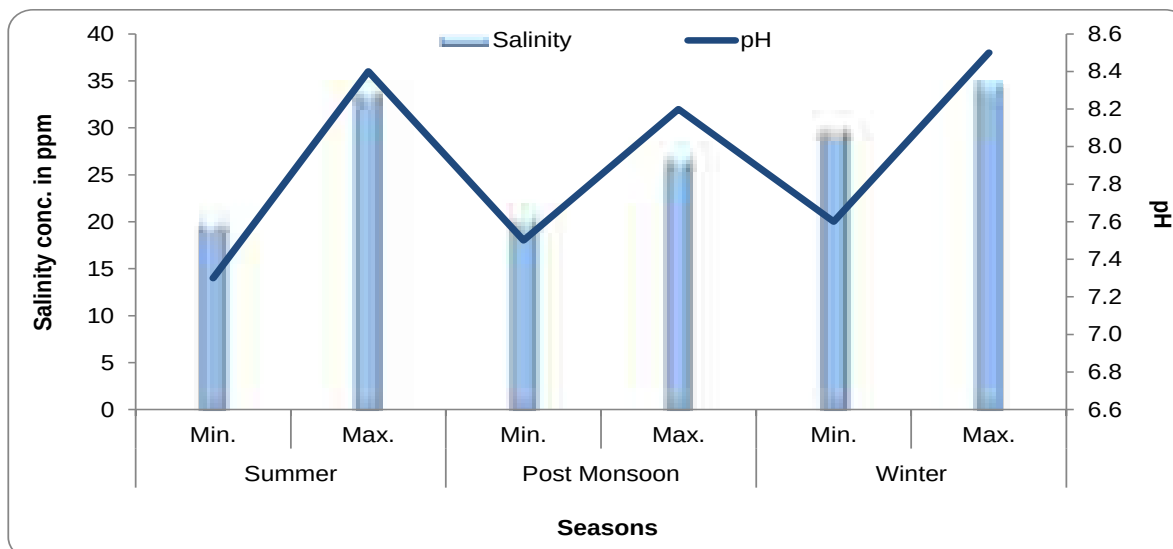


Figure 4-18: Variations in Salinity and pH

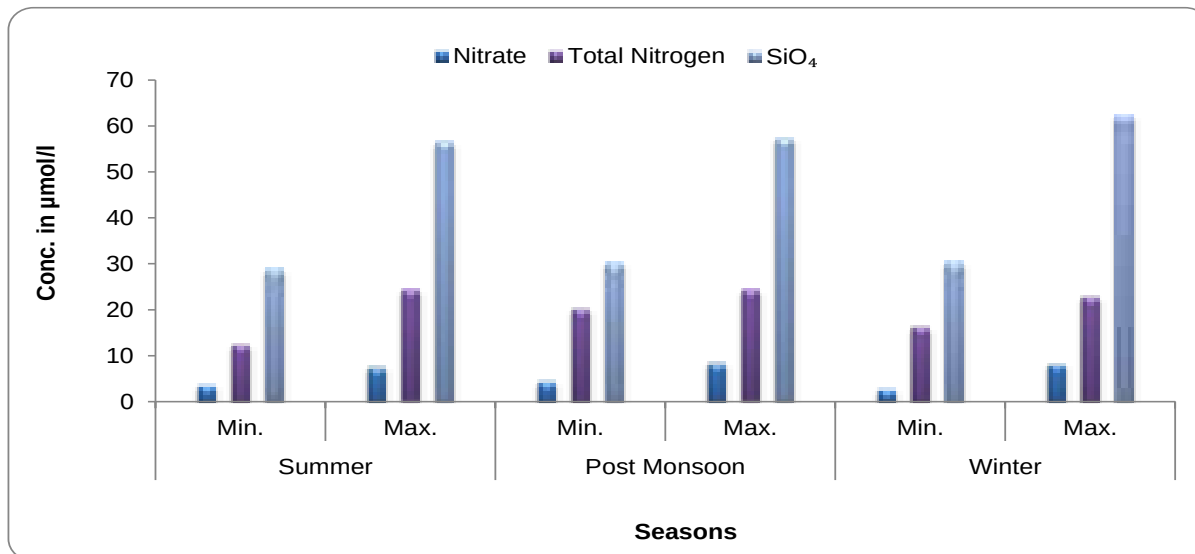


Figure 4-19: Variations in Nitrate, Total Nitrogen and Silicate

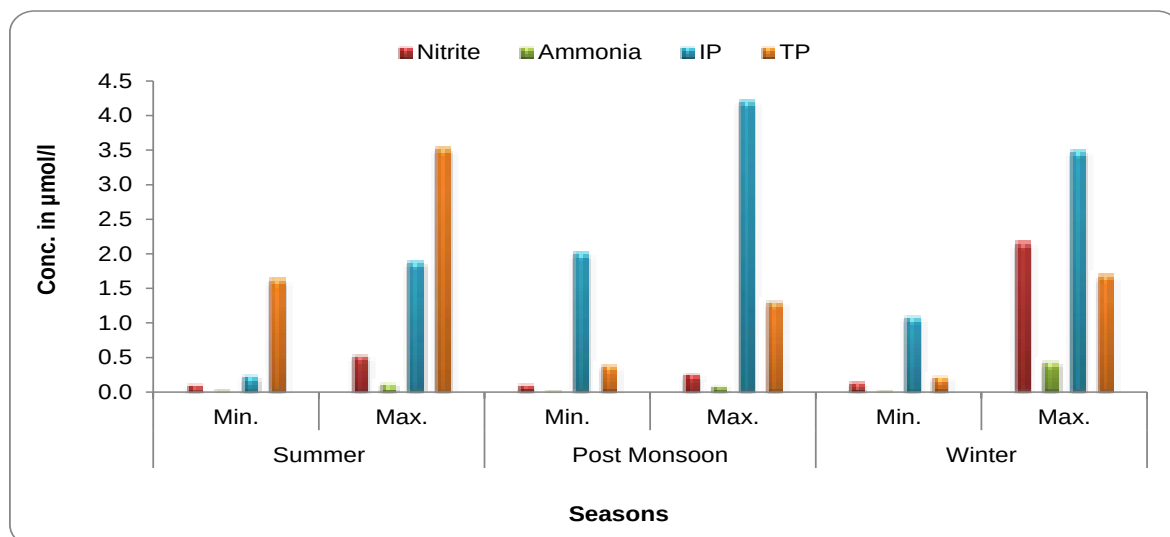


Figure 4-20: Variations in Nitrite, Ammonia, IP and TP

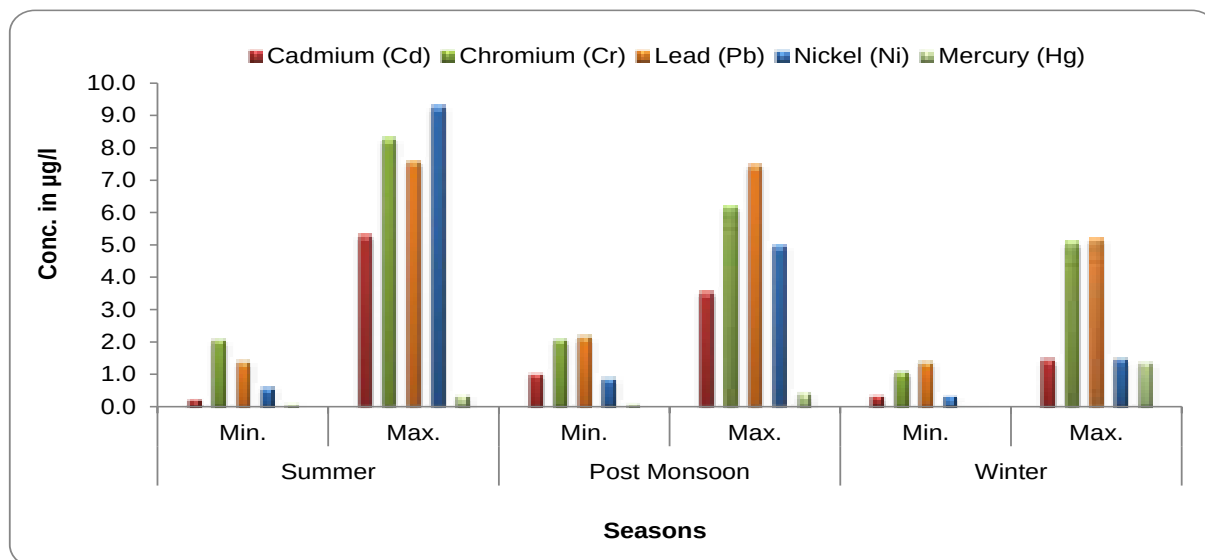


Figure 4-21: Variations in Cd, Cr, Pb, Ni and Hg

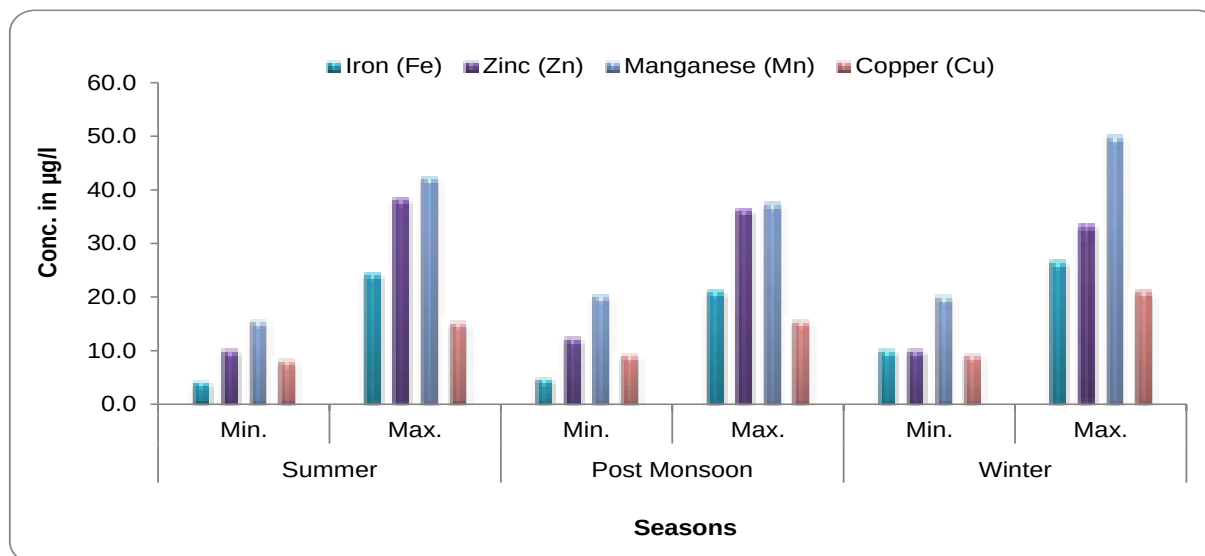


Figure 4-22: Variations in Fe, Zn, Mn and Cu

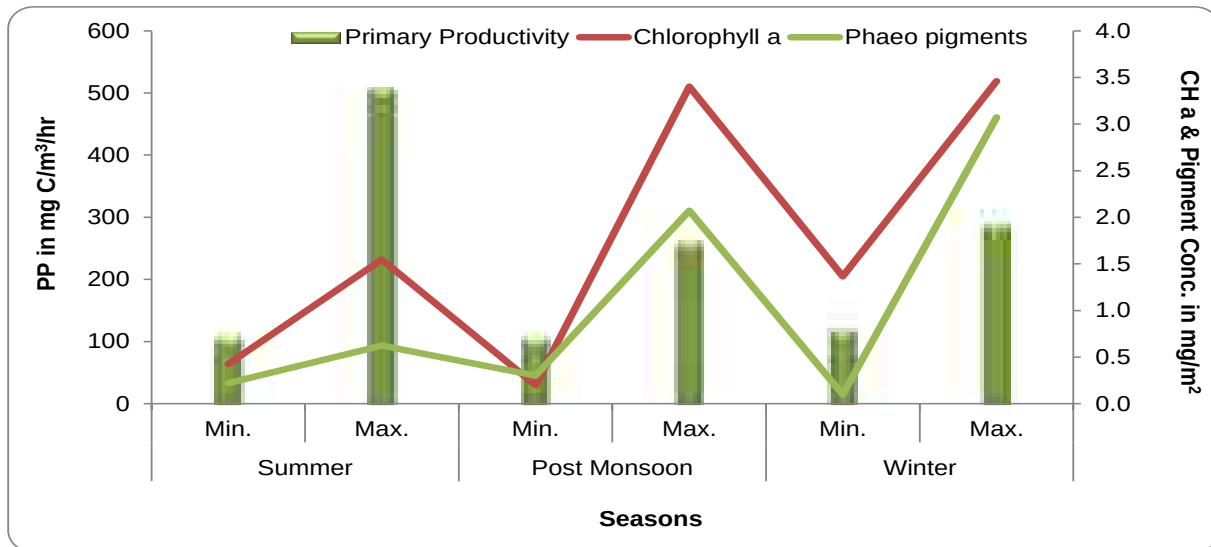


Figure 4-23: Variations in Primary Productivity, Chlorophyll a and Phaeopigments

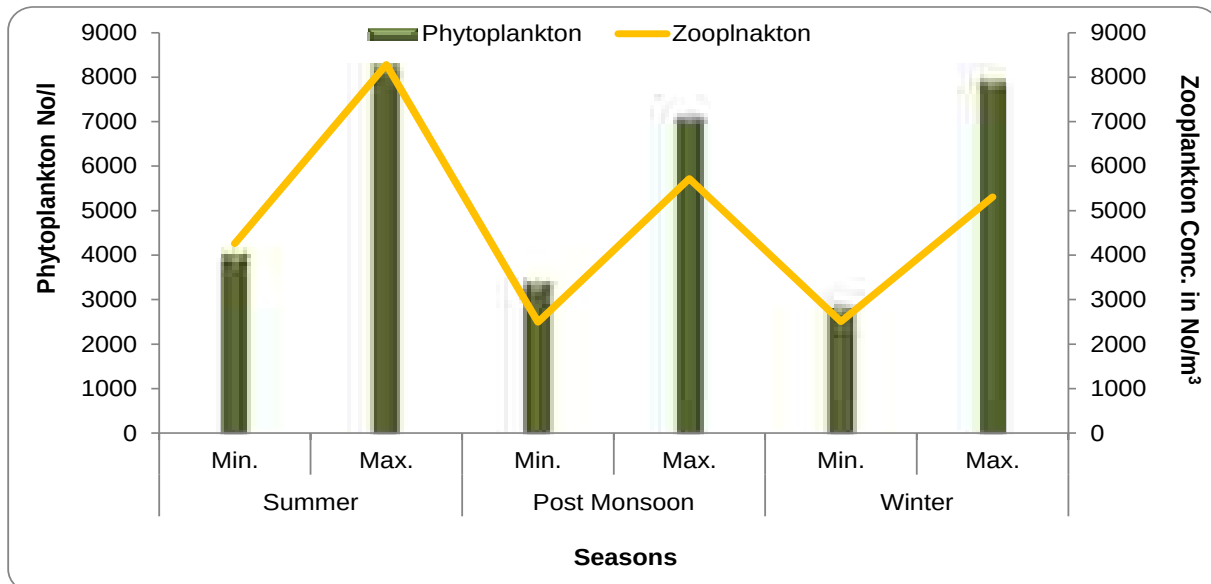


Figure 4-24: Variations in Phytoplankton and Zooplankton

- Water temperature ranged from 26.0°C to 31.0°C
- Salinity (ppt) varied between 20 ppt and 35.5 ppt
- pH is slightly neutral to alkaline at all stations. It ranged between 7.3 and 8.5
- Total Suspended Solids (TSS) varied from 67.4 ppm at MSL-10 during high tide in Summer season to 254.4 ppm at MSL-3 during high tide in Post monsoon season
- Turbidity varied from 7.0 NTU at MSL-1 during low tide in Summer season to 35.7 NTU at MSL-4 during high tide in Post monsoon season
- Dissolved Oxygen (DO) varied between 4.0 mg/l at MSL-5 during low tide and also at MSL-8 and MSL-10 high tide in Summer season respectively to 6.9 mg/l at MSL-2 during high tide in Post monsoon season
- Biological Oxygen Demand (BOD) varied between 0.1 mg/l at MSL-1 during low tide to 3.0 mg/l at MSL-1 during high tide both in Summer season respectively
- Nitrite concentration ranged between 0.107 µmol/l at MSL-4 during low tide in Summer season and 2.18 µmol/l at MSL-2 during high tide in Winter season

- Nitrate concentration ranged between 2.9 $\mu\text{mol/l}$ at MSL-5 during low tide in Winter season and 8.5 $\mu\text{mol/l}$ at MSL-4 during low tide in Post monsoon season
- Ammonical Nitrogen concentration ranged between 0.021 $\mu\text{mol/l}$ at MSL-10 during low tide and 0.45 $\mu\text{mol/l}$ at MSL-3 and MSL-6 during high tide both in Post Monsoon season respectively
- Total Nitrogen (TN) ranged between 12.46 $\mu\text{mol/l}$ at MSL-7 during low tide and 24.56 $\mu\text{mol/l}$ at MSL-2 during high tide both in Summer season respectively
- Inorganic Phosphate (IP) concentration ranged between 0.245 $\mu\text{mol/l}$ at MSL-9 during high tide in Summer season and 4.23 $\mu\text{mol/l}$ at MSL-3 during high tide in Post Monsoon season
- Total Phosphate (TP) concentration ranged between 0.23 $\mu\text{mol/l}$ at MSL-6 during low tide in Winter season and 3.54 $\mu\text{mol/l}$ at MSL-10 during high tide in Summer season
- Silicate concentration ranged between 28.98 $\mu\text{mol/l}$ at MSL-5 during low tide in Summer season and 62.4 $\mu\text{mol/l}$ at MSL-9 during high tide in Post Monsoon season
- Cadmium (Cd) concentration ranged between 0.21 $\mu\text{g/l}$ at MSL-10 during high tide and 5.32 $\mu\text{g/l}$ at MSL-1 during high tide both in Summer season respectively
- Iron (Fe) concentration ranged between 4.32 $\mu\text{g/l}$ at MSL-6 during low tide in Summer season and 26.78 $\mu\text{g/l}$ at MSL-4 during high tide in Winter season
- Lead (Pb) concentration ranged between 1.4 $\mu\text{g/l}$ at MSL-10 during high tide in Winter season and 7.6 $\mu\text{g/l}$ at MSL-4 during high tide in Summer season
- Nickel (Ni) concentration ranged between 0.32 $\mu\text{g/l}$ at MSL-5 during low tide in Winter season and 9.32 $\mu\text{g/l}$ at MSL-3 and MSL-6 during high tide in Summer season respectively
- Zinc (Zn) concentration ranged between 10.21 $\mu\text{g/l}$ at MSL-1 during low tide and 38.43 $\mu\text{g/l}$ at MSL-8 during high tide both in Summer season respectively
- Manganese (Mn) concentration ranged between 15.67 $\mu\text{g/l}$ at MSL-8 during low tide in Summer season and 50.2 $\mu\text{g/l}$ at MSL-4 during high tide in Winter season
- Copper concentration ranged between 8.32 $\mu\text{g/l}$ at MSL-7 during low tide in Summer season and 21.24 $\mu\text{g/l}$ at MSL-4 during high tide in Winter season
- Mercury concentration ranged between 0.02 $\mu\text{g/l}$ at MSL-3, MSL-5, MSL-7 and MSL-10 during low tide and 1.39 $\mu\text{g/l}$ at MSL-4 during high tide both in Winter season respectively
- Primary Productivity (PP) ranged between 105.5 mg C/m³/hr at MSL -6 during high tide in Post Monsoon season and 507.59 mg C/m³/hr at MSL-6 during high tide in Summer season
- Chlorophyll-a ranged between 0.2 mg/m³ at MSL-4 during low tide in Post Monsoon season to 3.46 mg/m³ at MSL-4 during high tide in Winter season
- Phaeopigment ranged between 0.1 mg/m³ at MSL-7 during high tide to 3.07 mg/m³ at MSL-5 during high tide both in Winter season respectively
- Total Biomass varied between 10.21 ml/100m³ at MSL-7 during high tide in Summer season and 45.54 ml/100m³ at MSL-1 during low tide in Winter season
- Phytoplankton was represented by 4 taxonomic group's viz. Blue greens, Diatoms, Dinoflagellates and Algae during the study. Diversity of around 77 species were recorded. Phytoplankton density ranged between 2865 Nos./l at MSL-7 during low tide in Winter season and 8283 Nos./l at MSL-5 during high tide during Summer season. Thalassiothrix frauenfeldii is the most dominating species in survey. Thalassiosira subtilis, Ceratium trichoceros and C. tripos species are dominated in Summer season, Odontella mobilensis, Rhizosolenia sp. and Diatoma anceps species are dominated in Post monsoon season and Ditylum brightwellii, Ceratium macroceros and Tricodesmium erythraeum species are dominated Winter season
- Zooplankton was represented by 7 taxonomic group's viz. Calanoida, Cyclopoida, Foraminifera, Harpacticoida, Larval forms, Others and Spirotricha during the study. Diversity of around 45 species are recorded. Zooplankton Density ranged between 2495 Nos/m³ at MSL-4 during low tide in Post monsoon season and 8283 Nos/m³ at MSL-5

during low tide in Summer season. *Lucifer hansenii* is the most dominating species in survey. *Favella brevis*, *Oithona rigida* and *Barnacle naupilii* species are dominated in Summer season, Crustacean naupili, *Cresis* sp. and *Euterpina acutiformis* species are dominated in Post monsoon season and *Microsetella rosea*, *Favella brevis* and *Paracalanus parvus* species are dominated Winter season

- Results indicate that the marine water physico-chemical and biological parameters seasonal variations possess normal sea environment conditions.

Seasonal variations in Marine sediment physicochemical parameters were given in **Table 4-22** and shown in **Figure 4-25** to **Figure 4-28**. The status of bed sediment quality assessed during post-monsoon season, 2017 and winter season, 2017-18 are given as **Appendix G**.

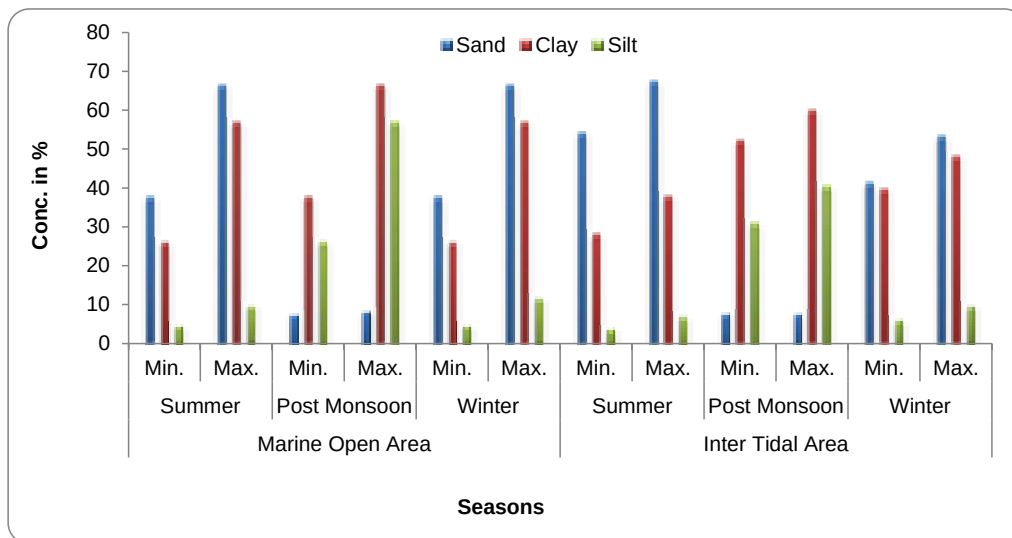


Figure 4-25: Variations in Sand, Silt and Clay Compositions

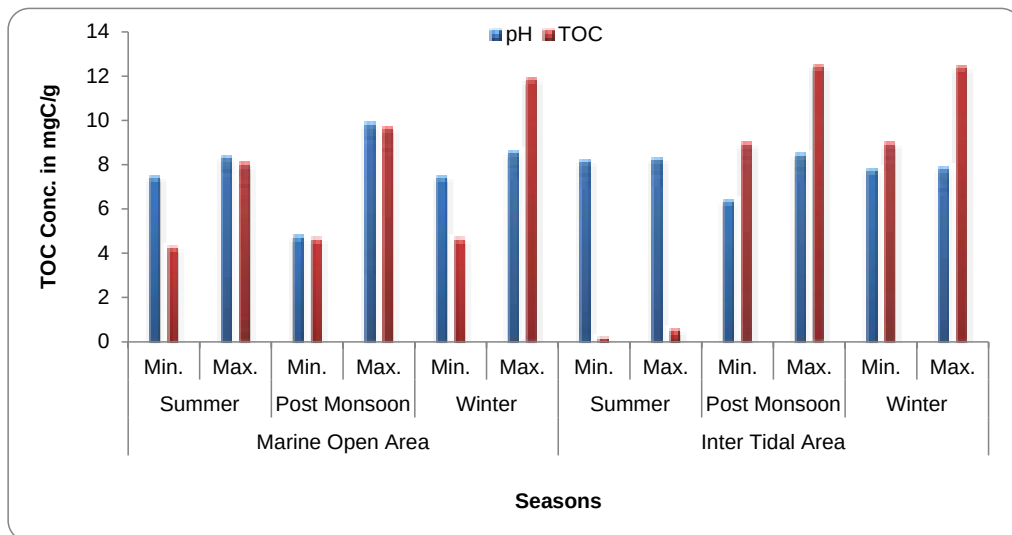


Figure 4-26: Variations in Sediment pH and TOC

Table 4-22: Seasonal Variations in Marine Sediment Parameters

Parameters	Unit	Marine Open Area						Inter Tidal Area					
		Summer		Post Monsoon		Winter		Summer		Post Monsoon		Winter	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Sand	%	38.04	66.67	7.5	8.4	38.0	66.7	54.48	67.72	7.8	7.9	41.65	53.60
Clay		26.47	57.17	38	66.7	26.5	57.2	28.41	38.15	52.5	60.3	40.00	48.47
Silt		4.80	9.85	26.5	57.2	4.8	12.0	3.87	7.37	31.2	40.7	6.20	9.85
TOC	mgC/g	4.30	8.10	4.7	9.7	4.7	11.9	0.19	0.564	9	12.5	9.00	12.45
Sediment PHC	µg/g	0.06	0.68	0.18	0.90	0.18	0.97	4.32	6.40	0.03	0.08	0.06	0.25
Cadmium (Cd)		7.65	19.32	8.5	22.3	10.1	15.5	10.23	13.9	11.3	13.5	12.4	22.3
Chromium (Cr)		9.32	14.56	10.3	14.6	10.3	20.1	12.34	13.54	10.4	12.3	10.4	12.3
Iron (Fe)		1043	6043	1204	9458	1204	8965	1023	3000	2034	4053	2034	6875
Lead (Pb)		2.12	9.95	10.32	16.54	10.2	19.6	6.55	8.96	10.32	14.32	10.3	14.3
Nickel (Ni)		7.54	14.56	7.8	15.8	9.8	15.3	10.32	14.56	13.5	14.6	10.2	16.3
Zinc (Zn)		10.32	34.43	10.32	34.67	10.3	34.7	10.34	19.32	26.54	29.34	20.4	36.3
Manganese (Mn)		18.6	75.95	20.43	80.43	20.5	90.3	9.95	39.3	30.43	32.56	30.1	32.6
Copper (Cu)		10.56	32.43	12.3	30.4	12.3	32.2	18.43	32.43	29.3	30.6	12.5	29.4
Mercury (Hg)		0.21	0.42	0.21	0.54	0.21	0.65	0.21	0.35	0.24	0.45	0.35	0.54
Macrobenthos Density	No/m ²	900	1875	425	1075	600	1075	1250	1775	650	875	550	675
Macrobenthos Diversity	No of Species	14	21	9	16	10	16	20	22	11	14	10	15
Meiobenthos	10 cm/m ²	139	218	64	148	94	141	144	195	79	124	88	95
Meiobenthos Diversity	No of Species	23	33	14	23	16	22	23	30	15	24	16	19

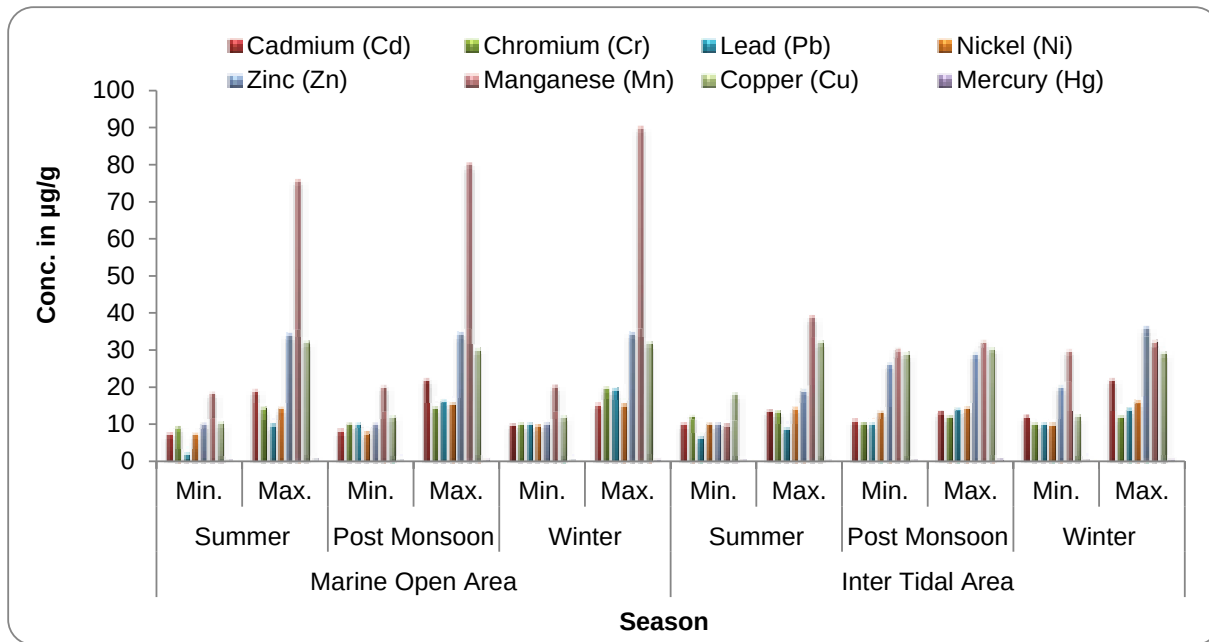


Figure 4-27: Variations in Sediment Heavy metals

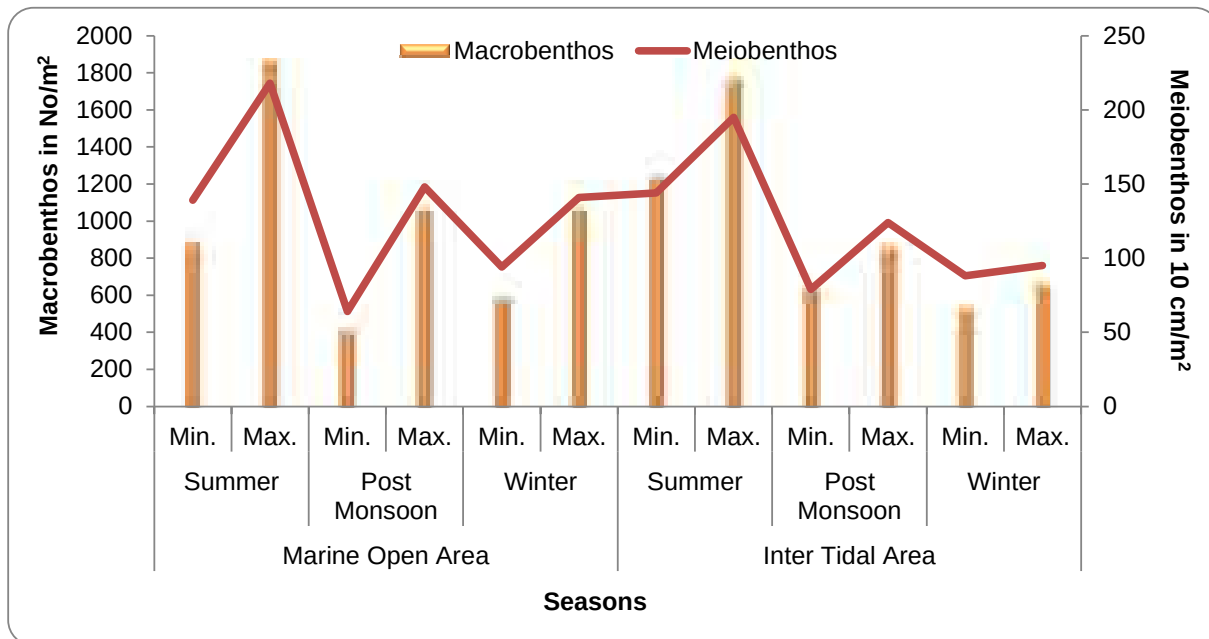


Figure 4-28: Variations in Macrobenchos and Meiobenthos

- Sand ranged between 7.5% at MSL-3 during low tide in Post monsoon season and 66.67% at MSL-6 during high tide in Summer season
- Silt ranged between 4.8% at MSL-8 during high tide in Summer season and 57.2% at MSL-1 and MSL-7 both during high tide in Post monsoon season
- Clay ranged between 26.47% at MSL-6 during high tide in Summer season and 66.7% at MSL-5 during high tide in Post monsoon season
- Total Organic Carbon varies between 4.3 mgC/g at MSL-2 during low tide in Summer season and 11.9 mgC/g at MSL-1 during high tide in Winter season

- Sediment Petroleum Hydrocarbons varied between 0.061 µg/g at MSL-6 during low tide in Summer season and 0.965 µg/g at MSL-1 during high tide in Winter season
- Cadmium concentration ranged between 7.65 µg/g at MSL-1 during low tide in Summer season and 22.3 µg/g at MSL-4 during high tide in Post monsoon season
- Chromium concentration ranged between 9.32 µg/g at MSL-10 during low tide in Summer season and 20.1 µg/g at MSL-3 during high tide in Winter season
- Iron concentration ranged between 1043 µg/g at MSL-8 during low tide in Summer season and 9458 µg/g at MSL-2 during high tide in Post monsoon season
- Lead concentration ranged between 2.12 µg/g at MSL-10 during low tide in Summer season and 19.6 µg/g at MSL-9 during high tide in Winter season
- Nickel concentration ranged between 7.54 µg/g at MSL-1 during low tide in Summer season and 15.8 µg/g at MSL-2 during high tide in Post monsoon season
- Zinc concentration ranged between 10.3 µg/g at MSL-4 and MSL-9 both during low tide in Summer season respectively and 34.7 µg/g at MSL-10 during high tide in Winter season
- Manganese concentration ranged between 18.6 µg/g at MSL-1 and MSL-6 both during low tide in Summer season respectively and 90.3 µg/g at MSL-1 during low tide in Winter season
- Copper concentration ranged between 10.56 µg/g at MSL-4 during high tide in Summer season and 32.43 µg/g at MSL-1 during high tide in Winter season
- Mercury concentration ranged between 0.21 µg/g at MSL-10 during high tide in Summer season and 0.65 µg/g at MSL-10 during high tide in Winter season
- Macro benthos was represented by 4 taxonomic groups viz., Polychaetes, Bivalves, Crustaceans and Gastropods. Around 63 species of macro benthos was recorded during 2014-15. Minimum Density (425 Nos/m²) was observed at MSL-5 during high tide in Post monsoon season and the Maximum density (1875 Nos/m²) was observed at MSL-8 during low tide in Summer season. *Mirocerberus* sp. is the most dominating species in survey. *Cerithedia cingulate*, *Perineries* sp., *Nereis* sp., *Turris indica* species are dominated in Summer season, *Cossura coasta*, *Perineries* sp. and *Anadara veligers* species are dominated in Post monsoon season and *Maldanidae* sp. and *Goniada* sp. species are dominated Winter season
- Meiobenthos was represented by 4 taxonomic group's viz., Nematodes, Foraminiferans, Harpacticoids and Ostrocodes during the study. Around 60 species was recorded during 2014-15. The meiobenthos density was ranged between 64 Nos/10 cm² at MSL-3 during high tide in Post monsoon season and 218 Nos/10 cm² at MSL-10 during low tide in Summer season. *Metisignea* sp. is the most dominating species in survey. *Ammonia tepida*, *Cervinia* sp. and *Textularia agglutians* species are dominated in Summer season, *Rosalina floridana* and *Elphidium subarficum* species are dominated in Post monsoon season and *Cervinia* sp., *Metisignea* sp. and *Cibicides pseudoungerianus* species are dominated Winter season

4.6.5.2 Observations on Intertidal Area Sediment Samples

- Sand ranged between 7.8% during high tide and low tide in Post monsoon season and 67.7% during high tide in Summer season both at Location "A"
- Silt ranged between 3.87% during high tide in Summer season and 40.7% during low tide in Post monsoon season both at Location "A"
- Clay ranged between 28.41% during high tide in Summer season and 60.3% during high tide in Post monsoon season both at Location "A"

- Total Organic Carbon varies between 0.19 mgC/g during low tide in Summer season and 12.5 mgC/g during high tide in season both at Location “B”
- Sediment pH is near neutral to alkaline in nature and varied from 6.4 to 8.5
- Sediment Petroleum Hydrocarbons varied between 0.034 µg/g at Location “A” during high tide in season and 6.4 µg/g at Location “B” during high tide in season
- Cadmium concentration ranged between 10.23 µg/g at Location “A” during low tide in Summer season and 22.3 µg/g at Location “B” during low tide in Winter season
- Chromium concentration ranged between 10.4 µg/g at Location “A” during low tide in Post monsoon season and 13.5 µg/g at Location “B” during high tide in Summer season
- Iron concentration ranged between 1023 µg/g at Location “B” during high tide in Summer season and 6875 µg/g at Location “A” during high tide in Winter season
- Lead concentration ranged between 6.55 µg/g during low tide in Summer season and 14.32 µg/g during high tide in Post monsoon season both at Location “B”
- Nickel concentration ranged between 10.2 µg/g during high tide in Winter season and 16.3 µg/g during low tide in Post monsoon season both at Location “A”
- Zinc concentration ranged between 10.34 µg/g during low tide in Summer season and 36.3 µg/g during high tide in Winter season both at Location “B”
- Manganese concentration ranged between 9.95 µg/g at Location “B” during low tide and 39.3 µg/g at Location “A” during low tide both in Summer season respectively
- Copper concentration ranged between 12.5 µg/g at Location “B” during high tide in Winter season and 32.43 µg/g at Location “A” during low tide in Summer season
- Mercury concentration ranged between 0.21 µg/g at Location “A” during low tide in Summer season and 0.54 µg/g at Location “B” during high tide in Winter season
- Macro benthos was represented by 4 taxonomic groups viz., Polychaetes, Bivalves, Crustaceans and Gastropods. Around 53 species of macro benthos was recorded during 2014-15. Minimum Density (550 Nos/m²) was observed during high tide in Winter season and the Maximum density (1775 Nos/m²) was observed during high tide in Summer season both at Location “B” respectively. *Amphinome* sp. and *Goniadopsis incerta* are the most dominating species in survey. *Turris indica* and *Littorina* sp. species are dominated in Summer season, *Goniada emerita*, *Nereis* Sp. and *Notomastus aberans* species are dominated in Post monsoon season and *Nereis* sp. *Anadara rhombea* and *Donax veligers* species are dominated Winter season
- Meiobenthos was represented by 4 taxonomic group's viz., Nematodes, Foraminiferans, Harpacticoids and Ostrocodes during the study. Around 60 species was recorded during 2014-15. The meiobenthos density was ranged between 79 Nos/10 cm² during high tide in Post monsoon season and 195 Nos/10 cm² during low tide in Summer season both at Location “B” respectively. *Ammonia beccari* is the most dominating species in survey. *Ammonia tepida*, *Pararotalia globosa* and *Globigernita glutinata* species are dominated in Summer season, *Asterorotalia trispinosa* and *Greeffiella* sp. species are dominated in Post monsoon season and *Tricoma* sp. and *Ammonia beccari* species are dominated Winter season

4.6.6 Fisheries

4.6.6.1 Odisha State Fisheries Profile

Odisha is one of the major maritime States having 480 km long coastline with 24,000 km² continental shelf area has huge potential for marine fisheries development. The fresh water resources of the State include about 6.75 lakhs ha area under tanks and ponds, lakes and reservoirs, swamps and Jheels, rivers and canals etc. Chilika a brackish water lagoon

extending over an area of 79,000 Ha²⁶. Out of 30 districts seven belongs to coastal district with fishermen population of 8,78,190 (Inland) and 7,47,606 (Marine).

The present total fish production of the state is 4.10 lakhs MT (1.18 lakhs tones of marine, 2.62 lakhs tones of inland sector and 0.30 lakhs tones brackish water). The present level of fish production in the State is about 62% of the overall fisheries potential.

4.6.6.2 Annual Fish Production of Bhadrak and Kendrapara Districts

Marine Fish Production (in MT) for Bhadrak and Kendrapara Districts is given in **Table 4-23**.

Table 4-23: Annual Marine Fish Production (MT)

Year	Bhadrak	Kendrapara	Year	Bhadrak	Kendrapara
2000-01	9350	13206	2008-09	12310	7363
2001-02	9216	13594	2009-10	12811	4798
2002-03	10405	9483	2010-11	12631	6853
2003-04	10001	10795	2011-12	9773	6339
2004-05	10853	10923	2012-13	11086	4898
2005-06	10856	7971	2013-14	11076	7474
2006-07	11854	7787	2014-15	11721	7009
2007-08	11973	7289			

4.6.6.3 Fish landing details at Dhamara Fishing Harbour

Fish landing data during the period 2010 to 2016 were collected from the Management Society, Dhamra Fishing Harbour, Dhamra. The average fish landing in Dhamra Fishing Harbour during 2010 to 2016 is 3638 metric tons (MTs) per year. The major fishing categories are Sciaenids (790.45 MTs/year), Silver Pomfret (385.64 MTs/year), Black Pomfret (273 MTs/year), Catfish (272 MTs/year), Metapenius (268.2 MTs/year), Trichiuridae (233 MTs/year). Other miscellaneous fish categories accounts for 294 MTs/year. The other significant fishing categories include Clupeid (110 MTs/year), Shad (107MTs/year), Eel (92 MTs/year), *Penius monodon* (86 MTs/year), *Penius indicus* (80 MTs/year) and *Chirocentrus* (80 MTs/year). The details of the landing of different category of fishes are presented in **Table 4-24**.

Table 4-24: Fish landing in Dhamra Fishing Harbour during 2010 to 2016

Category	Fish Catch in Metric Tons								
	2010	2011	2012	2013	2014	2015	2016	Total	Average
Shark	23.2	-	-	-	-	-	-	23.2	23.2
Rays	101.1	24	25.5	45	24	31	26.02	276.62	39.5
Oil Sardine	3	17	7	1	4	9	3.03	44.03	6.3
Other Saardine	44	33	11	1	6	9	3.04	107.04	15.3
Hilsa shad	100.2	81.2	166	6	54	48	46.5	501.9	71.7
Others shad	133.4	146.9	225	9	100	72	64	750.3	107.2
Trisocles	17.5	23	47	30	23	23	23.02	186.52	26.6
Anchovies	98.1	50	64	84	37	34	44.1	411.2	58.7
Other clupeids	135.4	87	133.6	116.7	94	118.5	87.54	772.74	110.4
<i>Harpodon neherus</i>	18.9	22	33	43	204	100	89	509.9	72.8
Chirocentrus (Silver bar)	147.5	77	76.4	68	54	72	70.1	565	80.7
Polynemids	5.2	-	-	-	-	4	3	12.2	4.1
Chorinemus	7.6	-	5	-	-	0.5	-	13.1	4.4
Trichiuridae	224.5	231	158.9	285.57	244	284.5	209.3	1637.77	234.0
Carangids	17	50	79.5	57	45	31	36.04	315.54	45.1

²⁶ Disaster Management Plan of Fisheries Department, 2014-15, Directorate of Fisheries, Odisha

Category	Fish Catch in Metric Tons								
	2010	2011	2012	2013	2014	2015	2016	Total	Average
Indian Mackerel	15.5	-	-	21	5	22	18.02	81.52	16.3
Other Makeral	14.2	-	-	-	2	-	-	16.2	8.1
<i>Scobiromirus commerson</i>	36.4	3	-	16	2	6	11	74.4	12.4
<i>S. gutatus</i>	36.2	3	-	-	8	8	3.04	58.24	11.6
Tunnies	18	23.3	4.5	-	-	-	-	45.8	15.3
Mugil (Mullet)	115.7	57	36.1	61.4	22	23	22.1	337.3	48.2
Eels	145.2	63	40.7	149.8	57	98	90.26	643.96	92.0
Catfish	291.6	168.1	258.9	305.1	225	376	282.2	1906.9	272.4
Threadfin Bream	2	-	-	11	-	-	-	13	6.5
Other Perches	13.8	-	60	4	6	6.5	10.9	101.2	16.9
Sciaenids (Croaker)	247.3	692.15	883.1	1097.9	956	866.8	789.9	5533.15	790.5
Leignathus	-	2	5	7	-	4	4	22	4.4
Black pomfret	162.2	160.6	246.7	304	364	349	325.5	1912	273.1
Silver Pomfret	184.5	257.3	340.4	411	530	497	478	2698.2	385.5
Sole (Flat Fish)	32.8	33.9	31.7	31.5	50	93.5	63.16	336.56	48.1
<i>Penaeus monodon</i>	66.1	43.5	94	100	93.5	106	100	603.1	86.2
<i>P. indicus</i>	79.5	31.1	85	88	98	90.5	88	560.1	80.0
<i>Metapenaeus</i> sp.	295.4	600.5	238	154	188.5	218	183	1877.4	268.2
Non penaid Shrimp	84.4	30	-	3	-	4	-	121.4	30.4
Crustaceans (Crab)	4.3	-	-	-	-	-	-	4.3	4.3
Molluses	1	-	239	-	8	14	14.03	276.03	55.2
Squids & Cuttle fish	-	-	-	-	24	14	11	49	16.3
Misc Fish	185.3	216.95	206.5	273.83	722.8	236	218.5	2059.88	294.3
Total	3108	3227.5	3801.5	3784.8	4250.8	3868.8	3417.3	25458.7	3638.4

4.6.6.4 Socio-Economic Profile of Bhadrak and Kendrapara District Fisher folks

District Profile, Population distribution structure, Educational status, Active fisher folk, Lifesaving equipment's & electronic equipment's, Fishing craft in the fishery, Craft owned by fisher folk, Fishing gear owned by fisher folk, housing & education, Infrastructure facilities and Fishery related Infrastructure for both Bhadrak and Kendrapara Districts extracted from Marine Fisheries Census 2010 is given in **Table 4-25** to **Table 4-34**.

Table 4-25: District Profile

District	Landing Centre's	Fishing villages	Fishermen families	Fisherfolk population
Bhadrak	10	95	12,765	64,574
Kendrapara	7	117	13,527	76,361

Table 4-26: Active fisherfolk

District	Actual fishing		Fish seed collection				Total
	Full time	Part time	Full time		Part time		
			Male	Female	Male	Female	
Bhadrak	10,552	5,889	34	16	14	28	16,533
Kendrapara	8,951	3,687	631	2,968	404	2,065	18,706

Table 4-27: Educational Status

District	Primary		Higher Secondary		Above Higher Secondary		Unschool'd*	
	Male	Female	Male	Female	Male	Female	Male	Female
Bhadrak	6,795	5,980	3,153	2,266	629	238	18,044	17,252
Kendrapara	11,376	9,620	5,929	4,075	521	133	16,783	17,353

* Children below 5 years excluded

Table 4-28: Population Distribution Structure

District	Male			Female			Total	Average family size	Sex ratio (females per 1000 males)
	Adult	Children		Adult	Children				
		Upto 5 yrs	Above 5 yrs		Upto 5 yrs	Above 5 yrs			
Bhadrak	18,554	5,026	10,067	16,636	5,191	9,100	64,574	5.06	919
Kendrapara	23,895	5,548	10,714	21,783	5,023	9,398	76,361	5.65	902

Table 4-29: Infrastructure - Housing and Education

District	No. of villages	No. of Families	Housing		Education			
			Kutcha houses	Pucca houses	Primary	Secondary	College	Technical Institutions
Bhadrak	95	12,765	11,266	1,499	106	48	1	0
Kendrapara	117	13,527	12,493	1,034	108	31	3	0

Table 4-30: Infrastructure / Facilities

District	No. of fishing villages	Villages having							Number of					
		Electricity	Bus stop /stand	Hospitals	Police station	Post Offices	Mob. Phone coverage	Internet facility	Banks	Fisheries Co-operative Societies	Other Co-operative Societies	Community centers	Cinema theatres	Liquor shops
Bhadrak	95	43	42	9	11	7	45	2	9	45	31	34	26	199
Kendrapara	117	52	18	5	4	24	101	4	8	8	28	59	2	1

Table 4-31: Infrastructure - Fishery Related

District	Boat yards	Ice factories	Cold storages	Freezing plants	Curing yards	Peeling sheds	Processing plants
Bhadrak	2	11	2	0	0	0	0
Kendrapara	1	1	0	0	0	0	0

Table 4-32: Life Saving Equipment's & Electronic Equipment's (No. of Families)

District	Life Saving Equipment	Electronic /Communication gadgets		
		Mobile phone	GPS	Others
Bhadrak	492	2,255	3	202
Kendrapara	2,119	5,065	60	1,272

Table 4-33: Fishing Craft in the Fishery

District	Trawlers	Gillnetters	Dolnetters*	Liners	Total Mechanized	Motorized	Nonmotorized	Total
Bhadrak	189	111	50	0	350	558	105	1,013
Kendrapara	0	0	0	0	0	228	1,250	1,478

*Craft mainly employed in bagnet fishery

Table 4-34: Fishing Gear Owned by Fisherfolk (100% Ownership)

Type	Bhadrak	Kendrapara
Trawlner	281	46
Gillnet	2,130	3,948
Driftnet	280	1,803
Ringseine	116	47
Boatseine	379	501
Bagnet	1,379	616
Shoreseine	152	995
Castnet	5,492	4,751
Hooks&Lines	97	350
Trollline	19	22
Fixednet	139	9
Traps	1	8
Scoopnet	1,210	802
Others	40	16

4.6.6.5 Demographic/Socio-Economic Profile of Coastal Fishermen in Study Area/PIA

The details of Fishermen Population in this study area are collected from Odisha Marine Fisheries Census 2010. The study area considered for the coastal fishing hamlet/village socio-economic baseline description consists of 15 km radius around the Project stretch. As per Odisha Marine Fisheries Census 2010, Two costal PIA Tehsil i.e., Basudevapur (4 villages) and Chandabali (23 villages) in Bhadrak district and One Tehsil i.e., Rajnagar (45 villages) in Kendrapara district covering a total of 72 numbers of PIA fishing hamlets are falling in the study area²⁷.

The details of fishing villages in the study area are given in **Table 4-35** and in **Figure FD0405**.

Table 4-35: Details of Fishing Hamlets in Study area

S. No	District	Tehsil	Name of the village/Hamlets	Distance from Project Boundary	
				Distance (KM)	Direction
1	Bhadrak	Basudevapur	Balarampur	14.8	NW
2			Dadhibamanpur	7.4	NW
3			Nuagan	14.2	W
4			Pohadpur	11.8	NW
5		Chandabali	Amarnagar	0.1	W
6			Begunia	14.5	W
7			Bidutaprava	2.76	W
8			Charadia	10.0	WSW
9			Dhamara	5.4	WSW
10			Dosinga	0.08	S
11			Gobindpur	5.5	W
12			Guanla	6.6	W

²⁷ However, as per Census 2011, Four (04) Tehsils Namely Naikanidihi, Chandabali, Bansada, Dhamra Marine and Two (02) tehsils namely Rajnagar, Jamboo Marine in Kendrapara district are falling the study area as per revised taluks list.

S. No	District	Tehsil	Name of the village/Hamlets	Distance from Project Boundary	
				Distance (KM)	Direction
13			Guansol	5.8	NW
14			Jagula	4.6	W
15			Kananpali	7.2	WSW
16			Karanjamala	2.5	NW
17			Kuanri Kanthi	12.3	W
18			Narendrapur	3.0	NW
19			Nuagan	6.3	W
20			Orasahi	14.5	WSW
21			Paikasahi	4.2	WSW
22			Purnaprasad	1.3	W
23			Rabindra Nagar	0.1	W
24			Sabitrisarai	1.5	SW
25			Saraswati	3.8	NW
26			Singity	14.8	W
27			Tentulida	8.5	w
28	Kendrapara	Rajnagar	Ahirajpur	7.3	SSE
29			Amarabati	7.8	S
30			AnantaKeshori	7.3	SSE
31			Badkata	8.3	SSW
32			Baghamari	4.8	SSE
33			Baghua	9.5	SW
34			Banipal	8.1	S
35			Baradia	12.2	SW
36			Bhanja Prasad	4.3	S
37			Birabhanjapur	4.3	S
38			Chanrakolla	9.1	SSW
39			Dangamal	11.2	SW
40			Dola Sahi	6.6	S
41			Garta	8.7	S
42			Giriapahi	6.4	S
43			Gopaljipatna	13.2	SSW
44			Harin Pokhari	7.7	SSW
45			Jyoti Prasad	3.6	S
46			Kanaknagar	8.1	SW
47			Kervapala	7.6	S
48			Khasmunda	5.8	S
49			Krushnanagar	8.2	SW
50			Manjulapalli	5.5	S
51			Nalitapatia	13.5	SW
52			Narayanpur	9.6	SW
53			Pattaparia	11.3	SSW
54			Prabhathi	9.2	SSE
55			Radhamalopur	6.1	SSW
56			Ragadapaatia	12.8	SW
57			Rajendranagar	5.2	SSW
58			Rajendranarayanpur	15.5	SW
59			Rajeshwarinagar	6.2	SSW
60			Rangoni	8.9	SSW
61			Sailendranagar	6.2	SW
62			Sailendranarayanpur	14.4	SSW
63			Sailendrapur	7.8	SW
64			Sailendrasarai	5.7	SW
65			Sikar Pahi	6.5	SSW
66			Sir Rajendrapur	8.6	S
67			Subarnapur	10.1	SW
68			Talchua	5.3	SSW

S. No	District	Tehsil	Name of the village/Hamlets	Distance from Project Boundary	
				Distance (KM)	Direction
69			Tikayat Nagar	4.5	SW
70			Trilochanpur	11.1	SW
71			Udyan	5.3	S
72			Vekta	7.4	SSW

4.6.6.6 Fisherflok Socio Economic Assessment in PIA

For assessing the Socio Economic profile of coastal fishermen, Hamlets/panchayats/villages falling in PIA have been divided into four groups based on radial distance from the project boundary. These categories include:

- Group I (0-1 km radius), Project adjacent Area
- Group II (1-5 km radius), Core area
- Group III (5-10 km radius), General Study area (excluding Core area)
- Group IV (10-15 km radius), General Study area (excluding Core area)

Total of 72 fishing hamlets (FH) are falling in PIA under Three (03) Tehsil and Two (02) Districts viz. Basudevpur and Chandbali tehsil in Bhadrak district and Rajnagar tehsil in Kendrapara district. As per Marine Fisheries Census, 2010, Odisha Fishing hamlets/villages falling in the PIA are clustered in to four groups viz. Group I, Group II, Group III and Group IV.

In Group I, Three (03) FH's are falling under Chandbali tehsil in Bhadrak District. In Group II, Fourteen (14) FH's are falling where One (01) FH is falling under Basudevpur tehsil and Eight (08) FH's are falling under Chandbali tehsil in Bhadrak District respectively and remaining Five (05) FH's are falling under Rajnagar tehsil in Kendrapara district. In Group III, Thirty Eight (38) FH's are falling where only Eight (08) FH's are falling under Chandbali tehsil in Bhadrak District and remaining Thirty (30) FH's are falling under Rajnagar tehsil in Kendrapara district. In Group IV, Seventeen (17) FH's are falling where Three (03) FH's is falling under Basudevpur tehsil and Four (04) FH's are falling under Chandbali tehsil in Bhadrak District respectively and remaining Ten (10) FH's are falling under Rajnagar tehsil in Kendrapara district and given in **Table 4-36**.

Table 4-36: Group wise list of PIA Villages/Hamlets present in the Study Area

Group I	Group II	Group III	Group IV
District: Bhadrak	District: Bhadrak	District: Bhadrak	District: Bhadrak
Tehsil: Chandbali	Tehsil: Basudevpur	Tehsil: Chandbali	Tehsil: Basudevpur
Dosinga	Dadhibamanpur	Dhamara	Pahadpur
Amarnagar	Tehsil: Chandbali	Gobindpur	Nuagan
Rabindra Nagar	Purnaprasad	Guansol	Balarampur
	Sabitrisarai	Nuagan	Tehsil: Chandbali
	Karanjamala	Guanla	Kuari Kanthi
	Bidutaprava	Kananpali	Begunia
	Narendrapur	Tentulida	Urasahi
	Saraswati	Charadia	Singity
	Paikasahi	District: Kendrapara	District: Kendrapara
	Jagula	Tehsil: Rajnagar	Tehsil: Rajnagar
	District: Kendrapara	Rajendranagar	Subarnapur
	Tehsil: Rajnagar	Talchua	Trilochanpur
	Jyoti Prasad	Udyan	Dangamal
	Bhanja Prasad	Manjulapalli	Patta Paria
	Birabhanjapur	Sailendrasarai	Baradia
	Tikayat Nagar	Khasmunda	Ragadapaatia
	Baghamari	Radhamalopur	Gopaljipatna

Group I	Group II	Group III	Group IV
		Rajeshwarinagar Sailendranagar Giriapahi Sikar Pahi Dolai Sahi Ahirajpur AnantaKeshori Vekta Kervapala Harin Pokhari Amarabati Sailendrapur Banipal Kanaknagar Krushnanagar Badkata Sir Rajendrapur Garta Rangoni Chanrakolla Prabhati Baghua Narayanpur	Nalitapatia Sailendranarayanpur Rajendranarayanpur

4.6.6.6.1 Fishermen Population v/s PIA Population

Total fishermen families are 7532 and Total fishermen population is 42896 in numbers in PIA. Comparison of the fishermen population with Study area population shows that

- Total Fishermen households forms 23.44 % of total households in PIA
- Total Fishermen population forms up to 25.63% of the PIA population,
- Total fishermen males forms 26.17% of total males in PIA,
- Total fisherwomen (females) forms 25.07% of total females of PIA and
- Sex ratio is lower in fishermen population (928) to total population (969) in study area.

4.6.6.6.2 Fishermen Population in the Study Area

The details of Fishermen Population in the study area for tehsil and hamlets are collected from Marine Fisheries Census, 2010 and given in **Table 4-37**.

Table 4-37: Fishermen Population in FH in PIA

As Per District Census - 2011*			As Per Marine Fisheries Census - 2010				
No. of Villages	Total House Holds	Total Population	No. Fishing Hamlets (FH)	Fishermen Families	Traditional Fishermen Families	BPL Families	Fisher folk Population
Group I							
14	2691	13390	3	480	477	251	2587
Group II							
26	3958	20876	14	1665	1122	863	8788
Group III							
76	9474	49669	38	3576	960	1141	21282
Group IV							
102	16004	83433	17	1811	1180	661	10239
Grand Total							
218	32127	167368	72	7532	3739	2916	42896

4.6.6.6.3 Fishermen Population Distribution Structure in the Study Area

As per marine census 2010, 22,245 numbers of male fisherflok population including 3,233 children of up to 5 years and 7,527 children of above 5 years and 20,651 numbers of female fisherflok population including 3,054 children of up to 5 years and 7,033 children of above 5 years in PIA are reported. Average fisherflok family size is 5.7 and Sex ratio (females per 1000 males) is 928 for entire fisherflok population and 920 among the Adults in Fishermen Population. The Fishermen Population Distribution Structure in the Study Area is presented in **Table 4-38**.

Table 4-38: Fishermen Population Distribution Structure in the Study Area

As Per District Census - 2011*				As Per Marine Fisheries Census - 2010										
No. of Villages	Male	Female	Sex Ratio	No. Fishing Hamlets (FH)	Male			Female			Total	Average family size	Sex ratio females per 1000 males)	Sex ratio in Adults (females per 1000 males)
					Adult	Children		Adult	Children					
						Upto 5 yrs	Above 5 yrs		Upto 5 yrs	Above 5 yrs				
Group I														
14	6897	6493	941	3	617	202	454	585	268	461	2587	5.4	1032	948
Group II														
26	10699	10177	951	14	2296	704	1519	2149	725	1395	8788	5.0	945	936
Group III														
76	25372	24297	958	38	5583	1523	3936	5249	1317	3674	21282	6.2	927	940
Group IV														
102	42032	41401	985	17	2989	804	1618	2581	744	1503	10239	5.7	892	863
Grand Total														
218	85000	82368	969	72	11485	3233	7527	10564	3054	7033	42896	5.7	928	920

(Note: * District Census – 2011 for PIA)

4.6.6.6.4 Educational Status of Fishermen

Overall status of education of the fishermen communities shows that on an average, only ~37.98% of the people have attended schools and forms only 13.81% of total literates in PIA and Iliterates are forming 62.02% of the total fishermen population. Among fisherflok of literates, males occupy 55.77% and females 44.23% and when compared to total literates of PIA occupying 13.76% and 13.88% only. The boys been educated more than girls and at Higher Secondary level and Above Higher Secondary levels girls are only 10.59% and 0.66% female literates in total fishermen communities are 4.02% and 0.25% of PIA respectively. Most of the elder fisher men and women are illiterate while youngsters have at least primary education. The details of Educational Status in the Study Area are collected from Marine Fisheries Census, 2010 and given in **Table 4-39**.

Table 4-39: Details of Educational Status

No. Fishing Hamlets	Primary		Higher Secondary		Above Higher Secondary		Total	Illiterates
	Male	Female	Male	Female	Male	Female		
Group I								
3	495	416	232	210	29	5	1387	1200
Group II								
14	1403	1261	624	461	86	23	3858	4930
Group III								
38	3259	2855	1177	722	168	45	8226	13056
Group IV								
17	935	841	588	333	90	35	2822	7417
Grand Total								
72	6092	5373	2621	1726	373	108	16293	26603

4.6.6.6.5 Active Fishermen

Altogether 11,708 fishermen are active in fishing including both fulltime and parttime participation in fishing activity and forming 27.29% among the total fishermen population and out of them 7,023 are involved in actual fishing in which 4,614 as a full time employment and 2,409 members take fishing as a part time work. 4,685 persons are engaged in fish seed collection where 96.50% are female in which 62.2% are in fulltime seed collection and 37.8% are in part time seed collection activities. The details are given in **Table 4-40**.

Table 4-40: Details of Active Fishingfolk

No. Fishing Hamlets	Actual Fishing		Fish seed collection				Total	Total Fishermen
	Full time	Part time	Full time		Part time			
			Male	Female	Male	Female		
Group I								
3	285	246	0	1	0	0	532	2587
Group II								
14	1079	818	3	228	15	331	2474	8788
Group III								
38	1827	788	36	2051	87	1142	5931	21282
Group IV								
17	1423	557	14	532	9	236	2771	10239
Grand Total								
72	4614	2409	53	2812	111	1709	11708	42896

4.6.6.6.6 Occupational Status

Besides fishing, the fisher families are engaged in allied activities and their occupational pattern in the study area are collected from Marine Fisheries Census, 2010 and given in **Table 4-41**. The work participation rate among fishermen is 45.65% out of which 59.79% are involved in Actual Fishing followed by 30.97% are labourers, 3.86% are engaged in Marketing of fish, 2.42% are involved in other than fishing and the remaining 1.75%, 1.02%, 0.19% and 0.01% are engaged in Making/Repairing Net, Curing/Processing, Peeling and Others respectively.

Table 4-41: Details of Occupational Status

No. Fishing Hamlets	Fishermen involved in fishing allied activities								Total occupied
	Active fishermen	Marketing of fish	Making/ Repairing Net	Curing/ Processing	Peeling	Laborer	Others	Other than	
Group I									
3	532	13	10	11	0	11	0	13	590

No. Fishing Hamlets	Fishermen involved in fishing allied activities								Total occupied
	Active fishermen	Marketing of fish	Making/ Repairing Net	Curing/ Processing	Peeling	Laborer	Others	Other than	
Group II									
14	2474	199	59	42	3	654	0	28	3459
Group III									
38	5931	252	138	74	20	4082	1	204	10702
Group IV									
17	2771	291	135	72	15	1317	0	229	4830
Grand Total									
72	11708	755	342	199	38	6064	1	474	19581

4.6.6.6.7 Religion and Community (No. of Families)

Data on religious status of the fishermen families shows that 96.24% of them belong to Hindu (families) community and the remaining are Muslims and Christians. The details of Religion and Community (No. of Families) in the study area are given in **Table 4-42**.

Table 4-42: Details of Religion and Community

No. Fishing Hamlets	Fishermen Families	Religion					Community SC/ST
		Hinduism	Islam	Christianity	Others	Total	
Group I							
3	480	479	1	0	0	480	90
Group II							
14	1665	1561	104	0	0	1665	668
Group III							
38	3576	3406	169	1	0	3576	806
Group IV							
17	1811	1803	8	0	0	1811	1233
Grand Total							
72	7532	7249	282	1	0	7532	2797

4.6.6.6.8 Fishermen Co-Operatives

The details of fisherman membership in co-operatives in PIA are given in **Table 4-43**.

Table 4-43: Details of Fishermen Co-Operatives

No. Fishing Hamlets	Members in		Total
	Fisheries co-operatives	Other co-operatives	
Group I			
3	0	0	0
Group II			
14	558	53	611
Group III			
38	3037	309	3346
Group IV			
17	817	115	932
Grand Total			
72	4412	477	4889

4.6.6.6.9 Gender-Wise Fishing Allied Activities

Work participation of women in allied activities is more than men and it is important that both of them work to earn a living. Among the working categories, 21.25% are male and 16.54% are women. Women are engaged more in marketing of fish, curing/processing and peeling of fish and other labour works. The details of Gender-Wise Fishing Allied Activities in the study area are collected from Marine Fisheries Census, 2010 and given in **Table 4-44**.

Table 4-44: Details of Gender-Wise Fishing Allied Activities

Number of Fishing Hamlets	Total Occupied	Marketing of fish		Making/ Repairing Net		Curing/ Processing		Peeling		Labourer		Others	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Group I													
3	590	11	2	2	8	2	9	0	0	8	3	0	0
Group II													
14	3459	33	166	39	20	18	24	3	0	331	323	0	0
Group III													
38	10702	90	162	72	66	4	70	6	14	2486	1596	1	0
Group IV													
17	4830	91	200	112	23	21	51	3	12	827	490	0	0
Grand Total													
72	19581	225	530	225	117	45	154	12	26	3652	2412	1	0

4.6.6.6.10 Fishing Craft Owned by Fisherfolk (Full Ownership) in the PIA

The details of fishing craft in the study area are given in **Table 4-45**. There are 526 motorised and 861 non- motorised crafts operating in the area.

Table 4-45: Details of Fishing Craft in PIA

No. Fishing Hamlets	Mechanized	Outboard	Non-motorized
Group I			
3	69	8	33
Group II			
14	129	21	177
Group III			
38	144	63	501
Group IV			
17	76	16	150
Grand Total			
72	418	108	861

4.7 Terrestrial Flora and Fauna

Biological communities are the indicator of environmental condition and resource of its distribution and survival. Biotic component comprises of both plants (Flora) and animal (Fauna) communities, which interact not only within and between them but also with the abiotic components, viz. physical and chemical components of the environment. The changes in biotic community are studied in the pattern of distribution, abundance and diversity.

Project Location, Proposed Development Salient Features of the project are presented in **Section 4.2**. General Description of the Study Area, study period and Environmentally/Ecologically Sensitive Areas and Project Influence Area (PIA), Land Availability and Land Use-Land Cover studies for PIA in Sections 4.2, 4.3 and 4.4 respectively.

In addition, In line with the suggestion given by EAC, MoEF&CC during ToR meeting and vide its MoM (2nd meeting of Expert Appraisal Committee (Infra-2), MoEF&CC) and to understand the environment in a comprehensive manner the collected data during Summer season, 2014, Post monsoon season, 2014 and Winter season, 2014-15 with respect to Flora and Fauna has been reviewed for comparison and presented below

4.7.1 Methodology for the Flora & Fauna Study

Flora and fauna studies were conducted to assess the list of plant and animal species and their habitat in and around the port site. Methodology adopted for carrying out flora and fauna study is as follows:

Flora: A total of 32 sampling locations were chosen covering project area, core area and buffer area using restricted randomization technique, where the sampling locations were selected based on their proximity to areas of dense vegetation, and proximity to water bodies. These locations were determined using topographic sheets from the Survey of India as well as the existing land use maps. The sampling locations of flora and fauna are shown in **Figure FD0404**.

Fauna: Methodology for study of fauna consisted of detailing taxonomic accounts based on visual observation, circumstantial evidence based on pug marks, excreta, droppings, feathers, nests and the habitat features, reports from locals especially the herdsmen and farmers as well as published literature including the reports, records and working plans of the forest department.

Data Collection: The primary data was collected by visual observations (documented in the field forms) as well as by discussion with villagers. The secondary data corresponding to project region were gathered from published literature, District Forest Department and Social Forestry Division.

A comparative list of all floral and faunal species of the study area was prepared based on the field observations/collections as well as the secondary data from authenticated sources like the state forest and wildlife departments. The coordinates of sampling locations is given in **Table 4-46**.

Table 4-46: Sampling Locations with GPS Co-ordinates

Location	Latitude	Longitude	Location	Latitude	Longitude
1	20°50'32.60"N	86°57'2.16"E	17	20°46'6.95"N	86°59'36.56"E
2	20°51'6.30"N	86°57'5.21"E	18	20°45'6.28"N	87° 0'15.21"E
3	20°51'26.60"N	86°57'3.38"E	19	20°45'54.84"N	86°57'25.42"E
4	20°50'17.26"N	86°57'5.28"E	20	20°45'21.58"N	86°54'44.02"E
5	20°50'6.21"N	86°57'18.58"E	21	20°45'10.66"N	86°52'34.22"E
6	20°49'40.75"N	86°57'21.48"E	22	20°43'17.93"N	86°54'35.17"E
7	20°49'0.73"N	86°57'48.27"E	23	20°42'57.16"N	86°57'49.75"E
8	20°49'10.10"N	86°56'39.85"E	24	20°42'59.38"N	87° 0'32.00"E
9	20°49'32.42"N	86°55'47.68"E	25	20°42'7.68"N	86°59'1.42"E
10	20°48'23.13"N	86°56'56.04"E	26	20°42'9.64"N	86°54'56.93"E
11	20°48'8.92"N	86°57'37.39"E	27	20°46'40.15"N	86°53'30.33"E
12	20°47'33.00"N	86°56'0.37"E	28	20°47'43.23"N	86°51'5.20"E
13	20°49'17.74"N	86°59'38.88"E	29	20°50'38.02"N	86°51'34.23"E
14	20°48'17.05"N	86°59'53.77"E	30	20°53'49.91"N	86°53'36.01"E
15	20°49'2.02"N	86°55'0.07"E	31	20°52'40.99"N	86°51'18.80"E
16	20°50'41.69"N	86°56'4.54"E	32	20°55'28.97"N	86°55'2.55"E

Quantitative Analysis of the Vegetation: Plot-based random quadrat sampling method was adopted to generate the Phyto-sociological data viz., density, frequency, abundance and important value index (IVI). Other ecological parameters viz., abundance, density, frequency, IVI, Shannon-Wiener diversity index, Simpson's dominance index, Abundance/Frequency (A/F) ratio for distribution pattern of species and Similarity Index were derived from the above basic data. These indices are also been calculated with statistical tools such as PAST, SPSS, and Biodiversity PRO etc.

Area Wise Classification: The proposed project falls in 6C – Deccan Peninsula Eastern Highland as per the Biogeographic Classification of India and Tropical Savannah type as per the India's Koppen climate classification. The vegetation of the study area falls under 5A: Southern tropical dry deciduous forests C3: Southern dry mixed deciduous forest, 4B- Tidal Swamp Forest under subclass TS2 – Mangrove forest by revised classification given by Champion and Seth. These types of forests are not seen locally in but known to occur in other parts of the country.

4.7.2 Status of Flora and Vegetation

Project Area: The entire area was colonized common halophytic vegetation mainly by *Suaeda maritima*, *Suaeda monoica*, *Suaeda nudiflora*, *Sesuvium portulacastrum* and *Scirpus littoralis*. The uniformity was spoiled here and there by a few scattered individuals of *Acanthus ilicifolius* and *Prosopis juliflora*. *Aeluropus lagopoides*, *Heliotropium curasavicum*, *Cyperus compactus* and *Cyperus corymbosis* were found in the drier regions close to high tide levels. Saplings of *Avicennia* sp. are also observed in this zone.

Core Area: Species of halophytic by a salt grass, *Aeluropus lagopoides* vegetation include *Sesuvium portulacastrum*, *Suaeda maritima*, *Suaeda monoica*, *Suaeda nudiflora*, *Fimbristylis ferruginea*, *Acanthus ilicifolius*, *Aeluropus lagopoides*, *Avicennia alba*, *Avicennia marina*, *Salicornia brachiata* are common mangrove species of this zone.

Buffer Area: This zone has more ecologically sensitive areas such as reserve forests and Wildlife sanctuaries. Typical village zones having agricultural activities are predominantly seen in the West side of the project site. Some places inhabited with natural forest, wetlands

and Riverine ecosystems. The list of species and their seasonal occurrence is given in **Table 4-47**.

4.7.2.1 Vegetation as per the Study Categories in PIA

Agriculture Vegetation: Rice is the major crop in kharif season and pulses and oilseeds in Rabi season. The other crops such as pulses, oil seeds, fibres, sugar cane, vegetables and spices are also grown here. Horticulture crops grown in the district include Coconut, Mango and Cashew nut. In the recent past the cultivation of citrus has increased. Mango orchards were observed on the way to the Bansada. Most of the area was covered by the Coconut grove and the paddy cultivation.

Social Forestry Plantation/ Agro-Forestry Species: Social Forestry Division of Bhadrak District has carried out plantation in few areas on the road side and in villages. Various schemes have been started to develop village forest, fuel wood resources and for rejuvenation of degraded forest land. Tree plantation in social forestry is all local and native species. Some of the species recorded in that area are *Peltoforum*, *Pongamia pinnata*, *Delonix regia*, *Mangifera indica*, Tamarindus, Neem Sissoo etc.

Greenbelts Developed near the Project Site: Near the existing port, greenery has been developed by the port authority. *Casuarina* is the dominant patch of this region. *Prosopis* is the common weed and *Suaeda maritima* is the common and natural saltmarsh plants present here. Near the corridors and other vacant places, some native and very common species such as *Pongamia*, *Peltoforum*, *Albezia amara*, Sissoo, Ficus, Neem, *Delonix*, *Samania saman* and other ornamental herbs and shrubs are raised.

Natural Vegetation: Natural vegetation is limited to road sides, residential areas, field bunds and croplands. It is composed of common avenue trees, fruit trees, ornamentals, weeds, agro forest species and vegetables. Baically, there are two types of natural vegetation in the study area. One is the Mangrove Forests including halophytes and the other is the inland vegetation.

Reserve Forests: Dominant vegetation in the forested areas are *Acanthus ilicifolius*, *Aeluropus lagopoides*, *Avicennia alba*, *Avicennia marina*, *Salicornia brachiata*, *Scirpus littoralis*, *Acanthus volubilis*, *Acrostichuma ureum*, *Aegialitisrotundi folia*, *Aegiceras corniculatum*, *Avicennia officinalis*, *Bruguiera cylindrica*, *Bruguiera gymnorhiza*, *Cerbera manghus*, *Ceriops decandra*, *Ceriops tagal*, *Clerodendron inerme*, *Cyperus compactus*, *Cyperus corymbosis*, *Dalbergia spinosa*, *Derriss candens*, *Dolichandrone pathacea*, *Excoecaria agallocha*, *Finlaysonia obovata*, *Flageliaria indica*, *Heritiera littoralis*, *Hibiscus tiliaceus*, *Kandelia candel*, *Lumnitzera racemosa*, *Lumnitzera littorea*, *Pandanus fascicularis*, *Phoenix paludosa*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Sonneratia apetala*, *Tamarix troupii*, *Thespesia populnea*, *Xylocarpus granatum*, *Xylocarpus mekongensis*, *Xylocarpus moluccensis*, *Sesuvium portulacastrum*, *Suaeda maritima*, *Suaeda monoica*, *Suaeda nudiflora*, *Fimbristylis ferruginea* and *Heliotropium curassavicum* are common species of various forest blocks of the study area as per the primary and secondary database. Other than mangrove and mangrove associated, the common trees such as *Casurina equisitifolia*, *Anogeissus latifolia*, *Prosopis chilensis*, *Acacia nilotica*, *Eucalyptus globulus*, *Aegleamar melos*, *Azadirachta indica*, *Borassus flabellifer*, *Arecaca techu*, *Cassia siamea*, *Butea monosperma*, *Ailanthus excelsa*, *Albizia lebbeck*, *Albizia procera*, *Ficus bengalensis*, *Ficus religiosa*, *Tectona grandis*, *Delonix regia*, *Tamarindus indica*, *Syzygium cumini*, *Ziziphus mauritiana*, *Acacia auriculiformis*, *Saraca indica* and *Phoenix sylvestris* are also recorded in this region.

Non-Forest Vegetation (Road side, Village side etc.): In the non-forest area, different types of vegetation are recorded. Tree species in are mostly planted and few are natural. Other than the mangroves listed, there are no territorial or terrestrial forests or protected forests in the buffer zone. *Prosopis juliflora*, *Acaica nilotica*, *Pithecellobium dulce* and *Phoenix sylvestris* were the most common wild trees. *Malachra capitata*, *Acanthus ilicifolius*, *Hyptis suaveolens*, *Typha angustata*, *Eichhornia crassipes*, *Pistia statiotes*, *Ipomeoa aquatca*, *Ipomeoa canea* and *Parthenium hysterophorus* etc. are the common herbaceous species. Thus the inland vegetation is not ecologically sensitive and there are no REET species.

Dominant Trees: Most dominant trees like *Cocos nucifera*, *Casurina equisitifolia*, *Anogeissus latifolia*, *Prosopis chilensis*, *Acacia nilotica*, *Eucalyptus globulus*, *Aegleamar melos*, *Azadirachta indica*, *Borassus flabellifer*, *Areca catechu*, *Cassia siamea*, *Buteamono sperma*, *Ailanthus excelsa*, *Albizzia lebbeck*, *Albizzia procera*, *Ficus bengalensis*, *Ficus religiosa*, *Tectona grandis*, *Delonix regia*, *Tamarindus indica*, *Syzygium cumini*, *Ziziphus mauritiana*, *Acacia auriculiformis*, *Saraca indica* and *Phoenix sylvestris* were observed.

Dominant Shrubs: Most dominant shrubs observed were *Calotropis procera*, *Ipomeoa carnea*, *Ricinus communis*, *Ixora sp.*, *Agavea mericana*, *Lantana camara* and *Dodonaea viscosa*.

Dominant Herbs: Dominant herbs observed included *Vernonia cinerea*, *Tephrosia purpurea*, *Andrographis paniculata*, *Tridax procumbens*, *Aerva lanata*, *Cynodon dactylon*.

Medicinal Plants: Few medicinal plants were recorded which include *Azadirachta indica*, *Ficus bengalensis*, *Ficus retusa*, *Syzygium cumini*, *Ocimum sanctum*, *Leucas cephalotes* and *Zizyphus ragusa*.

Climbers: The common climbers observed were *Pergularia daemia*, *Abrus precatorius*, *Cocculus hirsutus*, *Corchorus trilocularis*, *Asparagus racemosus*, *Stigmaphyllons agraeum* and *Ipomeoa pestigridis*.

4.7.2.2 Quantitative Characteristics for Floral Species

The survey reveals that there are specific patches for certain species and mass plantations such as Casuarina, Cashew, Bamboo, mango etc. There are good number of plantations on the road side like *Ficus*, *Polyalthia longifolia*, *Peltophorum pterocarpum*, *Samania saman*, *Delonix regia*, *Tectona grandis* and *Acacia auriculiformis*. *Borassus flabellifer*, *Ceiba pentandra*, *Cocos nucifera*, *Ficus benghalensis*, *Ficus religiosa*, *Ficus racemosa*, *Mangifera indica*, *Prosopis juliflora* and *Tamarindus indica* found near the village premises. The unique field observation in this study area is the presence of certain very common species such as *Borassus*, *Coconut* and *Phoenix* dominant throughout the region. A good number of Butterfly and Dragon fly species are recorded in the wasteland and agricultural habitats. The larval and nectar host plants are very common here. The specific observations were also made for the micro habitats.

List of flora reported for PIA as per primary field survey and seasonal wise and zone wise status and Floral distribution in Core and Buffer areas are given in **Table 4-47**. As per secondary data source the List of Flora is given in **Table 4-48**. Status wise floral distribution in the PIA is given in **Table 4-49** and Ecosystem wise floral distribution is given in **Table 4-50**. Habit wise Distribution of Flora (As per primary survey) is shown in **Figure 4-29**, Floral distribution in Core and Buffer zones is shown in **Figure 4-30**, Status wise Floral Species in PIA is shown in **Figure 4-31** and Ecosystem wise floral distribution in PIA is shown **Figure**

4-32.

Table 4-47: List of flora in PIA as per Primary Field Survey and Seasonal Variations

S. No.	Scientific name	Family	Habit	Status	Core	Buffer	Summer	Winter	Monsoon
1	<i>Aegle marmelos</i>	Rutaceae	T	S	A	P	P	P	P
2	<i>Ailanthus excelsa</i>	Simaroubaceae	T	S	P	P	P	P	P
3	<i>Anacardium occidentale</i>	Anacardiaceae	T	S	A	P	P	P	P
4	<i>Annona squamosa</i>	Annonaceae	T	S	P	P	P	P	P
5	<i>Anthocephalus indica</i>	Rubiaceae	T	S	A	P	P	P	P
6	<i>Bruguiera gymnorrhiza</i>	Rhizophoraceae	T	S	P	P	P	P	P
7	<i>Butea monosperma</i>	Fabaceae	T	S	A	P	P	P	P
8	<i>Decalepis hamiltonii</i>	Asclepiadaceae	T	S	P	P	P	P	P
9	<i>Feronia elephantum</i>	Rutaceae	T	S	A	P	P	P	P
10	<i>Gmelina arborea</i>	Verbenaceae	T	S	P	P	P	P	P
11	<i>Limonia acidissima</i>	Rutaceae	T	S	A	P	P	P	P
12	<i>Lumnitzera racemosa</i>	Combretaceae	T	S	P	P	P	P	P
13	<i>Moringa oleifera</i>	Moringaceae	T	S	P	P	P	P	P
14	<i>Nyctanthes arbor-tristis</i>	Nyctaginaceae	T	S	A	P	P	P	P
15	<i>Pandanus fascicularis</i>	Pandanaceae	T	S	P	P	P	P	P
16	<i>Phoenix paludosa</i>	Arecaceae	T	S	A	P	P	P	P
17	<i>Phyllanthus emblica</i>	Euphorbiaceae	T	S	P	P	P	P	P
18	<i>Phyllanthus reticulatus</i>	Euphorbiaceae	T	S	A	P	P	P	P
19	<i>Plumeria alba</i>	Apocynaceae	T	S	P	P	P	P	P
20	<i>Polyalthia pendula</i>	Annonaceae	T	S	P	P	P	P	P
21	<i>Pongamia pinnata</i>	Fabaceae	T	S	P	P	P	P	P
22	<i>Rhizophora apiculata</i>	Rhizophoraceae	T	S	A	P	P	P	P
23	<i>Rhizophora mucronata</i>	Rhizophoraceae	T	S	P	P	P	P	P
24	<i>Samanea saman</i>	Mimosaceae	T	S	P	P	P	P	P
25	<i>Sapindus emarginatus</i>	Sapindaceae	T	S	P	P	P	P	P
26	<i>Sonneratia alba</i>	Sonneratiaceae	T	S	A	P	P	P	P
27	<i>Terminalia arjuna</i>	Combretaceae	T	S	P	P	P	P	P
28	<i>Ziziphus maritima</i>	Rhamnaceae	T	S	A	P	P	P	P
29	<i>Ziziphus oenoplia</i>	Rhamnaceae	T	S	P	P	P	P	P
30	<i>Alangium salvifolium</i>	Alangiaceae	T	R	P	P	P	P	P
31	<i>Holoptelia integrifolia</i>	Ulmaceae	T	R	P	P	P	P	P
32	<i>Kandelia candel</i>	Rhizophoraceae	T	R	P	P	P	P	P
33	<i>Randia dumetorum</i>	Rubiaceae	T	R	P	P	P	P	P
34	<i>Tamarix troupii</i>	Tamaricaceae	T	R	P	P	P	P	P
35	<i>Terminalia bellirica</i>	Combretaceae	T	R	P	P	P	P	P
36	<i>Ziziphus xylopyra</i>	Rhamnaceae	T	R	P	P	P	P	P
37	<i>Acacia auriculiformis</i>	Mimosaceae	T	D	P	P	P	P	P
38	<i>Acacia leucophloea</i>	Mimosaceae	T	D	P	P	P	P	P
39	<i>Acacia nilotica</i>	Mimosaceae	T	D	P	P	P	P	P
40	<i>Alstonia scholaris</i>	Apocynaceae	T	D	P	P	P	P	P
41	<i>Avicennia alba</i>	Avicenniaceae	T	D	P	P	P	P	P
42	<i>Avicennia marina</i>	Avicenniaceae	T	D	P	P	P	P	P
43	<i>Avicennia officinalis</i>	Avicenniaceae	T	D	P	P	P	P	P
44	<i>Azadirachta indica</i>	Meliaceae	T	D	P	P	P	P	P
45	<i>Bambusa arundinacea</i>	Poaceae	T	D	A	P	P	P	P
46	<i>Bauhinia purpurea</i>	Caesalpiniaceae	T	D	A	P	P	P	P
47	<i>Bauhinia racemosa</i>	Caesalpiniaceae	T	D	P	P	P	P	P
48	<i>Borassus flabellifer</i>	Arecaceae	T	D	P	P	P	P	P
49	<i>Ceiba pentandra</i>	Bombacaceae	T	D	A	P	P	P	P
50	<i>Cocos nucifera</i>	Araceae	T	D	P	P	P	P	P
51	<i>Dalbergia sisoo</i>	Caesalpiniaceae	T	D	P	P	P	P	P

S. No.	Scientific name	Family	Habit	Status	Core	Buffer	Summer	Winter	Monsoon
52	<i>Dendrocalamus strictus</i>	Poaceae	T	D	P	P	P	P	P
53	<i>Eucalyptus globulus</i>	Myrtaceae	T	D	P	P	P	P	P
54	<i>Ficus benghalensis</i>	Moraceae	T	D	P	P	P	P	P
55	<i>Ficus hispida</i>	Moraceae	T	D	A	P	P	P	P
56	<i>Ficus racemosa</i>	Moraceae	T	D	P	P	P	P	P
57	<i>Ficus religiosa</i>	Moraceae	T	D	P	P	P	P	P
58	<i>Mangifera indica</i>	Anacardiaceae	T	D	P	P	P	P	P
59	<i>Peltophorum pterocarpum</i>	Leguminosae	T	D	P	P	P	P	P
60	<i>Phoenix sylvestris</i>	Arecaceae	T	D	P	P	P	P	P
61	<i>Polyalthia longifolia</i>	Annonaceae	T	D	P	P	P	P	P
62	<i>Prosopis juliflora</i>	Mimosaceae	T	D	P	P	P	P	P
63	<i>Seauda maritima</i>	Chenopodiaceae	T	D	P	P	P	P	P
64	<i>Sonneratia apetala</i>	Sonneratiaceae	T	D	P	P	P	P	P
65	<i>Tamarindus indica</i>	Caesalpiniaceae	T	D	P	P	P	P	P
66	<i>Tectona grandis</i>	Verbenaceae	T	D	P	P	P	P	P
67	<i>Thespecia populnea</i>	Malvaceae	T	D	P	P	P	P	P
68	<i>Thevetia cascabela</i>	Apocynaceae	T	D	P	P	P	P	P
69	<i>Acacia catechu</i>	Mimosaceae	T	C	A	P	P	P	P
70	<i>Albizia amara</i>	Leguminosae	T	C	A	P	P	P	P
71	<i>Albizia lebbek</i>	Mimosaceae	T	C	P	P	P	P	P
72	<i>Balanites roxburghii</i>	Simarubaceae	T	C	A	P	P	P	P
73	<i>Bruguiera cylindrica</i>	Rhizophoraceae	T	C	P	P	P	P	P
74	<i>Caesalpinia pulcherrima</i>	Fabaceae	T	C	A	P	P	P	P
75	<i>Cassia fistula</i>	Caesalpiniaceae	T	C	A	P	P	P	P
76	<i>Cassia siamea</i>	Caesalpiniaceae	T	C	A	P	P	P	P
77	<i>Casuarina equisetifolia</i>	Casuarinaceae	T	C	P	P	P	P	P
78	<i>Ceriops decandra</i>	Rhizophoraceae	T	C	P	P	P	P	P
79	<i>Chukrasia tabularis</i>	Meliaceae	T	C	A	P	P	P	P
80	<i>Delonix regia</i>	Leguminosae	T	C	P	P	P	P	P
81	<i>Erythrina indica</i>	Fabaceae	T	C	A	P	P	P	P
82	<i>Excoecaria agallocha</i>	Euphorbiaceae	T	C	P	P	P	P	P
83	<i>Ficus microcape</i>	Moraceae	T	C	P	P	P	P	P
84	<i>Hibiscus tiliaceous</i>	Malvaceae	T	C	P	P	P	P	P
85	<i>Leucaena leucocephala</i>	Mimosaceae	T	C	P	P	P	P	P
86	<i>Mimosops elangi</i>	Sapotaceae	T	C	A	P	P	P	P
87	<i>Morinda tinctoria</i>	Rubiaceae	T	C	A	P	P	P	P
88	<i>Nerium odoratum</i>	Apocynaceae	T	C	A	P	P	P	P
89	<i>Pithecellobium dulce</i>	Mimosaceae	T	C	A	P	P	P	P
90	<i>Plumeria rubra</i>	Apocynaceae	T	C	A	P	P	P	P
91	<i>Prosopis chilensis</i>	Leguminosae	T	C	P	P	P	P	P
92	<i>Prosopis spicigera</i>	Leguminosae	T	C	A	P	P	P	P
93	<i>Syzygium jambolanum</i>	Myrtaceae	T	C	P	P	P	P	P
94	<i>Tecoma stans</i>	Bignoniaceae	T	C	P	P	P	P	P
95	<i>Terminalia catappa</i>	Combretaceae	T	C	A	P	P	P	P
96	<i>Terminalia chebula</i>	Combretaceae	T	C	A	P	P	P	P
97	<i>Vitex negundo</i>	Verbenaceae	T	C	P	P	P	P	P
98	<i>Caesalpinia bonduc</i>	Caesalpiniaceae	s	S	P	P	P	P	P
99	<i>Clerodendrum inerme</i>	Verbenaceae	s	S	P	P	P	P	P
100	<i>Dalbergia spinosa</i>	Fabaceae	s	S	A	P	P	P	P
101	<i>Grewia obtusa</i>	Tiliaceae	s	S	P	P	P	P	P
102	<i>Grewia tiliacefolia</i>	Tiliaceae	s	S	A	P	P	P	P
103	<i>Jatropha curcas</i>	Euphorbiaceae	s	S	P	P	P	P	P
104	<i>Opuntia dillenii</i>	Cactaceae	s	S	P	P	P	P	P
105	<i>Parkinsonia aculeata</i>	Leguminosae	s	S	P	P	P	P	P
106	<i>Carissa spinarum</i>	Apocynaceae	s	R	A	P	P	P	P
107	<i>Ceriops tagal</i>	Rhizophoraceae	s	R	P	P	P	P	P

S. No.	Scientific name	Family	Habit	Status	Core	Buffer	Summer	Winter	Monsoon
108	<i>Derris trifoliata</i>	Fabaceae	s	R	P	P	P	P	P
109	<i>Desmodium pulchellum</i>	Laguminosae	s	R	P	P	P	P	P
110	<i>Dodonaea viscosa</i>	Sapindaceae	s	R	P	P	P	P	P
111	<i>Erythroxylon monogynum</i>	Erythroxylaceae	s	R	P	P	P	P	P
112	<i>Acanthus ilicifolius</i>	Acanthaceae	s	D	P	P	P	P	P
113	<i>Calotropis gigantea</i>	Asclepiadaceae	s	D	P	P	P	P	P
114	<i>Datura metel</i>	Solanaceae	s	D	P	P	P	P	P
115	<i>Datura stramonium</i>	Solanaceae	s	D	P	P	P	P	P
116	<i>Suaeda fruticosa</i>	Chenopodiaceae	s	D	P	P	P	P	P
117	<i>Agave americana</i>	Asparagaceae	s	C	P	P	P	P	P
118	<i>Capparis sepiaria</i>	Capparidaceae	s	C	A	P	P	P	P
119	<i>Euphorbia antiquorum</i>	Euphorbiaceae	s	C	P	P	P	P	P
120	<i>Euphorbia cactus</i>	Euphorbiaceae	s	C	P	P	P	P	P
121	<i>Grewia hirsuta</i>	Tiliaceae	s	C	A	P	P	P	P
122	<i>Ixora coccinea</i>	Rubiaceae	s	C	P	P	P	P	P
123	<i>Jatropha glandulifera</i>	Euphorbiaceae	s	C	P	P	P	P	P
124	<i>Jatropha gossypifolia</i>	Euphorbiaceae	s	C	A	P	P	P	P
125	<i>Lantana camara</i>	Verbenaceae	s	C	P	P	P	P	P
126	<i>Opuntia elatior</i>	Cactaceae	s	C	P	P	P	P	P
127	<i>Pavetta indica</i>	Rubiaceae	s	C	P	P	P	P	P
128	<i>Plumbago zeylanica</i>	Plumbaginaceae	s	C	P	P	P	P	P
129	<i>Suaeda monoica</i>	Chenopodiaceae	s	C	P	P	P	P	P
130	<i>Vallisneria</i>	Hydrocharitaceae	Hy	S	P	P	P	P	P
131	<i>Nymphaea pubescens</i>	Nymphaeaceae	Hy	R	P	P	P	P	P
132	<i>Ammannia baccifera</i>	Lythraceae	Hy	C	P	P	P	P	P
133	<i>Aponogeton natans</i>	Aponogetonaceae	Hy	C	P	P	P	P	P
134	<i>Azolla pinnata</i>	Salvinaceae	Hy	C	P	P	P	P	P
135	<i>Eichornia crassipes</i>	Pontederiaceae	Hy	C	P	P	P	P	P
136	<i>Hydrilla verticillata</i>	Hydrocharitaceae	Hy	C	A	P	P	A	P
137	<i>Ipomoea aquatica</i>	Convolvulaceae	Hy	C	P	P	P	P	P
138	<i>Lemna minor</i>	Araceae	Hy	C	P	P	P	A	P
139	<i>Limnophila</i>	Plantaginaceae	Hy	C	P	P	P	P	P
140	<i>Marsilea quadrifolia</i>	Marsileaceae	Hy	C	P	P	P	P	P
141	<i>Nelumbo nucifera</i>	Nelumbonaceae	Hy	C	P	P	P	P	P
142	<i>Neptunia oleracea</i>	Leguminosae	Hy	C	P	P	P	P	P
143	<i>Nymphoides hydrophylla</i>	Menyanthaceae	Hy	C	P	P	P	P	P
144	<i>Pistia</i>	Araceae	Hy	C	P	P	P	P	P
145	<i>Typha angustata</i>	Typhaceae	Hy	C	P	P	P	P	P
146	<i>Aeschynomene indica</i>	Fabaceae	H	S	P	P	A	A	P
147	<i>Amaranthus caudatus</i>	Amaranthaceae	H	S	P	P	A	P	P
148	<i>Asparagus racemosus</i>	Asperagaceae	H	S	A	P	A	P	P
149	<i>Biophytum nervifolium</i>	Malpighiaceae	H	S	P	P	A	A	P
150	<i>Blumea mollis</i>	Asteraceae	H	S	A	P	A	A	P
151	<i>Colocasia esculenta</i>	Araceae	H	S	P	P	A	P	P
152	<i>Corchorus capsularis</i>	Tiliaceae	H	S	P	P	A	P	P
153	<i>Gomphrena globosa</i>	Amaranthaceae	H	S	P	P	A	A	P
154	<i>Ludwigia perennis</i>	Onagraceae	H	S	P	P	A	P	P
155	<i>Striga angustifolia</i>	Scrophulariaceae	H	S	P	P	A	P	P
156	<i>Suaeda maritima</i>	Chenopodiaceae	H	S	A	P	A	P	P
157	<i>Triumfetta rhomboidea</i>	Tiliaceae	H	S	P	P	A	P	P
158	<i>Urena lobata</i>	Malvaceae	H	S	P	P	A	A	P
159	<i>Aerva javanica</i>	Amaranthaceae	H	R	P	P	P	P	P
160	<i>Alternanthera sessilis</i>	Amaranthaceae	H	R	P	P	A	P	P
161	<i>Amaranthus spinosus</i>	Amaranthaceae	H	R	P	P	A	A	P
162	<i>Amaranthus viridis</i>	Amaranthaceae	H	R	P	P	A	A	P

S. No.	Scientific name	Family	Habit	Status	Core	Buffer	Summer	Winter	Monsoon
163	<i>Andrographis echinoides</i>	Acanthaceae	H	R	A	P	A	P	P
164	<i>Barleria prionitis</i>	Acanthaceae	H	R	A	P	A	P	P
165	<i>Blepharis maderaspatensis</i>	Acanthaceae	H	R	A	P	A	A	P
166	<i>Boerhavia erecta</i>	Nyctaginaceae	H	R	A	P	A	P	P
167	<i>Hibiscus lobatus</i>	Malvaceae	H	R	A	P	A	P	P
168	<i>Indigofera linnaei</i>	Fabaceae	H	R	P	P	A	A	P
169	<i>Justicia adhatoda</i>	Acanthaceae	H	R	A	P	A	P	P
170	<i>Leonotis nepetifolia</i>	Acanthaceae	H	R	P	P	A	P	P
171	<i>Mollugo nudicaulis</i>	Aizoaceae	H	R	P	P	A	A	P
172	<i>Ocimum americanum</i>	Lamiaceae	H	R	A	P	A	A	P
173	<i>Cassia tora</i>	Caesalpinaceae	H	D	P	P	P	P	P
174	<i>Catharanthus roseus</i>	Apocyanaceae	H	D	A	P	P	P	P
175	<i>Cleome viscosa</i>	Capparidaceae	H	D	P	P	A	P	P
176	<i>Crotan bonplandianum</i>	Euphorbiaceae	H	D	P	P	A	P	P
177	<i>Eclipta alba</i>	Asteraceae	H	D	P	P	A	P	P
178	<i>Euphorbia tirucalli</i>	Euphorbiaceae	H	D	P	P	P	P	P
179	<i>Parthenium hysterophorus</i>	Asteraceae	H	D	P	P	A	P	P
180	<i>Phyllanthus amarus</i>	Euphorbiaceae	H	D	P	P	P	P	P
181	<i>Sesuvium portulacastrum</i>	Aizoaceae	H	D	P	P	P	P	P
182	<i>Sida acuta</i>	Malvaceae	H	D	P	P	P	P	P
183	<i>Solanum xanthocarpum</i>	Solanaceae	H	D	P	P	P	P	P
184	<i>Tehrosia purpurea</i>	Fabaceae	H	D	P	P	P	P	P
185	<i>Tribulus terrestris</i>	Zygophyllaceae	H	D	P	P	P	P	P
186	<i>Tridax procumbens</i>	Asteraceae	H	D	P	P	P	P	P
187	<i>Abrus precatorius</i>	Fabaceae	H	C	P	P	A	P	P
188	<i>Abutilon indicum</i>	Malvaceae	H	C	P	P	P	P	P
189	<i>Acalypha indica</i>	Euphorbiaceae	H	C	P	P	A	P	P
190	<i>Achyranthes aspera</i>	Amaranthaceae	H	C	P	P	P	A	P
191	<i>Aerva lanata</i>	Amaranthaceae	H	C	A	P	P	P	P
192	<i>Aerva tomentosa</i>	Amaranthaceae	H	C	P	P	P	P	P
193	<i>Aloe vera</i>	Tiliaceae	H	C	P	P	A	P	P
194	<i>Argemone mexicana</i>	Papaveraceae	H	C	P	P	A	P	P
195	<i>Blumea amplexans</i>	Asteraceae	H	C	A	P	P	P	P
196	<i>Boerhavia diffusa</i>	Nyctaginaceae	H	C	P	P	A	P	P
197	<i>Cardiospermum halicacabum</i>	Sapindaceae	H	C	P	P	P	P	P
198	<i>Cassia occidentalis</i>	Leguminosae	H	C	P	P	A	P	P
199	<i>Cleome aspera</i>	Capparidaceae	H	C	A	P	A	P	P
200	<i>Clitoria ternatea</i>	Fabaceae	H	C	P	P	P	A	P
201	<i>Crotalaria juncea</i>	Fabaceae	H	C	P	P	P	P	P
202	<i>Cyperus triceps</i>	Cyperaceae	H	C	P	P	A	P	P
203	<i>Dioscorea anguina</i>	Dioscoriaceae	H	C	A	P	P	P	P
204	<i>Echinops echinata</i>	Asteraceae	H	C	P	P	P	A	P
205	<i>Euphorbia hirta</i>	Euphorbiaceae	H	C	P	P	P	A	P
206	<i>Hyptis suaveolens</i>	Lamiaceae	H	C	P	P	P	P	P
207	<i>Indigofera ennaephylla</i>	Fabaceae	H	C	P	P	P	P	P
208	<i>Leucas aspera</i>	Lamiaceae	H	C	A	P	A	A	P
209	<i>Mimosa pudica</i>	Leguminosae	H	C	A	P	A	P	P
210	<i>Ocimum basilicum</i>	Lamiaceae	H	C	P	P	A	P	P
211	<i>Ocimum sanctum</i>	Lamiaceae	H	C	P	P	P	P	P
212	<i>Oldenlandia umbellata</i>	Rubiaceae	H	C	P	P	A	P	P
213	<i>Oxalis corniculata</i>	Oxalidaceae	H	C	P	P	P	P	P
214	<i>Pavonia zeylanica</i>	Malvaceae	H	C	P	P	A	P	P

S. No.	Scientific name	Family	Habit	Status	Core	Buffer	Summer	Winter	Monsoon
215	<i>Phyllanthus virgatus</i>	Euphorbiaceae	H	C	A	P	A	A	P
216	<i>Sida cordata</i>	Malvaceae	H	C	P	P	P	A	P
217	<i>Solanum surattense</i>	Solanaceae	H	C	A	P	A	A	P
218	<i>Vernonia cinerea</i>	Asteraceae	H	C	P	P	A	P	P
219	<i>Waltheria indica</i>	Sterculiaceae	H	C	A	P	P	A	P
220	<i>Xanthium strumarium</i>	Asteraceae	H	C	P	P	P	P	P
221	<i>Cymbopogon citratus</i>	Poaceae	G	S	A	P	P	P	P
222	<i>Cymbopogon flexuosus</i>	Cyperaceae	G	C	P	P	P	P	P
223	<i>Cyperus castaneus</i>	Poaceae	G	C	P	P	P	P	P
224	<i>Fimbristylis dichotoma</i>	Poaceae	G	C	P	P	A	A	P
225	<i>Jasminum arborescens</i>	Oleaceae	C	S	P	P	P	A	P
226	<i>Smilax zeylanica</i>	Liliaceae	C	S	A	P	A	P	P
227	<i>Ipomoea hederifolia</i>	Convolvulaceae	C	R	P	P	A	P	P
228	<i>Ipomoea obscura</i>	Convolvulaceae	C	R	P	P	P	A	P
229	<i>Tinospora cordifolia</i>	Menispermaceae	C	R	A	P	A	P	P
230	<i>Cissus quadrangularis</i>	Vitaceae	C	D	P	P	A	P	P
231	<i>Ipomoea pes-caprae</i>	Convolvulaceae	C	D	P	P	P	P	P
232	<i>Pergularia daemia</i>	Asclepiadaceae	C	D	P	P	P	P	P
233	<i>Gloriosa superba</i>	Liliaceae	C	C	P	P	P	P	P
234	<i>Hemidesmus indicus</i>	Periplocaceae	C	C	P	P	P	P	P
235	<i>Ipomoea macrantha</i>	Convolvulaceae	C	C	P	P	P	A	P
236	<i>Ipomoea nil</i>	Convolvulaceae	C	C	A	P	P	A	P
237	<i>Luffa cylindrica</i>	Cucurbitaceae	C	C	A	P	P	A	P
238	<i>Merremia tridentata</i>	Convolvulaceae	C	C	P	P	P	P	P

(Note: Habit: Tree: T; Shrubs: s; Climbers: C; Grass: G; Hydrophyte: Hy; Herbs: H Status: Dominant: D; Sparse: S; Rare: R; Common: C A: Absent; P: Present)

Table 4-48: List of Other Flora in PIA based on Secondary sources

S. No	Botanical name	Family	Habit
1	<i>Acacia mangium</i>	Mimosaceae	Tree
2	<i>Aegialitis rotundifolia</i>	Plumbaginaceae	Tree
3	<i>Aegiceras corniculatum</i>	Myrsinaceae	Tree
4	<i>Aglaia cucullata</i>	Meliaceae	Tree
5	<i>Albizia procera</i>	Mimosaceae	Tree
6	<i>Antigonon leptopus</i>	Polygonaceae	Tree
7	<i>Artocarpus heterophyllus</i>	Moraceae	Tree
8	<i>Boswellia serrata</i>	Meliaceae	Tree
9	<i>Breynia vitis-idea</i>	Euphorbiaceae	Tree
10	<i>Brownlowia tersa</i>	Tiliaceae	Tree
11	<i>Bruguiera parviflora</i>	Rhizophoraceae	Tree
12	<i>Bruguiera sexangula</i>	Rhizophoraceae	Tree
13	<i>Butea superba</i>	Fabaceae	Tree
14	<i>Canthium didymium</i>	Rubiaceae	Tree
15	<i>Cerbera manghas</i>	Apocyanaceae	Tree
16	<i>Cerbera odollam</i>	Apocyanaceae	Tree
17	<i>Cleistanthus collinus</i>	Euphorbiaceae	Tree
18	<i>Cynometra iripa</i>	Caesalpiniaceae	Tree
19	<i>Dalbergia latifolia</i>	Leguminosae	Tree
20	<i>Derris scandens</i>	Fabaceae	Tree
21	<i>Diospyros melanoxylon</i>	Ebenaceae	Tree
22	<i>Elaeodendron glaucum</i>	Celastraceae	Tree
23	<i>Euphorbia trigona</i>	Euphorbiaceae	Tree
24	<i>Ficus retusa</i>	Moraceae	Tree
25	<i>Ficus tomentosa</i>	Moraceae	Tree
26	<i>Finlaysonia obovata</i>	Asclepiadaceae	Tree
27	<i>Flacourtia ramontchi</i>	Bixaceae	Tree
28	<i>Flagellaria indica</i>	Flagellariaceae	Tree

S. No	Botanical name	Family	Habit
29	<i>Hardwickia binata</i>	Leguminosae	Tree
30	<i>Heritiera fomes</i>	Sterculiaceae	Tree
31	<i>Heritiera littoralis</i>	Sterculiaceae	Tree
32	<i>Intsia bijuga</i>	Caesalpiniaceae	Tree
33	<i>Jacaranda acutifolia</i>	Bignoniaceae	Tree
34	<i>Lagerstroemia parviflora</i>	Lythraceae	Tree
35	<i>Manilkera hexandra</i>	Sapotaceae	Tree
36	<i>Merope angulata</i>	Rutaceae	Tree
37	<i>Myriostachya wrightiana</i>	Poaceae	Tree
38	<i>Nypa fruticans</i>	Arecaceae	Tree
39	<i>Phragmites karka</i>	Poaceae	Tree
40	<i>Plectronia didyma</i>	Rubiaceae	Tree
41	<i>Porteresia coarctata</i>	Poaceae	Tree
42	<i>Randia uliginosa</i>	Rubiaceae	Tree
43	<i>Salicornia marina</i>	Chenopodiaceae	Tree
44	<i>Salvadora persica</i>	Salvadoraceae	Tree
45	<i>Shorea robusta</i>	Dipterocarpaceae	Tree
46	<i>Sonneratia caseolaris</i>	Sonneratiaceae	Tree
47	<i>Soyimida febrifuga</i>	Meliaceae	Tree
48	<i>Strobilus asper</i>	Moraceae	Tree
49	<i>Syzygium cumini</i>	Myrtaceae	Tree
50	<i>Tylophora indica</i>	Asclepiadaceae	Tree
51	<i>Vitex peduncularis</i>	Verbenaceae	Tree
52	<i>Xylocarpus granatum</i>	Meliaceae	Tree
53	<i>Xylocarpus mekongensis</i>	Meliaceae	Tree
54	<i>Xylocarpus moluccensis</i>	Meliaceae	Tree
55	<i>Acrostichum aurum</i>	Acrostichaceae	Shrub
56	<i>Caesalpinia crista</i>	Caesalpiniaceae	Shrub
57	<i>Calotropis procera</i>	Asclepiadaceae	Shrub
58	<i>Solanum melongena</i>	Solanaceae	Shrub
59	<i>Solanum trilobatum</i>	Solanaceae	Shrub
60	<i>Operculina turpethum</i>	Convolvulaceae	Hydrophyte
61	<i>Abelmoschus moschatus</i>	Malvaceae	Herb
62	<i>Achyranthes bidentata</i>	Amaranthaceae	Herb
63	<i>Aeschynomene aspera</i>	Fabaceae	Herb
64	<i>Ageratum conyzoides</i>	Asteraceae	Herb
65	<i>Allmania longipedunculata</i>	Amaranthaceae	Herb
66	<i>Allmania nodiflora</i>	Amaranthaceae	Herb
67	<i>Alocasia decipiens</i>	Araceae	Herb
68	<i>Alternanthera pungens</i>	Amaranthaceae	Herb
69	<i>Alysicarpus monilifer</i>	Fabaceae	Herb
70	<i>Amaranthus hybridus</i>	Amaranthaceae	Herb
71	<i>Bidens biternata</i>	Asteraceae	Herb
72	<i>Borreria hispida</i>	Rubiaceae	Herb
73	<i>Bulbostylis barbata</i>	Cyperaceae	Herb
74	<i>Celosia argentea</i>	Amaranthaceae	Herb
75	<i>Chrozophora rotleri</i>	Euphorbiaceae	Herb
76	<i>Cleome chelidonii</i>	Capparidaceae	Herb
77	<i>Cleome gynandra</i>	Capparidaceae	Herb
78	<i>Commelina benghalensis</i>	Commelinaceae	Herb
79	<i>Commelina cristata</i>	Commelinaceae	Herb
80	<i>Commelina diffusa</i>	Commelinaceae	Herb
81	<i>Conyza stricta</i>	Asteraceae	Herb
82	<i>Corchorus aestuans</i>	Tiliaceae	Herb
83	<i>Crotalaria linifolia</i>	Fabaceae	Herb
84	<i>Crotalaria medicaginea</i>	Fabaceae	Herb
85	<i>Crotalaria prostrata</i>	Fabaceae	Herb

S. No	Botanical name	Family	Habit
86	<i>Crotalaria ramosissima</i>	Fabaceae	Herb
87	<i>Crotalaria retusa</i>	Fabaceae	Herb
88	<i>Crotalaria verrucosa</i>	Fabaceae	Herb
89	<i>Datura innoxia</i>	Solanaceae	Herb
90	<i>Desmodium gangeticum</i>	Papilionaceae	Herb
91	<i>Desmodium triquetrum</i>	Fabaceae	Herb
92	<i>Digera arvensis</i>	Amaranthaceae	Herb
93	<i>Digera muricata</i>	Amaranthaceae	Herb
94	<i>Dioscorea tomentosa</i>	Dioscoriaceae	Herb
95	<i>Eclipta prostrata</i>	Asteraceae	Herb
96	<i>Eichhornia crassipes</i>	Pontederiaceae	Herb
97	<i>Emilia sonchifolia</i>	Asteraceae	Herb
98	<i>Euphorbia chamaesyce</i>	Euphorbiaceae	Herb
99	<i>Euphorbia indica</i>	Euphorbiaceae	Herb
100	<i>Euphorbia nivulia</i>	Euphorbiaceae	Herb
101	<i>Hedyotis corymbosa</i>	Rubiaceae	Herb
102	<i>Hedyotis diffusa</i>	Rubiaceae	Herb
103	<i>Hedyotis herbacea</i>	Rubiaceae	Herb
104	<i>Hedyotis racemosa</i>	Rubiaceae	Herb
105	<i>Hedyotis umbellata</i>	Rubiaceae	Herb
106	<i>Heylandia latebrosa</i>	Fabaceae	Herb
107	<i>Indigofera linifolia</i>	Fabaceae	Herb
108	<i>Indigofera oblongifolia</i>	Fabaceae	Herb
109	<i>Indigofera tinctoria</i>	Fabaceae	Herb
110	<i>Indigofera trita</i>	Fabaceae	Herb
111	<i>Ipomoea carnea</i>	Convolvulaceae	Herb
112	<i>Justicia diffusa</i>	Acanthaceae	Herb
113	<i>Justicia procumbens</i>	Acanthaceae	Herb
114	<i>Leucas cephalotes</i>	Lamiaceae	Herb
115	<i>Malachra capitata</i>	Malvaceae	Herb
116	<i>Malvastrum coromandelianum</i>	Malvaceae	Herb
117	<i>Melochia corchorifolia</i>	Sterculiaceae	Herb
118	<i>Mollugo pentaphylla</i>	Aizoaceae	Herb
119	<i>Neptunia triquetra</i>	Mimosaceae	Herb
120	<i>Ocimum canum</i>	Lamiaceae	Herb
121	<i>Pedaliium muricatum</i>	Pedaliaceae	Herb
122	<i>Pedilanthus tithymaloides</i>	Euphorbiaceae	Herb
123	<i>Peristrophe bicalyculata</i>	Acanthaceae	Herb
124	<i>Peristrophe paniculata</i>	Acanthaceae	Herb
125	<i>Phaseolus aconitifolius</i>	Fabaceae	Herb
126	<i>Phaseolus mungo</i>	Fabaceae	Herb
127	<i>Phaseolus radiatus</i>	Fabaceae	Herb
128	<i>Phaseolus trilobus</i>	Fabaceae	Herb
129	<i>Phyla nodiflora</i>	Verbenaceae	Herb
130	<i>Phyllanthus maderaspatensis</i>	Euphorbiaceae	Herb
131	<i>Physalis minima</i>	Solanaceae	Herb
132	<i>Polycarpaea corymbosa</i>	Caryophyllaceae	Herb
133	<i>Polygala arvensis</i>	Polygalaceae	Herb
134	<i>Polygala chinensis</i>	Polygalaceae	Herb
135	<i>Polygala elongata</i>	Polygalaceae	Herb
136	<i>Polygala erioptera</i>	Polygalaceae	Herb
137	<i>Polygala persicariifolia</i>	Polygalaceae	Herb
138	<i>Portulaca oleracea</i>	Portulacaceae	Herb
139	<i>Psoralea corylifolia</i>	Fabaceae	Herb
140	<i>Rhynchosia minima</i>	Fabaceae	Herb
141	<i>Rhynchosia rothii</i>	Fabaceae	Herb
142	<i>Rhynchosia suaveolens</i>	Fabaceae	Herb

S. No	Botanical name	Family	Habit
143	<i>Rothia indica</i>	Fabaceae	Herb
144	<i>Ruellia tuberosa</i>	Acanthaceae	Herb
145	<i>Rungia repens</i>	Acanthaceae	Herb
146	<i>Salicornia brachiata</i>	Chenopodiaceae	Herb
147	<i>Schoenoplectus articulatus</i>	Cyperaceae	Herb
148	<i>Sesamum indicum</i>	Pedaliaceae	Herb
149	<i>Sesamum prostratum</i>	Pedaliaceae	Herb
150	<i>Sesbania aculeata</i>	Fabaceae	Herb
151	<i>Sesbania procumbens</i>	Fabaceae	Herb
152	<i>Sida rhombifolia</i>	Malvaceae	Herb
153	<i>Sida spinosa</i>	Malvaceae	Herb
154	<i>Solanum nigrum</i>	Solanaceae	Herb
155	<i>Spermacoce stricta</i>	Rubiaceae	Herb
156	<i>Sphaeranthus indicus</i>	Asteraceae	Herb
157	<i>Striga asiatica</i>	Scrophulariaceae	Herb
158	<i>Stylosanthes fruticosa</i>	Fabaceae	Herb
159	<i>Tephrosia procumbens</i>	Fabaceae	Herb
160	<i>Tephrosia pulcherrima</i>	Fabaceae	Herb
161	<i>Tephrosia villosa</i>	Fabaceae	Herb
162	<i>Tragia involucrata</i>	Euphorbiaceae	Herb
163	<i>Trianthema decandra</i>	Aizoaceae	Herb
164	<i>Trianthema portulacastrum</i>	Aizoaceae	Herb
165	<i>Trianthema triquetra</i>	Aizoaceae	Herb
166	<i>Trichosanthes cordata</i>	Cucurbitaceae	Herb
167	<i>Trichosanthes tricuspidata</i>	Cucurbitaceae	Herb
168	<i>Triumfetta pentandra</i>	Tiliaceae	Herb
169	<i>Vanda tessellata</i>	Orchidaceae	Herb
170	<i>Vigna aconitifolia</i>	Fabaceae	Herb
171	<i>Vigna mungo</i>	Fabaceae	Herb
172	<i>Vigna radiata</i>	Fabaceae	Herb
173	<i>Vigna trilobata</i>	Fabaceae	Herb
174	<i>Withania somnifera</i>	Solanaceae	Herb
175	<i>Aeluropus lagopoides</i>	Poaceae	Grass
176	<i>Andropogon contortus</i>	Poaceae	Grass
177	<i>Aristida adscensionis</i>	Poaceae	Grass
178	<i>Aristida funiculata</i>	Poaceae	Grass
179	<i>Aristida hystrix</i>	Poaceae	Grass
180	<i>Aristida setacea</i>	Poaceae	Grass
181	<i>Brachiaria eruciformis</i>	Poaceae	Grass
182	<i>Chloris barbata</i>	Poaceae	Grass
183	<i>Chloris montana</i>	Poaceae	Grass
184	<i>Cymbopogon coloratus</i>	Poaceae	Grass
185	<i>Cynodon dactylon</i>	Cyperaceae	Grass
186	<i>Cyperus brevifolius</i>	Poaceae	Grass
187	<i>Cyperus compressus</i>	Poaceae	Grass
188	<i>Cyperus flavidus</i>	Cyperaceae	Grass
189	<i>Cyperus rotundus</i>	Poaceae	Grass
190	<i>Dactyloctenium aegyptium</i>	Poaceae	Grass
191	<i>Digitaria ciliaris</i>	Poaceae	Grass
192	<i>Eragrostis tenella</i>	Poaceae	Grass
193	<i>Imperata cylindrica</i>	Poaceae	Grass
194	<i>Saccharum spontaneum</i>	Poaceae	Grass
195	<i>Schima nervosum</i>	Poaceae	Grass
196	<i>Trachys muricata</i>	Poaceae	Grass
197	<i>Zizania latifolia</i>	Poaceae	Grass
198	<i>Cissus repens</i>	Vitaceae	Climber
199	<i>Cissus vitiginea</i>	Vitaceae	Climber

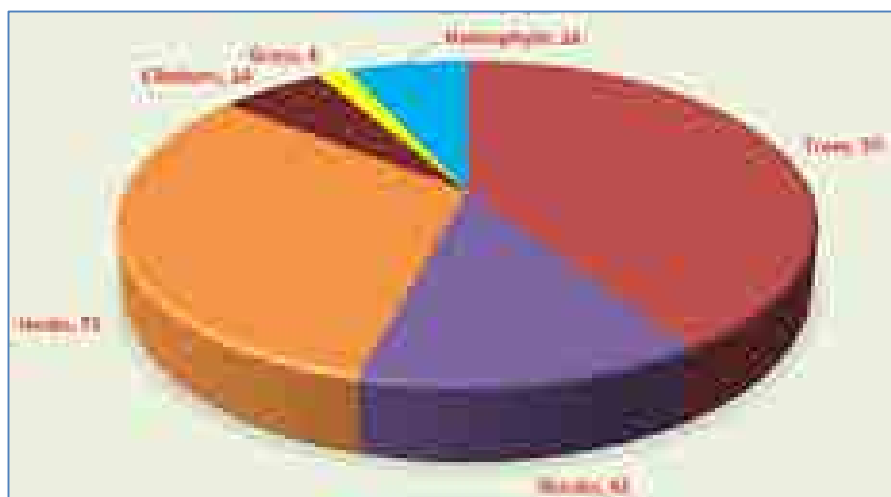
S. No	Botanical name	Family	Habit
200	<i>Cissus quadrangularis</i>	Vitaceae	Climber
201	<i>Coccinia grandis</i>	Cucurbitaceae	Climber
202	<i>Derris uliginosa</i>	Leguminosae	Climber
203	<i>Desmodium triflorum</i>	Fabaceae	Climber
204	<i>Dioscorea pentaphylla</i>	Dioscoriaceae	Climber
205	<i>Evolvulus alsinoides</i>	Convolvulaceae	Climber
206	<i>Leptadenia reticulata</i>	Asclepiadaceae	Climber
207	<i>Momordica dioca</i>	Cucurbitaceae	Climber
208	<i>Mucuna pruriens</i>	Leguminosae	Climber
209	<i>Naravelia zeylanica</i>	Ranunculaceae	Climber
210	<i>Symphorema involucratum</i>	Verbenaceae	Climber

Table 4-49: Status wise Floral Distribution

Habit	Dominant	Common	Sparse	Rare	Total
Trees	32	29	29	7	97
Shrubs	5	13	8	6	32
Herbs	14	34	13	14	75
Climbers	3	6	2	3	14
Grass	0	3	1	0	4
Hydrophytes	0	14	1	1	16
Total	54	99	54	31	238

Table 4-50: Ecosystem wise Floral Distribution

Habitat	No. of Species
Terrestrial	137
Aquatic	16
Agriculture	28
Mangroves	57
Total	238

**Figure 4-29: Habit wise Distribution of Flora**

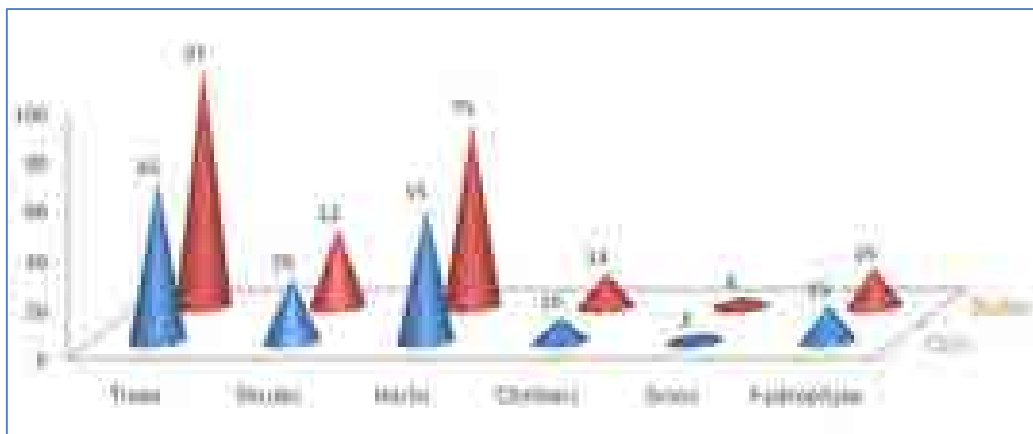


Figure 4-30: Floral distribution in Core and Buffer zones

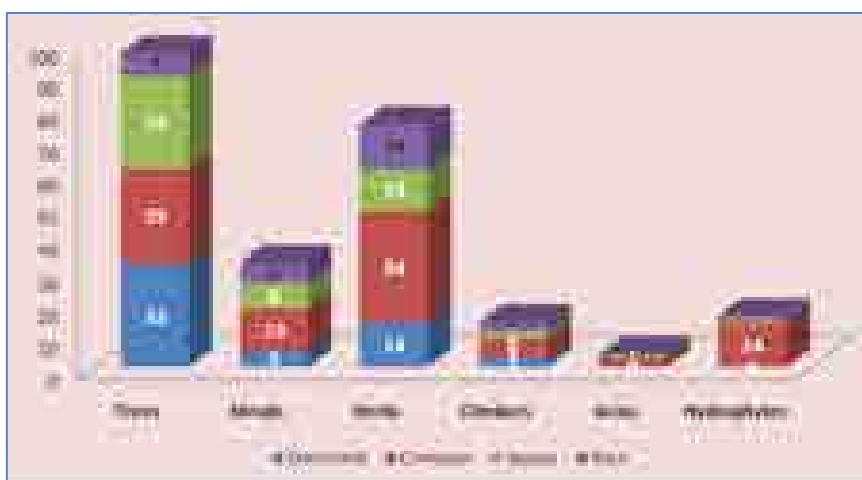


Figure 4-31: Status wise Floral Species in PIA

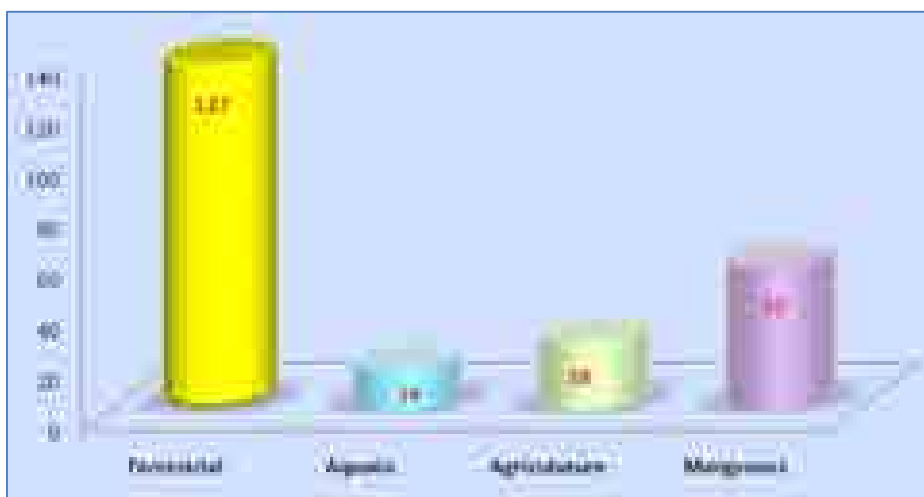


Figure 4-32: Ecosystem wise floral distribution in PIA

For statistical analysis project area and core area are taken as core zone and statistical evaluations were presented. Statistical analysis and IVI values (Non Mangrove species) for Ecosystem level in PIA (Core Zone) is given in **Table 4-51**, Statistical analysis and IVI values for floral species (Non Mangrove species) in the Buffer zone area is given in **Table 4-52** and

Statistical analysis and IVI values for Mangrove Floral species in the Core and Buffer zones is given in **Table 4-53**. Biodiversity indices of floral species in Core and Buffer zones is given in **Table 4-54** and Raunkiaer's Frequency Classes for floral species in core and buffer zones is given in **Table 4-55**.

Table 4-51: Ecosystem wise Statistical Analysis

S. No	Scientific Name	Rel. Density	Rel. Frequency	Rel. Abundance	IVI
1	<i>Casuarina equisetifolia</i>	8.874	4.762	9.03	22.67
2	<i>Ficus microcape</i>	7.509	8.73	4.167	20.41
3	<i>Leucaena leucocephala</i>	4.778	4.762	4.862	14.4
4	<i>Tecoma stans</i>	3.072	5.556	2.679	11.31
5	<i>Acacia auriculiformis</i>	7.167	8.73	3.978	19.88
6	<i>Acacia nilotica</i>	5.461	5.556	4.763	15.78
7	<i>Alstonia scholaris</i>	3.072	4.762	3.126	10.96
8	<i>Azadirachta indica</i>	6.826	5.556	5.954	18.34
9	<i>Borassus flabellifer</i>	4.778	4.762	4.862	14.4
10	<i>Dalbergia sisoo</i>	2.389	2.381	4.862	9.63
11	<i>Ficus benghalensis</i>	5.119	3.968	6.251	15.34
12	<i>Peltophorum pterocarpum</i>	2.389	2.381	4.862	9.63
13	<i>Prosopis juliflora</i>	5.802	4.762	5.904	16.47
14	<i>Tectona grandis</i>	4.778	4.762	4.862	14.4
15	<i>Thespecia populnea</i>	4.778	3.968	5.834	14.58
16	<i>Pongamia pinnata</i>	5.802	5.556	5.06	16.42
17	<i>Samanea saman</i>	4.096	3.175	6.251	13.52
18	<i>Vitex negundo</i>	3.072	3.175	4.688	10.93
19	<i>Phoenix sylvestris</i>	4.778	7.143	3.241	15.16
20	<i>Polyalthia longifolia</i>	5.461	5.556	4.763	15.78
Total		100	100	100	300

Table 4-52: Floral species in the Buffer Zone Area

S. No	Scientific Name	Rel Density	Rel Frequency	Rel Abundance	IVI
1	<i>Azadirachta indica</i>	8.306	6.294	6.431	21.03
2	<i>Bambusa arundinacea</i>	3.654	4.895	3.638	12.19
3	<i>Bauhinia purpurea</i>	2.990	4.895	2.977	10.86
4	<i>Borassus flabellifer</i>	7.309	5.594	6.367	19.27
5	<i>Caesalpinia pulcherrima</i>	4.651	5.594	4.052	14.30
6	<i>Casuarina equisetifolia</i>	6.977	3.497	9.724	20.20
7	<i>Ceiba pentandra</i>	3.322	4.196	3.859	11.38
8	<i>Chukrasia tabularis</i>	4.651	4.196	5.402	14.25
9	<i>Dalbergia sissoo</i>	4.983	4.895	4.961	14.84
10	<i>Delonix regia</i>	2.658	3.497	3.705	9.86
11	<i>Eucalyptus globulus</i>	6.645	8.392	3.859	18.90
12	<i>Ficus benghalensis</i>	3.987	4.196	4.631	12.81
13	<i>Ficus microcape</i>	4.651	4.196	5.402	14.25
14	<i>Grewia hirsuta</i>	5.648	4.895	5.623	16.17
15	<i>Peltophorum pterocarpum</i>	4.651	4.196	5.402	14.25
16	<i>Phoenix sylvestris</i>	4.983	4.895	4.961	14.84
17	<i>Pithecellobium dulce</i>	4.651	3.497	6.483	14.63
18	<i>Plumeria alba</i>	3.654	6.294	2.830	12.78
19	<i>Polyalthia longifolia</i>	5.316	4.895	5.292	15.50
20	<i>Pongamia pinnata</i>	6.312	6.993	4.399	17.70
Total		100	100	100	300

Table 4-53: Mangrove Floral species in the Core and Buffer zones

S. No	Scientific Name	Rel Density	Rel Frequency	Rel Abundance	IVI	Shannon Index
1	<i>Avicennia alba</i>	10.076	9.615	5.433	25.124	0.231
2	<i>Avicennia marina</i>	13.098	8.654	7.848	29.600	0.266

S. No	Scientific Name	Rel Density	Rel Frequency	Rel Abundance	IVI	Shannon Index
3	<i>Avicennia officinalis</i>	7.557	7.692	5.093	20.342	0.195
4	<i>Bruguiera cylindrica</i>	4.786	5.769	4.301	14.856	0.145
5	<i>Clerodendrum inerme</i>	3.778	3.846	5.093	12.718	0.124
6	<i>Dalbergia spinosa</i>	2.771	5.769	2.490	11.030	0.099
7	<i>Derris trifoliata</i>	5.038	4.808	5.433	15.278	0.151
8	<i>Excoecaria agallocha</i>	2.771	2.885	4.980	10.636	0.099
9	<i>Hibiscus tiliaceus</i>	2.267	4.808	2.445	9.520	0.086
10	<i>Phoenix paludosa</i>	3.023	6.731	2.328	12.082	0.106
11	<i>Salicornia brachiata</i>	2.519	2.885	4.527	9.931	0.093
12	<i>Bruguiera gymnorhiza</i>	0.756	1.923	2.037	4.716	0.037
13	<i>Lumnitzera racemosa</i>	0.756	1.923	2.037	4.716	0.037
14	<i>Acanthus ilicifolius</i>	11.587	11.538	5.207	28.332	0.250
15	<i>Sonneratia alba</i>	1.763	3.846	2.377	7.986	0.071
16	<i>Sonneratia apetala</i>	1.008	1.923	2.716	5.647	0.046
17	<i>Tinospora cordifolia</i>	1.763	3.846	2.377	7.986	0.071
18	<i>Suaeda fruticosa</i>	8.060	3.846	10.866	22.772	0.203
19	<i>Suaeda maritima</i>	9.320	3.846	12.564	25.730	0.221
20	<i>Suaeda monoica</i>	7.305	3.846	9.847	20.998	0.191
	Total	100.000	100.000	100.000	300.000	2.723

Table 4-54: Biodiversity indices of floral species in Core and Buffer zones

Biodiversity Indices	Woody plants	
	Core	Buffer
Dominance D	0.053	0.052
Shannon H	2.976	2.980
Simpson 1-D	0.947	0.948
Evenness e ^{H/S}	0.981	0.984
Margalef	3.333	3.331

Table 4-55: Raunkiaer's Frequency Classes for floral species in core and buffer zones

Class	Woody species	
	Core	Buffer
A	2	0
B	10	6
C	6	12
D	2	2
E	0	0
Total (n)	20	20

4.7.2.4 Observations

As per the Raunkiaer's law of frequency classification, the present study indicates $A < B > C > D > E$ for Core zone species indicates that species diversity is distributed maximum for 20 to 40% of the area and none of the species is common throughout the core zone. For the buffer zone the result of the frequency table indicates that $A < B < C > D > E$ which indicates the species distribution is between 40% to 60%. It is very clear that the distribution of species is more random in buffer zone than in core zone. In conservation aspect, the protection of dominant as well as rare species is to be considered while managing the green belt. The overall result is most of the plant species are very common throughout the region. The present distribution pattern ratio (A/F Value) is 0.061 in core zone and 0.050 in buffer zone. This indicates more contiguous/clumped type of distribution is seen for plant species in the core zone and random distribution in buffer zone which is very common in nature due to Casuarina plantations and Mangrove species. Similarity index for core and buffer zones is 0.545 (54%). The Shannon Wiener Index for the study area is 2.976 and 2.980 which reveals

that there are not only has a greater number of species (species richness), but the individuals in the community are distributed more equitably among these species for both the core (including project area) and buffer zones.

4.7.3 Faunal Distribution

As the animal species are capable of moving from place to place either for food or shelter or mate, it is not proper to list them separately for core and buffer areas. Hence, common check lists have been prepared based mainly on direct observation and authentic secondary data, indirect or circumstantial evidence such as foot prints, feathers, skin, hair, hooves etc. There are several instances of conflict between crocodiles and humans in and around Bhitarkanika Reserve Forest and Bhitarkanika wildlife sanctuary²⁸. During the survey, carcasses of Olive Ridley Turtles and a dead Dolphin was seen on the Kanika Sand Island but no live turtles were spotted. Kanika Island also hosts varied population of birds.

Bhitarkanika National Park/WLS Fauna: Rhesus monkey, leopard cat, fishing cat, jungle cat, small Indian civet cat, toddy cat, common mongoose, jackal, striped hyena, Indian fox, wild pig, Indian porcupine, mole rat, long tailed tree mouse, spotted deer, sambar, common otter and smooth Indian otter etc. Reptiles such as the mugger Crocodiles, venomous as well as non-venomous snakes are also very common.

The Bhitarkanika Heronry: As per the secondary source of information, it is the one of the oldest and largest mixed species colony in India. Over 30,000 birds breed every year in this heronry, a single unbroken patch with an approximate area of less than 5 ha area comprising 3800 - 4200 trees are used for nesting. Birds use five species of mangrove trees for nesting which include *Excoecaria agallocha* (Guan), *Heritiera rafomes* (Bada Sundari), *Cynome trairipa* (Singada), *Hibiscus tiliaceus* (Bania), *Tamarix troupii* (Jagula) for nesting in the heronry. The breeding birds in this mixed species colony are Asian openbill stork, Great Egret, Intermediate Egret, Little Egret, Cattle Egret, Grey Heron, Purple Heron, Black-crowned Night Heron, Little Cormorant, Darter and Black-headed Ibis. The Asian Openbill is the most abundant species nesting in the heronry (66%) and the least abundant being the little egret (0.8%). Abundant food resources in and around the heronry and the minimal disturbance due to the remoteness of the area are speculated to be the principal factors for this large congregation of breeding birds.

Nest constituents were visually identified and types of tree species used for nesting were noted. Since the average height of the trees in the heronry are around 5-6 m (personal observation), nest height was approximately estimated using one meter graded pole. Asian openbill storks showed affinity to nest in the top canopy and their mean nest height was 14 ft. They nest extensively on *Excoecaria agallocha*, which had a mean tree height of 14.5 ft. Most of the nesting species showed affinities to nest in the upper and upper middle canopy.

Though some species are said to be locally rare but none of them except Marsh Crocodile (*Crocodylus palustris*), and the Olive Ridley Turtle (*Lepidochelys olivacea*) belongs to Vulnerable category. Wildlife Institute of India (WII) has reported an increase in Crocodile population. Wild life attacks were reported from Bhitarkanika WLS²⁹.

Status of Fauna observed in the study period is given in **Table 4-56**. List of Mammals reported from the study area in three seasons (Secondary data) is given in **Table 4-57**, List of Avian Fauna reported from the study area (Primary and Secondary data) is given in **Table**

²⁸ Times of India (Bhubaneswar edition) dt. 7-12-2009

²⁹ Times of India (Bhubaneswar edition) dt. 7-12-2009

4-58, Reptiles in PIA (Secondary source) is given in **Table 4-59**, Amphibians reported from the core and buffer areas (Secondary data) is given in **Table 4-60**, Butterflies found in the Study area in the three seasons (Primary data) is given in **Table 4-61**.

Table 4-56: Status of Observed Fauna in PIA

Common name	Latin Name	Location	WPA
Chital	<i>Axis axis</i>	Sanctuary	Schedule III
Jackal	<i>Canis aureus</i>	Sanctuary	Schedule II
Jungle cat	<i>Felis chaus</i>	Sanctuary	Schedule II
Ruddy mongoose	<i>Herpestes smithii</i>	Sanctuary	Schedule II
Striped Hyena	<i>Hyaena hyaena</i>	Sanctuary	Schedule III
Rhesus monkey	<i>Macaca mulatta</i>	Scattered	Schedule II
Common palm civet	<i>Paradoxurus hermaphroditus</i>	Sanctuary	Schedule II
Fishing cat	<i>Prionailurus viverrinus</i>	Kalibanjdia & Sanctuary	Schedule I (Endangered)
Wild pig	<i>Sus scrofa</i>	Kalibanjdia, Kanika sands & Sanctuary	Schedule III
Small Indian Civet	<i>Viverricula indica</i>	Sanctuary	Schedule II
Crested Tree Swift	<i>Hemiprocne coronata</i>	WLS	(Least Concern as per IUCN)
White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>	WLS	Schedule I (Least Concern as per IUCN)
Dog faced water snake	<i>Fordonia Leucobalia</i>	Reported by Dutta <i>et al</i> (2007)	Schedule II (Least Concern as per IUCN)
Saltwater or estuarine crocodile	<i>Crocodylus palustris</i>	Sanctuary	Schedule I (Vulnerable as per IUCN)
Olive Ridley Turtle	<i>Lepidochelys olivacea</i>	Gahirmata, Wheeler Island	Schedule I (Vulnerable as per IUCN)

Table 4-57: List of Mammals Reported in PIA based on Secondary Sources

Common name	Scientific Name	WPA
Chital	<i>Axis axis</i>	Schedule III
Large bandicoot Rat	<i>Bandicota indica</i>	Schedule V
Jackal	<i>Canis aureus</i>	Schedule II
Jungle cat	<i>Felis chaus</i>	Schedule II
Three striped squirrel	<i>Funambulus palmarum</i>	Schedule IV
Indian bush rat	<i>Golunda ellioti myothrix</i>	Schedule IV
Indian gray mongoose	<i>Herpestes edwardsi</i>	Schedule IV
Ruddy mongoose	<i>Herpestes smithii</i>	Schedule II
Striped Hyena	<i>Hyaena hyaena</i>	Schedule III
Indian hare	<i>Lepus nigricollis</i>	Schedule IV
Rhesus monkey	<i>Macaca mulatta</i>	Schedule II
Indian field mouse	<i>Mus booduga</i>	Schedule V
Mouse	<i>Mus musculus homeurus</i>	Schedule V
Home mouse	<i>Mus musculus tyleri</i>	Schedule V
Bandicoot rat	<i>Nosokia indica indica</i>	Schedule V
Common palm civet	<i>Paradoxurus hermaphroditus</i>	Schedule II
Fishing cat	<i>Prionailurus viverrinus</i>	Schedule I (Endangered)
Common Indian rat	<i>Rattus rattus gangutrianus</i>	Schedule V
Common Indian rat	<i>Rattus rattus refescens</i>	Schedule V
Savi pygmy shrew	<i>Suncus etruscus</i>	Schedule V
House shrew	<i>Suncus murinus</i>	Schedule V
Wild pig	<i>Sus scrofa</i>	Schedule III
Small Indian Civet	<i>Viverricula indica</i>	Schedule II

Table 4-58: List of Avian Fauna reported in PIA

Common Name	Latin Name	Location	WPA
Asian Koel	<i>Eudynamys scolopacea</i>	WLS	Not listed

Common Name	Latin Name	Location	WPA
Asian Openbill	<i>Anastomus oscitans</i>	WLS	Not listed
Asian Paradise Flycatcher	<i>Terpsiphone paradisi</i>	WLS	Schedule IV
Asian Pied Starling	<i>Sturnus contra</i>	Common	Not listed
Baya Weaver	<i>Ploceus philippinus</i>	Common	Schedule IV
Black Drongo	<i>Dicrurus macrocercus</i>	Common	Schedule IV
Black Eagle	<i>Ictinaetus malayensis</i>	Common	Not listed
Black-hooded Oriole	<i>Oriolus xanthornus</i>	Common	Schedule IV
Black-rumped Flame Back	<i>Dinopium benghalense</i>	Common	Not listed
Black-shouldered Kite	<i>Elanus caeruleus</i>	Common	Not listed
Black-bellied Tern	<i>Sterna acuticauda</i>	Common	Not listed
Black-capped Kingfisher	<i>Halcyon pileata</i>	Common	Schedule IV
Common Black-headed Gull	<i>Larus ridibundus</i>	Common	Schedule IV
Black-headed Ibis	<i>Threskiornis melanocephalus</i>	WLS	Schedule IV
Black-tailed Godwit	<i>Limosa limosa</i>	Common	Not listed
Blue-tailed Bee-eater	<i>Merops philippinus</i>	Common	Not listed
Brahminy Starling	<i>Sturnus pagodarum</i>	Common	Schedule IV
Bronze-winged Jacana	<i>Metopidius indicus</i>	Common	Schedule IV
Cattle Egret	<i>Bubulcus ibis</i>	Common	Schedule IV
Chestnut-headed Bee-eater	<i>Merops leschenaulti</i>	Common	Not listed
Collared Kingfisher	<i>Todirhamphus chloris</i>	Common	Schedule IV
Common Hawk Cuckoo	<i>Hierococcyx varius</i>	Common	Schedule IV
Common Iora	<i>Aegithina tiphia</i>	Common	Schedule IV
Common Kingfisher	<i>Alcedo atthis</i>	Common	Schedule IV
Common Mynah	<i>Acridotheres tristis</i>	Common	Schedule IV
Common Redshank	<i>Tringa totanus</i>	Common	Not listed
Common Sandpiper	<i>Tringa hypoleucos</i>	Common	Schedule IV
Common Tailor Bird	<i>Orthotomus sutorius</i>	Common	Not listed
Common Hoopoe	<i>Upupa epops</i>	Common	Not listed
Common-ringed Plover	<i>Charadrius hiaticula</i>	Common	Schedule IV
Coppersmith Barbet	<i>Megalaima haemocephala</i>	Common	Schedule IV
Crested Tree Swift	<i>Hemiprocne coronata</i>	WLS	Not listed
Dark-necked Tailor Bird	<i>Orthotomus atrogularis</i>	Common	Not listed
Eurasian Collared Dove	<i>Streptopelia decaocto</i>	Common	Schedule IV
Eurasian Curlew	<i>Numenius arquata</i>	Common	Schedule IV
Eurasian Golden Oriole	<i>Oriolus oriolus</i>	Common	Schedule IV
Eurasian Oystercatcher	<i>Haematopus ostralegus</i>	Common	Schedule IV
Greater Coucal	<i>Centropus sinensis</i>	Common	Schedule IV
Greater Sand Plover	<i>Charadrius leschenaultii</i>	Common	Schedule IV
Little Green Bee-eater	<i>Merops orientalis</i>	Common	Not listed
Grey Heron	<i>Ardea cinerea</i>	Common	Not listed
House Crow	<i>Corvus splendens</i>	Common	Schedule V
House Sparrow	<i>Passer domesticus</i>	Common	LC as per IUCN
House Swift	<i>Apus nipalensis</i>	WLS	Schedule IV
Indian Grey Hornbill	<i>Ocyrceros birostris</i>	WLS	Schedule IV
Indian Nightjar	<i>Caprimulgus asiaticus</i>	WLS	Schedule IV
Indian Pond Heron	<i>Ardeola grayii</i>	Common	Not listed
Indian Robin	<i>Saxicoloides fulcata</i>	Common	Not listed
Indian Roller	<i>Coracias benghalensis</i>	Common	Schedule IV
Indian Skimmer	<i>Rynchops albicollis</i>	Common	Not listed
Intermediate Egret	<i>Mesophoyx intermedia</i>	Common	Schedule IV
Jungle Babbler	<i>Turdoides striatus</i>	Common	Schedule IV
Jungle Mynah	<i>Acridotheres fuscus</i>	Endemic (WLS)	Schedule IV
Kentish Plover	<i>Charadrius alexandrinus</i>	Common	Schedule IV
Large-billed Crow	<i>Corvus macrorhynchos</i>	Common	Not listed
Lesser Crested Tern	<i>Sterna bengalensis</i>	Common	Not listed
Lesser Sand Plover	<i>Charadrius mongolus</i>	Common	Schedule IV
Little Cormorant	<i>Phalacrocorax niger</i>	Common	Schedule IV

Common Name	Latin Name	Location	WPA
Little Egret	<i>Egretta garzetta</i>	Common	Schedule IV
Little Grebe	<i>Tachybaptus ruficollis</i>	Common	Schedule IV
Little Stint	<i>Calidris minuta</i>	Common	Not listed
Little-ringed Plover	<i>Charadrius dubius</i>	Common	Schedule IV
Long-toed Stint	<i>Calidris subminuta</i>	WLS	Not listed
Mangrove Pitta	<i>Pitta megahyncha</i>	WLS	Schedule IV
Oriental Magpie Robin	<i>Copsychus saularis</i>	Common	Not listed
Paddyfield Pipit	<i>Anthus rufulus</i>	Common	Schedule IV
Purple-rumped Sunbird	<i>Nectarinia zeylonica</i>	Common	Schedule IV
Purple Sunbird	<i>Nectarinia asiatica</i>	Common	Schedule IV
Red-vented Bulbul	<i>Pycnonotus cafer</i>	Common	Schedule IV
Red-wattled Lapwing	<i>Vanellus indicus</i>	Common	Not listed
River Tern	<i>Sterna aurantia</i>	Common	Not listed
Rock Pigeon	<i>Columba livia</i>	Common	Schedule IV
Rose-ringed Parakeet	<i>Psittacula krameri</i>	Common	Schedule IV
Rufous Treepie	<i>Dendrocitta vagabunda</i>	Common	Schedule IV
Scaly-breasted Munia	<i>Lonchura punctulata</i>	Common	Schedule IV
Shikra	<i>Accipiter badius</i>	Common	Not listed
Short-toed Snake Eagle	<i>Circaetus gallicus</i>	WLS	Not listed
Spotted Dove	<i>Streptopelia chinensis</i>	Common	Schedule IV
Spotted Owlet	<i>Athene brama</i>	WLS	Schedule IV
Temminck's Stint	<i>Calidris temminckii</i>	Common	Not listed
Whimbrel	<i>Numenius phaeopus</i>	Common	Not listed
White-bellied Drongo	<i>Dicrurus caerulescens</i>	Common	Schedule IV
White-breasted Water Hen	<i>Amaurornis phoenicurus</i>	Common	Not listed
White-rumped Shama	<i>Copsychus malabaricus</i>	Common	Not listed
White-throated Fantail	<i>Rhipidura albicollis</i>	Common	Not listed
White-throated Kingfisher	<i>Halcyon smyrnensis</i>	Common	Schedule IV
White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>	WLS	Schedule I
Yellow Wagtail	<i>Motacilla flava</i>	Common	Not listed
Yellow-wattled Lapwing	<i>Venellus malabaricus</i>	Common	Not listed

Table 4-59: List of Reptile fauna for the PIA

Common Name	Scientific Name	IWPA/IUCN Status
Brook's Gecko	<i>Hemidactylus brookii</i>	Common
Marbled Tree Gecko	<i>Hemidactylus leschenaultii</i>	Common
Asian House Gecko	<i>Hemidactylus frenatus</i>	Very common
Fan-throated Lizard	<i>Sitana ponticeriana</i>	Rare
Indian Garden Lizard	<i>Calotes versicolor</i>	Very common
Indian Chameleon	<i>Chamaeleo zeylanicus</i>	Common
Little Indian Skink	<i>Mabuya macularia</i>	Common
Common Brahminy Skink	<i>Mabuya carinata</i>	Very common
Snake Skink	<i>Riopa punctatus</i>	Uncommon
Common Indian Monitor	<i>Varanus bengalensis</i>	Common
Yellow Monitor lizard	<i>Varanus flavescens</i>	Rare
Brahminy Worm Snake	<i>Ramphotyphlops braminus</i>	Rare
Common Sand Boa	<i>Eryx conicus</i>	Common
Common Vine snake	<i>Ahaetulla nasutus</i>	Common
Common Bronzebacked Tree Snake	<i>Dendrelaphis tristis</i>	Common
Indian Rat Snake	<i>Ptyas mucosa mucosa</i>	Common
Common Wolf Snake	<i>Lycodon aulicus</i>	Rare
Common Cat Snake	<i>Boiga trigonatus</i>	Rare
Checkered Keelback	<i>Xenochrophis piscator</i>	Rare
Dog faced water snake	<i>Fordonia leucobalia</i>	Schedule II of WPA ³⁰
Monocellate Cobra	<i>Naja naja</i>	Rare

³⁰Reported by Dutta et al (2007)

Common Name	Scientific Name	IWPA/IUCN Status
Bamboo Pit Viper	<i>Triemeresurus gramineus</i>	Common
File Snakes	<i>Acrochordus granulatus</i>	Common
Glossy Marsh Snake	<i>Gerarda Prevostiana</i>	Schedule
White-bellied Mangrove snake	<i>Fordonia leucobalia</i>	Schedule IV
Marsh crocodile	<i>Crocodylus palustris</i>	Vulnerable as per IUCN
Saltwater or estuarine crocodile	<i>Crocodylus porosus</i>	Least concern
Olive Ridley Turtle	<i>Lepidochelys olivacea</i>	Vulnerable as per IUCN

Table 4-60: Amphibians reported in PIA

Common Name	Scientific Name	Status in and around DPCL
Common Indian Toad	<i>Duttaphrynus melanostictus</i>	Very Common
Common Toad	<i>Bufo scaber</i>	Very common
Crab-eating Frog	<i>Fejervarya cancrivora</i>	Reported by Dutta (2007)
Cricket Frog	<i>Fejervarya limnocharis</i>	Common
Paddy Field Frog	<i>Fejervarya syhadrensis</i>	Common
Paddy Field Frog	<i>Fejervarya orissaensis</i>	Common
Indian Bull Frog	<i>Hoplobatrachus tigerinus</i>	Common
Jerdon's Bull Frog	<i>Hoplobatrachus crassus</i>	Common
Skipper Frog	<i>Euphlyctis cyanophlyctis</i>	Rare
Green Pond Frog	<i>Euphlyctis hexadactylus</i>	Very Common
Ornate Frog	<i>Microhyla ornata</i>	Common
Marbled Balloon Frog	<i>Uperodon systoma</i>	Uncommon
Painted Frog	<i>Kaloula pulchra</i>	Uncommon
Tree Frog	<i>Polypedates maculatus</i>	Common

Table 4-61: Butterflies found in the Study area in the three seasons (Primary data)

S. No	Scientific Name	Common Name	Population status
1	<i>Badamia exclamationis</i>	Brown Awl	Sparse
2	<i>Hasora chromus chromus</i>	Oriental Banded Awl	Rare
3	<i>Borbo cinnara</i>	Rice Swift	Common
4	<i>Borbo bevani</i>	Bevan's Swift	Dominant
5	<i>Telicota ancilla bambusae</i>	Dark Palm Dart	Rare
6	<i>Spialia galba galba</i>	Indian Grizzled Skipper	Rare
7	<i>Curetis thetis</i>	Indian Sunbeam	Common
8	<i>Castalius rosimon rosimon</i>	Continental Common Perrot	Dominant
9	<i>Catochrysops strabo strabo</i>	Oriental Forget-me-not	Rare
10	<i>Chilades lajus lajus</i>	Indian Lime Blue	Sparse
11	<i>Euchrysops cnejus cnejus</i>	Oriental Gram Blue	Sparse
12	<i>Everes lacturnus syntala</i>	Dakhan Cupid	Common
13	<i>Freyeria trochylus trochylus</i>	African Grass Jewel	Dominant
14	<i>Jamides celeno celeno</i>	Oriental Common Cerulean	Sparse
15	<i>Leptotes plinius plinius</i>	Asian Zebra Blue	Sparse
16	<i>Prosotas nora</i>	Common Line Blue	Dominant
17	<i>Pseudozizeeria maha ossa</i>	Dakhan Pale Grass Blue	Sparse
18	<i>Tarucus nara</i>	Rounded Pierrot	Dominant
19	<i>Zizeeria karsandra</i>	Dark Grass Blue	Dominant
20	<i>Zizina otis indica</i>	Lesser Grass Blue	Sparse
21	<i>Polyura athamas athamas</i>	Common Nawab	Sparse
22	<i>Danaus chrysippus chrysippus</i>	Plain Tiger	Dominant
23	<i>Danaus genutia genutia</i>	Striped Tiger	Dominant
24	<i>Euploea core core</i>	Common Crow	Dominant
25	<i>Tirumala limniace exotica</i>	Blue Tiger	Sparse
26	<i>Acraea violae</i>	Tawny Coster	Dominant
27	<i>Phalanta phalantha phalantha</i>	Common Leopard	Dominant
28	<i>Euthalia aconthea meridionalis</i>	Baron	Sparse
29	<i>Moduza procris undifragus</i>	Commander	Sparse
30	<i>Neptis hylas varmona</i>	Common Sailer	Sparse

S. No	Scientific Name	Common Name	Population status
31	<i>Hypolimnna bolina jacintha</i>	Oriental Great Eggfly	Dominant
32	<i>Hypolimnna misippus</i>	Danaid Eggfly	Dominant
33	<i>Junonia almana almana</i>	Oriental Peacock Pansy	Sparse
34	<i>Junonia hierta hierta</i>	Oriental Yellow Pansy	Sparse
35	<i>Junonia iphita iphita</i>	Oriental Chocolate Pansy	Dominant
36	<i>Junonia lemonias lemonias</i>	Chinese Lemon Pansy	Dominant
37	<i>Junonia orithya ocyale</i>	Dark Blue Pansy	Dominant
38	<i>Symphaedra nais</i>	Baronet	Sparse
39	<i>Melanitis leda leda</i>	Oriental Common Evening Brown	Rare
40	<i>Melanitis phedima bela</i>	Dark Evening Brown	Dominant
41	<i>Melanitis zitenius zitenius</i>	Himalian Great Evening Brown	Rare
42	<i>Graphium agamemnon menides</i>	Dakhan Tailed Jay	Common
43	<i>Graphium nomius nomius</i>	Indian Spot Sword Tail	Rare
44	<i>Graphium sarpedon teredon</i>	Dakhan Blue Bottle	Rare
45	<i>Papilio demoleus</i>	Lime Butterfly	Dominant
46	<i>Papilio polytes polytes</i>	Common Mormon (polytes)	Dominant
47	<i>Papilio polytes romulus</i>	Common Mormon (romulus)	Common
48	<i>Papilio polytes stichius</i>	Common Mormon (stichius)	Common
49	<i>Pachilioptia aristolochiae aristolochiae</i>	Common Rose	Common
50	<i>Pachilioptia hector</i>	Crimson Rose	Common
51	<i>Catopsilia pyranthe pyranthe</i>	Mottled Emigrant	Common
52	<i>Catopsilia crocale</i>	Lemon Emigrant	Common
53	<i>Colias fieldii fieldii</i>	Himalyan Dark Clouded Yellow	Sparse
54	<i>Eurema brigitta rubella</i>	Red-line Small Grass Yellow	Sparse
55	<i>Eurema hecabe simulata</i>	Oriental Common Grass Yellow	Dominant
56	<i>Colotis danae danae</i>	Crimson Tip	Dominant
57	<i>Colotis etrida</i>	Small Orange Tip	Sparse
58	<i>Colotis eucharis eucharis</i>	Plain Orange Tip	Sparse
59	<i>Ixias marianne</i>	White Orange Tip	Sparse
60	<i>Ixias pyrene sesia</i>	Yellow Orange Tip	Sparse
61	<i>Pareronia valeria hippia</i>	Common Wanderer	Dominant
62	<i>Appias albina darada</i>	Common Albatross	Dominant
63	<i>Belenois aurota aurota</i>	Indian Pioneer	Sparse
64	<i>Cepora nerissa nerissa</i>	Common Gull	Sparse
65	<i>Delias eucharis</i>	Common Jezebel	Dominant

The following exhibits from **Exhibit 4-4** to **Exhibit 4-21** shows the some of the flora and fauna observed during site visits in core and buffer areas of the proposed project.



Exhibit 4-4: Skipper Butterfly on *Lantana camara* in Study Area



Exhibit 4-5: Red Dragonfly in General Study Area

	
Exhibit 4-6: Dragonfly in General Study Area	Exhibit 4-7: Hoopoe On Mangrove Tree in General Study Area
	
Exhibit 4-8: Bee-eaters in general Study Area)	Exhibit 4-9: Kingfisher in General Study area
	
Exhibit 4-10: Cormorant in General Study Area	Exhibit 4-11: Grapsid Crab in General Study Area



Exhibit 4-12: Dragonfly Variety in General study area



Exhibit 4-13: Red wattled lapwing in General study area



Exhibit 4-14: Grey heron In general Study area



Exhibit 4-15: Lesser Egret in General Study Area



Exhibit 4-16: Magpie Robin in General Study Area)



Exhibit 4-17: Saltwater Crocodile (*Crocodylus porosus*) in BNP

	
Exhibit 4-18: Spotted Deer (<i>Axis axis</i>) in Study Area	Exhibit 4-19: Giant wood spider in Study Area
	
Exhibit 4-20: <i>Suaeda</i> sp. Near the proposed site	Exhibit 4-21: Painted stork in Buffer area

4.7.4 Kanika Island

This island is mostly a low lying deltaic estuarine silt containing dense mangrove vegetation³¹. The oval shaped island is roughly 5 km in length and 2.7 km in width. The eastern side beach is sandy that stretches over 6.2 km from north to south with extended sand banks on the south. The width of the sandy beach varies from 50 m to 140 m. The forests of this island are coming under the Chandbali range of Bhadrak Wildlife Division. It has not been covered in the Working Plan and hence has no prescribed management practices.

4.7.4.1 Floristic Composition

The vegetation can be classified as category 4B–Tidal swamp Forests as per the Forest type classification of Champion & Seth. The predominant species are *Avicennia marina* (Singala Bani) on the north portion and *Avicennia alba* (Kala Bani) in the southern part of the island. *Avicennia officinalis* (Dhala Bani) are also found mixed together with the predominant species. The other species colonizing are *Suaeda maritima*, *Sesuvium portulacastrum*, *Bruguiera sexangula* (Bandari), *Derris trifoliata*, *Sonneratia alba* (Orua), *Excoecaria agallocha* (Guan) *Aegiceras corniculatum* (Kharsi), *Acanthus ilicifolius* (Harakancha), *Ceriops decandra* (Garani) *Ipomeae biloba*, *Cynodon dactylon* (Doob grass) *Casuarina equisetifolia*

³¹ Conservation Plan for Kanika Sand Island, 2013

(Jhau), *Hibiscu stiliaceous* (Bania), *Prosopis juliflora* and *Pongamia pinnata* (Karanja). Flora of Kaniana Island is shown in **Exhibit 4-22**.



Exhibit 4-22: Flora of Kaniana Sand Island

4.7.4.2 Faunal Composition

The island has no major fauna apart from wild boar (*Susscrofa*) and water monitor (*Varanus bengalensis*). The island with its dense mangrove cover also provides habitat for pelagic oceanic birds like the Pallas's Sea Gull. The mangrove forests towards the interior of the island are frequented by roosting flocks of Terns, Herons and Egrets. Large raptors like the Brahminy kite as well as the White bellied sea eagle are also noted in these islands. In the inter-tidal zone, The Ghost fiddler crab of the Ocypodidae family is the dominant species in this island. Apart from the Ghost fiddler crab, Ghost crabs, Hermit crabs, Sand fleas are seen in the sandy inter – tidal zone of this island. While the mud banks on the west as well as the creeks are frequented by Mud skippers, Mollusks, edible Mud crabs and Nematodes. Some fauna of Kanika Sand Island is shown in **Exhibit 4-23**.



Exhibit 4-23: Pallas's Gull found and Red Ghost crabs in Kanika Sand Island

4.8 Air Environment

4.8.1 General Meteorological Scenario based on IMD Data

The nearest Indian Meteorological Department (IMD) station located to project site is Chandibali. The Climatological data for Chandibali (20° 47' N and 86° 44' E), published by the IMD, based on daily observations at 08:30 and 17:30 hour IST for a 30 year period, is presented in the following sections on the meteorological conditions of the region. The monthly variations of the relevant meteorological parameters are reproduced in **Table 4-62**.

Table 4-62: Climatological Summary – Chandibali (1971-2000)

Month	Temp (°C)		Rainfall (mm)		Relative Humidity (%)		Station Level Pressure hPa		Mean Wind Speed (km/h)	Predominant Wind Directions (From)*	
	Daily Max.	Daily Min.	Total	No. of days	08:30	17:30	08:30	17:30		08:30	17:30
Jan	27.7	14.3	9.6	0.6	73	61	1016.8	1013	3.6	N,NE	E,SE
Feb	30.1	17.4	34.5	2.1	75	62	1014.5	1010.8	4.4	N,NE,S	E,S,SE
Mar	34.2	21.1	33.9	1.7	75	61	1011.7	1007.6	6.8	S,SW	S,SE,E
Apr	36.6	24.1	48.5	3	75	65	1008	1003.8	9.8	S,SW	S,SE,SW
May	36.4	25.4	96	5.1	76	69	1004.4	1000.8	10.6	S,SW	S,SW
Jun	34.4	25.4	210.4	10.1	80	76	1000.1	997.3	8.3	S,SW	S,SW
Jul	32.1	24.8	262.7	13.6	85	81	1000.6	998	6.6	S,SW	S,SW
Aug	31.7	25	369.9	15	85	82	1001.2	998.6	6.7	S,SW	S,SW
Sep	32.1	24.9	229.6	11.2	83	81	1005.6	1002.5	5.5	S,SW	S,SW
Oct	31.9	23.1	194.8	6.7	80	77	1010.5	1007.3	3.7	N,NE,S	S,E
Nov	30.2	18.7	53.7	2.2	75	69	1014.4	1011.1	3.7	N,NE	E,N,NE
Dec	28	14.2	6.6	0.6	73	63	1017.2	1013.5	3.4	N,NE	E,NE

As per the above Climatological table the observations drawn for the study area are given below.

- Daily maximum temperature is 36.6°C and the daily minimum temperature is 14.2°C were recorded in the months of April and December respectively
- Maximum and minimum relative humidity of 85% during the months of July and August respectively and 61% were recorded in the month of January and March respectively
- Monthly average Maximum and minimum rainfall of 369.9 mm and 6.6 mm was recorded in the months of August and December respectively
- Annual Total or Mean rainfall recorded is 1550.3 mm
- Maximum and minimum Mean wind speed is 10.6 kmph (2.9 m/s) and 3.4 kmph (1.0 m/s)

4.8.2 Meteorological Scenario during Study Period

Meteorological scenario in and around the project site is an essential requirement during study period for proper interpretation of baseline air quality status. Site-specific meteorological data was collected during the study period (Summer 2016) and during Summer season, Post monsoon season and Winter season of 2014-15. Automatic weather station was installed at project site to record the meteorological parameters during the study period. Meteorological parameters recorded include temperature, wind speed, wind direction, relative humidity and rainfall.

In addition, for the purpose of carrying out the air quality modelling study, site specific meteorological data (pre-processed from MM5) for the complete year of 2015 (January to December) obtained from Lakes Environment, Canada. The wind roses were drawn for the

met files obtained on a sixteen-point compass (N, NNE, NE, ENE; E, ESE, SE, SSE; S, SSW, SW, WSW; W, WNW, NW, and NNW). Wind pattern representing 24 hours for the entire year of 2015 is discussed. The frequency occurrence of wind at various speeds was calculated on the basis of total number of observations recorded in the respective wind speed category. The overall wind pattern recorded for 24 hours during the Summer 2015 and entire year 2015 is given in Figure below. The predominant wind directions observed were from South South West followed by South West; calm conditions prevailed for 3.50% of the total time. The average wind speed was observed to be 3.24 m/s. The overall wind pattern observed during the study period (Pre Monsoon 2015) is shown in **Figure 4-33** and annual wind pattern is shown in **Figure 4-34**.

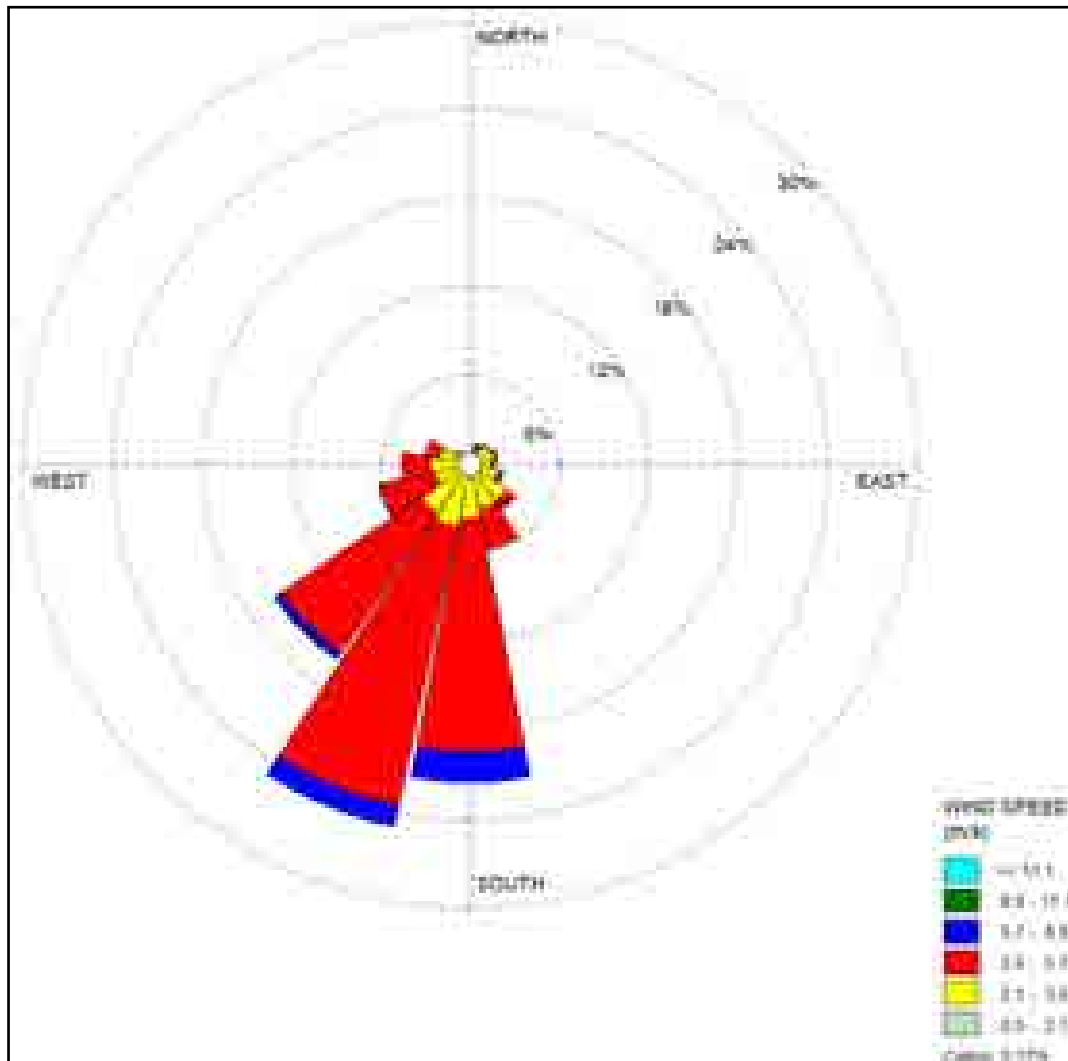


Figure 4-33: Wind Rose Diagram for Summer season of PIA

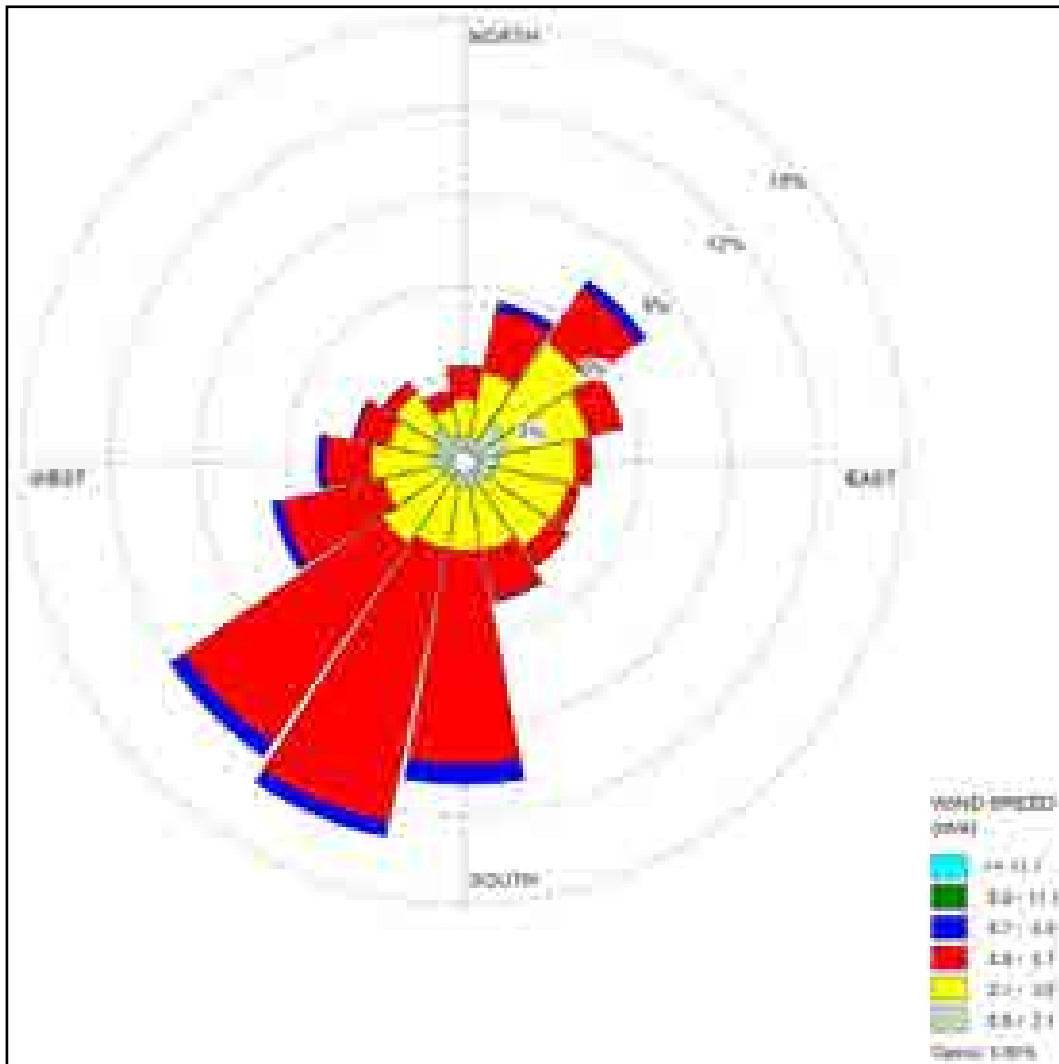


Figure 4-34: Annual Wind Rose

4.8.3 Ambient Air Quality

To evaluate the baseline air quality of the study area, **Nine (09)** locations have been identified. A map showing the air sampling locations is given as **Figure FD0406** and details of the locations are given in **Table 4-63**. Ambient air quality was monitored twice a week for complete season during the study period summer 2016 as per CPCB for all the Twelve (12) parameters. The status of ambient air quality quality assessed during post-monsoon season, 2017 and winter season, 2017-18 are given as **Appendix G**.

Table 4-63: Ambient Air Quality Locations

Station No.	Location	Distance from Project Boundary (km)	Azimuth Directions	Project Area/Study Area	Environmental Setting
A1	Port Site			Project Area	Industrial/Port Area
A2	Kishorprasad	0.5	W	Study Area	Residential
A3	Kanakprasad	0.6	W		Residential
A4	Bali Sahi	1.4	W		Residential
A5	Sabitri Sarai	1.5	W		Residential
A6	Narsinghprasad	1.6	W		Residential
A7	Narendrapur	3.0	NW		Residential
A8	Dakshina Dhamra	5.2	W		Residential
A9	Talchua	5.3	SSW		Sensitive

4.8.3.1 Results and Discussions

The maximum, minimum and mean values of PM₁₀, PM_{2.5}, SO₂, NO₂ and O₃ are given in **Table 4-64** and **Table 4-65** and the variations of PM₁₀, PM_{2.5}, SO₂, and NO₂ levels are compared with National Ambient Air Quality Standards (NAAQS), CPCB Notification, November (2009) and shown in **Figure 4-35** to **Figure 4-37**. The concentrations of Carbon Monoxide (CO), Ammonia (NH₃), Benzene (C₆H₆), Lead (Pb), Benzo (α) Pyrene (BaP), Arsenic (As) and Nickel (Ni) are found to be Below Detectable Limits (BDL) at all the locations.

Table 4-64: Ambient PM₁₀ and PM_{2.5} Monitoring Data

Parameter		No. of samples	PM ₁₀			PM _{2.5}			NAAQ Standards	
Monitoring Station & Category			Maximum (µg/m ³)	Minimum (µg/m ³)	Mean (µg/m ³)	Maximum (µg/m ³)	Minimum (µg/m ³)	Mean (µg/m ³)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)
Port Site	A1	24	63.44	44.02	54.00	36.81	23.02	29.00	100	60
Kishorprasad	A2	24	40.3	27.7	33.73	19.2	13.2	16.02		
Kanakprasad	A3	24	42.1	28.5	34.76	19.7	13.6	16.68		
Bali Sahi	A4	24	38.9	26.3	32.16	18.2	12.6	15.45		
Sabitri Sarai	A5	24	40.5	27.4	33.44	18.9	13.1	16.10		
Narsinghprasad	A6	24	39.7	26.9	32.78	18.6	12.8	15.82		
Narendrapur	A7	24	36.8	24.9	30.35	18.4	12.0	14.86		
Dakshina Dhamra	A8	24	50.8	34.4	41.95	23.7	16.3	20.13		
Talchua	A9	24	38.2	25.9	31.53	19.3	12.3	15.23		

Table 4-65: Ambient NO₂, SO₂ and O₃ Monitoring Data

Parameter		No. of samples	NO ₂			SO ₂			O ₃			NAAQ Standards	
Monitoring Station & Category			Maximum (µg/m ³)	Minimum (µg/m ³)	Mean (µg/m ³)	Maximum (µg/m ³)	Minimum (µg/m ³)	Mean (µg/m ³)	Maximum (µg/m ³)	Minimum (µg/m ³)	Mean (µg/m ³)	SO ₂ & NO ₂ (µg/m ³)	O ₃
Port Site	A1	24	23.60	16.40	20.51	6.70	5.10	5.80	3.60	2.00	2.83	80	100
Kishorprasad	A2	24	11.60	1.3	10.03	4.80	4.00	4.41	2.90	2.10	2.49		
Kanakprasad	A3	24	12.40	8.9	10.70	4.80	4.00	4.34	2.90	2.10	2.50		
Bali Sahi	A4	24	12.20	9.5	10.88	5.70	4.10	4.95	3.20	2.00	2.60		
Sabitri Sarai	A5	24	11.70	8.8	10.35	4.80	4.00	4.28	3.00	2.10	2.45		
Narsinghprasad	A6	24	11.70	9.3	10.48	4.80	4.00	4.34	3.40	2.10	2.60		
Narendrapur	A7	24	10.70	7.9	9.35	4.60	4.00	4.24	3.20	2.00	2.50		
Dakshina Dhamra	A8	24	12.50	8.9	10.72	5.00	4.00	4.45	3.10	2.10	2.57		
Talchua	A9	24	11.30	7.9	9.62	4.60	4.00	4.23	2.90	2.00	2.50		

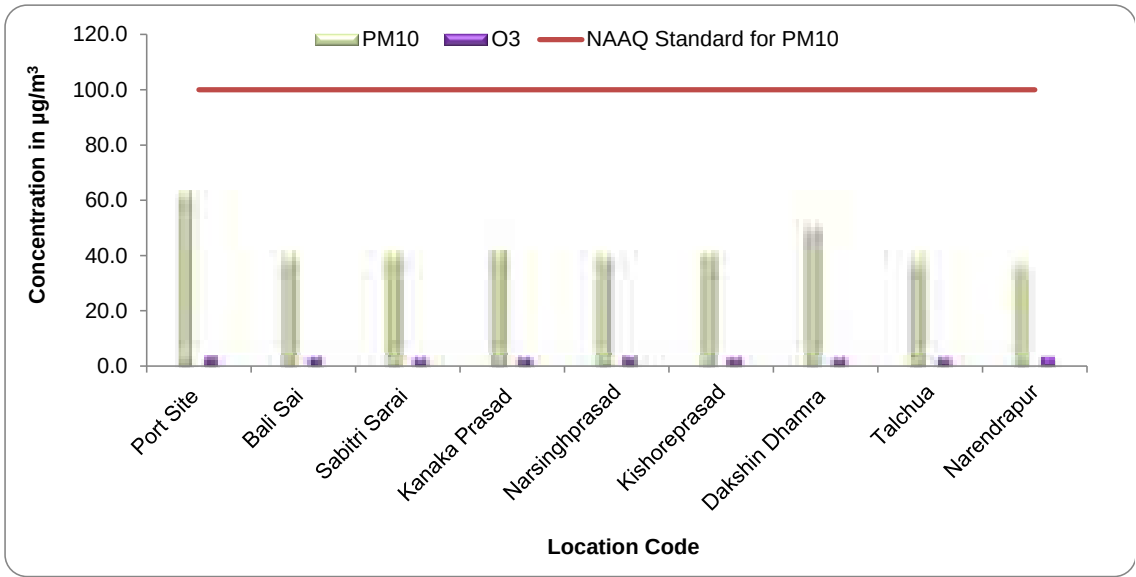


Figure 4-35: Ambient PM_{10} and O_3 Levels

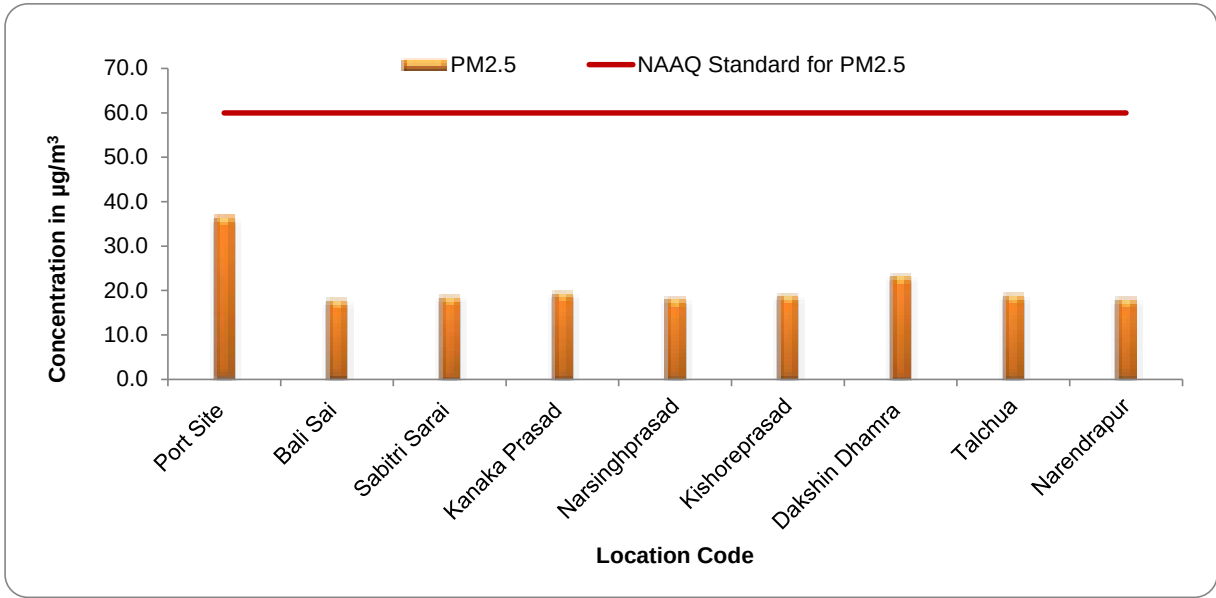


Figure 4-36: Ambient $\text{PM}_{2.5}$ Levels

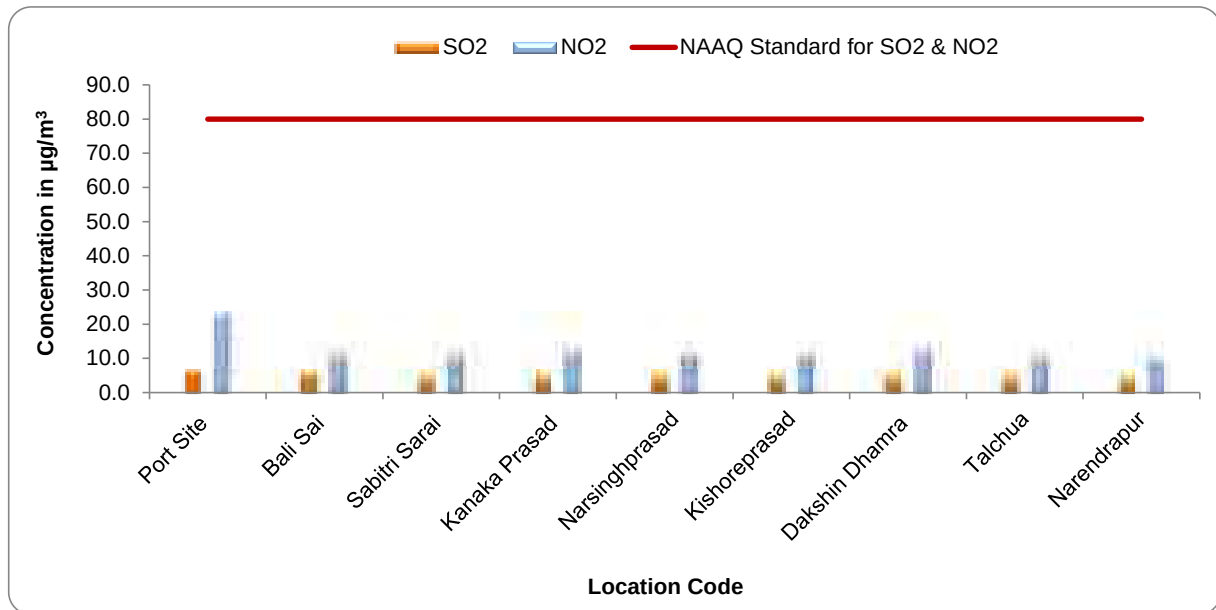


Figure 4-37: Ambient SO₂ and NO₂ Levels

Inferences on air quality assessment are given below.

- PM₁₀ values ranged between 36.80 µg/m³ at Narendrapur and 63.44 µg/m³ at Port Site
- PM_{2.5} values ranged between 18.2 µg/m³ at Bali Sai and 36.81 µg/m³ at Port
- SO₂ values ranged between 4.6 µg/m³ at Talchua and Narendrapur respectively and 6.7 µg/m³ at Port Site
- NO₂ values ranged between 10.7 µg/m³ at Narendrapur and 23.6 µg/m³ at Port Site
- O₃ values ranged between 2.9 µg/m³ at Talchua and 3.6 µg/m³ at Port Site

Maximum concentrations of PM₁₀, PM_{2.5}, SO₂, NO₂ and O₃ are well within the National Ambient Air Quality Standards for Industrial, Residential and Rural Areas.

In line with the suggestion given by EAC, MoEF&CC during ToR meeting and vide its MoM (2nd meeting of Expert Appraisal Committee (Infra-2), MoEF&CC) and to understand the environment in a comprehensive manner the data was collected for the comprehensive studies for five parameters namely PM₁₀, PM_{2.5}, SO₂, NO₂ and CO with respect to Ambient Air Quality has been reviewed and presented below.

Inferences on comprehensive air quality assessment are given below.

- PM₁₀ values ranged between 20 µg/m³ at Talchua and 69 µg/m³ at Port Site both during Summer Season respectively
- PM_{2.5} values ranged between 10 µg/m³ at Sabitri Sarai, Kanakprasad, Narsinghprasad, Talchua and Dakshina Dhamra and 37 µg/m³ at Port Site both during Summer Season respectively
- SO₂ values ranged between 10 µg/m³ at all the sampling locations except Port Site during Summer season and 19 µg/m³ at Port Site, Kanakprasad, Narsinghprasad and Narendrapur during Winter season respectively
- NO₂ values ranged between 10 µg/m³ at all the sampling locations except Port Site and Dakshin Dhamra during Post Monsoon season and also at Kishorprasad and Talchua

during Winter season respectively and $17 \mu\text{g}/\text{m}^3$ at Port Site and Kishorprasad during Post monsoon season respectively

- CO values ranged between 0.83 ppm at Kanakprasad and Kishorprasad during Post monsoon season respectively and 1.53 ppm at Port Site during Winter season

Maximum concentrations of PM_{10} , $\text{PM}_{2.5}$, SO_2 , NO_2 and CO are well within the National Ambient Air Quality Standards for Industrial, Residential and Rural Areas.

4.9 Other Natural Hazards

4.9.1 Cyclone, Flood, Storm Surge and Depressions

An analysis of cyclones / depressions that have crossed Odisha coast during the period 1891-1994 show that these are confined to the months of May to November. Balasore district is more prone to cyclones (50%) than other districts, while Ganjam gets the least (11%). Altogether 387 depressions and cyclones crossed Odisha coast from 1891 to 2007, 32 from 1988 to 2007 and 11 depressions during 2000-07.

Bhadrak District: The district is directly on the tracks of most of the cyclonic storms and depressions which form in the head of the Bay of Bengal in the monsoon season and cross the Odisha coast. These cause widespread heavy rain and strong winds. A few of the storms and depressions in the post monsoon season also affect the district. Sometimes violent thunderstorms occur in the summer season and in October. Even during the monsoon season, rainfall is often associated with thunder. The thunderstorms in summer are occasionally accompanied with squalls and hails. During the cold season fog or mist occurs particularly in the coastal region.

Bhadrak district is not only vulnerable to cyclonic storms of highest intensity along with concurrent high Storm Surge, but also to very high floods, as the mighty river systems in this district do not drain in to the sea due to high tidal water levels. As per vulnerability atlas published by the Building Materials and Technology Promotion Council, Ministry of Urban Development, Government of India (1977) has assessed Bhadrak as a very severely vulnerable district.

Bhadrak district is very high (RISK FACTOR- very High) with the possible height of storm surge above the concurrent sea level at 9.8 meters. The maximum possible wind speed is 78m/sec (i.e., 280 km per hours). The coastal 10 km zone being very flat, the whole area is likely to be very much susceptible to inundation and high wind velocities.

Two coastal blocks namely Chandbali and Basudevpur come under High Risk Zone and most vulnerable for cyclone, tsunami and flood³². Calamity Faced by Bhadrak District since 1994³³ is given in **Table 4-66**. Maximum numbers of casualties are observed during high flood and cyclone. The casualties due to sunstroke were very high in 1998 because of an extreme summer spell. The number of casualties due to different calamities year-wise is shown in **Table 4-67**.

Table 4-66: History of Disaster in Bhadrak District

Calamity	No. of Times	Blocks Affected	ULB	Gram Panchayat	Village	Affected Population (Lakh)
Flood 1994	3	5		56	244	2.99

³² District Irrigation Plan of Bhadrak (Odisha), Pradhanmantri Krishi Sinchayee Yojana(PMKSY), March, 2016

³³ Odisha District Gazetteers – Bhadrak, Gopabandhu Academy of Administration (Gazetteers unit), General Administration Department Government of Odisha, 2016

Calamity	No. of Times	Blocks Affected	ULB	Gram Panchayat	Village	Affected Population (Lakh)
Heavy Rainfall-95	1	7		166	1211	5.14
Flood 1995	1	4	2	38	198	1.98
Flood 1997	3	5		45	263	2.36
Drought 1998	1	6		69	441	
Flood 1999	1	4		41	193	1.92
Super Cyclone -99	1	7	2	166	1400	11.06
Flood 2001	1	7		141	186	3.6
Drought-2002	1	1		16	45	1.01
Flood 2003	2	7	2	177	1087	11.36
Flood 2004	1	3	-	30	138	1.58
Flood 2005	1	4	-	36	156	1.9
Flood 2006	4	4	-	39	173	2.23
Flood 2007	4	7	2	147	744	7.17
Flood 2008	1	4	-	49	222	2.62
Flood 2009	0	0	0	0	0	0
Drought 2010		5	-	57	386	3.81
Flood 2011	2	6	2	95	453	4.42
Drought 2012	1	1	-	3	4	0.32
Flood 2013	1	7	2	151	1035/53 wards	12.72
Flood 2014	2	6	1	51	207/10 wards	3.26

Table 4-67: Causalities due to natural calamities in Bhadrak district

Year	Death due to				Total
	Flood	Fire Accident	Lightening	Sun Stroke	
1997	10	0	0	0	10
1998	0	0	7	70	77
1999	103	0	8	0	111
2000	0	3	10	2	15
2001	1	0	12	0	13
2002	0	0	12	0	12
2003	1	3	9	9	22
2004	0	1	14	14	29
2005	2	2	12	12	28
2006	2	1	11	11	26
2007	13	0	13	2	28
2008	5	0	12	1	18
2009	0	2	17	0	19
2010	0	5	9	0	9
2011	13	2	8	1	24
2012	1	5	14	4	24
2013	13	2	6	2	26
2014	7	3	10	1	21

Every year usually the period from June to October is seen as the most vulnerable period for the natural calamities like flood and cyclone and more fire accident cases are observed during the pick hot period. The probability of occurrence with respect to period for different calamities is shown in **Figure 4-38**.



Figure 4-38: Probability Period of Natural Hazards in Bhadrak

The most severe cyclones on record in this region occurred in October 1999. The estimated maximum wind speeds associated with these cyclones were 72 m/s making them the most severe cyclones ever recorded in the Bay of Bengal. The cyclone at the end of October also had the top maximum wind speed at Dhamra with 44.6 m/s. Nearly a set of 170 storms from 1969 to 2013 giving an average of just under 4 cyclones per year that tracked within 500 km of Dhamra port location extracted from IBTrACS is shown in **Figure 4-39**.

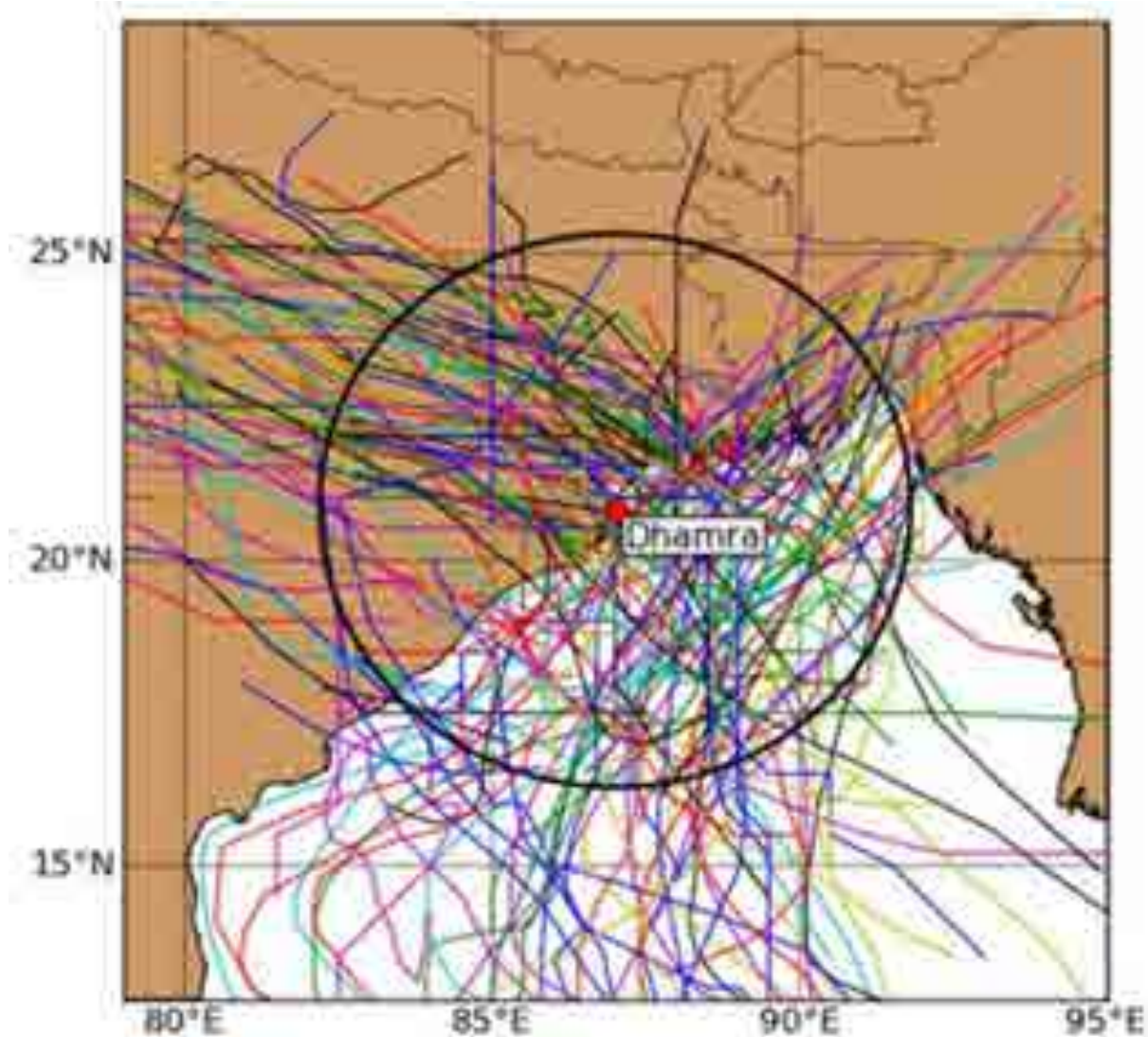


Figure 4-39: The tracks of the storms from 1969 to 2013 within 500 km of Dhamra port

Kendrapara District: The Kendrapara district is directly in the belt of the cyclonic storm, which frequently cross the district during the monsoon season. Annual average rainfall is about 60 inches³⁴. The cyclone in 1971 created the worst havoc leading to loss of lives in thousands and submergence of thickly populated three villages in Satabhaya area forever. The Super Cyclone, 1999 and Phailin, 2013 also resulted in miseries. History of Disaster in Kendrapara District is given in **Table 4-68**.

Table 4-68: History of Disaster in Kendrapara District

Year	Calamity	Affected
1445	Cyclone	loss of life, properties and heavy crop loss and also created conditions for famine
1823	Cyclone	
1831	Cyclone	880 people died
1832	Cyclone	200 people died and 8 missing
1835	Cyclone	
1842	Cyclone	
1855	Flood	Loss of life and property and land measuring about 135 km ²
1865	Cyclone	25% of the population perished due to this great famine
1885	Cyclone "Sunia Batas"	5000 people died, high tide of 22 feet in the sea washed away 11 villages and affected more than 150 villages. Jamboo village was completely destroyed
1866	Flood	
1887	Cyclone	
1890	Strom	
1892	Cyclone	15000 people died. 298 villages were washed away
1892	Flood	
1893	Strom	
1896	Flood	Some lost their lives and property and there was considerable distress
1907	Flood	Starvation of innumerable people for days together
1908	Strom	
1920	Flood	Affected all rivers & rose to new record heights. Breaching the embankments in many places
1926	Flood	Affected many villages
1933	Flood	81 people died. 3919 houses collapsed and 7565 houses were damaged
1936	Cyclone	81 people died.
1937	Flood	6 people died. 758 villages were affected and 3378 houses were damaged
1955	Flood	
1967	Cyclone	
1971	Cyclone	1108 people died
1971	Flood	
1982	Cyclone	6 people died and 9 Lakh of people were rendered homeless
1998	Heat Waves	15 people died
1999	Super cyclone	375 people died. 205 Gram Panchayts and 1564 Villages consisting of Lakhs of population were affected
2001	Flood	1 person died
2002	Flood	2 people died
2003	Flood	6 people died
2005	Flood	3 people died
2006	Flood	2 people died
2007	Flood	4 people died
2008	Flood	10 people died
2009	Tornado	16 people died. total damage of rupees Rs.4,32,67,010
2011	Flood	13 people died. 7 people reported missing, 27000 houses were damaged and 5 lakhs of people were affected
2013	Cyclone "Phailin"	1 person died. The value of total loss of property due to the said disaster is Rs. 1,03,71,71,190.00.
2014	Cyclone "HUD-HUD"	2 persons died

³⁴ Odisha District Gazetteers – Kendrapara, Gopabandhu Academy of Administration (Gazetteers unit), General Administration Department Government of Odisha, 2016

4.9.2 Tsunami

Tsunami that had developed in Indian Ocean near 275 km SSW of Sumatra Islands in Indonesia in December, 2004 travelled over 2,500 km, before hitting the East and South Coast of India taking toll on life and property. The Tsunami created a tidal wave of between 2-3 m along the East Coast of India. As per the assessment made by Odisha State Disaster Management Authority, 22 blocks of different districts are vulnerable to Tsunami of which, Chandbali block of Bhadrak district is also included.

4.9.3 Seismicity

As per the IS: 1893 (Part 1) 2002 of Bureau of Indian Standards (BIS), Dhamra falls in Zone II is a low risk zone. The seismic zoning map of Odisha is shown in **Figure 4-40**.



Figure 4-40: Seismic Zoning Map of Odisha

4.10 Noise

4.10.1 Noise Quality

Baseline ambient noise quality has been established by monitoring noise levels at **Nine (09)** locations. Hourly noise levels were recorded at identified monitoring locations once during a season in the study period summer 2016. The noise monitoring locations in the study area were selected after giving due consideration to the various land use categories. The land use

categories include commercial, residential, rural and sensitive areas. The map showing the noise monitoring locations is given as **Figure FD0407** and the details of the same are given in **Table 4-69**. Noise levels were recorded on an hourly basis for one complete day at each location using pre- calibrated noise levels. The status of noise quality assessed during post-monsoon season, 2017 and winter season, 2017-18 are given as **Appendix G**.

Table 4-69: Details of Noise Locations

Station No.	Location	Distance from Project Boundary (Km)	Azimuth Direction	Project Area/Study Area	Environmental Setting
N1	Port Site	-		Project Area	Industrial Zone
N2	Balisahi	1.1	W	Study Area	Residential Zone
N3	Rabindra Nagar	0.3	W		
N4	Kanakaprasad	1.7	W		
N5	Sabitri Sarai	1.2	W		
N6	Narsinghprasad	2.3	W		
N7	Kishorprasad	1.3	W		
N8	Tikaitnagar	4.6	SSW		
N9	Dakshina Dhamra	4.8	W		

4.10.2 Noise Levels

Based on the recorded hourly noise levels at each monitoring location, the day equivalent (L_d) and night equivalent (L_n) were calculated,

L_d : Average noise levels between 6:00 hours to 22.00 hours.

L_n : Average noise levels between 22:00 hours to 6.00 hours.

The Day-Night (L_{dn}) equivalent noise levels were calculated using the US Environmental Protection Agency formula:

$$L_{dn} = 10 \log [0.0416 \{16 (10^{L_d/10}) + 8 (10^{L_n+10/10})\}]$$

The comparison of day equivalent noise levels (L_d) and night equivalent noise levels (L_n) with the respective CPCB stipulated noise standards for various land use categories are shown in **Table 4-70** and are represented in **Figure 4-41** and **Figure 4-42**.

Table 4-70: Comparison of L_d and L_n with CPCB Standards

Station No	Location	L_d	CPCB Standard L_d	L_n	CPCB Standard L_n
N1	Port Site	53.17	75	45.10	70
N2	Balisahi	49.54	55	38.93	45
N3	Rabindra Nagar	45.55	55	38.36	45
N4	Kanakaprasad	48.79	55	38.98	45
N5	Sabitri Sarai	49.10	55	38.95	45
N6	Narsinghprasad	49.02	55	38.96	45
N7	Kishorprasad	48.05	55	38.97	45
N8	Tikaitnagar	48.88	55	38.88	45
N9	Dakshina Dhamra	50.14	55	39.40	45

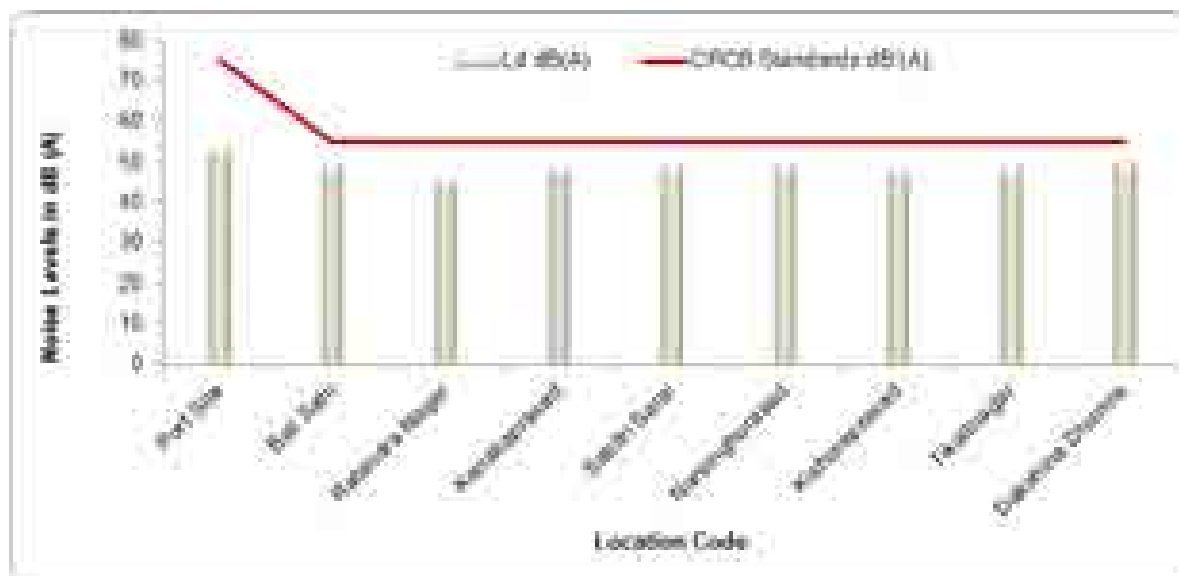


Figure 4-41: Comparison of L_d with CPCB Standard

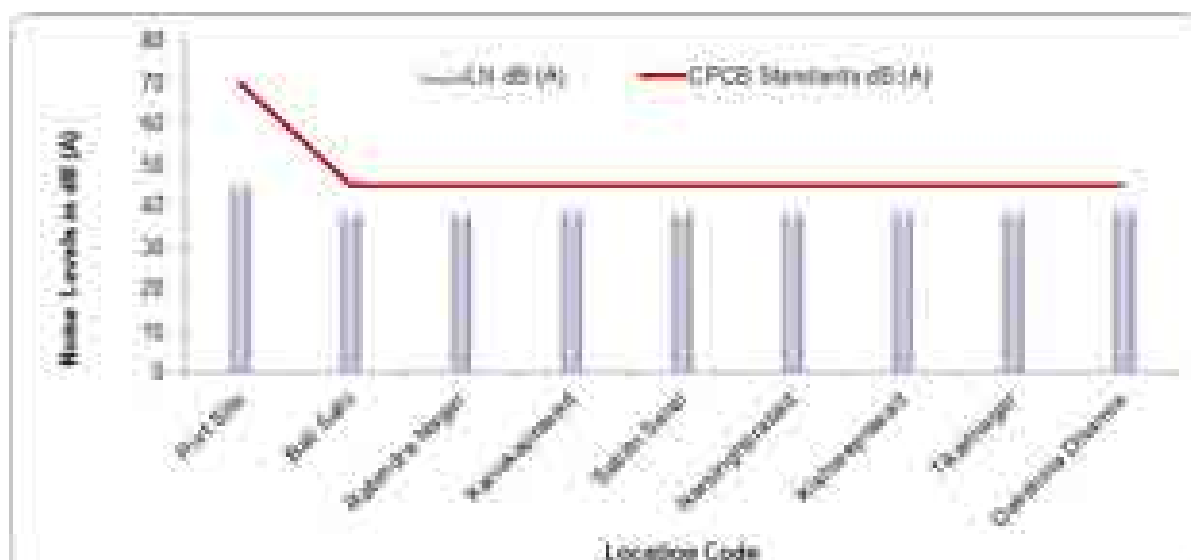


Figure 4-42: Comparison of L_n with CPCB Standard

4.10.2.1 Observations

The following are the observations;

- The port site is the only industrial location in the study area. Day and night equivalent noise levels (L_d and L_n) are 53.17 dB (A) and 45.10 dB (A)
- Day equivalent noise levels (L_d) ranged between 45.55 at Rabindra Nagar to 50.14 dB (A) at Dakshina Dhamra and Night equivalent noise levels (L_n) ranged between 38.36 at Rabindra Nagar to 39.40 dB (A) at Dakshina Dhamra in residential zone. The noise levels are well within the CPCB standards for residential zones

4.10.2.2 Ambient Noise Quality Status Based on Data Generated During 2014-2015

In line with the suggestion given by EAC, MoEF&CC during ToR meeting and vide its MoM (2nd meeting of Expert Appraisal Committee (Infra-2), MoEF&CC) and to understand the environment in a comprehensive manner the collected data with respect to Ambient Noise Quality has been reviewed and presented below.

- The Port site is the only industrial location in the study area.
 - o Day equivalent noise levels (L_d) varied from 61 dB (A) during Post monsoon and Winter seasons respectively and 73 dB (A) during Summer season
 - o Night equivalent noise levels (L_n) are 50 dB (A) Post monsoon and Winter seasons respectively and 54 dB (A) during Summer season
- Noise levels for residential areas
 - o Day equivalent noise levels (L_d) ranged between 41 dB (A) at Rabindra Nagar during Summer season to 55 dB (A) at Rabindra Nagar and Tikait Nagar during Post monsoon season and also at Bali Sahi during Winter season respectively
 - o Night equivalent noise levels (L_n) ranged between 36 dB (A) at Narsingh Prasad, Bali Sahi and Tikait Nagar during Summer Season respectively and 45 dB (A) at Tikait Nagar during Post monsoon season

Day equivalent noise levels equal the standards at two locations might be due to localised activities at the respective villages. Night equivalent noise levels are well within the CPCB standards for both industrial and residential zones, except at Tikait Nagar where night values are recorded equal to CPCB night noise standards might be due to the localised activities near the forest by department of forest and movement of ferry and people.

4.11 Socio-Economic Environment

The socio-economic profile of the project influence area was established through compilation of Census data 2011 and District Statistical Handbook 2011 for assessing the PIA profile.

4.11.1 Demographic/Socio-Economic Profile of Study Area/PIA

The study area **Figure FD0102** for the socio-economic baseline analysis includes 1 km, 5 km, 10 km and 15 km radius around the Project stretch. As per 2011 Census Handbook of Bhadrak and Kendrapara District Police Station (PS) wise villages coming within the Project Influence area (PIA) are as follows:

- Four (04) Police Stations (PS) in Bhadrak district and
- Two (02) Police Stations (PS) in Kendrapara district
- A total of Two Hundred and Eighteen (218) PIA villages are falling in the study area.
- In Bhadrak district, One Hundred and thirty Nine (139) PIA villages are falling under Bansada P.S., Three (03) PIA villages under Dhamara Marine P.S., Twelve (12) PIA Villages in Chandbali P.S. and Eleven (11) PIA villages under Naikanidihi P.S.
- In Kendrapara district, Forty Seven (47) PIA villages under Rajnagar P.S. and Six (06) PIA villages are covered under Jamboo Marine P.S.

For assessing the impact, the PIA has been divided into four groups based on radial distance from the project boundary. These categories include:

- Group I (0-1 km radius)
- Group II (1-5 km radius)
- Group III (5-10 km radius)
- Group IV (10-15 km radius)

The village's falling in the study area are presented under four groups as given in **Table 4-71**. Group I (G1) covers Fourteen (14) villages, Group II (G2) comprises of Twenty Six (26) villages, Group III (G3) comprises of Seventy Six (76) villages and Group IV (G4) comprises of One hundred and Two (102) villages respectively.

Table 4-71: Category wise list of PIA Villages present in the Study Area

Group I	Group II	Group III	Group IV
District: Bhdarak	District: Bhdarak	District: Bhdarak	District: Bhdarak
P.S.: Bansada	P.S.: Bansada	P.S.: Bansada	P.S.: Bansada
- Hrudayaprasad - Gouraprasad - Kishoreprasad - Saratprasad - Kaithkola - Purnaprasad - Krushnaprasad - Kanakprasad - Balisahi - Dosinga - Chianipahi - Pradyutanagar - Rabindranagar - Amarnagar	- Dhanakuta - Narendrapur - Saraswati - Bajarapur - Karanjamal - Laxmiprasad - Sasikadeipur - Baliarpur - Banuasahi - Jagannathprasad - Oramal - Narasinghaprasad - Balabhadraprasad - Jayadurgapatana - Jyosnamayee - Bidyutprava - Sampatia - Sabitrisarai	- Bhejaria - Sanasamukavedi - Naikulasahi - Panchutikiri - Anandapur - Khamarasahi - Kamalapada - Uttarsahi - Bijipur - Baincha - Kusunpur - Guansol - Dhirasahi - Kalibindha - Nachhipur - Dadhibamanpur - Mantapada - Hatapur - Nuagan - Bijipur - Sadanandapur near chhedak - Jantuali - Mahulia - Tentulipokhari - Gangadharpur - Tentuliadia - Nischintapur - Chhedak - Bansada - Biswanathpur - Sanatilanchi - Badatilanchi - Jharpada - Bijipur - Nuagan - Guanl - Sankhajori - Govindpur - Jharakata - Sailendrapalli - Rajendrapali - Rajarajeswarpalli - Harishpur - Kanakpalli - Dakshinadhamara - Khamarsahi - Narasinghpur	- Barol - Baghakolha - Chandrasekharpur - Sanapimpala - Badapimpala - Bijaypatana - Karanapali - Kuamara - Balighai - Badasamukavedi - Kaduanasi - Bishnupur - Bhimpur - Tarafraipur - Brahmatikiri - Raipur - Andiapat - Biriadia - Koliarla - Gopinathpur - Gangadharpurpatana - Totapada - Manipur - Ghanteswar - Bandiarisahi - Ankapada - Garadpur - Khakadakolha - Khadalpokhari - Sunaripokhari - Barakolha - Balasahi - Subhadia - Jaleswarpur - Nuasahi - Balabhadraprasad - Jashipur - Kudakanthi - Karanapokhari - Goudunipokhari - Haripur - Mausudha - Pharsibandha - Junuda - Nuagaon - Nalagohira - Jaladharpur - Badarupa - Pokharisahi - Jenapur - Kuanrikanthi - Kaliapat - Begunia - Saranaichhapur
	P.S.: Dhamara Marine		
	- Jagula - Narasingpurdian - Paikasahi		
	District: Kendrapara		
	P.S.: Rajnagar		
	- Tikayat Nagar - Birabhanjapur - Jyoti Prasad - Bhanja Prasad - Rajpatana	- Krishnanagar - Kanak Nagar - SailendraNagar - RajeswariNagar - RajendraNagar	

Group I	Group II	Group III	Group IV
		- Sailendra Sarai - Ananta Keshari - Khas Munda - Udyan - Dalei Sahi - Keruapal - Giria Pahi - Radhamalipur - Baghamari - Amarabati - Garta - Chanra Kolha - Sourendrapur - Sikar Pahi - Harina Pokhari - Narayanpur - Rangani - Vekta	- Chandakuda - Dhrubapahalipur - Banchhanidhipur - Harekrushnapur - Gouradeipur - Charadia
		P.S.: Jamboo Marine	P.S.: Chandabali
		- Talchua - Ahirajpur - Pravati - Sir Rajendrapur - ManjulaPalli - Banipal	- Bahu - Singiti - Mruganayani - Gobindapur - Nalitagaria - Pithiasenda - Tentulida - Kandagaradi - Orasahi - Bishrampur - Baghanata - Kasturikana
			P.S.: Naikanidihi
			- Sanahabelisahi - Badahabelisahi - Kaliaboda - Balarampur - Khedualpur - Damodarpur - Routarapur - Chhenakhia - Charitikira - Balimunda - Nandapatna
			District: Kendrapara
			P.S.: Rajnagar
			- Nalitapatia - Khamarsahi - Saradaprasad - Badhadia - Kamalpur - Trilochanpur - Dangamal - Pinchapatia - Subampur - Bankual - RagadaPatia - DurgaPrasad - RajendraNarayanpur - Govindpur - RajendraNarayanpur - Pata Paria - Gopaljew Patana - Sailendranarayanpur - Righa Garh

4.11.1.1 Population Characteristics in PIA

As per Census 2011, total population of PIA is 1,67,368 with 50.79% Male and 49.21% female. The sex ratio of 969 females to 1000 males in 32,127 number of Households. Population in the age-group 0-6 forms 13.81% of the study area total population. Group I (0-

01 km) comprises of 13,390 persons and has a sex ratio of 941. Group II (01-05 km) comprises of 20,876 persons and has a sex ratio of 951. Group III (05-10 km) has the population of 49,669 persons has the sex ratio of 958. Group IV (10-15 km) has the population of 83,433 persons has the sex ratio of 985. On an average the study area has a family size of 5.2 members in each household. The population details of the villages falling in the PIA are presented in **Table 4-72**.

Table 4-72: Population Details of the Study Area

No. of Villages	Total				Sex Ratio	Population in the age-group 0-6		
	HH	Pop	Male	Female		Population	Male	Female
Group I								
14	2691	13390	6897	6493	941	1822	941	881
Group II								
26	3958	20876	10699	10177	951	2825	1421	1404
Group III								
76	9474	49669	25372	24297	958	7229	3699	3530
Group IV								
102	16004	83433	42032	41401	985	11245	5703	5542
Grand Total	32127	167368	85000	82368	969	23121	11764	11357

4.11.1.2 SC & ST Details of the Study Area

The SC population in the study area is 18.01% of which 9.10% are males and 8.90% are females. The ST population in PIA is 1.16% of the total population in the PIA of which 0.57% is males and slightly dominated by females with 0.58% of the study area population. In Group I, Group II, Group III and Group IV the SC populations are 9.31% (minimum), 19.37%, 16.75% and 19.81% (maximum) respectively. In Group I, Group II, Group III and Group IV the ST populations are 1.25%, 0.05% (minimum), 1.85% (maximum) and 1.01% respectively. Group I shows that ST population is more than SC population. The other castes comprises of 80.84% of the total population in the study area. The population structure of Scheduled Tribes (ST) and Scheduled Caste (SC) population is given in **Table 4-73**.

Table 4-73: SC & ST Details of the Study Area

No. of Villages	Total Pop	Scheduled Castes (SC)			Scheduled Tribes			Total Other Castes
		Total population	Males	Females	Total population	Males	Females	
Group I								
14	13390	1247	618	629	168	87	81	11975
Group II								
26	20876	4043	2053	1990	11	7	4	16822
Group III								
76	49669	8321	4216	4105	917	462	455	40431
Group IV								
102	83433	16526	8353	8173	842	408	434	66065
Grand Total	167368	30137	15240	14897	1938	964	974	135293

4.11.1.3 Literacy

The literacy population in the study area comprises of 70.47% of the total population indicating that more than half of the population are literate's at least having primary education. Male literates comprises of 39.45% whereas the female literates comprises of 31.01% of the total literate population. The illiteracy population in the study area comprises of 29.53% of the total population. The female illiteracy population outnumbers the males in the

total number of illiterates and consists of 18.19% of the total study area population. Thus literacy promotion and girl child education has been recommended to increase the literacy in the study area. The educational details are given in **Table 4-74**.

Table 4-74: Educational Details of the Study Area

No. of Villages	Literates			Illiterates		
	Total	Male	Female	Total	Male	Female
Group I						
14	9578	5485	4093	3812	1412	2400
Group II						
26	14606	8335	6271	6270	2364	3906
Group III						
76	34592	19507	15085	15077	5865	9212
Group IV						
102	59173	32712	26461	24260	9320	14940
Grand Total	117949	66039	51910	49419	18961	30458

4.11.1.4 Occupational Details

The total workforce in the study area comprises 33.85% of the Total population. Main workers comprises of 62.04% whereas Marginal workers comprises of 37.96% of the total workforce. 66.15% are the non-workers in Total population including house wives, children, students, aged and disabled persons and some unemployed, which are the depending classes of the community.

Total workforce is dominated by males with 27.75% and females contribution of 6.08%. In main workforce 93.10% are males and only 6.89% are female's workers. Among non-workers nearly 66.15% of total population among them 43.18% of Females are non-workers. the developmental schemes and skill development programmes for their utilization as workforce shall be prime aspect for bringing economic stability in the society.

Main and Marginal Workers are further divided into Cultivators (CL), Agricultural Labourers (AL), household workers (HH) and others category workers (OT). Considering the study area to be a rural community, present census study reveals that the number of workers are more in Cultivators and Agricultural Labourers group. Population of workers is less in the other category workers.

The Occupational and Non Workers categories and details of the cultivators, agricultural labourers, house-hold and other workforce divided in main and marginal categories are given in **Table 4-75** and **Table 4-76**.

Table 4-75: Work Force and Non Workers in the Study Area

No. of villages	Workforce			Main			Marginal			Non Workers		
	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females
Group I												
14	4415	3781	634	2863	2727	136	1552	1054	498	8975	3116	5859
Group II												
26	7180	5870	1310	4021	3667	354	3159	2203	956	13696	4829	8867
Group III												
76	17602	13750	3852	10920	10102	818	6682	3648	3034	32067	11622	20445
Group IV												

No. of villages	Workforce			Main			Marginal			Non Workers		
	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females
102	27454	23060	4394	17341	16224	1117	10113	6836	3277	55979	18972	37007
Grand Total	56651	46461	10190	35145	32720	2425	21506	13741	7765	110717	38539	72178

Table 4-76: Classification of Main and Marginal Workforce in the Study Area

No. of villages	Main Workforce				Marginal Workforce											
					Industrial category of Marginal workers				Marginal workers Worked for 3-6 months				Marginal workers Worked for 0-3 months			
	CL	AL	HH	OT	CL	AL	HH	OT	CL	AL	HH	OT	CL	AL	HH	OT
Group I																
14	936	567	70	1290	221	832	8	491	193	730	6	442	28	102	2	49
Group II																
26	1650	723	118	1530	533	1171	103	1352	397	861	94	1216	136	310	9	136
Group III																
76	4669	2312	155	3784	1289	3880	136	1377	946	3374	110	1049	343	506	26	328
Group IV																
102	8038	5607	189	3507	2194	6388	159	1372	1783	5114	126	1020	411	1274	33	352
Grand Total	15293	9209	532	10111	4237	12271	406	4592	3319	10079	336	3727	918	2192	70	865

CL-Cultivators; AL-Agricultural labourers; HH-Household Industry Workers; OT-Other Workers

The Project influence area too has agriculture as its primary livelihood sector. Fishing is another occupation due to vast coastal stretch of the area. Animal husbandry coincides with agriculture as an additional income. Poultry farming also is very promising occupation.

4.11.2 District Census & Public Utilities

The District has amenities which have helped in increasing utilities provided to the people and over view of the same is provided in **Table 4-77**. It has helped in raising the standard of living. The district profile covers the overall picture of the village³⁵.

Table 4-77: District Amenities and Utilities

Parameters/ District	Kendrapara	Bhadrak
Population	1440361	1506337
Rural population	94.20%	87.67%
Urban population	5.80%	12.33%
Area	2644 km ²	2505 km ²
Density/ km	545	601
Sex Ratio	1006	981
Literacy	85.93%	82.78%
Population Growth 2001-2011	10.63%	12.94%
Law & Order (Police Stations)	13	12
Economy (Major)	Agriculture, Livestock, Egg and Meat production, labourers etc.	
Human Development Index	--	0.646
Income Index	--	0.463
Health Index	--	0.673
Performance of Districts Annual Index of Real Per Capita NDDP, 2010-11 (Per Capita Real NSDP = 100)	73	72
Share of GDDP to GSDP in 2010-11 at 2004-05 Prices (Percent)	2.33	2.16

³⁵ NIC District web sites – Bhadrak and Kendrapara and Odisha Economic Survey 2014-15 by planning and coordination department Govt. Odisha

Parameters/ District		Kendrapara	Bhadrak				
Gross District Domestic Product (GDDP) (Rs. In lakh) at Current Prices							
Year	Odisha State data	Kendrapara		Bhadrak			
2004-05	7772943	177602		185546			
2005-06	8509649	192118		201733			
2006-07	10183947	215619		234149			
2007-08	12927445	265518		291865			
2008-09	14849071	295931		332391			
2009-10	16294643	336249		385289			
2010-11	19752990	407080		443787			
District wise Employment Generation under MGNREGA, 2013-14							
Odisha State data		Kendrapara		Bhadrak			
Funds Available (Rs. Crore)	1322.78	23.31		27.27			
Total Expenditure (Rs.Crore)	1289.13	22.20		27.44			
Employment Generated (lakh mandays)							
SC	116.42	2.27		2.5			
ST	290.51	1.40		2.15			
OC	304.90	8.02		12.67			
Total	711.83	11.69		17.32			
Women (Out of total)	238.94	1.72		3.10			
District wise Percentage of Villages Electrified, 2013-14		98.15		99.52			
District-wise Household Access to Toilet/Latrine within their premises, 2011		17.8		20.1			
Sanitation Facilities at District Level							
Status of Individual Household Latrines, School Toilets and Anganwadi Toilets by the end of March 2014		Target	Cum. Ach.	% of Cum. Ach.	Target/	Cum. Ach.	% of Cum. Ach.
Individual Household Latrine		216192	151191	69.9	218481	130928	59.9
School Toilets		2583	2629	101.8	1855	1855	100.00
Anganwadi Toilets		1064	1065	100.0	1190	1109	93.2
Medical Institutions in Odisha with Beds as on 31 st March2014 (Government Sector)							
Odisha State data		Kendrapara			Bhadrak		
Total Hospital	141	2			4		
CHC	377	9			7		
PHC (N)	1227	45			50		
MHU	199	0			1		
Total Med. Institution	1944	56			62		
Health sub-centres	6688	227			178		
Beds	16537	268			409		
Medical Institutions in Odisha with Beds as on 31 st March 2013 (Private Sector)							
Medical Institution	1593	15			24		
Nos. of Beds	13758	85			432		

4.11.2.1 Power/Electricity

As per the District Statistical Data, 2011 almost all the inhabited villages and hamlets in the study area mandals have proper electrification facilities. The electricity is being provided for domestic, agriculture, industrial and other services.

4.11.2.2 Drinking Water Facilities

Public Water Supply (PWS) system, Borewells, Open wells, etc. has been considered as drinking water sources in the villages. Study area mandals have access to each of the mentioned drinking water sources.

4.11.2.3 Sanitation coverage and facilities

The sanitation facilities in the district are given in the **Table 4-77**. Individual household sanitation is a challenge to achieve. However, individuals, families as well as communities are making efforts towards construction of toilets in the houses. The problem of open defecation is slowly reducing

4.11.2.4 Communications

As per the 2010-2011 data of District Statistical Handbook, Sub-post offices, Branch offices and telephone connections are available in all the mandals.

4.11.2.5 Public Finance

Nationalised banks are available in all the mandals in the study area.

4.11.2.6 Social Welfare

In nearby population areas, houses are made of pucca and kaccha, both types. Tar road is available in near villages. People are mostly dependent on agriculture and fishing activities. However, due to uncertainty and irregular incomes from these two sources, people of the area move towards other places in search of employment. Due to the proposed revised master plan of Dhamra port, employment opportunities during construction as well as operation phase will be generated.

Educational facilities are available in the form of primary and secondary schools. For further education, students are availing facilities from the nearest towns. Medical facilities in the project study area need improvement. Communication services like post office and telephones are available in the study area. Most of the villagers are having mobile phones.

4.11.2.7 Land Ownership

Revision of master plan development will be carried in total area of 2013.4 ha. This includes Phase I - 234 ha, Phase II - 456 ha including basin area, proposed reclamation of Sea/Submerged intertidal area 1075.7 ha, and proposed applied vacant government land 247.7 ha. Area required for the proposed revised master plan development is calculated considering all the facilities essential for envisaged operations and also by focusing on possibility of limiting the extent of land area requirement. Accordingly, revised master plan layout has been prepared. Careful site selection ensures no displacement of households. Approximately 9 Ha will be left as no development zone for existing mangroves on the southern side of the port. The proposed expansion site comprises of Dry Barren Mud, Dry Mud with Giria Grass, Thorny scrub, Sea/Submerged land which falls in inter tidal zone without any macro vegetation and without any habitations. Hence, no rehabilitation and resettlement (R&R) is envisaged and this impact is completely avoided.

As per concession agreement GoO will lease the land and submerged area that will be required for the project.

4.12 Archaeological Monuments and Important Places

There are no Archaeological Monuments as per the Archaeological Survey of India and State Archaeological department observed in the study area.

Chapter 5 Anticipated Environmental Impacts and Mitigation Measures

5.1 General

The development of Revised Master Plan for Dhamra port involves various landside and marine side construction and operational activities. The development activities such as capital dredging, reclamation, dredge spoil disposal, expansion/modification of navigational facilities, offshore structures will impact marine environment. Site grading and development, civil construction and mechanical erection of facilities, onsite infrastructure, environmental management facilities and backup area development are likely to cause impacts on the terrestrial environment. During the operation phase, activities such as cargo handling/storage movement of ships and tugs, etc. are also likely to cause certain marine as well as terrestrial Impacts.

In this chapter, likely impacts (Extreme – 30 years) of these activities on environmental attributes have been identified, assessed and presented. To mitigate likely environmental impacts during construction and operation phases due to landside and marine side activities, suitable mitigation measures are incorporated as a part of planning process itself. The impacts have been assessed both quantitatively and qualitatively for various terrestrial and marine environmental components and impact specific mitigation measures are proposed.

5.2 Land Environment

5.2.1 Potential Impact due to Port Location

5.2.1.1 Impact due to Land Acquisition

The revised master plan envisages only un-inhabited barren government land and Sea/submerged (Intertidal) land is proposed to be leased out to the project as per the concession agreement. There will be no land acquisition, no resettlement and rehabilitation and hence no impact.

5.2.1.2 Impacts due to Changes in Land Use Pattern

The development of Revised Master Plan of Dhamra Port is planned within the approved port limits. No agricultural land or settlements are present within the land identified for port expansion. The existing land use and the proposed land use are discussed in the Chapter 4 and Chapter 2 respectively. The change in land use pattern will be as per the requirement of Revised Master Plan development facilities. Land reclamation and change in land use pattern will be limited to the proposed expansion area and will be carried out in such a way that to ensure the proper drainage by providing surface drainage systems including storm water network etc., Approximately 110 MCM of dredged material will be used for reclamation of proposed backup yard and level rising upto 5 to 7 m CD. Natural drainage pattern of the Dhamra and its surrounding area is being maintained through Dhamra River (Brahmani/Baitarani river), Matai river, tributaries of Brahmani and through direct discharge to Bay of Bengal. Dhamra port back up area falls between Matai River, Dhamra River and Bay of Bengal. There are few natural third/fourth order drains are passing through the project

site, therefore, storm water drainage network is planned to facilitate the proper drainage pattern of the area. The requirements of local villagers for tide water and boat movement has been duly considered in the drainage plan.

The details of the proposed Storm Water Drainage System are given in **Section 7.6** of Chapter 7.

5.2.1.3 Impacts due to Changes in Coastline/Shoreline

The shoreline/coastline changes such as erosion/accretion is usually expected due to the construction of marine structures such as breakwaters, berthing facilities and reclamation etc. Dhamra port site naturally has very good tranquil conditions which do not require breakwaters. The following offshore construction activities are proposed in the Revised Master Plan (5 Years and 30 Years) of Dhamra Port.

- Construction of Multipurpose (including Liquid) berths, Transloading facility, Liquid/Gaseous/cryogenic Berths, Port Craft Berths.
- Capital Dredging – to create the berthing pockets and widening of channel
- Disposal of unused dredged material
- Reclamation for preparation of backup area and level rising

The existing status of shoreline change due to erosion/accretion along the Dhamra Coast has been studied by Institute of Ocean Management, Anna University as a part of National Assessment of Shoreline Changes of Odisha Coast. The Shoreline change status in 15 km radius of Dhamra Port is shown in the **Figure 5-1**. Dhamra port expansion boundary for the Revised Master Plan is superimposed on this map for identification of erosion and accretion status of the coast.

As per shoreline changes assessment, it can be inferred that north of Dhamra Port is mostly high accreting coast with a small extent in between of eroding coast. The extent of water front area of Dhamra port expansion is combination of high/ medium accretion, low, medium erosion and stable coast. North of dharma river mouth is low accreting and south of dharma river mouth is medium eroding followed by low erosion and accreting coast upto Maipura Nadi.



Figure 5-1: Shoreline Status of Dhamra Port

5.2.1.4 Impacts due to Reclamation

Land/Sea/Submerged area reclamation will be carried out within the approved port limits for the complete requirement Revised Master Plan for 30 Year development plan during the 5 year plan development itself. The dredged material will be used for land reclamation for the proposed backup area and level rising after suitable ground preparation. A detailed topographic survey has been carried out by M/s Fugro Geonics Pvt. Ltd and the results indicates that that areas available for expansion is flat with ground levels ranging from +1.0 m CD to +3.5 m CD away from the shore. The expansion area will be reclaimed up to +5.0 to + 7.0 m CD by using the dredged material.

Recent past Marine sediment quality analysis of the material to be dredged was carried out by DPCL in terms of its toxic metals: Cadmium, Chromium (VI), Mercury, Manganese, Copper, Lead, Iron, Nickel, and Zinc. Results of the analysis show that the concentrations of the toxic metals are in low level. Hence it is pertinent to mention that the dredge material will be of high volume, low effect material and non-hazardous which will render insignificant impact on the marine environment. Hence, based on this analysis, the dredged material can be suitably used for reclamation and any excess/unused material can be safely disposed in appropriately selected offshore location approved by MoEF&CC during Phase II EC/CRZ clearance.

Predominantly the land proposed to be reclaimed is Sea/Submerged (intertidal zone) land and in seaward area which is saline in nature and having slope towards sea. Also the proposed applied land of 273.3 Ha is also close to sea and soil analytical results of the area shows higher conductivity and hence saline in nature. Hence, the impact due to this activity on land environment will not be significant.

Inter tidal bio diversity has been carried out and found that the Macro benthos was represented by 4 taxonomic groups viz., Polychaetes, Bivalves, Crustaceans and Gastropods. Around 53 species of macro benthos was recorded during the 2014-2015. Minimum Density (550 Nos/m²) and the Maximum density (1775 Nos/m²) was observed. Meiobenthos was represented by 4 taxonomic group's viz., Nematodes, Foraminiferans, Harpacticoids and Ostrocodes during the study. Around 60 species were recorded during the 2014-2015. The meiobenthos density was ranged between 79 Nos/10 cm² and 195 Nos/10 cm².

Reclamation would result in the smothering or blanketing of intertidal communities. During Reclamation sessile forms will be covered along with reclamation material and mobile species tend to move away and are likely to increase species diversity in areas adjoining the site.

5.2.1.5 Mitigation Measures

Reclamation with dredged material is likely to impact the reclamation area with the turbid water. Total Sea/Submerged inter tidal land of about 1075.7 Ha is proposed to be reclaimed as a part of Revised Master Plan for 5 Year development by keeping vision of 30 year development plan. Protective reclamation bunds or containment bunds (rock/boulders) will be constructed around the planned reclamation areas to avoid spreading of dredge material and to reduce turbidity. The dredged material will be pumped into the reclamation area enclosed by reclamation bunds wherein the sand will be allowed to settle and the supernatant water will be directed into sea through appropriate outfall pipelines. Thereafter the reclamation levels within the bunds shall be raised in suitable stages known as

cascading, to prevent overloading of underlying subsoil. After completion of the reclamation and hard standing, necessary development shall be carried out.

Since reclamation is proposed mostly into the Sea/Submerged (Inter tidal) partly in the applied land for level rising which is saline in nature. Hence, the impact due to this activity will not be significant.

Following are the additional mitigation measures.

- Judicial planning of project facilities will be carried out
- Reclamation will take place within the stipulated project area limits
- Existing drainage pattern around the project site will not be disturbed. Storm water drainage network will be provided within the project development area
- Reclamation bunds shall be constructed. Also minimum required retention time of return water in the reclamation area will be ensured
- Regular monitoring of return water (turbid water) from the reclamation area will be carried out at nearby points in the sea.
- In order to study variations in groundwater quality, regular groundwater quality monitoring shall be carried out.
- Minimum 50 m Buffer shall be maintained near the mangrove areas (Northern Side). In addition due care shall be taken during construction and reclamation.
- Temporary access created during construction if any shall be removed after completion of construction activities.

5.2.2 Potential Impact during Construction

5.2.2.1 Impact on Local Infrastructure

Transportation of Construction Material: Transportation of huge quantities of construction material for construction of berths, jetties, stockyards, operational and administrative buildings etc., results in use of public infrastructure like roads, railways, drainage, water and power supply which in turn results in congestion. In order to minimize the strain on the existing infrastructure in the region, DPCL has completed laying of dedicated rail corridor from Howrah-Chennai main line as part of the Phase-I development. Also, DPCL has already developed the infrastructure facilities such as, drainage, water and power supply for phase I development and these facilities shall be augmented/used during construction phase of proposed expansion. Proposed National Water Way (NW-5) will also be used for the transport of part of construction material which will reduce likely congestion on road. Also, DPCL has planned to develop proposed road in the dedicated corridor as a part of approved immediate phase development.

The basic raw material for construction such as Coarse/Fine aggregates and stone etc., is required during the construction phase of Dhamra Port expansion. Initially, five quarries are identified i.e. Laxmi Stone Products Kuruda, Balasore; Swarnachuda Stone Mirigini Stone, Balasore; Ambhajar Stone Quarry, Nilagiri, Balasore and Shiva Stone Quarry Subndergarh. However, other quarry sites will also be explored if need during the execution of the project for which necessary permission from local competent authority will be obtained if required. Ready mix concrete will be made out of the basic raw material on site itself. Batching plants of respective size and capacity as per requirement will be installed at the site.

Thus transportation of raw materials from nearby areas is likely to result in increased road traffic but only temporary during construction phase.

Construction Workers Camp: During the construction phase of the project there will be employment generation (around 500 labours and 50 staff) in the form of skilled and semiskilled labourers and technical staff. Also, majority of the works will be sub-contracted. As the Revised Master Plan is for 5 Years and 30 Years, temporary workers camps is planned to be set up for skilled and semi-skilled labourers in the project area and technical staff will be provided housing infrastructure within the project area. There will be impact/strain on local infrastructure, if self-sustained facilities are not provided.

5.2.2.2 Mitigation Measures

- During the construction phase of 5 year development plan, then the existing roads shall be strengthened by DPCL and shall be used for the construction material transportation.
- Drivers should be sensitized with respect to need to drive carefully while passing through the villages. Speed is one of the main causes for accidents. So, speed of the trucks shall be controlled especially when they are passing through villages by providing speed breakers, sign boards and other appropriate speed control techniques
- Proper lighting, signboards shall be provided at required locations
- Construction material shall be sourced from Government approved quarries and vendors/agencies
- Transportation management will be adopted for movement of dumpers transporting quarry stones and construction materials and traffic will be regulated
- Vehicles deployed will confirm to emission norms (air/noise) of CPCB and have valid Pollution Under Control (PUC) certificates
- Dumpers and trucks will comply with standards for exhaust emissions and noise levels

To avoid/minimise impact/strain on the existing infrastructure, the worker and technical staff housing areas will be self-sufficient and would not rely on any local resource. This would help to avoid any conflict with the local population. To mitigate impacts from health hazards, sanitation facilities will be provided. Further, the worker camps in the project site will be located away from the CRZ area. Following additional mitigation measures shall also be considered:

- The camps will be adequately equipped with all the necessary facilities such as water supply, power supply, wastewater collection, solid waste collection and sanitation
- The domestic wastes generated from the camps will be disposed at approved disposal sites
- No bore wells will be made for the drinking water requirements.
- Periodic health check-ups will be undertaken for early detection and control of communicable diseases
- Medical facilities including first aid will be available in the workers camps for attending to injured workers

5.2.2.3 Impact on Existing Port Operations

Construction of revised master plan developments facilities envisages both land side and marine side construction activities such as movement of construction equipment/vehicles, construction material transport/ temporary storage, reclamation, creation of buildings and structures as per land use plan, Dredging at harbour area and channel, construction of offshore structures, movement of barges/dredgers, etc., These activities may hinder the existing port operation if not managed/ planned in a proper manner.

5.2.2.4 Mitigation Measures

- All the construction activities shall be planned judiciously without interrupting the existing operations.
- Construction area shall be earmarked and activities shall be confined within that area.
- Construction activities in the existing port operational areas such as deepening and widening of the channel and harbour basin etc., shall be planned in consultation with harbour master by ensuring safe navigation of the vessel movements for the existing operations.
- All the necessary safety precautions shall be implemented while doing the construction activities near the existing operational area.
- Necessary sign boards and marker buoys shall be installed and shall be communicated to Port employees/Harbour master/Piolt etc., about the marker buoys indicating the areas of construction so that they may avoid those areas.

5.2.2.5 Impact due to Utility Corridor Development

Dhamra port has already constructed a rail link of 62.5 Km with single line track, connecting the port with the Indian Railway network near Bhadrak railway station. The port has acquired 125 m wide land corridor from Dhamra to Bhadrak for providing exclusive connectivity with the hinterland. Approval has already been obtained for 4 lane road and 2 rail tracks (as a part of Phase I & II Clearance). As a part of Revised Master Plan, it is to develop further additional 2 lane road and 1 rail tracks in the existing corridor.

In addition, for easy evacuation of cargo, a new rail, road and utilities corridor (approx. 12 km x 125 m wide) is also proposed from Northern side development of Dhamra Port. Development of Norther UC (mostly Rail corridor) beyond the project area on the northern side will be taken up as a separate project. Necessary clearances from the relevant authorities such as Department of Railways etc. will be carried out after finalisation of route up to Bansada, Bhadra (where it shall meet existing rail route).

During planning stages itself, the alternative routes for the utility corridor has been considered and the proposed route envisages on sparse mangrove area with minimal disturbances. It is estimated that ~ 0.1 ha of sparse mangrove area will come under the development of utility corridor where the corridor will be developed on piles. Considering the mangroves footprint, 10 times or as finalised by regulatory authorities of mangrove plantation shall be done.

5.2.3 Potential Impact during Operations

5.2.3.1 Discharges from Ships on Land

No discharge of wastewater/waste from the ships calling at Dhamra Port will be permitted into the port area. Reception facilities will be explored to receive the waste from ship during emergency at port. The ships will have their own sewage reception/treatment facilities on board and hence no discharge of sewage will be done at the port. In addition, the ships are expected to discharge sewage in deep seas as per defined procedures for International ship movements (MARPOL). This will ensure the ships have their own storage capacities in their on board sewage receptions to handle wastes generated during the period/days the ship is at the port. The sewage generated in the port area will be treated in the STP (1 MLD during 5 Year development and 2 MLD during 30 Year development) which is proposed on Modular basis at various locations within the operational area.

Sewage & wastewater will be generated from toilet blocks, office buildings, residential areas & Canteen blocks. The sewage/wastewater generation would be around 0.9 MLD (5 Year)

Due to site topography and coastal belt location it is proposed to have a combination of gravity & pressure sewer system to collect and convey sewage/wastewater from toilet blocks and other facilities to STP.

Sewage treatment Plant will be of compact size with efficient treatment to treat raw sewage of following Inlet Parameter at STP:

S. No.	Parameter	Unit	Design Parameter for Raw Sewage @inlet
1	pH	-	6.0-8.5
2	TSS	ppm	1000
3	BOD	ppm	300-350

Process Consideration: In general process for treatment of domestic sewage/wastewater involves the following

- Primary Treatment (Screening, Grit Removal, Oil & Grease removal and Primary settling tank)
- Secondary Treatment (Aerobic Biological Treatment and Secondary settling tank)
- Sludge Treatment and Tertiary Treatment

Following biological treatment is considered which appear to be suitable for this magnitude of STP and considering recycling in irrigation/horticulture area.

Moving Bed Bioreactor (MBBR):

The MBBR is an aerobic attached growth process which uses cylindrical shaped polyethylene or polypropylene carrier elements for biological growth. The moving media increase the contact time between the microorganisms and the organics. Since the media provides large surface area for microorganisms to attach and grow, It has excellent characteristics for BOD/COD removal and nitrification/denitrification for all types of sewage. It is compact and requires comparatively lesser space than the conventional system. The Process Flow Diagram for STP based on MBBR technology is given in **Figure 5-2**.



S. No.	Parameter	Unit	Design Parameter for Treated water @ outlet
1	pH	-	6.5-9.0
2	TSS	ppm	<100
3	BOD	ppm	<30

5.2.3.2 Soil Contamination

- Used oil/Spent oil & Used Battery, Containers/Barrels/liners Contaminated with HW/Chemicals and Sludge from oil water separator
- Municipal wastes in the form of canteen wastes, domestic wastes, papers, etc
- Cargo and Other Spills
- Other hazardous and non-hazardous wastes generated from operations

Good housekeeping and best practices of waste material handling shall be adopted to eliminate/minimise the risks of soil contamination. The provision for temporary storage of hazardous and other waste will be developed for a period of 90 days. The hazardous wastes generated at the Dhamra Port will be disposed at nearby Treatment, Storage and Disposal Facility (TSDF) or Common Hazardous Waste Incineration facility (CHWIF) and also sent to the approved vendors of Odisha State Pollution Control Board (OSPCB) and CPCB. The

nearest TSDF is located at village Kanchichuan, PO Mangalpur, district Jajpur, at a distance ~150km by road. This TSDF has treatment, storage and disposal facility. The secured engineering landfill capacity is 25,000 TPA, waste treatment and storage facility of 12,000 TPA and storage facility for incinerable waste is 3000 TPA. The TSDF is developed by M/s Ramky Environ Engineer Limited and operating under the name of Odisha Waste Management project. The facility is in operation since 2010-11. Accidental spills if any, it will be attempted to contain and recover at the earliest. However, possible waste minimisation techniques will be adopted in order to minimise the generation of wastes.

5.2.3.4 Shoreline Changes/ Shoreline Evolution Study

The shoreline morphology is dynamic in nature and undergoes changes due to sea currents, upland river discharges and storms. The prediction of shoreline change plays important role in design and development of onshore and offshore coastal structures. The behaviour of shoreline depends on type of textural classification of soil, literal & long shore currents caused by wind and wave currents, type of coastline etc. The prediction of shoreline covers the changes in 10 years from the existing coastline of year 2016 as per the satellite image. **Figure 5-3** shows the Proposed Revised Master Plan and the coastal zonal demarcation for studying the shoreline changes.

The details of coastline zones are furnished in **Table 5-1**.

Table 5-1: Details of Zones for Shoreline Study

Zones	Description	Length(m)
Zone-A	Northern side of Dhamra Port	8000m
Zone-B	Southern side of Dhamra Port	4500m
Zone-C	Southern side of Dhamra River	9500m
Zone-D	North-Eastern side of Kanika Island	8500m
Zone-E	Gahirmatha Beach	17000m
Zone-F	Wheeler Island	8500m
Zone-G	Wheeler Island	10000m



Figure 5-3: Study Zone Demarcation

The study area covers around 66km alongside Dhamra port (North and South region), and nearby coastal features. The sea bed material consists of fine sand, silt and clay in and around the Dhamra port. The channel sediments tend to be finer with dominance of silt/clay. Towards the Bay of Bengal the tidal flats next to the channel are characterized by fine sand. The hydrodynamic study has been carried out for various tidal conditions incorporating with existing developments and the proposed expansion.

5.2.3.4.1 Prediction of Shoreline Change:

The software “Hydrodyn-SEDSoft” has been run for prediction of shoreline morphology for 10 years incorporating the existing marine developments including channel and port facilities and the proposed expansion. The shoreline of 2016 has been digitized exactly based on the Cartosat1-Mono satellite image of 23rd March 2016 of 2.5 m resolution and considered as a bench mark and analysed the results of model. The changes in the shoreline through the processes of accretion and erosion can be analysed by measuring differences in 2016 and after 10 years at various zones. Accurately determining shoreline positions over the course of 5 years and 10 years is the key to quantitatively and accurately assessing coast erosion or accretion over a given period of time.

This study has been carried out along 66km alongside of Dhamra Port (North and South Region) nearby coastal features, for 10 years at 1 year interval. The study area is subdivided into seven zones, and segments at uniform interval of 500m have been chosen within each zone. Based on the available image information shoreline is digitized and prepared for March 2016. The study area for shoreline change is divided into seven zones A, B, C, D, E, F and G.

The software has been run with the available data of flow, wind and wave for various tidal conditions to predict the sedimentation processes along the coast. The coastline has been bisected into several segments all along the coastline to identify the erosion / accretion locations exactly. The rate of change of shoreline can be calculated from the amount of shift along each segment. The shoreline change was predicted by model from 2016 to 10 years.

The shoreline of 2016 considered as bench mark. Negative values indicate erosion, and positive values indicate accretion.

Zone A (North of Dhamra Port):

A coastal stretch of 8000m north of Dhamra Port (**Figure 5-4**) was analyzed for spatial and temporal shoreline changes using output data of model for 10 years.



Figure 5-4: Predicted shoreline change for Zone-A (After proposed expansion)

The shoreline change of March 2016, after 1 year interval for 10 years has been plotted for Zone- A as shown in **Figure 5-4**. From the figure, the created layers of multi-year shorelines were used to calculate the rate of change at various segments created in the shore-normal direction. Zone- A is divided into 16 segments of equal spacing with an interval of 500m. Segments are placed exactly on 2016 shoreline. Shoreline change of entire stretch of Zone-A has been predicted and plotted segment wise. The variation of shoreline for 10 years is as shown in **Table 5-2** and **Table 5-3**.

Table 5-2: Predicted shoreline change rate accretion / deposition–Zone A (Proposed expansion)

Segment Number Zone-A / Year	Shoreline Evolution in m (Zone-A)								
	A1-A2	A2-A3	A3-A4	A4-A5	A5-A6	A6-A7	A7-A8	A8-A9	A9-A10
1	-9	-10	6.7	-25	-37	-39	-79	10	18
2	-11	-5	9	-36	-54	-49	-82	7.9	18
3	-10.4	-8.4	5.1	-36	-77	-61	-91	8	16
4	-15	-8	6.9	-55	-87	-73	-100	7.2	14
5	-16	-8.8	1.7	-70	-102	-82	-104	-0.9	9
6	-29	-17	-14	-100	-103	-82	-113	-3.7	10
7	-33	-29	-21	-101	-123	-103	-117	-11	9
8	-36	-35	-31	-104	-135	-111	-127	-16	10

Segment Number Zone-A / Year	Shoreline Evolution in m (Zone-A)								
	A1-A2	A2-A3	A3-A4	A4-A5	A5-A6	A6-A7	A7-A8	A8-A9	A9-A10
9	-38	-28	-37	-106	-159	-120	-127	-18	-4.4
10	-43	-36	-32	-127	-162	-130	-139	-26	-1.5
Average	-4.3	-3.6	-3.2	-12.7	-16.2	-13	-13.9	-2.6	-0.15

*(-/+ indicates Erosion/Accretion)

Table 5-3: Predicted shoreline change rate accretion / deposition–Zone A (Proposed expansion)

Segment Number Zone-A / Year	Shoreline Evolution in m (Zone-A)						
	A10-A11	A11-A12	A12-A13	A13-A14	A14-A15	A15-A16	A16-A17
1	30	19	22	4.7	16.6	1.1	3.4
2	29	22	20	7.7	10.5	-1.0	1.3
3	33	18	22	8.5	9	-4	0.6
4	26	20	23	8.6	10.9	3	2
5	24	19	15	3.9	12	-8	-2.5
6	24	11	21	2	7	-7.2	-0.5
7	22	12	19	-1.6	2.6	-7.7	-3.3
8	19	5	19	-4.7	-1	-4.2	-0.5
9	19	0.5	-18	-10	-5	-12	-3.4
10	17	2.2	13	-7.9	-9.4	-15	-8.1
Average	1.7	0.22	1.3	-0.79	-0.94	-1.5	-0.81

*(-/+ indicates Erosion/Accretion)

Figure 5-5 and **Figure 5-6** show the variation of erosion and accretion at variation segments along the shoreline of 2016 after 5 years & 10 years of after proposed expansion respectively. From the **Table 5-2** and **Table 5-3**, it can be observed that Northern area of Zone A will experience erosion, and southern area of Zone A will experience accretion. Average Shoreline change movement for Zone A will be - 4.38m/ year.

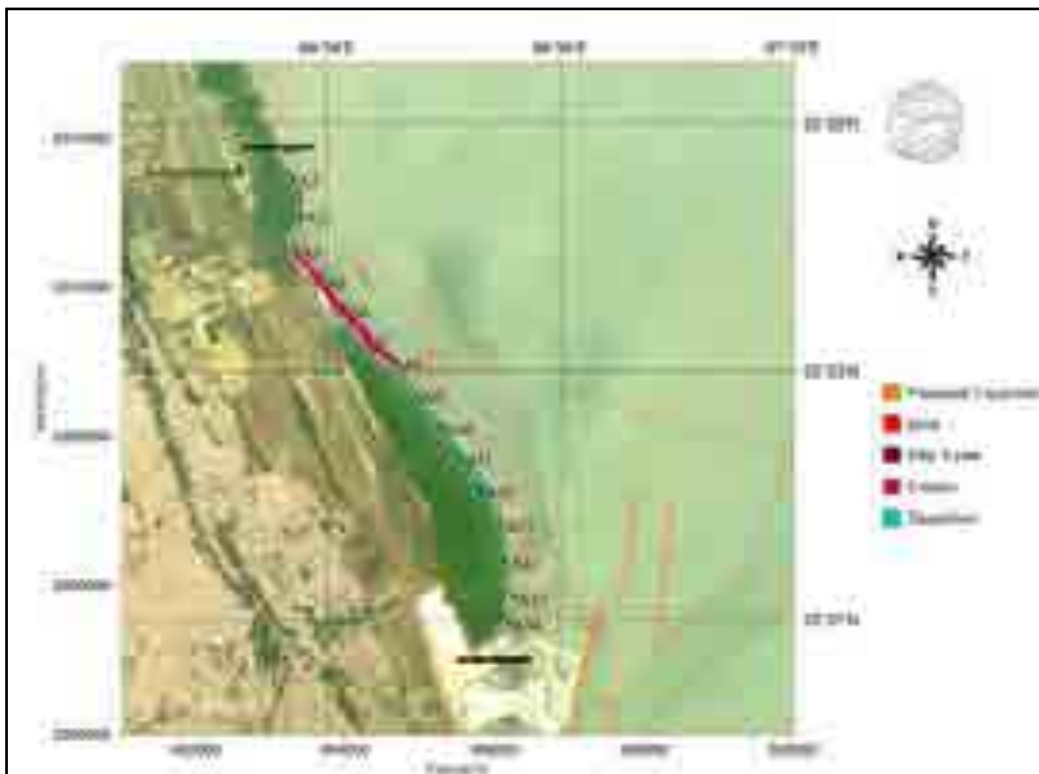


Figure 5-5: Zones of erosion and accretion in Zone A (after 5 years from 2016) for proposed expansion

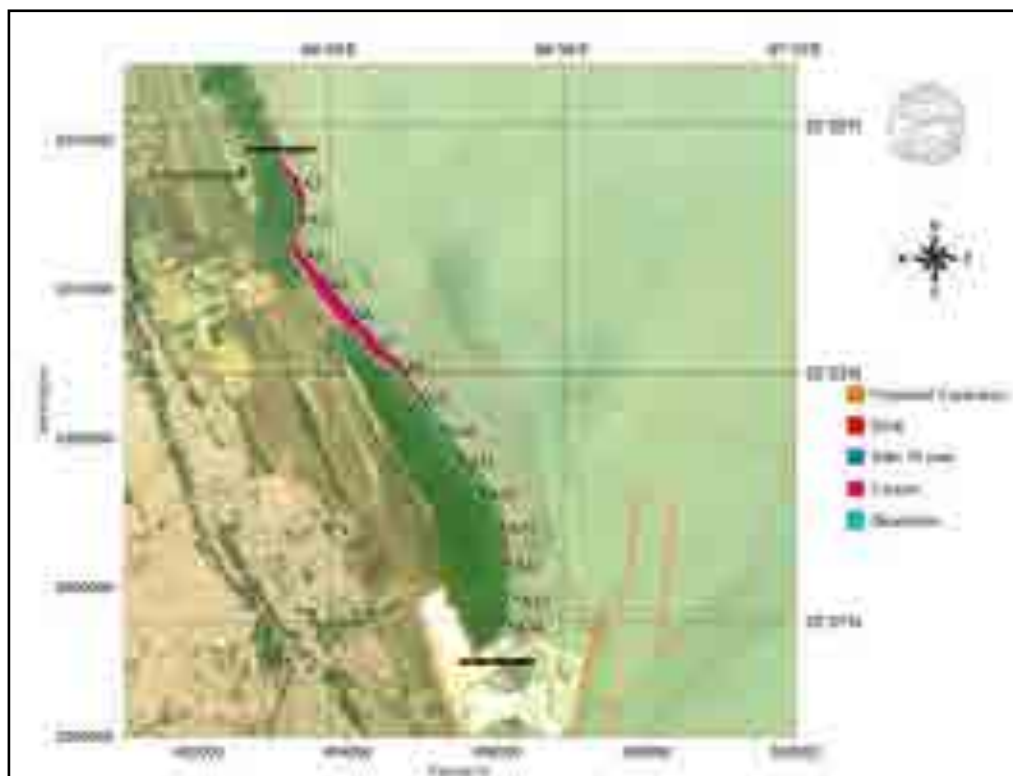


Figure 5-6: Zones of erosion and accretion in Zone A (after 10 years from 2016) for proposed expansion

Zone B (North of Dhamra River / South of Dhamra Port):

A coastal stretch of 4500m south of Dhamra Port (**Figure 5-7**) was analysed for spatial and temporal shoreline changes using output data of model for 10 years.



Figure 5-7: Predicted shoreline change for Zone-B (After proposed expansion)

The shoreline change of March 2016 after 1 year interval for 10 years has been plotted for Zone B as shown in **Figure 5-7**. From the figure, the created layers of multi-year shorelines were used to calculate the rate of change at various segments created in the shore-normal direction. Zone- B is divided into 09 segments of equal spacing with an interval of 500m. Segments are placed exactly on 2016 shoreline. Shoreline change of entire stretch of Zone-B has been predicted and plotted segment wise. The variation of shoreline for 10 years is as shown in **Table 5-4**.

Table 5-4: Predicted shoreline change rate accretion / deposition–Zone B (Proposed expansion)

Segment Number Zone-B / Year	Shoreline Evolution in m (Zone-B)								
	B1-B2	B2-B3	B3-B4	B4-B5	B5-B6	B6-B7	B7-B8	B8-B9	B9-B10
1	7.7	-42	-55	-3.9	1.1	6	1.7	0.7	-4.7
2	17.4	-35.8	-47.4	-4.7	5.9	1.6	-7.6	-1.7	0.7
3	31.3	-38.8	-43	-4.8	4.7	1.5	-6.8	-0.7	-5.5
4	38.48	-29.9	-42	-4	8.6	2.8	-3.5	-2	-3.7
5	44.6	-25	-37.8	-4.5	8.7	2.7	-1.7	-3	-2.7
6	46	-22.3	-24	-3.1	13.5	4.3	-1.5	1.8	1
7	56	-22	4.1	-3.2	16.5	5.5	0.5	-2.5	4.2
8	73.1	-6.1	22.2	-4	23.6	7.6	3.1	-0.5	0.5
9	81.6	7.64	37.3	0.25	24.6	12.5	6.1	3	-5.07
10	92.6	10.2	39.3	0.2	24.5	12.19	7.56	3.75	-4.7
Average	9.26	1.02	3.93	0.02	2.45	1.219	0.756	0.375	-0.47

*(-/+ indicates Erosion/Accretion)

Figure 5-8 and **Figure 5-9** show the variation of erosion and accretion at variation segments along the shoreline of 2016 after 5 years & 10 years of after proposed expansion respectively. From the **Table 5-4** it can be observed that entire Zone B will experience accretion throughout stretch wrt 10 years. Average Shoreline change movement for Zone B will be 2.06 m/ year.

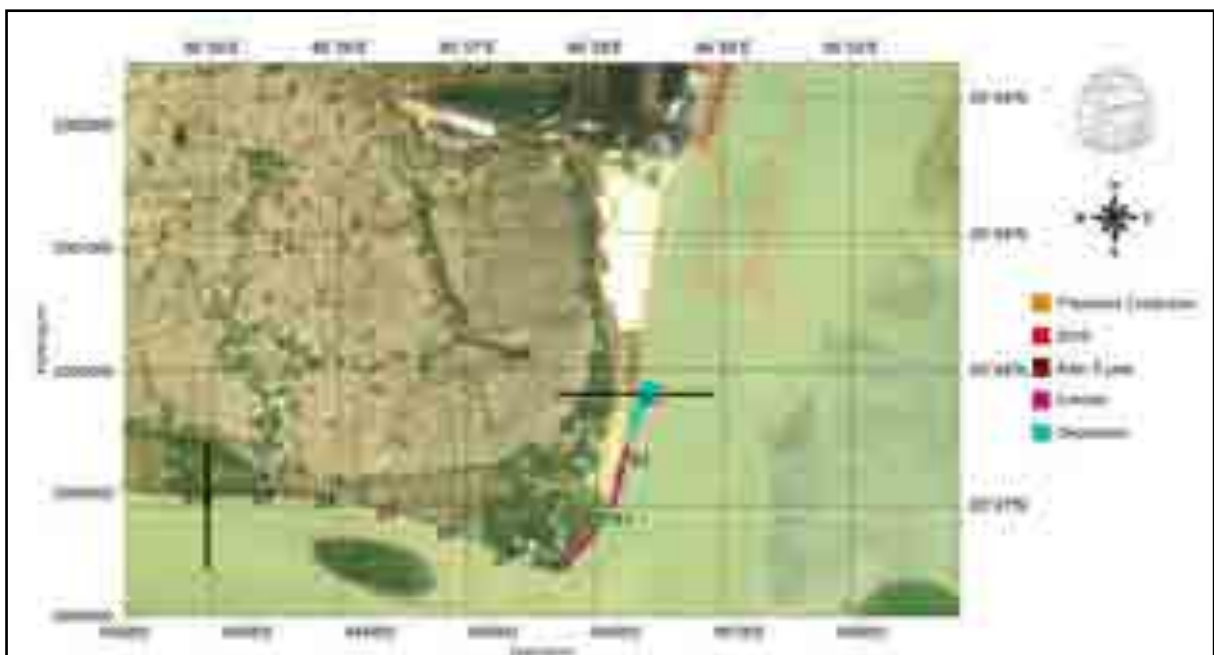


Figure 5-8: Zones of erosion and accretion in Zone B (after 5 years from 2016) for proposed expansion

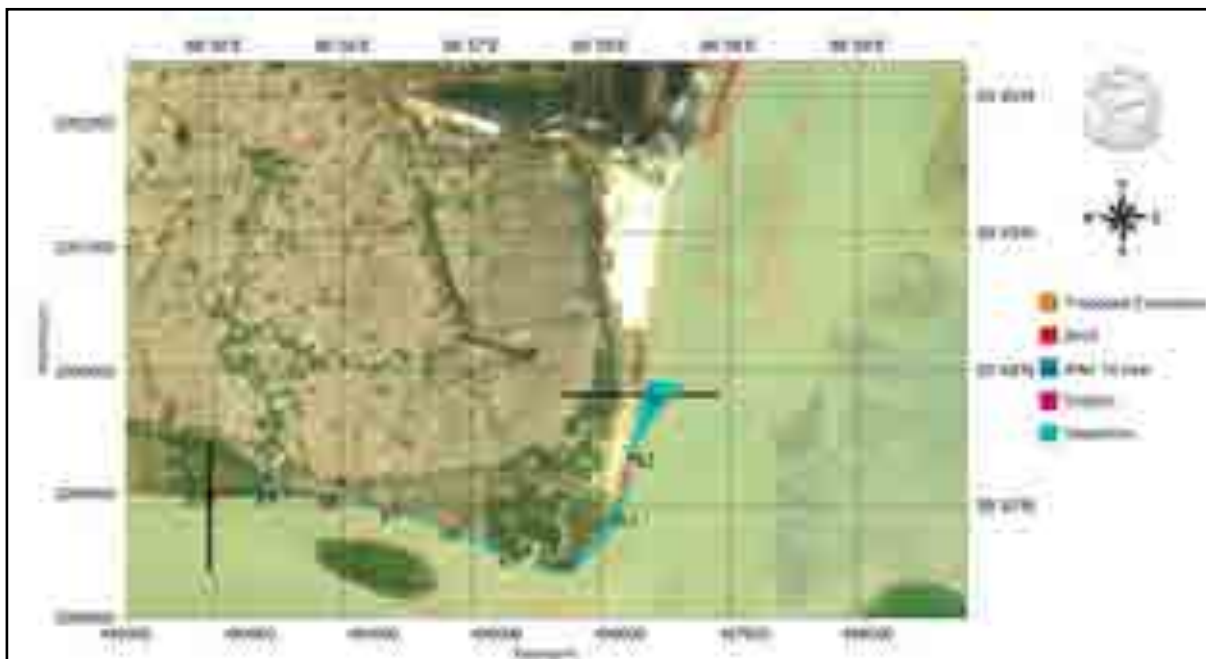


Figure 5-9: Zones of erosion and accretion in Zone B (after 10 years from 2016) for proposed expansion

Zone C (South of Dhamra River):

A coastal stretch of 9500m south of Dhamra River (**Figure 5-10**) was analysed for spatial and temporal shoreline changes using output data of model for 10 years.



Figure 5-10: Predicted shoreline change for Zone-C (After proposed expansion)

The shoreline change of March 2016 and after 1 year interval for 10 years has been plotted for Zone C as shown in **Figure 5-10**. From the figure, the created layers of multi-year shorelines were used to calculate the rate of change at various segments created in the shore-normal direction. Zone- C is divided into 19 segments of equal spacing with an interval of 500m. Segments are placed exactly on 2016 shoreline. Shoreline change of entire stretch of Zone-C has been predicted and plotted segment wise.

The variation of shoreline for 10 years is as shown in **Table 5-5** and **Table 5-6**.

Table 5-5: Predicted shoreline change rate accretion / deposition–Zone C (Proposed expansion)

Segment Number Zone-B / Year	Shoreline Evolution in m (Zone-C)								
	C1-C2	C2-C3	C3-C4	C4-C5	C5-C6	C6-C7	C7-C8	C8-C9	C9-C10
1	-10	-6	-15	-14	-13	-13	-8.5	-2.8	0.5
2	-19	-15	-27	-25	-31	-30	-17	-18	-1
3	-10.5	-22	-38	-32	-42	-8	-23	-24	-6.5
4	-26	-25	-54	-57	-53	-57	-43	-23	-12
5	-18	-35	-72	-68	-75	-36	-56	-31	-11
6	-25	-37	-73	-70	-76	-89	-69	-33	-15
7	-16	-42	-82	-92	-82	-111	-78	-27	-17
8	-18	-48	-74	-99	-85	-110	-86	-32	-14
9	-8.5	-50	-77	-104	-97	-126	-106	-34	-15
10	-21.7	-55	-87	-118	-125	-139	-117	-35	-19
Average	-2.17	-5.5	-8.7	11.8	-12.5	-13.9	-11.7	-3.5	-1.9

*(-/+ indicates Erosion/Accretion)

Table 5-6: Predicted shoreline change rate accretion / deposition–Zone C (Proposed expansion)

Segment Number Zone-C / Year	Shoreline Evolution in m (Zone-C)									
	C10-C11	C11-C12	C12-C13	C13-C14	C14-C15	C15-C16	C16-C17	C17-C18	C18-C19	C19-C20
1	-0.2	2.8	-0.5	-0.7	-1.3	-0.6	0.4	-0.7	-1.1	2.3
2	-0.7	-0.5	-1.6	-4.4	-1.4	-0.45	1	-1.6	-2.7	0.6
3	-0.7	-0.5	-1.3	-8.7	-7.4	-2.5	4	-14	-3.4	0.5
4	-6.25	-7	-5.8	-12.5	-9.4	-3.9	3.8	-12	-2	0.4
5	-7.2	-9	-7.6	-13	-6.9	-3.6	-10	-2.2	-1.3	1.4
6	-7.5	-7.5	-6.5	-11	-13	-7.6	-2.29	-8	-2.2	2.4
7	-10	-12	-8.5	-13	-15.3	-15	2	-1	-0.2	2
8	-9	-8	-7	-13	-13.4	-7.1	3.1	0.8	4.5	2.1
9	-8	-7.8	-7.6	-13	-14	-8	5.2	1.2	10.2	2.7
10	-15	-7	-8	-7.5	-17	-15	8.6	1.5	17	8
Average	-1.5	-0.7	-0.8	-0.75	-1.7	-1.5	0.86	0.15	1.7	0.8

*(-/+ indicates Erosion/Accretion)

Figure 5-11 and **Figure 5-12** show the variation of erosion and accretion at variation segments along the shoreline of 2016 after 5 years & 10 years after proposed expansion respectively. From the **Table 5-5** and **Table 5-6**, it can be observed that Zone C that upper segment (C1 – C16) will experience erosion; whereas lower segment (C16-C20) will show moderate accretion. Average Shoreline change movement for Zone C will be -2.71m/ year.



Figure 5-11: Zones of erosion and accretion in Zone C (after 5 years from 2016) for proposed expansion



Figure 5-12: Zones of erosion and accretion in Zone C (after 10 years from 2016) for proposed expansion

Zone D (Kanika Island):

A coastal stretch of 8500m Kanika Island, south-eastern of Dhamra Port (**Figure 5-13**) was analysed for spatial and temporal shoreline changes using output data of model for 10 years.



Figure 5-13: Predicted shoreline change for Zone-D (After proposed expansion)

The shoreline change of March 2016 and after 1 year interval for 10 years has been plotted for Zone D as shown in **Figure 5-13**. From the figure, the created layers of multi-year shorelines were used to calculate the rate of change at various segments created in the shore-normal direction. Zone- D is divided into 30 segments of equal spacing with an interval of 500m. Segments are placed exactly on 2016 shoreline. Shoreline change of entire stretch of Zone-D has been predicted and plotted segment wise. The variation of shoreline for 10 years is as shown in **Table 5-7** to **Table 5-10**.

Table 5-7: Predicted shoreline change rate accretion / deposition–Zone D (Proposed expansion)

Segment Number Zone-D / Year	Shoreline Evolution in m (Zone-D)								
	D1-D2	D2-D3	D3-D4	D4-D5	D5-D6	D6-D7	D7-D8	D8-D9	D9-D10
1	1.5	1.25	2.7	2	2.6	2	1.9	1.4	1.5
2	0.5	3	5.3	5.2	4.6	4	3.9	3.7	4.4
3	3.6	4.7	7.7	7	7	9	8.5	6.8	5.5
4	7.8	8.3	10.2	10.3	11.3	14.4	12.6	9.2	7
5	9.6	8.8	12	12	15.1	17.1	15.8	15.5	8.7
6	10.8	9.5	13.5	14.4	18.6	24.6	21.3	20	11.2
7	10.3	9.3	15.4	18.3	30.1	37	26.2	23.5	13.5
8	11.7	12	15.8	26.9	40.6	48.9	39.4	30	15.7
9	12.6	13	17.2	33	45.8	53.9	43.6	33.9	15.8
10	12.8	14.3	19.1	36	52.7	59.4	51.4	41.2	18.3
Average	1.28	1.43	1.91	3.6	5.27	5.94	5.14	4.12	1.83

Table 5-8: Predicted shoreline change rate accretion / deposition–Zone D (Proposed expansion)

Segment Number Zone-D / Year	Shoreline Evolution in m (Zone-D cont...)							
	D10-D11	D11-D12	D12-D13	D13-D14	D14-D15	D15-D16	D16-D17	D17-D18
1	2.4	1.6	2.07	2.08	1.1	1.5	2.2	1.7
2	3.7	4.4	8.7	4.8	1.6	3.6	4.5	4.1
3	5.9	7.4	12.7	7.7	4	5.6	10.9	5.9
4	11.6	15.4	22.4	12.7	4.2	7.5	13	8.3
5	14.8	25.1	26.6	18.9	7	11.3	15.8	10.7
6	20.3	31.7	37.5	27.7	8.3	12.5	25.2	14.1
7	27.4	39.4	45.4	33	9.1	16.7	29	17
8	32.7	46.5	52.5	40.4	9.7	19.6	38.2	17.7
9	39.8	53.1	60.5	46.2	9.9	23.8	44.3	20
10	45.3	57.8	63.9	49.7	12	26.3	49.5	20.3
Average	4.53	5.78	6.39	4.97	1.2	2.63	4.95	2.03

Table 5-9: Predicted shoreline change rate accretion / deposition–Zone D (Proposed expansion)

Segment Number Zone-D / Year	Shoreline Evolution in m (Zone-D cont...)							
	D18-D19	D19-D20	D20-D21	D21-D22	D22-D23	D23-D24	D24-D25	D25-D26
1	1.4	2.6	2.1	1.28	2.5	1.9	1.8	1.17
2	3.8	5.2	3.75	2.3	3.5	3.17	3.25	2.6
3	5.9	9.4	5.6	6.6	6.2	4.45	6	4.7
4	7.8	15.3	8.2	1.5	9	6.9	10.1	9.25
5	11	18.08	11.7	12.5	11.5	8.4	12.5	11
6	14.5	23.6	14.3	21.8	14.4	10.3	17.6	13.3
7	17.7	29.3	21.2	28.7	18.2	14.2	21.9	15.6
8	25.2	38.6	27.6	32.1	19.2	17.8	25.8	19.8
9	32.7	44.5	34.4	37.7	21.3	18.7	31.19	22.3
10	34	50.18	39.48	41.9	23.8	20.7	35.8	24.5
Average	3.4	5.01	3.94	4.19	2.38	2.07	3.58	2.45

*(-/+ indicates Erosion/Accretion)

Table 5-10: Predicted shoreline change rate accretion / deposition–Zone D (Proposed expansion)

Segment Number Zone-D / Year	Shoreline Evolution in m (Zone-D)				
	D26-D27	D27-D28	D28-D29	D29-D30	D30-D1
1	1.18	5.7	2.01	2.3	1.95
2	2.2	11.7	3.9	4.8	2.8
3	5.3	21.5	7.6	9.7	5.8
4	8.3	28.03	12	16.3	15.7
5	10.9	40.6	16	20.15	18.6
6	12	58.9	24.14	25.05	25.19
7	16.3	70.4	37.6	29	25.7
8	17.6	92.3	50.2	34.7	33.5
9	19.9	111.9	62.8	38.8	38
10	25	125.9	72.04	43.8	43.5
Average	2.5	12.5	7.2	4.38	4.35

*(-/+ indicates Erosion/Accretion)

Figure 5-14 and **Figure 5-15** show the variation of erosion and accretion at variation segments along the shoreline of 2016 after 5 years & 10 years after proposed expansion respectively. From the **Table 5-7** to **Table 5-10**, it can be observed that Zone D will experience accretion throughout the stretch. Average Shoreline change movement for Zone D will be 4.03 m/ year.

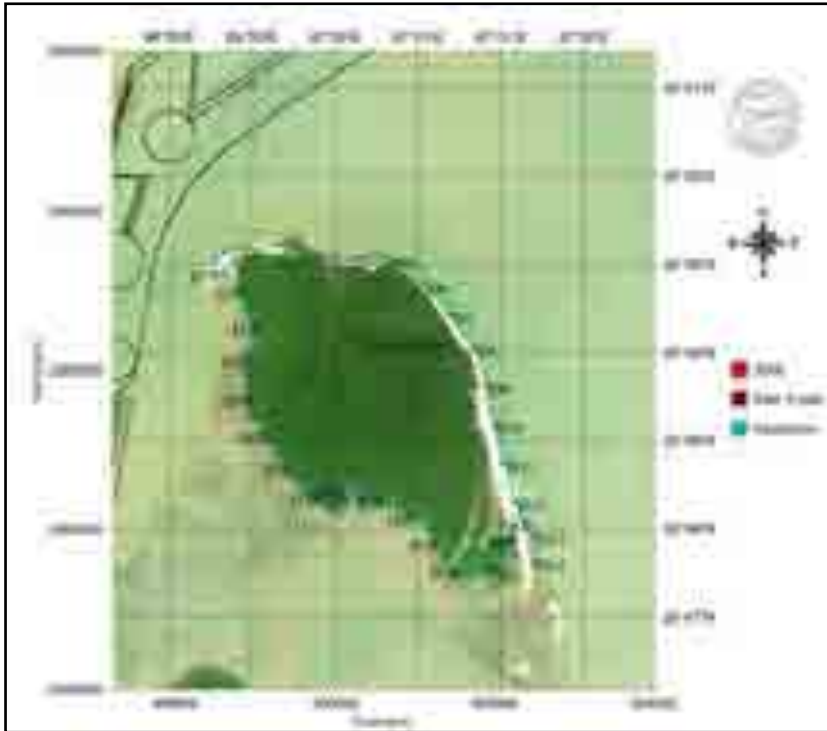


Figure 5-14: Zones of erosion and accretion in Zone D (after 5 years from 2016) for proposed expansion

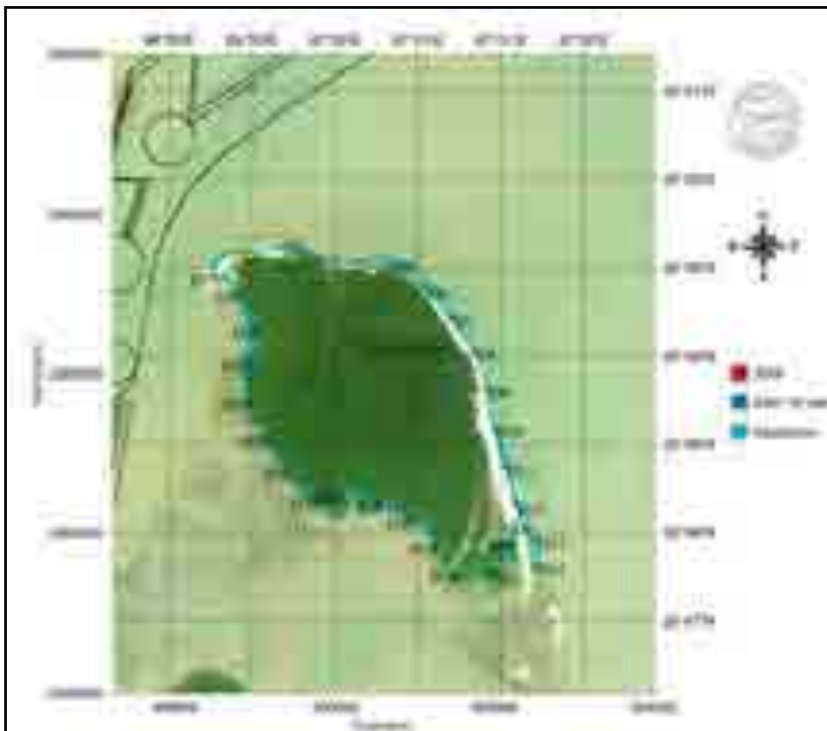


Figure 5-15: Zones of erosion and accretion in Zone D (after 10 years from 2016) for proposed expansion

Zone E (Gahirmatha Beach):

A coastal stretch of 17000m Gahirmatha Beach (**Figure 5-16**) was analyzed for spatial and temporal shoreline changes using output data of model for 10 years.



Figure 5-16: Predicted shoreline change for Zone-E (After proposed expansion)

The shoreline change of March 2016 and after 1 year interval for 10 years has been plotted for Zone E as shown in **Figure 5-16**. From the figure, the created layers of multi-year shorelines were used to calculate the rate of change at various segments created in the shore-normal direction. Zone- E is divided into 34 segments of equal spacing with an interval of 500m. Segments are placed exactly on 2016 shoreline. Shoreline change of entire stretch of Zone-E has been predicted and plotted segment wise. The variation of shoreline for 10 years is as shown in **Table 5-11** to **Table 5-14**.

Table 5-11: Predicted shoreline change rate accretion / deposition–Zone E (Proposed expansion)

Segment Number Zone-E / Year	Shoreline Evolution in m (Zone-E)								
	E1-E2	E2-E3	E3-E4	E4-E5	E5-E6	E6-E7	E7-E8	E8-E9	E9-E10
1	21.2	7.9	32.14	57	3.6	15.3	23	135	38.3
2	24.7	13.5	42.2	59	3.25	18.9	27.6	86	50.8
3	24.3	12.4	41.15	58.9	3.49	18.88	27.8	86.8	51.4
4	30.05	24.6	51.5	62.5	1.11	26.4	37.1	83.6	68.7
5	32.7	28.6	54.2	61.5	1.21	25.3	35.14	82.88	70.5
6	38.1	46.33	60.45	67.16	1.82	35.54	48.17	159.55	109.3
7	49.99	52.7	62.9	66.9	3.76	37.5	51.48	120.67	87.5
8	55.97	55.29	73.7	73.1	6.7	50.05	58.2	210.47	168.5
9	69.4	63	92.9	84.2	18.01	62.36	69.73	198.95	125.4
10	84.2	71.98	109.49	97.9	26.12	69.7	82.6	155.6	126.6
Average	8.42	7.198	10.949	9.79	2.612	6.97	8.26	15.56	12.66

*(-/+ indicates Erosion/Accretion)

Table 5-12: Predicted shoreline change rate accretion / deposition–Zone E (Proposed expansion)

Segment Number Zone-E / Year	Shoreline Evolution in m (Zone-E)						
	E10-E11	E11-E12	E12-E13	E13-E14	E14-E15	E15-E16	E16-E17
1	88.4	188	80.2	68.9	73.1	68.8	67.3
2	92.8	196.6	85.17	71.1	76.6	72.9	72.5
3	91.6	198.19	85.7	71.5	76.6	74.6	71.9

Segment Number Zone-E / Year	Shoreline Evolution in m (Zone-E)						
	E10-E11	E11-E12	E12-E13	E13-E14	E14-E15	E15-E16	E16-E17
4	117.7	185.7	94.8	77.7	82.1	80.8	75.8
5	110.9	211.9	94.08	79.33	84.54	80	78.7
6	114.5	190.33	105	87.07	90.69	92.21	88.31
7	118.67	225.9	112.47	93.35	99.9	98.29	96.36
8	131.31	134.9	121.4	104.05	102.68	111.12	103.9
9	131.64	289.18	139.08	124.9	137.2	128.6	125.5
10	105.8	253.3	156.07	144.9	156.4	145.4	141.5
Average	10.58	25.33	15.607	14.49	15.64	14.54	14.15

*(-/+ indicates Erosion/Accretion)

Table 5-13: Predicted shoreline change rate accretion / deposition–Zone E (Proposed expansion)

Segment Number Zone-E / Year	Shoreline Evolution in m (Zone-E)								
	E17-E18	E18-E19	E19-E20	E20-E21	E21-E22	E22-E23	E23-E24	E24-E25	E25-E26
1	67.4	54.7	69.5	71.5	74.2	73.7	85.2	100.5	94
2	71.3	57.6	73.2	75.17	79.14	77.38	92.57	104.6	96.6
3	72.3	58.15	72.8	74.7	79.1	78.14	93.92	105.2	96.5
4	77.2	60.8	76.4	82.7	86.7	84	104.8	109.6	100.5
5	79.4	63.38	79.65	83.2	88.5	88.36	108.21	112.12	104.1
6	86.19	68.52	84.5	93.65	98.26	96.41	114.17	117.79	109.59
7	94.79	76.18	93.26	101.9	103.78	106.99	119.8	128.14	117.69
8	102.3	84.5	99.3	108.3	110.6	113	128.2	134.15	126.15
9	122.5	106.8	130.4	130.2	133.8	135.03	156.18	162.5	153.38
10	128	134.5	177	145	181.7	161	167	155	154
Average	12.8	13.45	17.7	14.5	18.17	16.1	16.7	15.5	15.4

*(-/+ indicates Erosion/Accretion)

Table 5-14: Predicted shoreline change rate accretion / deposition–Zone E (Proposed expansion)

Segment Number Zone-E / Year	Shoreline Evolution in m (Zone-E)									
	E25-E26	E26-E27	E27-E28	E28-E29	E30-E31	E31-E32	E32-E33	E33-E34	E34-E35	E35-E36
1	94	82	77.3	74.9	67.7	64.4	66.2	64.2	48	29.4
2	96.6	89.3	83.9	81.4	71.2	67.3	68.12	66.4	60.4	36.4
3	96.5	90.48	84.8	82.6	72.5	68.5	68.9	66.1	60.9	35.6
4	100.5	97.8	90.6	88.2	76.03	74.7	72.58	69.18	73.35	51.66
5	104.1	102.2	94.8	93.47	78.89	75.4	78.09	71.24	73.99	50.89
6	109.5	106.4	102.0	100.0	85.58	81.65	81.03	76.39	77.1	72.21
7	117.6	113.5	108	105.5	90.32	87.6	86.4	81.81	79.6	75.7
8	126.1	120.8	114.9	111.2	102.9	97.13	94.8	88.25	84.7	82.77
9	153.3	147.6	137.1	132.7	123	119.8	115.5	107.3	98.36	94.3
10	154	146	151	140	166	102	112	96	94.5	90.19
Average	15.4	14.6	15.1	14.0	16.6	10.2	11.2	9.6	9.45	9.019

*(-/+ indicates Erosion/Accretion)

Figure 5-17 and **Figure 5-18** show the variation of accretion at variation segments along the shoreline of 2016 after 5 years & 10 years of after proposed expansion respectively. From the **Table 5-11** to **Table 5-14**, it can be observed that Zone E will experience accretion throughout the stretch. Average Shoreline change movement for Zone E will be 13.02 m/year.

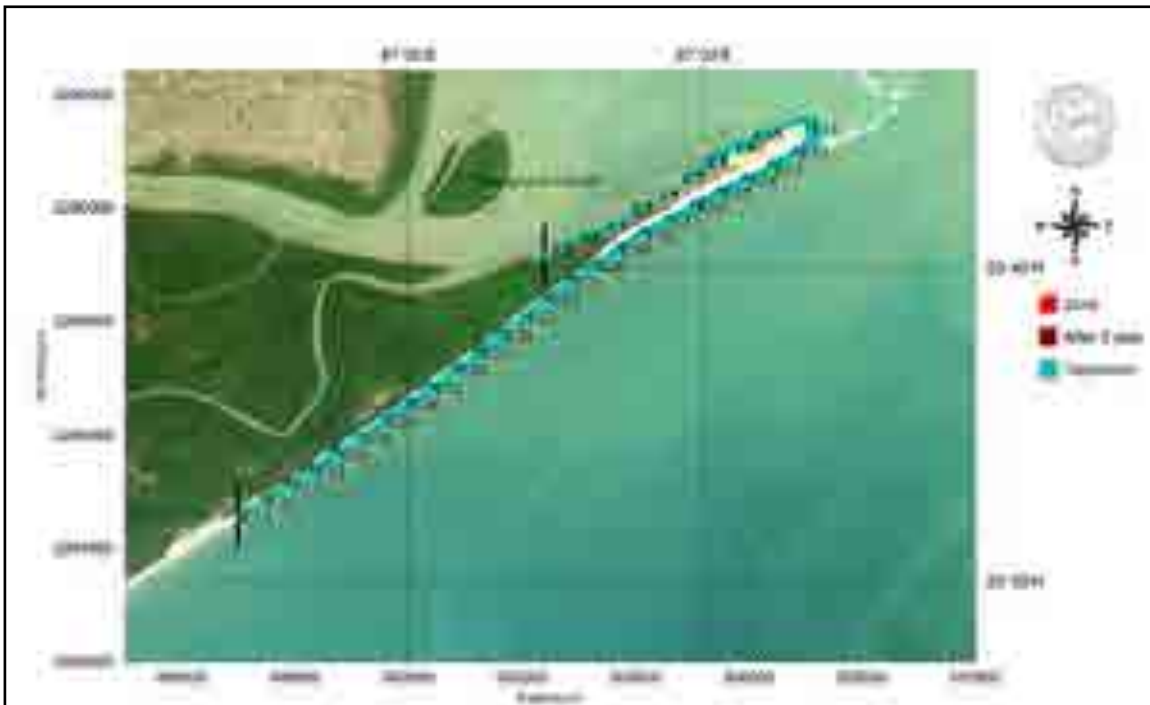


Figure 5-17: Zones of erosion and accretion in Zone E (after 5 years from 2016) for proposed expansion

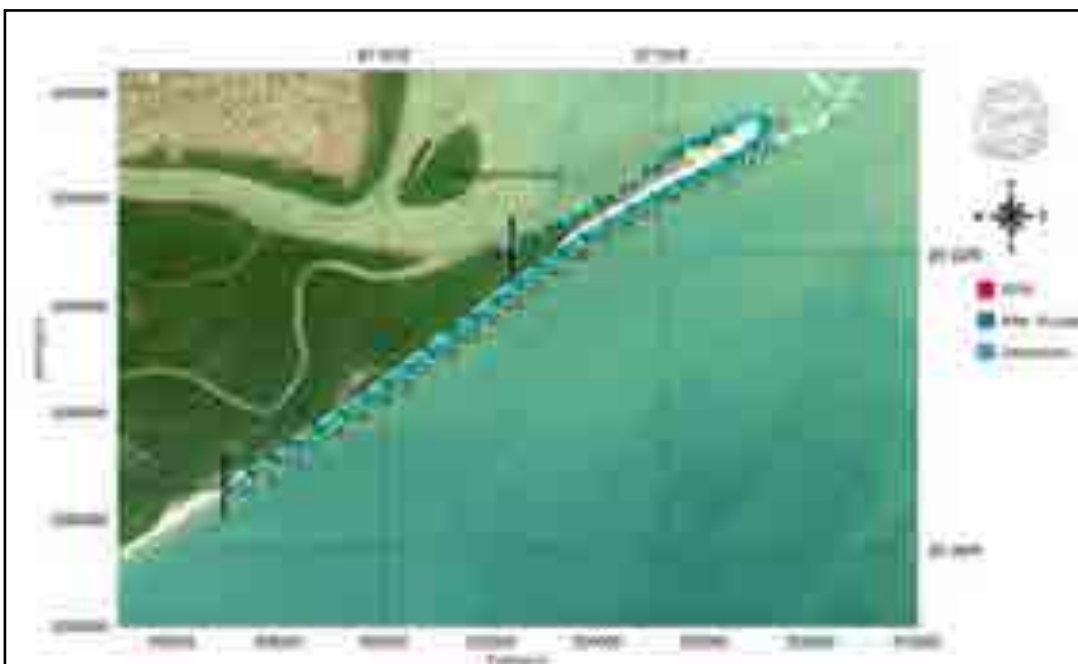


Figure 5-18: Zones of erosion and accretion in Zone E (after 10 years from 2016) for proposed expansion

Zone F & Zone G (Wheelers Island):

A coastal stretch of 18500m Wheelers Islands (**Figure 5-19**) was analysed for spatial and temporal shoreline changes using output data of model for 10 years.

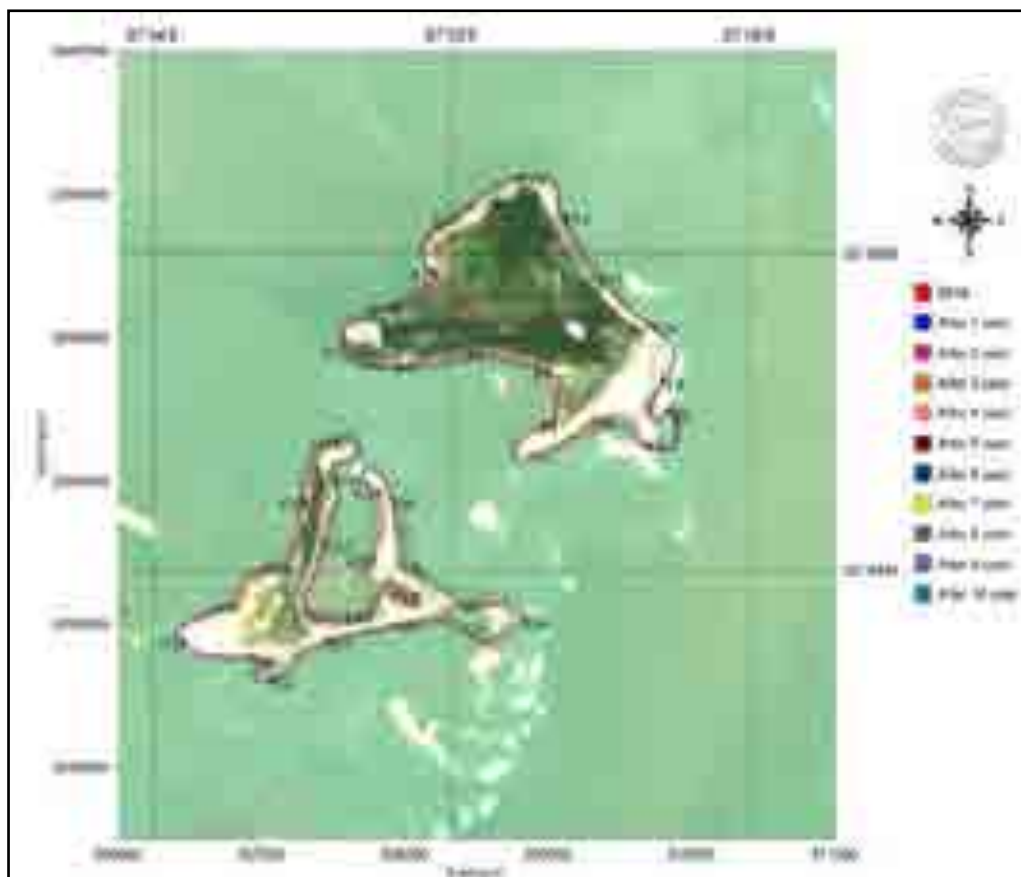


Figure 5-19: Predicted shoreline change for Zone-F & Zone-G (After proposed expansion)

The shoreline change of March 2016 and after 1 year interval for 10 years has been plotted for Zone F&G as shown in **Figure 5-19**. From the figure, the created layers of multi-year shorelines were used to calculate the rate of change at various segments created in the shore-normal direction. Zone- F divided into 16 segments & Zone- G divided into 20 segments of equal spacing with an interval of 500m. Segments are placed exactly on 2016 shoreline. Shoreline change of entire stretch of Zone-F & Zone-G predicted & plotted segment wise. The variation of shoreline for 10 years is shown in **Table 5-15** to **Table 5-18**.

Table 5-15: Predicted shoreline change rate accretion / deposition–Zone F (Proposed expansion)

Segment Number Zone-D / Year	Shoreline Evolution in m (Zone-F)								
	F1-F2	F2-F3	F3-F4	F4-F5	F5-F6	F6-F7	F7-F8	F8-F9	F9-F10
1	1.27	2.07	1.73	1.50	1.27	2.27	1.87	1.80	2.00
2	1.67	3.23	2.67	2.80	1.10	6.00	5.57	3.67	2.83
3	4.67	5.87	5.43	4.53	6.87	7.60	10.00	6.17	5.30
4	3.43	9.97	7.50	6.17	3.63	10.83	13.90	5.47	6.27
5	5.77	12.33	9.67	9.00	4.37	13.50	17.53	7.23	9.23
6	7.60	14.67	9.93	7.57	3.70	15.27	5.37	9.83	9.37
7	9.20	18.40	11.97	10.07	6.87	17.67	25.23	9.30	11.73
8	10.53	19.67	13.50	11.87	10.40	22.03	29.43	12.20	13.27
9	12.17	21.83	16.00	14.67	6.20	25.90	33.50	14.37	14.60
10	13.30	20.87	18.43	12.07	9.23	28.00	34.80	15.80	16.40
Average	1.330	2.087	1.843	1.207	0.923	2.8	3.480	1.580	1.640

Table 5-16: Predicted shoreline change rate accretion / deposition–Zone F (Proposed expansion)

Segment Number Zone-E / Year	Shoreline Evolution in m (Zone-F)							
	F10-F11	F11-F12	F12-F13	F13-F14	F14-F15	F15-F16	F16-F17	F17-F18
1	0.23	0.73	1.43	0.87	1.43	0.93	1.53	1.60
2	1.13	1.50	1.90	1.07	2.67	1.93	4.63	3.57
3	0.87	4.00	3.70	2.97	4.47	3.90	6.33	5.57
4	1.43	4.83	5.57	3.27	6.00	6.93	8.83	8.20
5	4.03	5.23	7.37	4.43	7.77	8.67	10.63	10.70
6	6.73	6.33	10.17	7.77	10.33	10.30	12.37	13.27
7	5.03	8.20	12.80	10.07	15.20	13.27	14.97	14.63
8	1.27	11.07	15.53	11.73	16.93	13.83	15.93	18.00
9	2.63	12.10	17.27	12.97	19.40	16.07	18.50	20.23
10	2.00	13.77	16.50	14.70	20.90	17.33	20.33	22.60
Average	0.2	1.377	1.650	1.470	2.090	1.733	2.033	2.260

Table 5-17: Predicted shoreline change rate accretion / deposition–Zone G (Proposed expansion)

Segment Number Zone-G / Year	Shoreline Evolution in m (Zone-G)									
	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	G9-G10	G10-G11
1	3.93	1.07	1.03	1.23	1.00	0.77	1.30	0.90	1.50	1.30
2	10.17	2.07	7.33	9.90	1.73	0.97	3.10	1.83	3.43	3.80
3	5.13	1.63	1.73	4.50	3.50	2.10	5.07	3.33	4.83	2.07
4	7.00	3.60	3.43	2.33	5.67	3.63	6.80	6.00	8.37	4.30
5	8.23	5.07	6.03	2.27	6.83	5.43	8.57	11.93	11.77	6.10
6	11.47	7.27	12.17	4.50	11.07	8.57	13.33	16.60	18.80	7.90
7	14.80	11.13	14.80	9.07	16.33	11.43	19.20	18.57	22.70	10.70
8	18.80	13.53	17.30	12.50	22.90	15.27	24.17	22.53	24.87	12.47
9	19.80	14.77	20.87	14.07	26.73	18.27	26.77	27.20	30.60	14.17
10	23.60	19.10	24.30	16.23	26.07	19.17	27.67	33.33	32.43	15.33
Average	2.360	1.910	2.430	1.623	2.607	1.917	2.767	3.333	3.243	1.533

*(-/+ indicates Erosion/Accretion)

Table 5-18: Predicted shoreline change rate accretion / deposition–Zone G (Proposed expansion)

Segment Number Zone-G / Year	Shoreline Evolution in m (Zone-G)									
	G11-G12	G12-G13	G13-G14	G14-G15	G15-G16	G16-G17	G17-G18	G18-G19	G19-G20	G20-G21
1	0.80	0.73	0.50	0.67	1.23	1.13	2.87	1.47	1.20	1.57
2	0.87	1.73	4.63	7.43	8.23	2.60	1.93	0.90	3.13	3.17
3	0.73	3.80	0.57	1.00	0.47	4.67	3.40	1.53	1.00	2.67
4	1.50	5.40	1.03	2.63	3.23	7.03	5.20	1.63	1.97	3.40
5	4.50	7.50	2.70	4.93	2.77	9.23	7.20	2.77	3.23	5.67
6	5.47	10.07	2.07	7.03	4.77	10.57	9.40	6.10	7.50	7.07
7	7.30	13.23	2.77	8.33	6.07	12.00	12.47	7.80	10.07	9.07
8	8.20	15.40	6.37	9.20	4.23	13.97	14.70	9.87	13.13	10.93
9	11.00	17.17	6.83	11.60	10.67	16.43	18.20	11.27	17.57	13.70
10	11.30	20.83	9.50	14.47	14.23	17.27	18.10	8.27	15.30	16.23
Average	1.130	2.083	0.950	1.447	1.423	1.727	1.810	0.827	1.530	1.623

*(-/+ indicates Erosion/Accretion)

Figure 5-20 and **Figure 5-21** show the variation of erosion and accretion at variation segments along the shoreline of 2016 after 5 years & 10 years of after proposed expansion respectively. From the **Table 5-15** to **Table 5-18**, it can be observed that Zone F&G will experience accretion throughout the stretch. Average Shoreline change movement for Zone F & G will be 1.747 & 1.913 m/ year respectively.

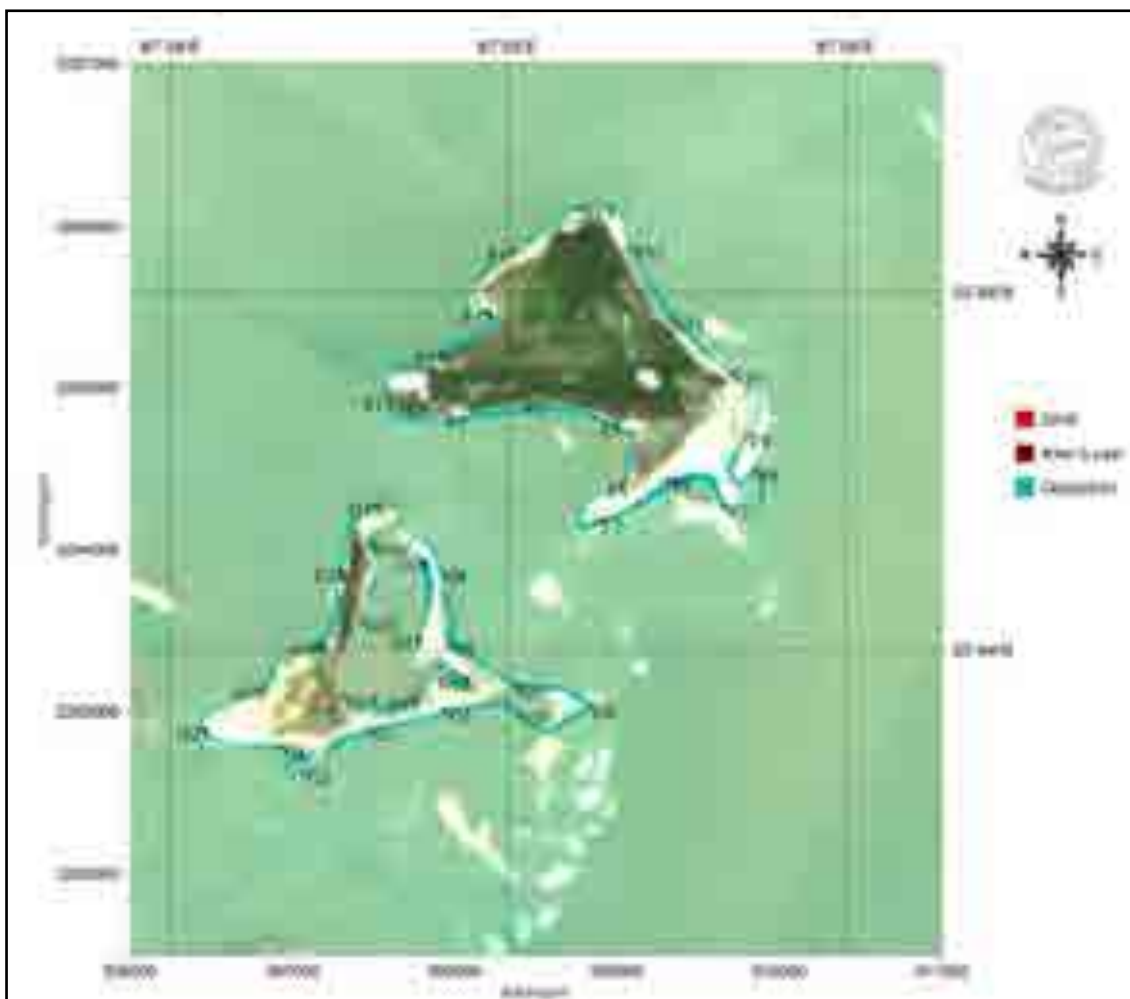


Figure 5-20: Zones of erosion and accretion in Zone F & Zone-G (after 5 years from 2016) for proposed expansion

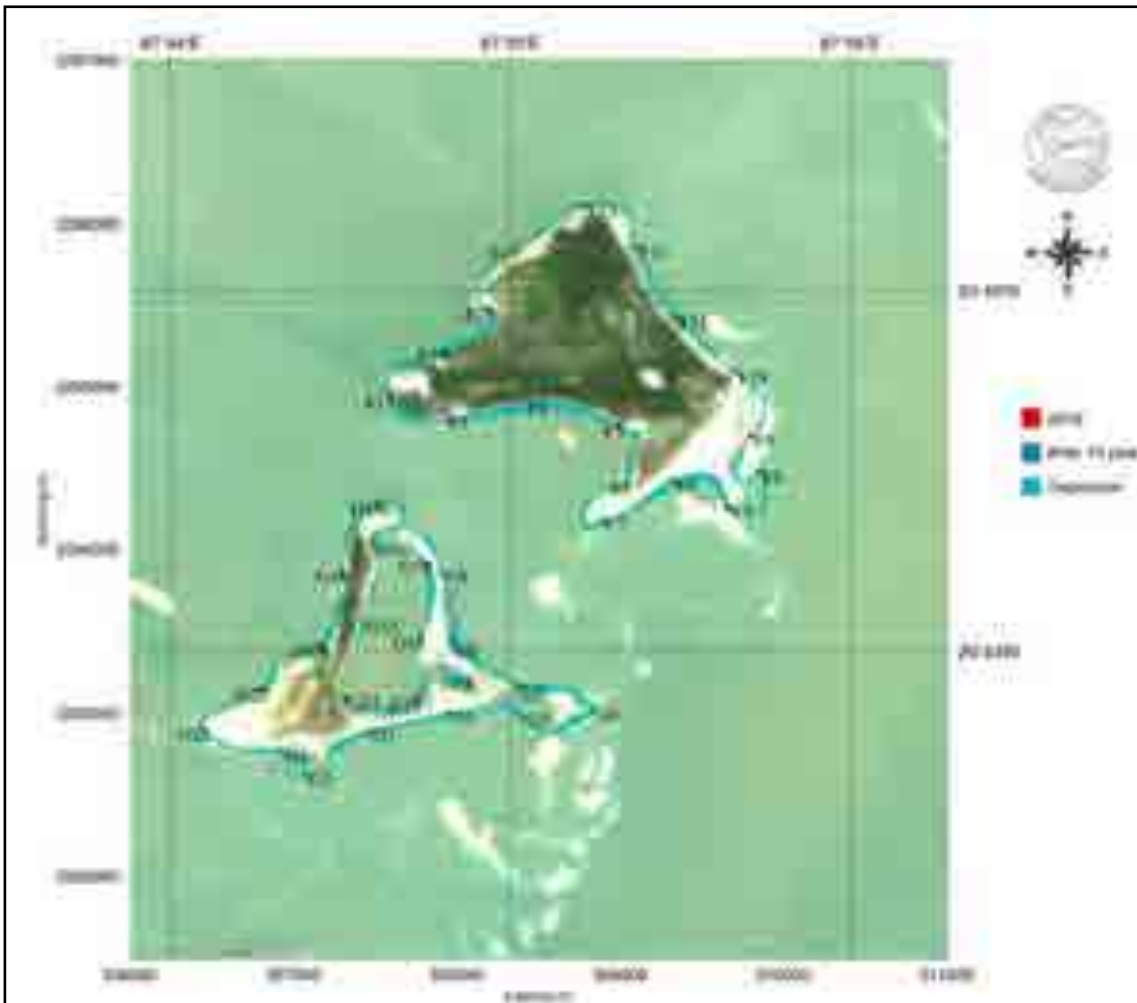


Figure 5-21: Zones of erosion and accretion in Zone F & Zone-G (after 10 years from 2016) for proposed expansion

From the Modelling studies the following observations were made:

- Northern area of Zone A will experience erosion, and southern area of Zone A will experience accretion. Average Shoreline change movement for Zone A will be -4.38m/ year
- Entire stretch of Zone B will experience accretion. Average Shoreline change movement for Zone B will be 2.06 m/ year. Zone C upper segment will experience erosion, whereas lower segment will show moderate accretion. Average Shoreline change movement for Zone C will be -2.71 m/ year. Entire stretch of Zone D (Kanika Island – Eastern side) will experience accretion. Average Shoreline change movement for Zone D will be 4.0316 m/ year. Entire stretch of Zone E (Gahirmatha Beach) will experience accretion. Average Shoreline change movement for Zone E will be 13.02 m/ year which may favours the turtle nesting. Entire stretch of Zone F & G will experience accretion. Average Shoreline change movement for Zone F & G will be 1.747 m/year & 1.913m/ year respectively which may favours the turtle nesting

5.2.3.5 Mitigation Measures

- Monitoring of shoreline with the help of high resolution satellite imageries during operation phase shall be carried out periodically.

- Based on the monitoring results appropriate remedial measures such as beach nourishment/ creation of sand trap/ any other suitable methods shall be carried out to maintain the stability of coast.

5.3 Water Environment

5.3.1 Potential Impact due to Port Location

5.3.1.1 Impact on Existing Water Resource

Based on the land use and land cover studies it was identified that study area (15.0 Km radius) mostly covered with Sea (49.25%), Agriculture – Crop land (24.53%) and Mangroves 13.01%. Other land use such as Aquaculture/Pisciculture (3.95%), Built-up – Rural/Urban (3.48%) and smaller % of Land with/without Scrub, Sandy area and Forest-Scrub lands are observed.

Only 3.40% of the study area is covered with Water bodies such as Rivers/Streams/Canals system. No major reservoirs/lakes are observed in the study area. The following are the rivers observed in the study area:

• Dhamra River	-	1.6 km S
• Matai Nadi	-	8.0 km W
• Mahul Jhor	-	3.5 km W
• Sotra Jhor	-	4.9 km WNW
• Kanthiakai Nala	-	5.5km S
• Munda Jhor Nadi	-	6.6 km SSW
• Bhekta Nala	-	6.8 km SSW
• Maipura Nadi	-	9.3 km S
• Sanjoga Nadi	-	11.1 km SW
• Baunsagarh Nadi	-	11.2 km S
• Bhitra Kanika Nadi	-	11.8 km SW
• Galla Nadi	-	12.2 km W
• Ranahansua River	-	12.3 km S
• Dosandhi Jhor	-	12.4 km NW
• Satabhaya Nala	-	14 km S

Among these, Dhamra River close to the revised master plan development and water for desalination plant is proposed to be sourced from Matai Nadi. Hence these two water bodies likely to be impacted due to the revised master plan developmental activities. Dhamra river water quality details are presented in **Section 4.5.3** of Chapter 4 which indicates more TDS as it has tidal influence.

Flow modelling was carried out by M/s Environ Software for neap and spring tide conditions in the offshore region of Dhamra considering existing and proposed revised master plan development. The model generated tides and currents are comparable to actual observations at Dhamra. The currents are slightly reduced at the mouth of Dhamra river mouth (0.2 m/sec) during flooding tide condition. The currents are slightly increased at the mouth of Dhamra river (0.1 m/sec) during ebbing tide condition. Flow regime changes for various tidal conditions in the study domain after the proposed expansion development of the Port are predicted to be not of much significance. Variation in the flow regime (in the current speeds) after the expansion is limited to the development location mostly and found to be

very much local in nature. No change in the flow regime of the rest of the domain is observed.

Water requirement for Revised Master Plan for 5 Year and 30 Year development of Dhamra Port during the construction phase is 1.95 MLD. The water requirements for Revised Master Plan for 5 Years and 30 Years development of Dhamra Port during the operation phase are 21.4 MLD and 40 MLD. The water requirement during the construction as well as operation phases will be met through desalination plant of 40 MLD which will be developed on modular basis. DPCL has developed a dedicated water supply system by constructing raw water intake at River Matai for dust suppression, potable water and fire fighting purpose and Water Resources Department, Government of Odisha allotted 2.05 cusec (~5000 KLD) of water from Matai River during Phase I development. The same intake will be utilized for the Revised Master Plan development of Dhamra port after augmenting the facilities and necessary permission will be taken from Water Resource Department. The maximum water withdrawal for the desalination plant for 5 Years and 30 Years development of Dhamra Port will be 63 MLD and 100 MLD.

Water of river Matai remains potable from July to February. During the remaining four months, the water of Matai is saline in nature due to tidal influx.

The reject brine around 38 MLD and 60 MLD for 5 Years and 30 Years development from the desalination plant will be discharged into the sea through an outfall arrangement environment (same outfall location for LNG/LPG Terminal). The reject TDS from the desalination plant discharged into the sea will be much lesser than the TDS value observed for the seawater in the region. Hence no impacts are envisaged due to discharge of reject brine from the outfall arrangement.

No downstream users are observed beyond the Intake Point at River Matai. Government of Odisha has accorded permission for water intake of 5 MLD from Matai River and necessary application will be filed for the remaining quantities and permission shall be obtained from the government authorities. No competing users such as industries and irrigation projects are currently using Matai River as a water source after DPCL intake location. As water requirement is proposed to be met from perennial surface water (Brackish during part of the year) resource and not relying on existing drinking water facilities/sources, significant impacts are not envisaged.

Dhamra port has already constructed a rail link of 62.5 Km with single line track, connecting the port with the Indian Railway network near Bhadrak railway station. The port has acquired 125 m wide land corridor from Dhamra to Bhadrak for providing exclusive connectivity with the hinterland. Approval has already been obtained for 4 lane road and 2 rail tracks (as a part of Phase I & II Clearance). As a part of Revised Master Plan, it is to develop further additional 2 lane road and 1 rail tracks in the existing corridor. As this corridor is already constructed with 62.5 km of rail line and sufficient measures are taken near the water body/ river matai crossing, No significant impacts are envisaged due to the development of further additional 2 lane road and 1 rail tracks in the existing corridor as a part of revised mater plan.

In addition, for easy evacuation of cargo, a new rail, road and utilities corridor (12 km x 125 m wide) is proposed from Northern side development of Dhamra Port. This corridor will connect Dhamra port with existing rail-road corridor near Bansada, Bhadrak. No major river or water bodies crossing are envisaged for the proposed alignment.

5.3.1.2 Impact due to Stagnation of Wastewater in Harbour

The construction of marine structures such as protected harbour will change the current patterns and results in tranquil conditions suitable for the operation of the port. In case, the untreated wastewater from the domestic as well as industrial activities in the vicinity of the port flows into the harbour, it results in stagnation of water. This condition may deteriorate through increase of phytoplankton and a decrease of dissolved oxygen, resulting from eutrophication of water, caused by effluents containing nutrient salts (chemical compounds including N and P). Anaerobic water leads to the generation of hydrogen sulphide (H_2S).

The expansion of Dhamra port does not involve construction of breakwaters or groynes due to the reason that the port site has tranquil conditions naturally. Further, the area surrounding the port location is undeveloped and rural which will not generate significant sewage and industrial discharges into water resources. Furthermore, the inflows from the Dhamra River flush the port harbour area by which the stagnation of wastewater, if any will not occur.

Also, the wastewater generated from the port area during construction as well as operational phases will be collected through a wastewater collection network and sent to the Sewage Treatment Plant and Effluent Treatment Plant for treatment. It is proposed to reuse the treated wastewater for the development of greenbelt within the port.

5.3.1.3 Mitigation Measures

- Sewage generated from port will be treated in STP of 1 MLD capacity during 5 years and 2 MLD during 30 Year development
- Effluent generated from port will be treated in ETP of 3 MLD capacity during 5 years and 5 MLD during 30 Year development
- The bilge water and waste oil will be received by appointing authorized vendors meeting all statutory requirements.
- Treated wastewater will be used for greenbelt development.

5.3.2 Potential Impact due to Construction

5.3.2.1 Impact due to Land Reclamation/Wastewater Generation

Generally, reclamation of low lying areas with capital dredged material is likely to affect groundwater quality due to intrusion of sea water and based on quality of dredged material. In **Section 5.2.1.4**, it is discussed in detail about the quality of marine sediments. The area proposed to be reclaimed is majorly in the sea (Inter tidal) which is saline in nature. The slope of project site is towards the sea and chances of intruding sea water into groundwater are envisaged to be negligible. Hence, no significant impacts are anticipated due to land reclamation on ground/surface water.

Also, as most of the development in the form of dredging and reclamation will be into the sea and small area towards landward side of the northern side of the port will be developed as backup area. The applied land to be reclaimed will be saline mud and is separated from the adjoining land mass through the salt dyke.

During construction phase of the proposed project, sewage will be generated from construction workers camp and from the project site. Wastewater generation at construction site includes surface runoff also which may contain pollutants and traces of solvents, paints, metal compounds, etc. which may impact the groundwater and nearby surface water resources if not managed properly.

5.3.2.2 Mitigation Measures

- The return sea water quality from the reclaimed area shall be monitored during reclamation phase
- Groundwater quality shall be monitored
- An adequate drainage system will be provided at the site with separate collection streams to segregate the storm run-off from roads, open areas, material storage areas, vehicle wash water and other wastewater streams. Suitable measures will also be taken to prevent the washing away of construction materials into the drainage system.
- Contaminated storm water will be collected and conveyed to sedimentation tank for removing grit.
- Sewage generated at site /construction workers camp will be treated in the existing STP.
- No wastewater shall be disposed directly on land or on existing surface water resources without appropriate treatment.
- Construction workers camp shall be located outside CRZ area

5.3.2.3 Impact on Existing Drainage Pattern

Natural drainage of the Dhamra and its surrounding area is being maintained through Dhamra River (Brahmani/Baitarani river), Matai river, tributaries of Brahmani and through direct discharge to Bay of Bengal. Dhamra port back up area falls between Matai River, Dhamra River and Bay of Bengal. There are few natural third/fourth order drains are passing through the project site, therefore, storm water drainage network is planned to facilitate the proper drainage pattern of the area. The requirements of local villagers for tide water and boat movement has been duly considered in the drainage plan.

5.3.2.4 Mitigation Measures

- Suitable measures will also be taken to prevent the washing away of construction materials into the drainage system.

5.3.3 Potential Impact due to Operation

5.3.3.1 Impact on Water Quality due to Cargo Operations

The Revised Master Plan development of Dhamra port will handle cargo such as Dry bulk cargo (Coal / Iron ore / limestone / Mines & Minerals & Other dry bulk); Multipurpose & General Cargo (Fertilizers and raw materials for manufacture of fertilizer / food grains / sugar / clinker / cement / Project cargo / timber & wood / machines/ Iron steel products / Break Bulk etc.); Container; Cryogenic Liquids and Gas (LNG, Propane, Butane, LPG, CNG, NG) and All Class A, B, C petroleum products, excluded petroleum products Including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos).

River Dhamra (1.6 km) and River Matai (8.0 Km) area are well away from Port operational areas. However, precautionary measures will be taken in case of spillage to reduce the impact on water quality. The proposed cargo is to be handled with specialized handling systems and equipments and hence very little chances of spill. However, in case of accidental spill of cargo during handling, spills will be contained and wash water or surface runoff containing spills will be collected separately and will be treated to avoid any further impact on water quality. Storm water runoff from the cargo storage areas and other areas of the project facilities may contaminate marine water quality if not regulated properly.

The following are the wastewater generation from the Dhamra Port:

- Estimated sewage for 5 Year and 30 year development will be around 0.9 MLD and 2 MLD
- Industrial Wastewater/Effluent with Oil presence from the areas such as equipment Workshop, Utility Building, Raw Water Pump House, Fire Water Pump House, fire station and, fuel station for 5 Year and 30 year development is estimated to be around 2.4 MLD and 5 MLD
- Dust Suppression water from cargo stock yard etc., containing mainly suspended particulates
- Rain washed roads and roof tops containing particulates

5.3.3.2 Mitigation Measures/Wastewater Management

It is proposed to develop STP of 1 MLD capacity for 5 Year development which will be augmented to 2 MLD for 30 Year development. Similarly, ETP will be developed of 3 MLD capacity for 5 Year development which will be augmented to 5 MLD for 30 Year development.

Storm water runoff will be directed as per the storm water drainage network planned considering the existing drainage pattern to finally discharge into the sea. Settling ponds are proposed for Dry Bulk Cargos such as Coal and iron ore stack yards etc., to settle coal and iron ore particles or other bulk cargo particles which would otherwise pollute the stream water. The size of the settling pond shall be determined from Detention time of 2.5 hours. Supernatant water from settling pond will be reused. During rainy season, the excess water will be discharged into the sea. The runoff from uncontaminated areas will be discharged into the greenbelt area. The oil contaminated water will be sent to ETP and the separated oil will be given to the authorised waste oil recycler. The separated water will be reused. Cargo spill control measures such as Oil Spill Contingency Plan etc., shall be followed the details are given of **Section 5.4.3**.

5.4 Marine Environment (Coastal Hydrology/Bottom Contamination, Sea/Harbour Water Quality)

5.4.1 Potential Impact due to Port Location

5.4.1.1 Hydrodynamic and Sediment Transport

5.4.1.1.1 Hydrodynamic Flow Modelling

Basic Governing Equation:

The basic governing equations of flow are solved numerically in simulation of tides and currents in the coastal environments. These equations are formulated based on incompressible flow and vertically integrated hydrostatic distribution since the vertical acceleration of the flow is much smaller than the pressure gradient. After applying these assumptions, the basic governing equations of flow momentum can be written in the conservation form as follows:

Continuity equation:

$$\frac{\partial \eta}{\partial t} + \frac{\partial uH}{\partial x} + \frac{\partial vH}{\partial y} = 0$$

Momentum equations:

The two depth-averaged momentum equations can be written as

$$\begin{aligned} \frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} + \frac{\partial}{\partial x} \left(K_x \frac{\partial u}{\partial x} \right) + \frac{\partial}{\partial y} \left(K_y \frac{\partial u}{\partial y} \right) + \frac{\partial}{\partial z} \left(K_z \frac{\partial u}{\partial z} \right) + f v - g \frac{\partial \eta}{\partial x} \\ \frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + w \frac{\partial v}{\partial z} + \frac{\partial}{\partial x} \left(K_x \frac{\partial v}{\partial x} \right) + \frac{\partial}{\partial y} \left(K_y \frac{\partial v}{\partial y} \right) + \frac{\partial}{\partial z} \left(K_z \frac{\partial v}{\partial z} \right) - f u - g \frac{\partial \eta}{\partial y} \end{aligned}$$

where, t = time; x, y are Cartesian co-ordinates; u and v are depth averaged velocity components in the x and y directions, respectively; f = Coriolis parameter; g = acceleration due to gravity; K_x, K_y diffusion coefficients in the x and y directions, respectively; η = water elevation with respect to mean sea level, H = total water depth at any instant.

Model Description:

Dedicated software Hydrodyn - FLOSOFT and Hydrodyn - SEDSOFT for prediction of tides and currents based on solving the hydrodynamic equations numerically through coupled way using the present state-of-art of technology are utilized for the studies.

Model Setup and Calibration:

Boundary conditions:

The region of study in the Dhamra port region located in Bhadrak District of Odisha is selected between geographical coordinates: Longitude of 459798.8125 E – 561563.5625 E and Latitude of 2247181.75N – 2340065.0N for carrying out sensitivity analysis.

The model domain selected for the study is shown in **Figure 5-22** with the proposed expansion. The software calibration points are selected as Station-1 (482063.0, 2295759.0), Station-2a (502708.3, 2307500.0), Station-2b (496310.0, 2297464.0), Station-3 (502303.0, 2297285.0), Station-4 (496903.0, 2302460.0) and Station-5-1 (496669.0, 2301489.0) points where the measurements for tides and currents were taken for the purpose of calibrating and validating the model.

The terrain features of the study domain for the model is given in **Figure 5-22**. The locations of the revised master Plans also shown in **Figure 5-23** and **Figure 5-24**. The model domain is divided into FEM grid. **Figure 5-23** shows the computational FEM grid for the domain. The bathymetry is selected from the measured hydrographic chart data and checked with the measured bathymetry data supplied. The interpolated bathymetric depth contours for the model are shown **Figure 5-24**. From the figure, it can be seen that the maximum depth contour is 116 m in the domain.

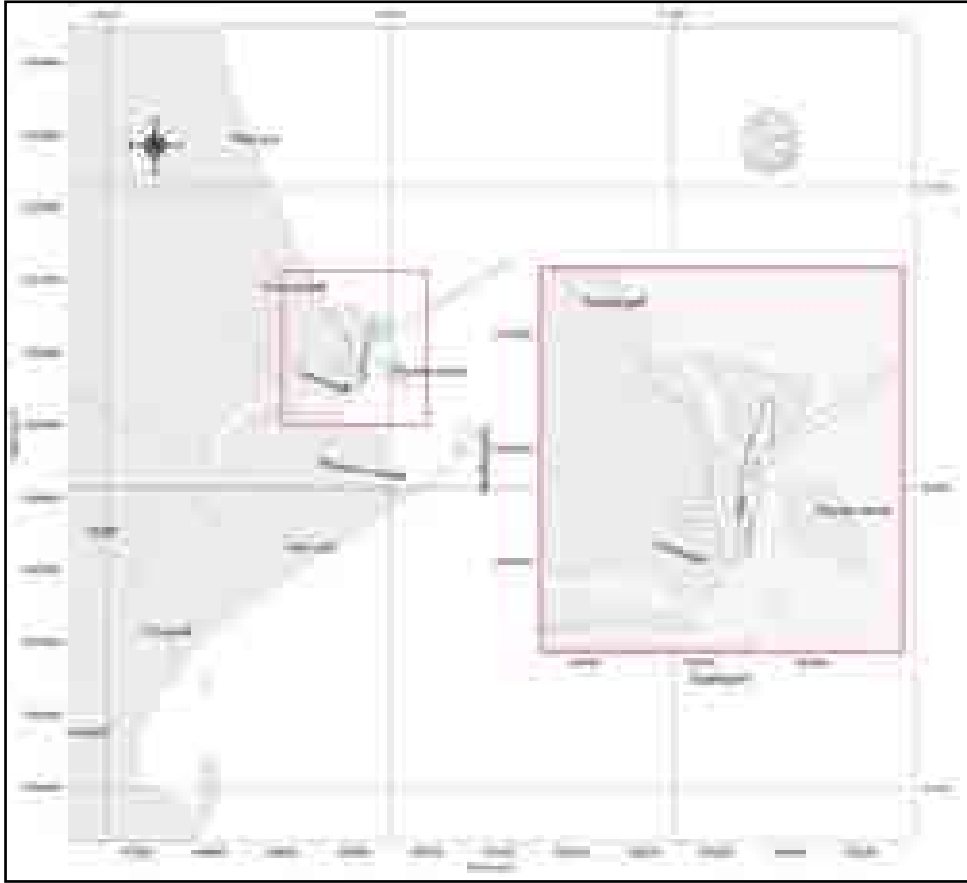


Figure 5-22: Study Domain for the Revised Master Plan

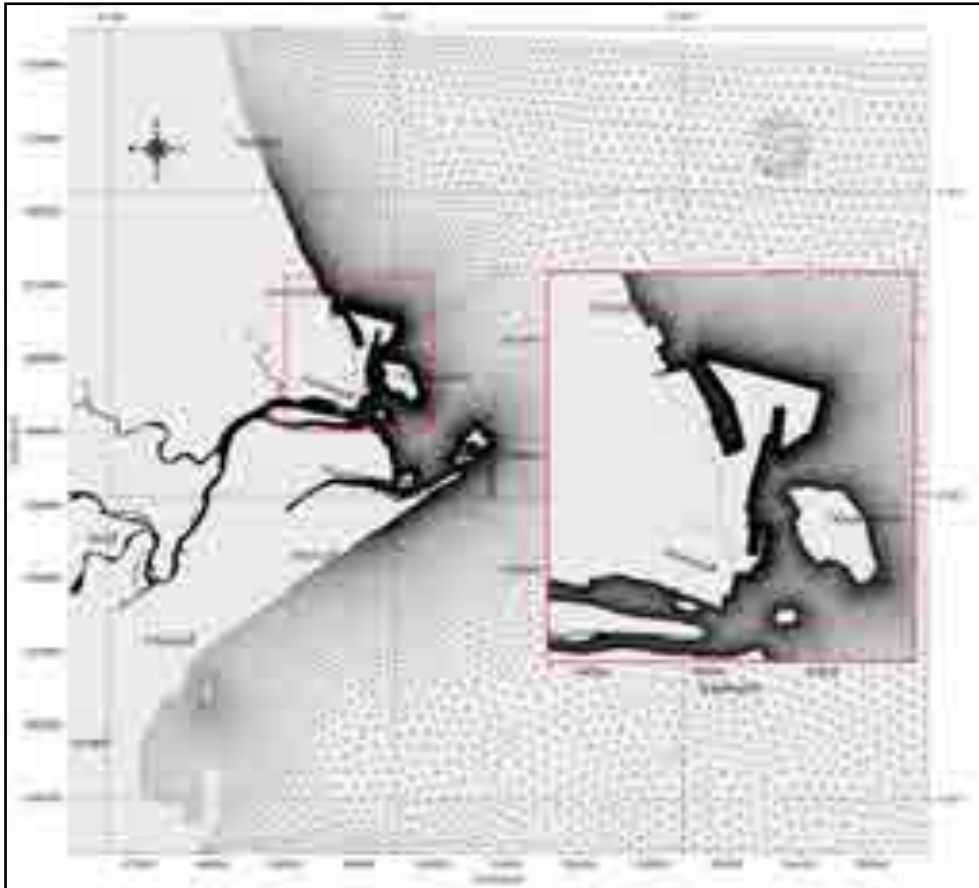
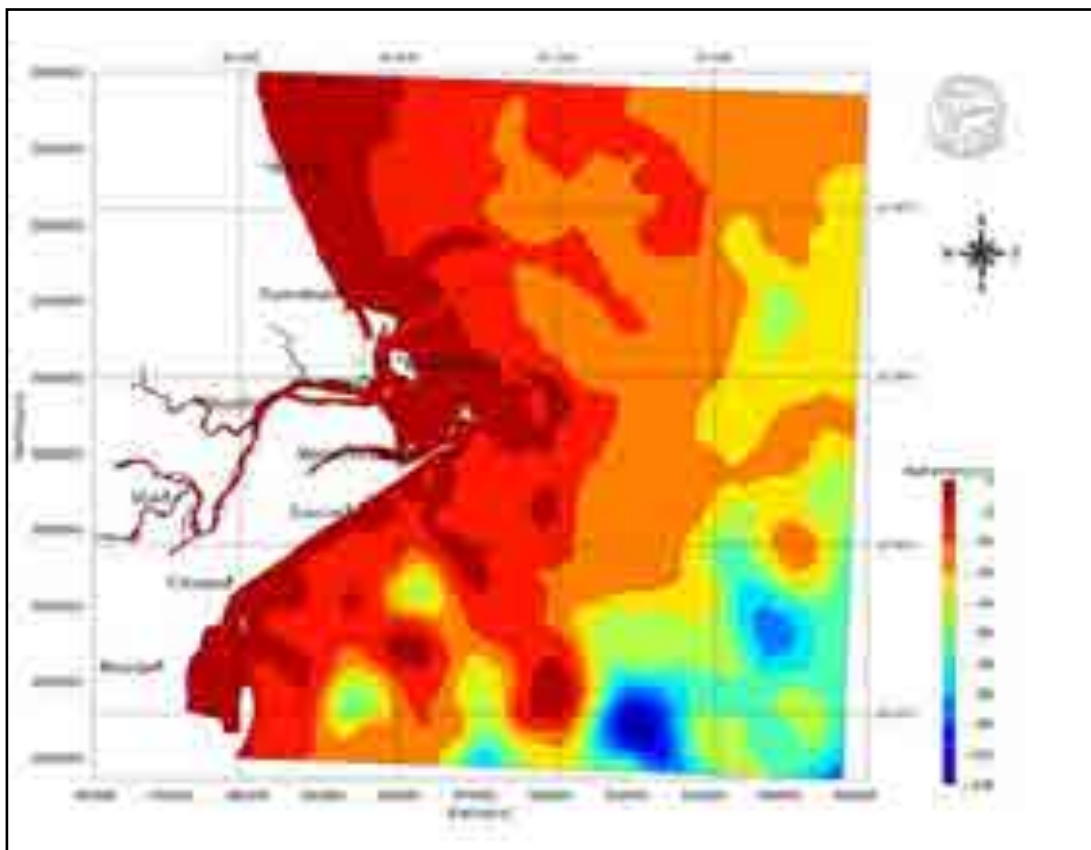


Figure 5-23: Computational mesh**Figure 5-24: Interpolated Bathymetric Depths**Model calibration:

Tide and current measurements were carried out at station-1 to station-5. These values are compared with the model simulated / computed results to check the variation and thus calibrate the model. The model gets validated when the computed and measured values match within the permissible variation allowed. The geographical location of these measurement stations/points are shown in **Figure 5-25** and given in the **Table 5-19**.



Figure 5-25: Locations of Observed data of Currents and Tides

Table 5-19: Location of Observed Data of Currents and Tides

Measurement Point	Latitude, N	Longitude, E	Measurements carried out for
Station-1	2295759.0N	482063.0E	Tides, Currents
Station-2a	2307500.0N	502708.3E	Tide, Currents
Station-2b	2297464.0N	496310.0E	Currents
Station-3	2297285.0N	502303.0E	Currents
Station-4	2302460.0N	496903.0E	Tides
Station-5_1	2301489.0N	496669.0E	Currents
Station-5_2	2301419.1N	496626.6E	Currents

A comparison has been made between the measured (observed) and computed tides and velocities at these locations Station-1 to Station-5 in the project area and is graphically shown in **Figure 5-26** to **Figure 5-31** respectively. From the figures, it can be inferred that the values match in general and the variation is small and is within the acceptable limits; (variation is less than <5% for the parameters compared). Hence it can be taken that the model is validated and will produce flow regime results accurately for the tides and velocities in the study domain.

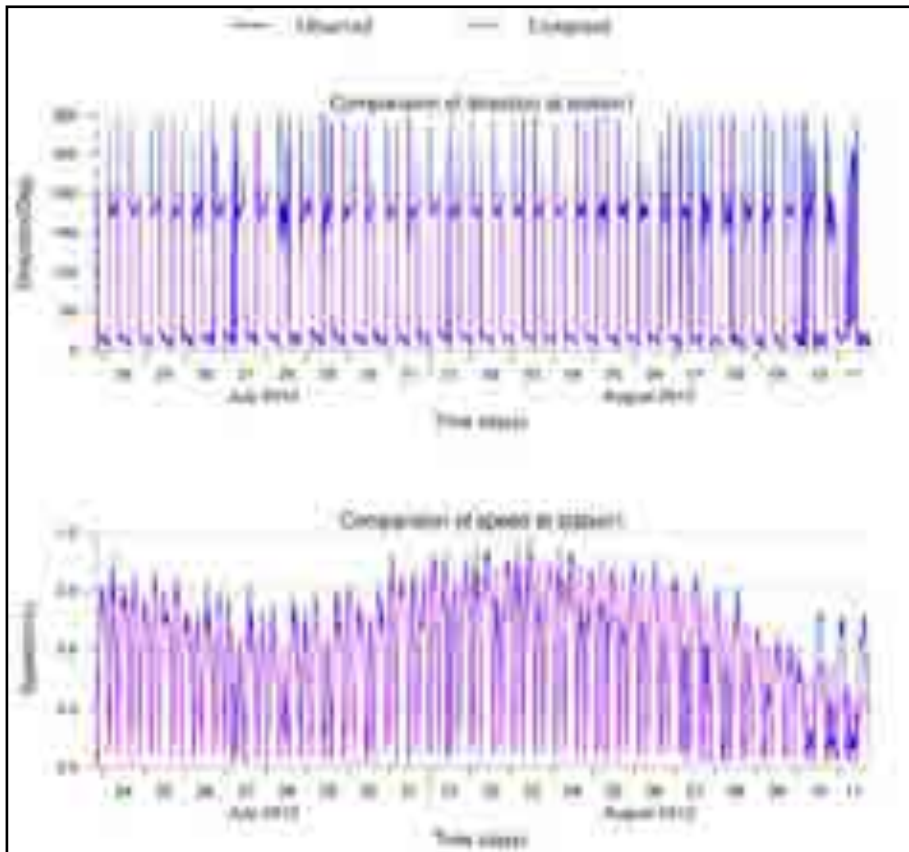


Figure 5-26: Comparison of computed and observed currents at station-1

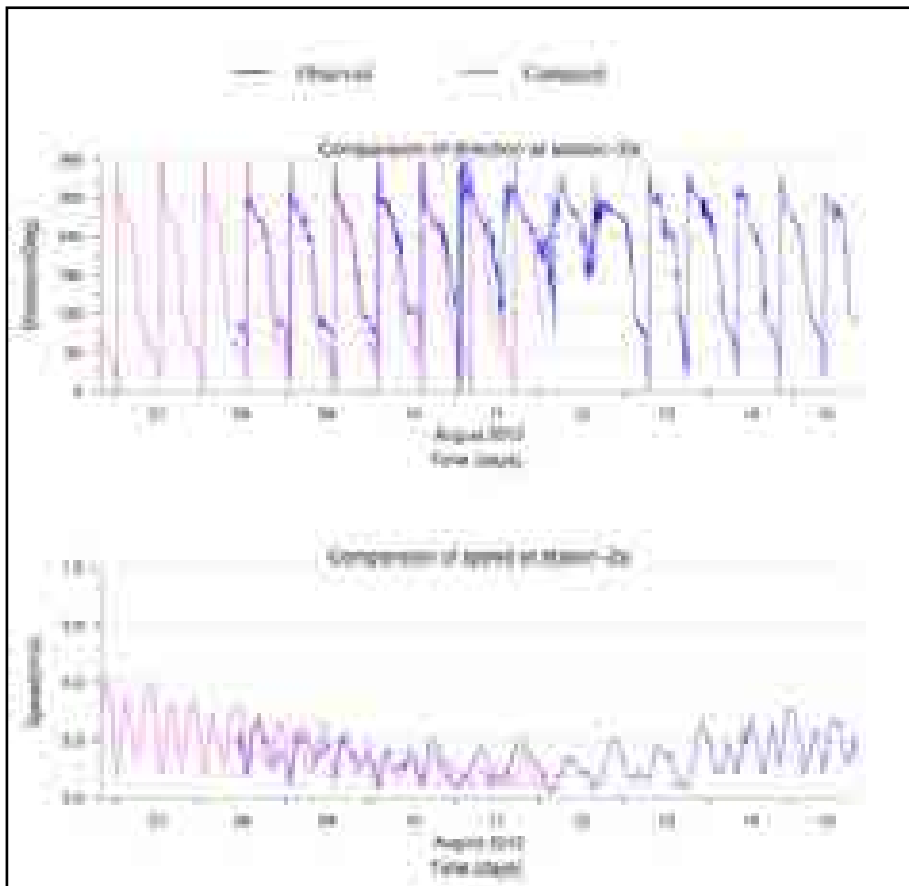


Figure 5-27: Comparison of computed and observed currents at station-2a

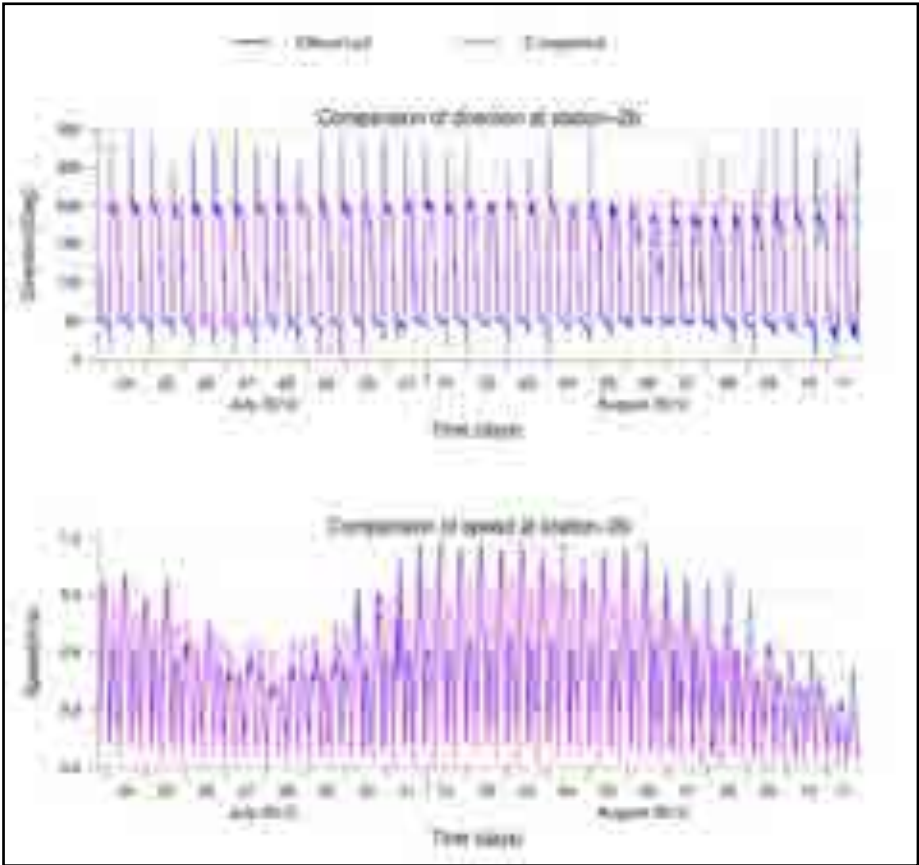


Figure 5-28: Comparison of computed and observed currents at station-2b

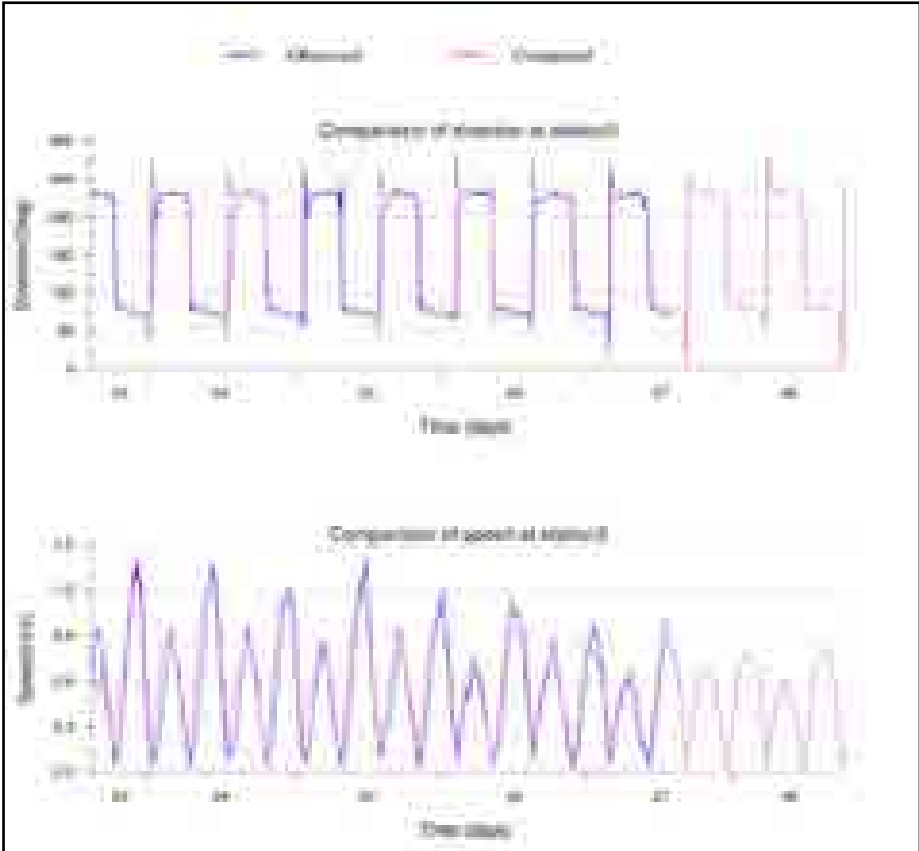


Figure 5-29: Comparison of computed and observed currents at station-3

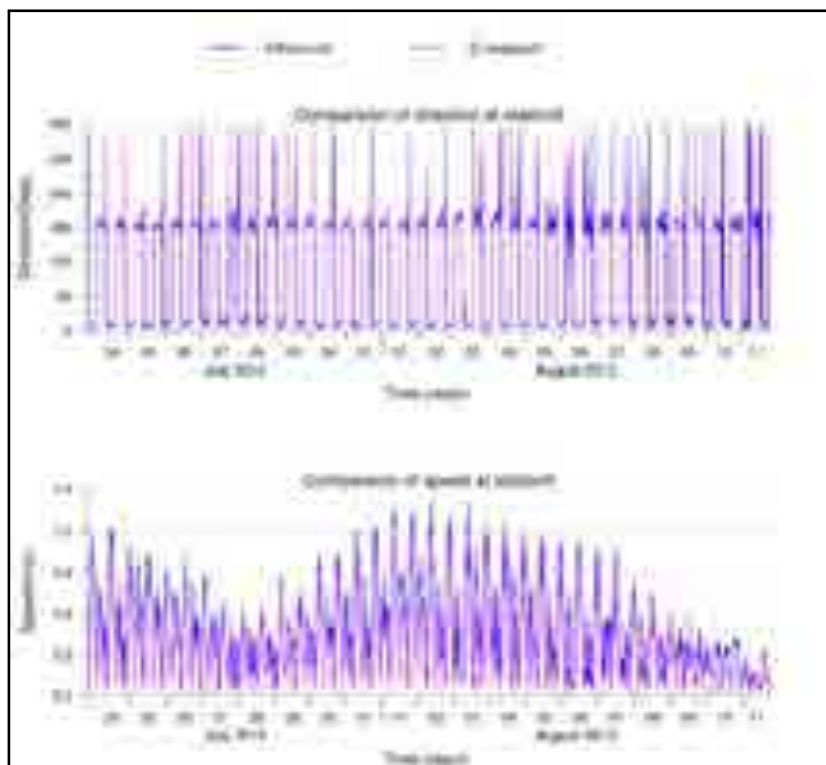


Figure 5-30: Comparison of computed and observed currents at station-5

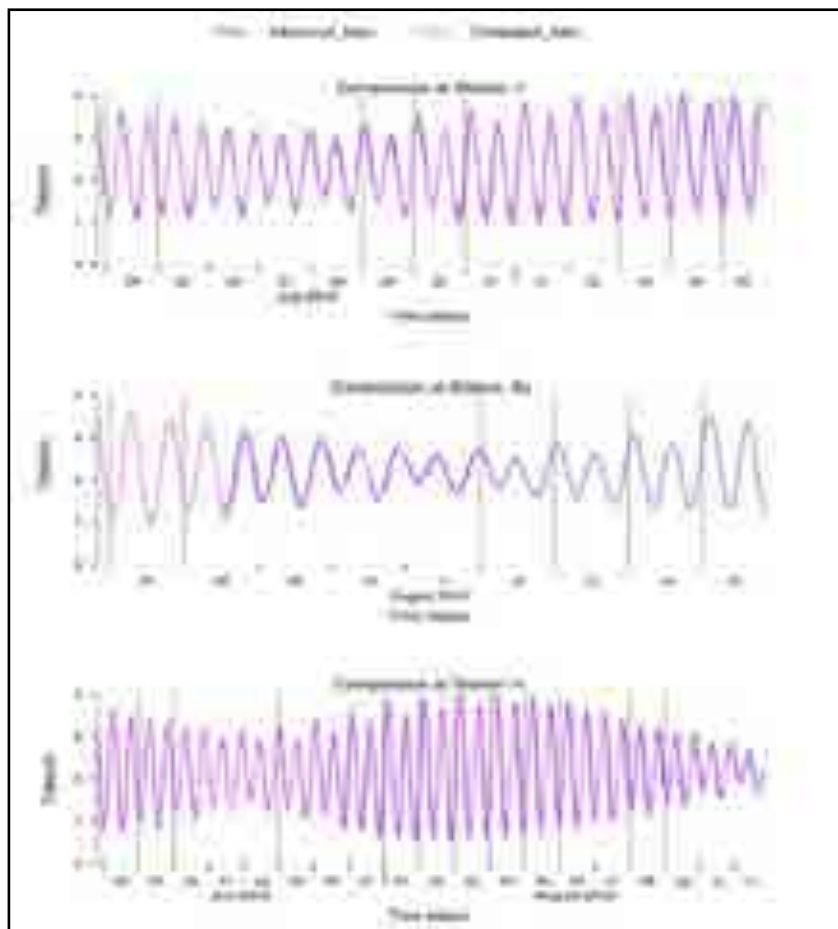


Figure 5-31: Comparison of computed and observed tides at station-1, Station-2a and at Station-4

The model runs have been carried out for a period of 15 days covering spring and neap tide conditions to obtain an insight into the basic hydrodynamic behaviour of the study domain. The model clearly reproduces the tidal variation at various locations in the study region in the Dhamra region.

In order to obtain better accuracy in the prediction of flow regime changes due to the proposed expansion, a finer mesh (**Figure 5-23**) is adopted to represent the study area for modelling purpose. Computational runs have been carried out on this local model domain.

The study domain selected for Dhamra is between the geographical coordinates Easting - 468000 to 522000 and Northing - 2277000 to 2322000. The proposed revised master plan consists of various marine related activities and the same are taken into account in this domain. The terrain features of the domain existing and after development (i.e after expansion) are shown in **Figure 5-32** & **Figure 5-33** respectively.



Figure 5-32: Computational study domain showing the offshore facilities (Existing Development- (ED)



Figure 5-33: Computational study domain showing the offshore facilities after Proposed Expansion (PE)

The size of the model domain is 54000 m x 45000 m. The model domain is divided into several computational triangular blocks and generated grids in x and y directions respectively. The size of the mesh varies between 5 m to 100 m. **Figure 5-34** and **Figure 5-35** shows the computational grid for the domain existing and after development. **Figure 5-36** and **Figure 5-37** show the interpolated bathymetric depth contours existing and after development respectively. From the figures, it can be seen that the maximum depth contour is 44 m. **Figure 5-38** and **Figure 5-39** show the zoomed portion showing the offshore facilities existing and after developments respectively. **Figure 5-40** and **Figure 5-41** are zoomed portions of computational grid. The bathymetry is selected from the measured hydrographic chart data.



Figure 5-34: Computation grid for study domain (ED)

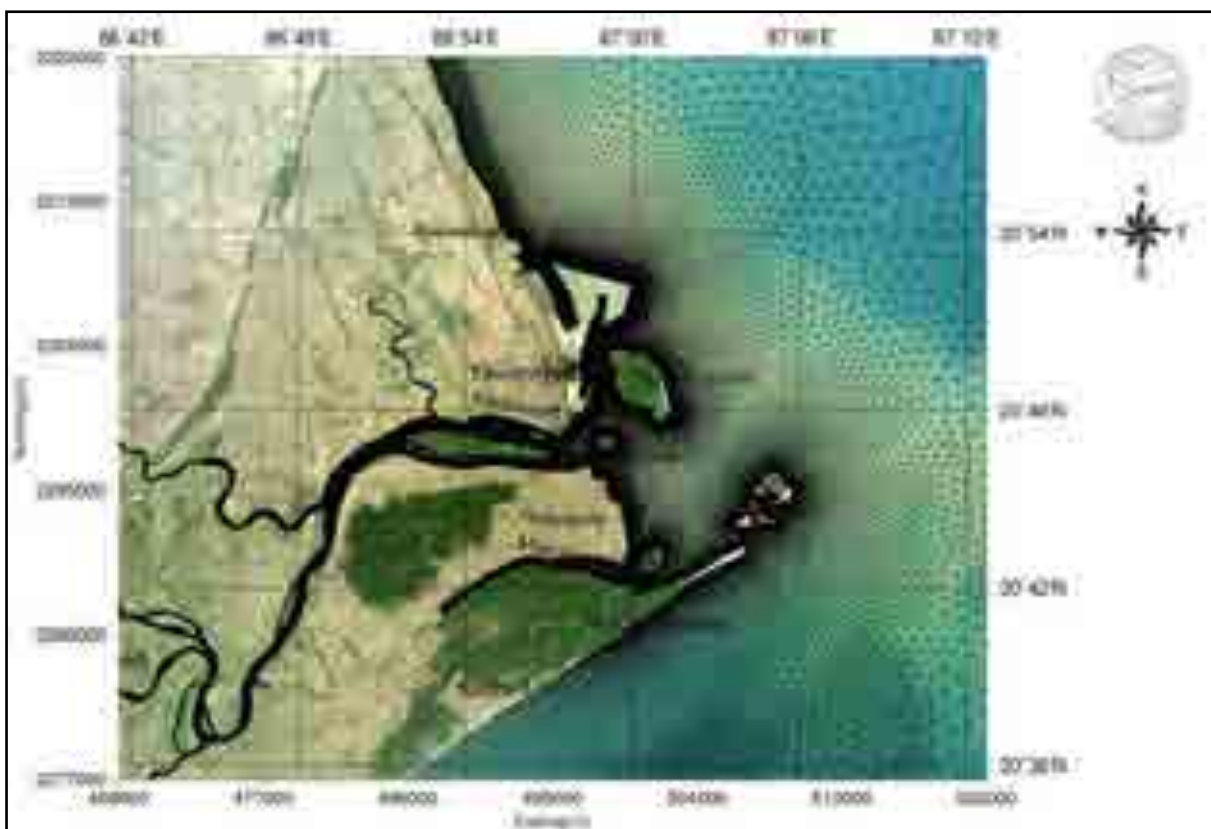


Figure 5-35: Computational grid for study domain (Proposed Expansion)

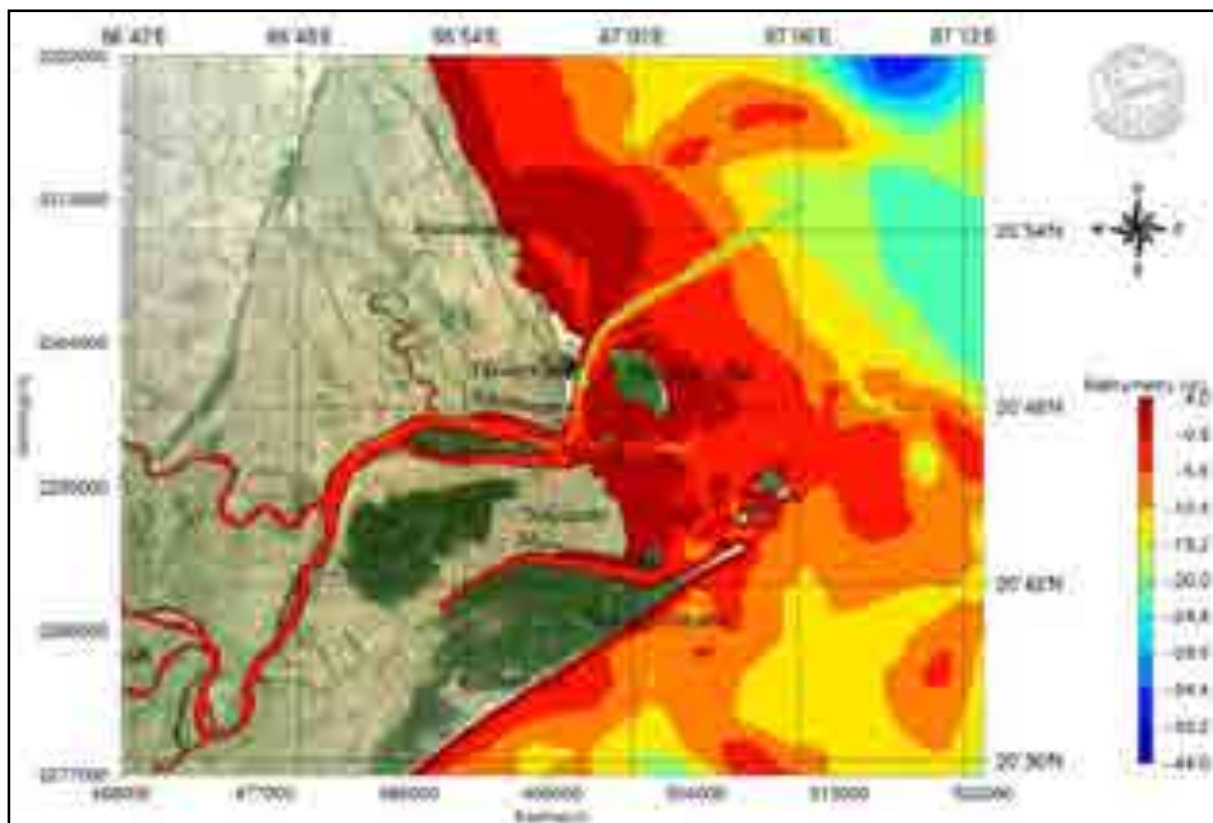


Figure 5-36: Interpolated depth contours of the study domain (ED)

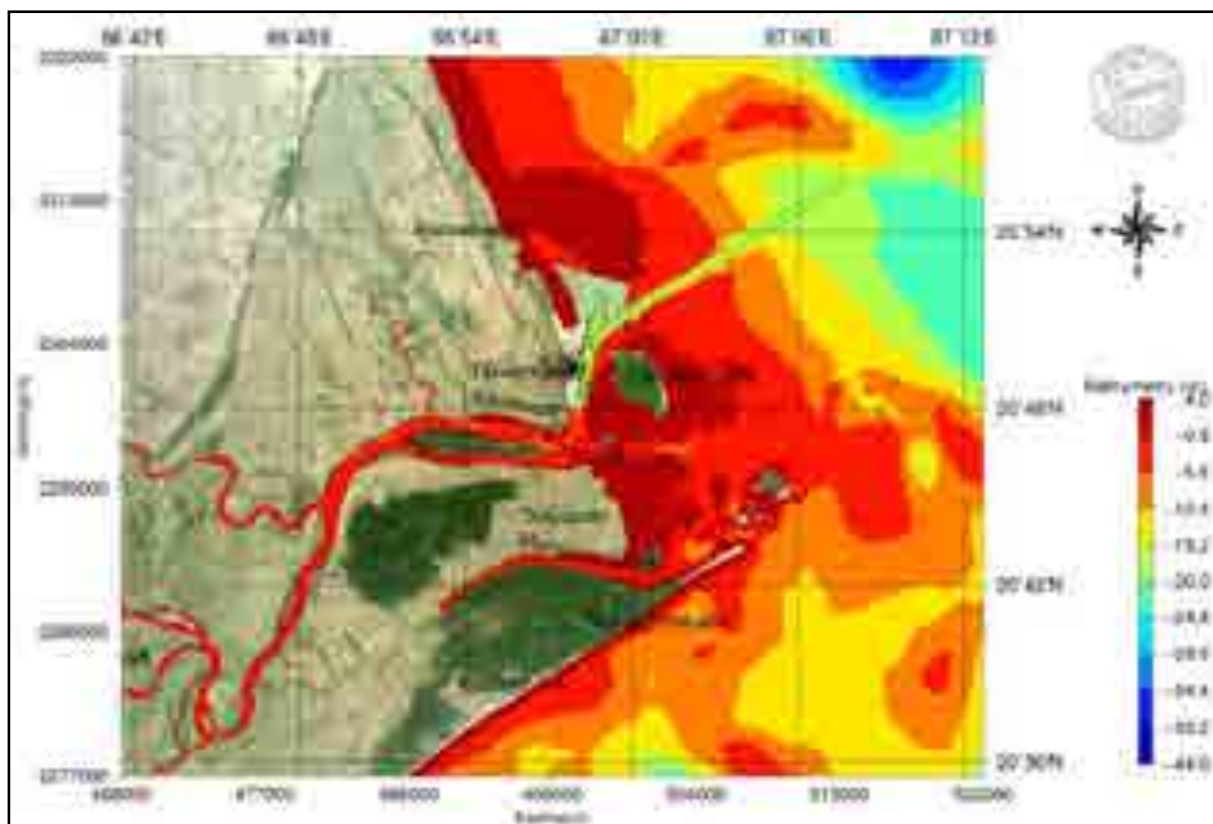


Figure 5-37: Interpolated depth contours of the study domain (Proposed Expansion)

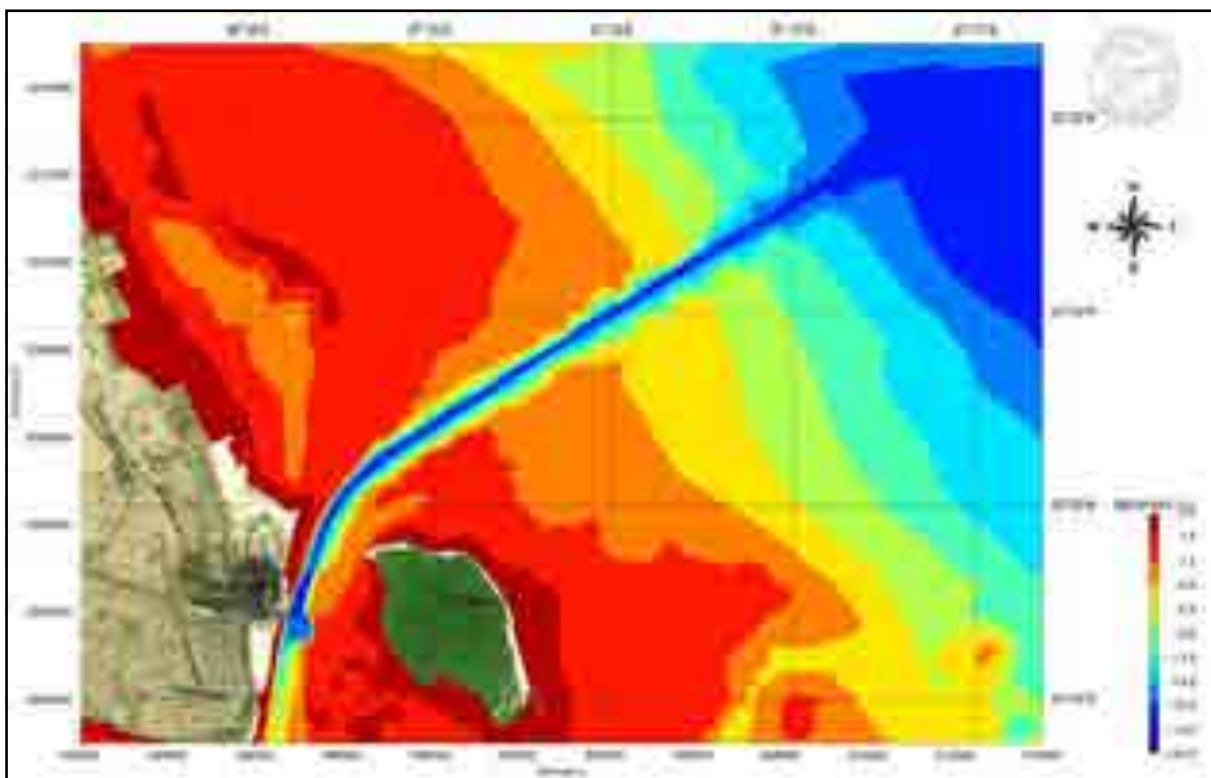


Figure 5-38: Zoomed Interpolated depth contours of the study domain (ED)

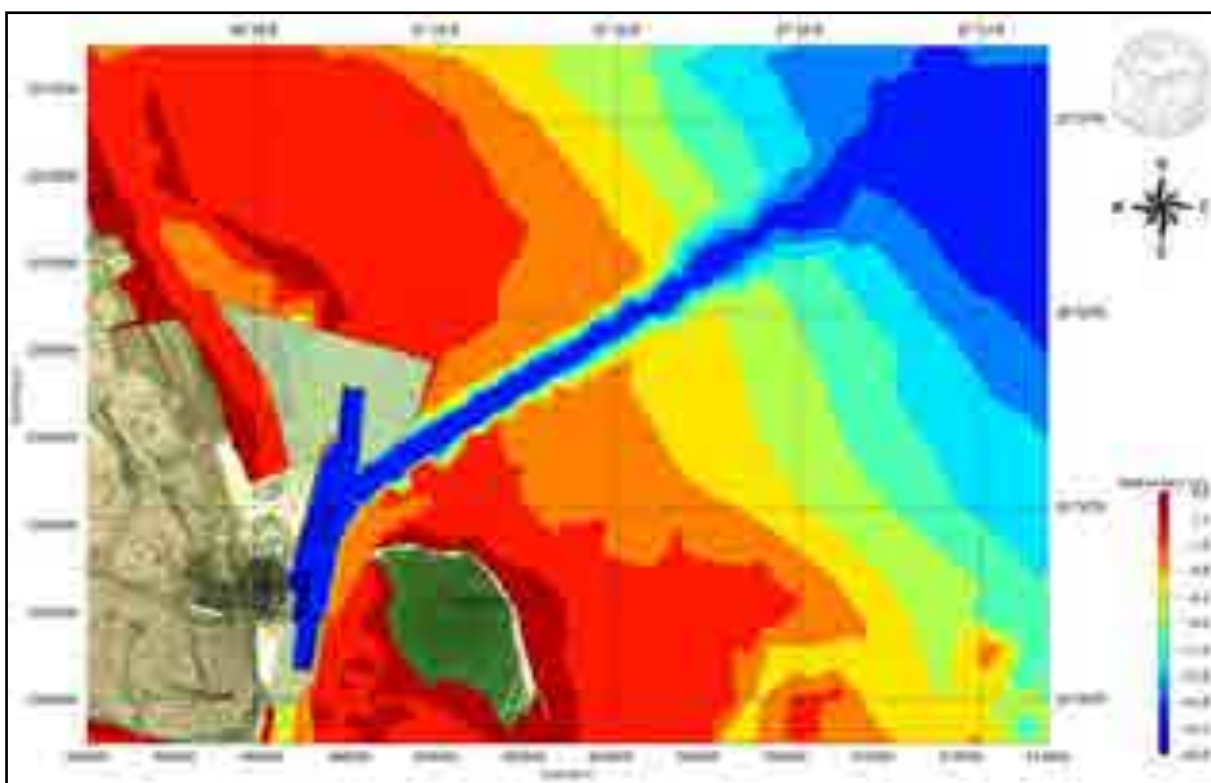


Figure 5-39: Zoomed Interpolated depth contours of the study domain (Proposed Expansion)



Figure 5-40: Zoomed up Computation grid for study domain (ED)

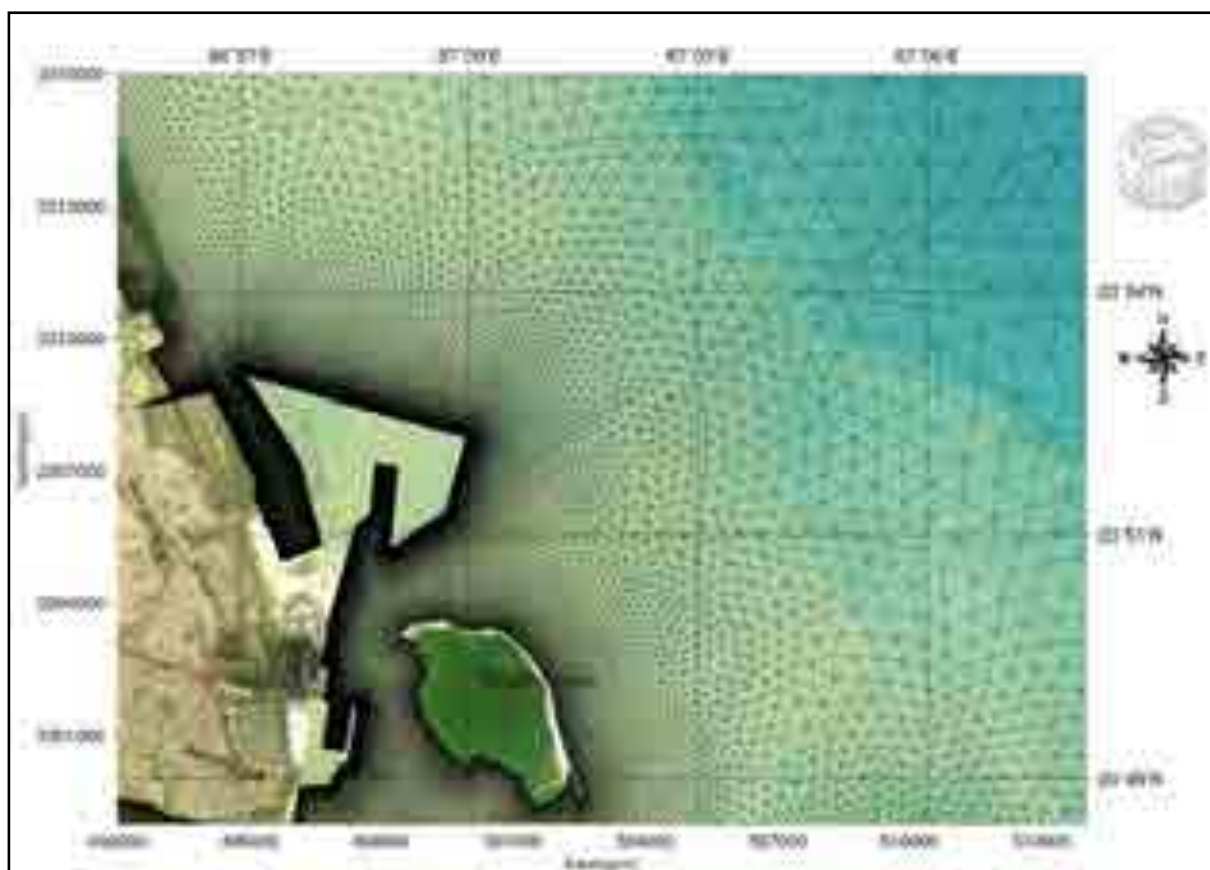


Figure 5-41: Zoomed up Computation grid for study domain (Proposed Expansion)

Modelling of flow regime:

The study has been carried out to predict the changes in the flow regime and circulation pattern due to the proposed expansion for various hydrodynamic conditions. The model clearly reproduces the tidal variation at various locations in the study area. The typical tidal elevations and velocities for Low Water (LLW), High Water (HHW), Peak Flood (PF) and Peak Ebb (PE) for the month of July & August 2012 have been generated and are discussed in the following sections. The software has been run for 15 days continuously representing spring and neap tide conditions for both the cases of existing development as well as after expansion and the predicted results are discussed below:

A) Neap tide condition-slack-1(LLW): The water levels during slack-1 for neap tide condition of existing and after the proposed expansion are shown in **Figure 5-42** and **Figure 5-43**, respectively. From the figures it can be seen that increase (0.3-0.6m) in water levels at north side Mangrove, Northern side mouth of Dhamra river, Kanika Island and Southern side mouth of Dhamra River, due to the proposed expansion. It is also observed from the figures that there is slight reduction in water level (0.1m) at Wheeler Island.

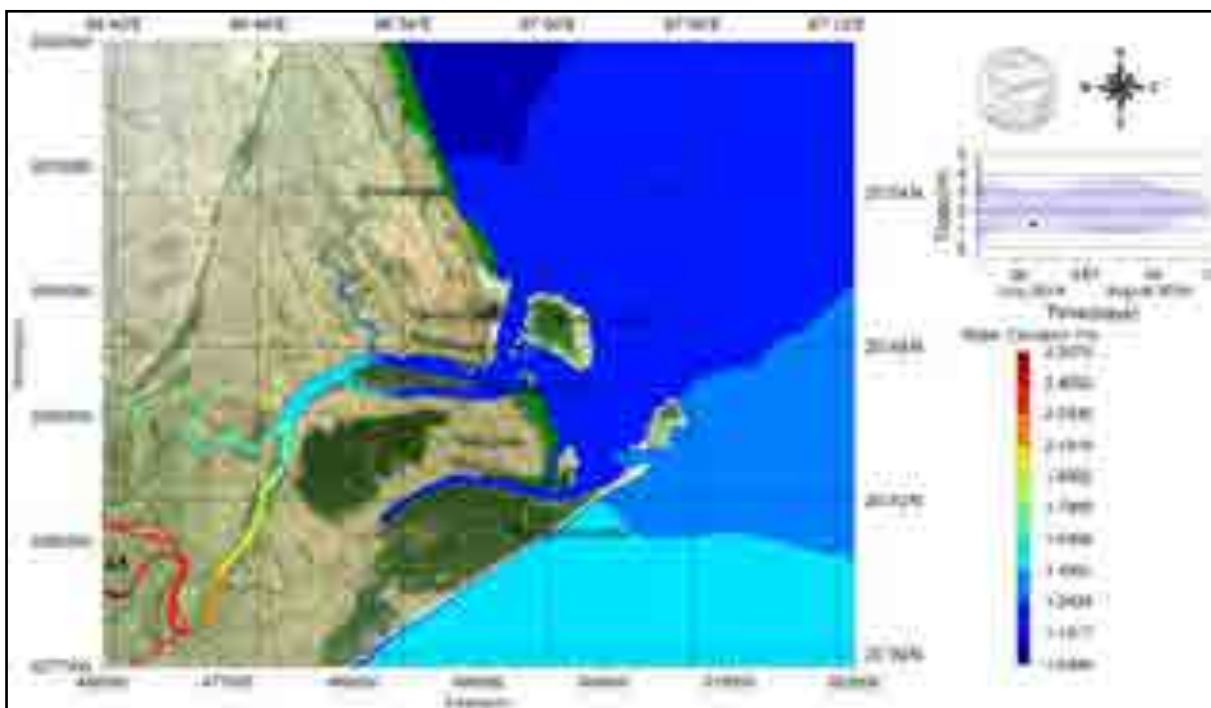


Figure 5-42: Simulated Tides (at 16:15:00 hrs of 27/07/2016) during neap tide-(LLW) Existing Development

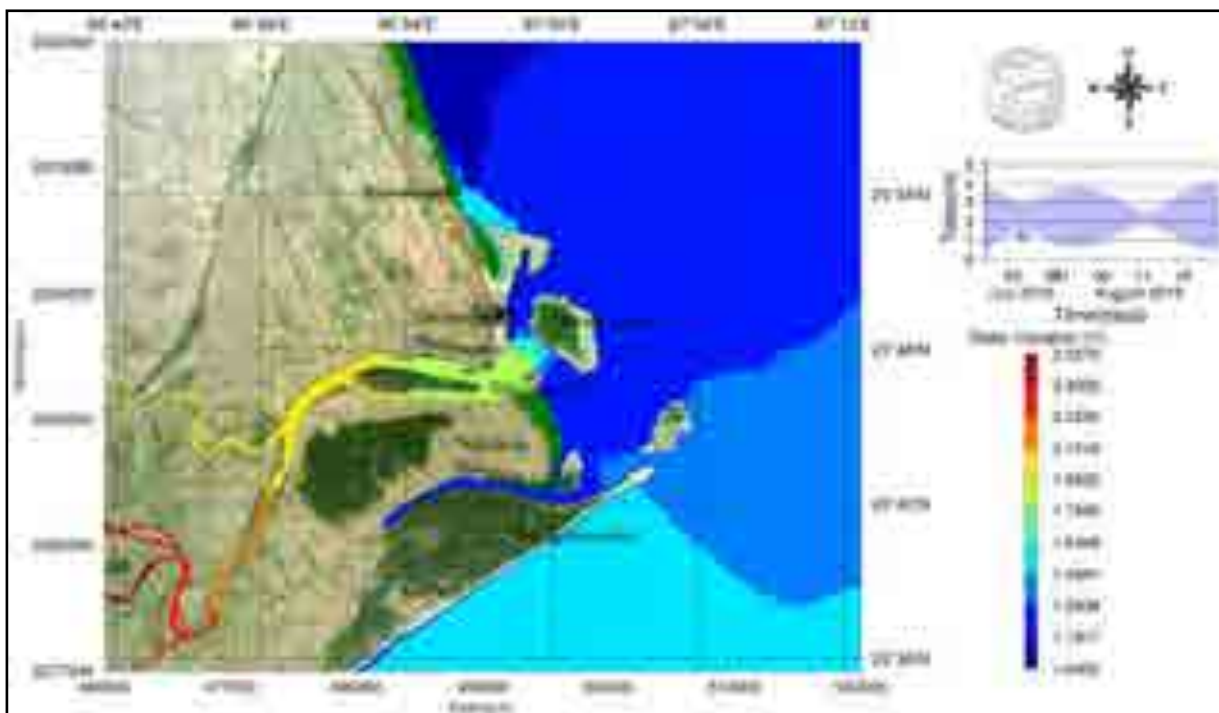


Figure 5-43: Simulated Tides (at 16:15:00 hrs of 27/07/2016) during neap tide-(LLW) After Proposed Expansion

The flow velocities during slack-1 for neap tide condition of existing and after the proposed expansion are shown in **Figure 5-44** and **Figure 5-45**, respectively. From the figures it can be seen that there is marginal increase in velocity (0.07 m/sec) at Northern side mouth of Dhamra, whereas decrease in flow velocity at Kanika Island (0.2 m/sec) and no changes have been observed at North Side Mangroves, Southern side mouth of Dhamra River and Wheeler Island.

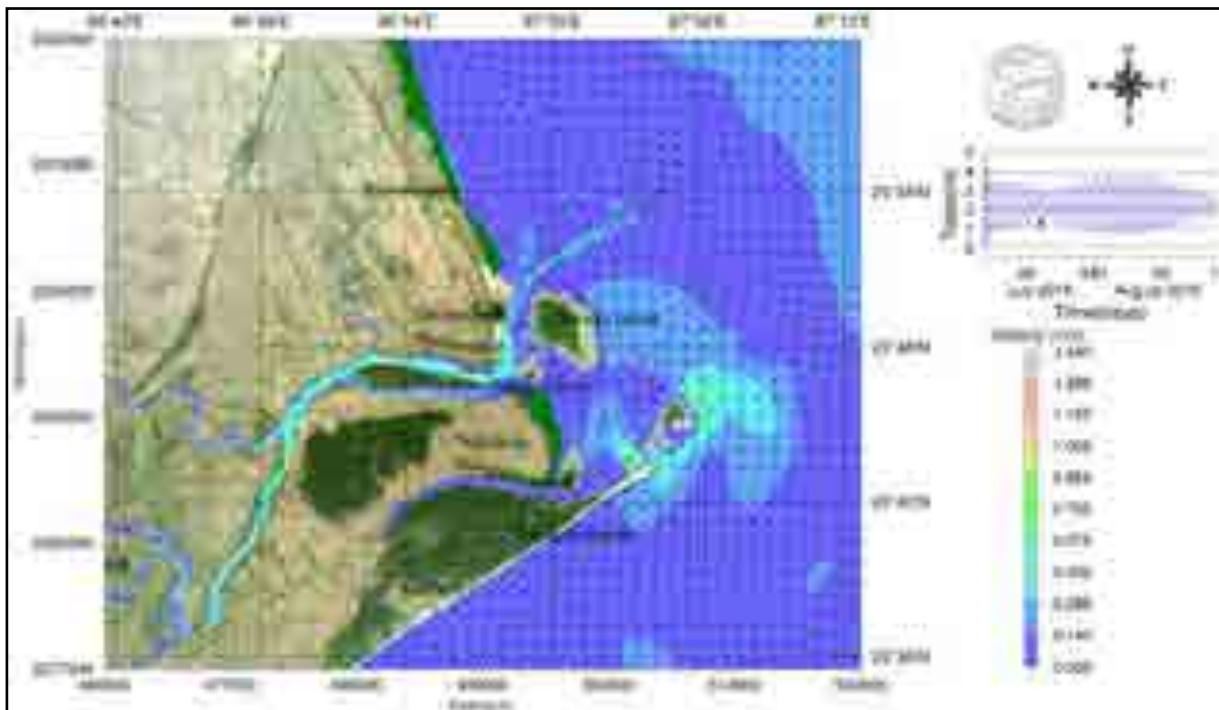


Figure 5-44: Simulated Currents (at 16:15:00 hrs of 27/07/2016) during neap tide-(LLW) Existing Development

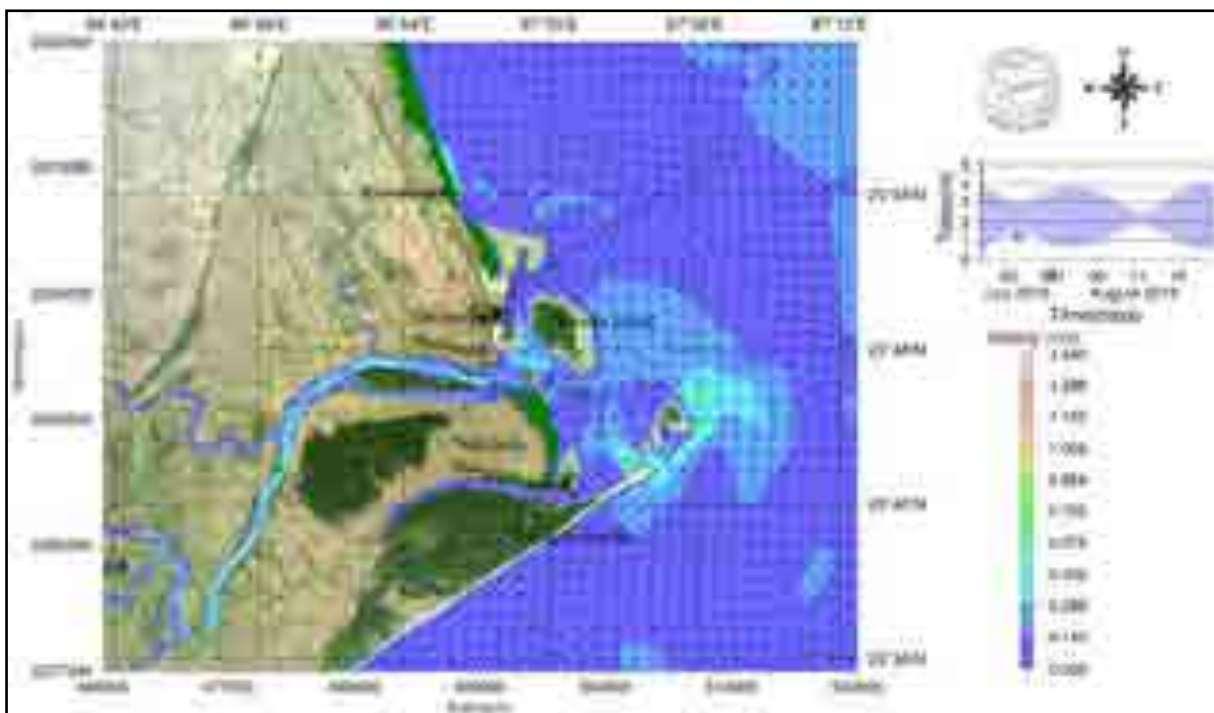


Figure 5-45: Simulated Currents (at 16:15:00hrs of 27/07/2016) during neap tide-(LLW) After Proposed Expansion

Figure 5-46 shows the difference in current speed between the existing and proposed expansion. From the figure it can be seen the current speed is slightly increased in western side of Kanika and reduced towards Northern side Mouth of Dhamra River.

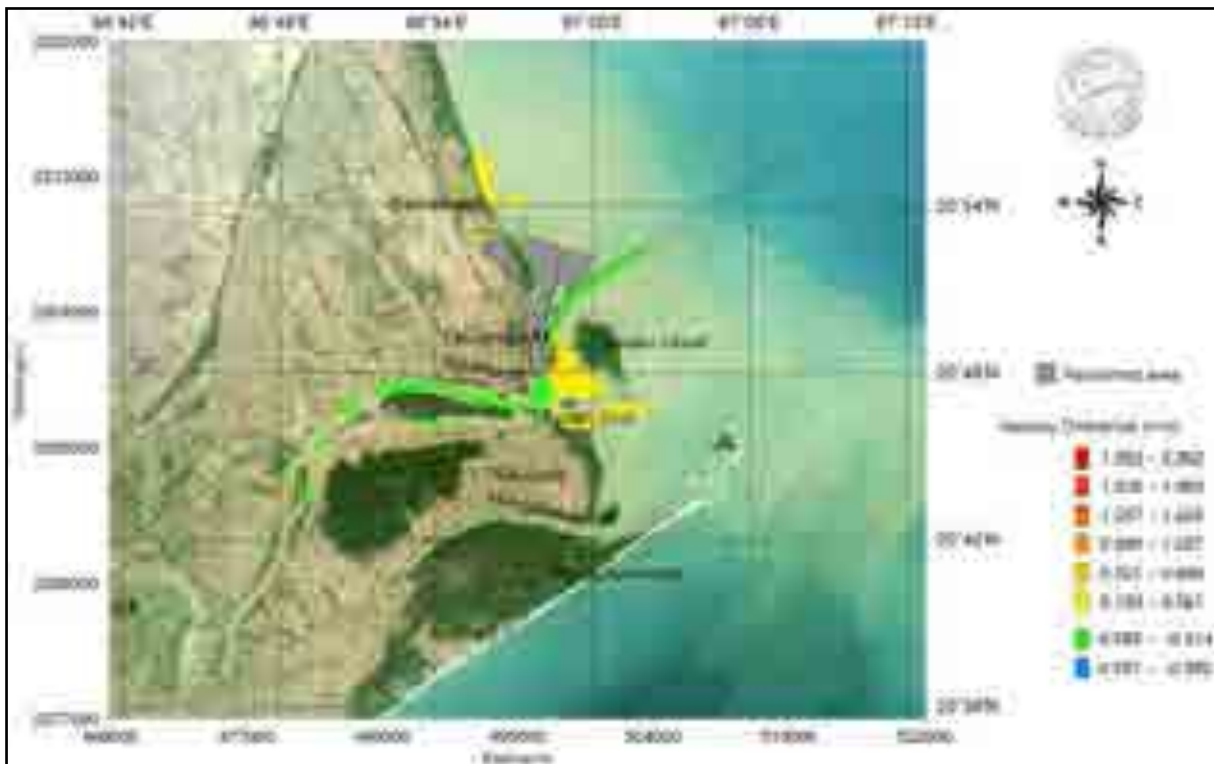


Figure 5-46: Difference in velocities between Existing Development and After Proposed Expansion (at 16:15:00 hrs of 27/07/2016) during neap tide-(LLW)

B) Neap tide condition-slack-1(PF): The water levels during Peak Flood of neap tide condition existing and after proposed expansion are shown in **Figure 5-47** and **Figure 5-48**, respectively. From the figures it can be seen that there is decrease (0.18 -0.3 m) in water levels at north side Mangrove, Northern side mouth of Dhamra River, and Southern side mouth of Dhamra River, due to the proposed expansion. Whereas, no changes have been observed at Wheeler Island and near Kanika Island due to proposed expansion.

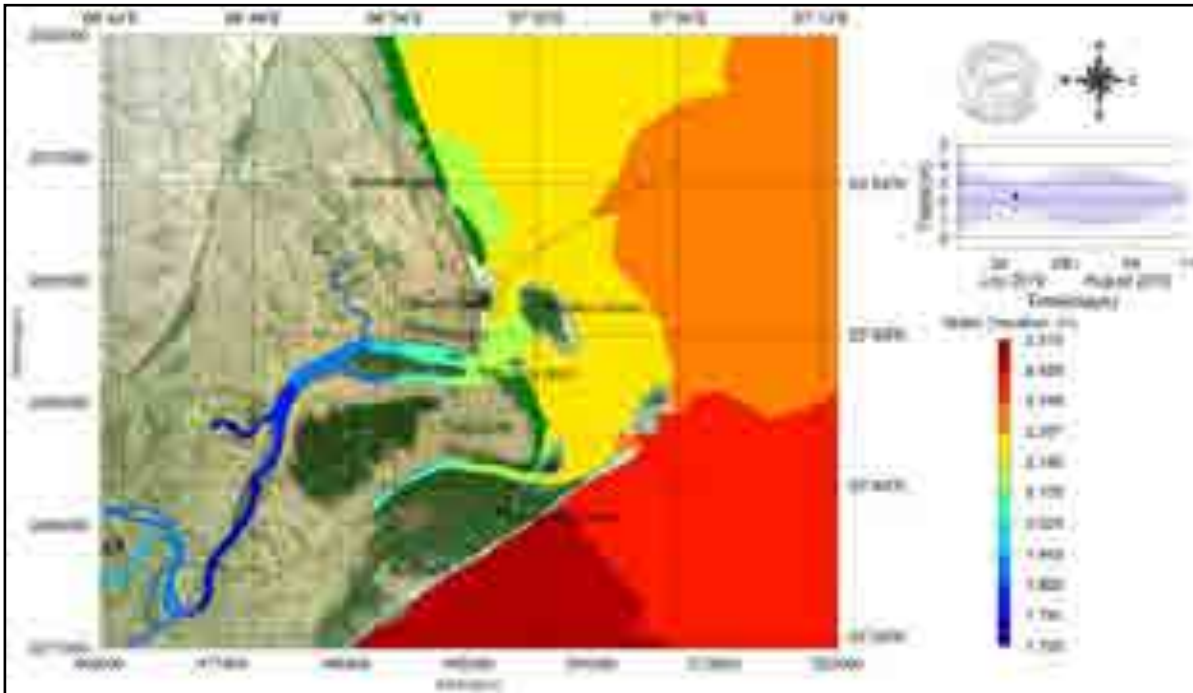


Figure 5-47: Simulated Tides (at 19:45:00 hrs of 27/07/2016) during neap tide-(FLD) Existing Development

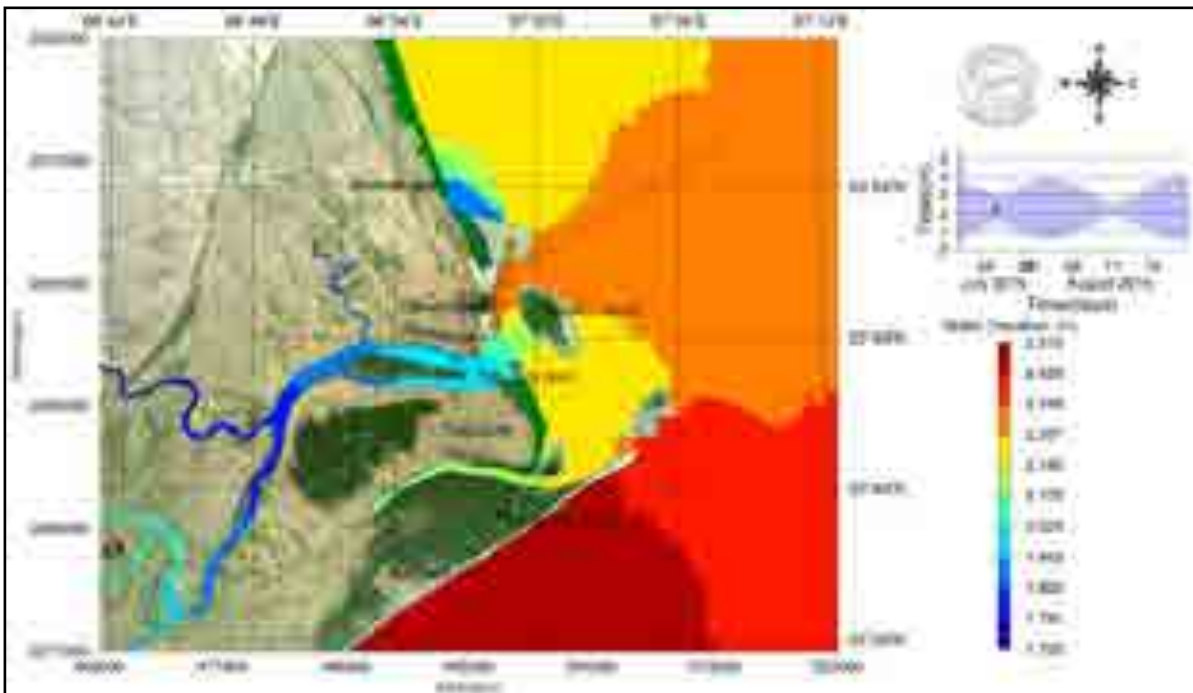


Figure 5-48: Simulated Tides (at 19:45:00 hrs of 27/07/2016) during neap tide-(FLD) After Proposed Expansion

The currents during Peak Flood of neap tide condition existing and after proposed expansion are shown in **Figure 5-49** and **Figure 5-50**, respectively. From the figures it can be seen that there is increase in velocity (0.65 m/sec) at Wheeler Island, where as decrease in flow velocity (0.12-0.25 m/sec) at Southern side mouth of Dhamra River and Northern side mouth of Dhamra River. Further no changes have been observed at North Side Mangroves, and Kanika Island due to proposed expansion.

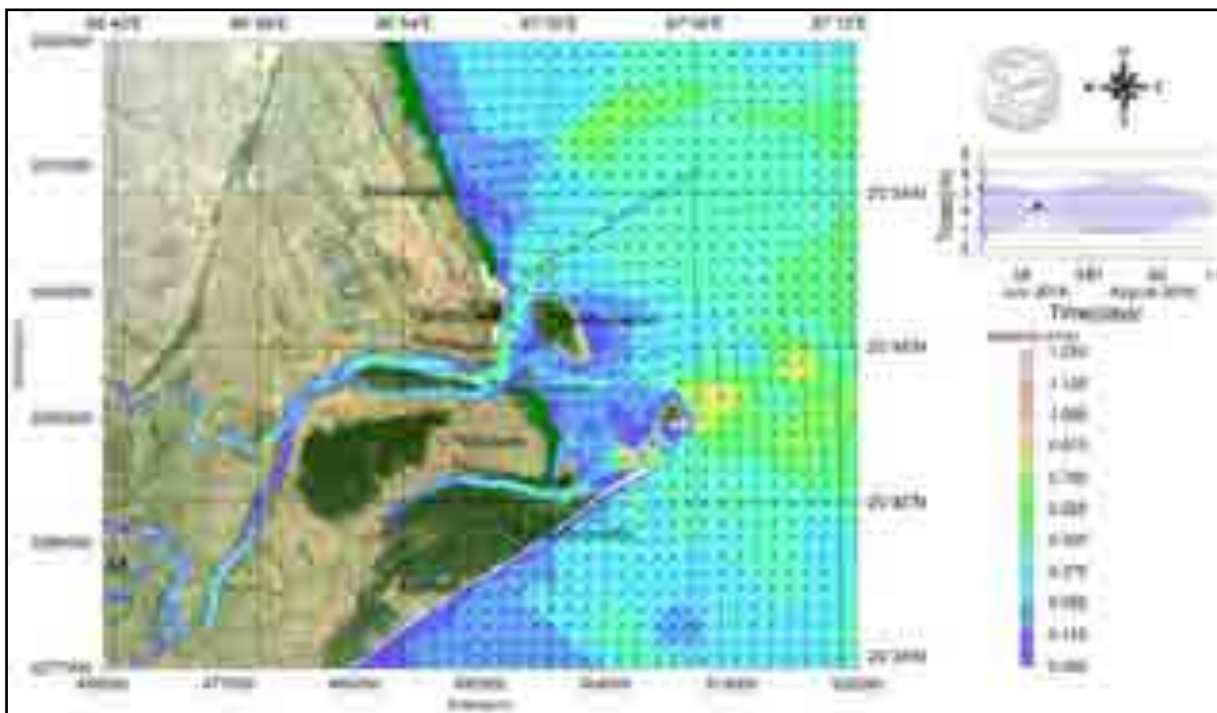


Figure 5-49: Simulated Currents(at19:45:00hrs of 27/07/2016) during neap tide-(FLD) Existing Development

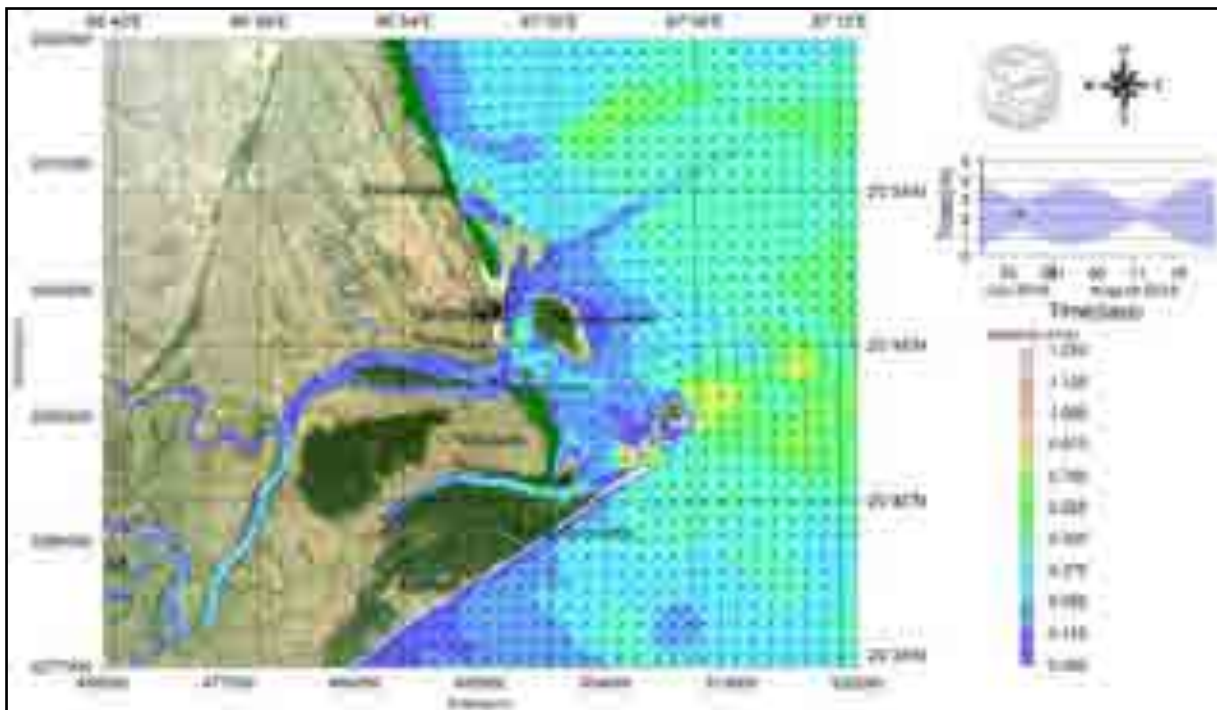


Figure 5-50: Simulated Currents (at 19:45:00hrs of 27/07/2016) during neap tide-(FLD) After Proposed Expansion

Figure 5-51 shows the difference in current speed between the existing and proposed expansion. From the figure it can be seen the current speed slightly increases in western side of Kanika, North side mangroves and Southern side mouth of Dhamra River and reduced towards Northern side Mouth of Dhamra River due to proposed expansion.

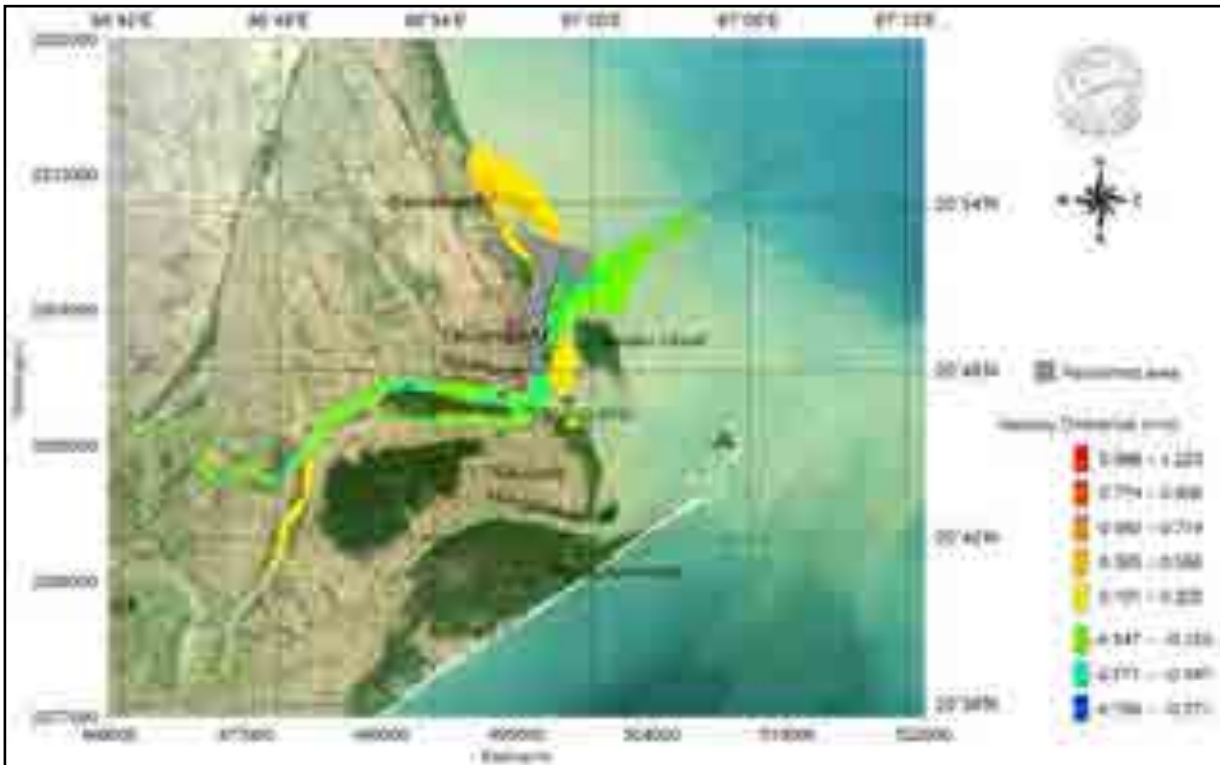


Figure 5-51: Difference in velocities between Existing Development and After Proposed Expansion

- C) Neap tide condition- highest high water (slack-2) (HHW):** The water levels during High water of neap condition existing and after proposed expansion are shown in **Figure 5-52** and **Figure 5-53**, respectively. From the figures it can be seen that there is marginal increase (0.1 -0.11 m) in water levels at North Side mangroves and Wheeler island, Whereas there is decrease (0.2 m) at Northern side mouth of Dhamra River and Southern side mouth of Dhamra River, no changes have been observed near Kanika Island due to proposed expansion.

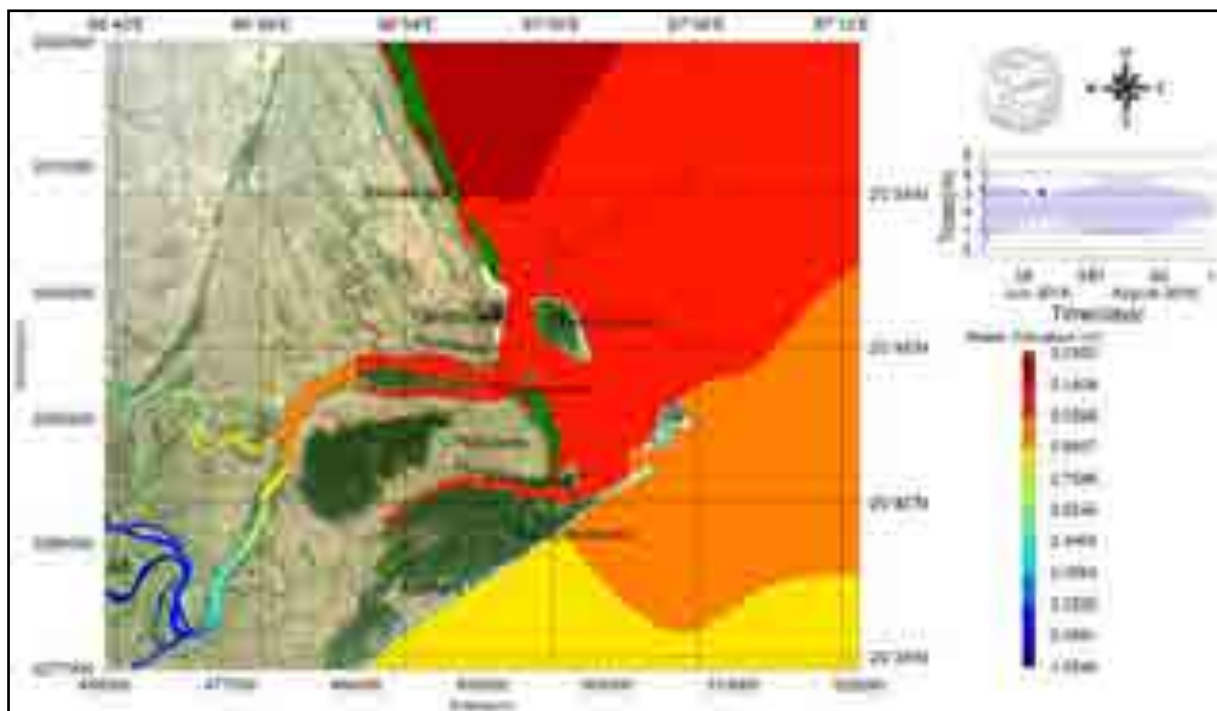


Figure 5-52: Simulated Tides(at 22:45:00 hrs of 27/07/2016) during neap tide-(HHW) Existing Development

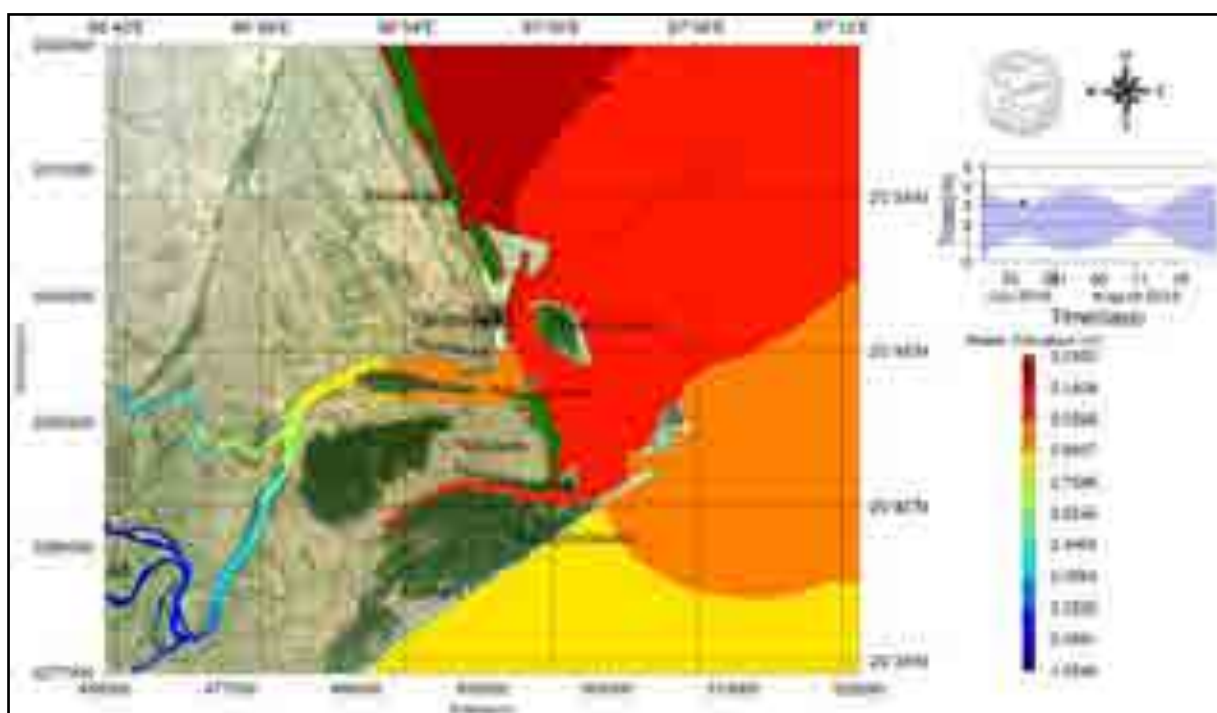


Figure 5-53: Simulated Tides (at 22:45:00 hrs of 27/07/2016) during neap tide-(HHW) After Proposed Expansion

The currents during High water of neap tide condition existing and after proposed expansion are shown in **Figure 5-54** and **Figure 5-55**, respectively. From the figures it can be seen that there is a marginal increase in velocity (0.017 – 0.3 m/sec) at North side mangrove, Kanika, northern side Mouth of Dhamra River and Southern side mouth of Dhamra River. Whereas decrease in flow velocity (0.2 m/sec) at Wheeler Island has been observed due to proposed expansion.

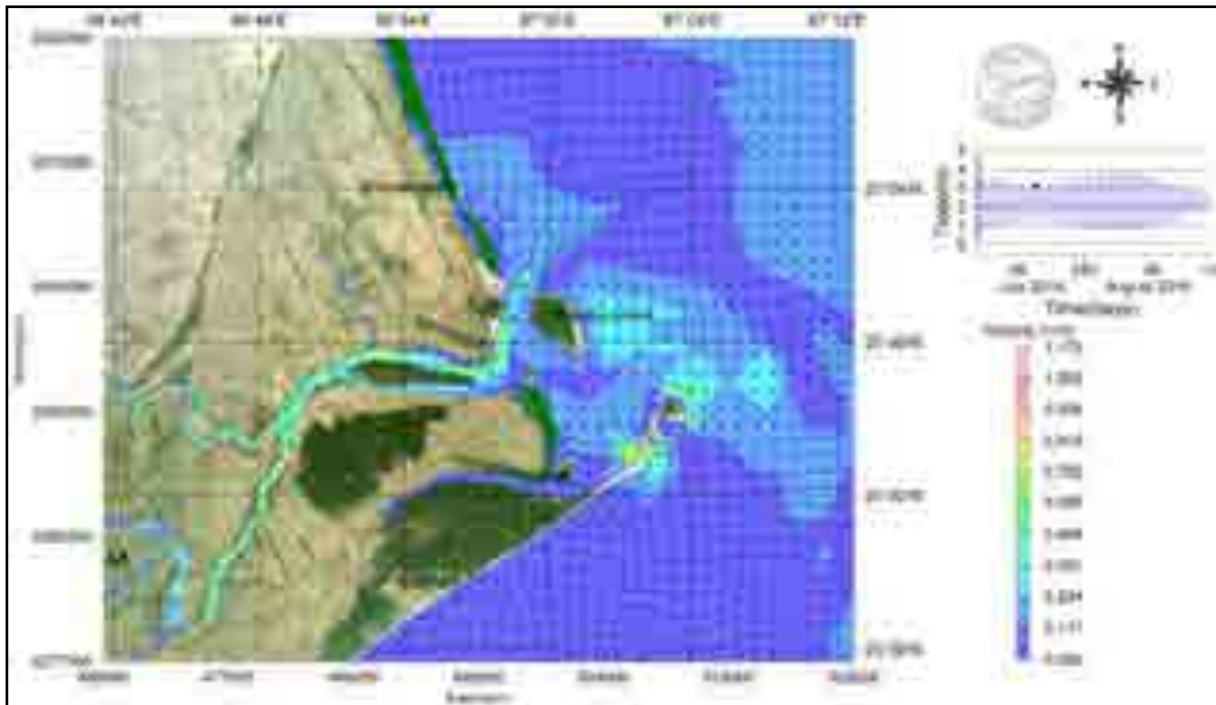


Figure 5-54: Simulated currents (at 22:45:00 hrs of 27/07/2016) during neap tide-(HHW) Existing Development

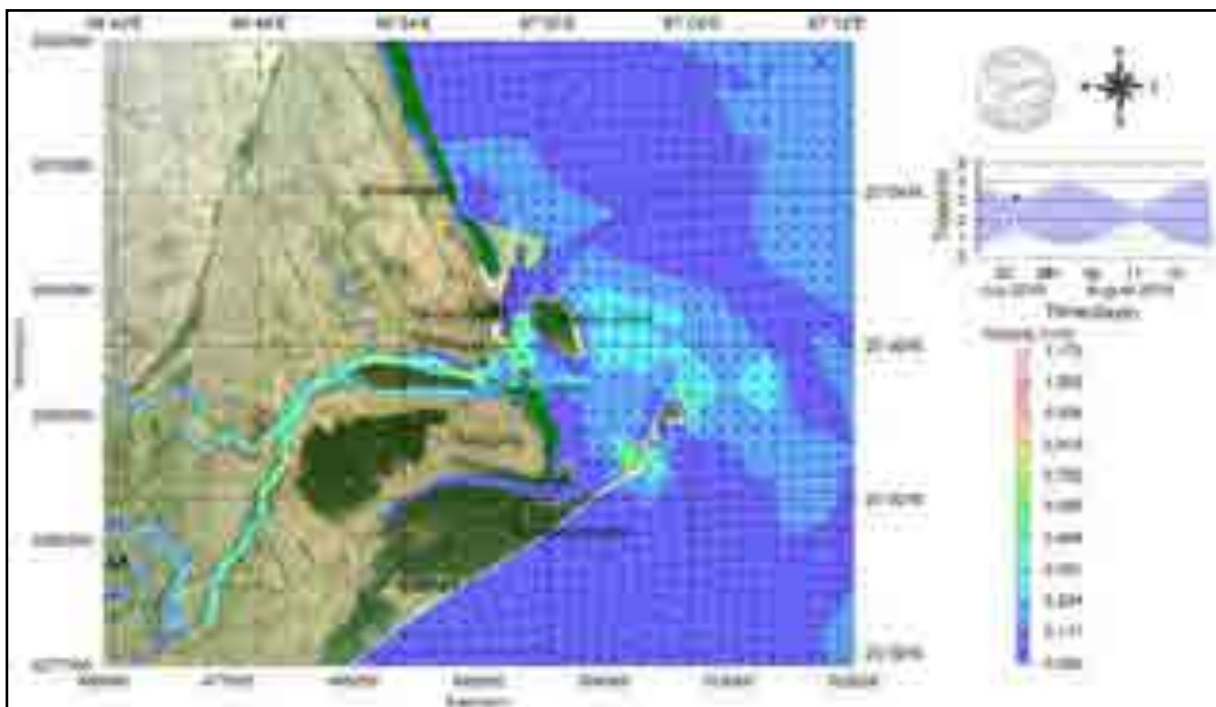


Figure 5-55: Simulated currents (at 22:45:00 hrs of 27/07/2016) during neap tide-(HHW) After Proposed Expansion

Figure 5-56 shows the difference in current speed existing and after the proposed expansion. From the figure it can be seen that the current speed slightly increases towards western side of Kanika island and Southern side mouth of Dhamra River and reduced towards the North side mangroves due to proposed expansion.

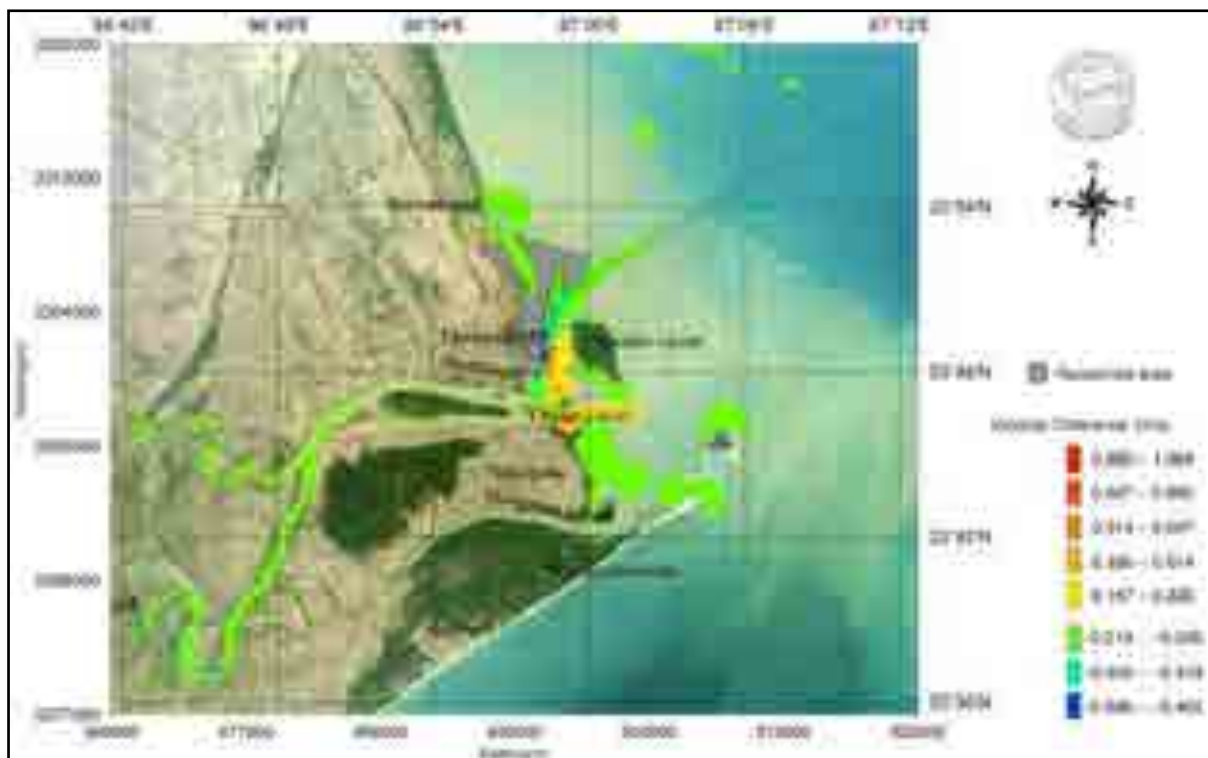


Figure 5-56: Difference in velocities between Existing Development and After Proposed Expansion (at 22:45:00 hrs of 27/07/2016) during neap tide-(HHW)

D) Neap tide condition - peak ebb (PE): The water level peak ebb for neap tide condition existing and after proposed expansion are shown in **Figure 5-57** and **Figure 5-58**, respectively. From the figures it can be seen that there is increase (0.1 m) in water levels at North Side mangroves, Northern side Mouth of Dhamra River and Southern side mouth of Dhamra River whereas, no changes have been observed near Kanika and Wheeler Island due to proposed expansion.

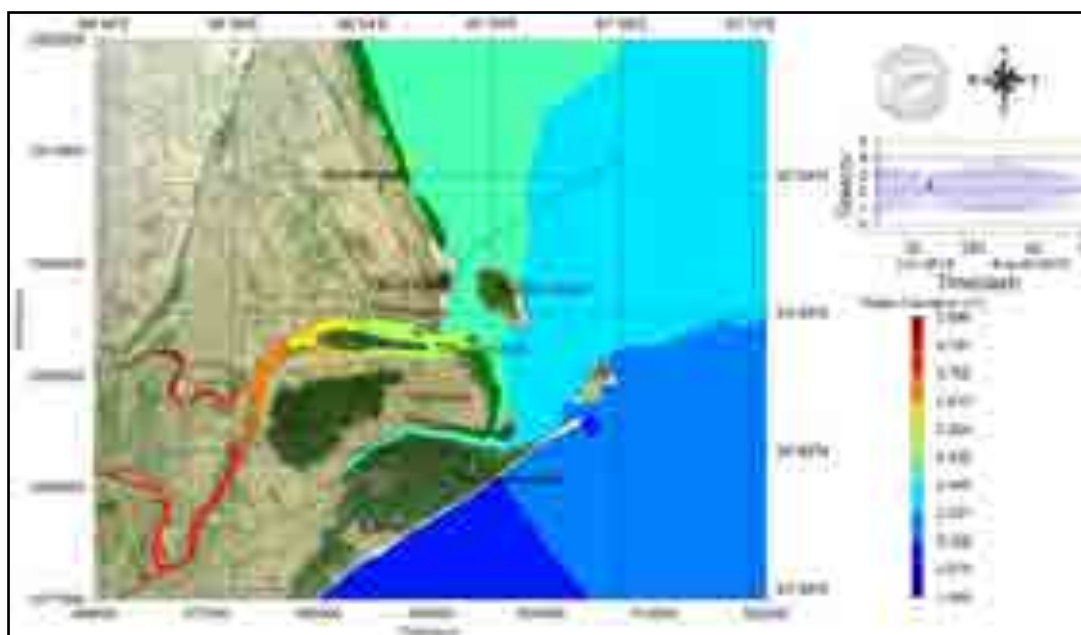


Figure 5-57: Simulated Tides(at 02:00:00 hrs of 28/07/2016) during neap tide-(EBB) Existing Development

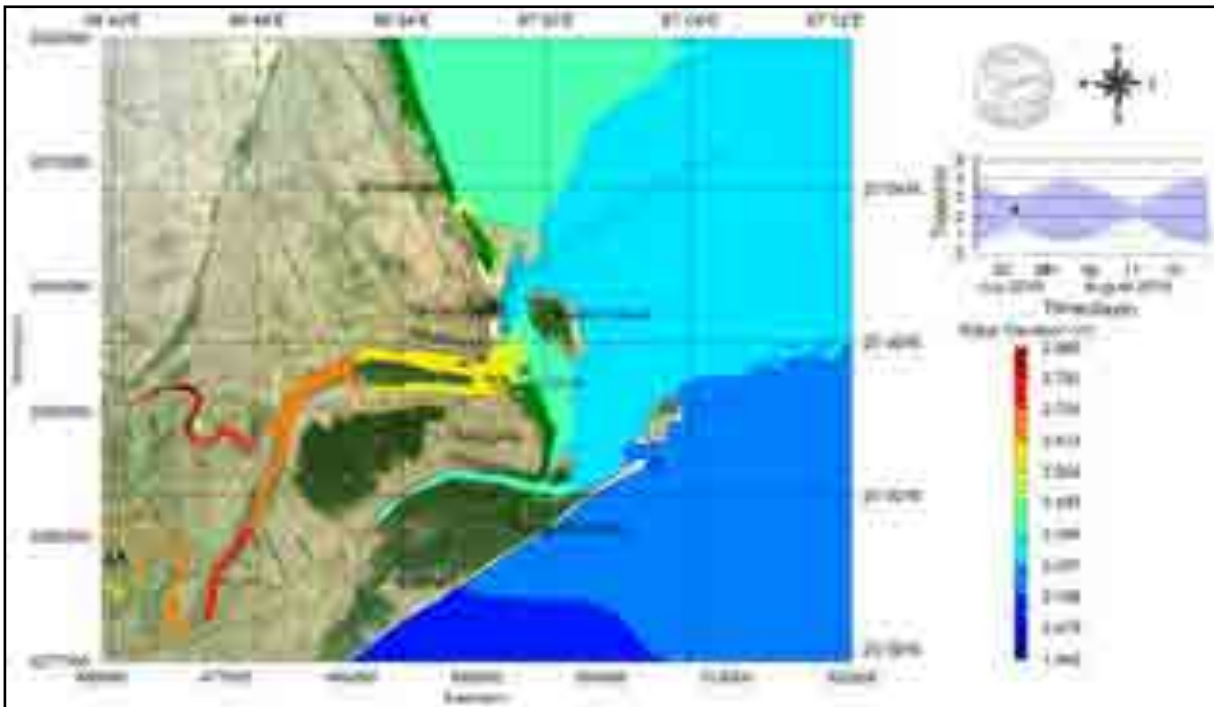


Figure 5-58: Simulated Tides (at 02:00:00 hrs of 28/07/2016) during neap tide-(EBB) After Proposed Expansion

The currents during peak ebb of neap tide condition existing and after proposed expansion are shown in **Figure 5-59** and **Figure 5-60**, respectively. From the figures it can be seen that there is marginal increase in velocity (0.06 – 0.12 m/sec) at Wheeler Island and Kanika Island where as decrease in flow velocity (0.12 m/sec) at Northern side Mouth of dharma River. No changes have been observed near North Side Mangroves and Southern side mouth of Dhamra River due to proposed expansion.

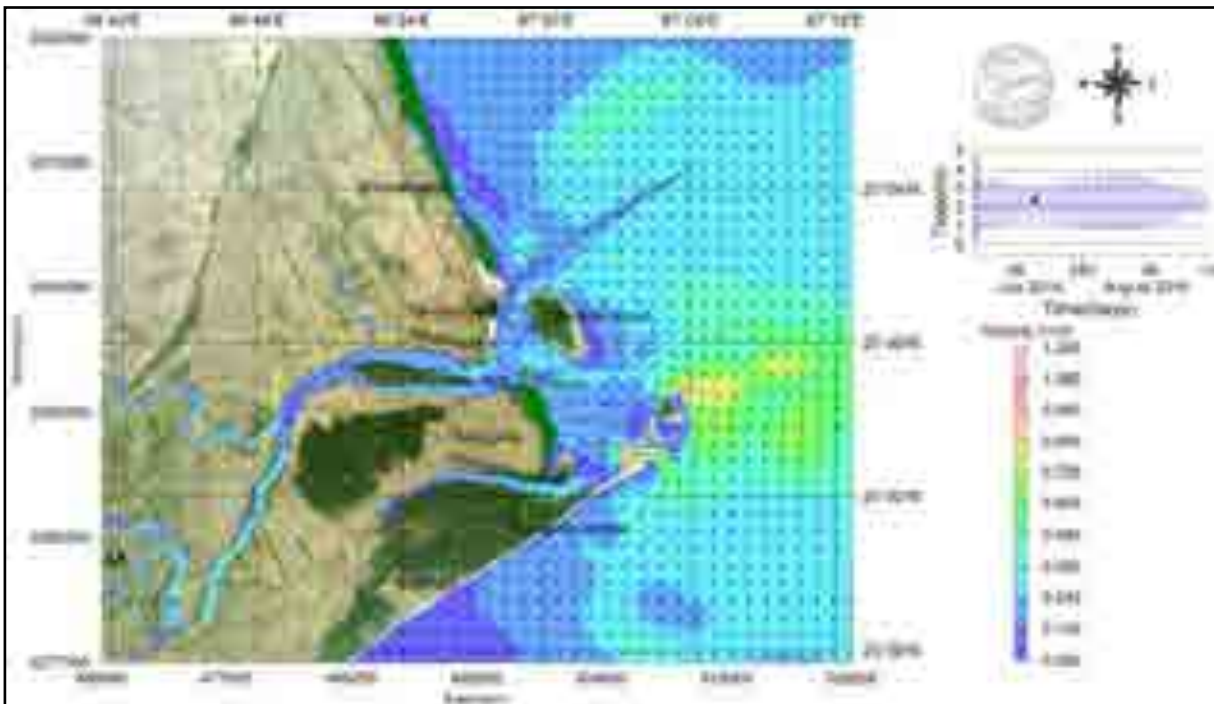


Figure 5-59: Simulated currents (at 02:00:00hrs of 28/07/2016) during neap tide-(EBB) Existing Development

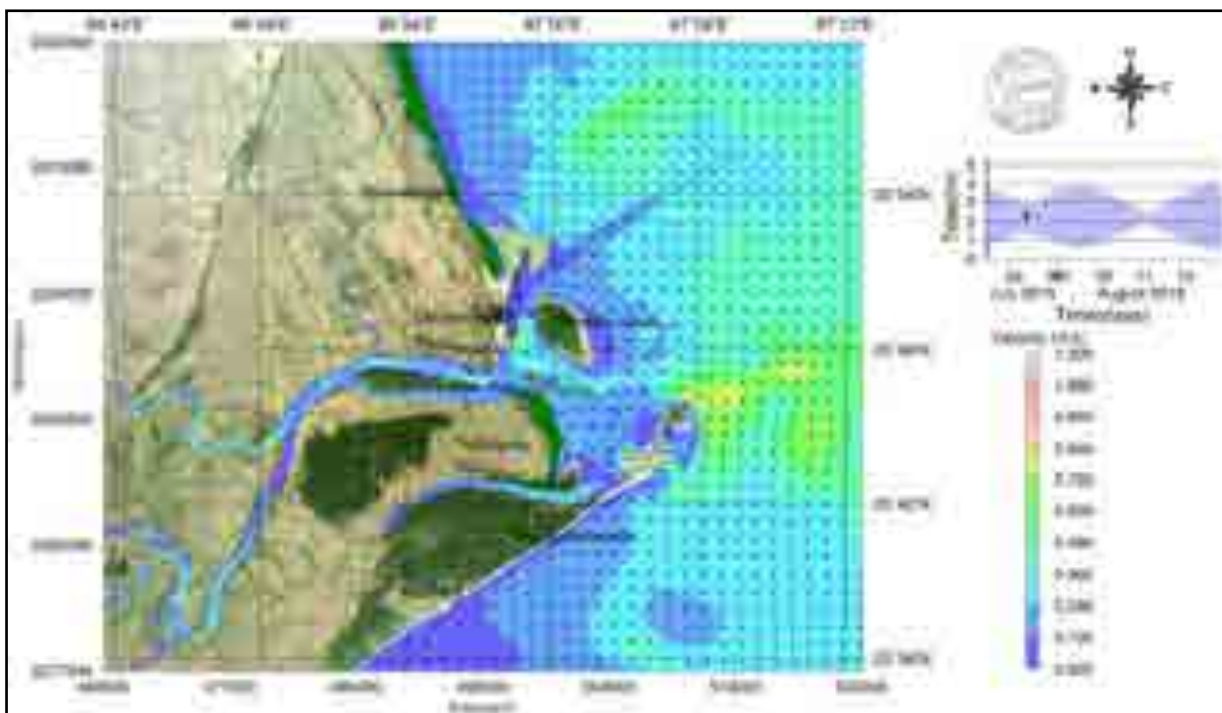


Figure 5-60: Simulated currents (at 02:00:00hrs of 28/07/2016) during neap tide-(EBB) After Proposed Expansion

Figure 5-61 shows the difference in current speed existing and after the proposed expansion. From the figure it can be seen the current speed slightly increases in western side of Kanika Island and reduced towards the northern side Mouth of Dharma River due to proposed expansion.

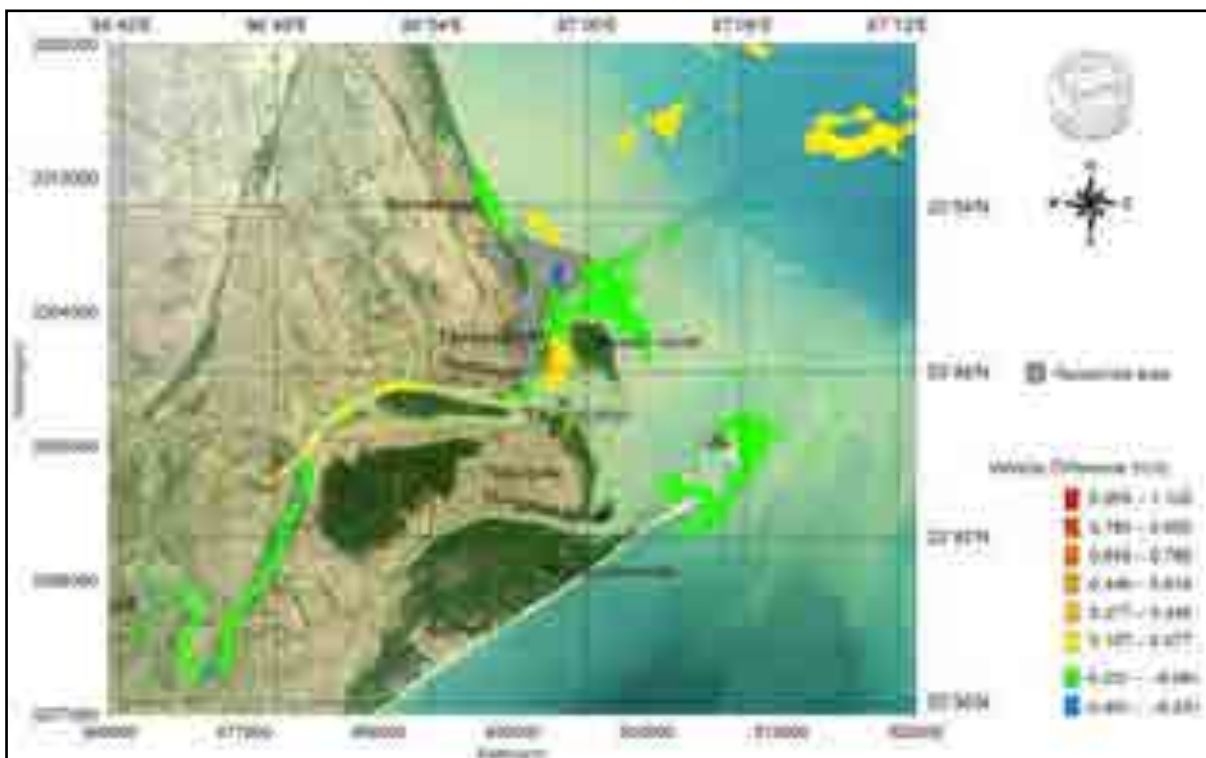


Figure 5-61: Difference in velocities between Existing Development and After Proposed Expansion (at 02:00:00 hrs of 28/07/2016) during neap tide-(EBB)

E) Spring tide condition-slack-1(LLW): The water levels during slack-1 for spring tide condition for existing and after proposed expansion are shown in **Figure 5-62** and **Figure 5-63**, respectively. From the figures it can be seen that there is increase (0.01 – 1.45 m) in water levels at North Side mangroves, northern side Mouth of Dhamra River, Kanika Island, Wheeler Island and Southern side mouth of Dhamra River due to proposed expansion.

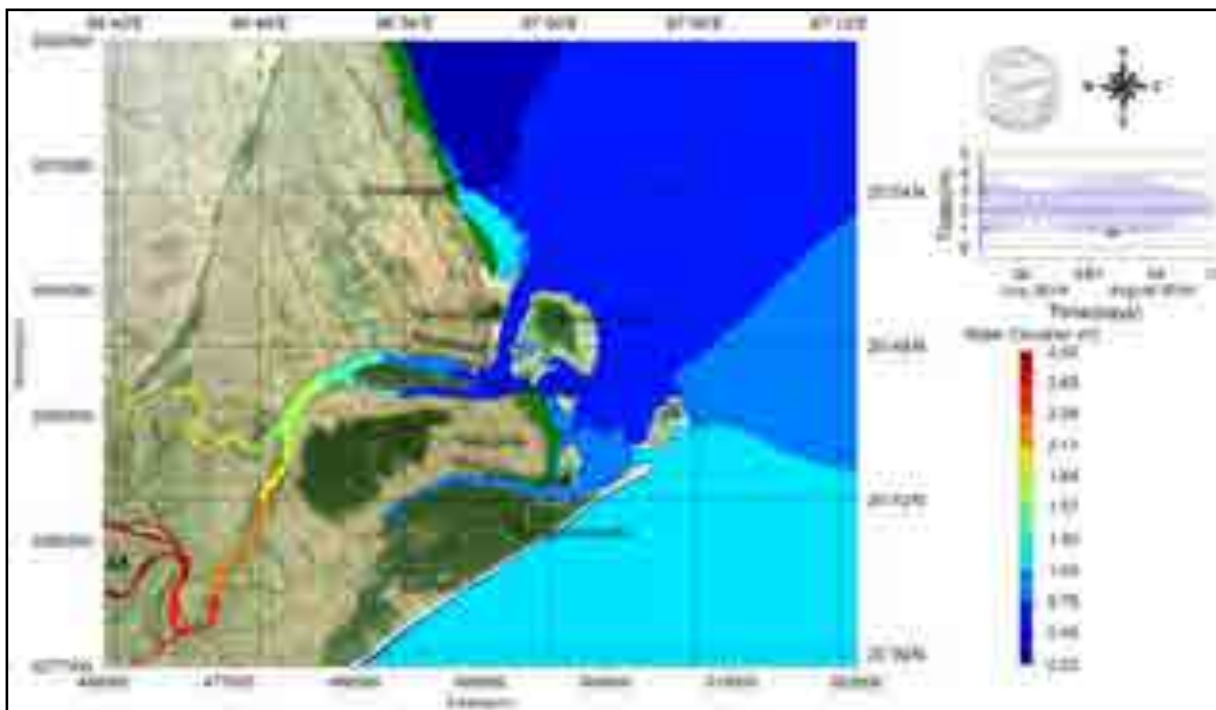


Figure 5-62: Simulated Tides (at 22:30:00hrs of 02/08/2016) during Spring tide-(LLW) Existing Development

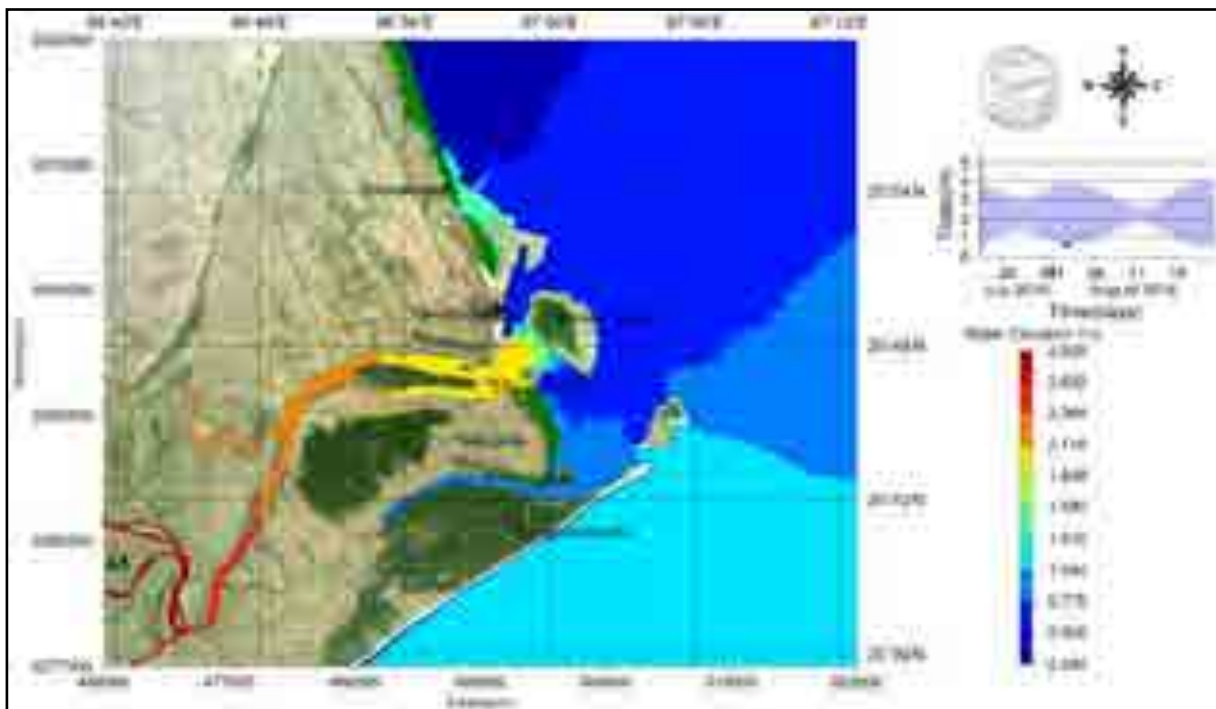


Figure 5-63: Simulated Tides (at 22:30:00 hrs of 02/08/2016) during Spring tide-(LLW) After Proposed Expansion

The currents during slack-1 for spring tide condition existing and after proposed expansion are shown in **Figure 5-64** and **Figure 5-65**, respectively. From the figures it can be seen that there is decrease in velocity (0.2 – 0.5 m/sec) at Southern side mouth of Dhamra River and northern side mouth of Dhamra River. No changes have been observed near North Side Mangroves, Kanika Island and Wheeler Island due to proposed expansion.

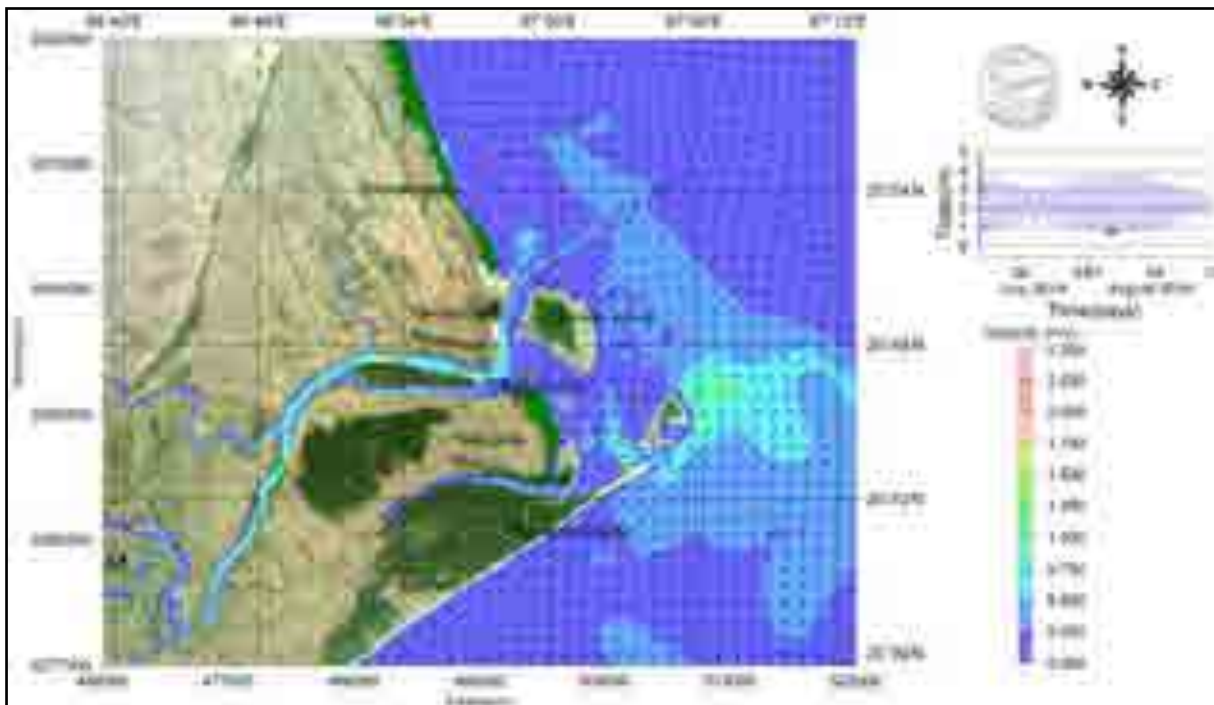


Figure 5-64: Simulated currents (at 22:30:00hrs of 02/08/2016) during Spring tide-(LLW) Existing Development

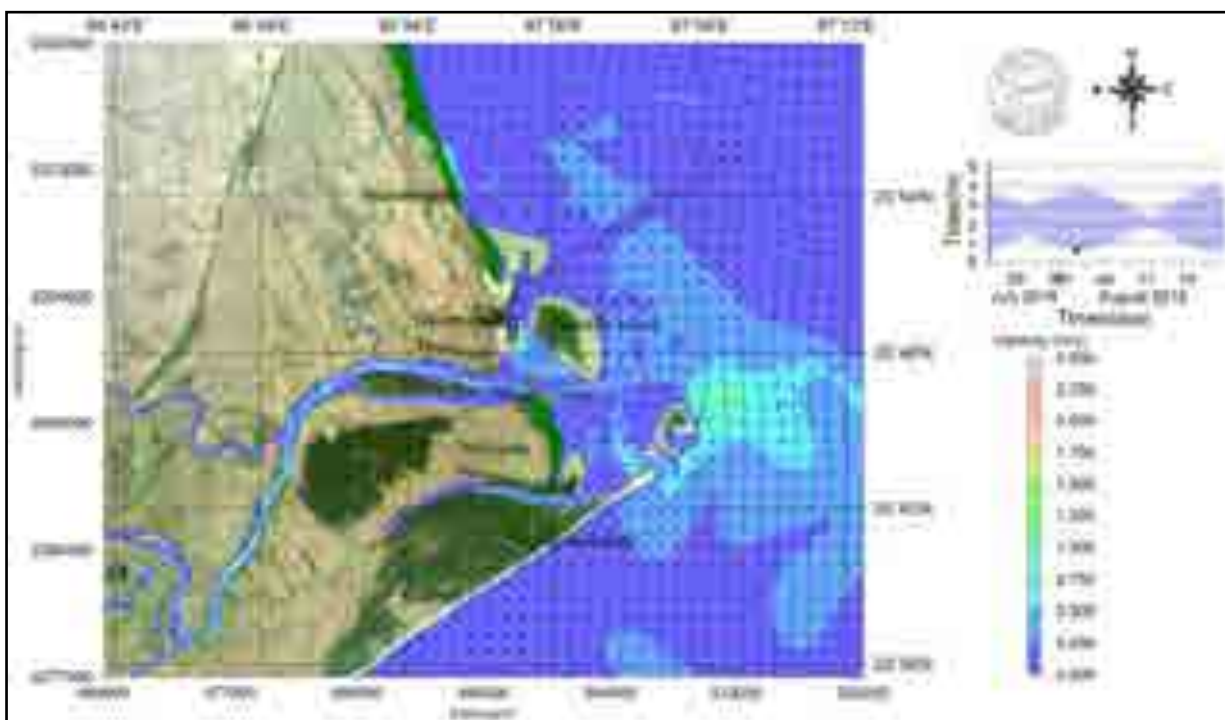


Figure 5-65: Simulated currents (at 22:30:00 hrs of 02/08/2016) during Spring tide-(LLW) After Proposed Expansion

Figure 5-66 shows the difference in current speed existing and after the proposed expansion. From the figure it can be seen the current speed slightly increases in western side of Kanika Island and Southern side mouth of Dhamra River, whereas slightly reduced towards the northern side Mouth of Dharma River due to proposed expansion.

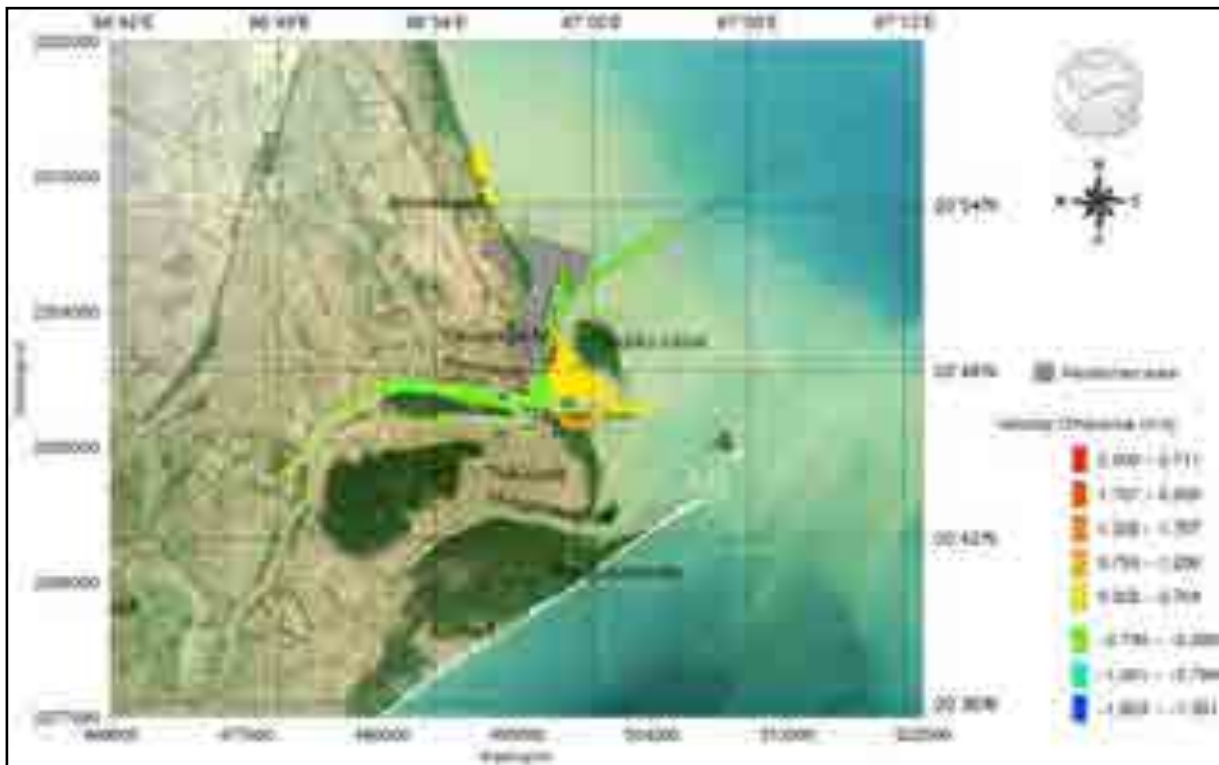


Figure 5-66: Difference in velocities between Existing Development and After Development (at 22:30:00 hrs of 02/08/2016) during spring tide-(LLW)

- F) Spring tide condition-peak flood (PF):** The water depth during peak flood of spring tide condition existing and after proposed expansion are shown in **Figure 5-67** and **Figure 5-68**, respectively. From the figures it can be seen that there is decrease (0.05 – 0.3 m) in water levels at Wheeler Island, Kanika Island and North Side mangroves, whereas, no changes have been observed at Southern side mouth of Dhamra River and Northern side Mouth of Dhamra River due to proposed expansion.

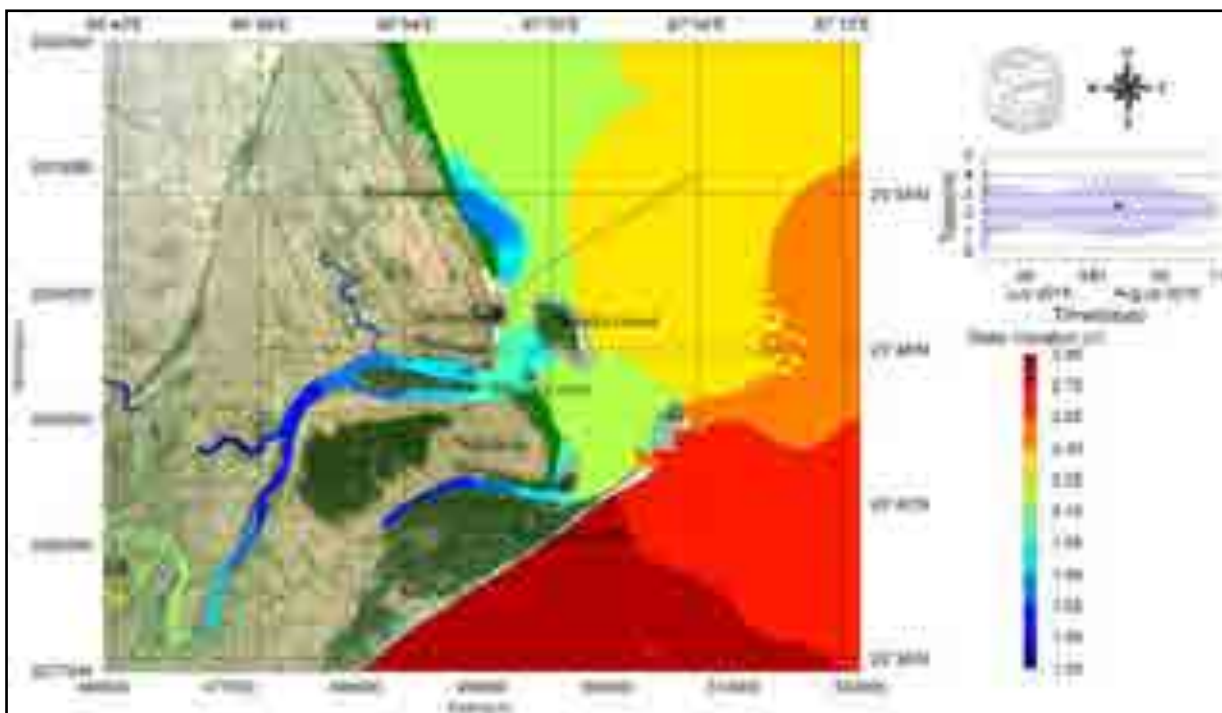


Figure 5-67: Simulated Tides (at 01:30:00 hrs of 03/08/2016) during Spring tide-(FLD) Existing Development

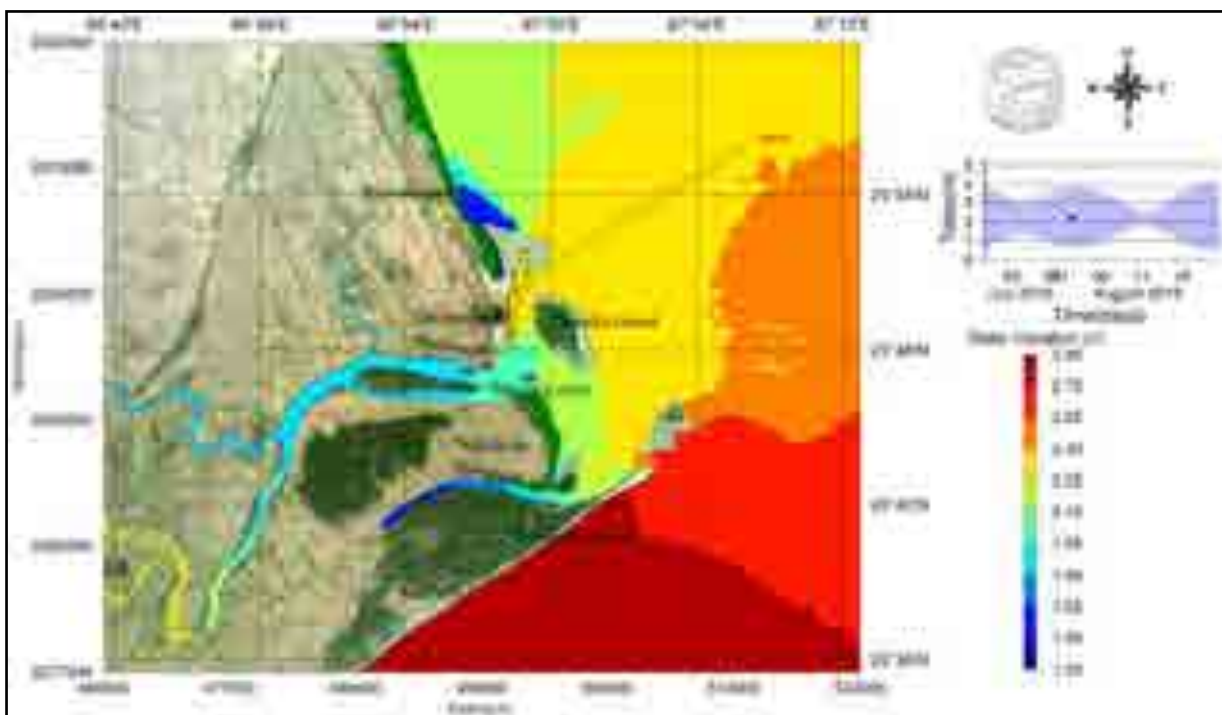


Figure 5-68: Simulated Tides (at 01:30:00 hrs of 03/08/2016) during Spring tide-(FLD) After Proposed Expansion

The currents during Peak Flood for spring tide condition existing and after proposed expansion are shown in **Figure 5-69** and **Figure 5-70**, respectively. From the figures it can be seen that there is decrease in velocity (0.4 – 0.6 m/sec) at Southern side mouth of Dhamra River and Northern side mouth of Dhamra River. No changes have been observed near North Side Mangroves, Kanika Island and Wheeler Island due to proposed expansion.

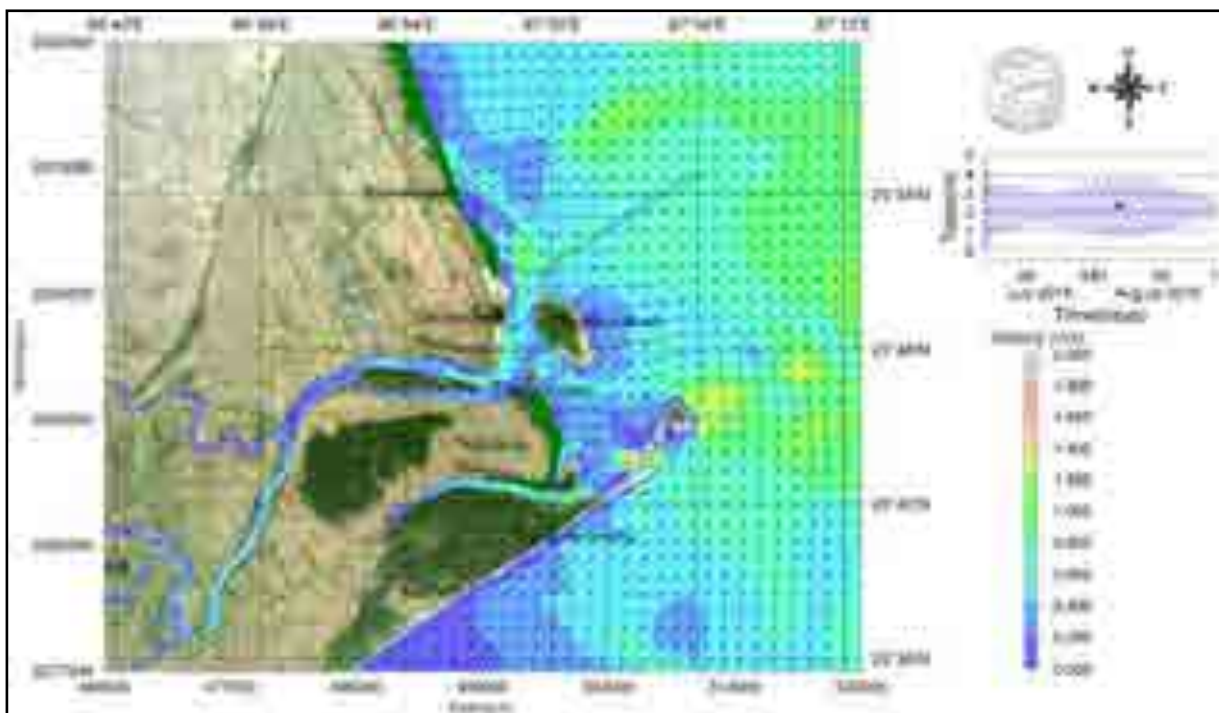


Figure 5-69: Simulated currents (at 01:30:00 hrs of 03/08/2016) during Spring tide-(FLD) Existing Development

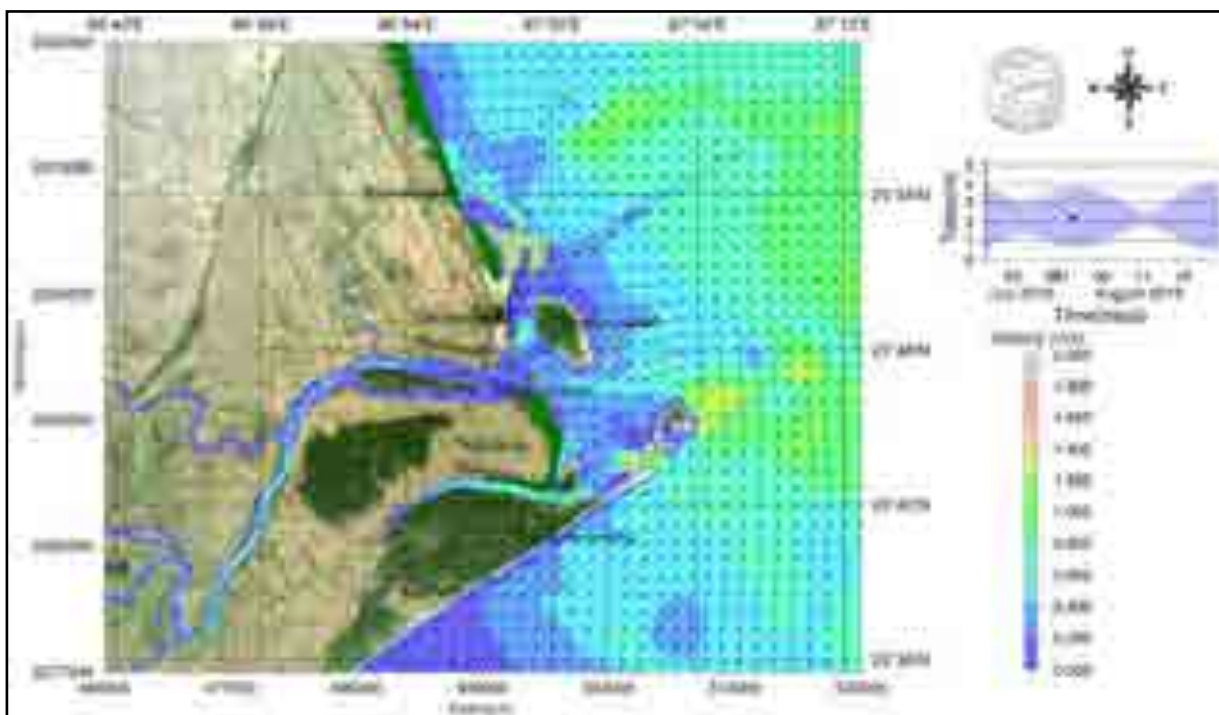


Figure 5-70: Simulated currents (at 01:30:00 hrs of 03/08/2016) during Spring tide-(FLD) After Proposed Expansion

Figure 5-71 shows the difference in current speed existing and after the proposed expansion. From the figure it can be seen the current speed slightly reduced towards the North Side Mangroves, west side Kanika Island & Northern side Mouth of Dhamra River due to proposed expansion.

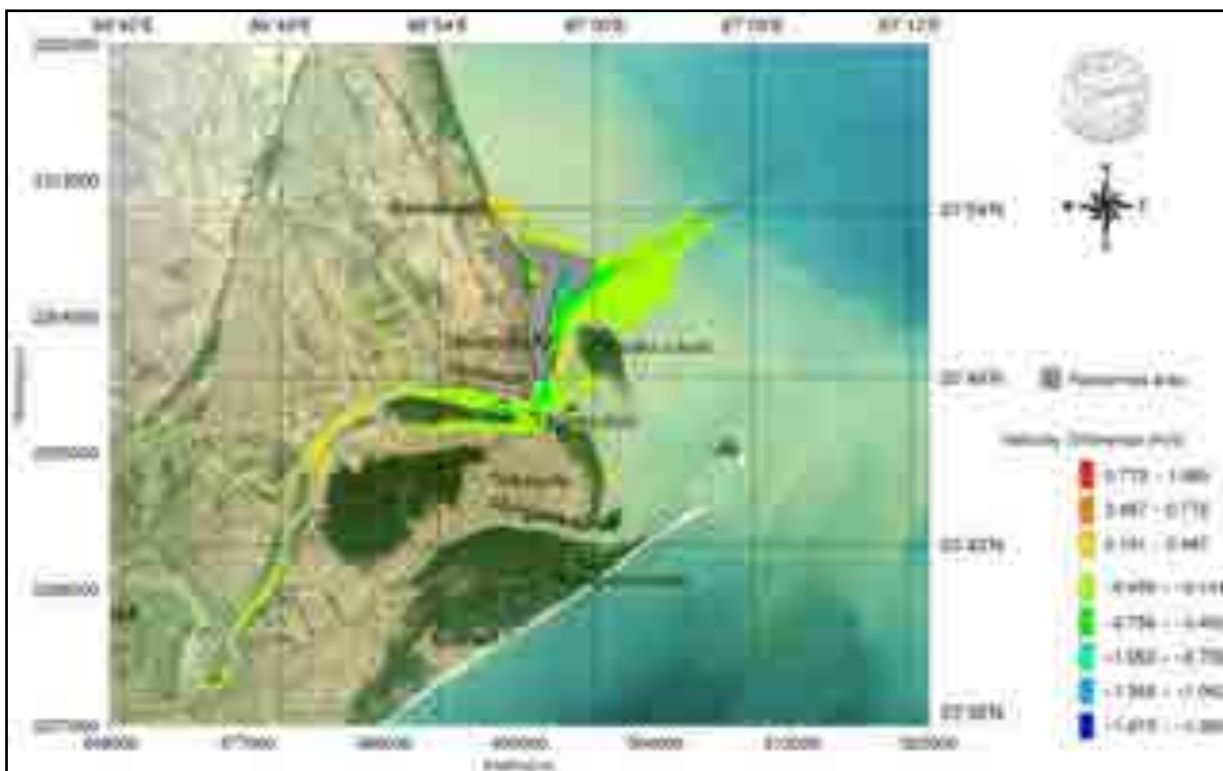


Figure 5-71: Difference in velocities between Existing Development and After Proposed Expansion (at 01:30:00 hrs of 03/08/2016) during spring tide-(FLD)

G) Spring tide condition-highest high water (slack-2) (HHW): The water depth during slack-1 for spring tide condition existing and after proposed expansion are shown in **Figure 5-72** and **Figure 5-73**, respectively. From the figures it can be seen that there is increase (0.03 – 0.3 m) in water levels at Wheeler Island, Southern side mouth of Dhamra River, Kanika Island and North Side mangroves, whereas there is decrease (0.14 m) in water level at northern side Mouth of Dhamra River due to proposed expansion.

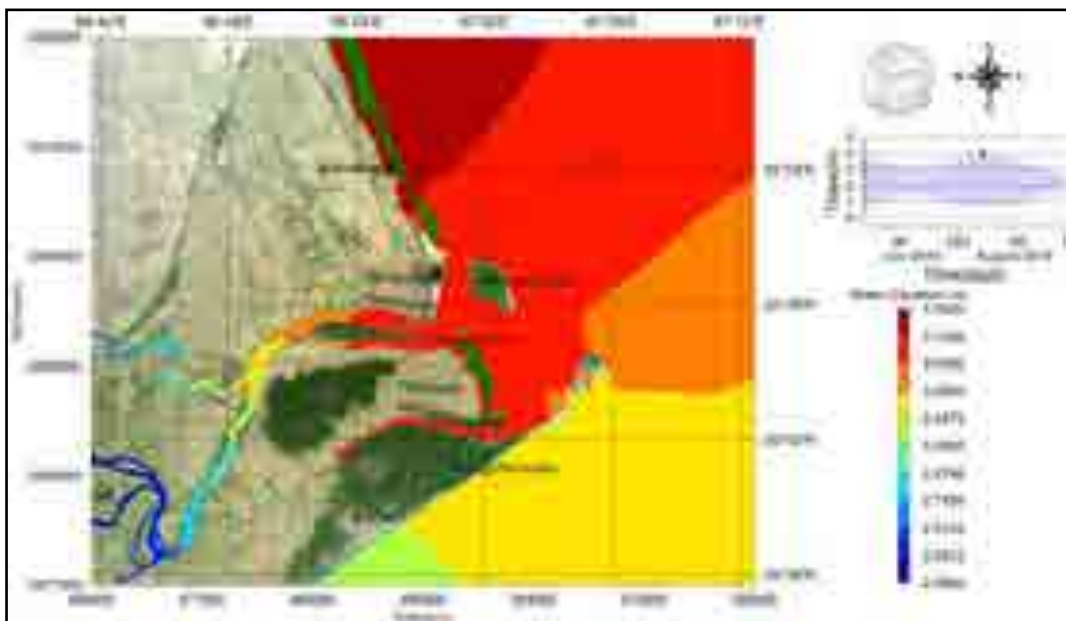


Figure 5-72: Simulated Tides (at 04:30:00 hrs of 03/08/2016) during Spring tide-(HHW) Existing Development

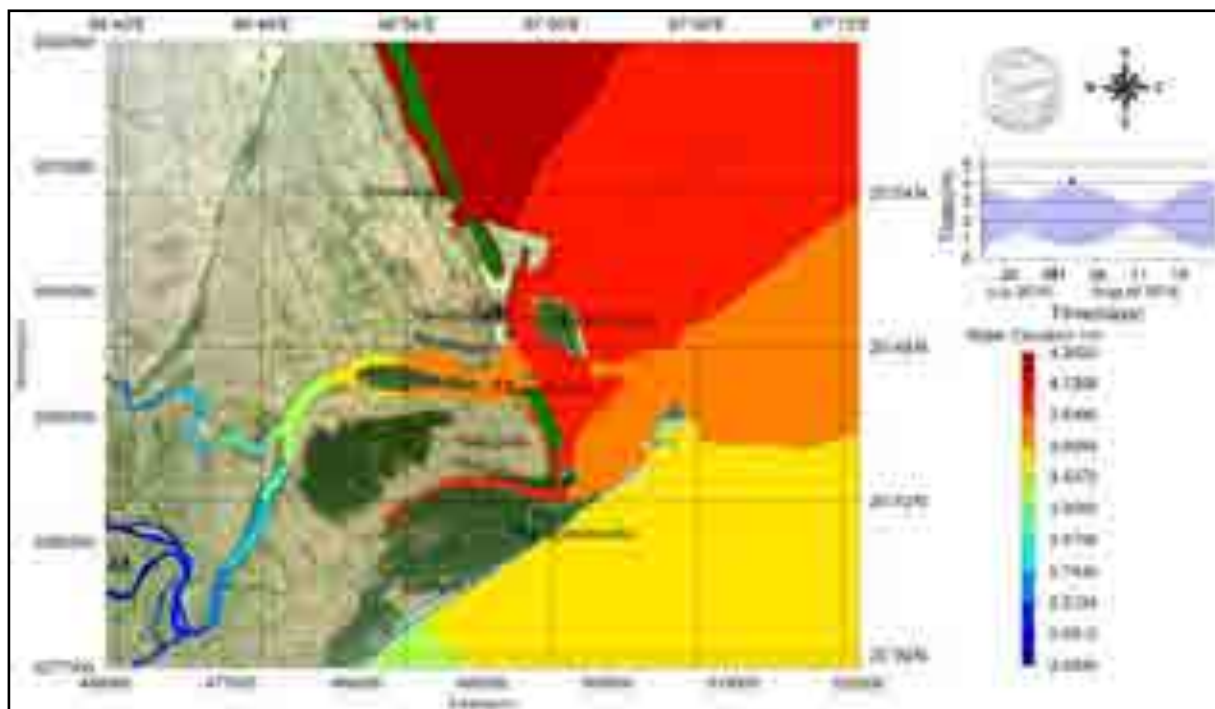


Figure 5-73: Simulated Tides (at 04:30:00 hrs of 03/08/2016) during Spring tide-(HHW) After Proposed Expansion

The currents during High water of spring tide condition existing and after proposed expansion are shown in **Figure 5-74** and **Figure 5-75**, respectively. From the figures it can be seen that there is increase in velocity (0.02 – 0.18 m/sec) at northern side mouth of Dhamra river and Kanika island, whereas decrease in velocity (0.32 m/sec) have been observed near wheeler island. No changes have been observed near North Side Mangroves, and Southern side mouth of Dhamra River due to proposed expansion.

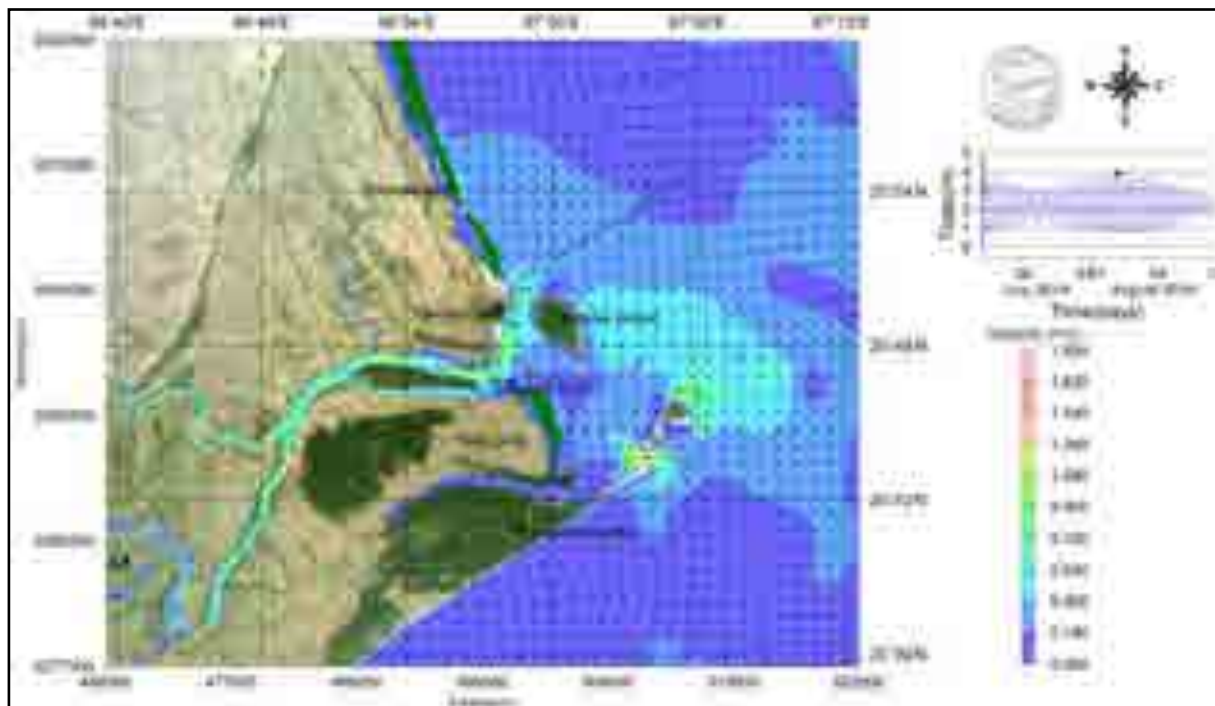


Figure 5-74: Simulated currents (at 04:30:00hrs of 03/08/2016) during Spring tide-(HHW) Existing Development

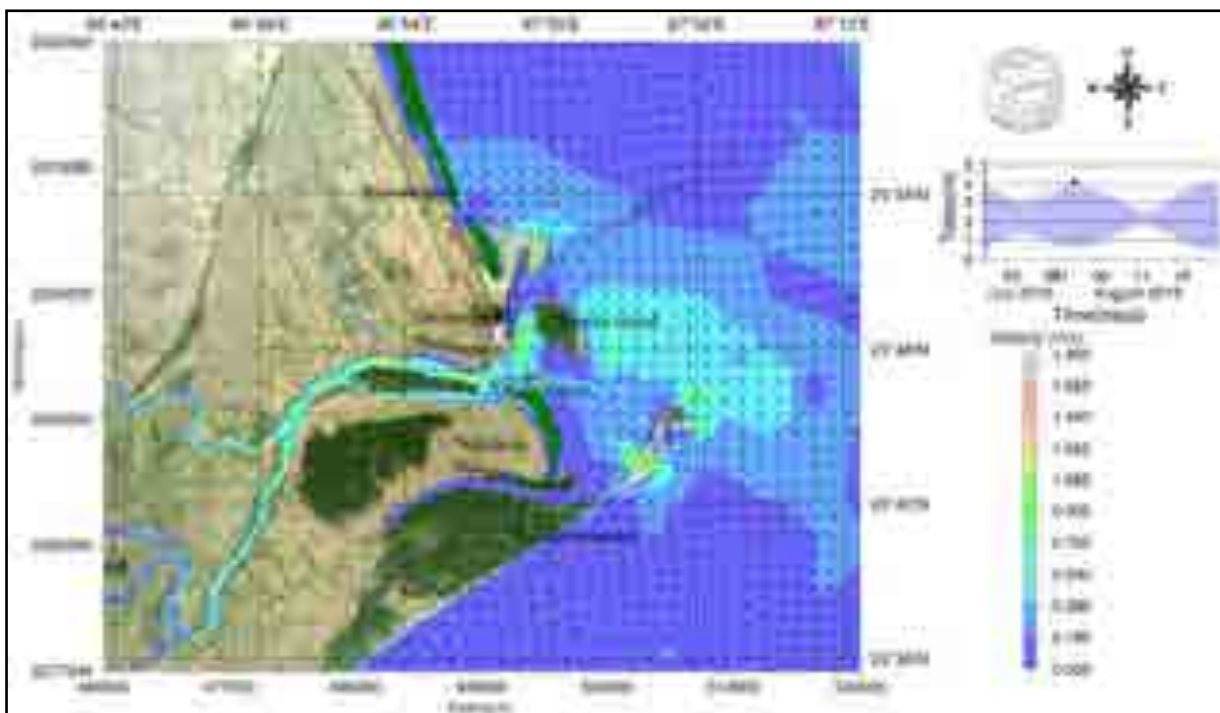


Figure 5-75: Simulated currents (at 04:30:00 hrs of 03/08/2016) during Spring tide-(HHW) After Proposed Expansion

Figure 5-76 shows the difference in current speed existing and after the proposed expansion. From the figure it can be seen that the current speed slightly Increases towards west side Kanika Island and Southern side mouth of Dhamra River, whereas reduced towards the south side Kanika Island, North Side Mangroves due to proposed expansion.

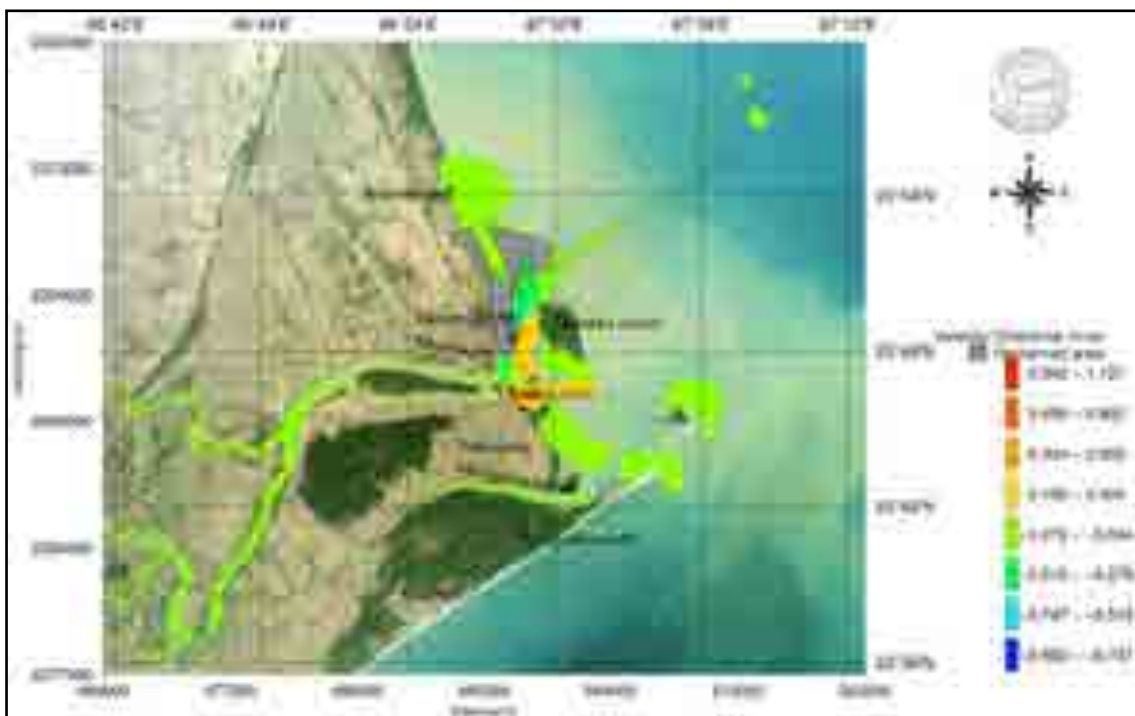


Figure 5-76: Difference in velocities between Existing Development and After Development (at 04:30:00 hrs of 03/08/2016) during spring tide-(HHW)

H) Spring tide condition-peak ebb (PE): The water depth peak ebb for spring tide condition existing and after proposed expansion are shown in **Figure 5-77** and

Figure 5-78, respectively. From the figures it can be seen that there is increase (0.2 m) in water levels at northern side Mouth of Dhamra River, whereas there is decrease (0.2m) in water level at Kanika Island. No change in water level has been observed at North side mangroves, Southern side mouth of Dhamra River and Wheeler Island due to proposed expansion.

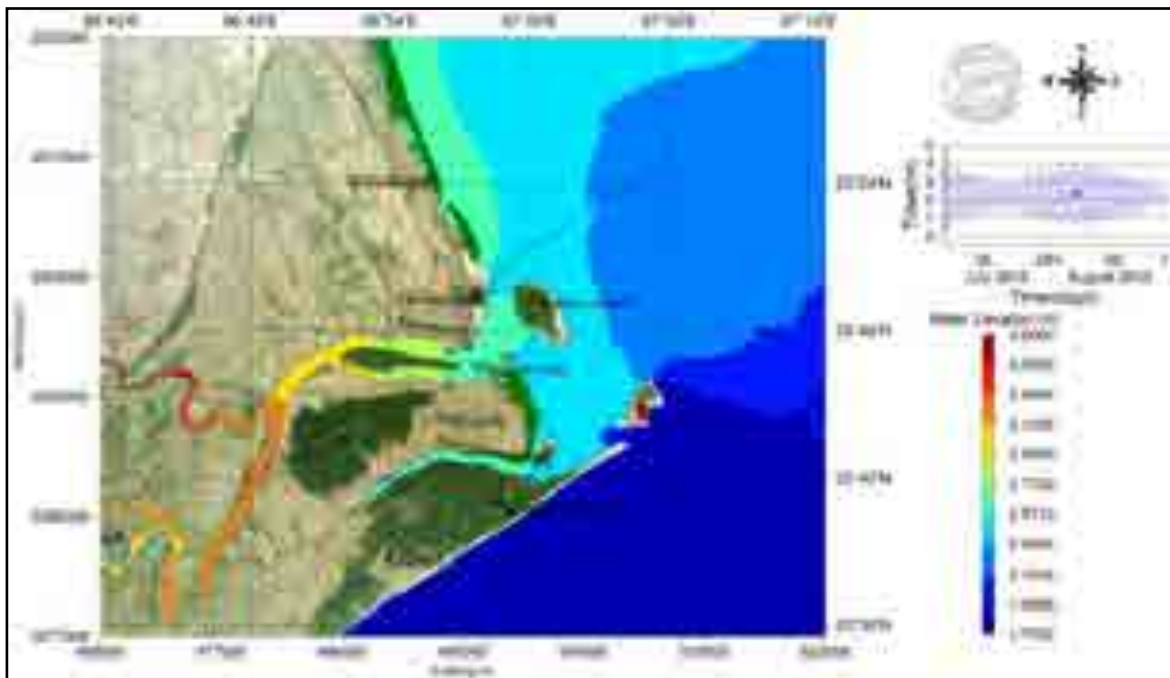


Figure 5-77: Simulated Tides (at 07:30:00 hrs of 03/08/2016) during Spring tide-(EBB) Existing Development

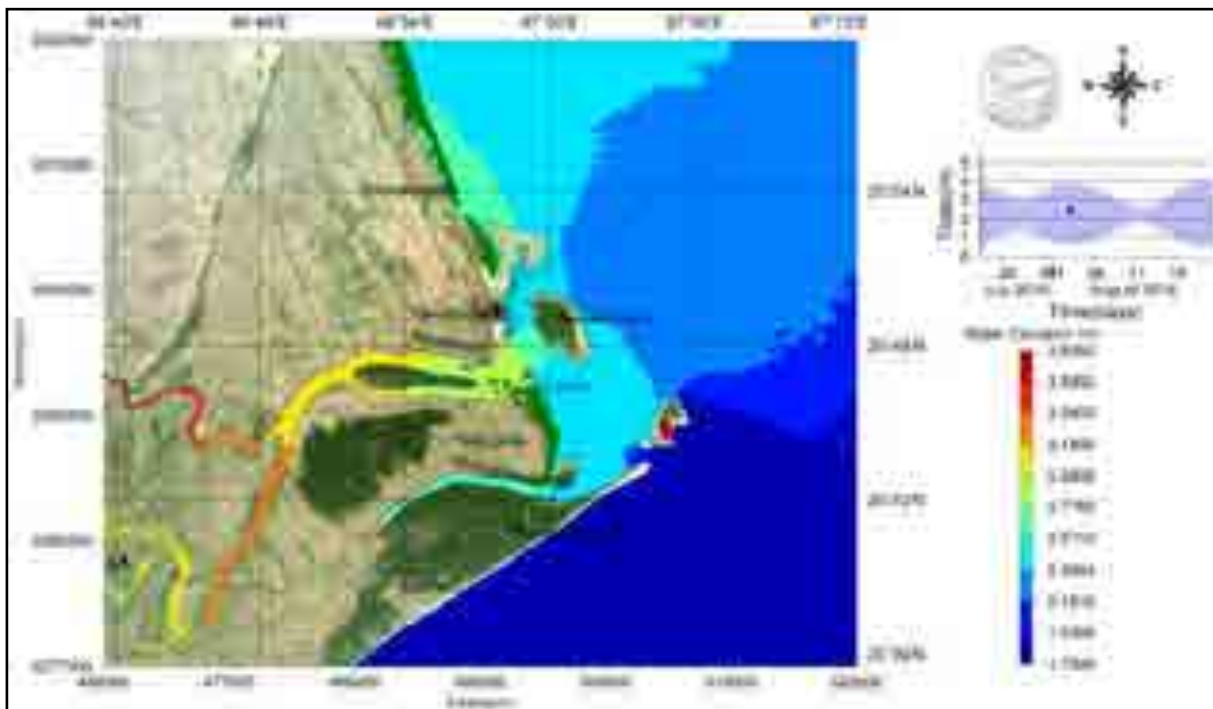


Figure 5-78: Simulated Tides (at 07:30:00 hrs of 03/08/2016) during Spring tide-(EBB) After Proposed Expansion

The currents during peak ebb of spring tide condition existing and after proposed expansion are shown in **Figure 5-79** and **Figure 5-80**, respectively. From the figures it can be seen that

there is decrease in velocity (0.4 – 0.6 m/sec) at Southern side mouth of Dhamra River and northern side mouth of Dharma River. No changes have been observed near North Side Mangroves, Kanika Island and Wheeler Island due to proposed expansion.

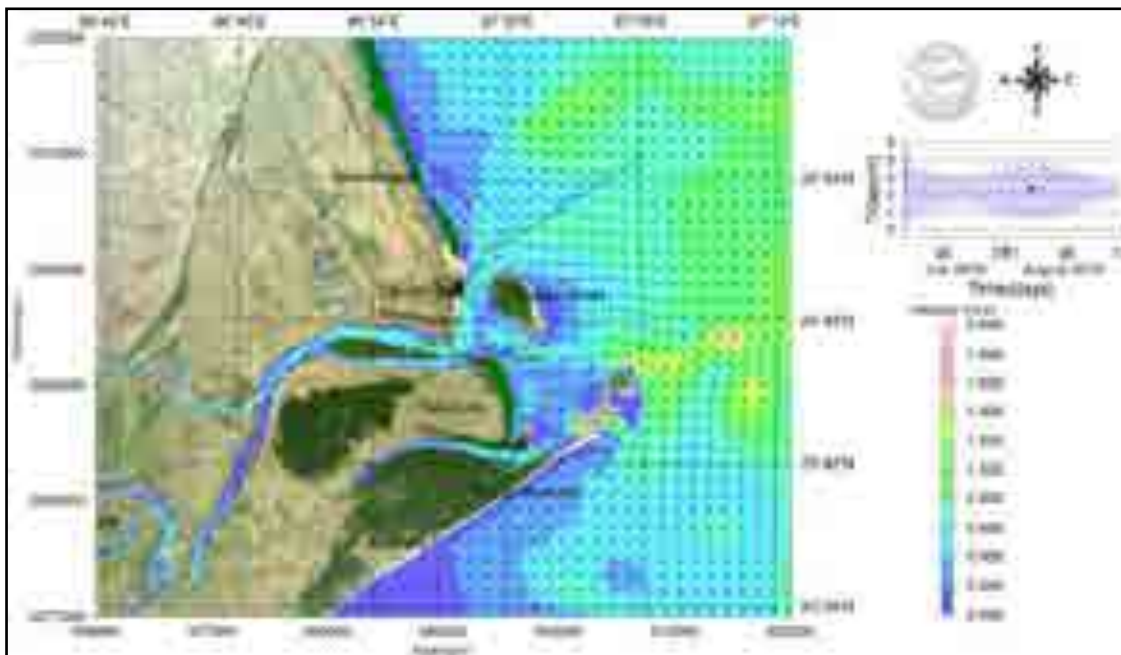


Figure 5-79: Simulated currents (at 07:30:00 hrs of 03/08/2016) during Spring tide- (EBB) Existing Development

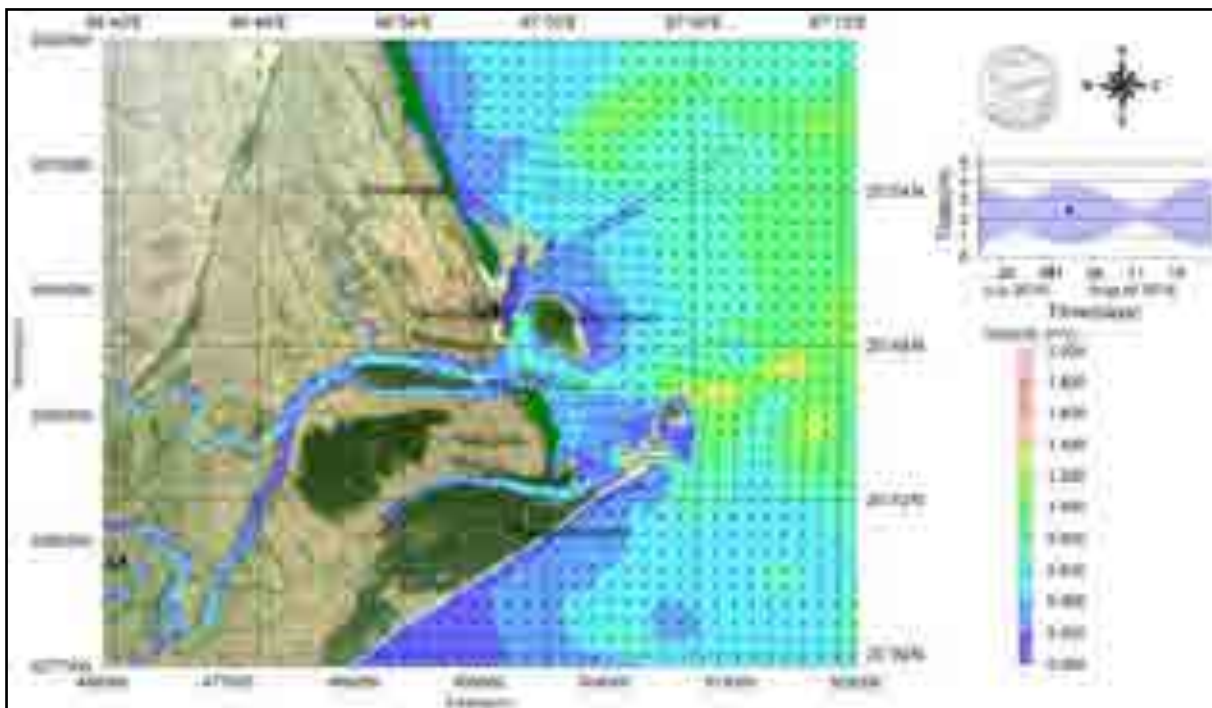


Figure 5-80: Simulated currents (at 07:30:00 hrs of 03/08/2016) during Spring tide- (EBB) After Proposed Expansion

Figure 5-81 shows the difference in current speed existing and after the proposed expansion. From the figure it can be seen the current speed slightly Increases towards west side Kanika Island, North side mangroves and Southern side mouth of Dhamra River, whereas reduced towards northern side mouth of Dhamra River, due to proposed expansion.

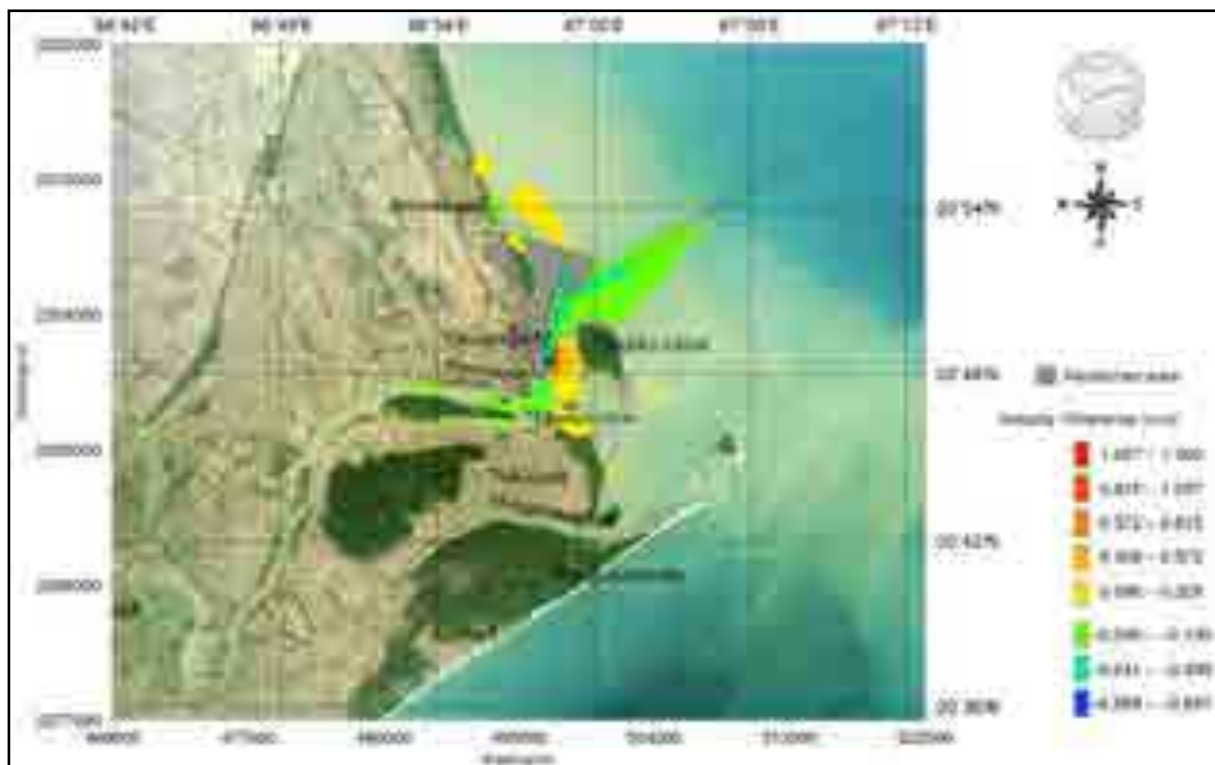


Figure 5-81: Difference in velocities between Existing Development and After Proposed Expansion (at 07:30:00 hrs of 03/08/2016) during spring tide-(EBB)

Impact on flow regime and flow circulation in the study domain:

The model has been run for 15 days continuously for predicting the changes in the flow regime and circulation for various hydrodynamic tidal conditions due to the proposed expansion. A number of observation points (1 through 20) have been put around the proposed expansion so that the variation of various parameters like velocity (flow) and bed levels existing and after development can be simulated and compared; thus enabling an assessment of the impact due to the proposed expansion. The location of the observation points for existing and after developments are shown graphically in **Figure 5-82** to **Figure 5-86** respectively.

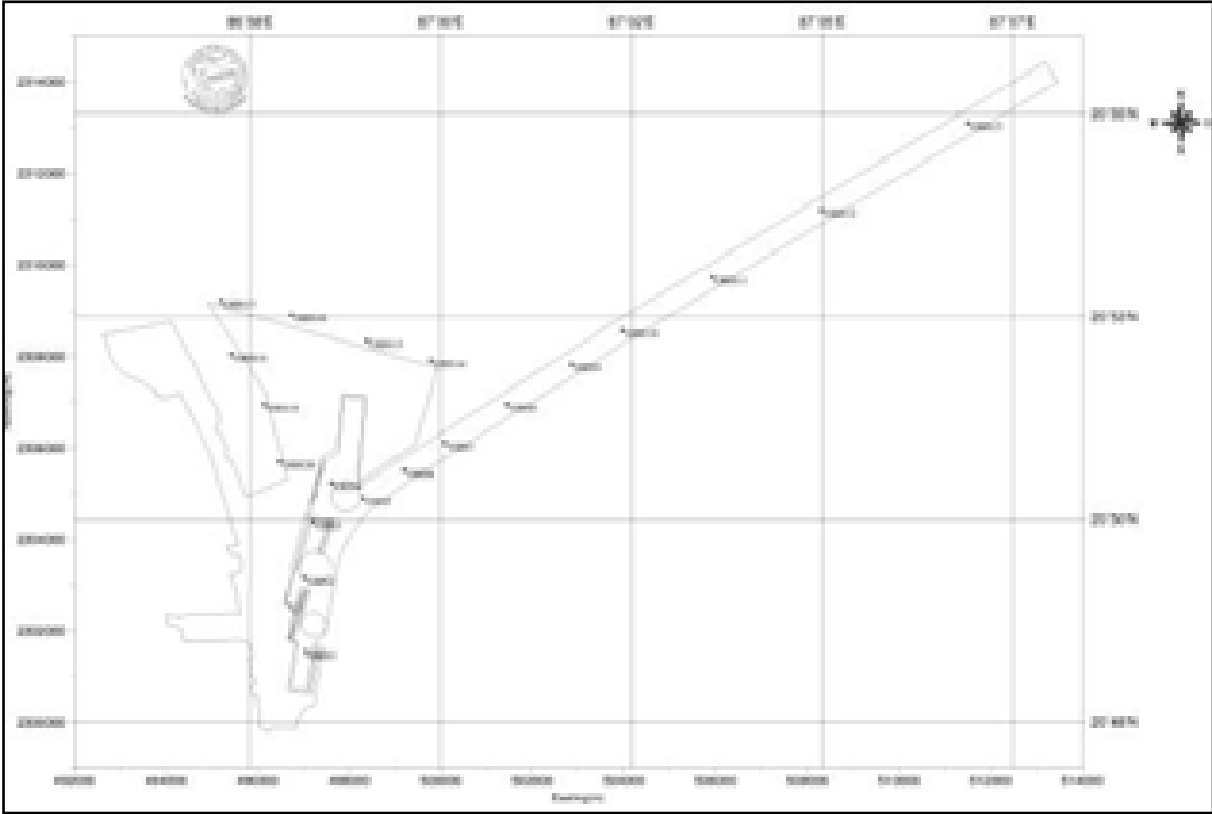


Figure 5-82: Observation points at and around the proposed expansion

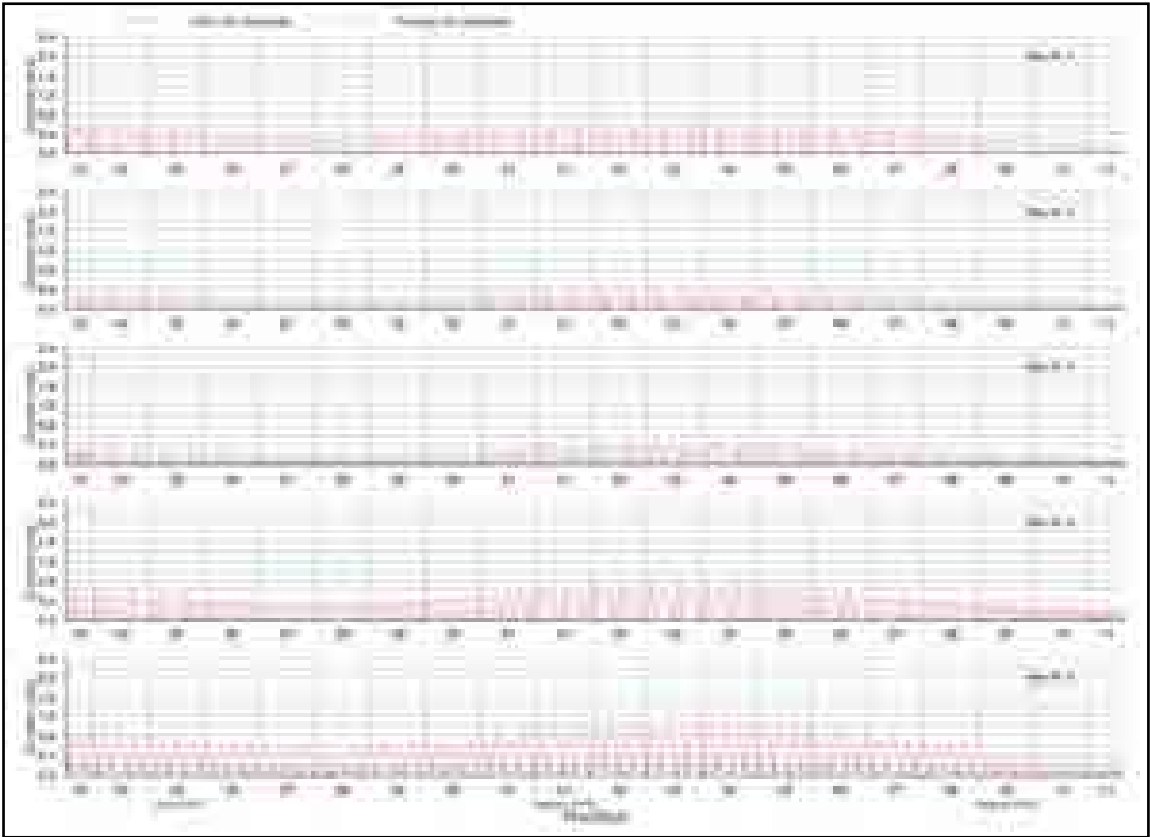


Figure 5-83: Comparison of velocities between Existing Development and After Proposed Expansion at different observation locations

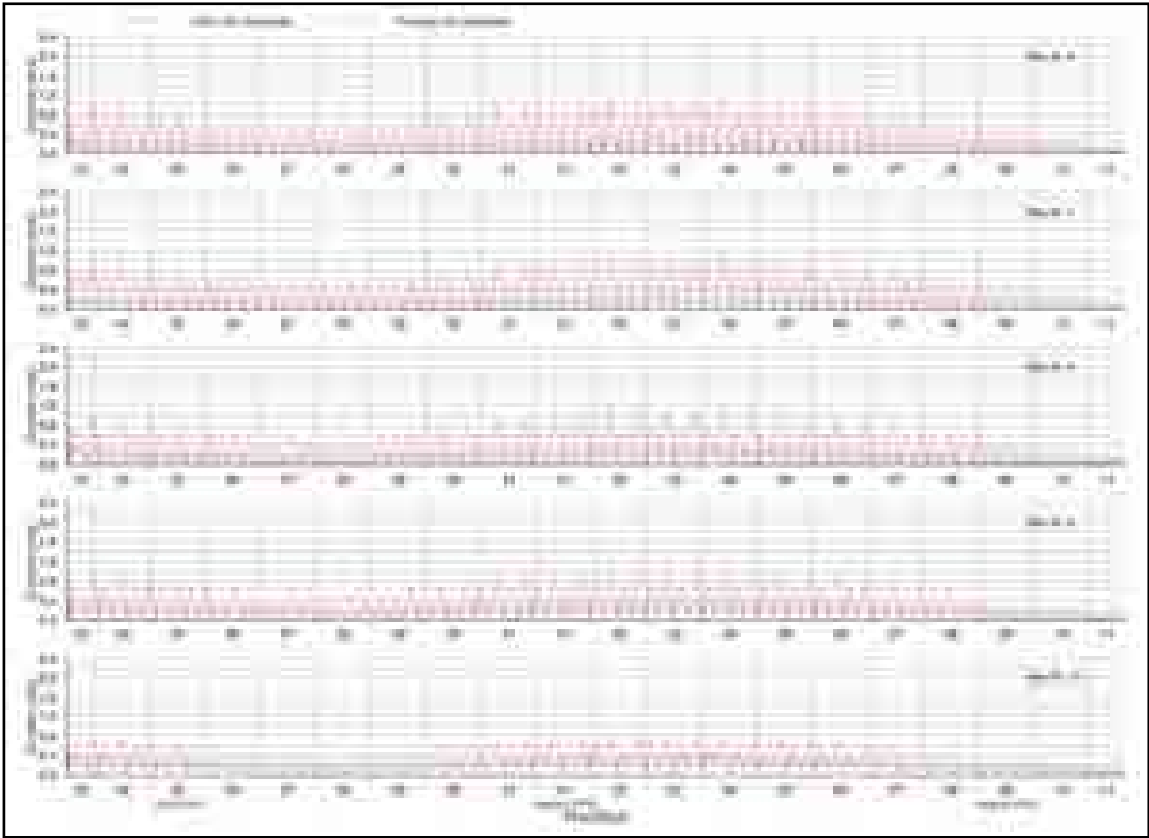


Figure 5-84: Comparison of velocities between Existing Development and After Proposed Expansion at different observation locations

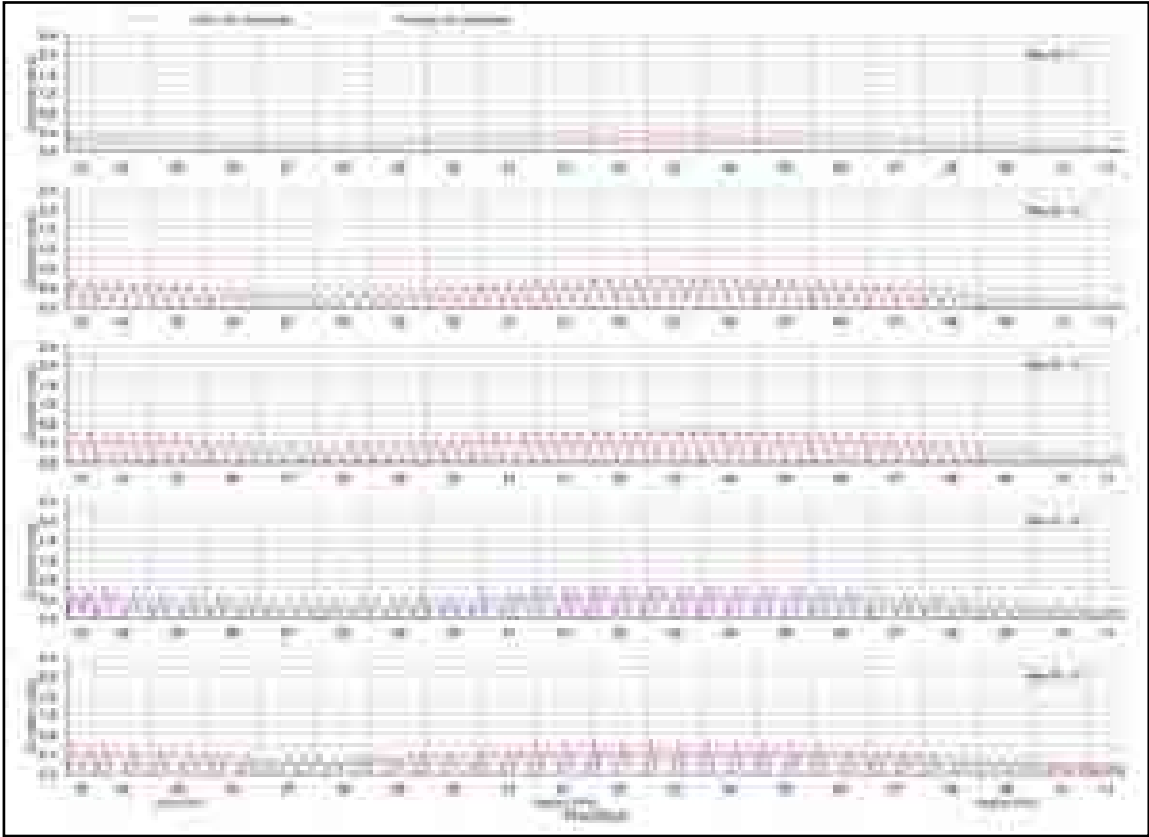


Figure 5-85: Comparison of velocities between Existing Development and After Proposed Expansion at different observation locations

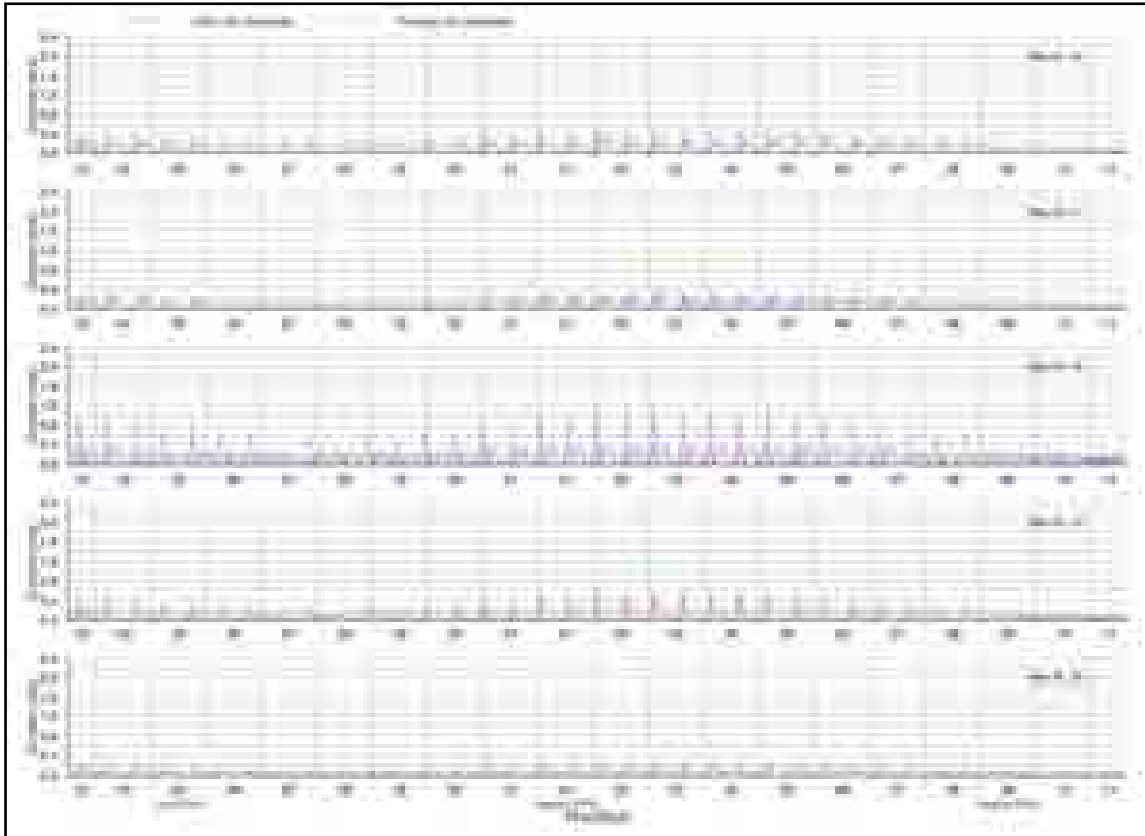


Figure 5-86: Comparison of velocities between Existing Development and After Proposed Expansion at different observation locations

Figure 5-83 to Figure 5-86 show the variation of currents at different observation points located around the development. It can be seen from the figures that the flow velocity slightly increases and observed that there was flow movement near the northern part of proposed reclamation and thus, water flow movement shall be maintained towards northern side mangroves. The velocity in the channel and turning circles gets reduced due to deepening and observed no significant changes other locations. It can be seen that there is no significant impact on tide / flow regime in general due to proposed expansion. The changes in the flow regime are mainly local as discussed at length in the above sections. From the results it can be seen that the maximum change in the flow regime in the approach channel, turning circles is in the tune of 0.3 - 0.5 m/sec. From the figures it can be noticed that the velocities get reduced around the Kanika Island after the proposed expansion.

Summary of Flow modelling:

The model generated tides and currents are comparable to actual observations at Dhamra. The currents are slightly increased (0.1 m/sec) in the northern part of Dhamra Port and near Kanika Island and reduced the currents (0.2 m/sec) in the approach channel and mouth of Dhamra river mouth during flooding tide condition. The currents are slightly reduced (0.2 m/sec) in the northern part of Dhamra Port and approach channel, Kanika Island and increases the currents (0.1 m/sec) in the mouth of Dhamra river during ebbing tide condition. Flow regime changes for various tidal conditions in the study domain after the proposed expansion development of the Port are predicted to be not of much significance. Variation in the flow regime (in the current speeds) after the expansion is limited to the development location mostly and found to be very much local in nature. No change in the flow regime of the rest of the domain is observed. It can be observed from the HD modelling studies that

there was flow movement near the northern part of proposed reclamation since the flow velocity slightly increased after expansion and thus sufficient flow circulation will be available for north side mangrove area.

Wave Modelling and Tranquillity Studies

The changes in the shoreline will be due to wind, wave and sea currents. Hence, prediction of wave currents for various prevailing wave conditions at the Dhamra Port project site is very important in the prediction of sedimentation processes along the coastline. Hence, the wave climate at Dhamra coastline was studied and wave conditions arrived at based on the predicted data. Wave climate at Dhamra is the result of offshore waves coming in from Bay of Bengal. The evaluation of coastal wave currents was done based on the available data pertaining to winds and waves and used in carrying out the wave modelling studies.

The geographical location of the Port area is such that it receives the wave affect from the directions covered by 45° to 300° sector (the angle measured clockwise with reference North). Hence incidence waves were imposed in the sector covering the 0° and 270° included angle to check the wave conditions / heights at the proposed expansion region.

Modelling for the wave tranquillity:

The coastline of Dhamra can be taken to be aligned approximately in east-west direction. Two scenarios (before and after proposed revised master plan) were studied to predict the wave heights and direction. Wave period of 15 sec has been taken as a worst scenario. Incidence wave height 7.0 m has been imposed uni-directionally to get the significant wave distribution in the study area before and after the proposed development.

Computational model domain:

The domain and bathymetry considered for the wave modelling is remain same as the modal domain considered for flow modelling.

The study involves forcing of waves in the domain to study the changes in the wave pattern before and after the development of the proposed marine facilities. The study results will be used to predict the long shore currents due to the proposed expansion.

A total of 7 simulations were carried out for each case of before and after proposed expansion. The **Table 5-20** lists the simulations carried out indicating the variables used for the different simulation / computational runs.

Table 5-20: Details of Simulation/Computational Runs

Simulation Run	Wave Heigh (H_s (m))	Imposed Wave Direction (Deg)	Wave Period T_z (Sec)
1	7	0	15
2	7	45	15
3	7	60	15
4	7	90	15
5	7	135	15
6	7	180	15
7	7	270	15

- A) Modelling for the existing condition (before expansion):** The computational study was carried out to simulate the wave disturbance in the study area in existing conditions. Modelling study was carried out with incident wave heights of 7.0 m with directions of 0°, 45°, 60°, 90°, 135°, 180° and 270°.

The wave distribution obtained / simulated is shown graphically in **Figure 5-87** to **Figure 5-93**. From these figures it can be seen that the wave attenuated near the coast of the

Dhamra area for the incidence wave height and angle imposed for modelling purpose. However, it can be seen from the flow regime plots that the maximum wave height at the port is limited to 0.44m occurring during the HHW condition of the spring tide.

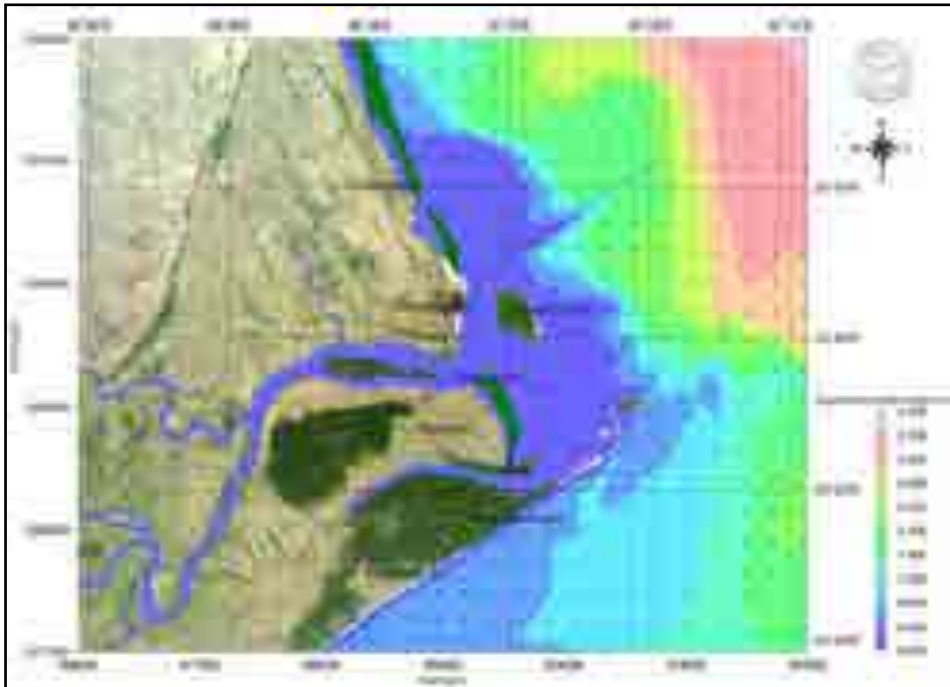


Figure 5-87: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 0^\circ$ (Existing Development)

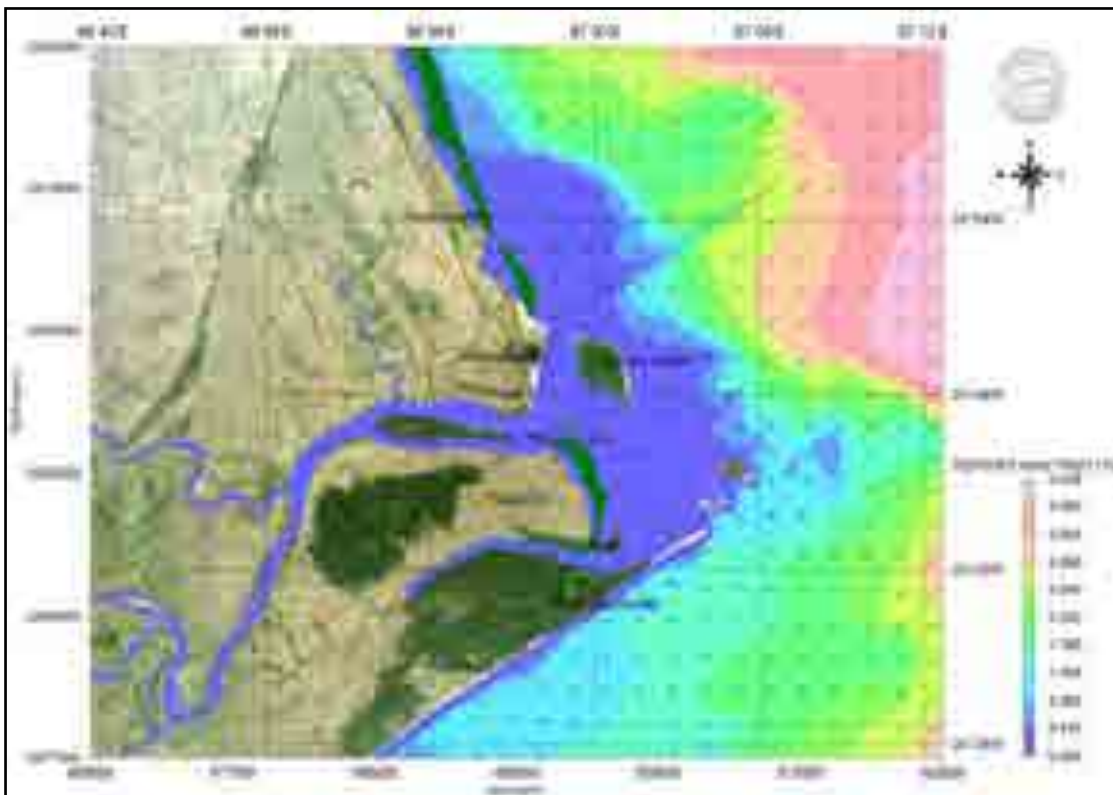


Figure 5-88: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 45^\circ$ (Existing Development)

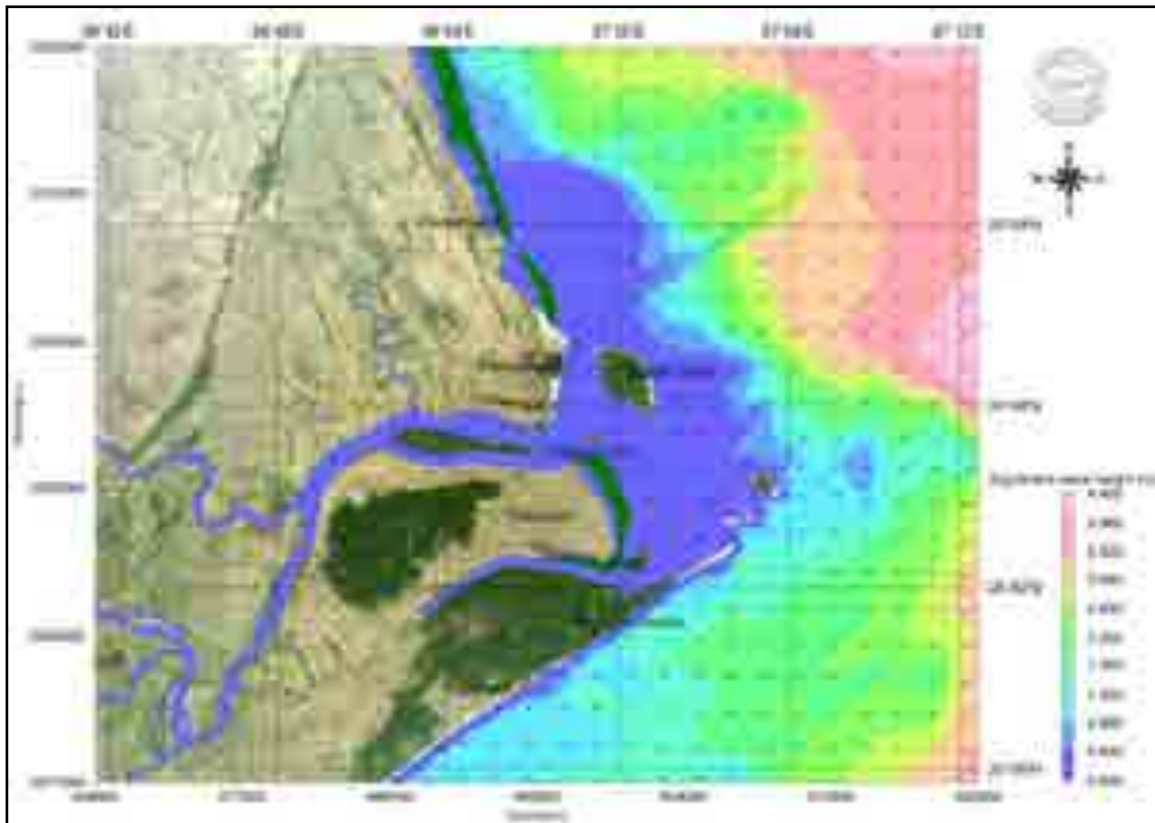


Figure 5-89: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 60^\circ$ (Existing Development)

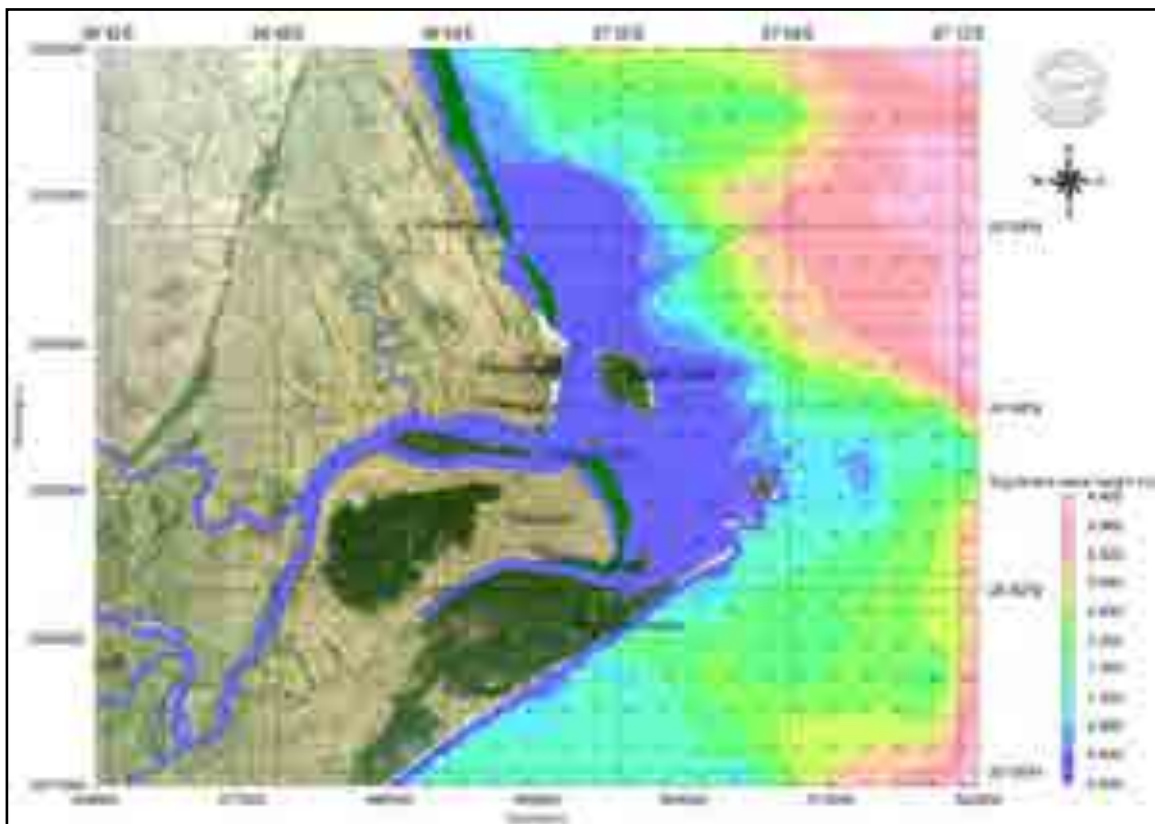


Figure 5-90: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 90^\circ$ (Existing Development)

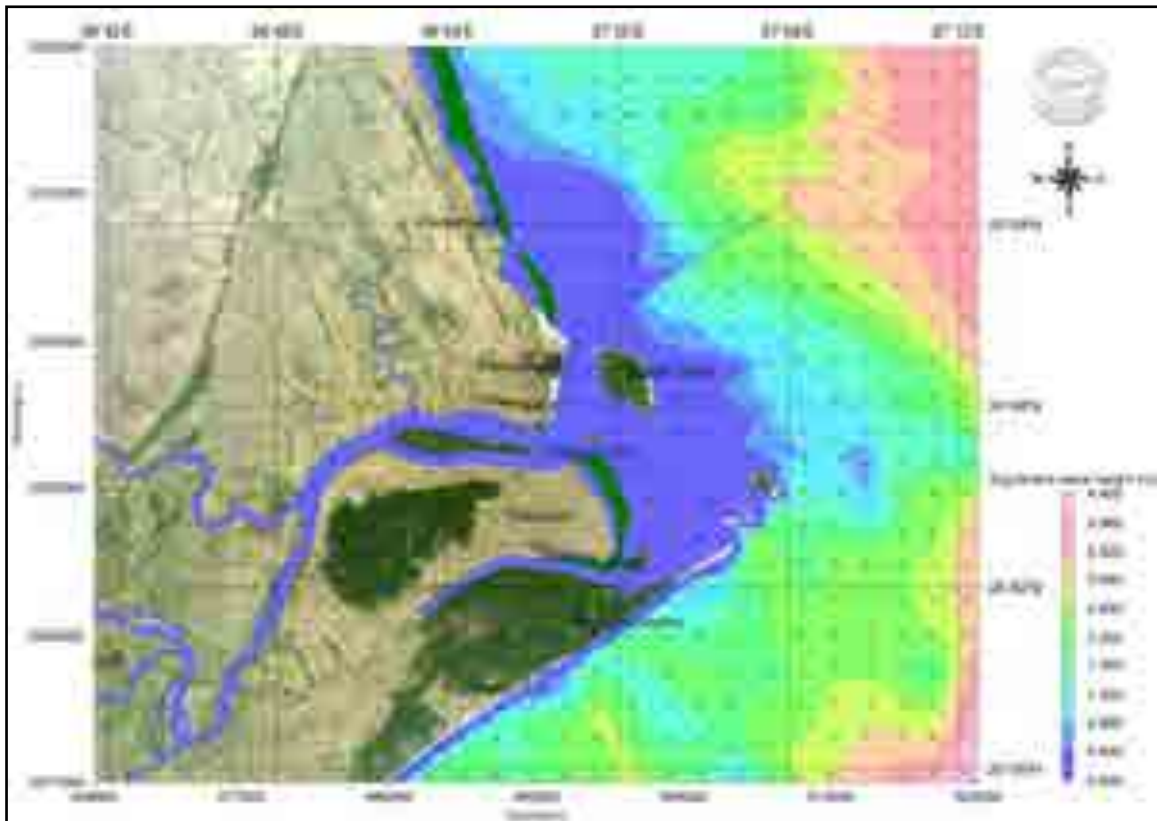


Figure 5-91: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 135^\circ$ (Existing Development)

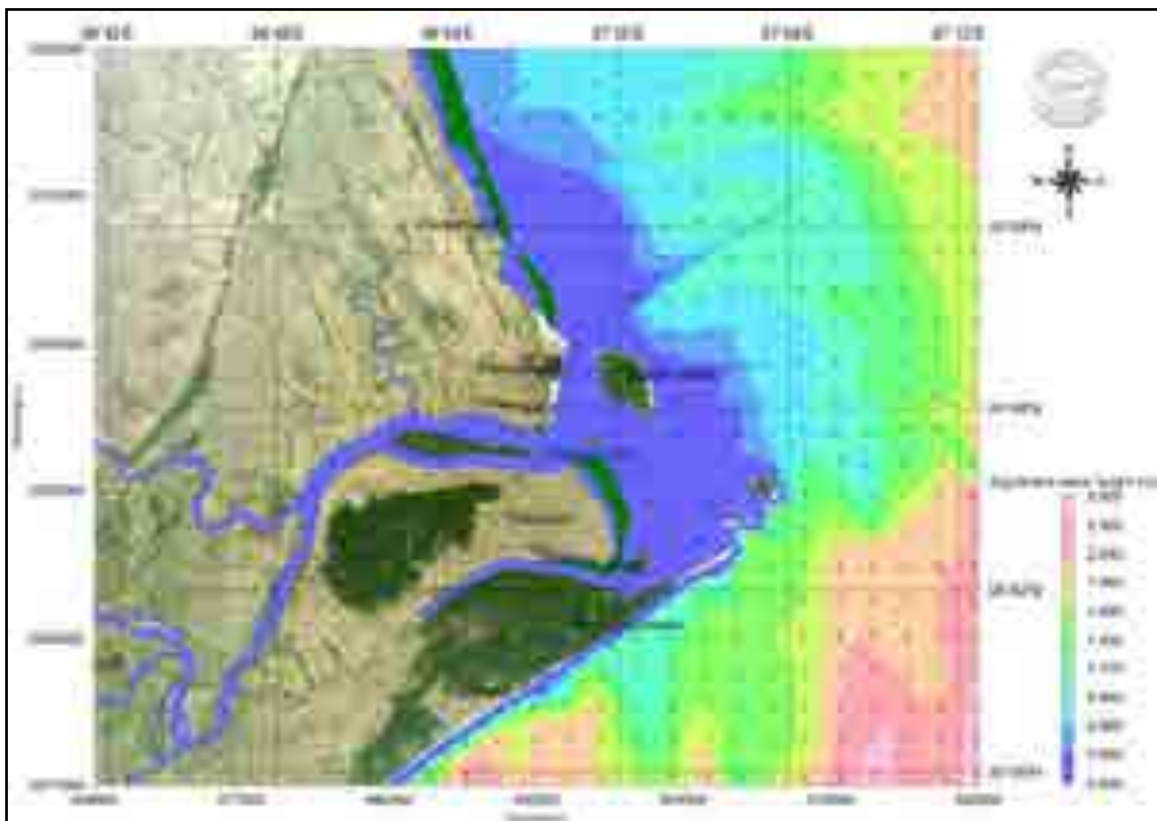


Figure 5-92: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 180^\circ$ (Existing Development)

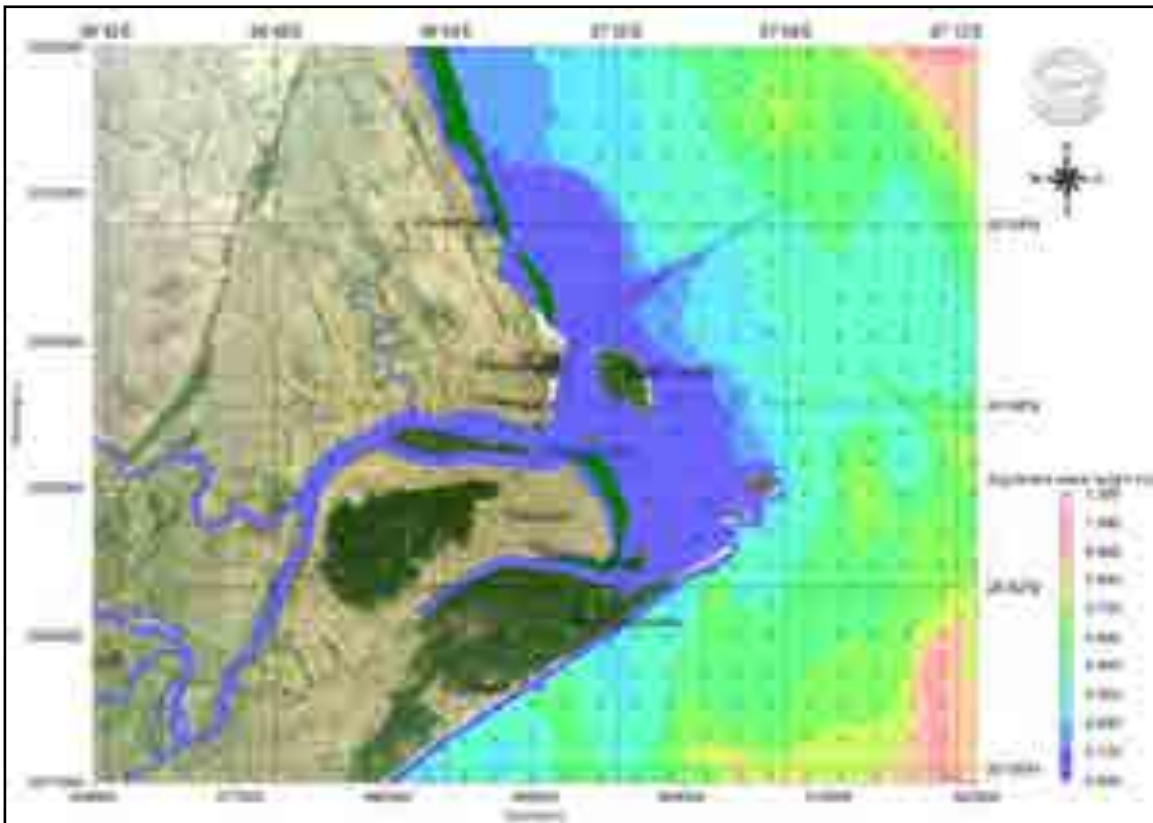


Figure 5-93: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 270^\circ$ (Existing Development)

B) Wave modelling after proposed expansion: With the proposed expansion in position, the wave propagation and energy dissipation undergoes no change. Modelling study was carried out again with incident wave heights of 7.0 m with directions of 0° , 45° , 60° , 90° , 135° , 180° and 270° . The wave distribution for each of the cases studied is given **Figure 5-94** to **Figure 5-100** for the proposed expansion. The wave height is about 0.44m at the location of the port during the HHW condition of the spring tide after the proposed revised master plan (for the different directional wave and 7.0 m wave height imposed for modelling purpose).

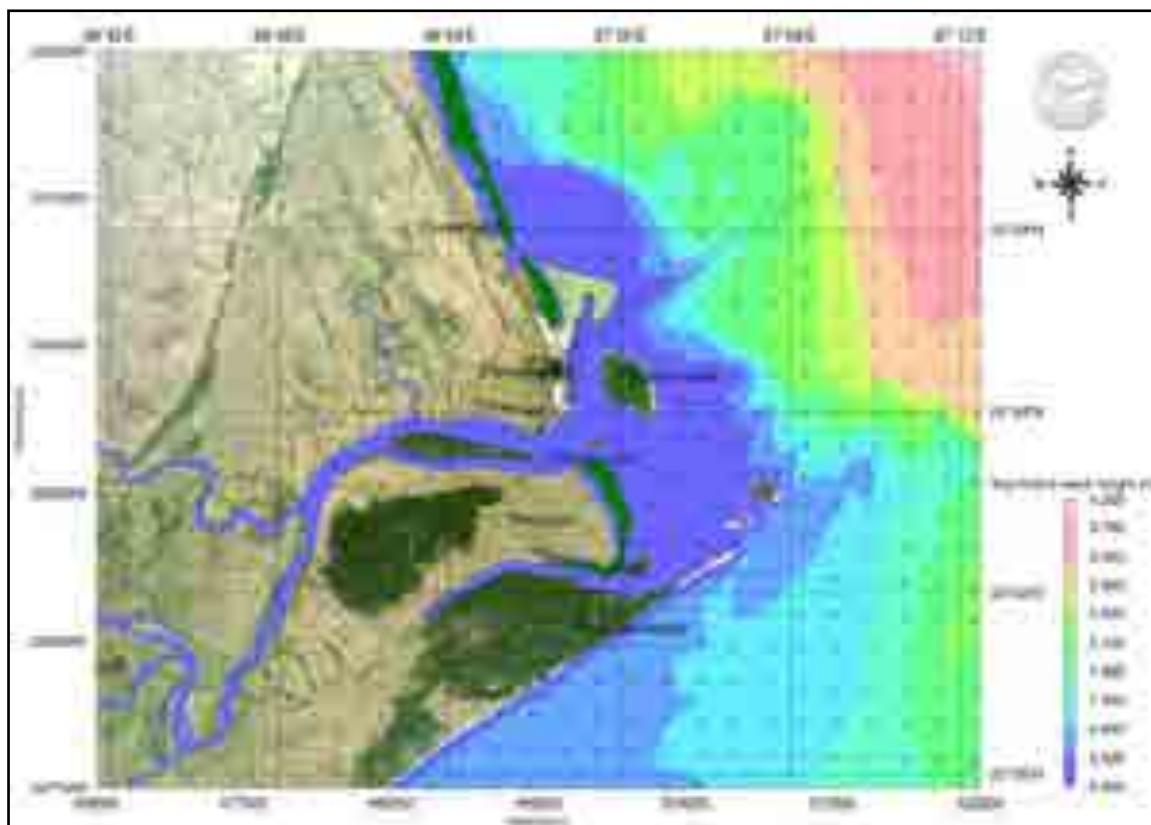


Figure 5-94: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 0^\circ$ (Proposed Expansion)

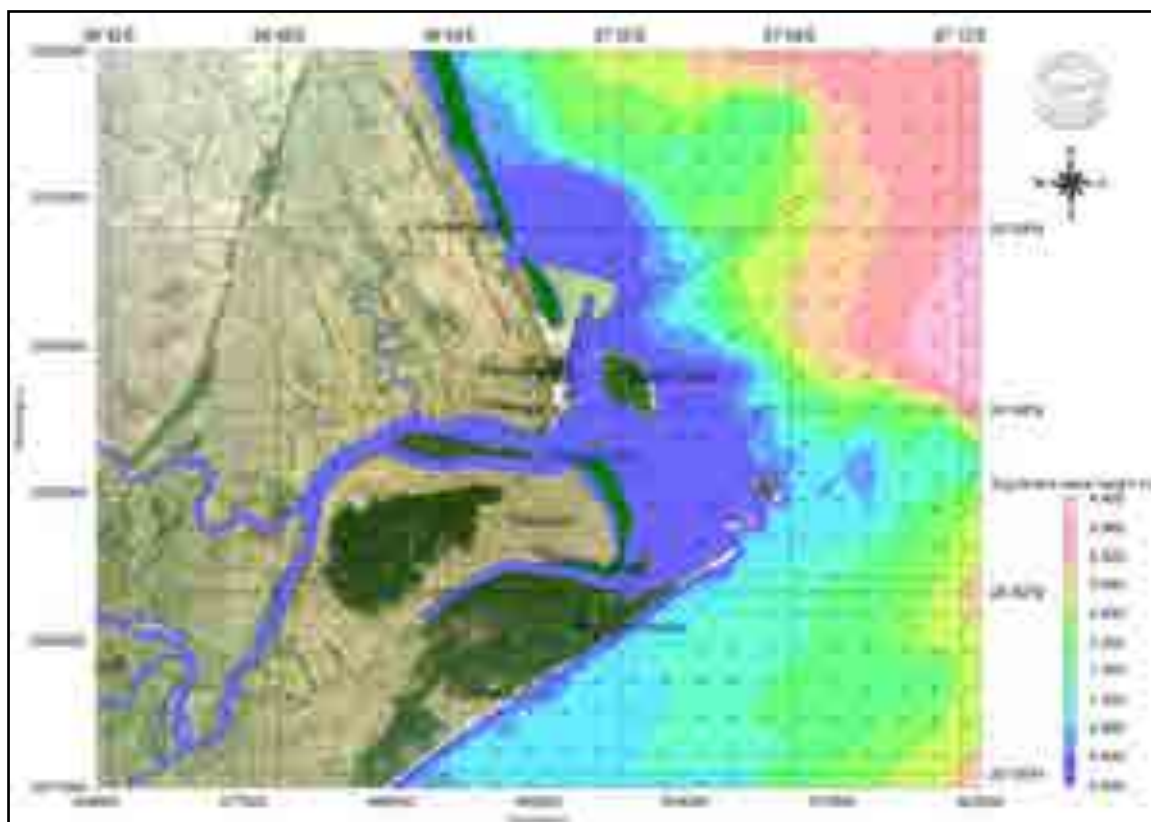


Figure 5-95: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 45^\circ$ (Proposed Expansion)

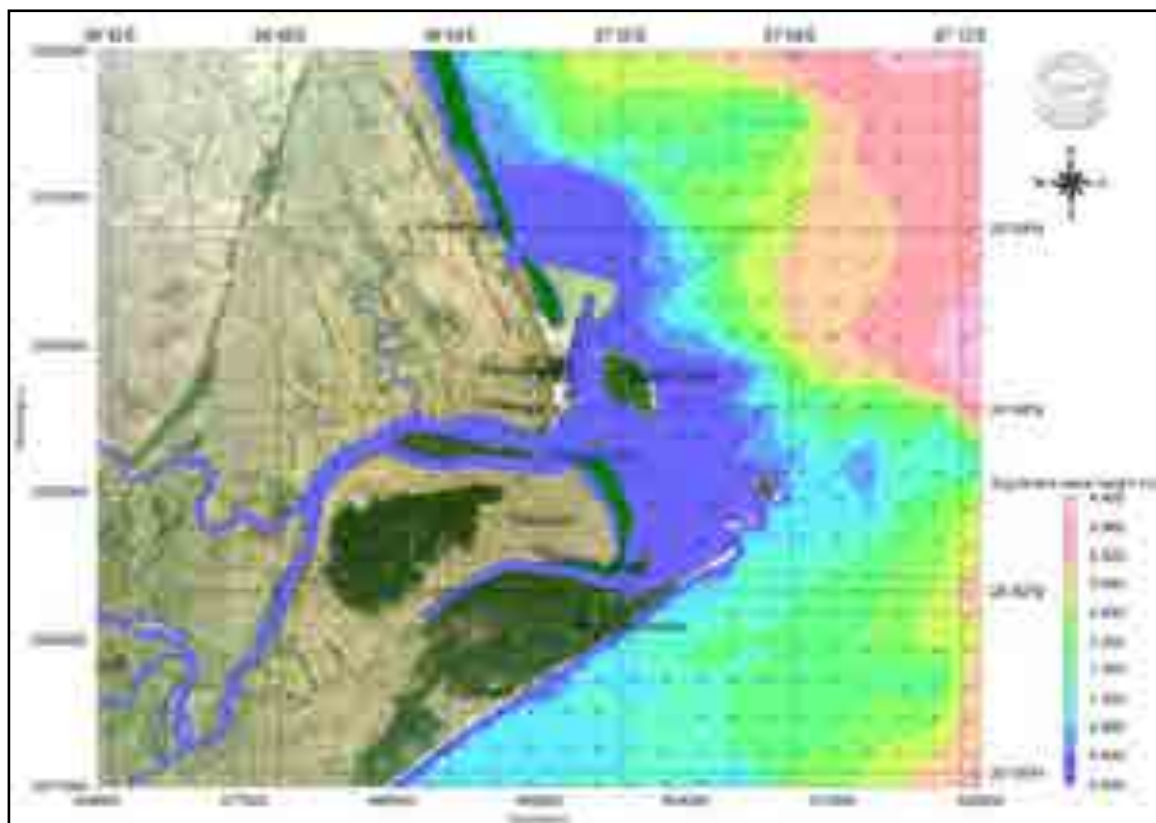


Figure 5-96: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 60^\circ$ (Proposed Expansion)

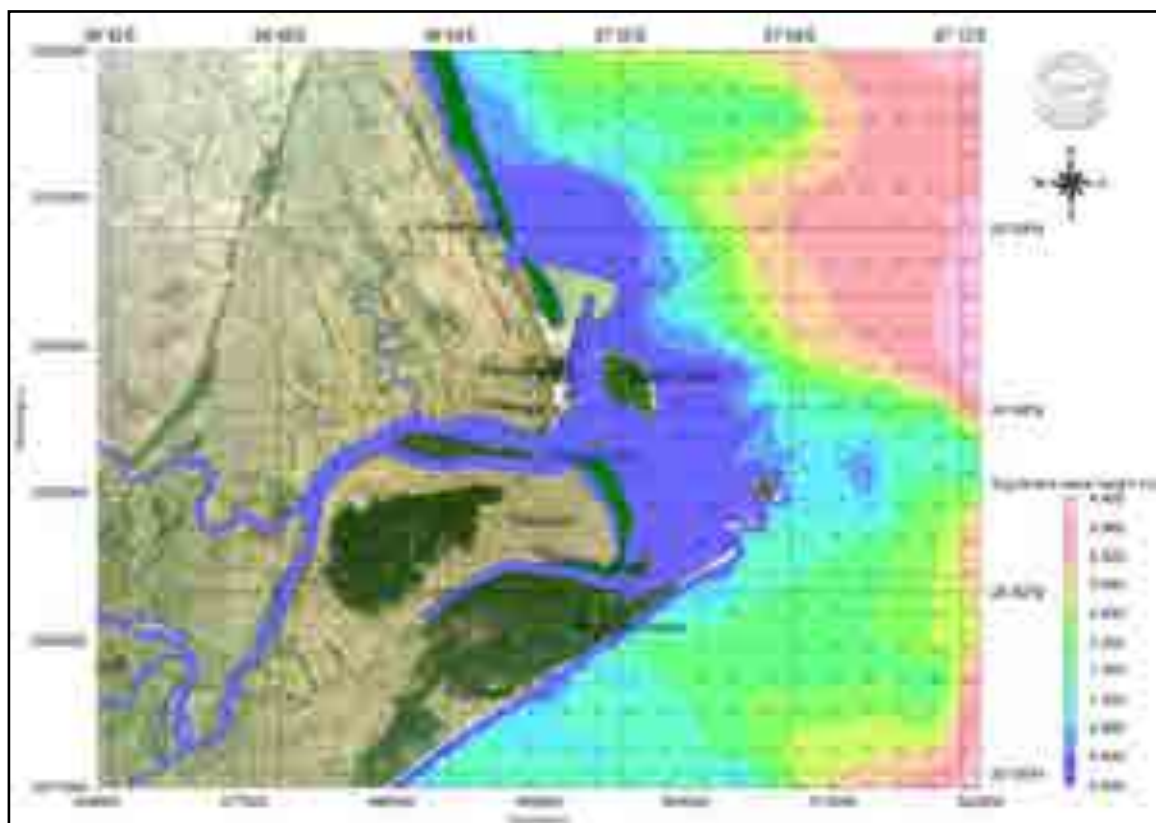


Figure 5-97: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 90^\circ$ (Proposed Expansion)

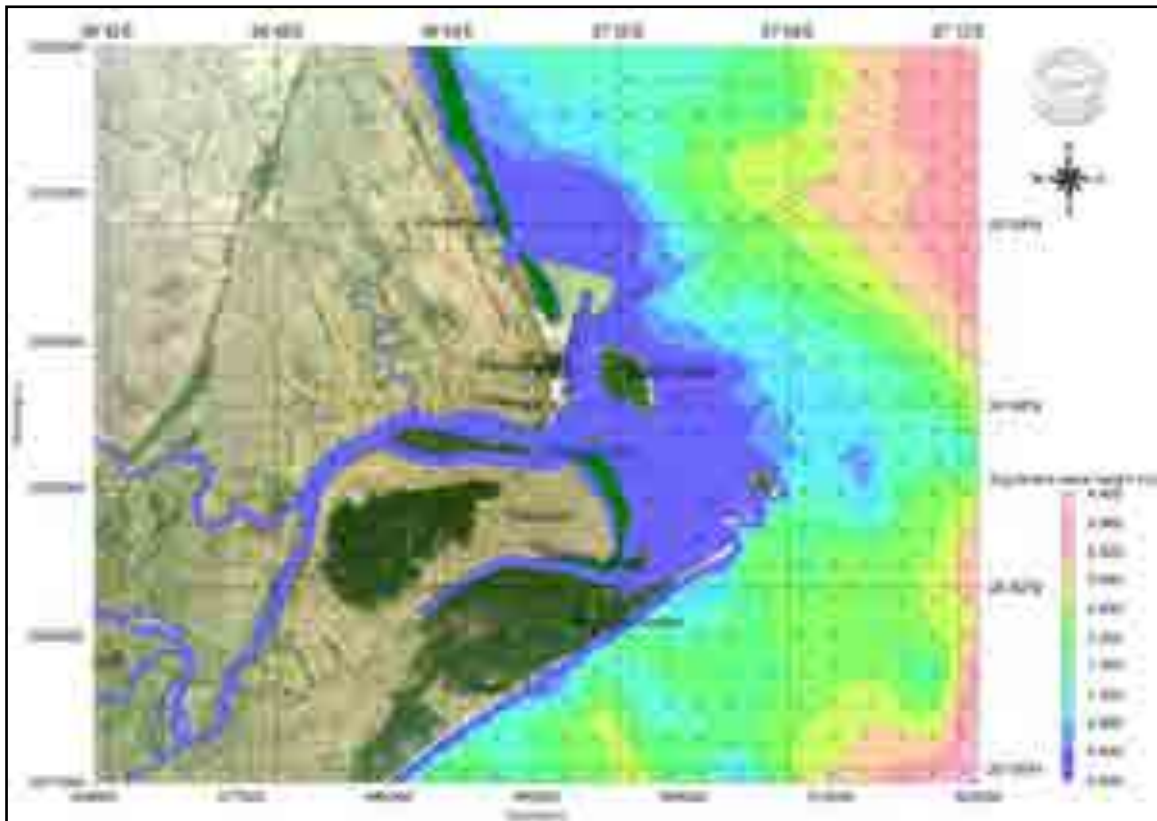


Figure 5-98: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 135^\circ$ (Proposed Expansion)

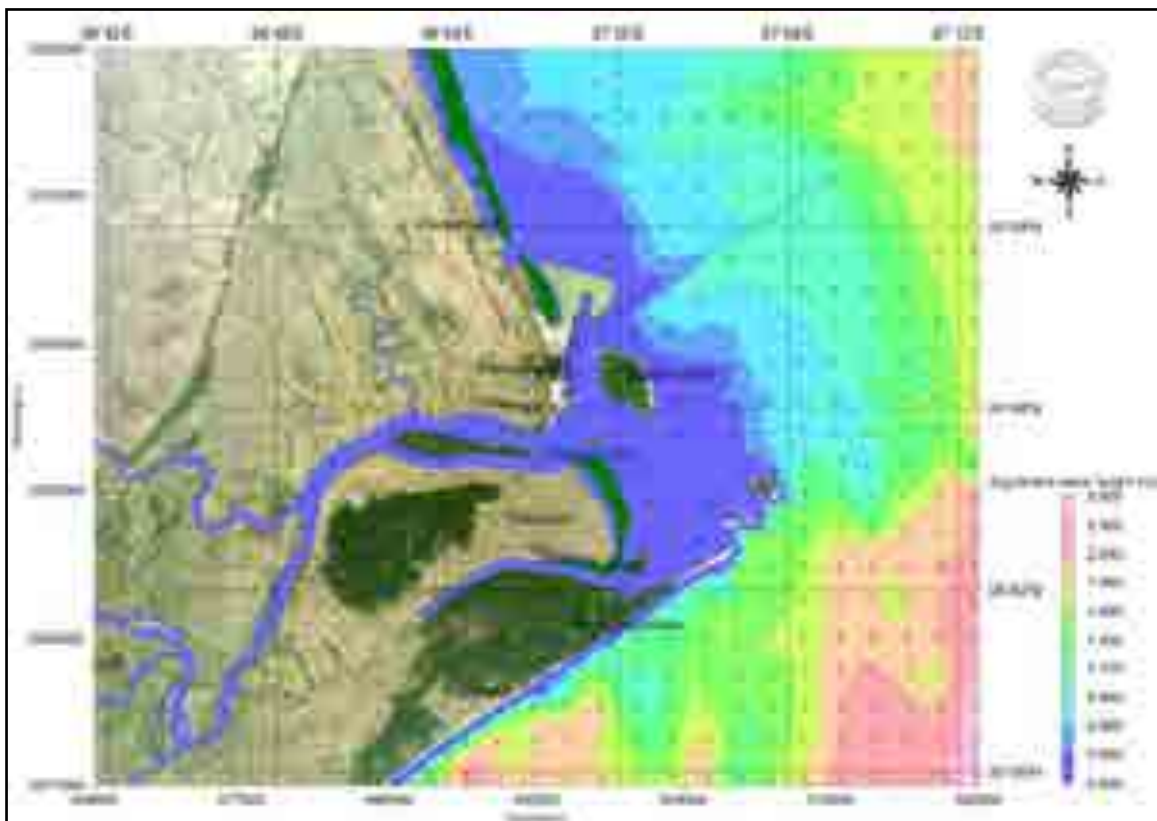


Figure 5-99: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 180^\circ$ (Proposed Expansion)

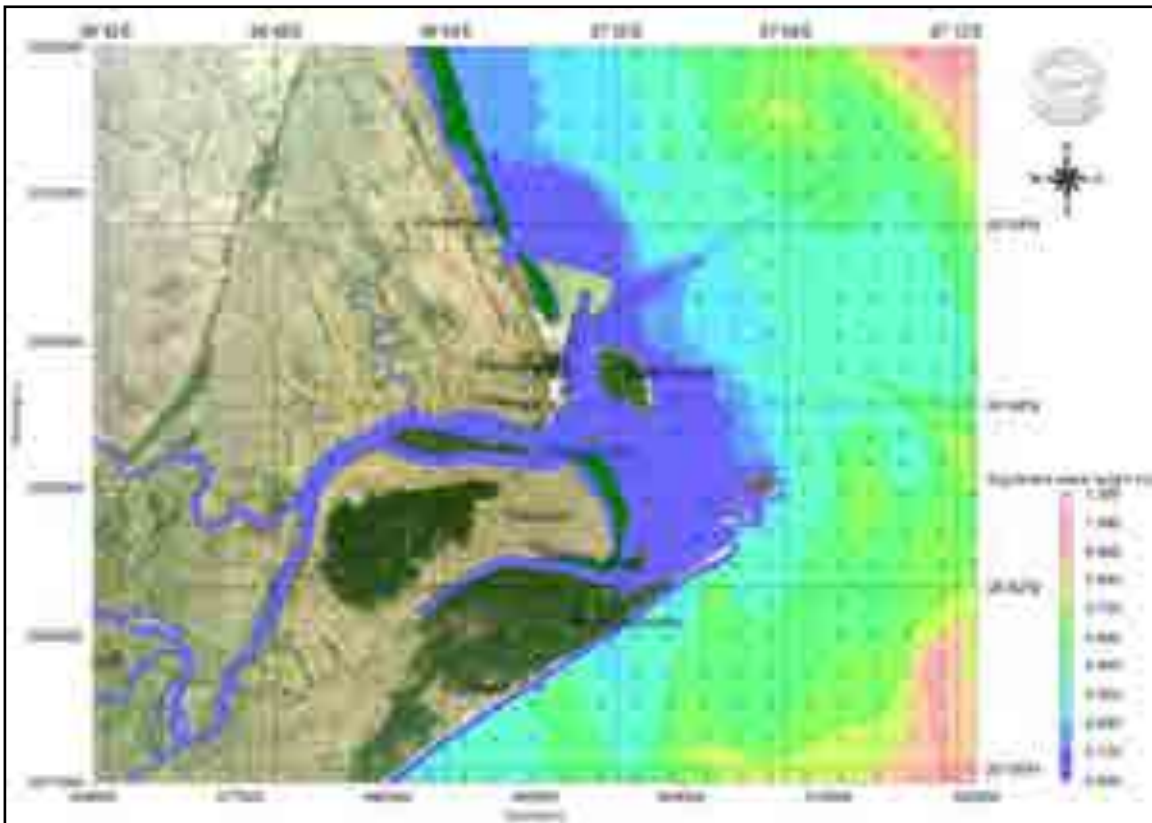


Figure 5-100: Significant wave height distribution for incident wave condition $H_s = 7.0$ m, $Dir = 270^\circ$ (Proposed Expansion)

C) Evaluation of Operational conditions (downtime): In order to evaluate the downtime at the proposed site, wave transformation studies were carried out to assess waves at the jetty/basins due to the incident near shore waves. Seven simulation runs have been carried to predict the wave climate at project site (**Table 5-20**) and results are shown graphically **Figure 5-87** to **Figure 5-93** and **Figure 5-94** to **Figure 5-100** respectively.

To quantify the downtime at the port, it is essential to define the thresholds of the maximum operable significant wave heights. From the available source, the threshold limit for bulk cargo vessels is 1 m for wave periods in the range of 6-8 sec. Results of the wave transformation studies seem to suggest that wave climate at the jetty/ basin not exceeding 0.5m in the study domain. Hence, berth availability is 100% based on the available wave data base for the above evaluation.

Summary of wave modelling and Tranquillity Studies:

Wave modelling and tranquillity studies were carried out by M/s Environ Software to establish that tranquillity conditions prevail at the port facility for most of the time in a calendar year. The proposed expansion in the port basin have ensured that the currents and tides around the berths are well within threshold limits applicable for safe berthing of vessels most of the time thus enabling unhindered operations at the port through-out the year.

Sediment Transport Study

The model developed at Environ “Hydrodyn-SEDSoft” was applied for predicting the changes in the bed morphology before and after the development (Revised Master Plan) of port facilities and also changes in the shoreline for 10 years.

Numerical approach to sediment transport Modelling Studies:

The principal aim of these studies was to assess the total (Cohesive and Non-Cohesive) sediment load getting deposited in the study area and to find out any changes in these values due to the proposed expansion. Accordingly the simulation runs were carried out with a sand/fine silt/mud transport which was appropriate for the conditions in these areas.

Data which was made available in the present study to provide input to the morphological studies comprised the following:

- Bathymetry data for the domain
- Sediment sample data of the creek
- Coastline data

Sediment transport simulation: Simulation of sediment transport in the model domain was carried out with the Hydrodyn-SEDSoft for various tide conditions during the year 2012 - 2013. Hydrodyn-SEDSoft is a 2D sediment transport model (Cohesive and non-Cohesive) and predicts the process of erosion, transport and deposition of sediment. Hydrodyn-SEDSoft was driven with the neap and spring tide hydrodynamic flow file and using standard parameters which describe the erosion and settling characteristics of the sediment. Simulation runs were carried by specifying sediment composition in the shallower (intertidal) zones where the tide induced bed shear stress was relatively low.

Following simulation of the sediment transport under existing conditions, the model was adjusted to include the effects of the bathymetry changes etc., due to the proposed expansion. The simulation runs were carried out for the study domain and the results are reported for the proposed expansion.

A) Sediment erosion before and after proposed expansion (Revised Master Plan):

The model has been for spring tide predicted values for the rate of erosion for various tidal conditions are discussed below.

- (i) **Spring tide - peak flood (PF):** The instantaneous rate of erosion before and after proposed expansion during spring tide PF condition in the study domain is shown in **Figure 5-101** and **Figure 5-102** respectively. From the figures it can be seen that the erosion rate is reduced at Kanika Island as well as in approach channel, turning circles and river mouth after development. It can be observed from the figures that there is an insignificant reduction in the erosion rate and can be considered as no change in the rate between before and after development. (The decrease observed is very small and is of the order of $0.001 \text{ kg/m}^2\text{-sec.}$)

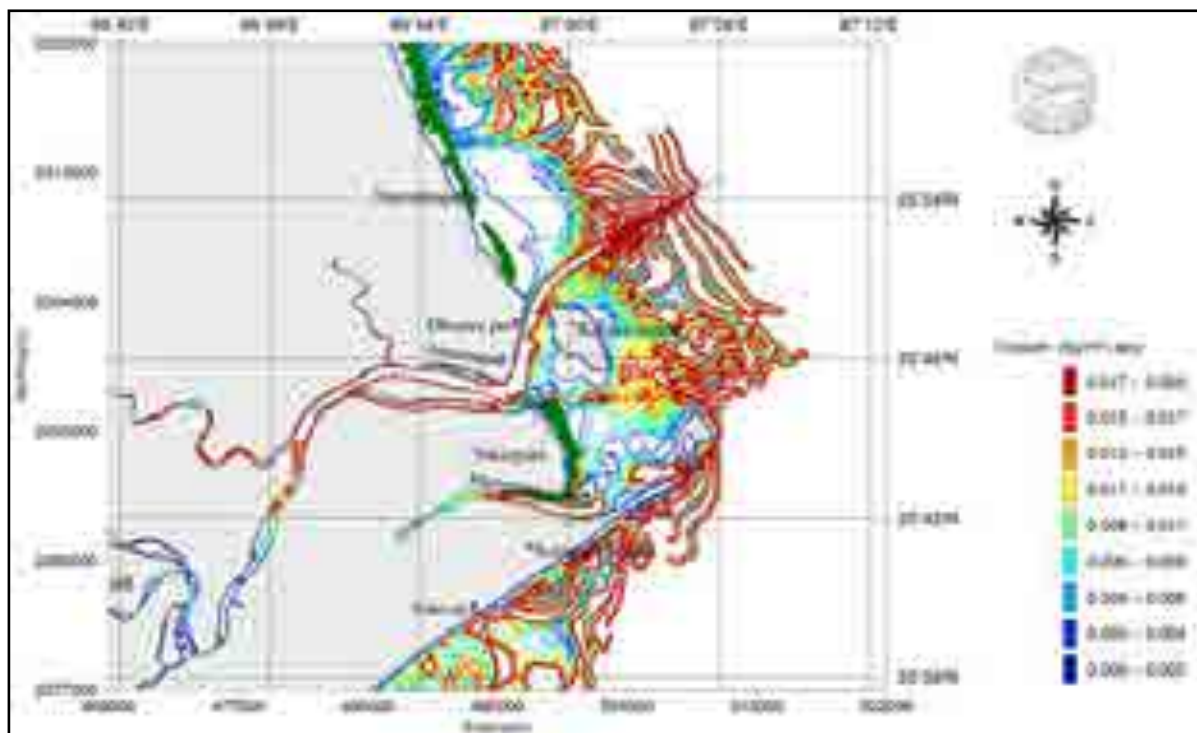


Figure 5-101: sediment erosion before Proposed Expansion during Flooding of spring tide

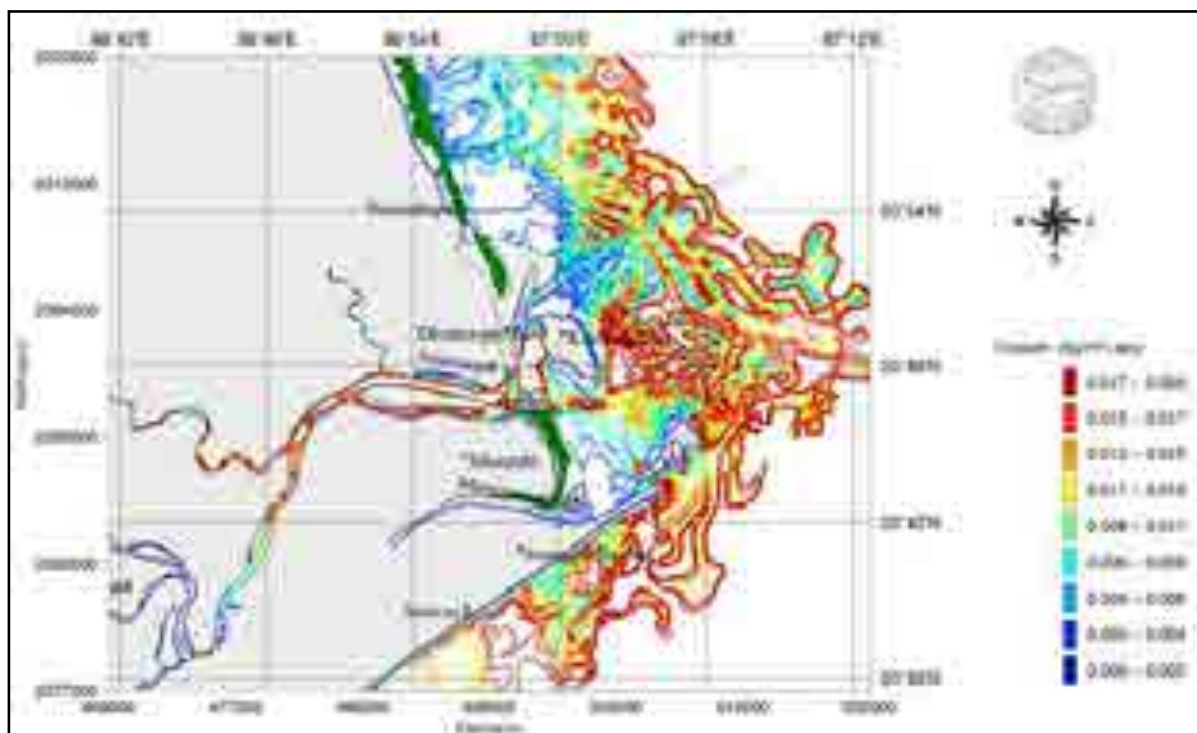


Figure 5-102: sediment erosion after Proposed Expansion during Flooding of spring tide

- (ii) **Spring tide - peak ebb (PE):** Figure 5-103 and Figure 5-104 shows the instantaneous rate of erosion before and after proposed expansion during Spring tide PE condition in the study domain. From the figures it can be observed that the erosion rate has been reduced at and around Kanika Island, in the approach channel, and turning circles etc after proposed expansion. It can be observed

from the figure that there is a very insignificant change reduction in the erosion rate, at areas other than the proposed expansion locations. The change observed is very small and is of the order of $0.002 \text{ kg/m}^2\text{-sec}$.

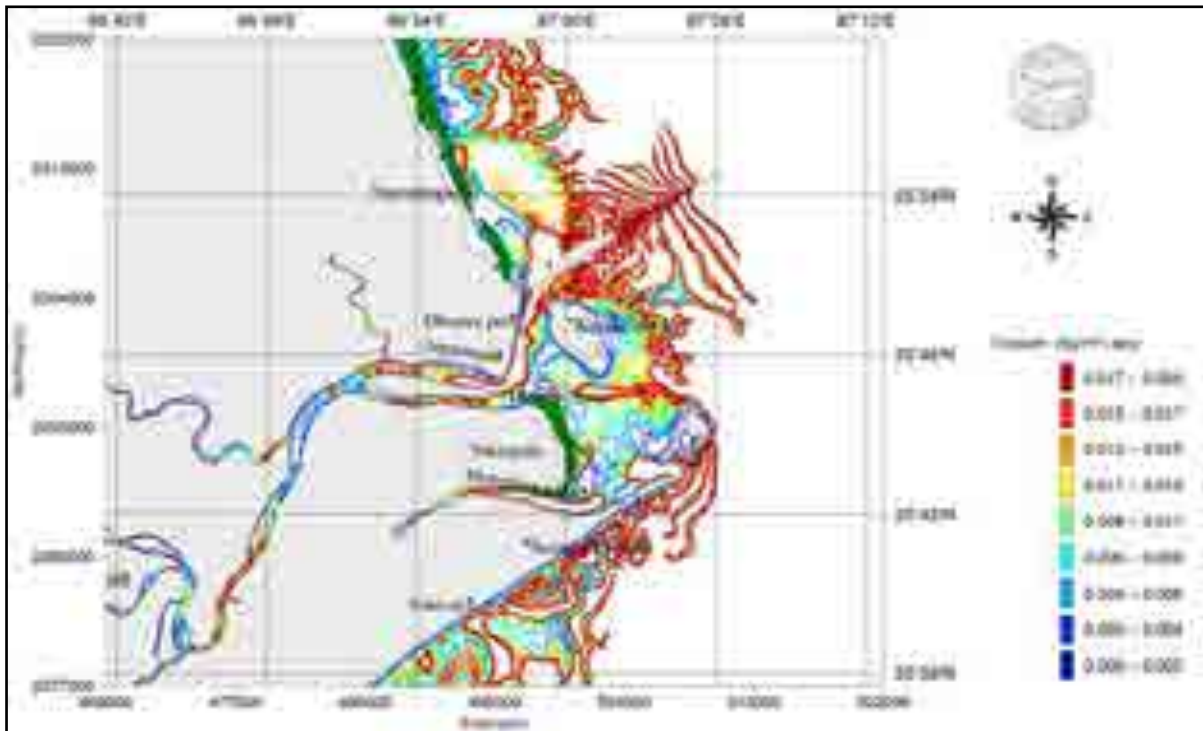


Figure 5-103: Sediment erosion before Proposed Expansion during EBB of spring tide

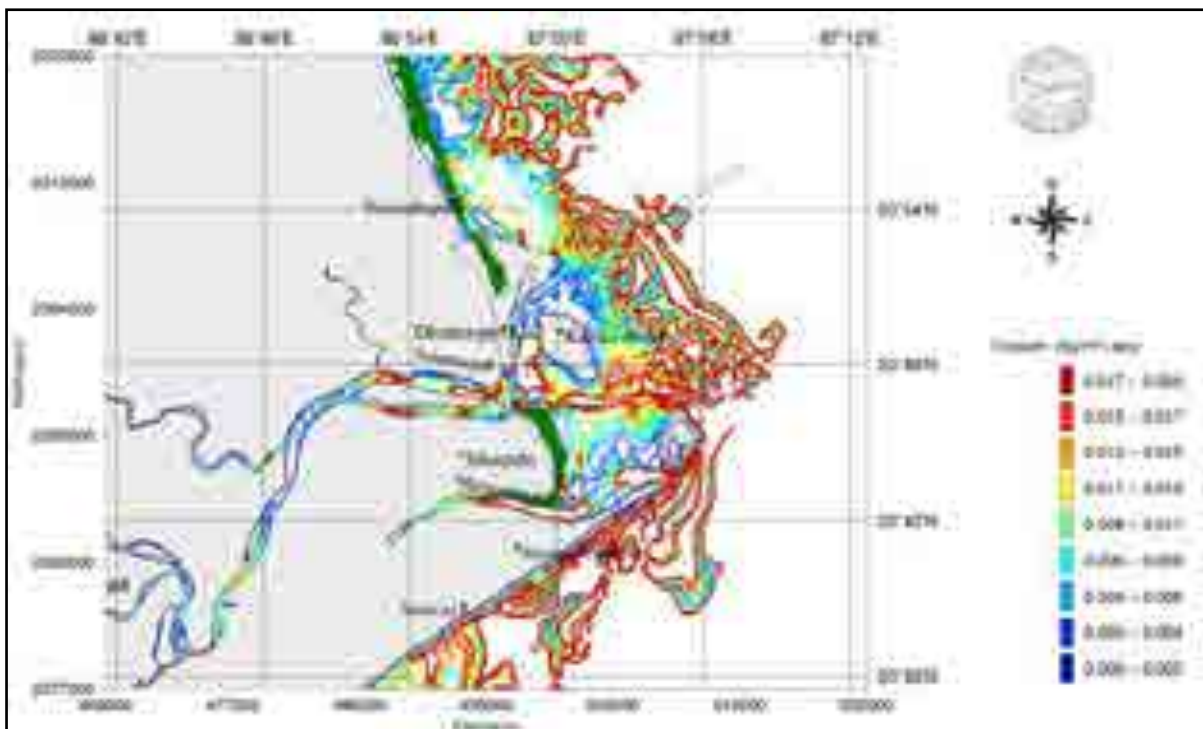


Figure 5-104: Sediment erosion after Proposed Expansion during EBB of spring tide

The comparison of sediment erosion rate before and after proposed expansion at different location points are shown in **Figure 5-105** to **Figure 5-108**. It can be seen that the change or variation in the erosion rate is limited to the vicinity of the proposed expansion and no

change observed in the rest of the domain. Change of Sediment erosion rate before and after expansion at other areas, i.e North side Mangroves, North side & South side mouth of Dhamra river, Gahirmatha beach & wheeler Island are noticed to be insignificant.

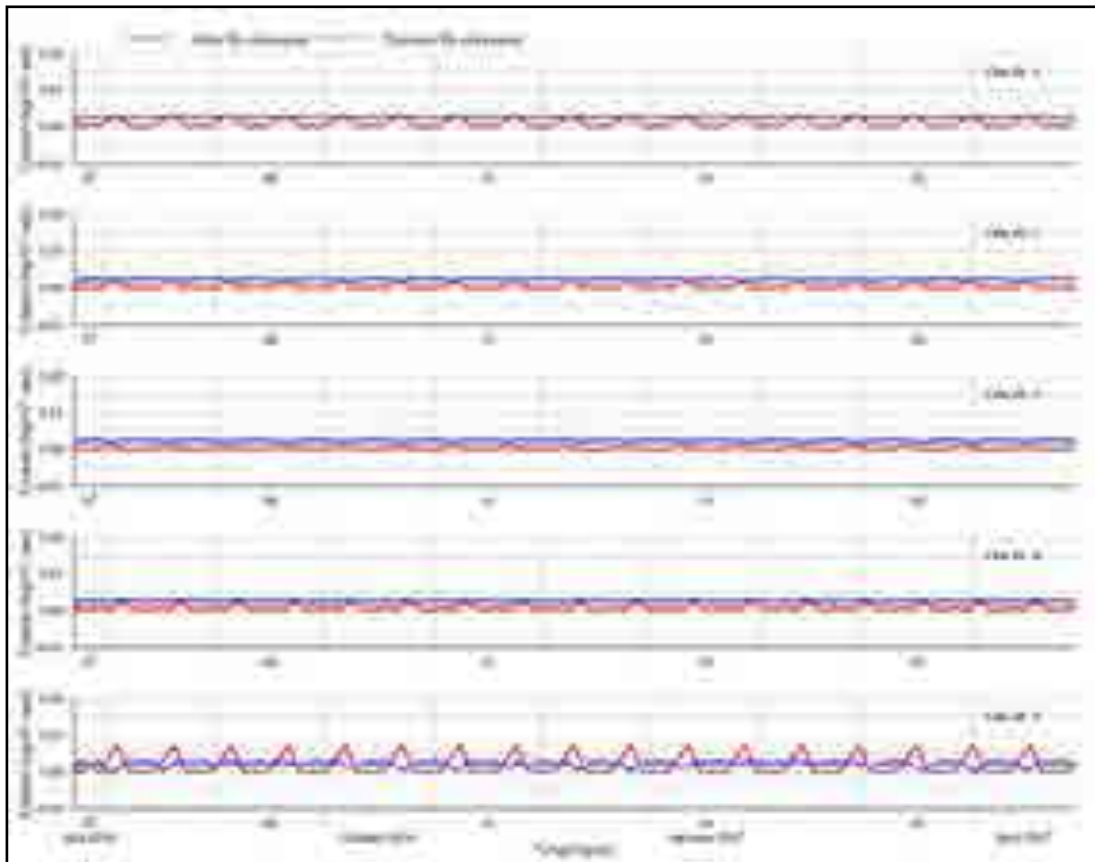


Figure 5-105: Comparison of sediment erosion before and after Proposed Expansion

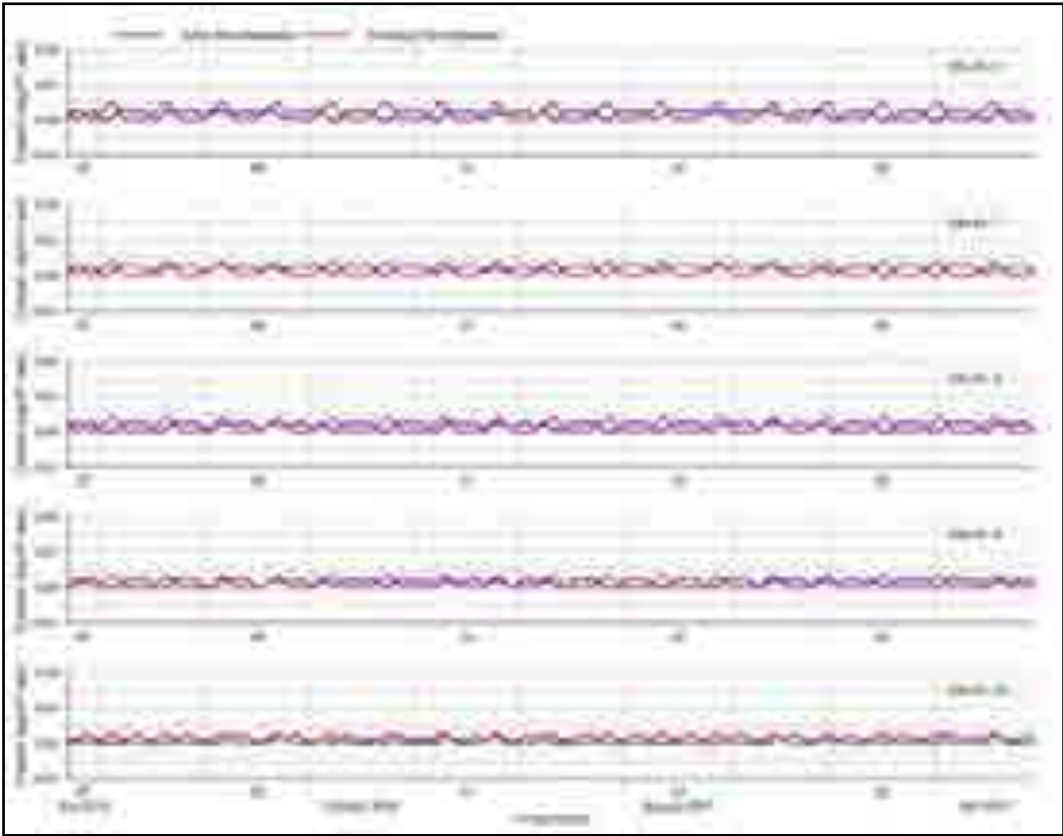


Figure 5-106: Comparison of sediment erosion before and after Proposed Expansion

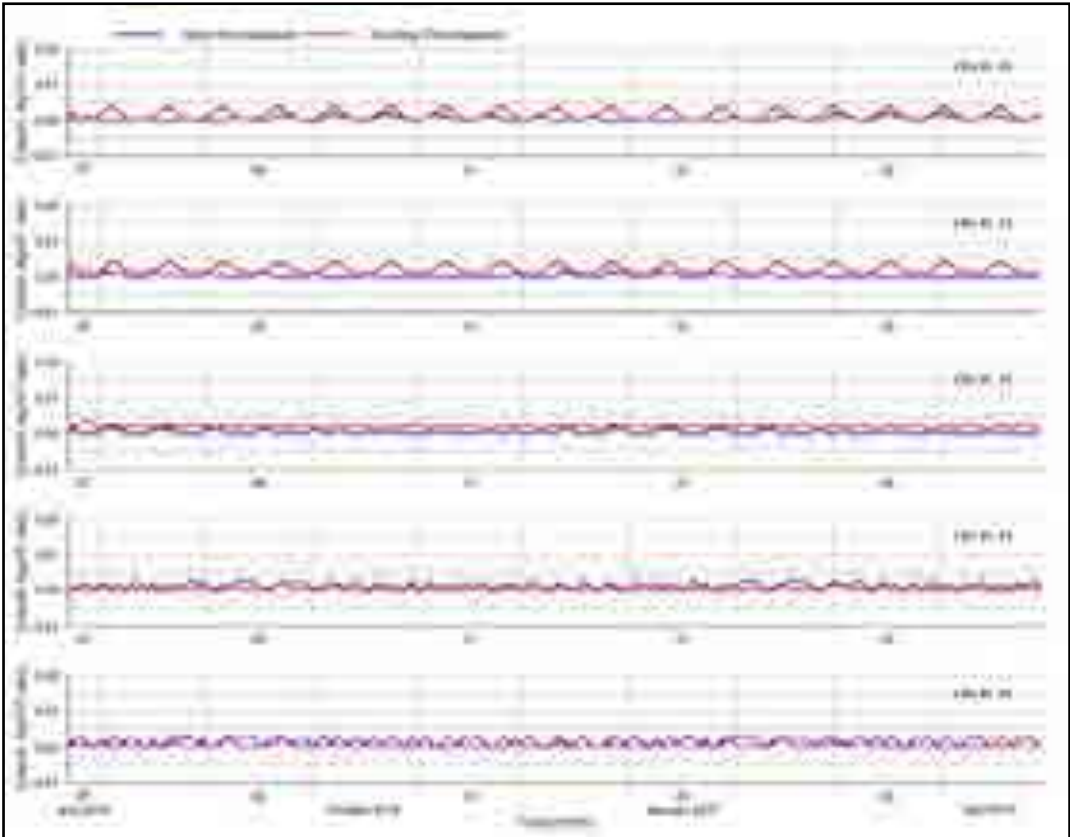


Figure 5-107: Comparison of sediment erosion before and after Proposed Expansion

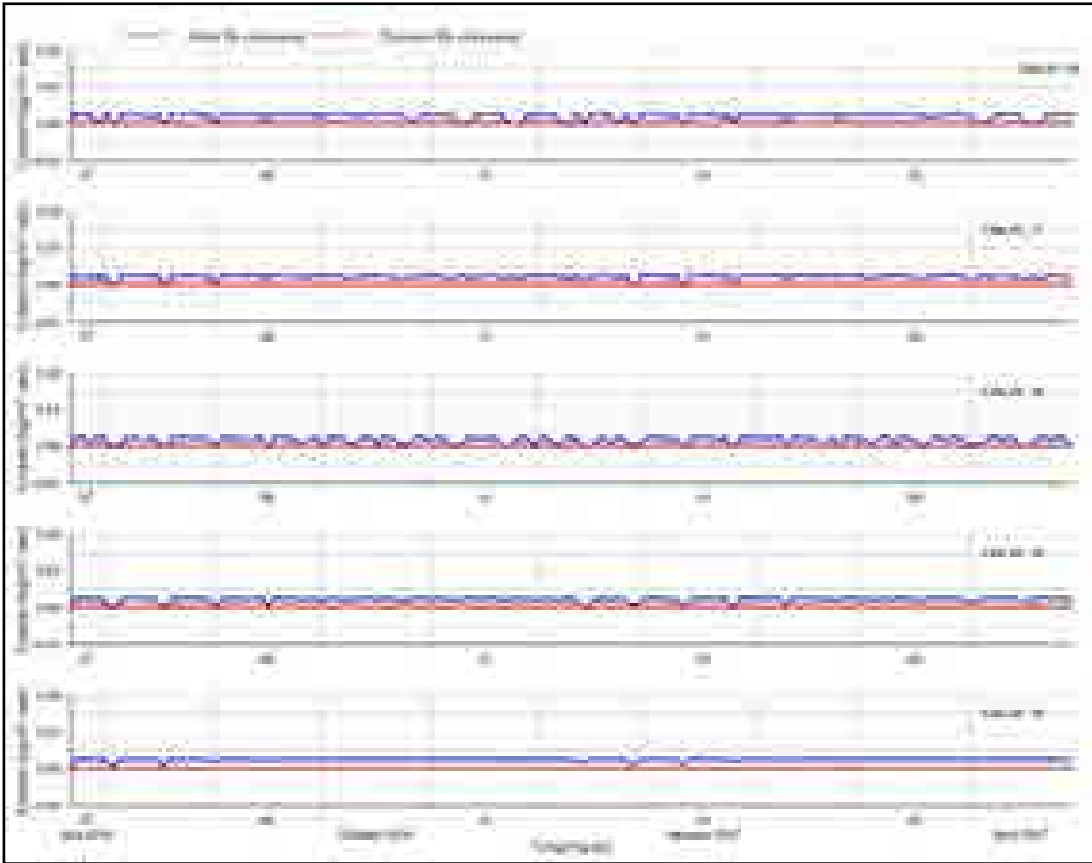


Figure 5-108: Comparison of sediment erosion before and after Proposed Expansion

B) Sediment deposition before and after proposed expansion:

The model predicted values for the rate of deposition for different tidal conditions are discussed below.

- (i) **Spring tide - slack-1 (LLW):** Figure 5-109 and Figure 5-110 show the instantaneous rate of deposition before and after proposed expansion in the study domain. It can be observed from the figure that there is slight increase in the sediment deposition in the basin, channel and turning circles in the order $0.02 \text{ Kg/m}^2\text{-sec}$

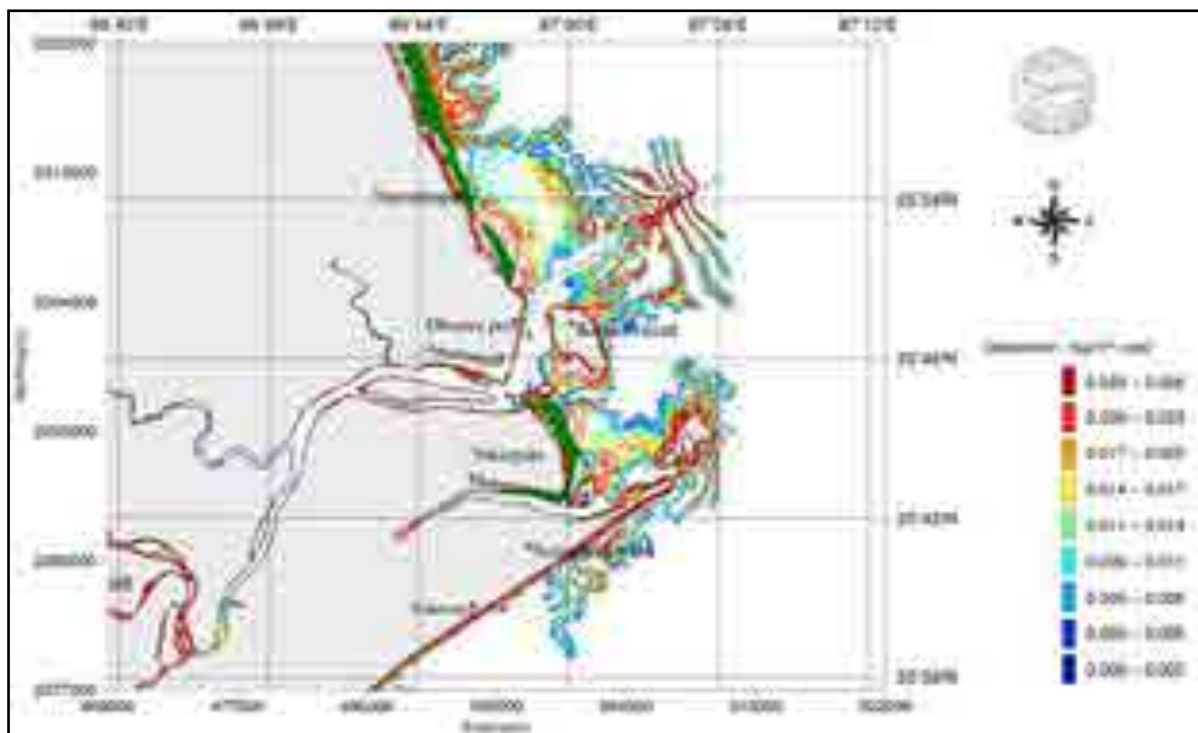


Figure 5-109: Sediment deposition before Proposed Expansion during LLW of spring tide

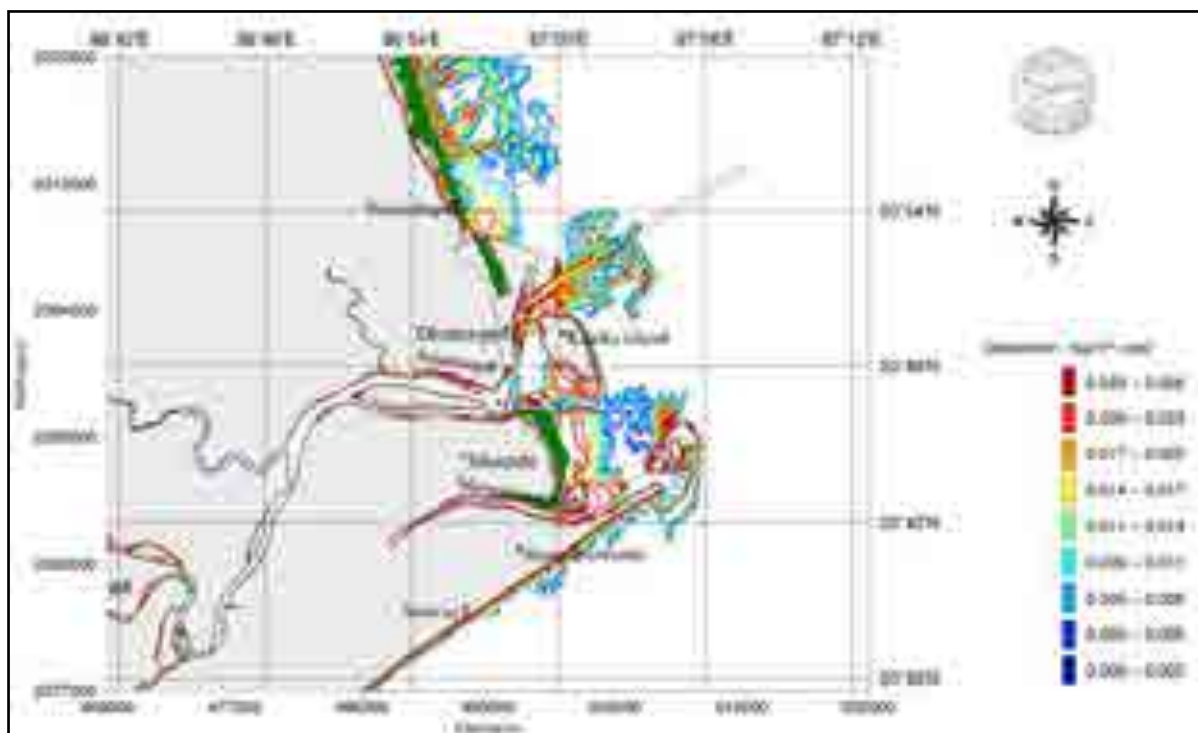


Figure 5-110: Sediment deposition After Proposed Expansion during LLW of spring tide

- (ii) **Spring tide - highest high water (HHW):** Figure 5-111 and Figure 5-112 show the instantaneous rate of deposition before and after proposed expansion in the study domain. It can be observed from the figure that there is a very small increase in the deposition rate ($0.001 \text{ kg/m}^2\text{-sec}$ to $0.003 \text{ kg/m}^2\text{-sec}$) in the dredged area locations after proposed expansion respectively.

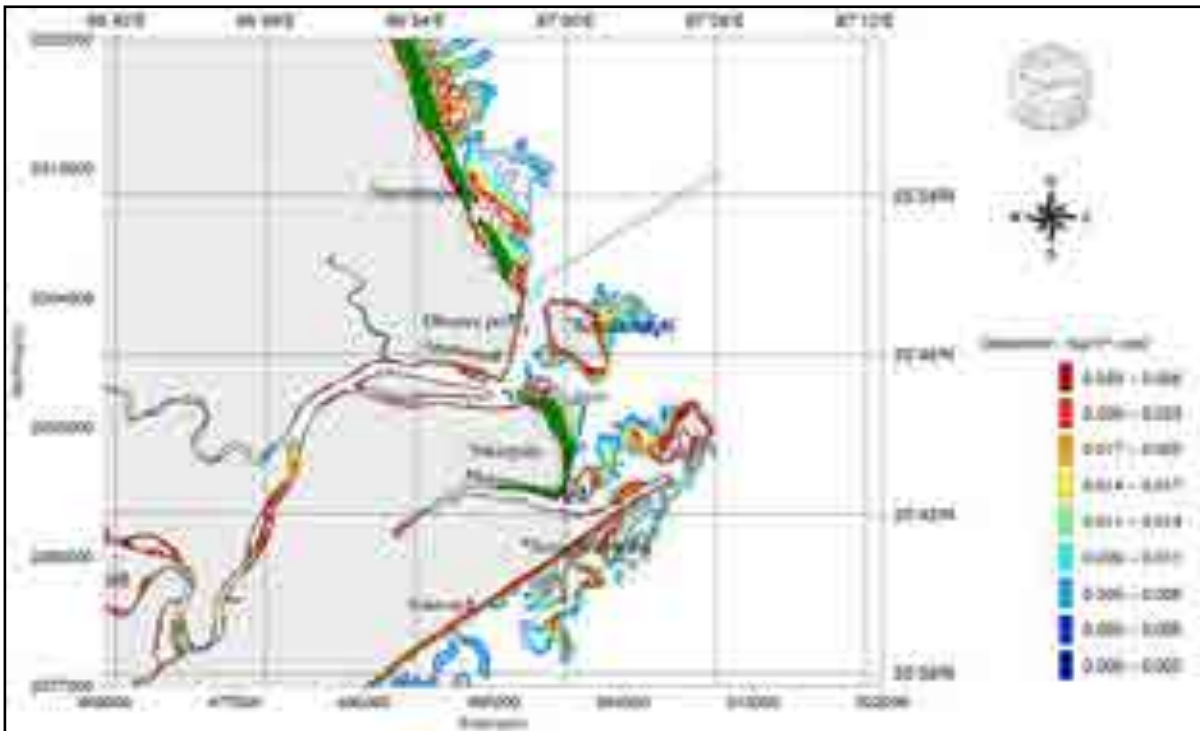


Figure 5-111: Sediment deposition before Proposed Expansion during HW of spring tide

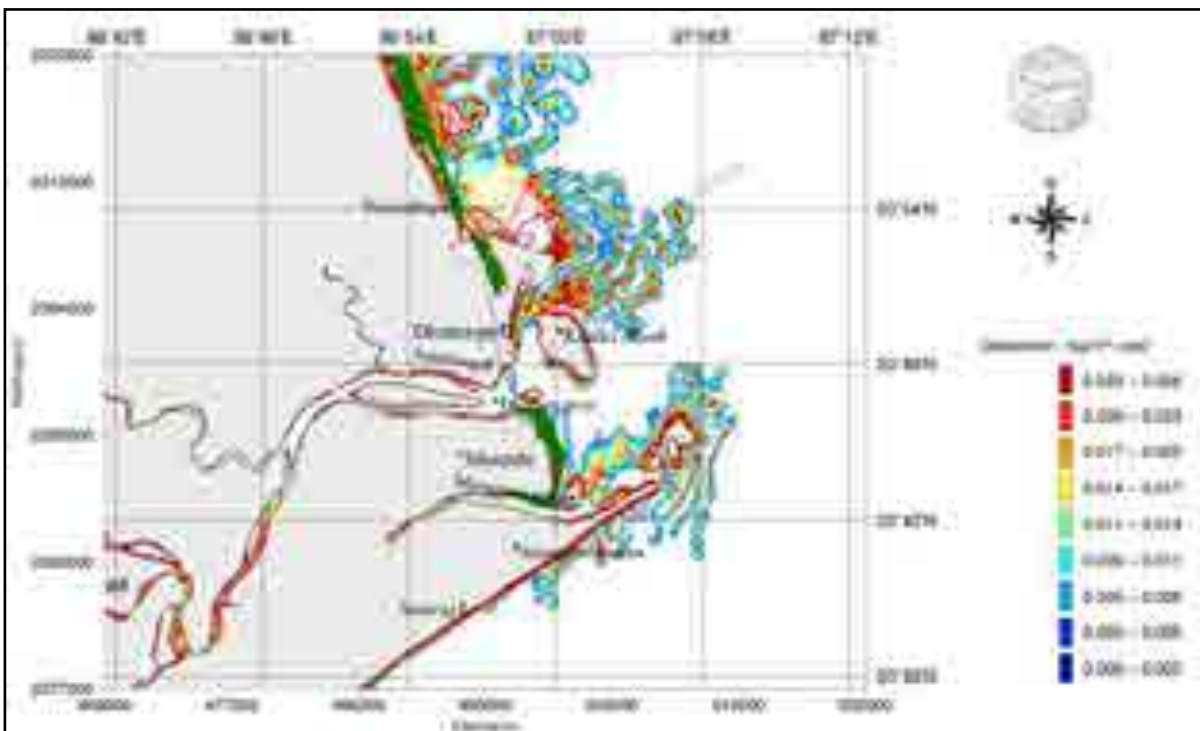


Figure 5-112: Sediment deposition After Proposed Expansion during HW of spring tide

The comparison of the rates of sediment deposition before and after expansion at different location points around the slipway basins is shown in **Figure 5-113** to **Figure 5-116**. It can be seen that the increase in the rate of deposition after proposed expansion is limited to the proposed expansion area only and thus are very much localized. Change of Sediment deposition rate before and after expansion at other areas, i.e North side Mangroves, North

side & South side mouth of Dhamra river, Gahirmatha beach & wheeler Island are noticed to be insignificant.

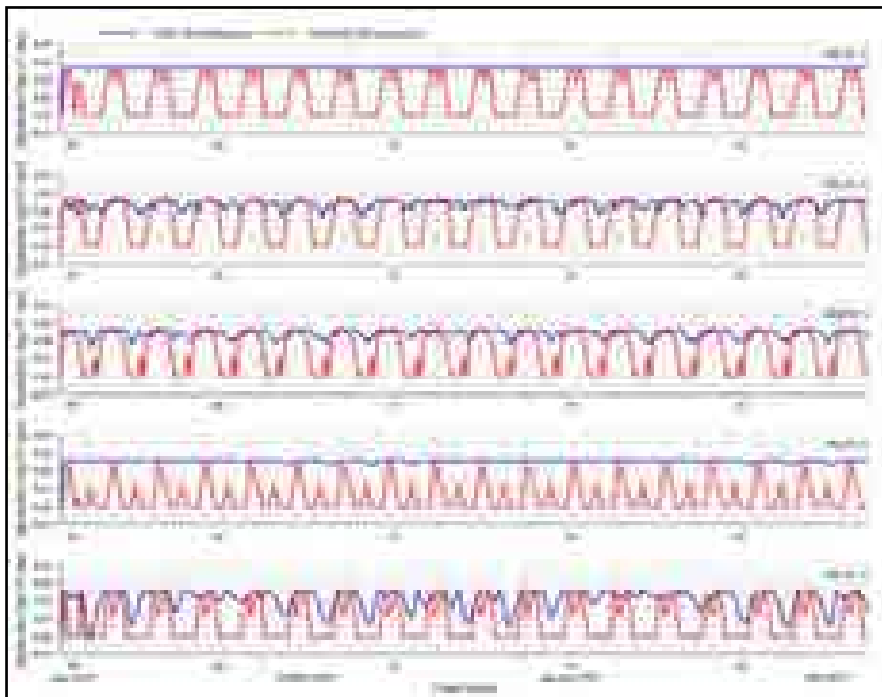


Figure 5-113: Comparison of sediment deposition before and After Proposed Expansion

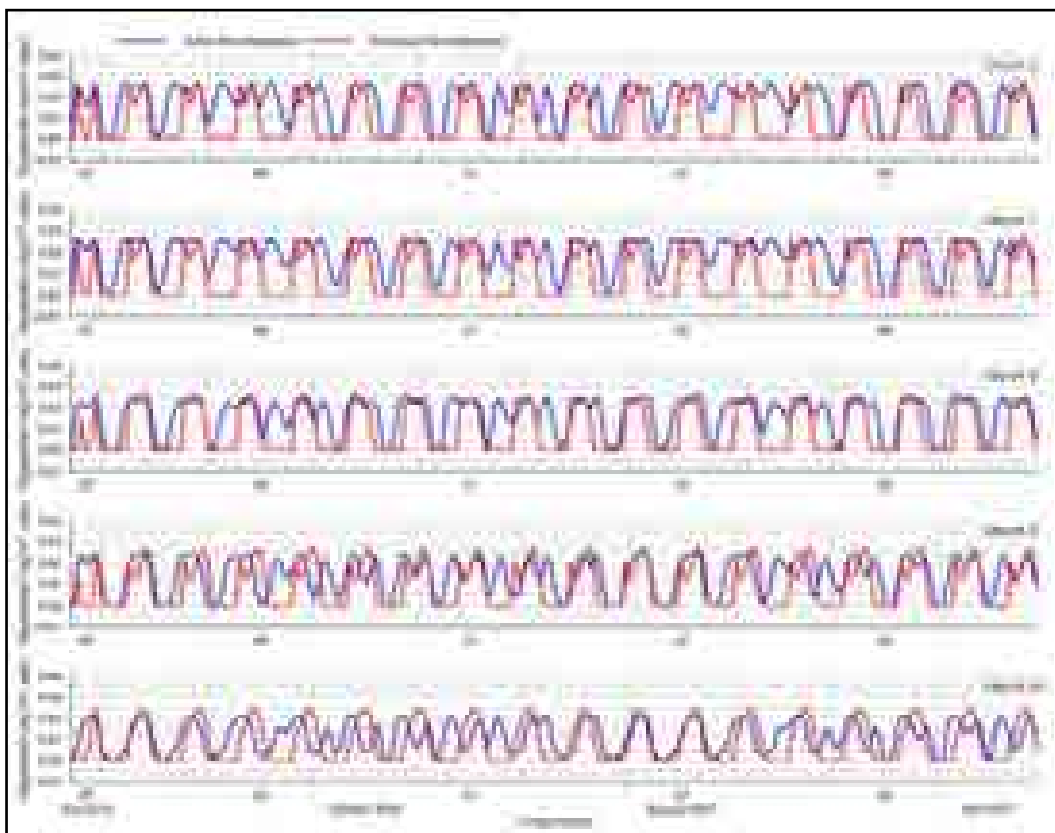


Figure 5-114: Comparison of sediment deposition before and After Proposed Expansion

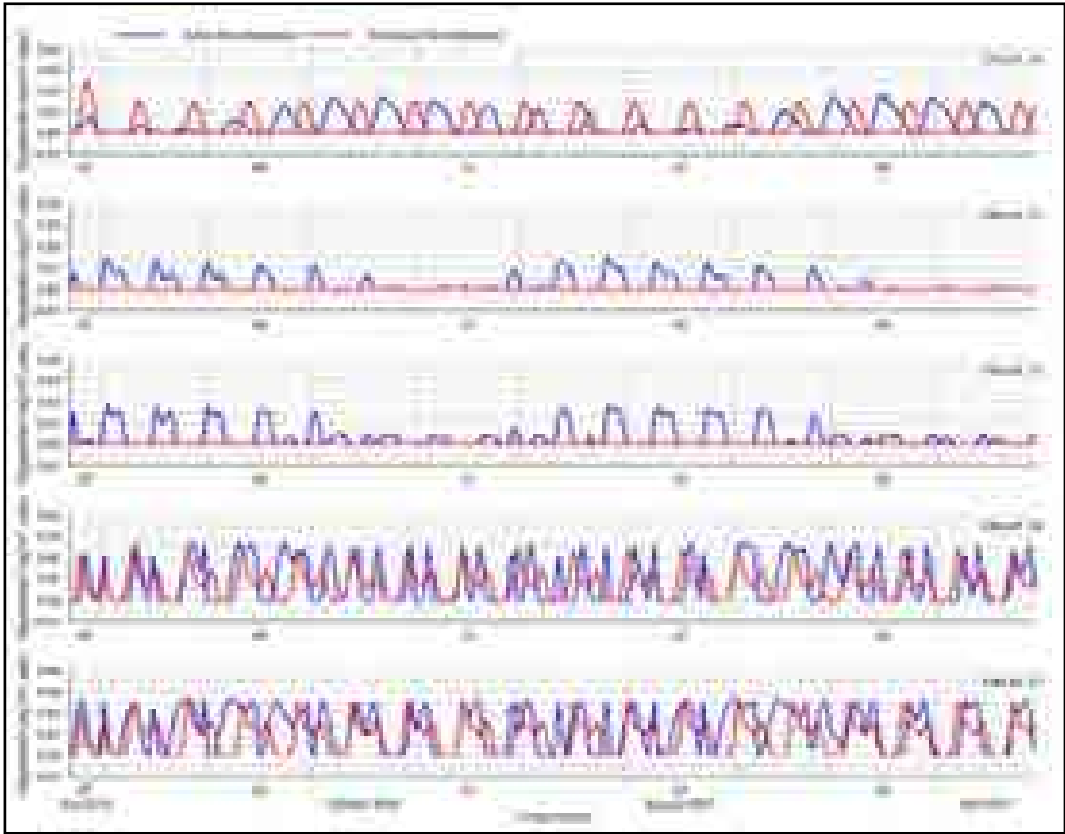


Figure 5-115: Comparison of sediment deposition before and After Proposed Expansion

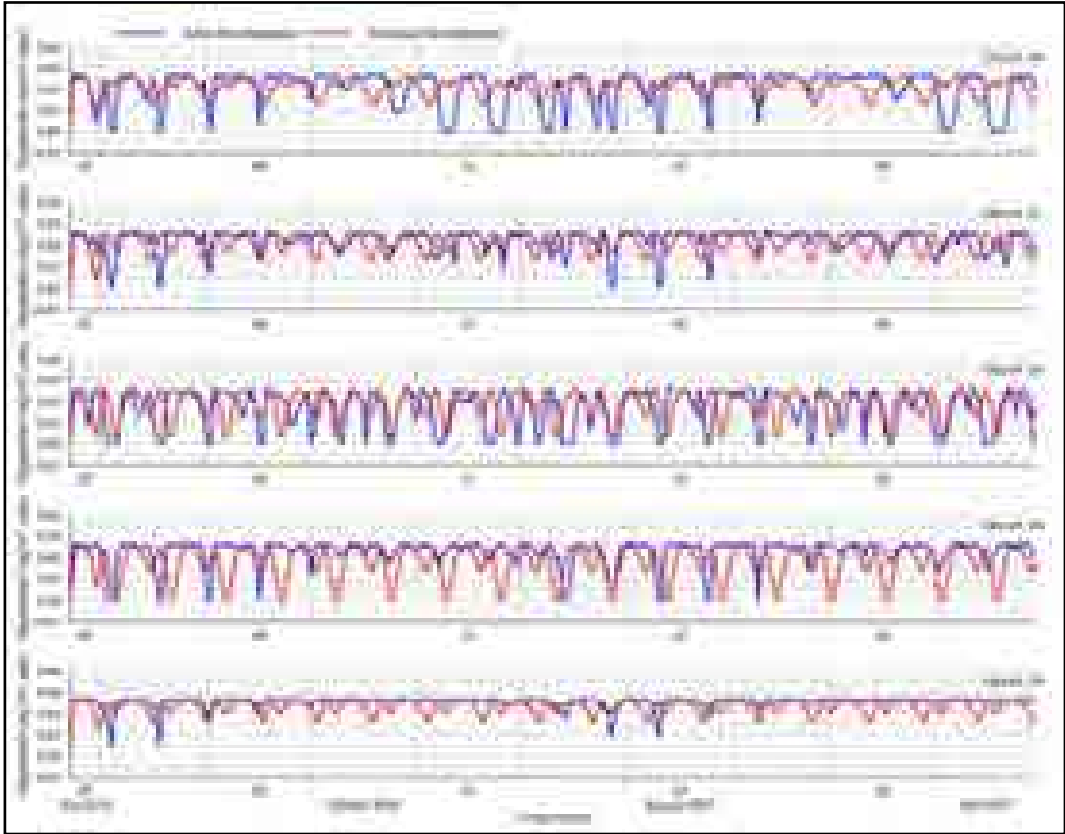


Figure 5-116: Comparison of sediment deposition before and After Proposed Expansion

From the figures it can be seen that the impact predicted on flow/sediment dynamics after proposed expansion is not significant and also it is limited to localized areas only.

C) Morphological changes:

The model has been run continuously for 6 months taking account of neap and spring tide conditions for various seasons and the morphological changes due to erosion and deposition in the domain after the proposed expansion. **Figure 5-117** gives the bed level after 6 months before proposed expansion and **Figure 5-118** gives the bed level after 6 months of proposed expansion respectively. It can be seen from the figures that the bed level changes are confined to the areas where proposed expansion is taken place (i.e at the approach channel, turning circles and the area where dredging has been carried out). From the Figures, it can be inferred that the variation or change in the bed level due to the proposed expansion is of the order of 0.42 m in the port area including turning circles, approach channel etc. Also noticed that the morphological changes around the western side of Kanika Island is in the order of 0.3 m. Also it was observed that no impact on Mouth of river (N&S), Gahirmatha beach etc. **Figure 5-119** to **Figure 5-122** give the comparison of bed levels before and after proposed expansion at various observation point locations set up in the study region. From the figure, it can be seen that the bed levels rises in the development areas i.e. port basin, turning circles and approach channel after the proposed expansion is not significant.

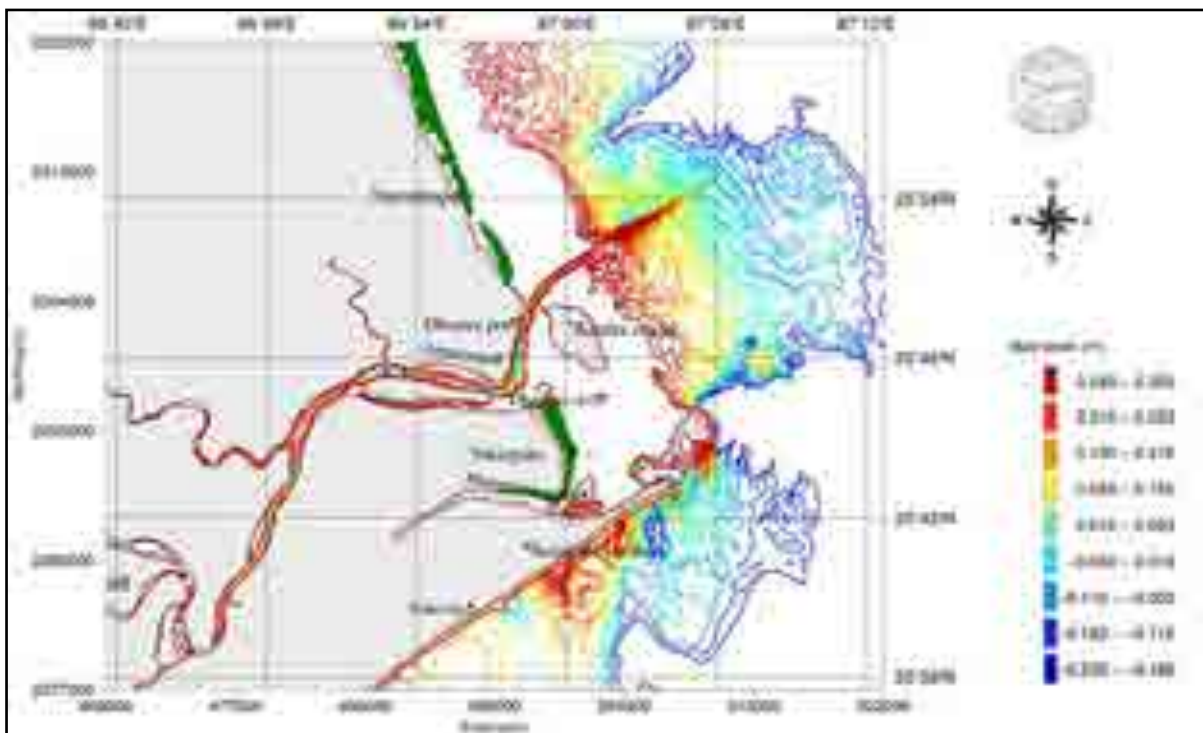


Figure 5-117: Change in Bed level Before Proposed Expansion (after 06 months)

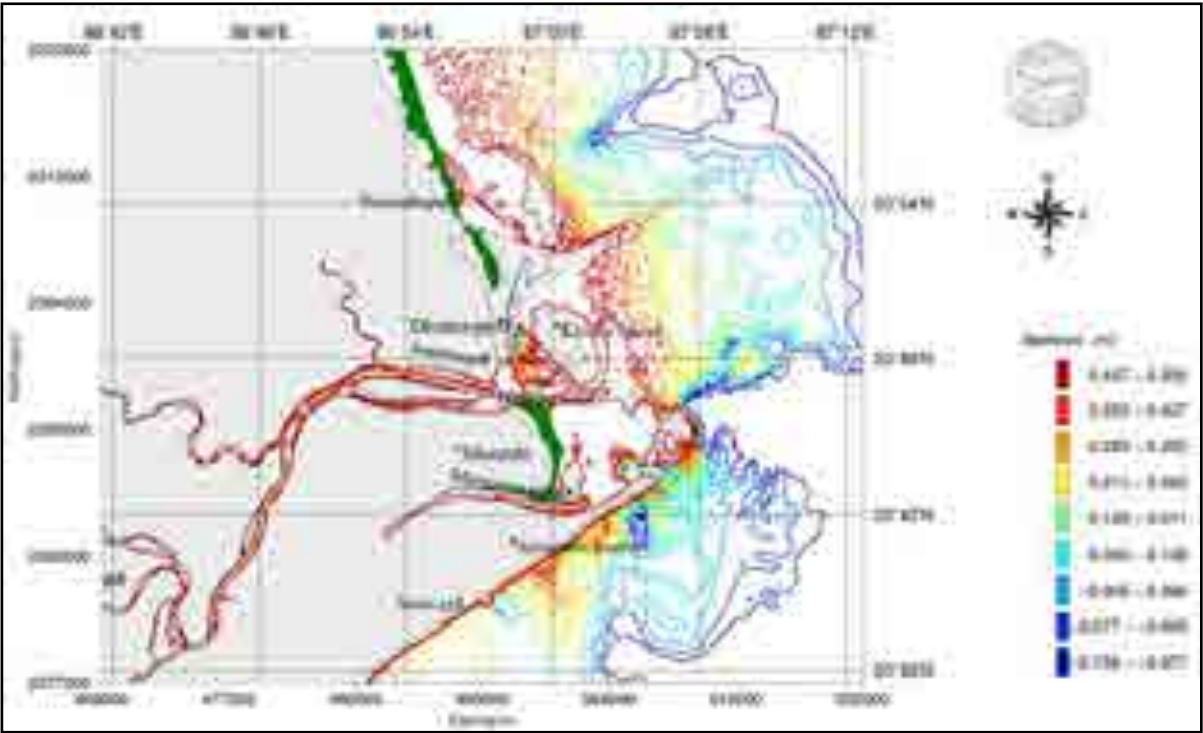


Figure 5-118: Change in Bed level After Proposed Expansion (after 06 months)

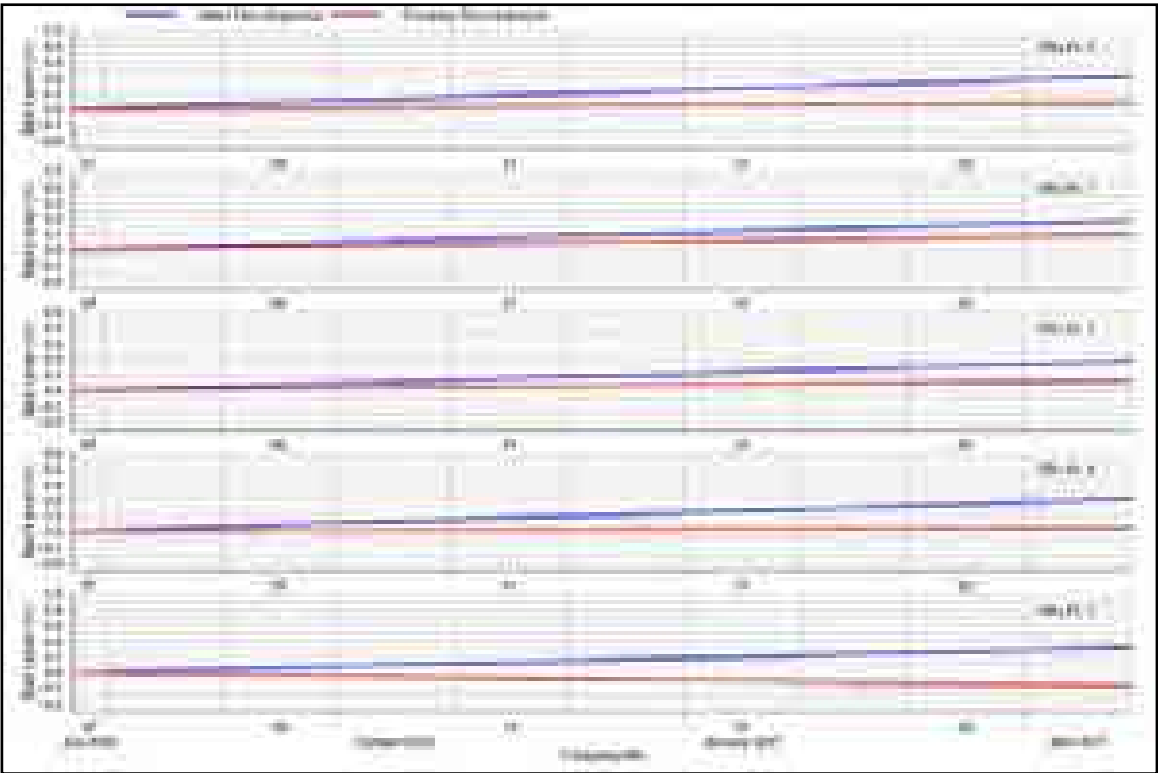


Figure 5-119: Comparison of Bed level Before and After Proposed Expansion

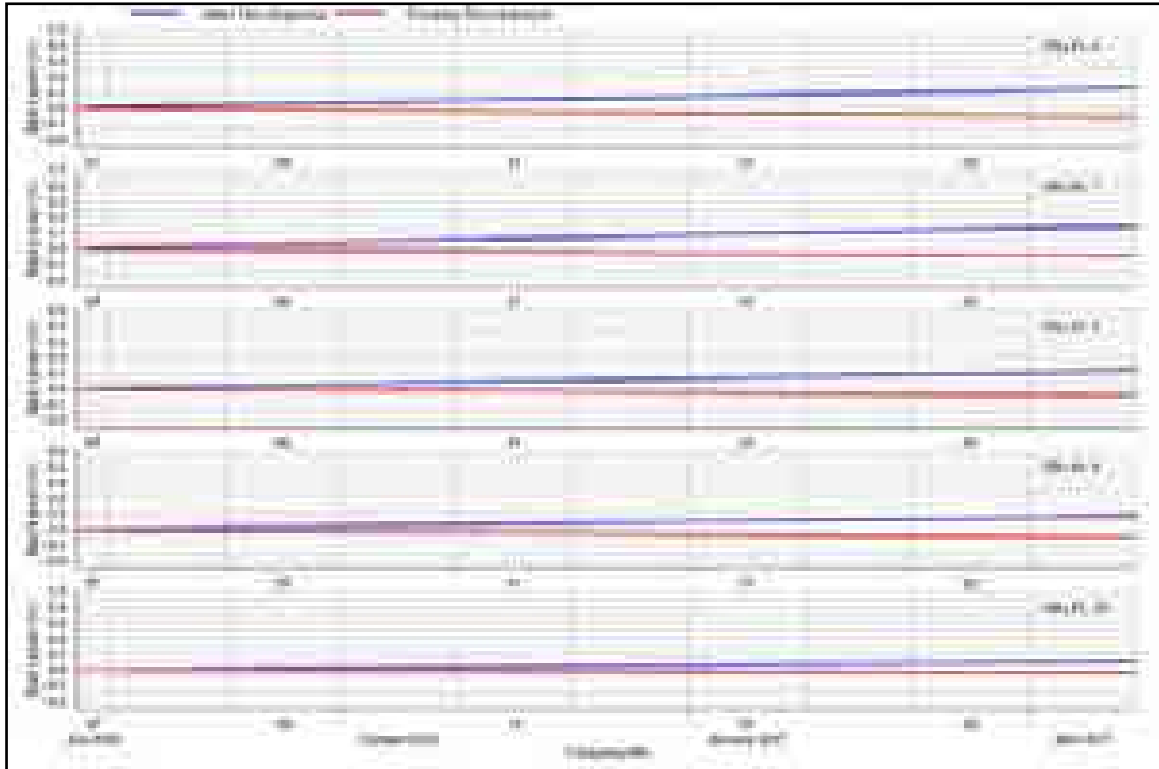


Figure 5-120: Comparison of Bed level Before and After Proposed Expansion

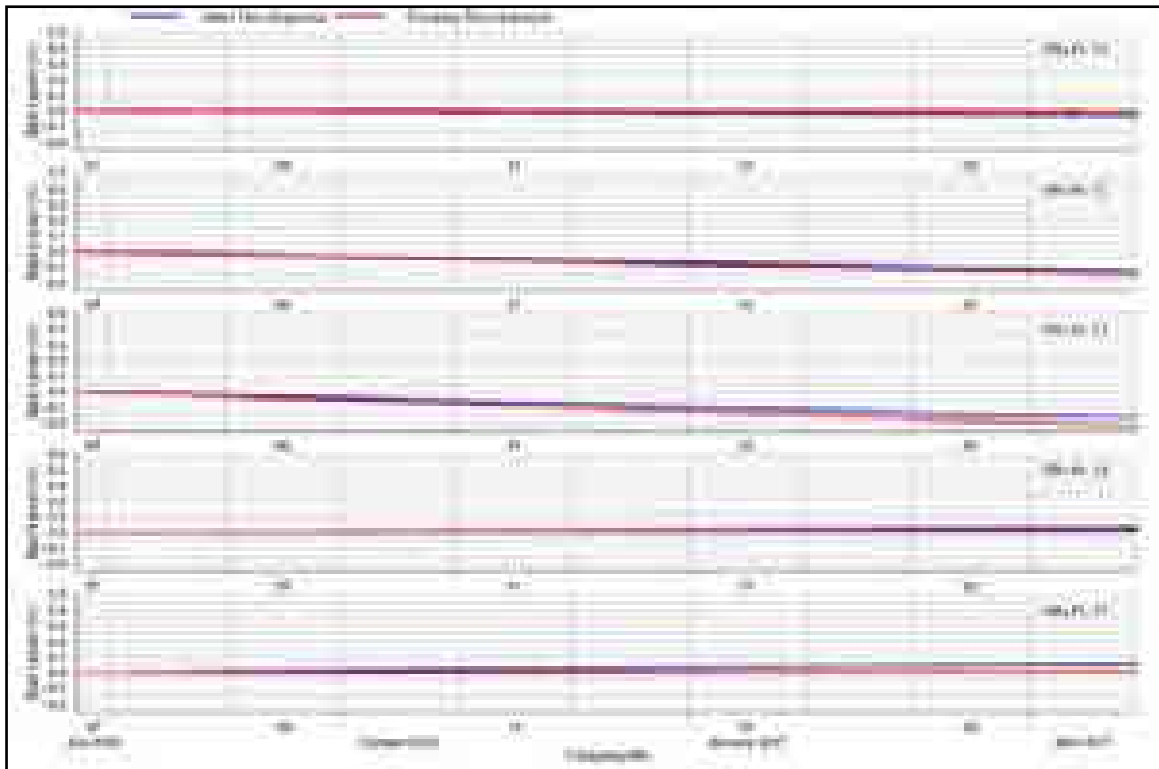


Figure 5-121: Comparison of Bed level Before and After Proposed Expansion

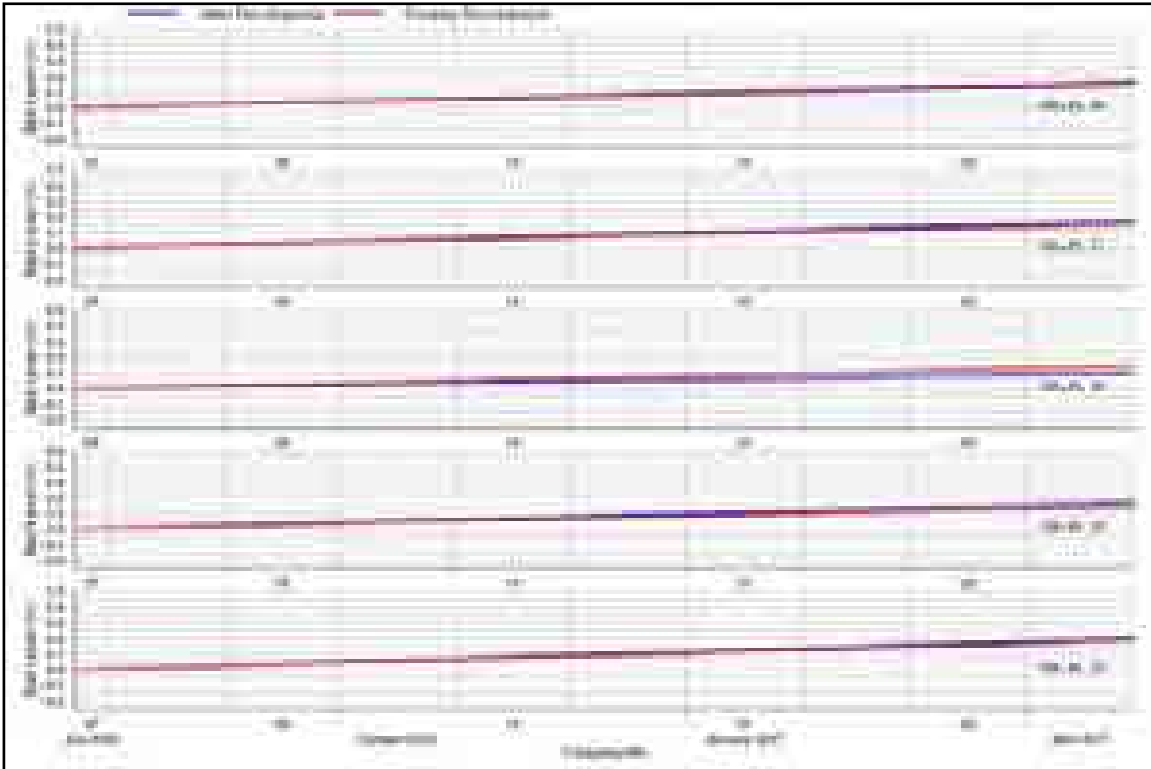


Figure 5-122: Comparison of Bed level Before and After Proposed Expansion

Summary of Sediment Transport Modelling:

From the model results, it can be seen that the changes in the sedimentation processes was localized due to proposed developments and no impact on the other than development area. The change in the bed levels due to the expansion development is not very significant and the change is limited to the basin, berth and approach channel only. The variation in the bed levels before and after development at the port basin location where the berths are located is of the order of 0.42 m over a period of six months & morphological changes around western side of Kanika island is in the order of 0.3 m over a period of six months. The total maintenance dredged quantity was estimated about 16 Mm³ – 20 Mm³ annually based on the bed morphological studies due to the proposed expansion.

5.4.1.2 Mitigation Measures

- Regular monitoring of bathymetry in the harbour basin, channel and in and around Revised Master Plan area.
- Maintenance dredging shall be carried out at regular intervals at harbour basin and channel to ensure safe navigation of vessels visiting the facility.
- Regular monitoring of shoreline using satellite imageries
- Marine water quality and sea bed monitoring shall be carried out.

5.4.2 Potential Impact due to Construction

Developmental activities such as capital dredging, dredged material disposal and construction of cargo berths will result in disturbance to marine environment. During these activities, particularly dredging, localised and short term impacts on marine water quality are likely to occur due to increased turbidity from suspended sediment. Further, marine sediment quality indicates that it is free from any significant pollution.

5.4.2.1 Impact due to Dredging and Disposal of Dredged Material

In order to study the likely impact due to disposal of dredge spoil at the identified offshore dumping ground, the model studies has been carried out. The extract of the model study results are presented in the following section.

Model Description

HYDRODYN-SEDSOFT is used to predict the transport of suspended particles of different size/ material and bed load transport within the water bodies with a free surface. The software can calculate the deposit on the bottom and the entrainment of suspension by the process of erosion. The software is integrated with HYDRODYN-FLOSOFT to take into account the advection of currents. For each sediment size various physical phenomena are taken into account such as transport by the current, diffusion, deposition, erosion, and time-dependent decay and source terms.

SEDSOFT is a part of the HYDRODYN systems developed by ENVIRON and employs the same FEM grid used by the system. SEDSOFT solves the appropriate governing equations of advection diffusion in two dimensions and the concentration of each transported variable is assumed to be constant throughout the water column. SEDSOFT as such, is a depth-averaged model. SEDSOFT solves the transport equation coupled from the hydrodynamics (FLOSOFT) of the modelled situation. (SEDSOFT is available on windows operating system.)

Initial and Boundary Conditions

The initial conditions for the model are selected based on no suspended particles in the water column. The vertical density gradients due to salinity variation have been neglected since the water column is well mixed. The FEM technique has been adopted to take care of shoreline shape and make fine mesh near the coastline. The grid is unstructured and it is a fine mesh near the coast and sediment disposal location.

The open boundary conditions identified are northern, eastern and southern open boundaries at Dhamra and west boundary is closed. The boundary conditions selected are as follows.

- No sediment flux at open boundaries
- No flux across the coastal boundary and
- Sediment flux at disposal site

In this model, diffusion coefficients for horizontal exchange of momentum vary with the space.

To the extent possible dredged material will be used for reclamation. Dredge material from the surrounding area of proposed development of offshore facilities is initially collected in a hopper bottom dump barge/ Trailer Suction Hopper Dredger (TSHD) without affecting the morphology/ecology of the adjacent area. It is proposed to dump the collected material at identified location in the offshore of Dhamra region (approved under Phase-II Environment / CRZ clearance). The proposed disposal site is designated as Location DP and graphically shown below and their geographical coordinates are shown in **Figure 5-123**.

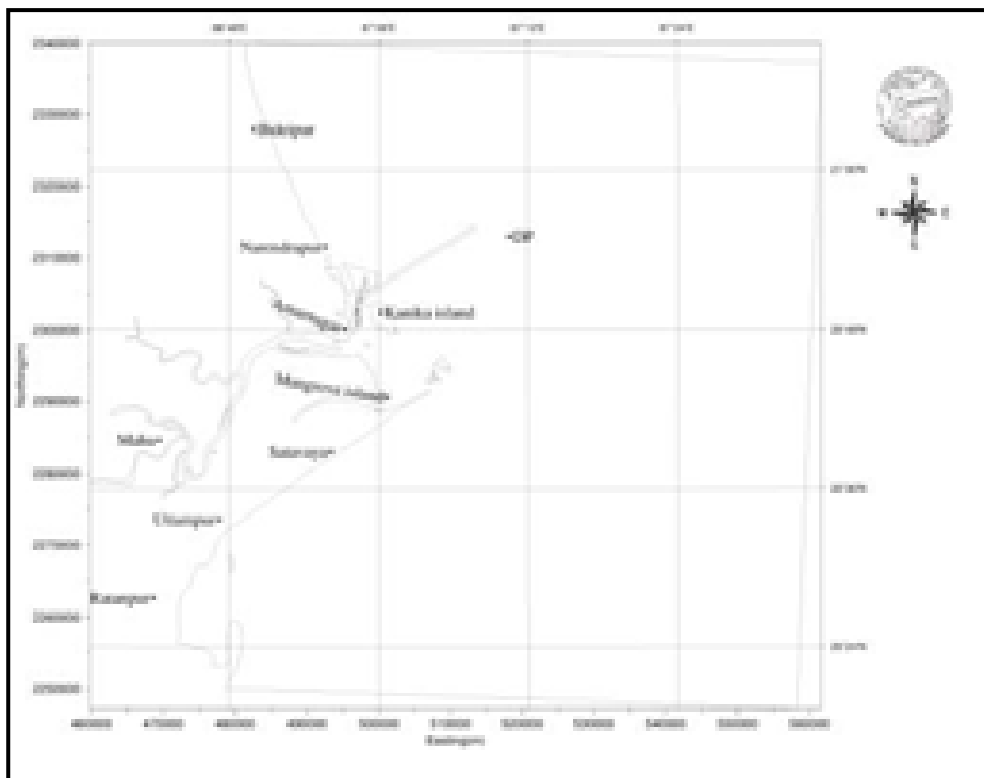


Figure 5-123: Dredged Material Disposal Location

The details of the dredged material disposal location are as follows:

- Latitude (N): 20° 55.1'
- Longitude (E): 87° 10.5' "
- Other details: Area of Dumping Ground is 4000m x 8000m and depth is more than 20m CD

Disposal of Dredged Material

The approximate quantity of dredged material is about 20 MCM per annum is proposed to be disposed in open water at the identified disposal site in a predetermined sequential manner through direct disposal method (hopper dredger). It is assumed that the adequate capacity of the Trailer Suction Hopper Dredger (TSHD) will be used for dredge disposal.

A study period of 12 months for simultaneous dredging and dredge disposal studies starting from December to November, in which the disposal will be around 8 months continuously i.e. from December to July at the rate of 2.5 MCM/month and next four months i.e. August to November there will not be any disposal of dredge material since it has proven as monsoon period. It should also to be noted that the dumping is considered to be carried out at the rate of 2.5 MCM/month in an average.

The computational runs have been made for the above data and the results of sediment concentration and bed level variations for various locations have been predicted. The results are discussed below.

The sediment concentration profile due to the disposal at location DP just 1 hr after the dump in the start of every month is shown in **Figure 5-124** to **Figure 5-136** respectively. It can be seen that the dispersion of the dumped material is observed to be spread on upstream as well as downstream of the location DP. As expected the sediment concentration is highest at the point of disposal location throughout the dumping period. From the figures it can be

observed that the maximum concentration levels at and around the dumping location varies between 9000 mg/l to 13000 mg/l. The total sediment concentration dispersion or plume is limited to a small area stretching in the South direction. From the figures it can be concluded that sediment concentration levels come down to ambient after 4000 m from the DP location.

Figure 5-132 to Figure 5-136 show the variation of suspended sediment concentration after ceasing the disposal of dredge material (after 8 months) at 3 h, 6 h, 9 h, 12 h and 1 day respectively. From the figures it can be seen and concluded that after 1 day of ceasing the disposal of dredge material, the sediment concentration attains ambient condition (50mg/l – 60 mg/l)

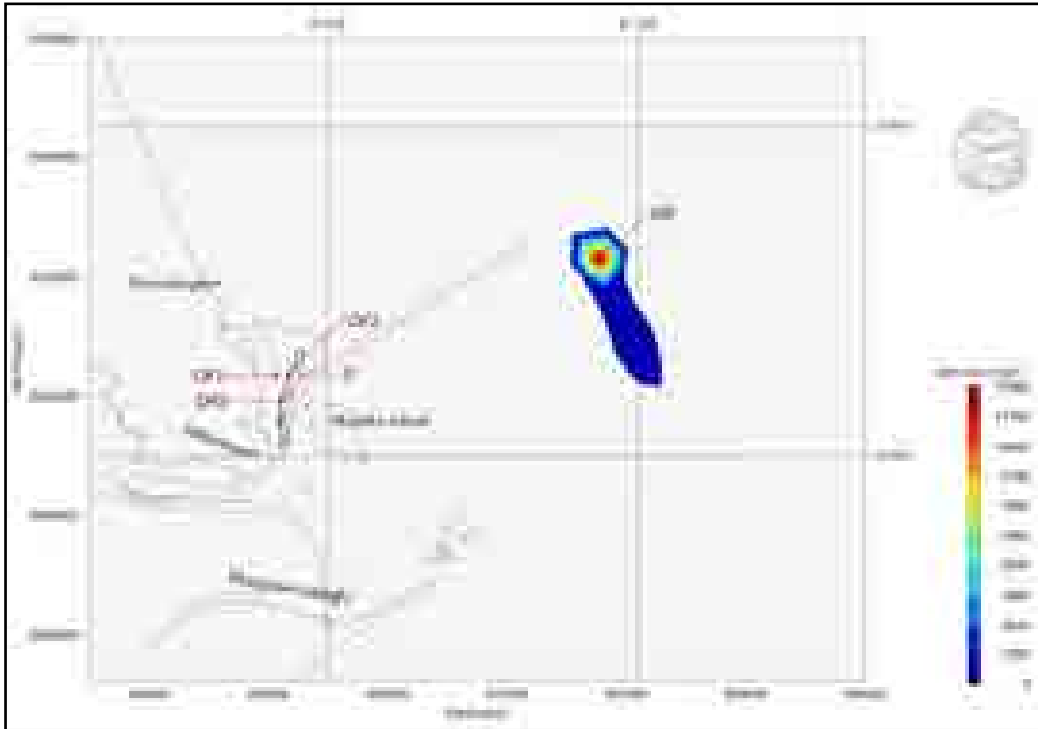


Figure 5-124: Variation of Sediment Concentration after 1 Month

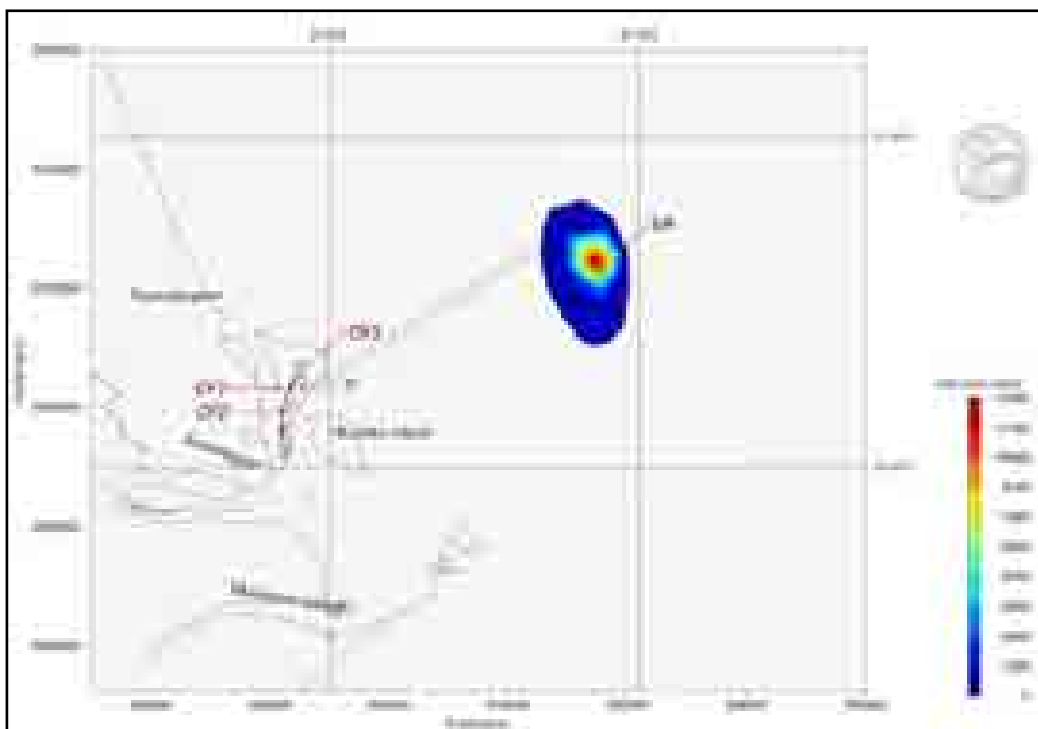


Figure 5-125: Variation of Sediment Concentration after 2 Months

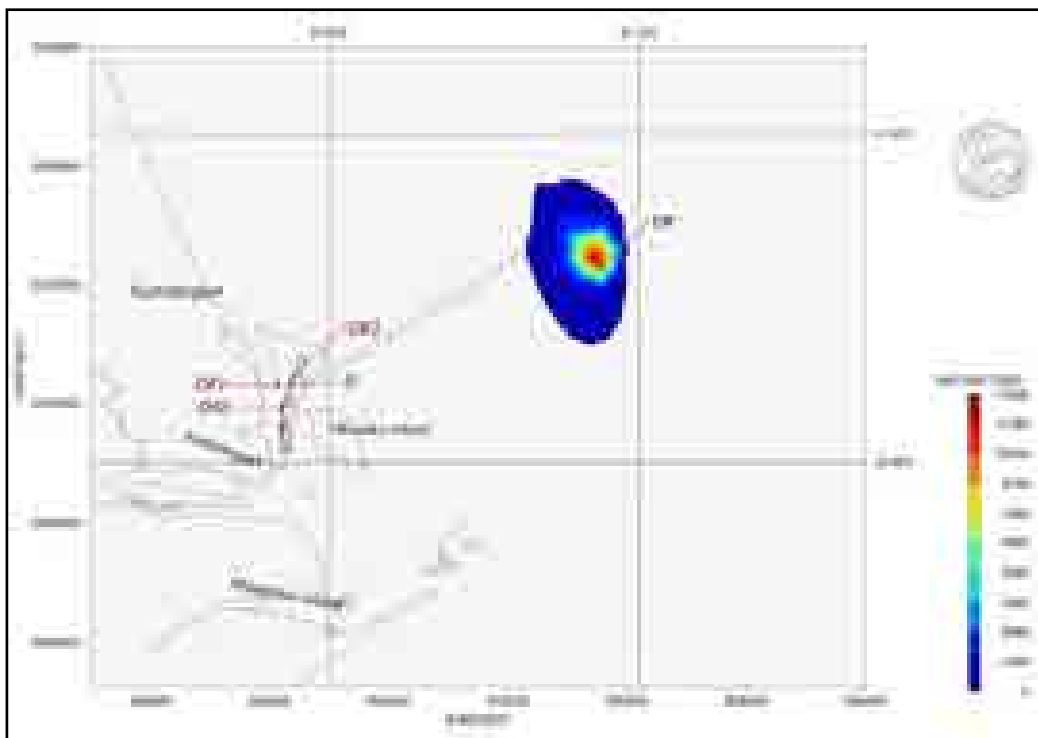


Figure 5-126: Variation of Sediment Concentration after 3 Months

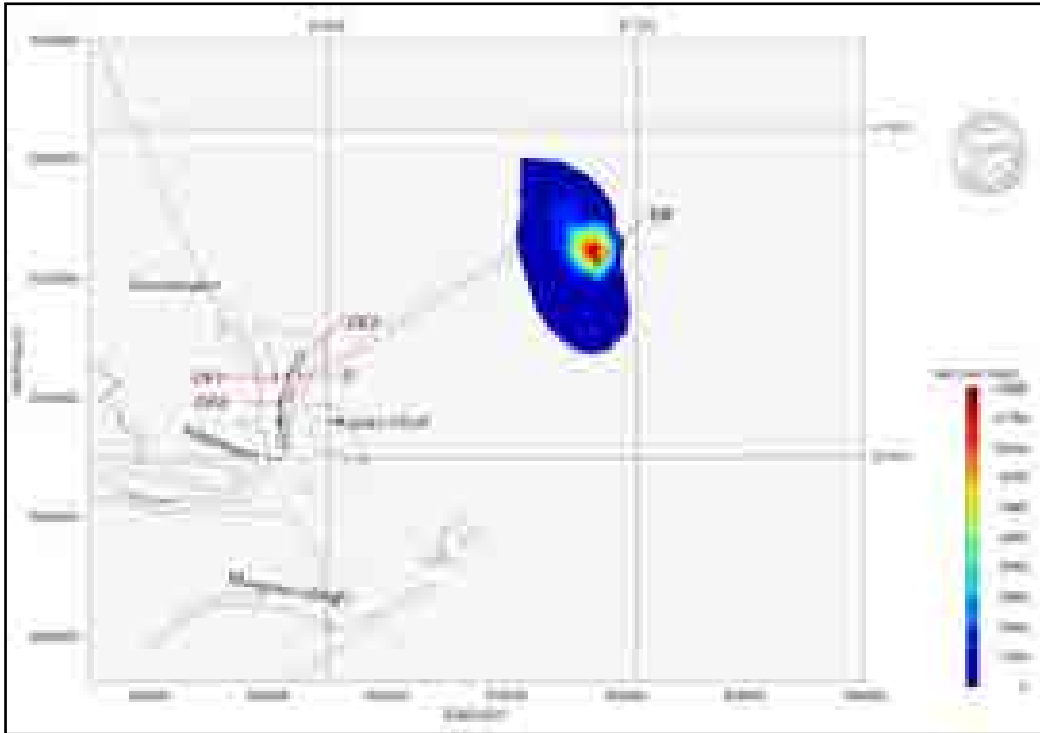


Figure 5-127: Variation of Sediment Concentration after 4 Months

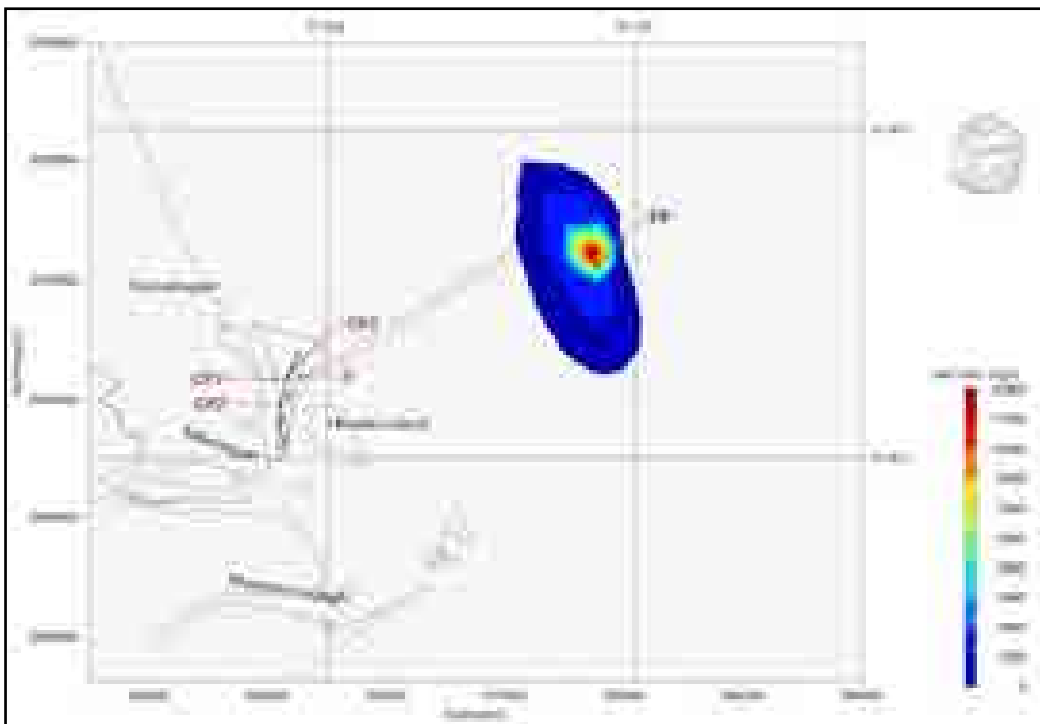


Figure 5-128: Variation of Sediment Concentration after 5 Months

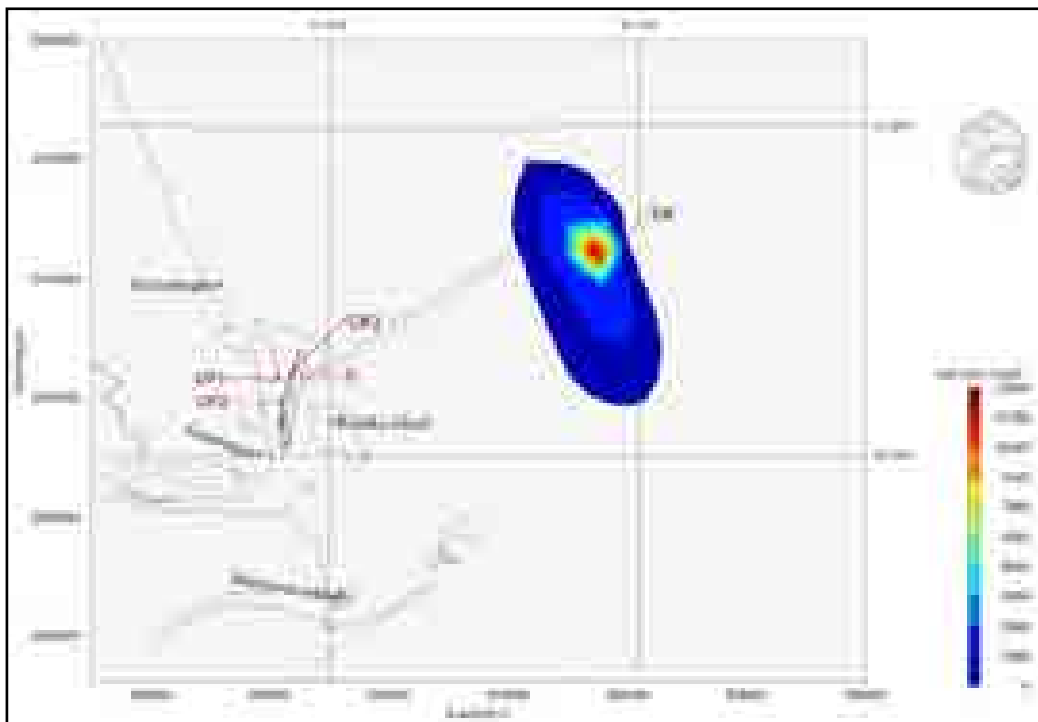


Figure 5-129: Variation of sediment concentration after 6 Months

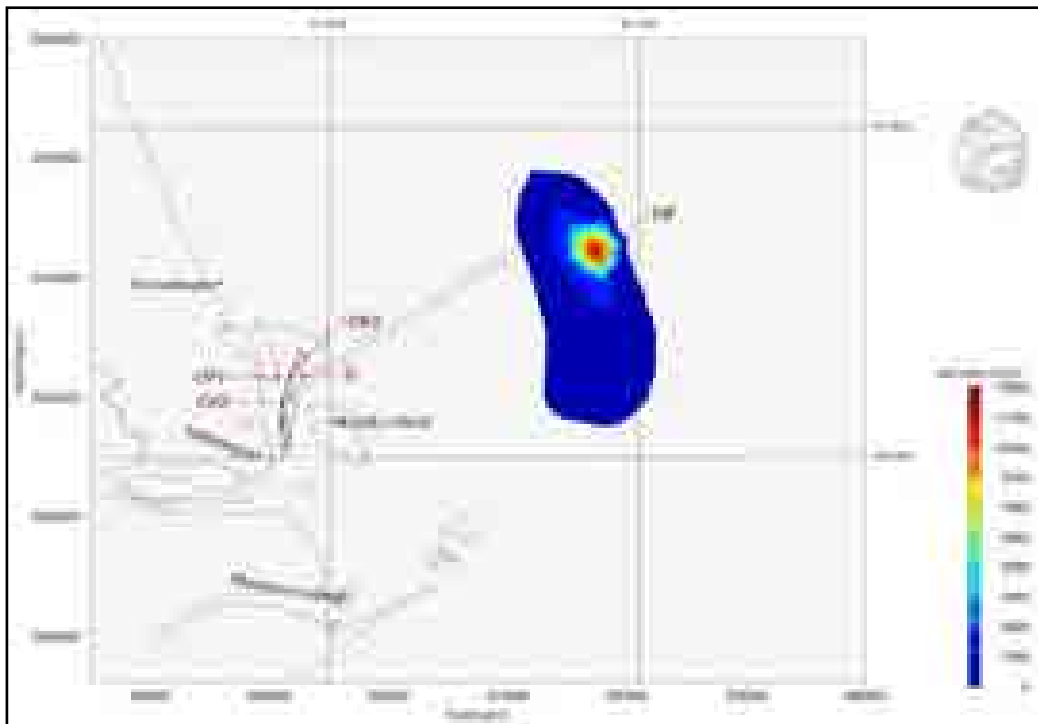


Figure 5-130: Variation of sediment concentration after 7 Months

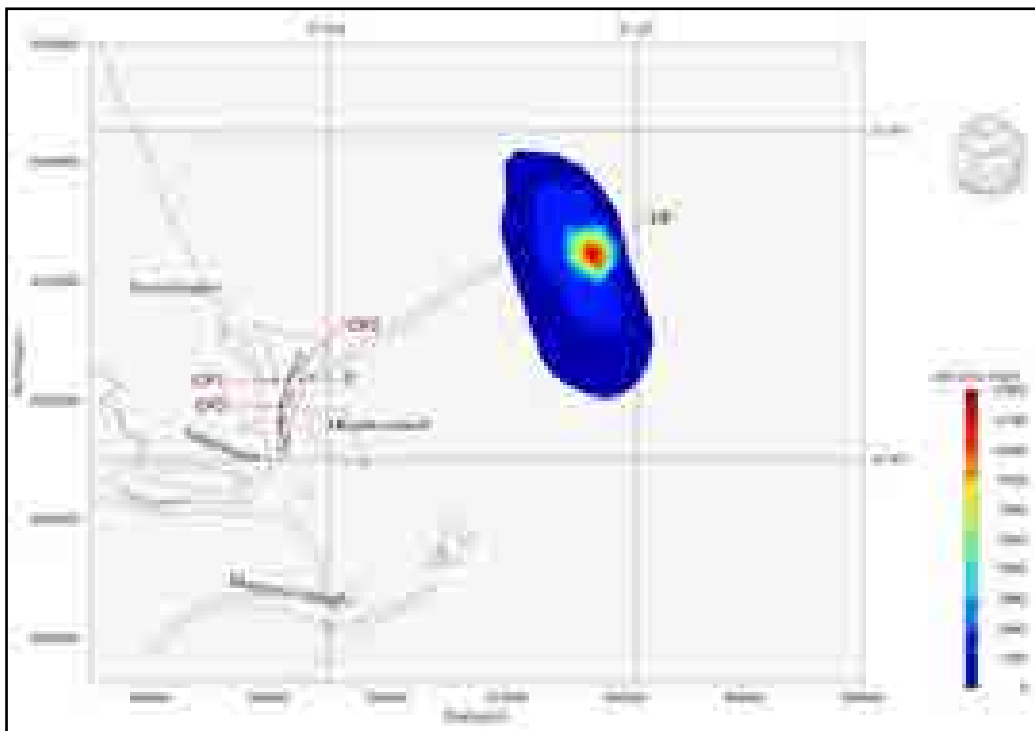


Figure 5-131: Variation of Sediment Concentration after 8 Months

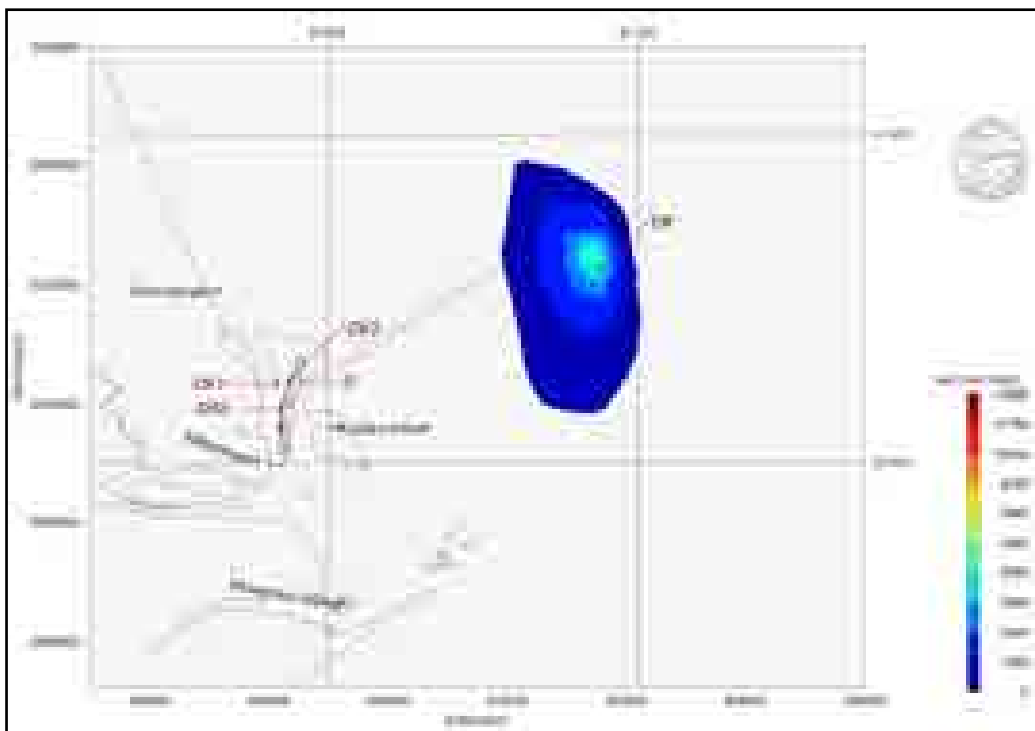


Figure 5-132: Variation of Sediment Concentration after 8 Months 3 hours

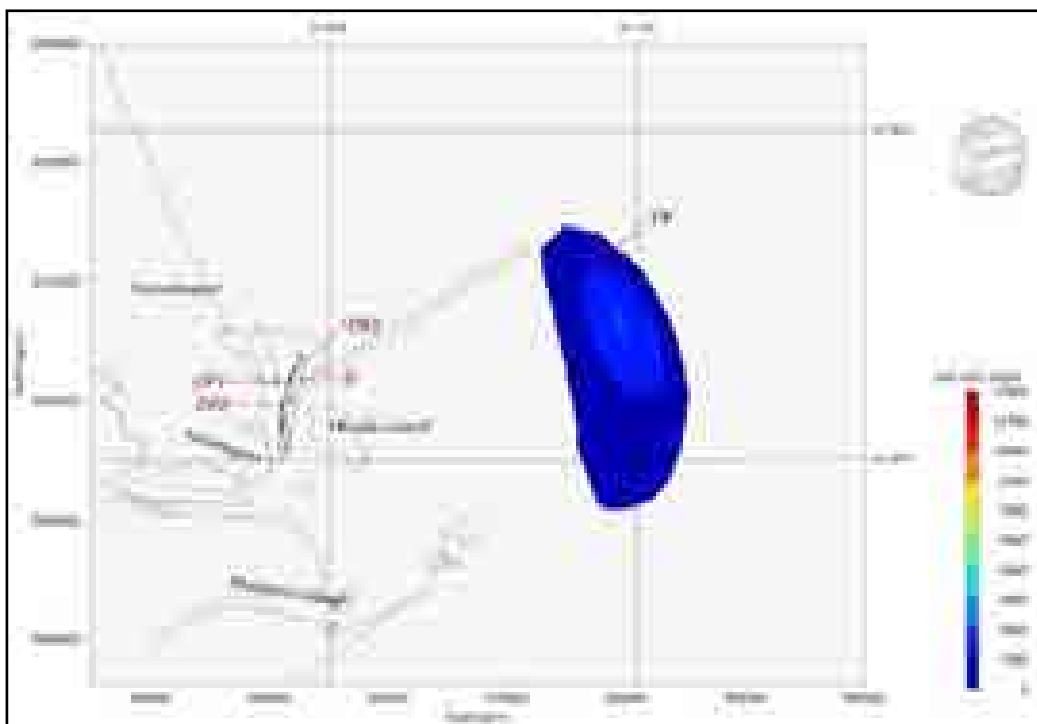


Figure 5-133: Variation of Sediment Concentration after 8 Months 6 hours

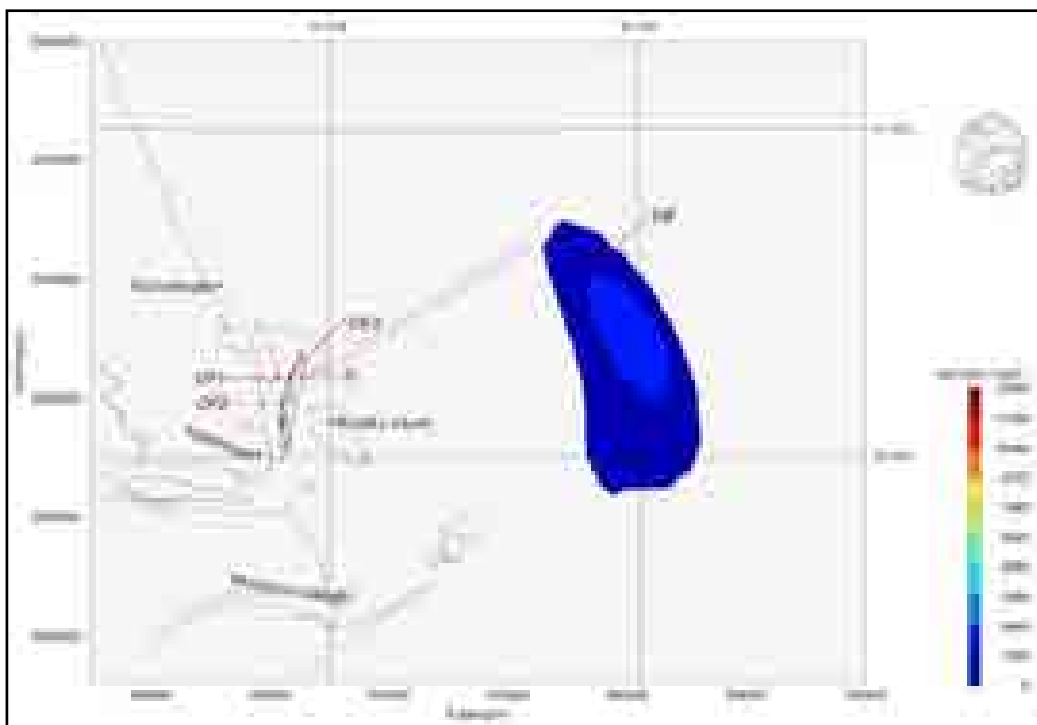


Figure 5-134: Variation of Sediment Concentration after 8 Months 9 hours

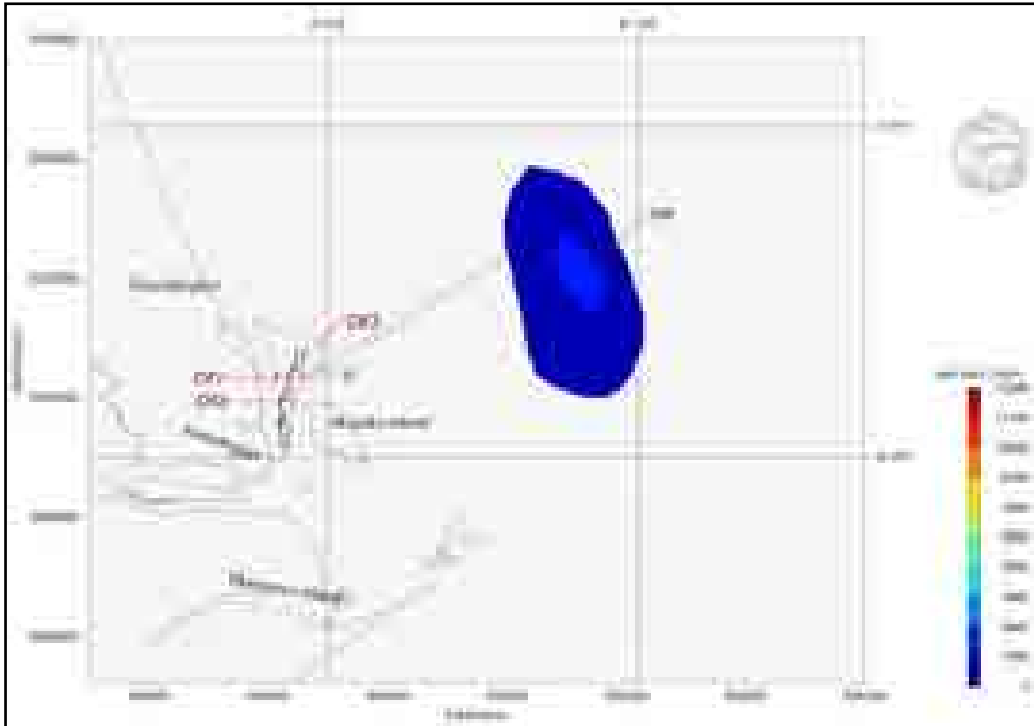


Figure 5-135: Variation of Sediment Concentration after 8 Months 12 hours

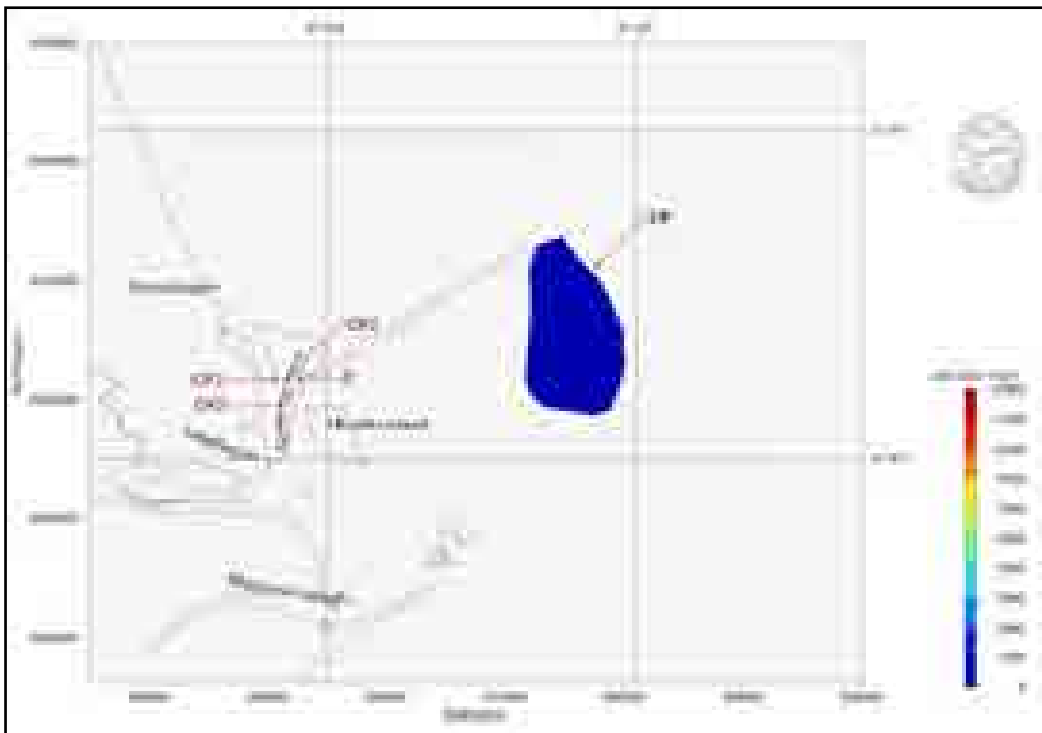


Figure 5-136: Variation of sediment concentration after 8 Months 1 day

Figure 5-137 to Figure 5-144 show the bed levels at and around location DP at the end of every month period starting from the start of dumping. It can be seen that the bed level change is limited to a small area and stretched in the North & South direction. It can be seen that the bed level variation over the period of 8 months dumping is of the order of 0.162m. The computational runs were continued for 4 months without any disposal of dredge material and the bed level variations at end of every month as shown in **Figure 5-145 to Figure 5-149**. It can be seen from the figures that the bed levels reducing gradually at and around

the dump location and spreads more area. The bed level has not increased more than 0.011 m at any point of time after 12 months with 8 months dumping and it would be much less by spreading the dumping disposal point judiciously within the dump location so that there will be no chance of the dump material forming a hump in the region.

From the figures it can also be seen that the bed levels will be slightly increasing at the mouth of approach channel due to entrainment of disposal of dredge material, but this is at very slow rate of sedimentation process and thus no impact due to the periodical maintenance of channel.

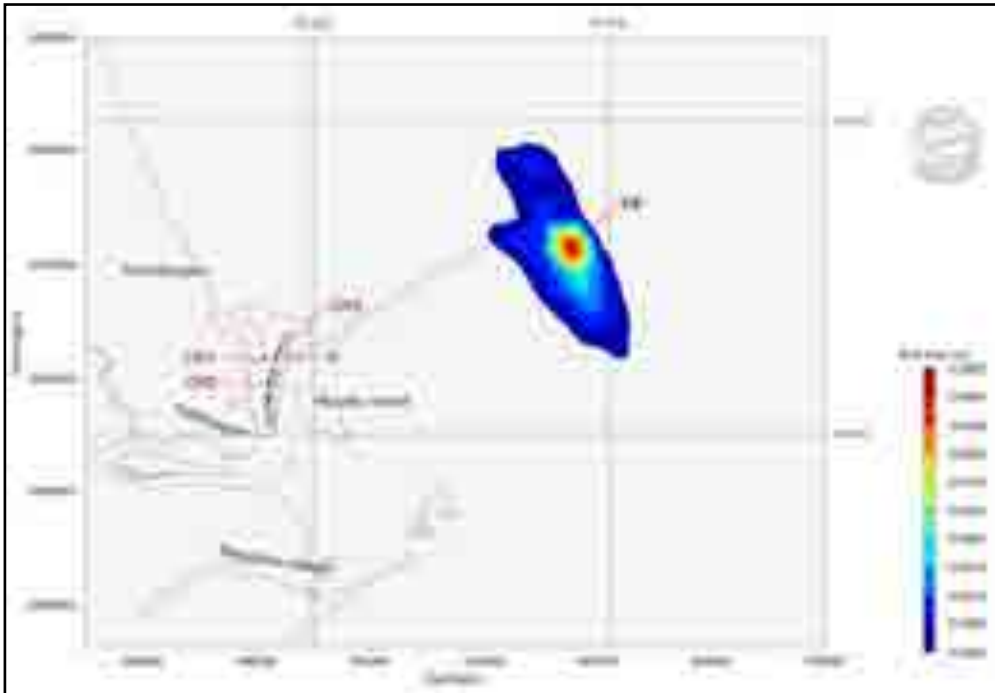


Figure 5-137: Variation of Sediment Bed Level after 1 Month

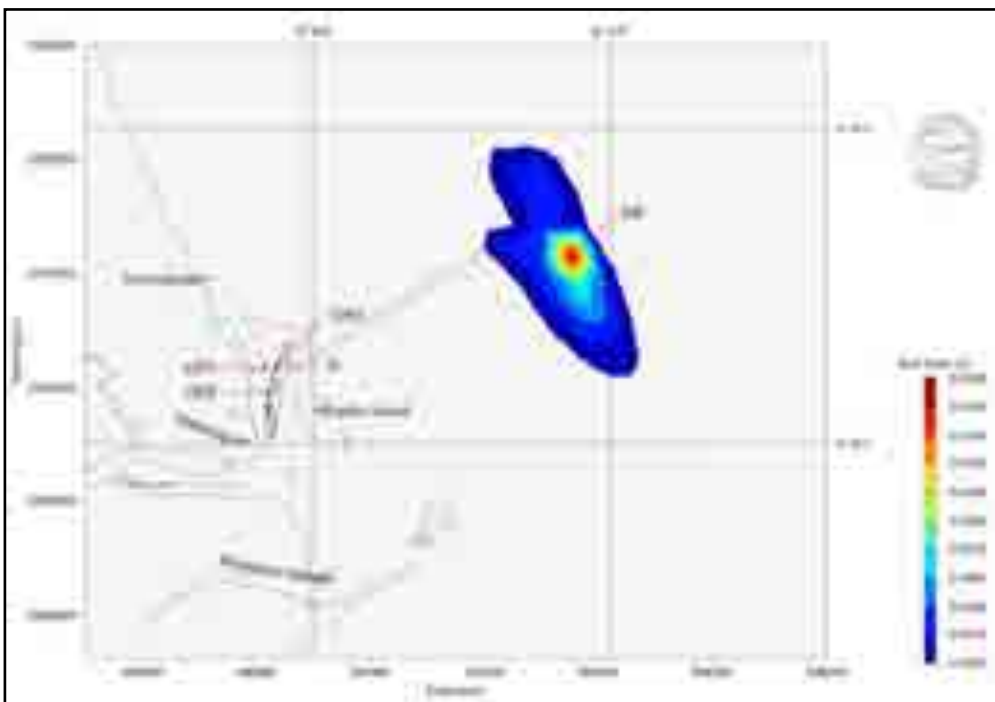


Figure 5-138: Variation of Sediment Bed Level after 2 Months

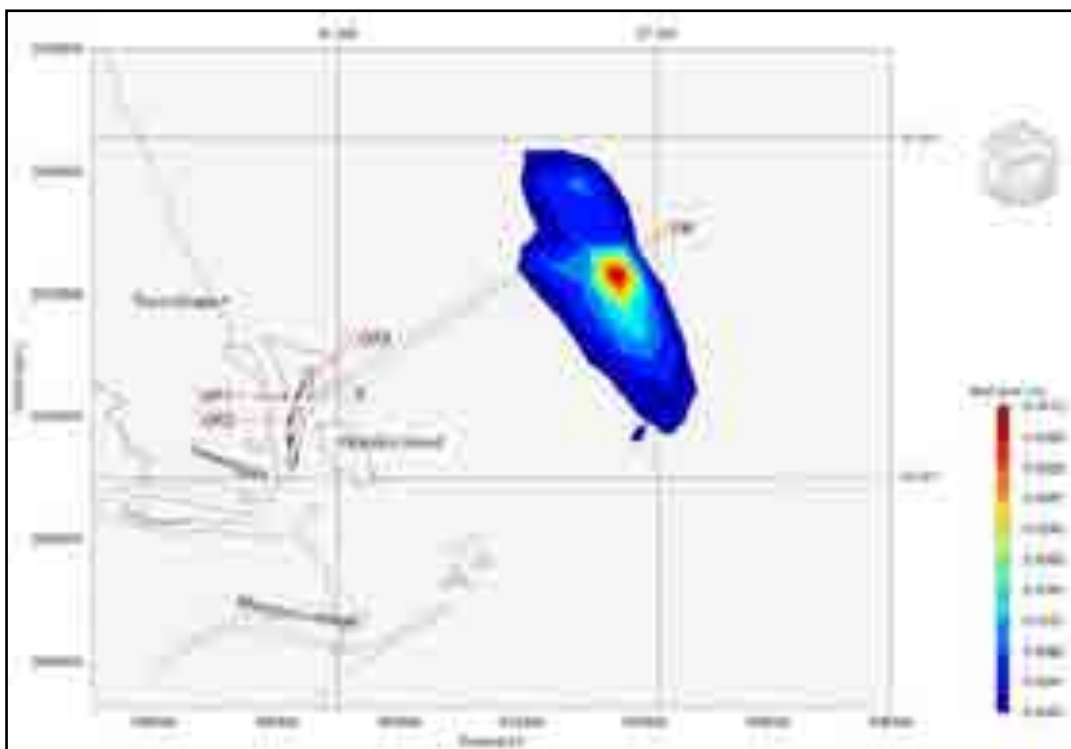


Figure 5-139: Variation of Sediment Bed Level after 3 Months

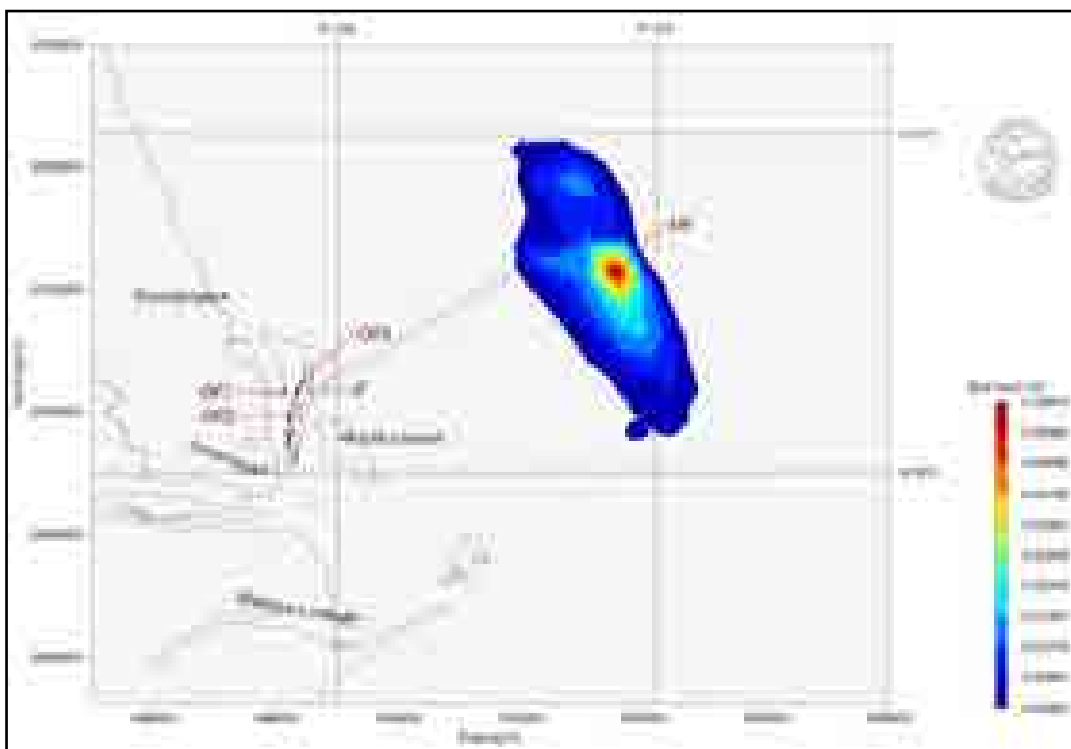


Figure 5-140: Variation of Sediment Bed Level after 4 Months

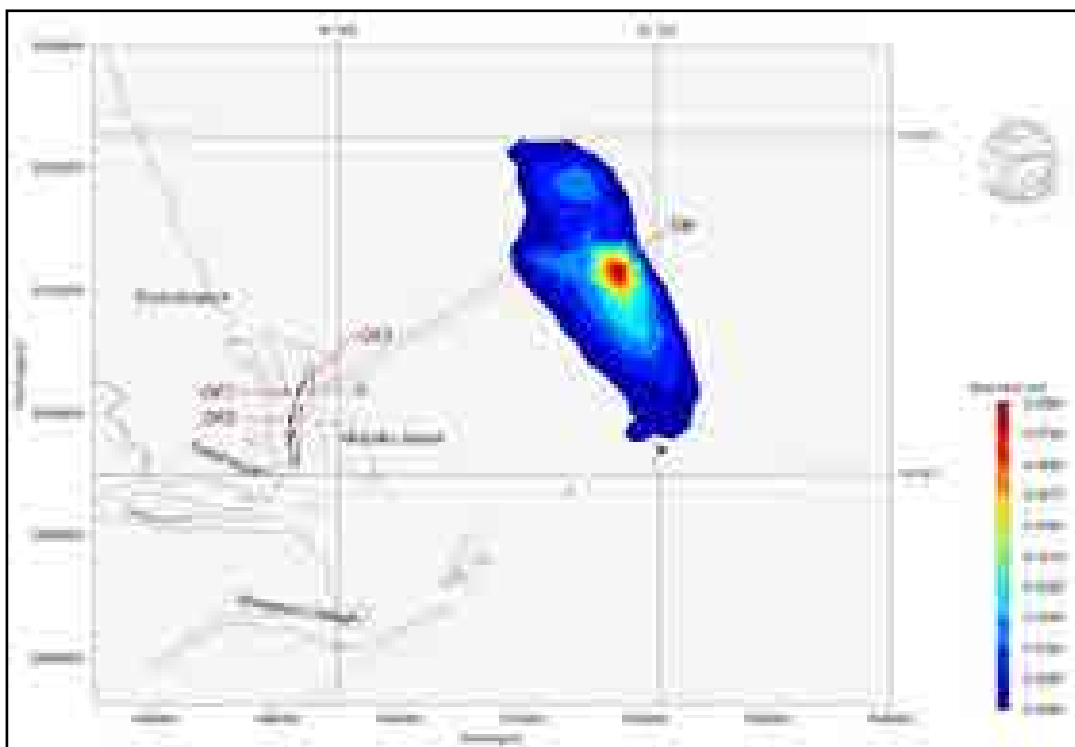


Figure 5-141: Variation of Sediment Bed Level after 5 Months

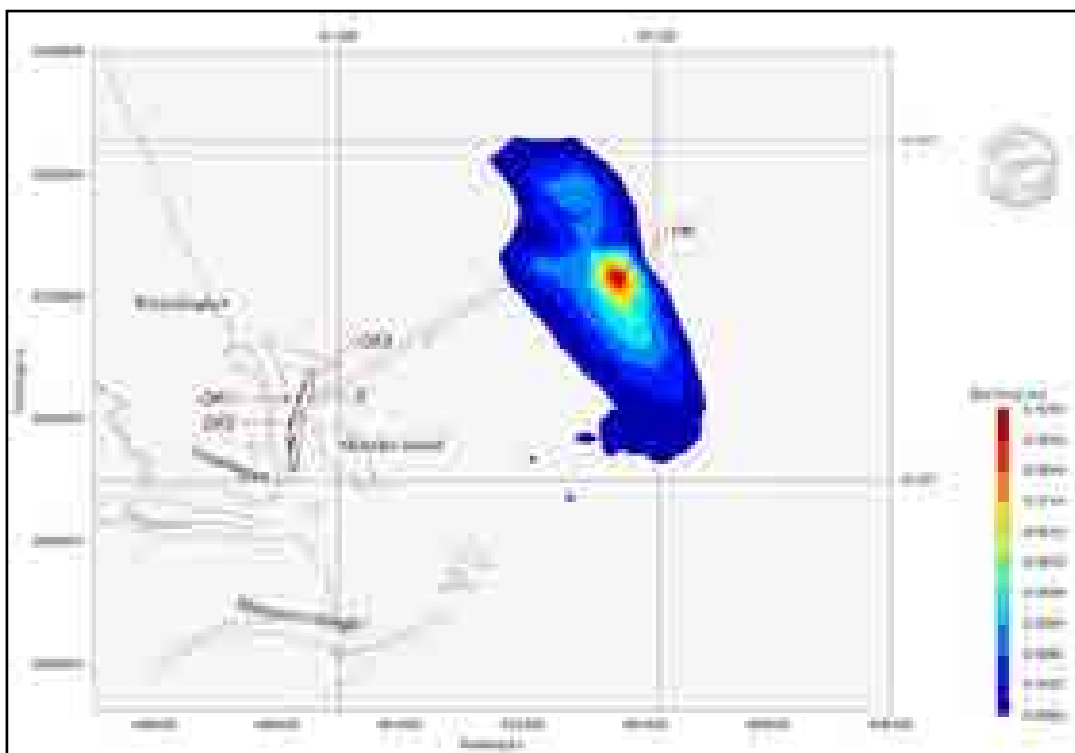


Figure 5-142: Variation of sediment Bed level after 6 Months

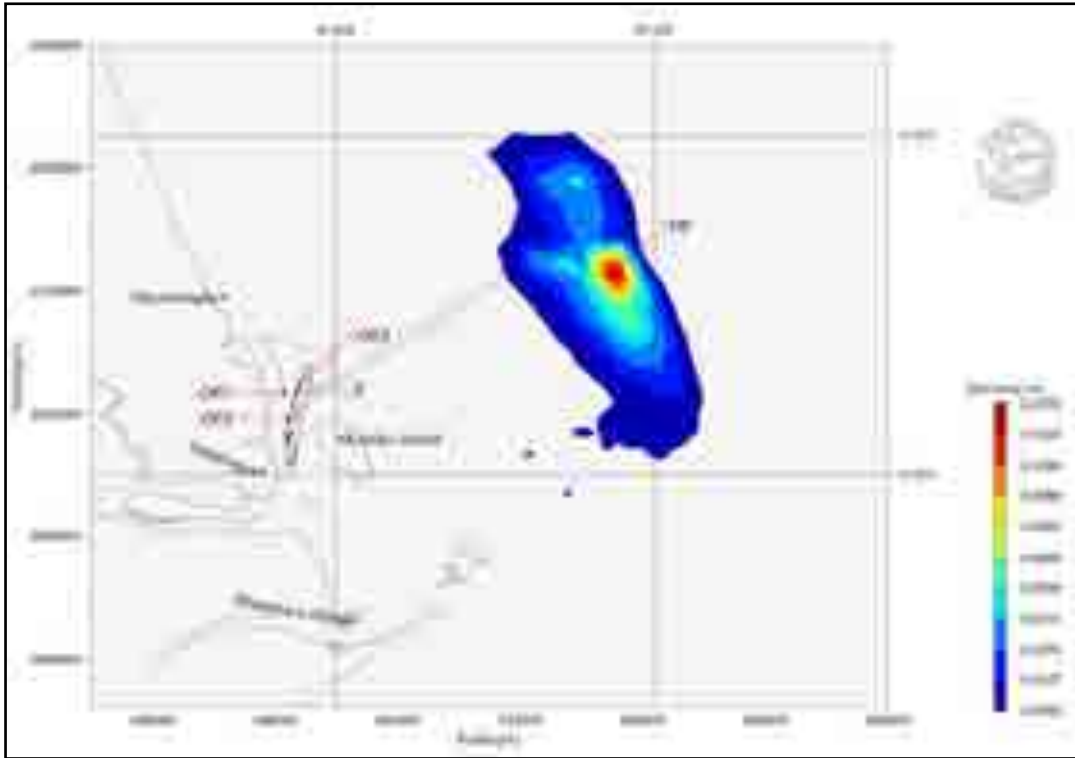


Figure 5-143: Variation of sediment Bed level after 7 Months

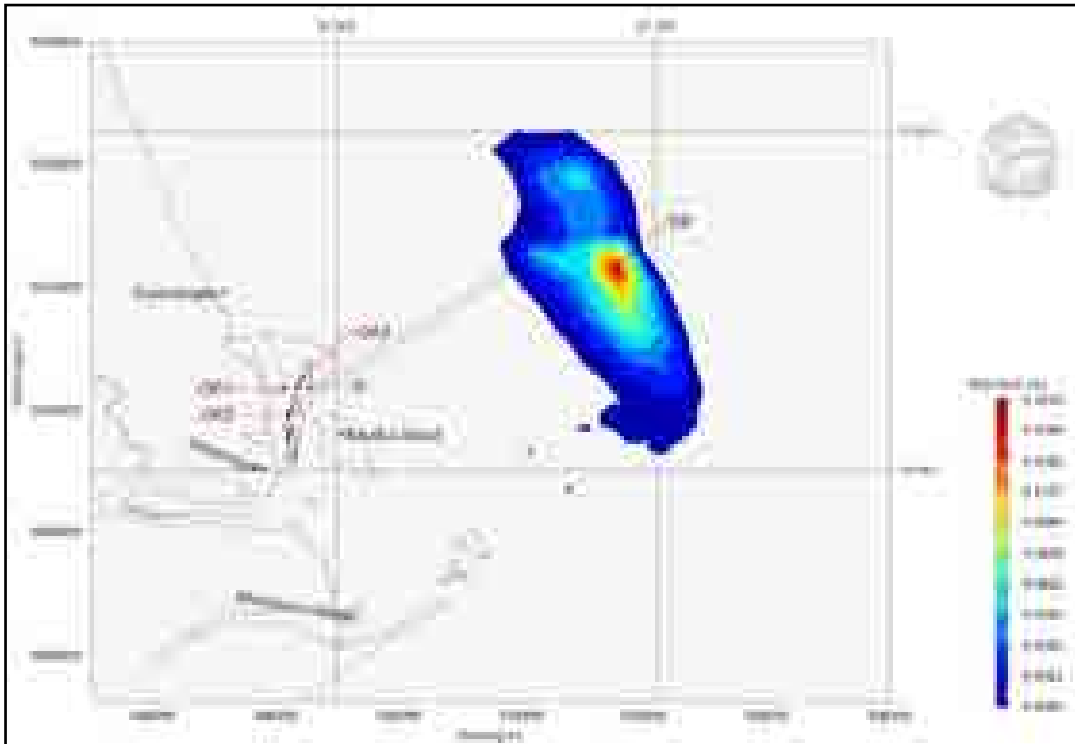


Figure 5-144: Variation of sediment Bed level after 8 Months

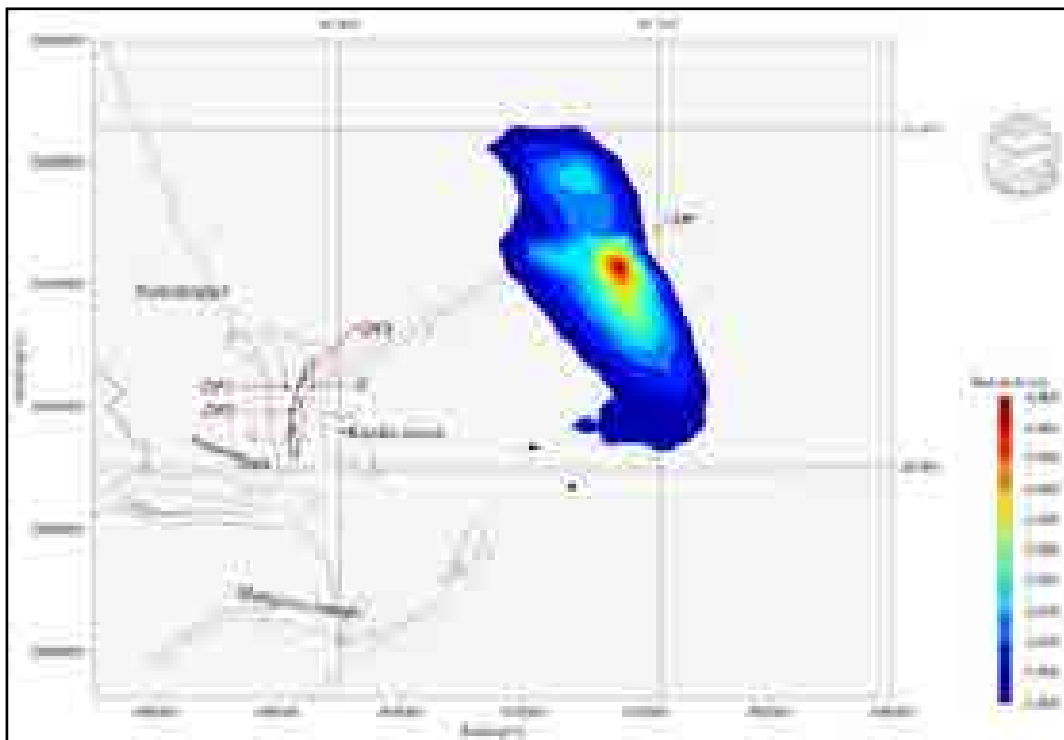


Figure 5-145: Variation of sediment Bed level after 8 months 15 days

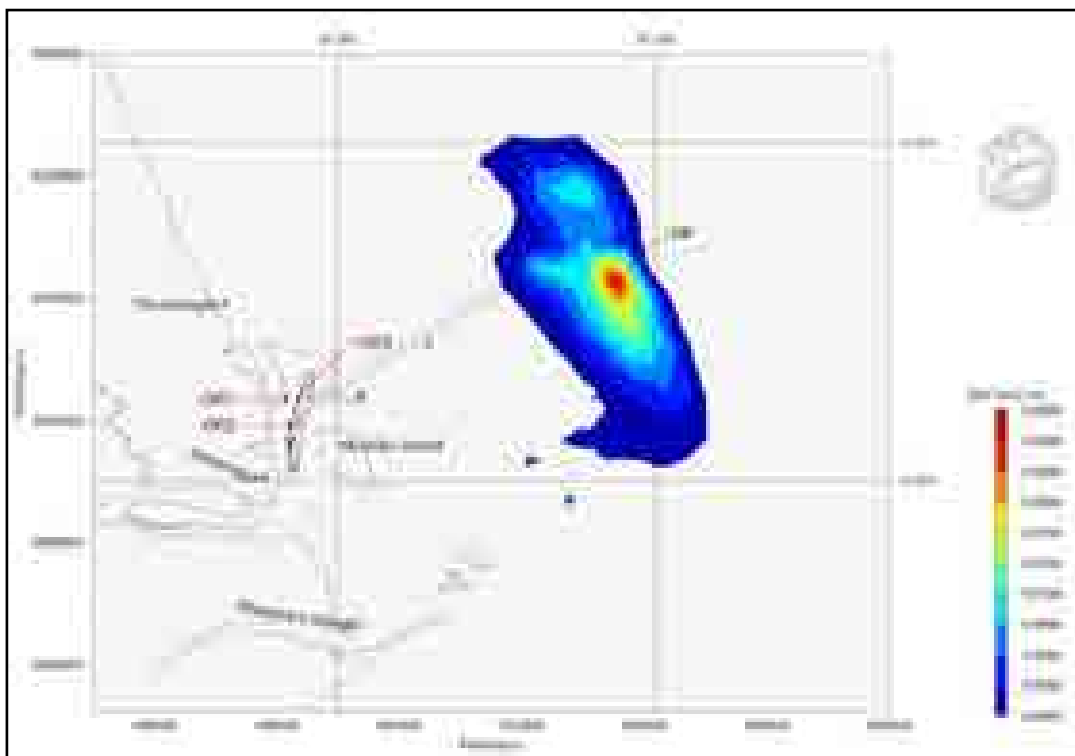


Figure 5-146: Variation of sediment Bed level after 9 Months

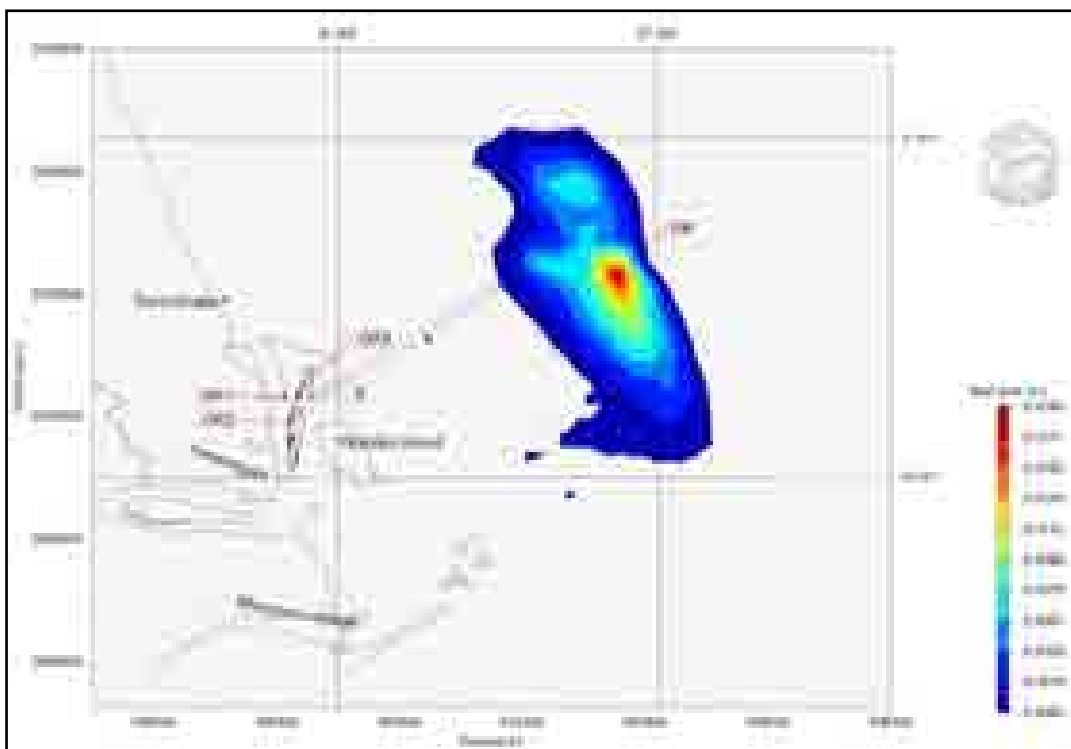


Figure 5-147: Variation of sediment Bed level after 10 Months

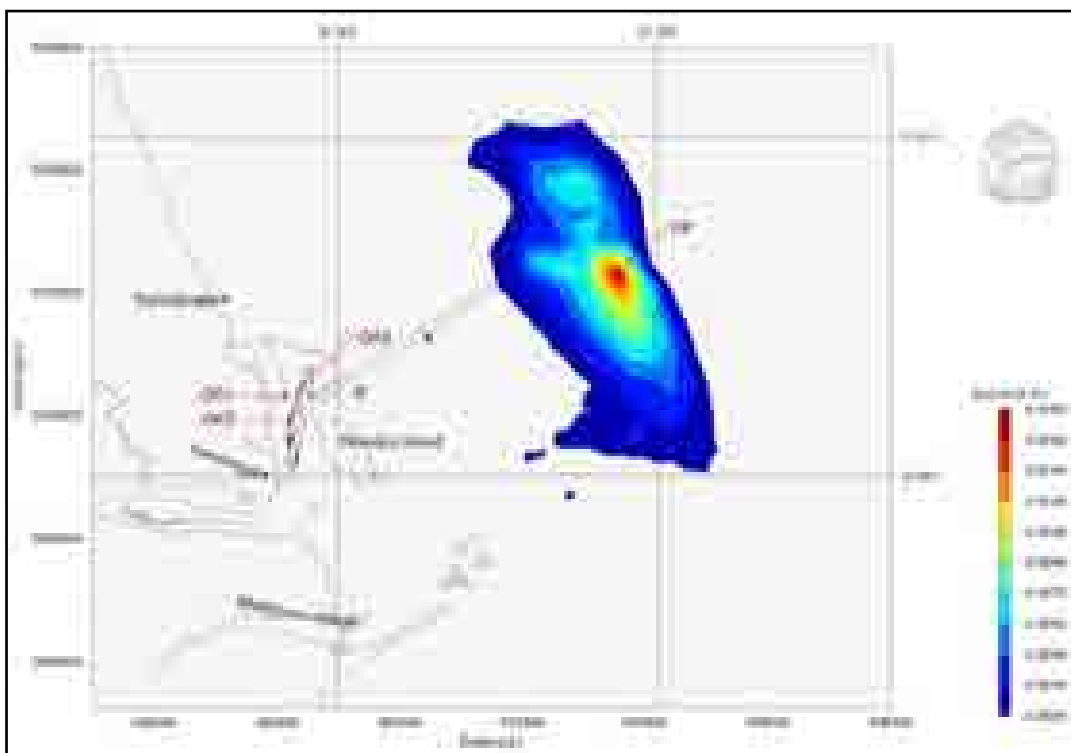


Figure 5-148: Variation of sediment Bed level after 11 Months

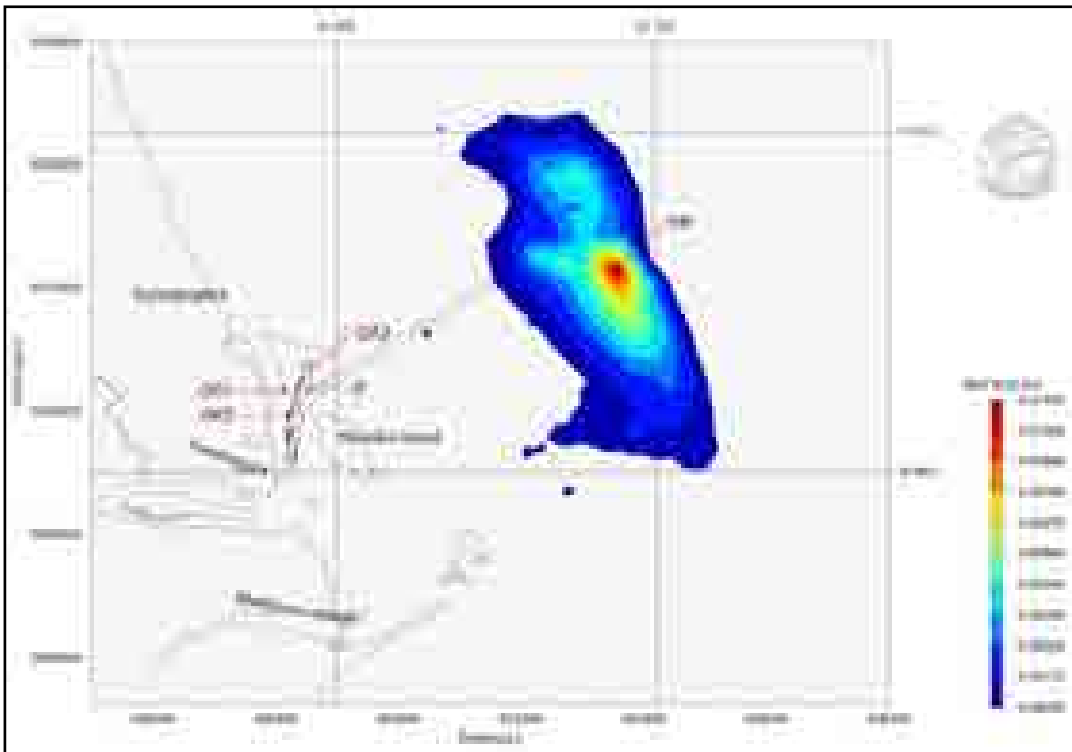


Figure 5-149: Variation of sediment Bed level after 12 Months

Particle Trajectory Modelling

The software has been run for 8 months with the same input data used for sedimentation processes as described above and particle trajectories at site DP plotted graphically and shown in **Figure 5-150** respectively. From the figure it can be seen that the trajectory of particle dumped at site DP follow a movement in a circular axis initially in eastern direction and finally towards the southern part of dumped site. At any point of time, it remains far away from the western Coast of Dhamra region and other eco sensitive areas and therefore it will have no impact. Hence, it can be said that the disposal of dredged material at proposed disposal sites / location DP will not have any significant impact on the western coast of Dhamra region and morphology of the study domain and all the changes are localised in nature.

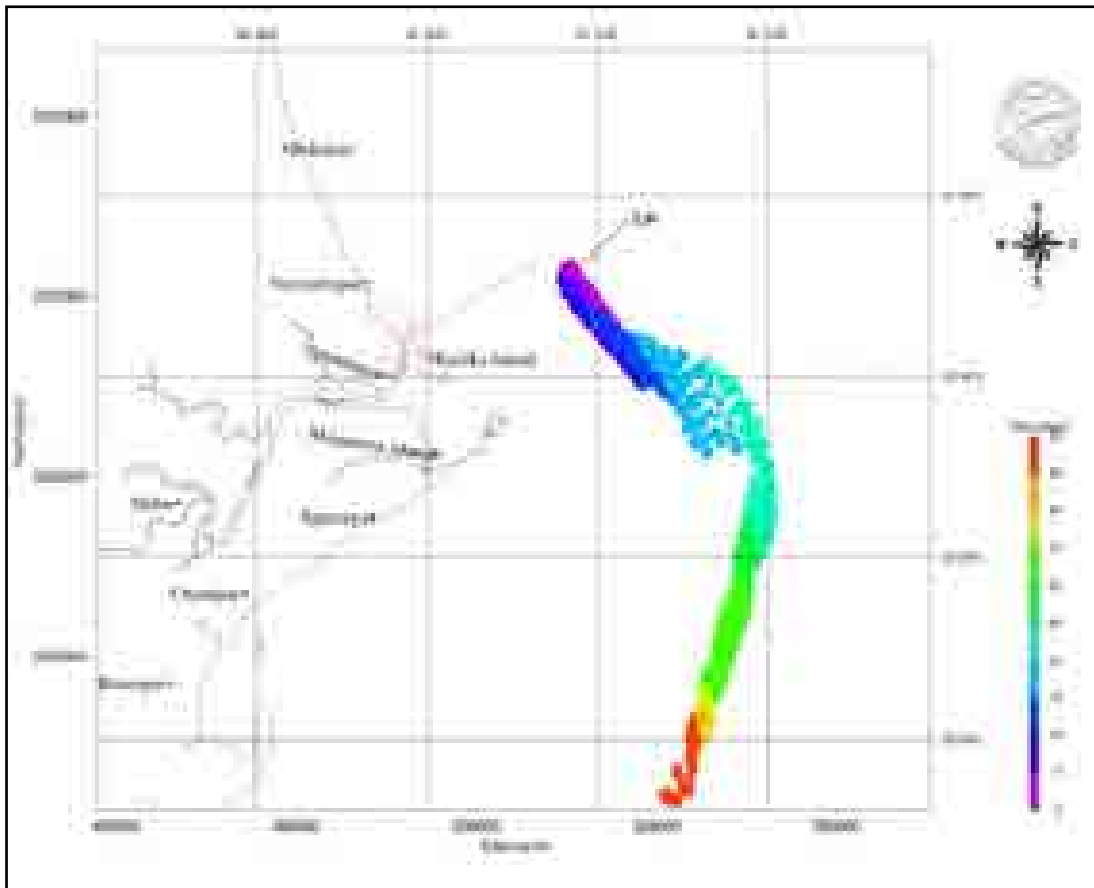


Figure 5-150: Trajectory of Sediment Particle

5.4.2.2 Impact due to Construction of Seawater Intake/Marine Outfall System

Seawater intake ($20^{\circ} 50' 55.936''$ N, $86^{\circ} 58' 28.933''$ E) will be located at -19.5 m to -23.0 m CD depth from where the sea water will be drawn to the fore-bay / pump-house located away from the high tide line and subsequently to the LNG/LPG facility. The potential marine environmental impacts during construction phase may arise due to laying of pipeline of marine intake/ outfall and transportation of construction equipment and storage of construction materials.

In marine side construction, there are two principal zones of construction activity each requiring a different technique, namely, in-shore/surf zone and the offshore zone. The construction of submarine pipelines through the surf zone will cause temporary disturbance to the seabed along the alignment. The exposed portions of the pipelines can become a new habitat for marine organisms.

5.4.2.3 Mitigation Measures

Construction within the surf zone requires that the pipe be placed in a trench excavated to a depth sufficient to provide protection of the completed pipeline during periods of heavy seas. In sandy surf conditions the pipe must be buried to a depth below the minimum profile level, which can be expected, and/or provided with other means to maintain stability. Where the sea bottom is rock, the pipe may be placed in an excavated trench, backfilled and provided with a concrete protective cover.

Construction of intake/outfall structures will be carried out in such a manner, which will have minimum impact on marine ecology. It shall be ensured that there will be minimum ecological disturbance. Adoption of good construction management practices such as construction activity will be confined within the project site, selection of trenching equipment etc., will minimize the impacts on surrounding ecology to the bare minimal level.

5.4.2.4 Impact on Marine Water Quality

Marine water quality will be impacted due to dredging, trenching and disposal, construction of cargo berths and offshore structures/facilities. Direct impact of these activities on marine water quality would be increased turbidity due to suspended sediment and will be predominant during dredging.

Turbidity due to dredging operation varies with depth and lateral distance from dredger location. During dredging, transport of sediment depends on velocity and fine material concentration. Very fine cohesive material will remain in suspension for a long time and is independent of hydrodynamic conditions. Due to above factors, there will be an increase in turbidity due to suspended sediment in water column. Thus, it can be inferred that dredging would cause a short-term and localised impact on marine water quality.

Apart from turbidity, the marine water quality may be affected due to aqueous discharge (oily wastes, sanitary wastes, etc.) from the dredgers, barges and workboats involved in the activities. No discharge from the dredgers or work boats shall be allowed into marine waters.

The dredging activity will be confined within the project site and the impact due to dredging will cease upon completion. The impact due to dredging can be minimised with the implementation of a dredge management programme.

5.4.2.5 Impact on Marine Ecology

Capital dredging, reclamation, expansion of approach channel and construction of cargo berths etc., will result in disturbance to marine ecology.

Turbulence – Changes in Dissolved Oxygen (DO) Levels: During dredging, oxygen-demanding compounds, nutrients and sediments from the sea bed enter into water column. Since concentrations of oxygen-demanding compounds are normally much higher in pore water than in water column, it will cause a drop in oxygen concentration. Nutrients may stimulate primary production when light and temperatures are sufficient and may cause eutrophication problems when released in favourable conditions. DO levels in bottom sediments, which are usually low, would increase during dredging period. Changes in DO levels and noise are likely to result in localised and short-term impacts on marine ecology.

Removal of Benthic Communities associated with Bottom Sediments: Dredging would result in removal of benthic communities associated with bottom sediments in the dredging area. During dredging, sessile forms are removed along with sediments and mobile species tend to move away and are likely to increase species diversity in areas adjoining dredging site. Further, it is observed that due to movement of mobile species and transfer of nutrients during dredging, there will be an increase in species diversity and density in areas adjoining the dredging operation.

To mitigate impacts on marine ecology, measures such as selection of equipment and dredgers, environmental monitoring and regulating activities based on monitoring results will be adopted.

Smothering Effect Due to Settling of Sediment: Settlement of the suspended sediments can result in the smothering or blanketing of sub-tidal communities and / or adjacent inter-tidal communities. Presently, the marine biota in the Eastern Coast of India is already subjected to considerable changes in turbidity due to large-scale littoral movement, which is a recurring regular natural phenomenon. Therefore, it would be able to withstand localised turbidity induced during the dredging.

5.4.2.6 Changes in Seabed Profile

Generally construction of marine structures may alter the seabed profile. In the present expansion, marine structures include laying of piles which in turn involves lowering of piles into the seabed. The changes in the seabed could be in terms of disturbance to the strata and localised sediment dispersion. The dispersed sediment tends to increase the turbidity of the seawater resulting in an impact on the food chain of the marine biota.

Numerical modelling studies on hydrodynamics, littoral drift and sediment transport resulting from dredging and disposal have been carried to assess the impact due to change in seabed and the results are discussed in above sections which shows that changes are not significant.

5.4.2.7 Mitigation Measures

Prior to commencement of dredging, a Dredging Management Programme will be prepared and implemented, which include the following details.

- A schedule for dredging shall be prepared and list of DO(s) and DO NOT(s) shall be circulated among the people involved in construction activities
- It is proposed to check turbidity levels with baseline turbidity levels as a reference during dredging and at disposal site.
- Currently, there are no standards in India to regulate turbidity levels during dredging. It is proposed to check turbidity levels during construction phase with baseline turbidity levels as a reference during dredging.
- It will be ensured that suitable dredging equipment is deployed to minimise the suspension of fine sediments at the dredge site. The turbidity at the dredged site will also be minimised through adoption of less intrusive dredging techniques along with timing of the dredging activity (avoiding sensitive periods).
- Dredging activity will be regulated during rough sea conditions.
- Environmental Monitoring Programme comprising of monitoring of marine water quality, marine sediment quality and marine ecology will be initiated one week prior to commencement of dredging and will be carried out throughout dredging period.
- It will be ensured that barges/workboats have slop tanks for collection of liquid/solid waste generated on board. Discharge of wastes into sea will be prohibited.
- Spill control measures will be adopted while fuelling dredgers, barges, workboats, etc.
- Pre and post dredge material disposal bathymetry survey at disposal location shall be carried out
- Based on the TSS/Turbidity monitoring results during dredging, nearby receptors if any impacted would be provided with suitable mitigations measures such as silt screen to contain the turbidity.

5.4.2.8 Due to Pile Driving for Various offshore Structures

The construction of offshore structures such as berths will require piling activity. During Piling, Bentonite slurry will be used as a drilling fluid. Bentonite mud circulation is used in advancing the bore holes to stabilise the sides and bottom of the bore holes along with casing pipes. Bore hole is always kept filled with drilling mud to prevent any hydrostatic pressure within bore hole. They also help the drilling process by lubricating the bits and coating the drill cutting and thus facilitating their raise to the surface.

Bentonite is an inert and non-toxic material which is widely used in an aqueous suspension during piling (water based mud). The overflow slurry with bored mud/soil etc., that comes out along with bentonite slurry will need to be recovered as much as possible by adopting best available construction methods in order to minimise the impact on marine environment.

Settled sediments may be removed from over flow slurry and bentonite can be reused repeatedly provided its properties are carefully monitored and kept under control. Release of bentonite in to the marine environment either accidental spill or during normal piling activity, will increase the turbidity and create smothering effect on the benthic communities. It is observed that the benthic communities are likely to recover with in short time following completion of construction.

5.4.2.9 Mitigation Measures

- Regular Leak Check of bentonite slurry pumps, pipelines etc.,
- Periodic Marine water and sediment quality monitoring in and around piling areas.
- Spills expected during normal operations are very less and short term in nature. It will cease upon the completion of construction activities.
- Accidental Spills if any has to be recovered by adopting available appropriate technologies.

5.4.3 Potential Impact during Operation

5.4.3.1 Impact on Marine Water Quality and Ecology in Harbour Basin

Due to Aqueous Discharges: During the operation phase there will be continuous movement of cargo vessels and port crafts round the clock. There is a possibility of aqueous discharges from the cargo vessels such as dumping of ship wastes (sullage) / sewage, bilge water, solid wastes, etc. if not regulated.

In Dhamra port, provision of reception facilities will be explored to receive the residues and oily mixtures generated from ship operations according to provisions of the International Convention for the Prevention of Pollution from Ships, 1973/78 (MARPOL). In addition, reception facilities for garbage, waste oil and bilge water from the ships shall also be provided. The bilge water will be collected by authorised waste recyclers and taken for further treatment.

In addition, land-based sources of pollution such as runoff from the cargo berths, waste water, and sewage from the port operations would also affect the marine water and sediment qualities in the harbour basin, if disposed without proper treatment.

Due to Maintenance Dredging: During the operational phase, maintenance dredging of the approach channel and the harbour basin will be carried out in order to maintain the required draft in the channel for the free movement of the vessels. The maintenance dredge quantity

for the expansion plan is estimated at 16-20 MCM. The maintenance dredge spoil will be dumped at identified offshore disposal location beyond 20 m contour as approved during Phase II expansion by MoEF&CC.

As pollution control measures are proposed to be adopted, no significant impact are anticipated from maintenance dredging on water quality except locally due to suspension of bottom sediment resulting in increased turbidity levels. Further, during the disposal of the dredge spoil at the identified disposal ground, the dredger hopper will be shifted to minimize the increase in turbidity/suspended solids concentration and built up of the bed material.

Due to Cargo Spills during Handling: Spills do not occur during normal operations, as the cargo will be handled by mechanised ship-loaders/unloaders. In the event of accidental spills of cargo during transfer from / to the ships, the marine water quality, sediment quality and ecology in the harbour basin will be impacted.

Due to Oil Spills during Fuelling: Oil spills do not occur during normal fuelling operations. In the event of accidental oil spills during fuelling of the ships / port crafts, the marine water quality in the harbour basin will be impacted. To minimise the impacts on marine water quality, the spills will be recovered as per oil spill contingency plan.

5.4.3.2 Mitigation Measures

- Ships visiting the port will comply with MARPOL convention and avoid such discharges
- A standard format of the advance notification form for waste delivery to port reception facilities and standard format for the waste delivery receipt following a ship's use of port reception facilities as recommended by Marine Environment Protection Committee, IMO will be maintained
- During emergency, provision of reception facilities will be explored to receive the residues and oily mixtures generated from ship operations
- Settling ponds will be provided for collection of runoff from cargo storage areas. The settled material will be retrieved and sent back to respective stockyards. The supernatant water will be used for dust suppression for the cargo stockyards.
- It will be ensured that the dumping of the maintenance dredge spoil would be uniform and only within the identified dredge disposal locations
- Environmental Monitoring Programme comprising of monitoring of marine water quality, marine sediment quality and marine ecology will be initiated one week prior to commencement of maintenance dredging and will be carried out during the dredging period
- In case of any cargo spillage during transfer from/to ships, it will be attempted to recover the spills.
- Oil spill control equipment such as booms / barriers will be provided for containment and skimmers will be provided for recovery.
- As the accidental spills will be in harboured waters, it would not spread spatially and the response time for shutting down the fuelling, containment and recovery will be quicker.

Ballast Water Management

Ballast water is water held on a ship to maintain balance and stability while sailing. Water is typically taken up in one location and emptied in another, resulting in the release of marine organisms into a new environment. This causes non-native species and pathogens to be introduced, which can be harmful to the environment and human health.

Ballast water management guidelines are applicable for ships and there are no guidelines for ports and harbours. The guidelines to ships issued by DG Shipping vide Merchant Shipping

Notification No. 13/2001 requires the ships to follow guidelines promulgated through International Maritime Organisation (IMO). The highlights of the guidelines are as follows:

- Ships shall conduct ballast water exchange at least 200 nautical miles from the nearest land and in water at least 200 m in depth prior to calling at a port.
- Where ballast water exchange at 200 nautical miles to nearest land is not possible, the exchange should take place at least 50 nautical miles from nearest land and in water at least 200 m in depth.
- Ships shall carry out ballast water exchange with an efficiency of at least 95% volumetric exchange.
- The master and crew of the vessel shall be familiar with the essential shipboard procedures relating to ballast water.
- Each ship shall have on board a ballast water record book which may be an electronic recording system. Port officers may inspect the ballast water record book and ask for relevant copies of record book.

5.4.3.3 Impact due to Seawater Intake

Model has been run for 15 days continuously for predicting the sudden drawdown of water levels during the spring low water conditions due to continuous withdrawal of water at the intake location. **Figure 5-151** and **Figure 5-152** represents the water level and current variation at seawater intake. It was observed from the figure of the water levels and velocities for spring low water condition that the drawdown is limited to 0.05 m and the impact on velocity is limited to a small area around the intake location and is very much localized.

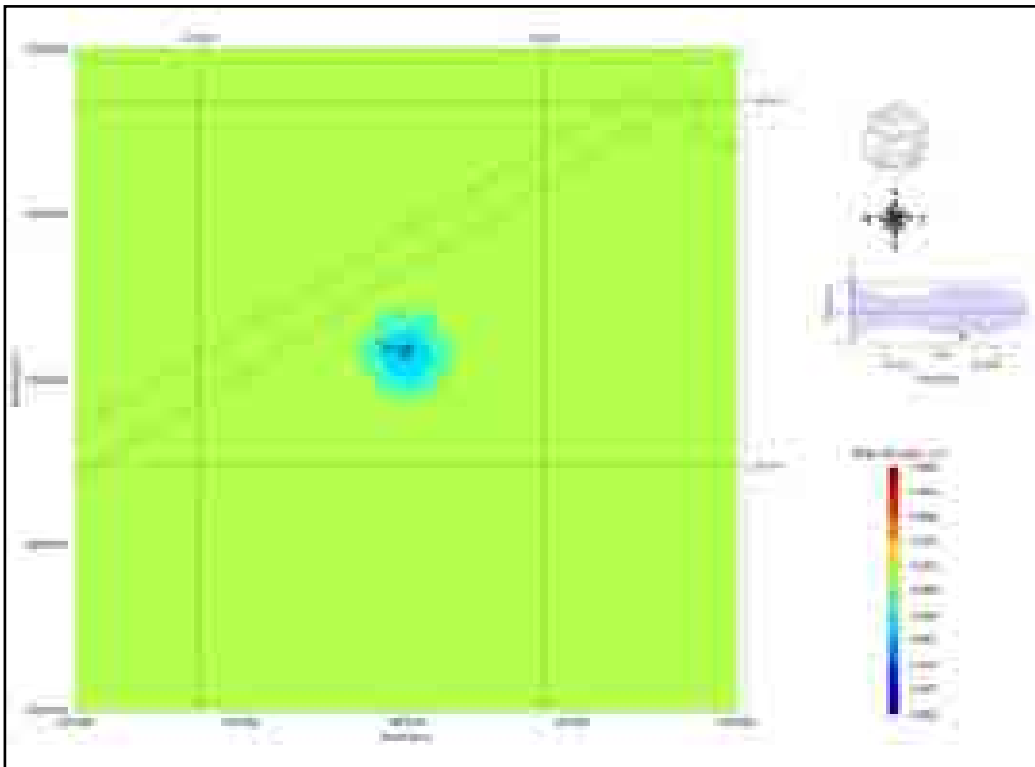


Figure 5-151: Water levels at Intake during spring lowest low water condition

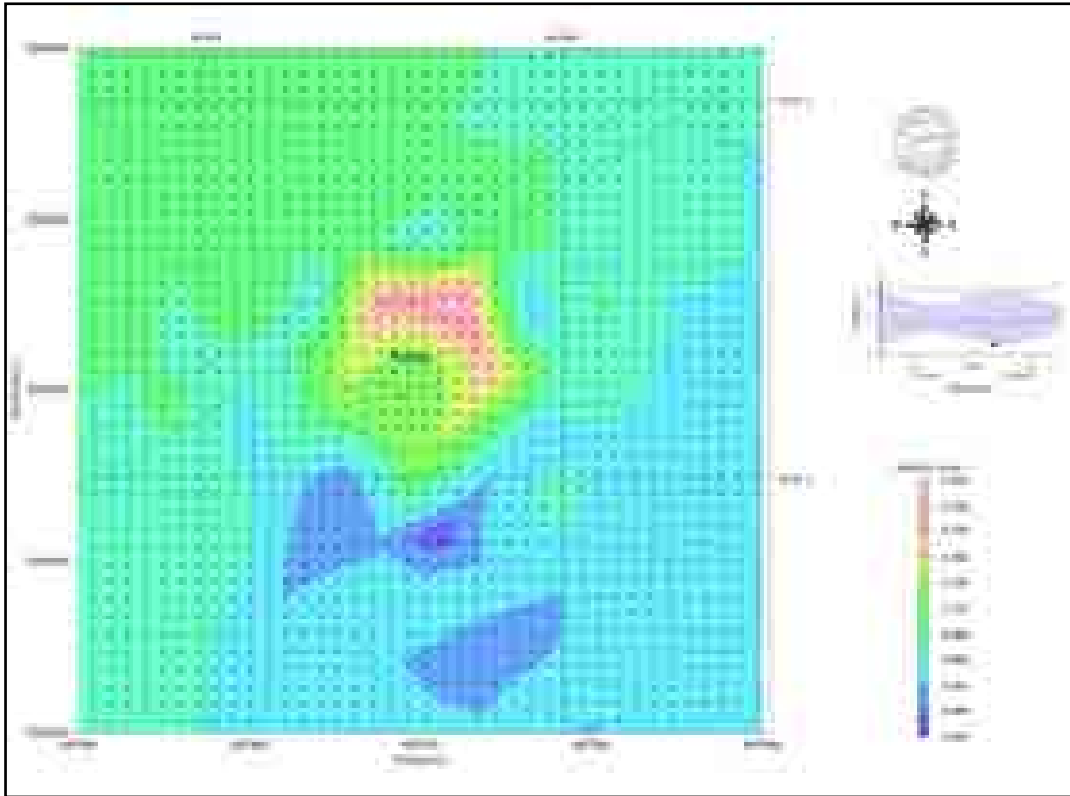


Figure 5-152: Variation of currents at Intake

The impact associated with the intake is due to Impingement, entrapment and entrainment of marine organisms. The intake well has to be designed in order to avoid vortex formation. The intake well (structure) shall be designed in cylindrical form to avoid interference of currents. It should not cause any danger to the boats and fishermen moving in the vicinity. The intake should have appropriate screens and trash bars with small openings to minimize the entry of small marine organisms, fish larvae and fishes.

Impingement occurs when organisms sufficiently large to avoid going through the screens are trapped against them by the force of the flowing source water – i.e., algae, plankton and bacteria are not exposed to impingement. On the other hand entrainment occurs when marine organisms enter the seawater intake, are drawn into the intake system, and pass through. Impingement typically involves adult aquatic organisms (fish, crabs, etc.) that are large enough to actually be retained by the intake screens, while entrainment mainly affects aquatic species small enough to pass through the particular size and shape of intake screen mesh. Organisms that enter the intake and cannot swim back out of it are often referred to as entrapped.

5.4.3.4 Mitigation Measures - Use of Low-Impact Intake Technologies – Coarse/Fine/ Wedge wire Screen Intakes

Coarse/Fine Screens: Open ocean intakes are typically equipped with coarse bar screens (**Figure 5-153**), which typically have openings between the bars of 20 mm to 150 mm followed by smaller-size (“fine”) screens with openings of 1 mm to 10 mm (**Figure 5-154**), which preclude the majority of the adult and juvenile marine organisms (fish, crabs, etc.) from entering the sea water systems. While coarse screens are always stationary, fine screens could be two types – stationary (passive) and periodically moving (i.e., rotating) screens.

**Figure 5-153: Intake Bar Screen****Figure 5-154: Fine Intake Screen**

Wedge Wire Screens: Wedge wire screens are cylindrical metal screens with trapezoidal-shaped “wedgewire” slots with openings of 0.5 to 10 mm. They combine very low flow-through velocities, small slot size, and naturally occurring high screen surface sweeping velocities to minimize impingement and entrainment. This is the only open intake technology approved by US EPA as Best Technology Available. The through screen design intake velocity is 0.5 feet/sec (0.1524 m/s) or less and the slot size is appropriate for the size of eggs, larvae, and juveniles of any fish and shellfish to be protected at the plant intake site.

Wedge wire screens are designed to be placed in a water body where significant prevailing ambient cross flow current velocities (≥ 1 fps) exist. This high cross-flow velocity allows organisms that would otherwise be impinged on the wedge wire screen intake to be carried away with the flow. An integral part of a typical wedge wire screen system is an air burst back-flush system, which directs a charge of compressed air to each screen unit to blow-off debris back into the water body, where they are carried away from the screen unit by the ambient cross-flow currents.

Even though there are several designs available, the model that employs the cylindrical Edge-Wire screen has shown the maximum efficiency ($> 99\%$ for impingement and 80 to 90% for entrainment problems). Some recent models have also incorporated efficient self-cleaning systems so that the inflow is not affected due to impingement (blocking of the screens by marine biota).

If chlorination is done, then the freely available chlorine at any point of time should be kept within 0.5 mg/l. Residual chlorine present in the return water can have synergistic effects on the flora and fauna of the receiving water.

5.4.3.5 Impact due to Cold Seawater Discharge

Numerical modelling studies for the dispersion of the temperature of the return water discharged through the pipeline with diffuser system into the sea were carried out to predict the extent of temperature dispersion below the ambient that would be felt in the waters from the point of disposal and predict the dilution that would be taking place around the discharge location. The parameter considered for the present study is Temperature at the disposal location.

Outfall Characteristics

The characteristics of sea water (cold return water from LNG/LPG terminal) is as given below

- Outfall Quantity: $1,20,000 \text{ m}^3/\text{hr}$ (Plus 10% additional buffer capacity)

- Temperature Difference: (-) 7⁰ C with respect to ambient

Three (03) options/locations have been selected for discharge of LNG/LPG plant rejects. Best location which is hydraulically and environmentally suitable among the three locations / options considered needs to be identified through hydrodynamic and dispersion modelling studies. In the options of outfall locations for cold return water discharge into the Dhamra region, the scheme is to discharge the return cold water through a subsea pipeline followed by diffuser system at a point having sufficient depth. **Figure 5-155** shows the proposed optional outfall locations. **Figure 5-157** shows the variation of currents at the proposed outfall (Outfall: 1, Outfall: 2 and Outfall: 3) and intake locations. From the figures it can be seen that the currents are stronger at outfall 2 than others. The variation of water depths at Intake location are shown in **Figure 5-156**. From the figure it can be concluded that there is sufficient depth available for required quantity of water for LNG/LPG plant.

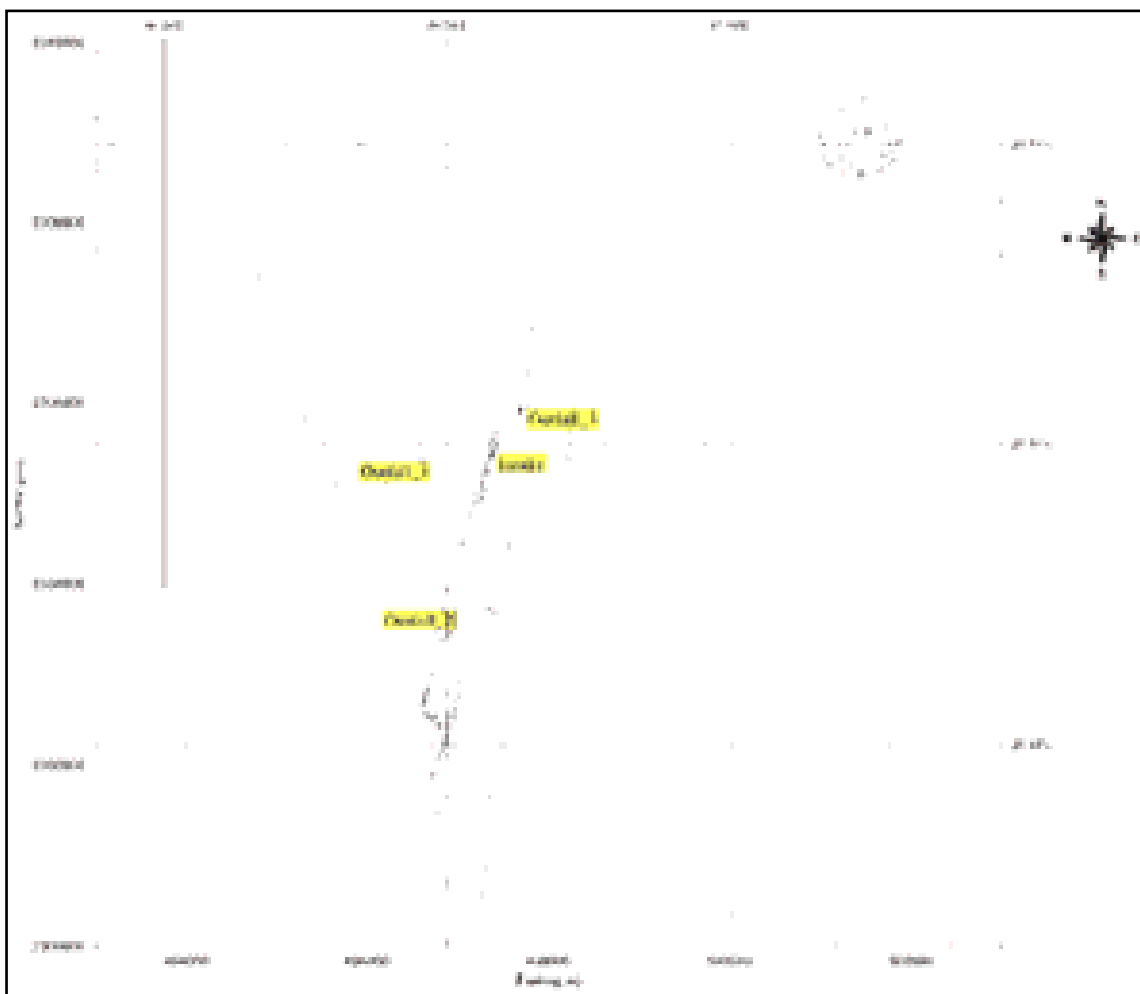


Figure 5-155: Locations of the proposed intake and optional outfall locations

The optional outfall locations are given in below **Table 5-21**.

Table 5-21: Optional outfall locations

Outfall Location	Co-ordinates	
	Easting	Northing
Option 1	496594.8592	2305340.6419
Option 2	496857.2520	2303697.2181
Option 3	497689.0950	2305921.1733

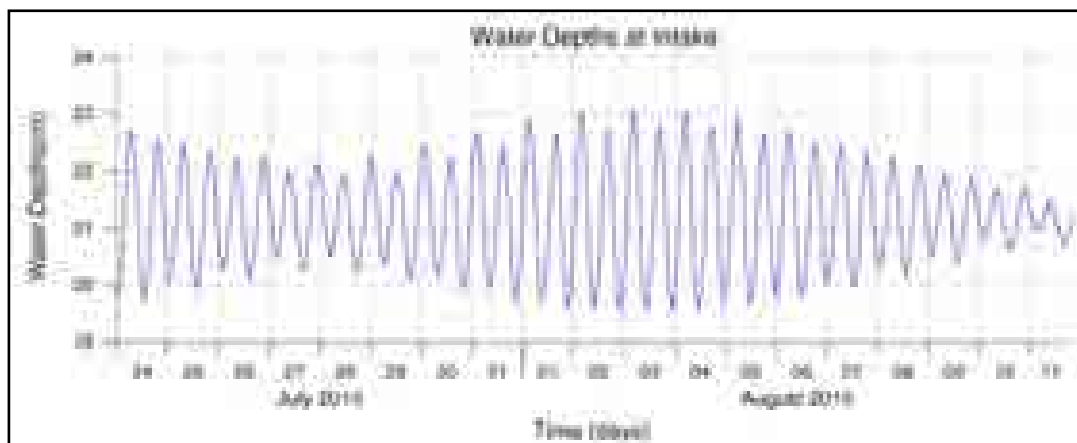


Figure 5-156: Variation of Water depths at intake

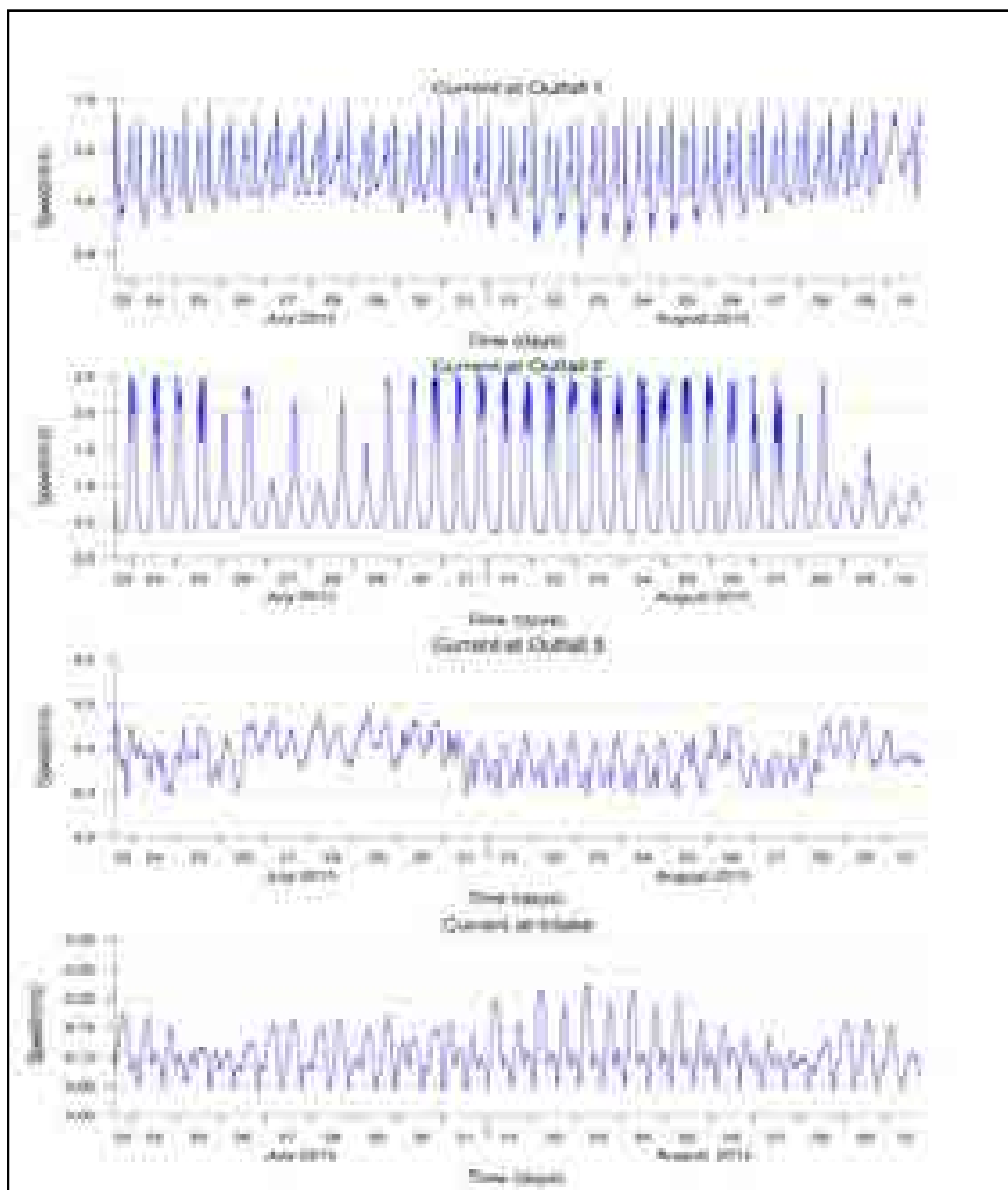


Figure 5-157: Variation of currents at intake and outfall locations

Modelling of Temperature for Outfall Discharge (Dispersion)

For modelling purpose, it was assumed that the discharge will at a minimum depth of 5 m. The results pertaining to variation of Temperature at and around the discharge point for spring tide are shown and discussed below:

Lowest Low water (LLW)

Outfall Option-1: The cold water from the LNG/LPG plant discharged at outfall option-1. **Figure 5-158** shows the variation of Temperature during LLW condition of spring tide. It can be observed from the figure that the dispersion is around 5 km towards north and 5 km towards east with the central patch having a lower Temperature value. The dispersion is trending towards north direction initially and extends 5 km towards east direction. The ambient conditions prevail within a distance of 5000 m from the point of disposal. However, it can be seen that there is no change in the Temperature observed at the proposed intake location.

Outfall Option-2: The cold water from the LNG/LPG plant discharged at outfall option-2 location, which is deeper in depth. **Figure 5-159** shows the variation of Temperature during LLW condition of spring tide. It can be observed from the figure that the dispersion is around 600 m towards north and 400 m towards south with the patch having a lower Temperature value at the disposal location. The ambient conditions prevail within a distance of 600 m from the point of disposal. However, it can be seen that there is no change in the Temperature observed at the proposed intake location.

Outfall Option-3: The cold water from the LNG/LPG plant discharged at outfall option-3 location, which is also deeper in depth. **Figure 5-160** shows the variation of Temperature during LLW condition of spring tide. It can be observed from the figure that the dispersion is around 1000 m towards south with the patch having a lower Temperature value at disposal location. The dispersion is trending towards south direction and extends 600 m towards south direction. The ambient conditions prevail within a distance of 600 m from the point of disposal. However, it can be seen that there is change in Temperature observed at the proposed intake location.

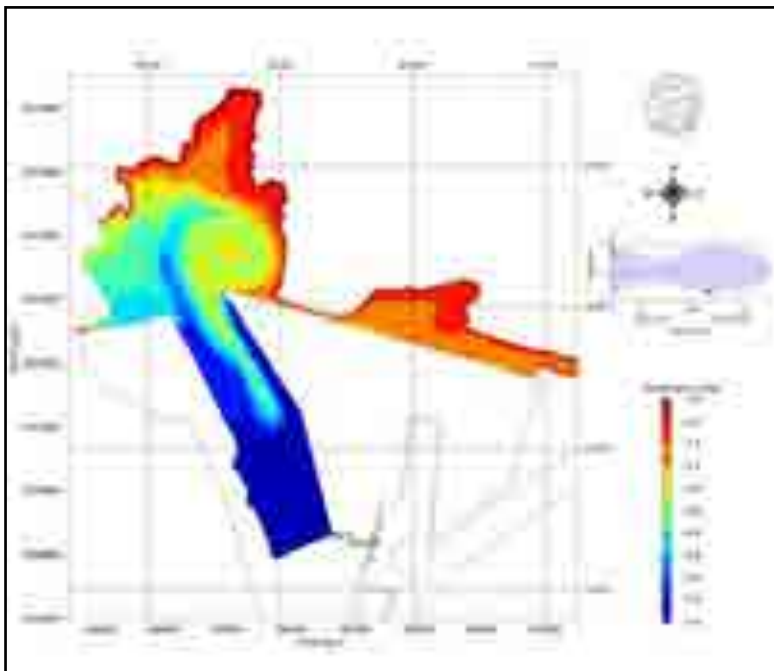


Figure 5-158: Temperature dispersion during spring tide – LLW (Option-1)

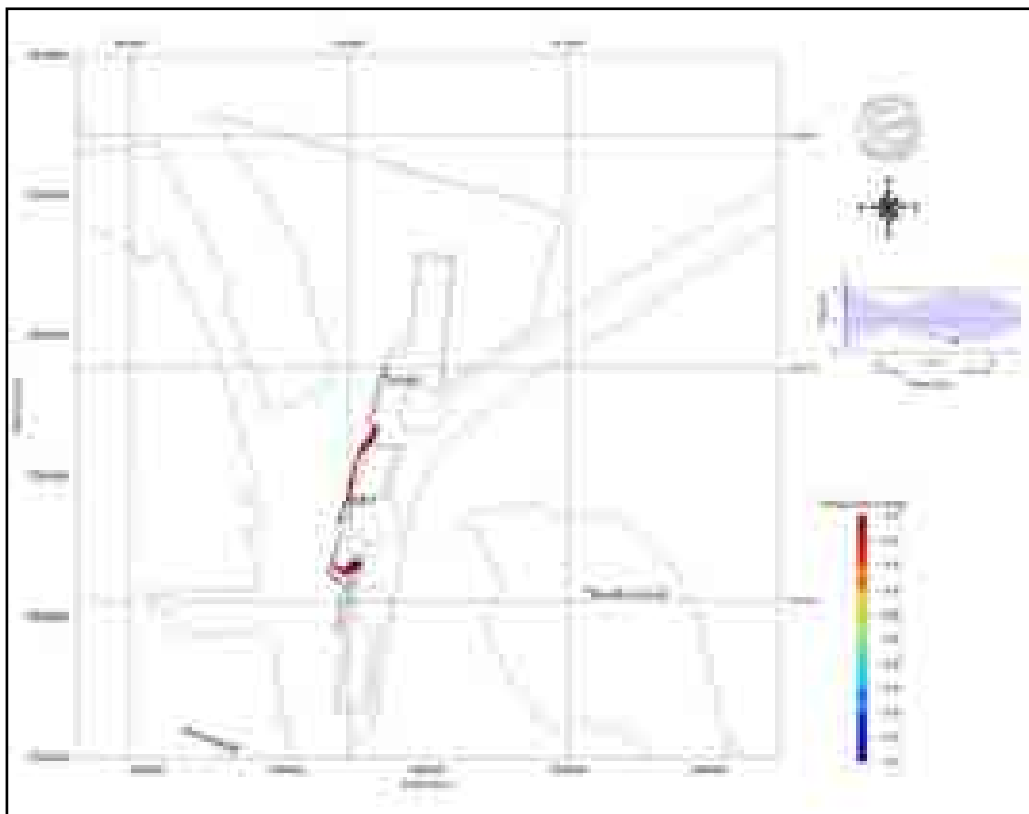


Figure 5-159: Temperature dispersion during spring tide – LLW (Option-2)

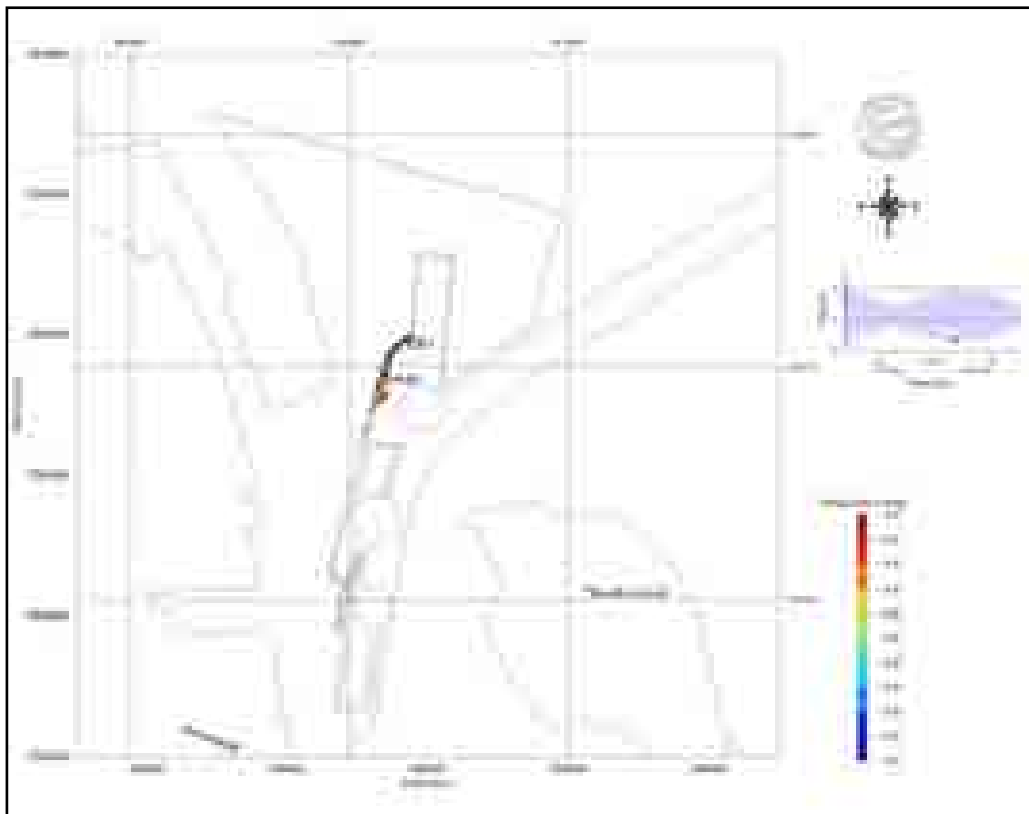


Figure 5-160: Temperature dispersion during spring tide – LLW (Option-3)

Peak Flood (PF)

Outfall Option-1: Figure 5-161 shows the variation of Temperature during Peak Flood condition of spring tide. It can be observed from the figure that the dispersion is elongated towards north direction and with the patch having a lower Temperature value at the disposal point. The ambient conditions prevail within a distance of 4000 m from the point of disposal. However, it can be seen that there is no change in the Temperature observed at the proposed intake location.

Outfall Option-2: The cold water from the LNG/LPG plant discharged at outfall option-2 location, which is deeper in depth. Figure 5-162 shows the variation of Temperature during Peak flood condition of spring tide. It can be observed from the figure that the dispersion is around 600 m towards south with the patch having a lower Temperature value at source location. The ambient conditions prevail within a distance of 600 m from the point of disposal. However, it can be seen that there is no change in the Temperature observed at the proposed intake location.

Outfall Option-3: The cold water from the LNG/LPG plant discharged at outfall option-3 location, which is also deeper in depth. Figure 5-163 shows the variation of Temperature during Peak flood condition of spring tide. It can be observed from the figure that the dispersion is towards south with the patch having a lower Temperature value at the disposal location. The ambient conditions prevail within a distance of 600 m from the point of disposal. However, it can be seen that there is change in the Temperature observed at the proposed intake location.

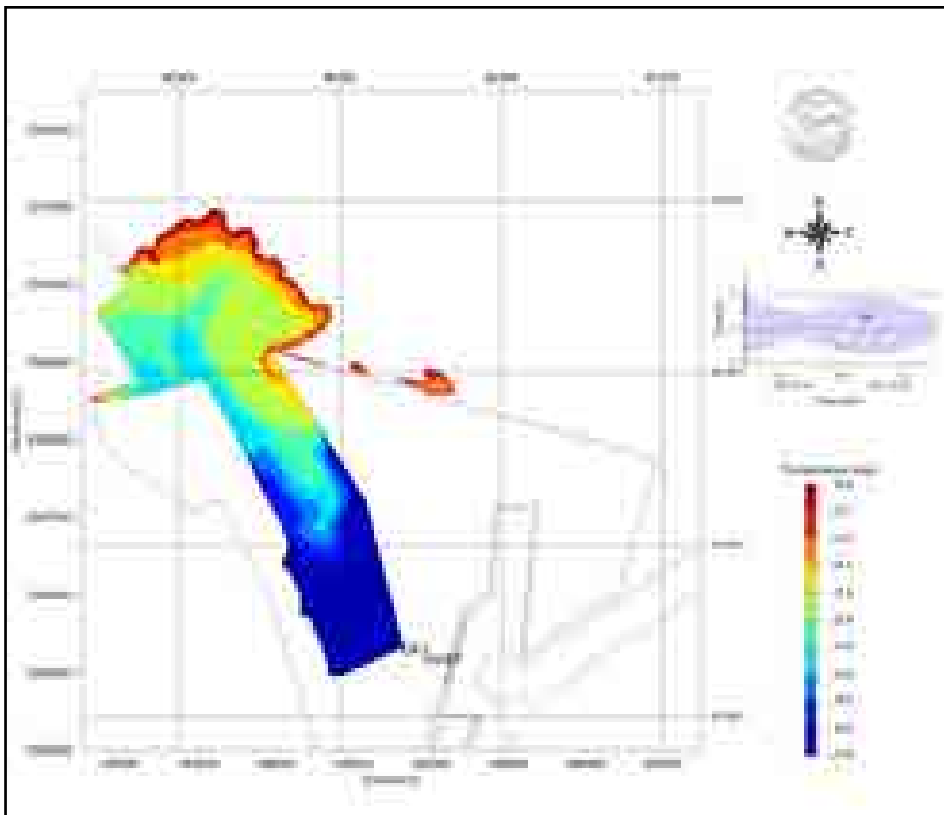


Figure 5-161: Temperature dispersion during spring tide – FLD (Option-1)

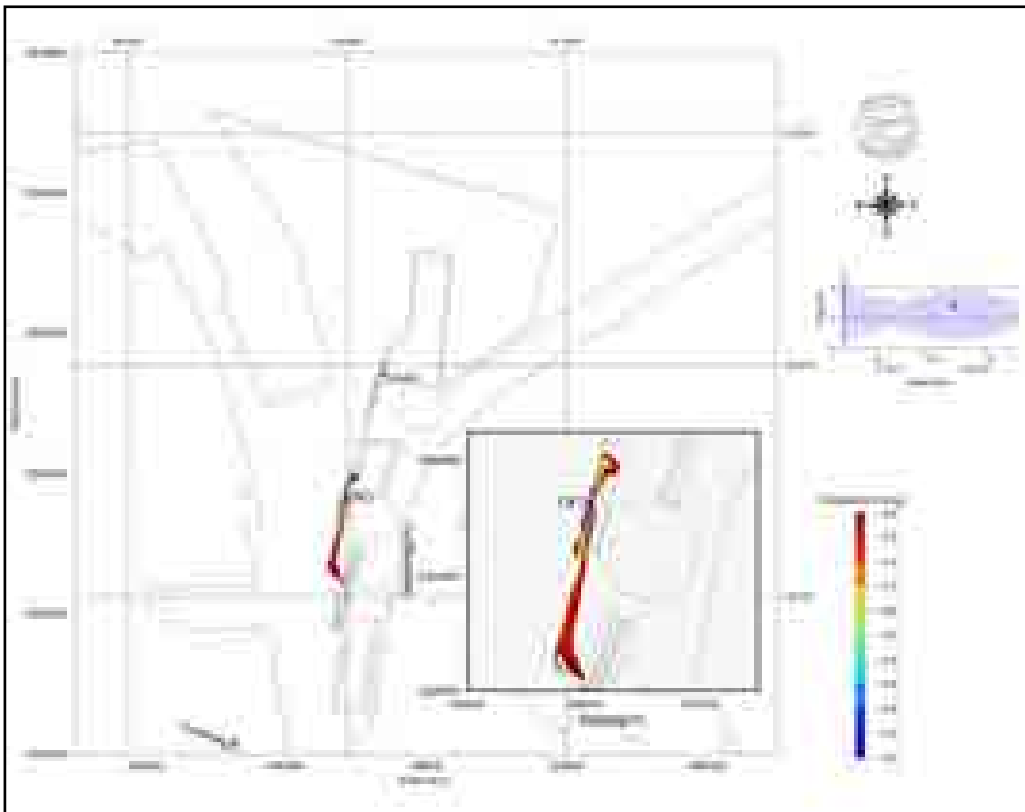


Figure 5-162: Temperature dispersion during spring tide – FLD (Option-2)

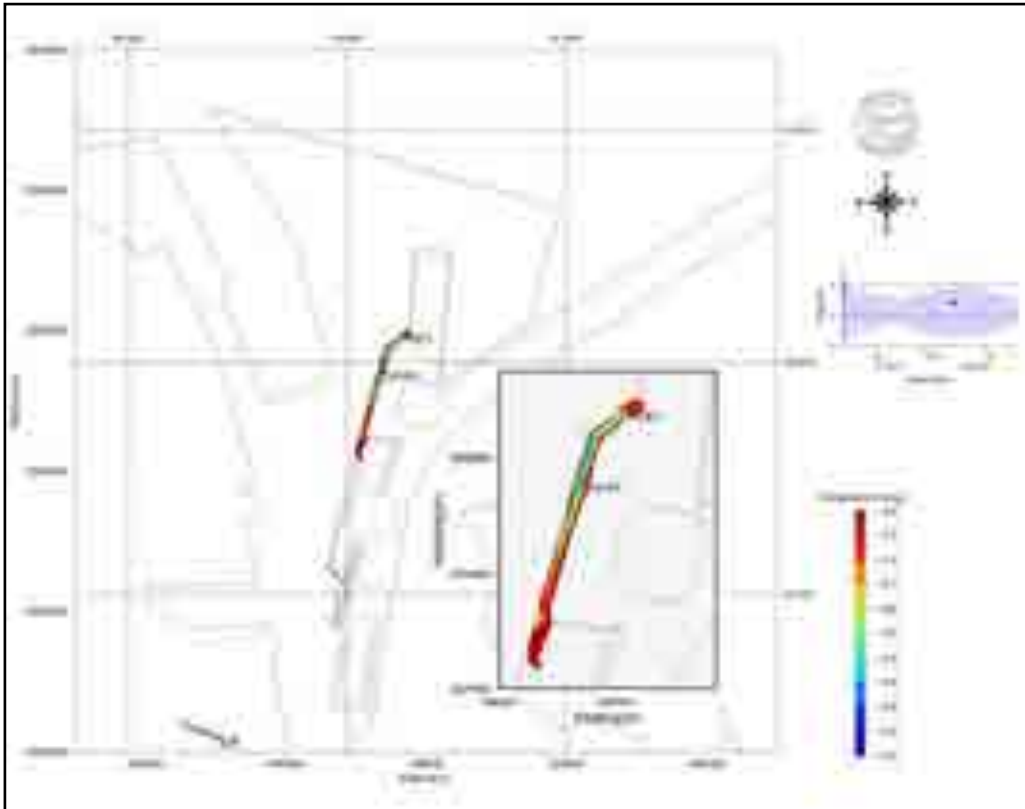


Figure 5-163: Temperature dispersion during spring tide – FLD (Option-3)

Highest High Water (HHW)

Outfall Option-1: Figure 5-164 shows the variation of Temperature during Highest High Water condition of spring tide. It can be observed from the figure that the dispersion is extended towards north direction and with the patch having a lower Temperature value at the disposal point. The ambient conditions prevail within a distance of 5000 m from the point of disposal. However, it can be seen that there is no change in the Temperature observed at the proposed intake location.

Outfall Option-2: The cold water from the LNG/LPG plant discharged at outfall option-2 location, which is deeper in depth. Figure 5-165 shows the variation of Temperature during HHW condition of spring tide. It can be observed from the figure that the dispersion is trending towards south direction and extends 600m with the patch having a lower Temperature value at source location. The ambient conditions prevail within a distance of 600 m from the point of disposal. However, it can be seen that there is no change in the Temperature observed at the proposed intake location.

Outfall Option-3: The cold water from the LNG/LPG plant discharged at outfall option-3 location, which is also deeper in depth. Figure 5-166 shows the variation of Temperature during Peak flood condition of spring tide. It can be observed from the figure that the dispersion is towards south with the patch having a lower Temperature value at the disposal location. The ambient conditions prevail within a distance of 600 m from the point of disposal. However, it can be seen that there is change in the Temperature observed at the proposed intake location.

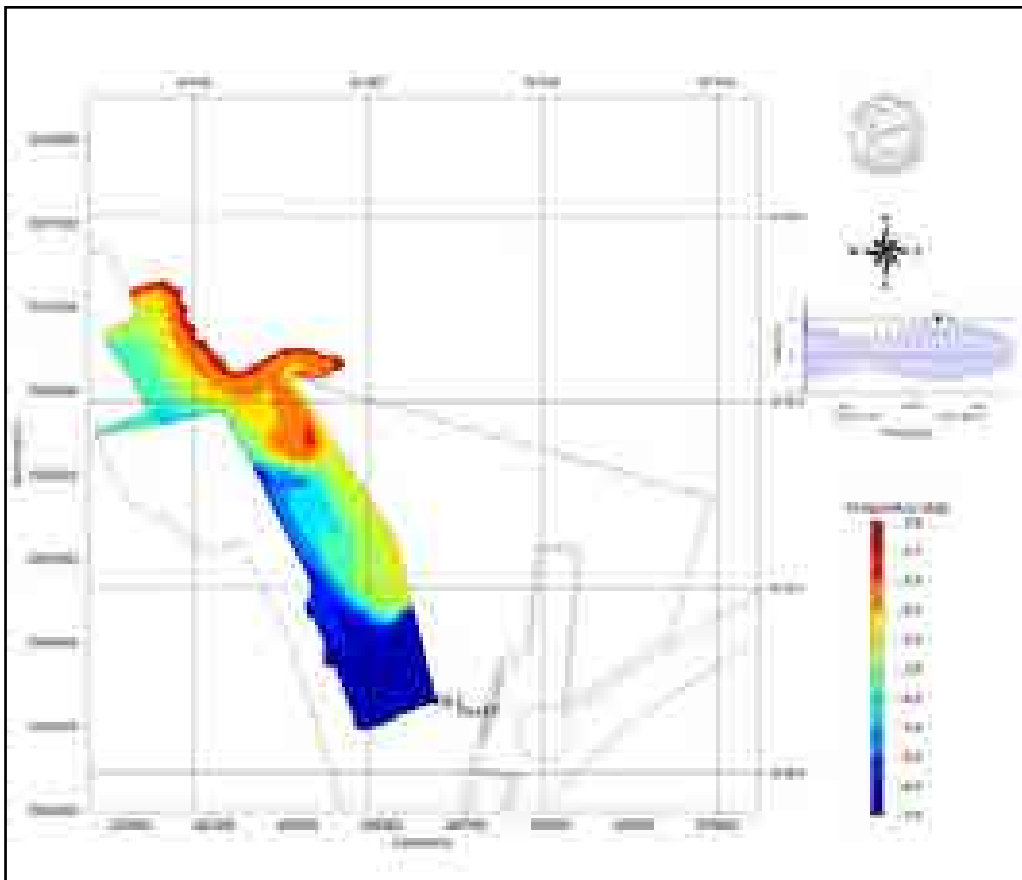


Figure 5-164: Temperature dispersion during spring tide – HHW (Option-1)

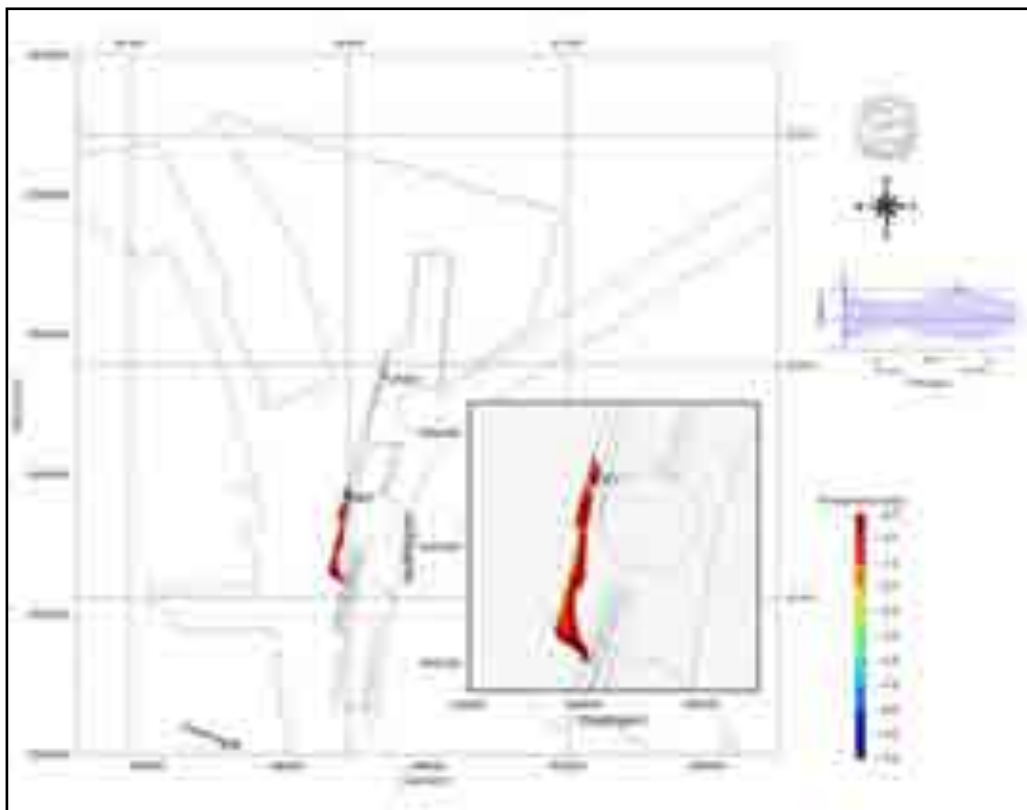


Figure 5-165: Temperature dispersion during spring tide – HHW (Option-2)

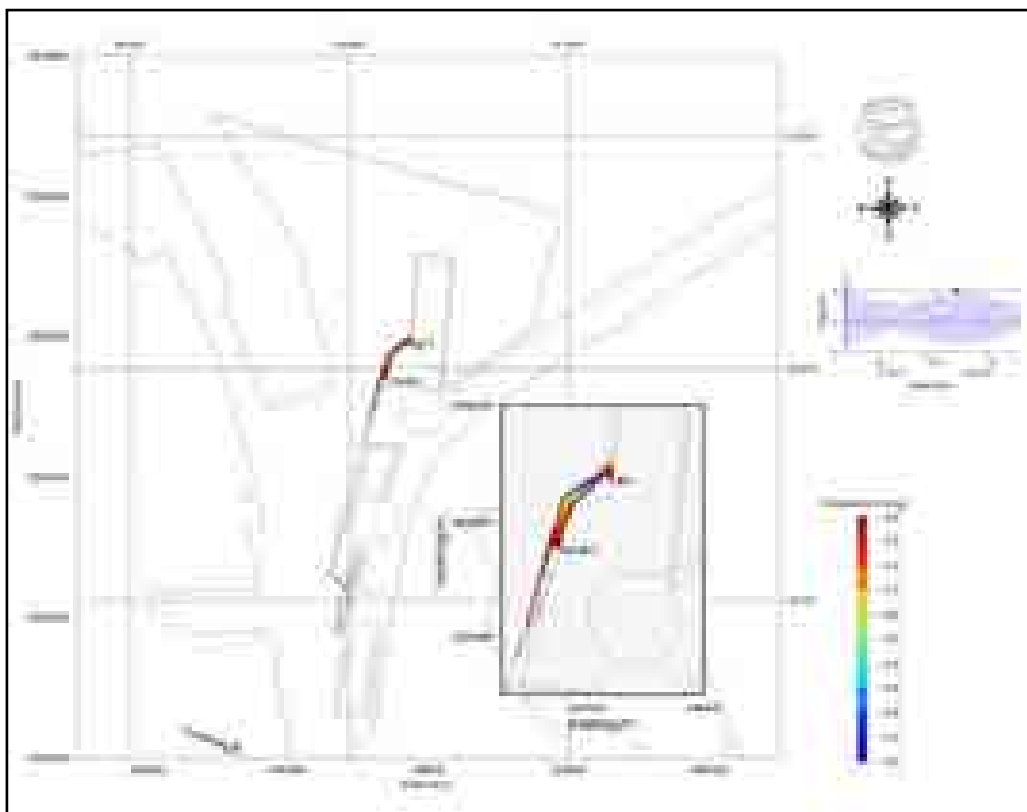


Figure 5-166: Temperature dispersion during spring tide – HHW (Option-3)

Peak Ebb (PE)

Outfall Option-1: Figure 5-167 shows the variation of Temperature during Peak ebb condition of spring tide. It can be observed from the figure that the dispersion is elongated towards North-West direction initially and then after East direction and with the patch having a lower Temperature value at the disposal point. The ambient conditions prevail within a distance of 6000 m from the point of disposal. However, it can be seen that there is no change in the Temperature observed at the proposed intake location.

Outfall Option-2: The cold water from the LNG/LPG plant discharged at outfall option-2 location, which is deeper in depth. Figure 5-168 shows the variation of Temperature during Peak ebb condition of spring tide. It can be observed from the figure that the dispersion is around 600m towards south and north with the patch having a lower Temperature value at source location. The ambient conditions prevail within a distance of 600 m from the point of disposal. However, it can be seen that there is no change in the Temperature observed at the proposed intake location.

Outfall Option-3: The cold water from the LNG/LPG plant discharged at outfall option-3 location, which is also deeper in depth. Figure 5-169 shows the variation of Temperature during Peak ebb condition of spring tide. It can be observed from the figure that the dispersion is towards south with the patch having a lower Temperature value at the disposal location. The dispersion is trending towards south direction and extends 300m towards south direction. The ambient conditions prevail within a distance of 300 m from the point of disposal. However, it can be seen that there is no change in the Temperature observed at the proposed intake location.

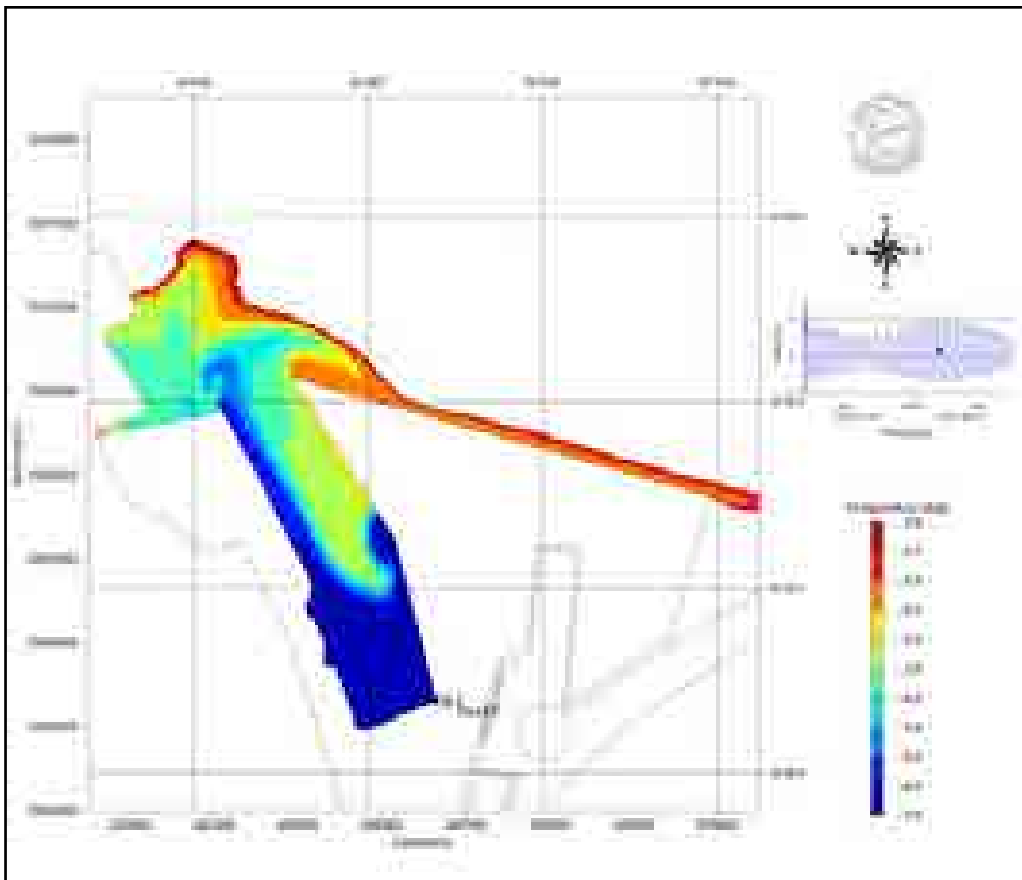


Figure 5-167: Temperature dispersion during spring tide – EBB (Option-1)

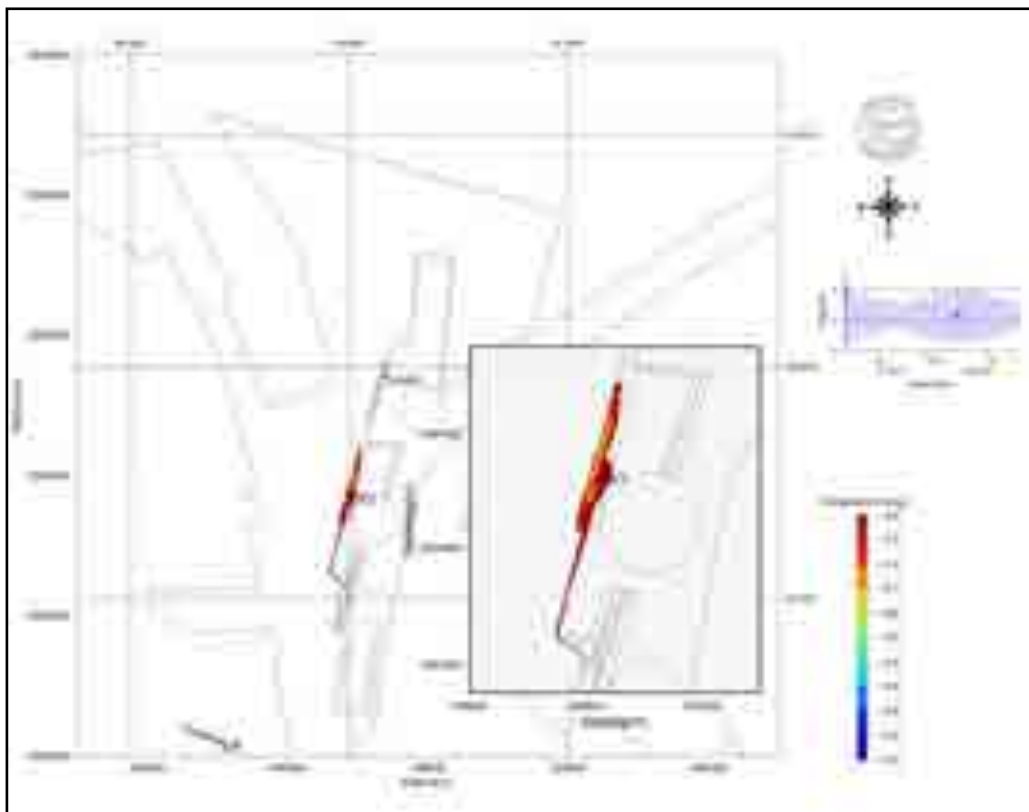


Figure 5-168: Temperature dispersion during spring tide – EBB (Option-2)

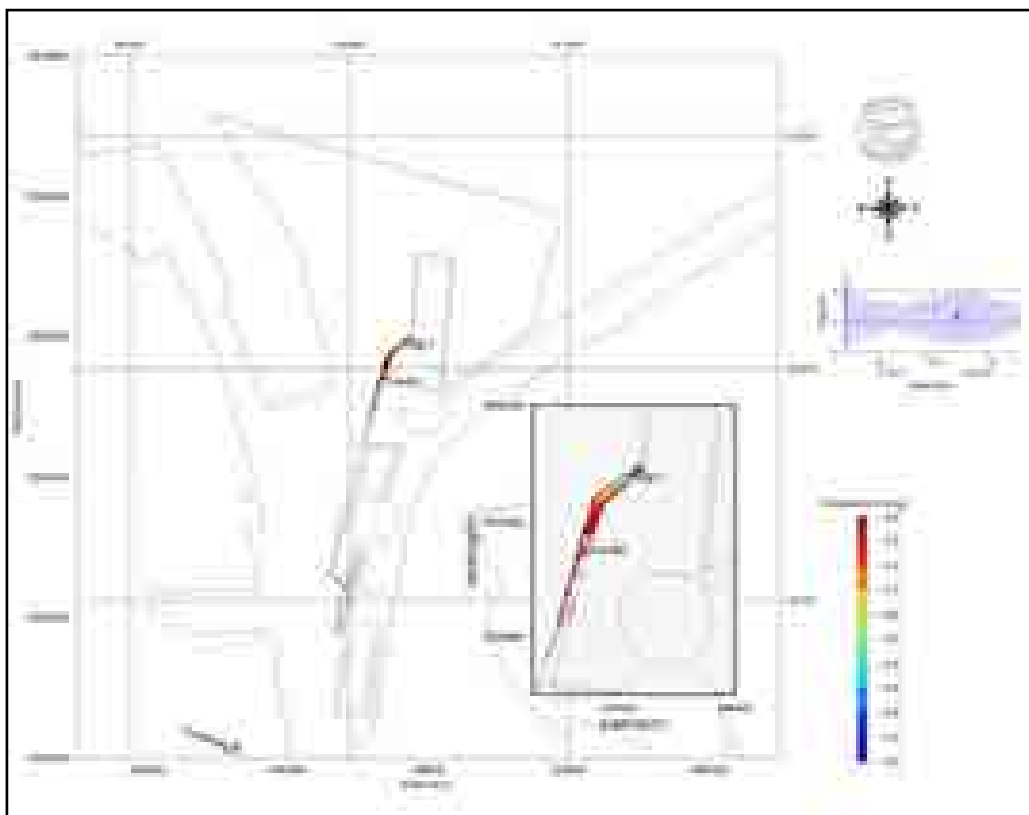


Figure 5-169: Temperature dispersion during spring tide – EBB (Option-3)

Results and Discussions

Dispersion is relatively more compact with higher Temperature value prevailing at the patch located at disposal location which is at the actual point of disposal during LW and HW condition of spring tides. The dispersion is more and occupying a larger patch area with the patch at disposal location. Temperature values lower during the Flood and Ebb conditions.

A number of observation points for three options of Outfall location (**Figure 5-170**, **Figure 5-171** and **Figure 5-172**) have been studied around the disposal of outfalls to measure and record the variation of Temperature. The distance of observation points from the outfall locations are furnished in the **Table 5-22**.

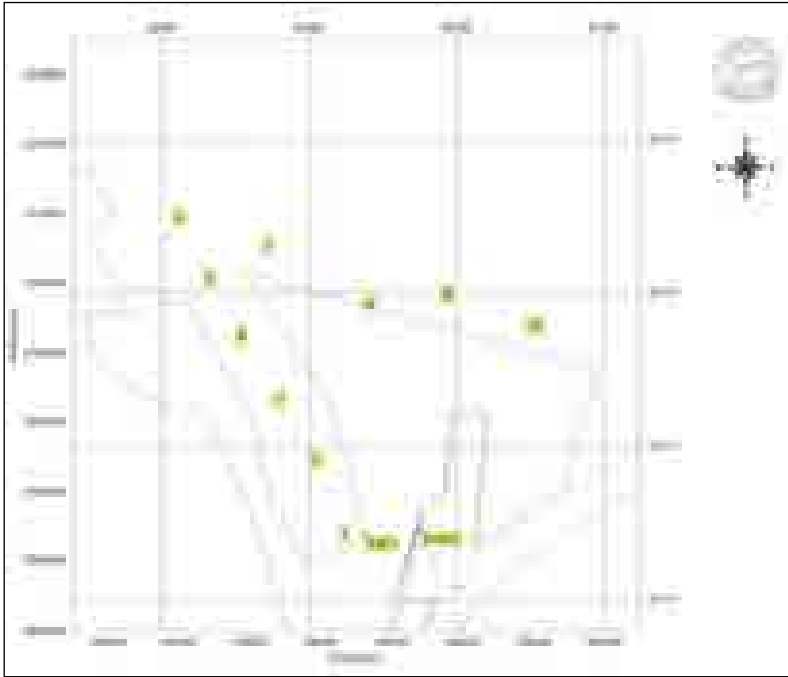


Figure 5-170: Observation points at and around outfall location- Option1

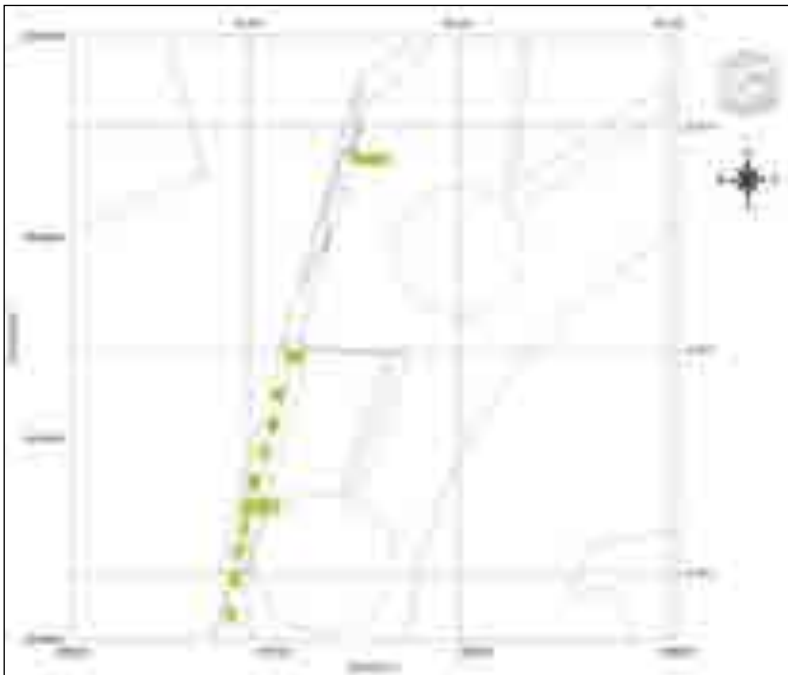


Figure 5-171: Observation points at and around outfall location - Option 2

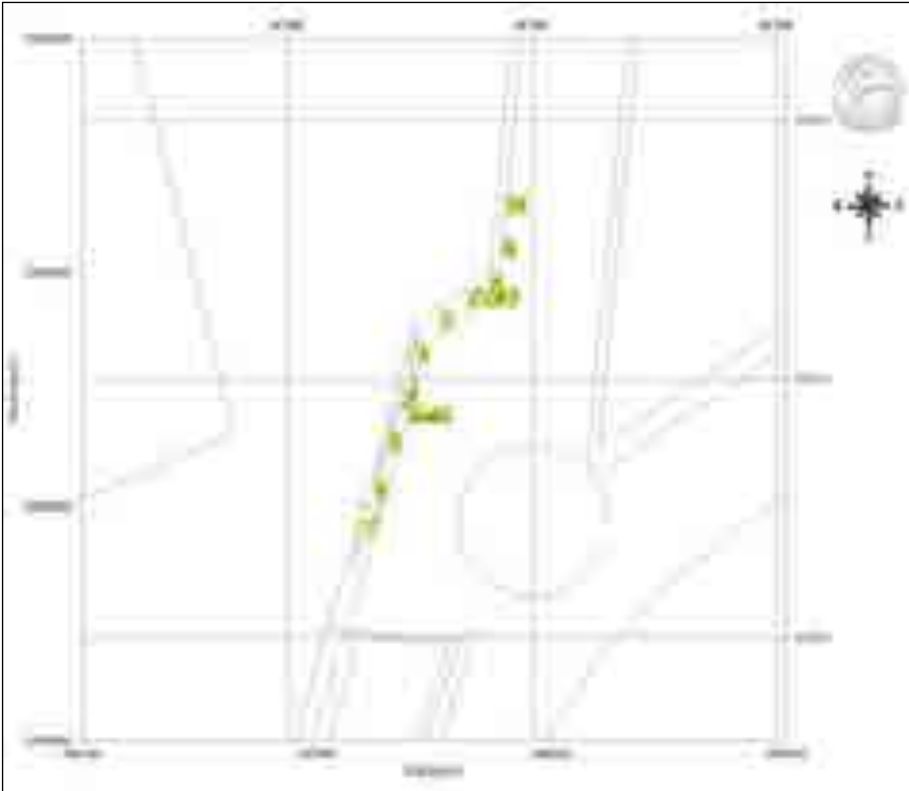


Figure 5-172: Observation points at and around outfall location – Option 3

Table 5-22: Distance of observation locations from outfall locations

S. No	Observation Points	Distance from Intake (m)		
		Outfall -1	Outfall -2	Outfall -3
1.	Point 1	13529.68	1799.35	684.97
2.	Point 2	12792.73	1915.45	549.60
3.	Point 3	11579.52	2032.32	392.59
4.	Point 4	10483.32	2155.48	209.49
5.	Point 5	10020.52	2335.17	123.57
6.	Point 6	10731.52	1698.10	219.53
7.	Point 7	9606.84	1524.65	389.82
8.	Point 8	7621.86	1379.72	880.89
9.	Point 9	7043.31	1221.51	950.51
10.	Point10	5693.34	1058.91	1135.98

The variation of Temperature at different locations (observation points) for the proposed outfall discharge is shown in **Figure 5-173** to **Figure 5-175**. From the figures, it can be seen that the Temperature dispersion at proposed intake location is affected due to outfall option-3. From the figures it also can be concluded that more dispersion can be observed in option-1 due to shallow water depth. Hence, option-1 and option-3 locations may not be suggested for disposal of LNG/LPG plant return cold water. For all conditions Option-2 is hydraulically and environmental suitable for disposal.

Finally, it can be concluded that there will not be any recirculation and there will be no impact on water qualities at the intake as well as at the shore due to the disposal taking place at the proposed outfall discharge location i.e., Option-2.

The FSRU and FSO are planned as a part of the interim requirement for handling of LNG and LPG, therefore, the modelling studies pertaining to cold return seawater needs to be carried out. However, the capacity of the FSRU and FSO is not exceeding the onshore LNG and LPG terminal planned as a part of the Revised Master Plan. Hence, locations of the

intake & outfall proposed for Onshore LNG/LPG terminal will remain the same for proposed FSRU and FSO and findings of LNG and LPG terminal modelling studies will hold good. No additional impacts/studies are envisaged.

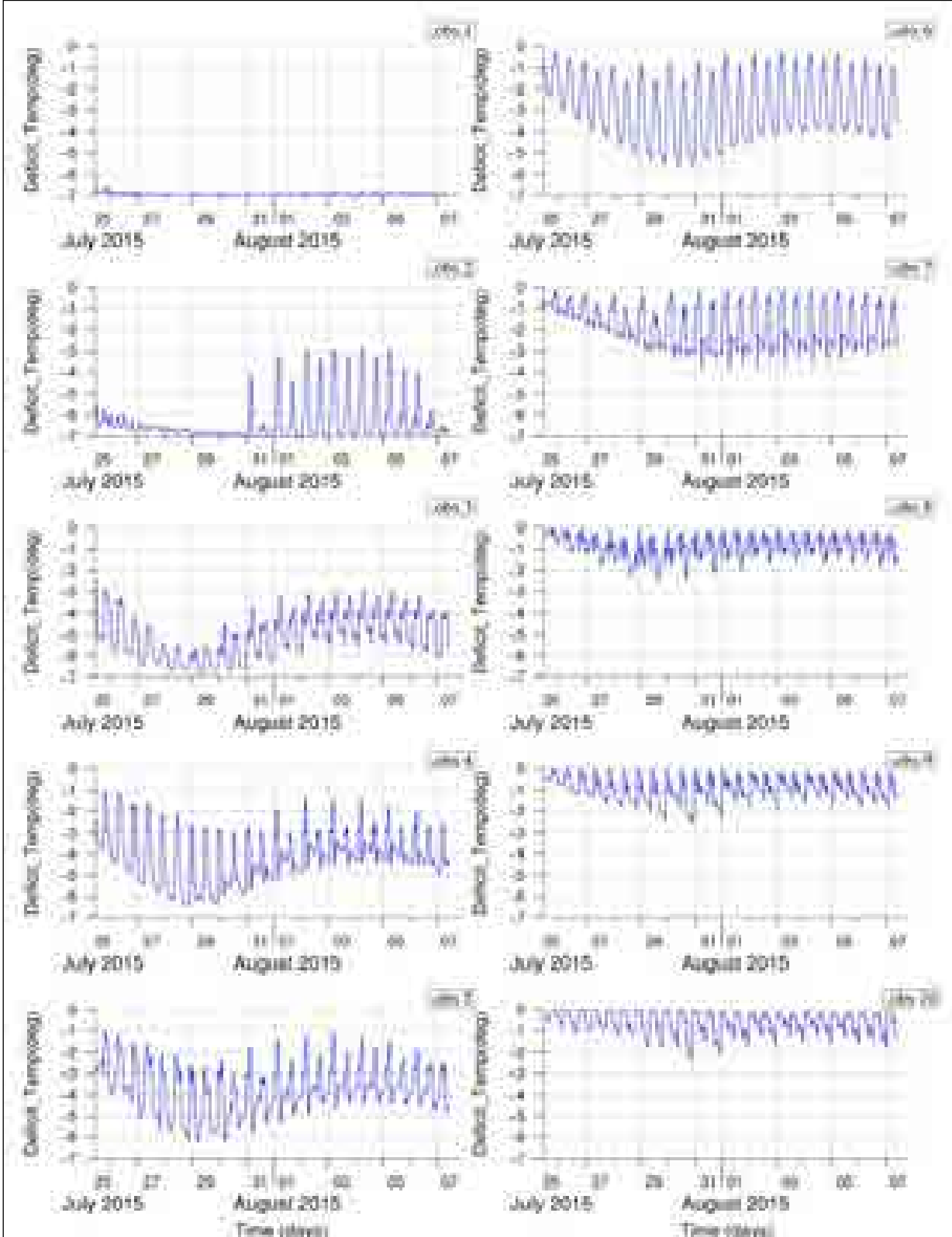


Figure 5-173: Variation of temperature at different Locations (Outfall Option - 1)

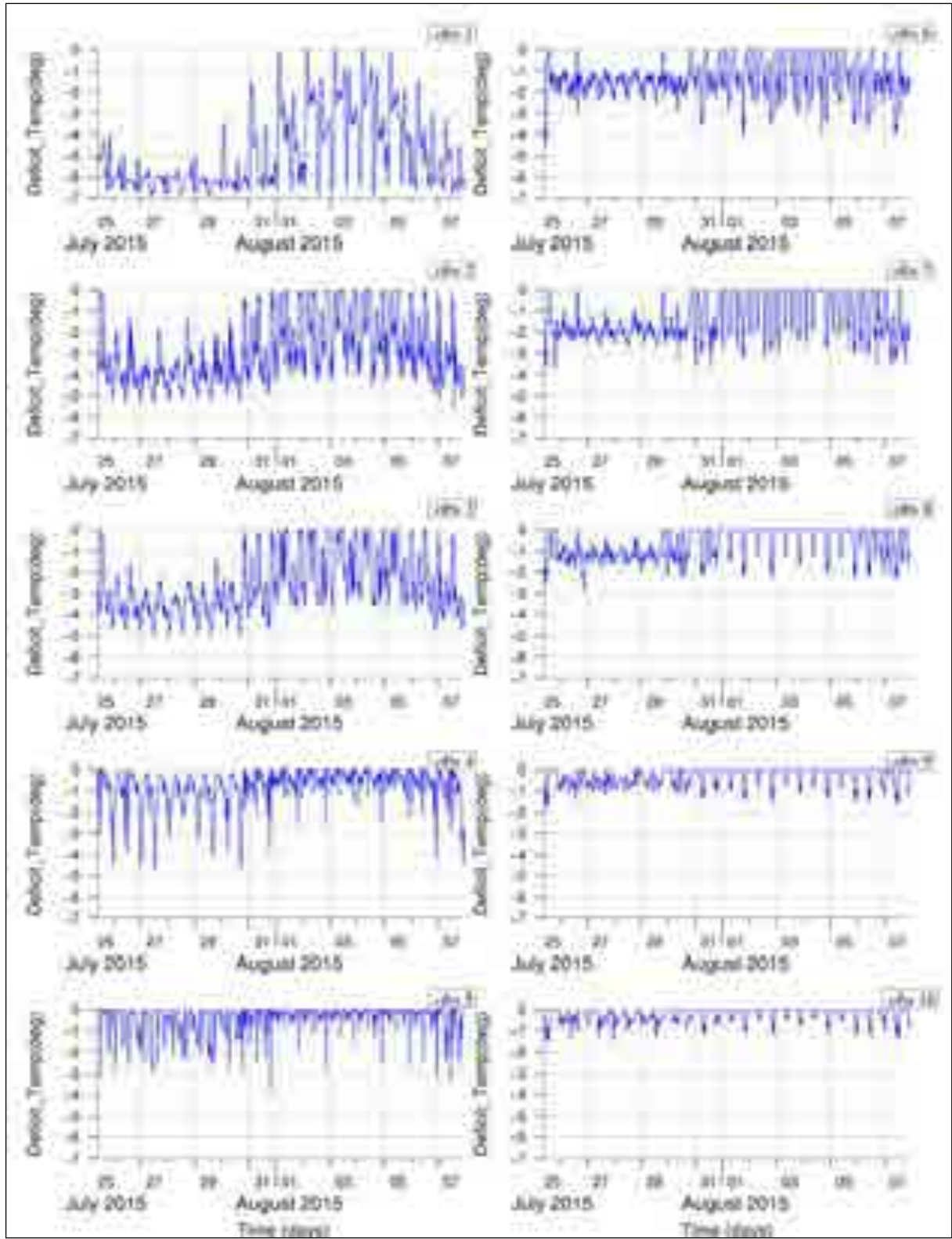


Figure 5-174: Variation of temperature at different Locations (Outfall Option - 2)

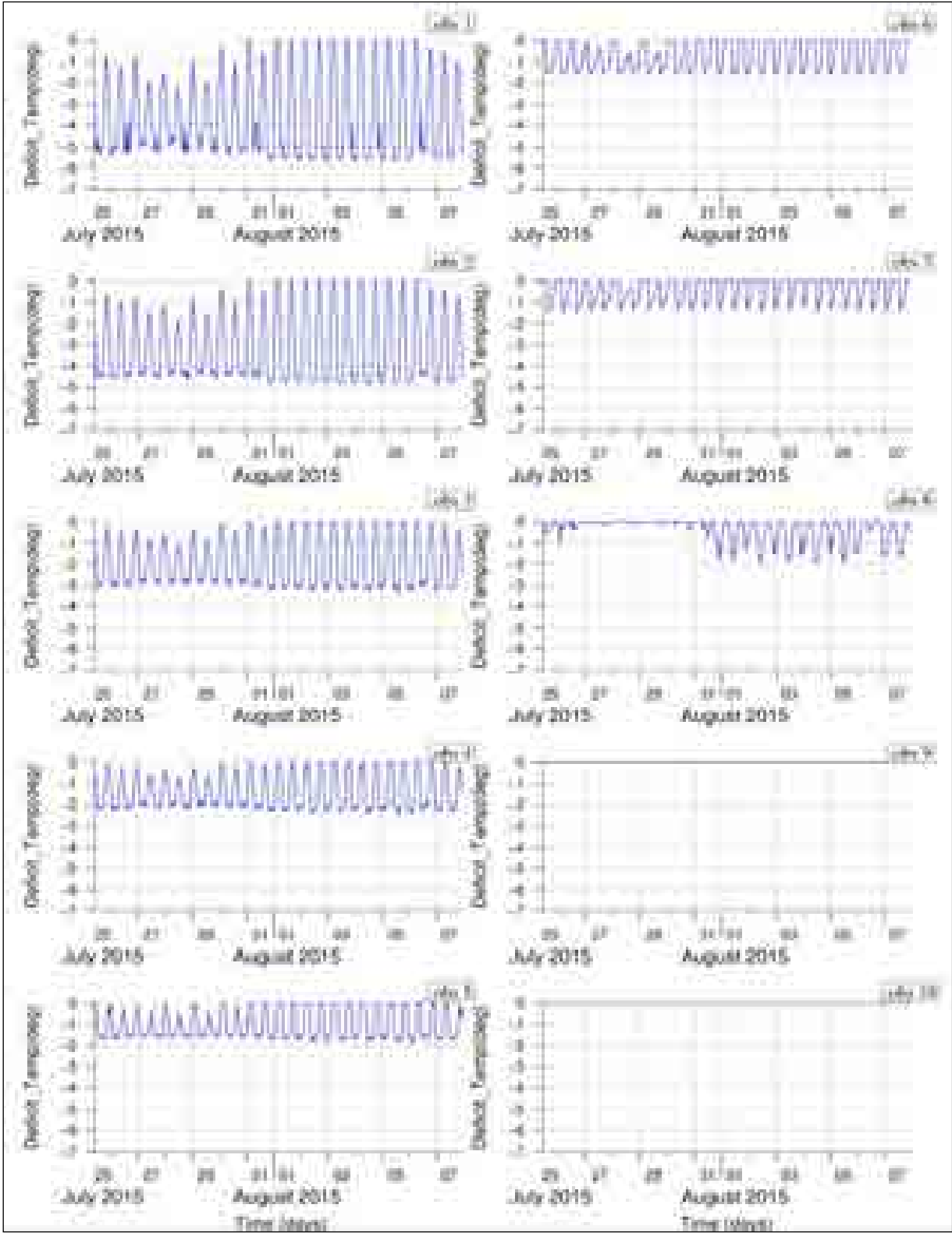


Figure 5-175: Variation of temperature at different Locations (Outfall Option - 3)

5.5 Biological Environment (Coastal and Marine Ecology)

5.5.1 Potential Impact due to Port Location

5.5.1.1 Impact on Mangrove Areas

Mangroves area in a identified location of 9.0 ha: Scattered mangroves are identified near the southern boundary of the port in Phase I development, these mangroves are scattered in an area of 9 ha. DPCL has excluded these mangroves from the port activity by fencing and implementing the conservation measures.

During construction activities of Revised Master plan there may be accidental illegal cutting of mangroves by contract labours and reduction of water exchange due to reclamation near mangroves. During operation fugitive dust emissions are envisaged due to cargo handling if proper mitigation measures are not implemented.

Mangroves on the northern side of project area: Minimum 50 m buffer has been provided near the Northern mangrove area and all the construction will be limited as per plan.

Utility Corridor is passing through a patch of sparse mangroves beyond the northern boundary of the project. It is estimated that about 0.1 ha area will come under the utility corridor. As per prevailing CRZ guidelines the corridor will be over piles without affecting tidal flow of water. Considering the mangrove footprint, 10 times or as finalised by regulatory authorities of mangrove plantation will be done.

In addition, there are threat to the the existing mangroves due to natural calamities such as cyclone and illegal cutting by locals.

Mangroves at Kanika island: Mangroves are existing at Kanika Island towards east of Dhamra Port. Impact on mangroves may be due to changes in hydrodynamics and fugitive dust emissions.

Mathematical Model studies shows that

- The currents are slightly reduced (0.2 m/sec) in the northern part of Dhamra Port and approach channel, Kanika Island. Flow regime changes for various tidal conditions in the study domain after the proposed expansion development of the Port are predicted to be not of much significance. Variation in the flow regime (in the current speeds) after the expansion is limited to the development location mostly and found to be very much local in nature. No change in the flow regime of the rest of the domain is observed
- The change in the bed levels due to the expansion development is not very significant and the change is limited to the basin, berth and approach channel only. The variation in the bed levels before and after development at the port basin location where the berths are located is of the order of 0.42 m over a period of six months & morphological changes around western side of Kanika island is in the order of 0.3 m over a period of six months
- Shoreline predictions suggest that Entire stretch of Kanika Island will experience accretion. Average Shoreline change movement for Kaknika island will be 4.0316 m/ year

5.5.1.2 Mitigation/Mangrove Conservation Measures

- Greenbelt will be developed along the port boundary which will act as an additional buffer and shelter belt for mangroves.

- Dust suppression measures, closed conveying system, wagon and truck loading silos etc., will also act as a buffer to prevent the likely fugitive emissions from dry bulk cargo storage areas and handling.
- Revised Master Plan ensures the Tidal exchange near the mangrove areas (both northern and southern side). Also the Northern Mangroves are partly protected from natural calamities with proposed reclamation.
- Proposed marine outfall for LNG/LPG/Desalination plant is sufficiently away from the Northern side mangrove area and separated by reclaimed land/backup area.
- Awareness will be given to workers in the port and locals about the importance of mangroves and their conservation.
- Discharge of wastes/waste water during construction and operation would not be allowed
- Illegal cutting of mangroves for firewood by workers during the construction and operation phases of port would be strictly prevented and awareness will be given to locals for illegal cutting and importance of mangroves
- Shoreline changes are suggested to monitor.
- Construction near mangrove areas shall be taken with due care.

5.5.1.3 Impact on Turtle Nesting at Gahirmatha Coast

Gahirmatha is a sandy coast in Rajanagar Tehsil, Kendrapara district, Odisha with an area that extends approximately 35-40 km stretch of the coastline from Maipura river mouth in the north up to Hansua river mouth in the south. The area comprises of wetland, backwater and brackish water regions. Gahirmatha coast is famed as one of the very few mass nesting sites of Olive Ridley Turtles in the world. It was authenticated by Chief Wildlife Warden, Government of Odisha that the ***“Dhamra port is located at a distance of 30 km away from nesting area by sea route and ~15 km as the crow flies”***.

Before commencement of Phase-I developmental activities, the members of the ***National Environmental Appellate Authority (NEAA)*** inspected the Dhamra port site and during the visit they did not find any mangrove or forest or breeding area of turtles in the area proposed for Dhamra Port. Further, NEAA declared that ***“the area between High Tide Line (HTL) & Low Tide Line (LTL) proposed for Dhamra Port being of clay soil and very sticky could never become a breeding centre for turtles”***.

Further, a desk study of nesting population is carried out.

Nesting Population:

The record of nesting population from 1976 to 2017 show that mass nesting did not occur at Gahirmatha during 1981-1982, 1987-1988, 1996-1997, 1997-1998, 2001-2002 and 2007-2008. This indicates that turtles do not visit every nesting beach every year.

Normal nesting of turtles occurred also during Phase I construction and Operation period. During the commencement of Phase II construction the turtle nesting in the year 2016-2017 was recorded the highest in last 16 years (6,03,962 Nesting Population). It shows that Construction and operation of Dhamra Port has no adverse impact on nesting at Gahirmatha.

5.5.1.4 Impact on Terrestrial Flora

The Project site is located in coastal area and do not have any significant vegetation/large well grown natural flora or any endangered species of flora except giria grass and natural scrub and shrubs. Baseline status of vegetation clearly suggests that the port site does not have any plant species of higher conservation significance. The proposed construction

activities will involve removal of grass and scrub areas. The dry grasslands, dominated by native species, are not locally or regionally significant. Impact due to dry bulk cargo dust such as coal dust emissions from stockyard and transport is envisaged during operation of the port.

5.5.1.5 Biodiversity Conservation and Management Plan

The main aim of Conservation of Biodiversity is to ensure "No Net Loss". The biodiversity-related Conventions are based on the premise that further loss of biodiversity is unacceptable. Biodiversity must be conserved to ensure it survives, continuing to provide services, values and benefits for current and future generations. The following approach has been chosen by the International Association of Impact Assessment (IAIA) to help achieve 'no net loss' of biodiversity:

- 1) Avoidance of irreversible loss of biodiversity.
- 2) Seeking alternative solutions to minimize biodiversity losses.
- 3) Use of mitigation to restore biodiversity resources.
- 4) Compensation for unavoidable loss by providing substitutes of at least similar biodiversity value.
- 5) Looking for opportunities for enhancement.
- 6) The DPCL undertakes to enforce and strictly adhere to the provisions of the following acts and legislations for conservation of biodiversity as applicable:
 - The Environment (Protection) Act (1986):
 - The Biological Diversity Act (2002)
 - Wild Life (Protection) Act (1972) Forest Conservation Act (1980)
 - Recognition of Forest Rights Act, (2006)

5.5.2 Potential Impact due to Construction

5.5.2.1 Impact due to Capital Dredging and Disposal

Capital Dredging will be carried out at proposed berthing facilities and extension of navigation channel which may cause disturbance to biological environment. Dredging removes bottom biota and dumping of dredged material covers bottom habitat. Piles, rubble mounds and concrete surfaces will form new habitat. The likely impacts on marine ecology are discussed in **Section 5.4.2.5**

5.5.2.2 Mitigation Measures during Dredging and Disposal

In addition to the mitigation measures followed in **Section 5.4.2.7**, the following will be adopted:

- Appropriate selection of equipment for dredging
- Uniform disposal of dredged material at identified disposal location

5.5.2.3 Impact on Ecology due to Reclamation

The port areas proposed to be reclaimed is majorly in the Sea /Submerged inter tidal area. These areas are going to be reclaimed with 110 MCM of dredged material. There will be loss of marine biodiversity due to reclamation.

5.5.2.4 Mitigation Measures during Reclamation

While reclaiming the existing area, bunds will be provided with a suitable overflow facilities so that only clear water will be returned to the harbour basin. Mangroves in the vicinity of the Port will be not be disturbed during reclamation.

Care shall be taken during reclamation near northern and southern side mangroves and reclamation bund shall be constructed to ensure that no impact on them. Construction of Northern rail link on trestle near northern side mangroves shall be taken with essential pre cautions.

5.5.2.5 Impact on Ecology during Construction Activities

The impacts caused due to construction activities include the following:

- Exhaust emissions from diesel run engines, construction machinery and vehicles
- Dust suspension during site preparation, construction, trenching and material transport
- Noise caused by vehicles transporting construction material
- Noise caused by handling of construction materials
- Noise & exhaust emissions from diesel run engines of construction machinery
- Interference to fishermen and fishing activities during seaside construction activities.

During construction the transport of construction material will cause dust emission, emission of exhaust gases from vehicles such as CO₂, CO and NO_x. The fugitive dust may coat the leaves of plants and trees. Fauna that occur in the study area may get disturbed with the sound of vehicles, construction and construction equipment.

5.5.2.6 Mitigation Measures

Spraying of water during handling of construction materials like sand and gravel will minimise dust emission. Properly maintained vehicles will produce reduced noxious emission. Temporary labour camps shall have proper sanitation facilities. The impacts caused by construction to fauna are temporary and not long term and most (if not all) of the observed and documented flora and fauna of the project area will adapt to these impacts.

5.5.3 Potential Impact due to Operation

5.5.3.1 Impact due to Aqueous Discharges and Mitigation Measures

During the operation phase there will be continuous movement of cargo vessels and port crafts round the clock. There is a possibility of aqueous discharges from the cargo vessels such as dumping of ship wastes (sullage) / sewage, bilge water, solid wastes, etc. if not regulated. The likely impacts and corresponding mitigation measures to be followed are discussed in **section 5.4.3.1** and **5.4.3.2** respectively.

5.5.3.2 Potential Impact due to Cargo Operations

Due to Cargo Spillage during Handling: Spills do not occur during normal operations, as the cargo will be handled by specialised ship-loaders/unloaders. In the event of accidental spills of cargo during transfer from / to the ships, the marine water quality, sediment quality and ecology in the harbour basin will be impacted.

5.5.3.3 Mitigation Measures

- Spill contingency plan as a part of Disaster Management Plan will be adopted in accordance to the cargo will be handled
- Spill recovery/immediate response measures will be displayed at cargo handling areas
- Material Safety data Sheet (MSDS) of cargo being handled will be displayed
- Mock drills will be conducted at periodic intervals

5.5.3.4 Impact due to Operational Activities

During Operation phase of the project as well as movement of vehicles may cause the fauna to flee because of the noise. Operational activities as well as the exhaust from DG sets will also result in the emission of exhaust gases such as CO, SO₂, NO_x and PM. In addition to the above; dust from the dry bulk cargo transported from the berths to stockyard through conveyors and transportation via road and rail may be respired by the fauna, if not handled properly. Dry bulk dust may be ingested by herbivorous species since the Particulate matter may coat the surface of vegetation. Dry Bulk cargo dust coating the leaf surfaces of vegetation results in blockage stomata (leaf pores responsible for gaseous exchange and water vapour exchange) and reduced photosynthetic performance.

5.5.3.5 Mitigation Measures

- Dry bulk cargo shall be transported through covered conveyors from berth to the stockyard and greenbelt and dust suppression measures will be provided at stockyard and while loading trucks and wagons
- Dry bulk cargo transporting wagons and trucks will be covered with tarpaulin covers.
- All vehicles for proposed cargo handling will confirm to Pollution Under Control (PUC) norms

5.5.3.6 Impact due to Lighting and Mitigation Measures

The glare of the port complex lighting system is likely to cause adverse impacts on the Nocturnal fauna and marine creatures. During the hatching of eggs laid by Olive Ridely turtle, the glare of light may destruct their movement to landward side causing desiccations and death. Considering this ecological issues, DPCL has adopted DARK SKY LIGHTING SYSTEM an exemplary activity for the coastal eco system.

This system of lighting doesn't allow the glares to outside and to the sky.

5.5.3.7 Mitigation Measures for Light Pollution

- All outdoor lighting, roadway lighting, wharf lighting, and lighting mounted on masts or other elevated structures will include no other luminaires except full cut-off luminaires. Full cut-off luminaires shall meet the (Illuminating Engineering Society of North America) IESNA classification for "full cut-off," which describes a luminary having a light distribution with zero candela intensity at or above an angle of 90° above nadir and with no more than 10% of candela intensity at or above a vertical angle of 80° above nadir. All full cut-off luminaires will be mounted horizontally so that the angle of 90° above nadir equals the Earth's horizon.
- All outdoor lighting, roadway lighting, wharf lighting, and lighting mounted on masts or other elevated structures will be of the minimum lamp wattage to achieve required safety within the lighted area.

- No area lighting or any lighting mounted on masts or other elevated structures will include fluorescent lamps, mercury vapour (MV) lamps, metal halide (MH) lamps, or other broad-spectrum high-intensity discharge lamp types.
- No lighting of grounds, building walls, signs, cranes, or other elevated structures will employ flood lighting, up-lighting, or other forms of directional lighting aimed above the horizon.
- Lighting of elevated walkways or conveyors will use luminaries that are <70 W HPS and shielded, so that candela intensity above an angle of 90° above nadir is 10% or less.
- Where ever possible, use full cutoff fixtures that specify shielding that keeps light at least 15° below the horizontal plane of fixture.
- Where ever possible, use low-pressure sodium vapour lamps or other light sources that exclude wavelengths less than 520 nm.

5.6 Air Environment

5.6.1 Potential Impact during Construction

5.6.1.1 Impact due to Transportation of Construction Material

Construction material may result into emissions during its transportation; therefore it shall be brought into covered condition.

The existing roads will be utilised for the transportation of raw materials for the construction during the Revised Master plan development and same is under widening by the state government. Transporting the construction material through sea/inland waterways route will also be explored during construction phase.

5.6.1.2 Emission during Construction at Site

During the construction activities, the sources of potential impacts on the air quality at the construction site can be categorised as:

- Exhaust emissions from diesel run engines, construction machinery and vehicles
- Dust suspension during site preparation, construction and material transport

Grading, soil compaction and reclamation will be involved as a part of site preparation before undertaking construction work. Area development will involve developing the internal road, utilities and services etc. Fugitive dust is expected particularly during dry weather conditions due to the site preparation and movement of transport vehicles for materials and personnel. Emissions from diesel power generators, construction equipment and transport vehicles will affect the air quality within the work areas, if not adequately managed. Movement of materials such as cement, steel, sand, etc. will cause disturbance to the adjoining communities/communities enroute.

The baseline concentrations of Particulate Matter (PM₁₀ and PM_{2.5}), SO₂, NO₂ and CO are within the limits of NAAQS stipulated by CPCB. With the present background concentrations of air quality parameters, it is expected that there will only be a mild build-up of air pollutants.

Further, because of the prevailing strong winds along the coastal region and the resulting dispersion the impact on air quality from pollutants would be reduced. The impacts during construction are short-term in nature and will cease on completion of the construction.

Further, adoption of suitable mitigation measures will ensure that these impacts are rendered insignificant.

5.6.1.3 Mitigation Measures

Construction Yard

- During planning, it will be attempted to prevent / minimise disturbance to adjacent properties / habitations. If unavoidable, same will be restored with consent from affected persons.
- Adequately sized construction yard will be provided at the site for storage of construction materials, equipment tools, earthmoving equipment, etc. In addition, temporary field offices and worker amenities will be provided. Appropriate spill control measures and labelling / handling procedures will be maintained.
- Construction sites will be provided with enclosures on all sides to prevent dispersion of dust and transmission of noise.
- Drainage system will be provided at construction yard. Measures will be taken to prevent silting of natural drainage due to runoff from construction areas.
- Proper area will be demarcated for storage of construction material. This will enable proper management of the materials including control of seepage and spillage thereby preventing contamination of the project area.

Movement of Machinery and Equipment

- Movement of material will be mostly during non-peak hours and regulated during peak hours. Mobile equipment such as intermittently used machines and transport vehicles will be either switched off or throttled down to a minimum.
- On-site vehicle speeds will be controlled to reduce excessive dust suspension in air and dispersion by traffic.
- Only PUC certified vehicles will be used for the transportation of material and equipments etc.
- Construction equipment and transport vehicles will be periodically washed to remove accumulated dirt.
- Vehicles transporting construction material susceptible for fugitive suspension will be covered with tarpaulin and will be prohibited from stopping near settlements.

Dust suppression

- Water sprinkling will be carried out to suppress fugitive dust during earthworks and along unpaved sections of access roads.

Environmental Awareness

- Environmental awareness program/training will be organised to the personnel involved in developmental works.

5.6.2 Potential Impact (Extreme) due to Operation Considering 30 Year Plan

The impact on air environment due to the operation of Dhamra port during the Revised Master Plan has been predicted based on air quality modelling studies. The AAQ model studies covered the following:

- Point sources ie., Emissions from Ships/Vessels during Berthing, Submerged Combustion Vaporizer (SCV) for LNG Regasification Units and Boiler for Steam Generation for LPG terminal

- Area Source i.e., Dry Bulk Cargo Storage (Coal/Iron Ore/Lime stones/Mines & Minerals and other Dry Bulk) Stockyards for Particulate Matter (PM)
- Line source i.e., increased vehicular activity due to normal and generated traffic on the road proposed in the dedicated corridor
- Volume Sources such as (Un)loading points at the berths, at trucks loading and train loading areas

As suggested in the ToR issued by MoEF&CC, in order to analyse the extreme impacts on the Air Environment due to the Revised Master Plan activities, the entire 30 year development Plan activities has been considered.

FSRU is planned as a part of the interim requirement for temporary handling of LNG, therefore, the emissions pertaining to FSRU such as emission due to captive power generation will likely to impact the air environment. However, onshore LNG terminal planned as a part of the Revised Master Plan development of Dhamra port considered emission from Submerged Combustion Vaporiser (SCV) as a continuous emissions for AQM Study. Considering the Seawater based Regasification for the proposed FSRU, no emissions are envisaged from SCV.

It is observed that the impact on air environment due to the emissions from FSRU on board power generation will be lesser (2 Generators 7530KW capacity emits NO₂ – 2.51 g/s each against SCV emission of 2.94 g/s NO₂) than the emissions considered due to SCV emission. The PM₁₀ emissions from the proposed LNG FSRU onboard Power generation units are not significant as Natural Gas will be used as a fuel and hence the impact on Air Environment due to this FSRU (interim activity) is insignificant.

Similarly FSO is planned as a part of the interim requirement for temporary handling of LPG, therefore, the emissions pertaining to FSO such as heating of LPG (Propane and Butane) in the FSO by using onboard heat exchanger will likely to impact the air environment. However, onshore LPG terminal planned as a part of the Revised Master Plan development of Dhamra port considered the emission from HSD based Boiler as a continuous emission for AQM study. Hence, the same will take care of the emission from the onboard heat exchanger and no additional emissions are envisaged.

5.6.2.1 Sources of Emission Considered for Air Quality Modelling

Following sources of emission are identified as a part of proposed development of Revised Master Plan of Dhamra port and considered in the air quality modelling study.

A. Point Sources

1. Emissions from Ships/Vessels visiting the Dhamra Port

During the operational phase, there will be an increase in the vessel traffic and hence, emissions from the vessels will also increase. The exhaust from tugs, launches, diesel operated small boats, dredgers etc. will add to pollution load during operational phase. With the increase in the number of ships and boats, their operation and movement of cargo to and from will also increase. These activities will increase the pollution load in the atmosphere.

Number of ships/vessels visiting the Dhamra Port facility for 30 Year revised Master Plan has been arrived based on the cargo handling rate and berth occupancy. Number of vessels expected to be berthed continuously are around Fifteen to Sixteen (15 to 16) ships per day.

Apart from a very few exceptions where power cables from land/offshore sources are connected and used on board vessels in port (Cold ironing), ships are self-sufficient

regarding energy supply. Potential sources of emissions of vessels are from the Main Engine (ME) and Auxiliary Engines (AE) and others such as boilers, emergency diesel engines and waste incinerators and emissions from are relatively very small and can be considered negligible.

MEs will be used primarily for ship propulsion. Normally MEs are shut down in port. AE will be used for Electric power generation on board for lighting, ventilation, cranes, pumps etc. Normally shut down at sea when a shaft generator on the MEs is used. The pollutants emitted as a result of a vessel's in-port operations have been identified as a threat to the air quality.

During the berthing time, the main engine of the ships will be turned off and the Auxiliary engines will be turned on to meet the auxiliary power requirement. It is assumed that the auxiliary engines will be running continuously during berthing. The vessel auxiliary engine power is assumed based on the type of cargo handled at the berth and details of the same along with emissions factors considered are given in **Table 5-23**.

Table 5-23: Details of Vessel Auxiliary Engine and Emission Factors

S. No.	Cargo	Auxiliary Engine Capacity (KW)	Emission Factor (g/kwh)		
			PM	SO ₂	NO _x
1.	LNG/LPG/Cryogenic	960	2.0	12.1	7.4
2.	POL	960	2.2	11.5	12.0
3.	Container	1200	1.2	5.2	13.2
4.	Liquid	1200	2.2	10.7	13.2
5.	Multipurpose	1200	1.2	5.2	12.8
6.	Bulk Cargo	1500	1.2	5.2	13.4

2. Emission from LNG Terminal Regasification Unit

LNG will be vaporized in shell and tube type vaporizer (STV) with LNG on the tube side and an ethylene glycol water mixture on the shell side. Then the eco-friendly technologies such as either Sea water or Ambient Air will be used to reheat the ethylene glycol or may be used directly to heat the LNG also. Hence there is no emission expected from the regasification process. However, for back up purpose, submerged combustion vaporiser (SCV) is proposed during winter (2 Nos can handle upto 10MMTPA). Roughly 90 days of working has been considered for calculating emissions from SCV. As SCV will be using Natural gas as a fuel, exhaust emission mainly consist of Nitrogen oxides (NO_x) and Carbon Monoxide along with insignificant quantities of Particulate Matter. Emissions from SCV are considered as continuous emission and other utilities are electric driven.

3. Emission from Boiler for Steam Generation for LPG Terminal

In the LPG terminal, propane and butane are heated in separate heating trains to 15°C in two steps. First preheating of refrigerated propane liquid at -44.4°C is performed in Propane Heater and preheating of refrigerated Butane at -4.4°C is done in Butane Heater by condensing hot propane vapors at 37°C to avoid freezing problems by direct heating with steam. Second the propane used for heating Propane and Butane is vaporized in a kettle type Propane Vaporizer by condensing steam. The steam condensate is used to heat the Propane and Butane/Propylene to 15°C in Propane Heater and Butane Heater respectively.

Steam is generated in the facility using 20 MT/hr HSD fired boiler (1 No. can handle upto 5.75 MMTPA). The generated LP steam is used to heat propane and butane before sending them to blending section. The steam condensate is collected and taken to condensate storage tank for further processing. The emissions from the boiler were estimated based on the typical fuel consumption for 20 MT/hr HSD based boiler and HSD characteristics.

The emission details for the point sources in the study region are given in **Table 5-24**.

Table 5-24: Point Sources Emission Details

Stack Details					Emissions (g/sec)			
Stack Code	Stack Height (m)	Stack Velocity (m/sec)	Stack Dia (m)	Exit Temp (K)	PM ₁₀	PM _{2.5}	SO ₂	NO ₂
1	Stacks of Auxillary Engine of Vessels during Berthing							
P1	18	25	0.8	593	0.40	0.16	1.73	4.40
P2	18	25	0.8	593	0.40	0.16	1.73	4.40
P3	18	25	0.8	593	0.40	0.16	1.73	4.40
P4	18	25	0.8	593	0.50	0.20	2.17	5.58
P5	18	25	0.8	593	0.50	0.20	2.17	5.58
P6	18	25	0.8	593	0.50	0.20	2.17	5.58
P7	18	25	0.8	593	0.50	0.20	2.17	5.58
P8	18	25	0.8	593	0.73	0.29	3.57	4.40
P9	18	25	0.8	593	0.59	0.23	3.07	3.20
P10	18	25	0.8	593	0.53	0.21	3.23	1.97
P11	18	25	0.8	593	0.40	0.16	1.73	4.27
P12	18	25	0.8	593	0.40	0.16	1.73	4.27
P13	18	25	0.8	593	0.40	0.16	1.73	4.27
P14	18	25	0.8	593	0.40	0.16	1.73	4.27
P15	18	25	0.8	593	0.40	0.16	1.73	4.27
P16	18	25	0.8	593	0.40	0.16	1.73	4.27
2	Submerged Combustion Vaporiser Stacks							
LNG1	30	7.73	1.4	360	-	-	-	2.94
LNG2	30	7.73	1.4	360	-	-	-	2.94
3	Boiler Stack for Steam Generation for LPG Terminal							
LPG1	38	22	0.4	588	0.34	0.13	7.64	5.20

B. Area Sources (Dry Bulk Cargo such as Coal/ and Iron Ore/Lime stones/Mines & Minerals and other Dry Bulk Stockyards)

The Dry Bulk cargo such as Iron Ore/Lime stones/Mines & Minerals, other Dry Bulk and coal to be imported or exported will be stored at their respective stockyards. The proposed storage is likely to generate fugitive dust emissions due to wind.

Due to the fugitive dust emission from the stockpile, the dust particles will be carried by the wind and causes pollution. This would pollute other clean areas of the port. The Dry Bulk Cargo dust particles carried by the wind likely to cause dust emission in the neighbouring villages also.

The dry bulk cargo (represented in terms of coal and iron ore) handling system in the form of covered conveyer system and transfer points for the transportation from the berths to the stockyard proposed to be provided.

Coal is susceptible to spontaneous combustion, most commonly due to oxidation of pyrite or other sulphidic contaminants in coal. Coal reacts with atmospheric oxygen even at ambient temperatures and this reaction is exothermic. If the heat liberated during the process is allowed to accumulate, the rate of the above reaction increases exponentially and there is a further rise in temperature. When this temperature reaches the ignition temperature of coal, the coal starts to burn and the phenomena is described as spontaneous combustion.

The spontaneous combustion of the coal as shown **Exhibit 5-1** would take place due to the voids in the pile and free flow of air. Initiation of spontaneous combustion is through development of hot spots in the coal stockpiles. This results in degradation of the coal. Wind and moisture in the coal play a major role in the spontaneous combustion of the coal. Wind supplies more oxygen for combustion. When the coal absorbs moisture, heat is generated.

This heat increases the temperature of the coal. During the spontaneous combustion of coal, some gases would be produced. This gas is also carried by the wind and causes pollution in the surrounding environment.



Exhibit 5-1: Spontaneous Combustion of Coal

The significant factors to be considered for prevention of this development are as follows:

- Ventilation
- Coal Quality: low carbon content and large amounts of volatile components support combustion
- Particle Size: the smaller the particles, the larger the surface, the higher the risk
- Stockpile Design
- Humidity
- Frequent spraying of water at coal stockyard

Coal dust is prone to ignition depending on its concentration in air and presence of ignition sources. Coal dust therefore represents a significant explosion hazard in coal storage and handling facilities where coal dust clouds may be generated in enclosed spaces. The significant factors which contribute to the dust explosion are:

- Concentration of dust in suspension
- Sufficient oxygen to enable combustion
- Source of energy for ignition
- A certain degree of confinement of the suspended dust mixed with oxygen

Coal dust poses a possibility of reduced lung function. Workers exposed to coal dust may develop lung damage and pulmonary fibrosis. The occupational exposure standard (OES) for coal dust is 2 mg/m³ of respirable dust (Exposure limit eight-hour TWA). OES is the level of dust at which there is no evidence of injury to people exposed day after day.

Wet suppression has proved to be the most effective means for controlling fugitive dust emissions and spontaneous combustion from stockpiles. Moisture is added to capture the dust particles that are already airborne. It is basically designed to prevent lift off of dust from stockpile and road area. The nature and particle size of dust generated in the material

handling system changes with change in size and characteristic of the material. In practice, the size of the dust particles has a very wide spectrum. A careful control of Air and Water Flow & Pressure is therefore necessary to obtain optimum dust suppression results. For this purpose, pressure regulators are provided in the system. Water is sprayed in at regular intervals depending on the site condition. The dust control is achieved by the agglomeration of dust particles with finely atomized water droplets equal to / close to / larger than the dust particles as the case may be, the collision between the water droplets and dust particles plays an important role in the process of agglomeration and heavier mass thus formed settles down to the source. Plain water dust suppression has been considered for top of Mobile hopper & Truck receipt area discharge chute. The system has been designed to control dust nuisance of the working environment during un-loading of coal from Grab & at the peripheral location of discharge chute of belt feeder towards truck receipt.

The fugitive emission from the Dry bulk cargo storage areas represented in terms of coal and iron ore stockyards and handling area are worked out considering the proposed air pollution control measures such as dust suppression measures and greenbelt etc.,. Since the fugitive emissions from the existing stockyards are considered in the baseline monitoring, the same is not considered as a part of air quality modelling for the proposed expansion.

The details of Dry bulk cargo storage areas represented in terms of coal and iron ore handling and likely emission from storage area are given in **Table 5-25**.

Table 5-25: Area Sources Emission Details

S. No	Details of Emission	Stockyard represented in terms of	
		Coal	Iron Ore
1	Total Dry Bulk Cargo (MMTPA)	134 ³⁶	
2	Silt Content (%)	3	5
3	Storage Duration (Days)	365	365
4	Stockpile Area (m ²)	1673511	248850
6	Emission due to Wind Erosion from Stockyard (g/s/m ²) without control	1.68E-06	2.81E-06
8	Total Emissions with control (g/s-m ²) (80% of total emissions)	3.37E-07	5.62E-07
9	PM ₁₀ Emissions after Incorporating the Control Measures (g/s-m ²)	2.02E-07	3.37E-07
10	PM _{2.5} (g/s-m ²)	8.09E-08	1.34E-07

C. Line Sources

The cargo volume to be handled for Revised Dhamra Port as per the traffic projections will be around 314 MMTPA for 30 years development plan. 30 Years development plan is assumed to be fully operational by 2048.

Therefore the increased vehicular traffic estimated for the year 2048 has been considered for Air Quality Modelling. It is proposed that part of the cargo will be transported through road proposed in the dedicated road/rail/utility corridor and part will be transported by rail. As the rail lines will be electrified, no emission is envisaged from the rail line proposed. Hence, only emission from road traffic is considered as a line source of emission.

The number of vehicle per day i.e. Heavy Vehicles and Light Commercial vehicles on the proposed road comprises of two components i.e. Normal Traffic Projection due to the developments in the region which will be diverted on the proposed road and Generated Traffic due to Dhamra port Revised Master Plan development (as per 30 Year development plan). The emission factors for heavy and light vehicles are taken from the report published by CPCB. Since the development is for 30 Years Master Plan, hence EURO VI emission

³⁶Total Dry Bulk Cargo handling expected in the 30 Year Plan is around 159 MMTPA including existing 25 MMTPA

factors are assumed to be implemented and are considered for calculating the vehicular exhaust emissions.

As per traffic Projections, the number of vehicle (both Light and Heavy) on proposed road has been considered for air quality modelling. The details of the emissions from the heavy and light vehicles are given in **Table 5-26**.

Table 5-26: Line Source Emission Details³⁷

Parameter	Proposed Road in the Dedicated Corridor	
	Heavy Vehicle	Light Vehicle
Vehicle per Day	14963 nos.	2686 nos.
Emission factor of SO ₂ (g/km)	0.14	0.09
Emission rate of SO ₂ (g/s)	0.3636	0.0419
Emission factor of PM (g/km)	0.03	0.0008
Emission rate of PM ₁₀ (g/s)	0.0467	0.00022
Emission rate of PM _{2.5} (g/s)	0.0187	0.000089
Emission factor of NO _x (g/km)	0.6887	0.0454
Emission rate of NO _x (g/s)	1.7890	0.0211

As these emissions are assumed as continuous in nature and this line source is considered as a string of volume sources for Air Quality modelling for prediction of impacts.

The map showing the road network proposed to be used by Dhamra Port during revised Master Plan cargo handling and the enroute habitation is given in **Figure 5-176**.

³⁷ All the emission factors(g/km) were taken from the National Summary Report-“Air quality monitoring, emission inventory and source apportionment study for Indian cities” developed by Central Pollution Control Board based on detailed study reports prepared by NEERI, TERI, ARA, IITK, IITM.



Figure 5-176: Road Network for Cargo Transport

D. Volume Sources

1. Bulk Cargo Unloading Points at Berths

Unloading points at the bulk cargo berths which are likely to generate fugitive dust emissions are considered for Air Quality modelling. Covered and mechanized unloading points with dust suppression system to be provided which will reduce the fugitive emissions to the minimum. Fixed cone nozzles will be placed at receiving hoppers. Since the fugitive emissions from the loading points of existing berths are considered in the baseline monitoring, the same is not considered as a part of air quality modelling for the proposed expansion. The details of the emissions from the proposed transfer points are given in **Table 5-27: Emission Details due to Unloading Points at Berths.**

Table 5-27: Emission Details due to Unloading Points at Berths

S. No	Details of Emission	Unloading at Bulk Berths
1	Total Dry Bulk Cargo (MMTPA)	134
2	Number of Unloading Points	8
3	Unloading Emission Factor (kg/t)	0.0017
4	Total Emission due to unloading points (kg/year)	227800
5	PM ₁₀ Emission due to single unloading point (g/s) Without Control	0.9029
6	PM ₁₀ (70% Control with closed unloading including water sprinkling) With Control	0.2708
7	PM _{2.5} With Control	0.1083

2. Bulk Cargo Loading Points to Train/Truck

Wagon loader for train loading and silos arrangement for truck loading proposed to be provided. Loading points are likely to generate fugitive dust emissions. The covered and

mechanized unloading points with dust suppression system are provided which will reduce the fugitive emissions to the minimum. Fixed cone nozzles will be installed, at regular intervals, at discharge point of shuttle conveyor on Rapid loading System. Since the fugitive emissions from the existing loading points are considered in the baseline monitoring, the same is not considered as a part of air quality modelling for the proposed expansion. The details of the emissions from the proposed transfer points are given in **Table 5-28: Emission Details due to Train/Truck Loading Points**. The wagon loading and silo truck loading systems are shown in **Exhibit 5-2** and **Exhibit 5-3**.

**Exhibit 5-2: Wagon Loading System****Exhibit 5-3: Truck Loading System****Table 5-28: Emission Details due to Train/Truck Loading Points**

S. No	Details of Emission	Details of Loading Points
1	Total Dry Bulk Cargo (MMTPA)	134
2	Number of Train (Un)loading Points	20
	Number of Truck (Un)loading Points	5
3	Loading Emission Factor (kg/t)	0.00017
4	Emission due to single (Un)loading for Train (kg/year)	797
	Emission due to single loading for Truck (kg/year)	1367
5	PM ₁₀ Emission due to single train (Un)loading points (g/s) Without Control	0.0252
	PM ₁₀ Emission due to single truck loading points (g/s) Without Control	0.0433
6	PM ₁₀ (70% Control with closed loading including water sprinkling) With Control for train	0.0075
7	PM _{2.5} With Control for train	0.0030
	PM ₁₀ (70% Control with closed loading including water sprinkling) With Control for truck	0.0130
	PM _{2.5} With Control for truck	0.0052

As these emissions are continuous in nature, these are considered for Air Quality modelling for prediction of impacts.

Dust Control System at the receipt and discharge points works on the principle of agglomeration. Dust particles released from a material handling plant which become air borne, are made to pass through a blanket of extremely fine dry fog. Plain water is mixed with compressed air in a ratio through our highly efficient acoustic nozzles which produces millions of minuscule water droplets which when kept entrapped within an enclosure in a dust generating transfer point, can efficiently contain and control even fine dust particle.

Each application point shall be provided with requisite number of Dual-fluid Dry Fog Acoustic oscillating type Nozzles. Flow Control Box is provided for a group of nozzles to regulate the pressure of compressed air and water as per requirement. Maximum moisture addition is within 0.1 %.

E. Other Emissions

Other emissions include fugitive emissions from liquid cargo handling and transfer operations, emissions from emergency DG set and LNG and LPG flares etc. Fugitive emission can be controlled by selecting suitable equipments, appropriate handling methods etc., and hence no emissions from these sources were considered.

As all the above emissions are expected only during emergency situation, they were not considered in the air quality modelling study.

5.6.2.2 AERMOD Model

AERMOD is a 'near-field, steady-state' Gaussian model. It uses boundary-layer similarity theory to define turbulence and dispersion coefficients as a continuum, rather than as a discrete set of stability classes. Variation of turbulence with height allows a better treatment of dispersion from different release heights. AERMOD requires Surface as well as Upper Air data as meteorological input.

5.6.2.2.1 Model Assumptions

The following are the assumptions for the air quality modelling;

- Uses rural dispersion
- Stack-tip downwash
- Model assumes receptor on flat terrain
- Used calms processing routine
- Used missing data processing routine
- No exponential decay
- No Dry and Wet Depletion

5.6.2.2.2 Input Data

The following technical details of Dhamra Port are considered for Air Quality Modelling studies:

- Point Source: The Point source inputs are given in **Table 5-24**.
- Area Source: The area source inputs (Emissions from Dry Bulk Cargo Stockyard) are given in **Table 5-25**
- Line Source: The Line source inputs (Vehicular Emissions) are given in **Table 5-26**
- Volume Source: The volume source inputs (unloading of Dry Bulk Cargo at berths and loading of Dry Bulk Cargo to train and trucks) are given in **Table 5-27** to **Table 5-28**

5.6.2.2.3 Meteorological Data Considered

For the purpose of carrying out the air quality modelling study, site specific meteorological data (pre-processed from MM5) for the complete year of 2015 (January to December) obtained from Lakes Environment, Canada was used. The raw met data have been processed in AERMET view to create surface and upper air data which can be used as inputs to AERMOD.

Wind Speed and Wind Direction

The wind roses were drawn for the met files obtained on a sixteen-point compass (N, NNE, NE, ENE; E, ESE, SE, SSE; S, SSW, SW, WSW; W, WNW, NW, and NNW). Wind pattern representing 24 hours for the entire year of 2015 is discussed. The frequency occurrence of wind at various speeds was calculated on the basis of total number of observations recorded in the respective wind speed category. The overall wind pattern recorded for 24 hours during the year 2015 is given in **Figure 5-177**. The predominant wind directions observed were from South South West followed by South West; calm conditions prevailed for 3.50% of the total time. The average wind speed was observed to be 3.24 m/s.

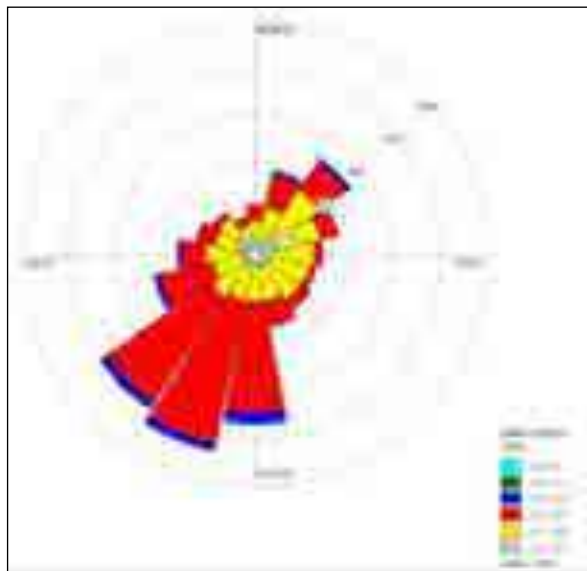


Figure 5-177: Annual Wind Rose

5.6.2.3 Receptors

The details of the receptors which are monitored for the baseline data as a part of CEIA Study and other Sensitive Receptors within 15.0 km radius of the boundary of the Revised Master Plan are given in **Table 5-29**. Also, to fulfil the requirement of the ToR point “**Ambient Air Quality assessment in areas within 100 meters of ore handling areas (inclusive of coal) shall be undertaken along with its impact on people authorized to enter in handling areas (inclusive of coal)**”, two receptor location has been considered which is being monitored by DPCL as a part of compliance monitoring of EC for phase 1 development.

Table 5-29: Receptors for Air Quality Modelling

Location No.	Receptors	Distance (km)	Azimuth Directions
I	Ambient Air Quality Monitoring Locations		
A1	Port Site	0.9	SW
A2	Bali Sahi	2.4	WNW
A3	Sabitri Sarai	3.1	SSW
A4	Kanakprasad	3.5	NW
A5	Narsinghprasad	3.8	W
A6	Kishorprasad	5.4	NW
A7	Dakshina Dhamra	7.4	SW
A8	Talchua	8.1	SSW
A9	Narendrapur	9.7	NW
II	Other Sensitive Receptors in the Study Area Considered for AQM		

Location No.	Receptors	Distance (km)	Azimuth Directions
A10	Kanika Island	2.4	E
A11	Mangroves Patch (Northern Side Boundary)	6.2	N
A12	Ghahirmata Beach	15.3	SE
A13	Bhitra Kanika Wild Life Sanctuary	16.5	SW
A14	Mangrove Patch Near Shailendrapur	10	SSE
A15	Kalibhanj Dian PF	6.6	SW
A16	Wheeler Island	13.9	SE
A17	MCC-1 (Near Switchyard) (within 100 m of dry bulk cargo handling areas)	0.95	S
A18	MCC-2 (Existing Stockyard Area) (within 100 m of dry bulk cargo handling areas)	0.16	N

Note: Distances and Directions have been taken from the centre of the Coal Stockyard (Existing)

5.6.2.4 Model Results

The 1st highest 24 hour and annual average incremental and the resultant concentration for PM₁₀, PM_{2.5}, SO₂ and NO₂ for AAQ monitoring locations are given in **Table 5-30** to **Table 5-33**.

Table 5-30: 1st 24-hour Average and Annual Average Incremental and Resultant Concentration of PM₁₀

Location No.	Receptors	1 st 24 Hour Average Incremental Concentration (µg/m³)	Annual Average Incremental Concentration (µg/m³)	Baseline Concentration(µg/m³)	Resultant Concentration (µg/m³)		NAAQ Standards (µg/m³)	
					1 st 24 Hour	Annual Average	24 hour	Annual
		PM ₁₀						
A1	Port Site	11.06	1.29	63.44	74.50	64.73	100	60
A2	Bali Sahi	6.35	0.94	38.90	45.25	39.84		
A3	Sabitri Sarai	10.37	0.70	40.50	50.87	41.20		
A4	Kanakprasad	8.19	0.99	42.10	50.29	43.09		
A5	Narsinghprasad	7.29	0.72	39.70	46.99	40.42		
A6	Kishorprasad	8.51	0.82	40.30	48.81	41.12		
A7	Dakshina Dhamra	5.47	0.44	50.80	56.27	51.24		
A8	Talchua	7.02	0.32	38.20	45.22	38.52		
A9	Narendrapur	6.24	0.59	36.80	43.04	37.39		

Table 5-31: 1st 24-hour Average and Annual Average Incremental and Resultant Concentration of PM_{2.5}

Location No.	Receptors	1 st 24 Hour Average Incremental Concentration (µg/m³)	Annual Average Incremental Concentration (µg/m³)	Baseline Concentration (µg/m³)	Resultant Concentration (µg/m³)		NAAQ Standards (µg/m³)	
					1 st 24 Hour	Annual	24 hour	Annual
		PM _{2.5}						
A1	Port Site	4.42	0.52	36.81	41.23	37.33	60	40
A2	Bali Sahi	2.54	0.38	18.20	20.74	18.58		
A3	Sabitri Sarai	4.15	0.28	18.90	23.05	19.18		
A4	Kanakprasad	3.28	0.39	19.70	22.98	20.09		
A5	Narsinghprasad	2.92	0.29	18.60	21.52	18.89		
A6	Kishorprasad	3.40	0.33	19.20	22.60	19.53		
A7	Dakshina	2.19	0.18	23.70	25.89	23.88		

Location No.	Receptors	1 st 24 Hour Average Incremental Concentration (µg/m³)	Annual Average Incremental Concentration (µg/m³)	Baseline Concentration (µg/m³)	Resultant Concentration (µg/m³)		NAAQ Standards (µg/m³)	
					1 st 24 Hour	Annual	24 hour	Annual
		PM _{2.5}						
	Dhamra							
A8	Talchua	2.81	0.13	19.30	22.11	19.43		
A9	Narendrapur	2.49	0.24	18.40	20.89	18.64		

Table 5-32: 1st 24-hour Average and Annual Average Incremental and Resultant Concentration of SO₂

Location No.	Receptors	1 st 24 Hour Average Incremental Concentration (µg/m³)	Annual Average Incremental Concentration (µg/m³)	Baseline Concentration (µg/m³)	Resultant Concentration (µg/m³)		NAAQ Standards (µg/m³)	
					1 st 24 Hour	Annual	24 hour	Annual
		SO ₂						
A1	Port Site	6.39	1.38	6.70	13.09	8.08	80	50
A2	Bali Sahi	2.91	0.69	5.70	8.61	6.39		
A3	Sabitri Sarai	4.80	0.81	4.80	9.60	5.61		
A4	Kanakprasad	1.92	0.44	4.80	6.72	5.24		
A5	Narsinghprasad	5.34	0.92	4.80	10.14	5.72		
A6	Kishorprasad	1.86	0.34	4.80	6.66	5.14		
A7	Dakshina Dhamra	3.04	0.31	5.00	8.04	5.31		20
A8	Talchua	4.32	0.36	4.60	8.92	4.96		
A9	Narendrapur	1.30	0.20	4.60	5.90	4.80		

Table 5-33: 1st 24-hour Average and Annual Average Incremental and Resultant Concentration of NO₂

Location No.	Receptors	1 st 24 Hour Average Incremental Concentration (µg/m³)	Annual Average Incremental Concentration (µg/m³)	Baseline Concentration (µg/m³)	Resultant Concentration (µg/m³)		NAAQ Standards (µg/m³)	
					1 st 24 Hour	Annual	24 hour	Annual
		NO ₂						
A1	Port Site	18.67	3.29	23.60	42.27	26.89	80	40
A2	Bali Sahi	10.05	2.12	12.20	22.25	14.32		
A3	Sabitri Sarai	10.90	1.86	11.70	22.60	13.56		
A4	Kanakprasad	6.13	1.32	12.40	18.53	13.72		
A5	Narsinghprasad	22.28	3.36	11.70	33.98	15.06		
A6	Kishorprasad	6.13	1.08	11.60	17.73	12.68		
A7	Dakshina Dhamra	5.67	0.90	12.50	18.17	13.40		30
A8	Talchua	7.87	0.80	11.30	19.17	12.10		
A9	Narendrapur	3.57	0.64	10.70	14.27	11.34		

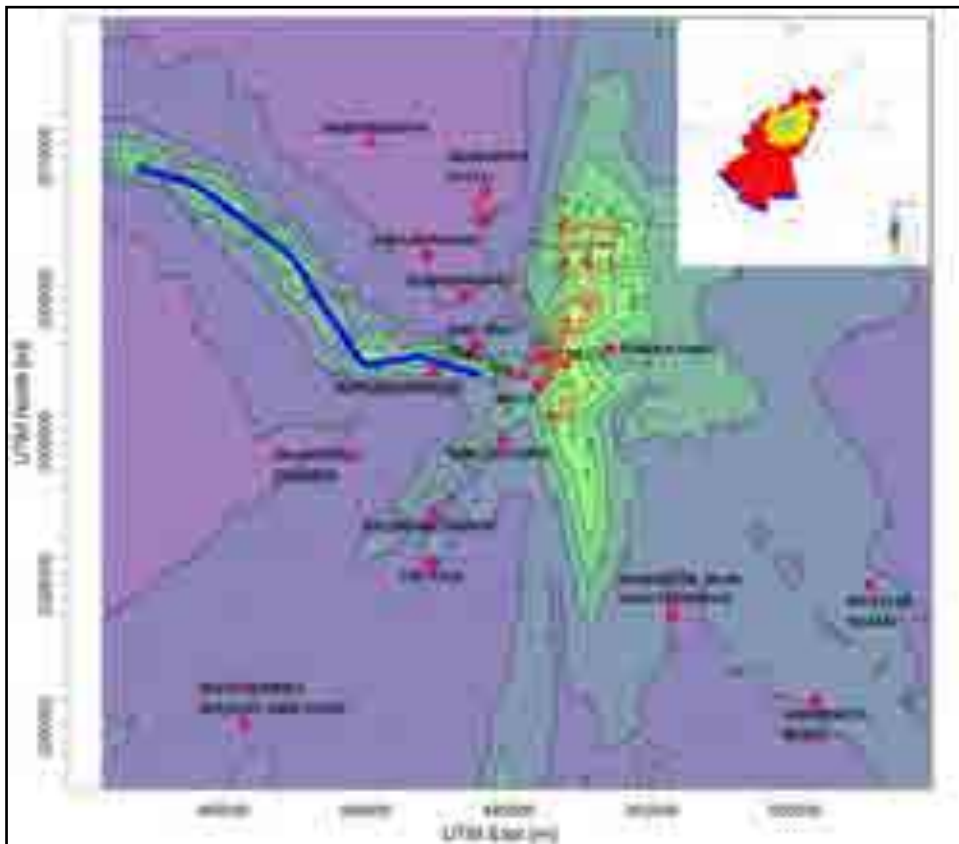
The 1st highest 24 hour and annual average incremental concentrations for PM₁₀, PM_{2.5}, SO₂ and NO₂ for the sensitive receptors in the vicinity of the project site and the receptor monitoring as a part of compliance monitoring are given in **Table 5-34**.

Table 5-34: 1st 24-hour Average and Annual Average Incremental Concentration of Sensitive Receptors

Location No.	Receptors	1 st 24 Hour Average Incremental Concentration ($\mu\text{g}/\text{m}^3$)				Annual Average Incremental Concentration ($\mu\text{g}/\text{m}^3$)			
		PM ₁₀	PM _{2.5}	SO ₂	NO ₂	PM ₁₀	PM _{2.5}	SO ₂	NO ₂
A10	Kanika Island	12.52	5.01	8.64	21.66	2.22	0.89	2.11	4.10
A11	Mangroves Patch (Northern Side Boundary)	6.49	2.59	1.25	4.62	1.25	0.50	0.23	0.61
A12	Ghahirmata Beach	2.49	1.00	3.94	8.84	0.18	0.07	0.24	0.51
A13	Bhitra Kanika Wild Life Sanctuary	4.02	1.61	2.42	4.99	0.20	0.08	0.20	0.47
A14	Mangrove Patch Near Shailendrapur	2.24	0.90	3.82	7.16	0.21	0.09	0.32	0.70
A15	Kalibhanj Dian PF	7.59	3.04	3.40	8.42	0.42	0.17	0.39	0.92
A16	Wheeler Island	3.74	1.49	4.26	7.54	0.28	0.11	0.30	0.62
A17	MCC-1 (Near Switchyard)	14.82	5.93	8.23	22.76	1.52	0.61	2.05	4.83
A18	MCC-3 (Existing Stockyard Area)	10.42	4.17	8.53	25.51	2.25	0.90	2.65	6.27

5.6.2.5 Isopleths

The Isopleths for 1st incremental 24-hour Average Concentration of all the parameters are shown in **Figure 5-178 to Figure 5-181**.

**Figure 5-178: Isopleth for 1st 24-Hr Average Incremental Concentration of SO₂**

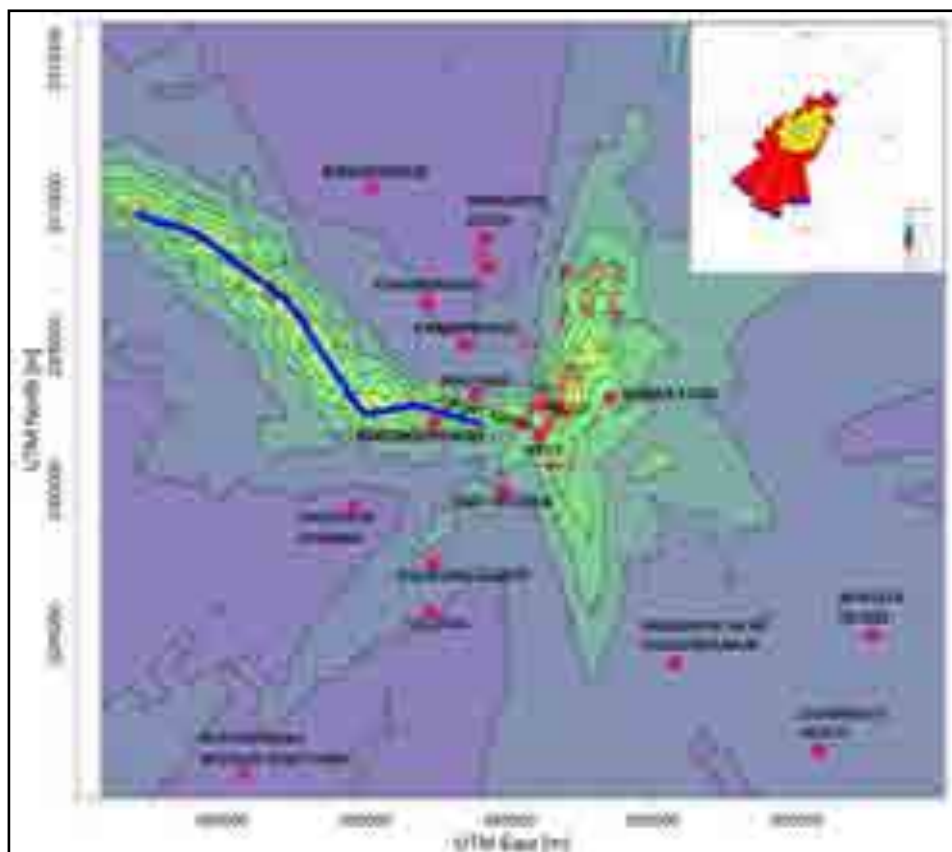


Figure 5-179: Isopleth for 1st 24-Hr Average Incremental Concentration of NO₂

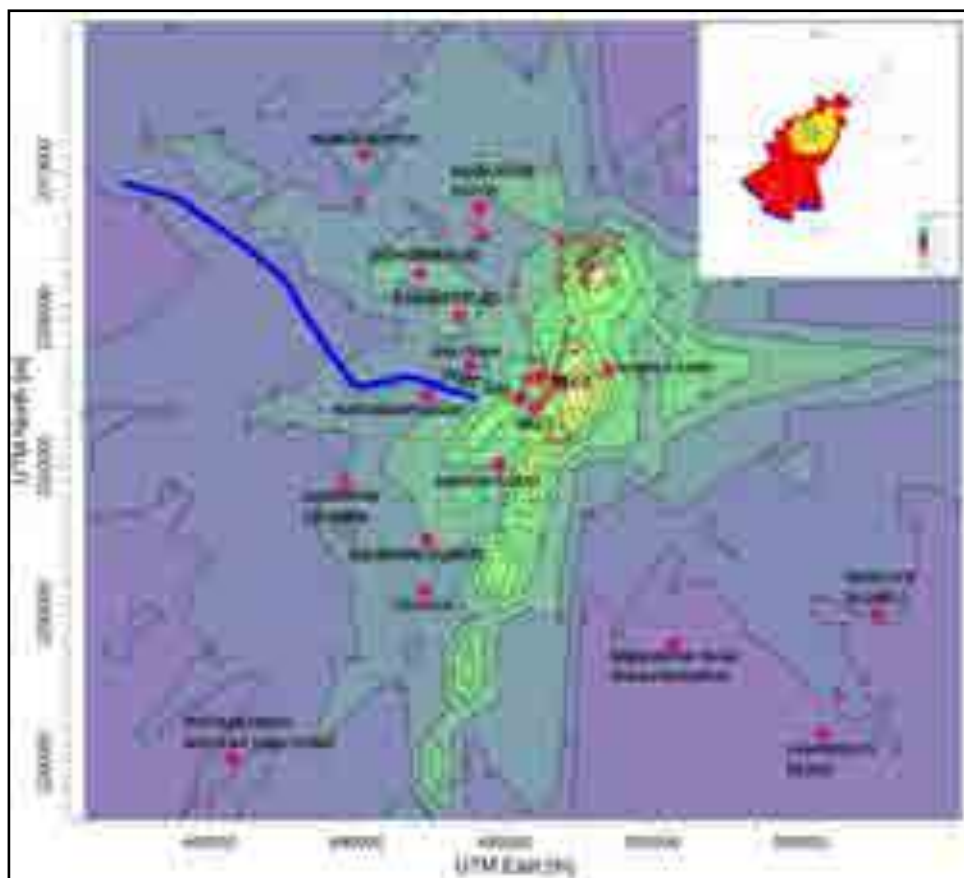


Figure 5-180: Isopleth for 1st 24-Hr Average Incremental Concentration of PM₁₀

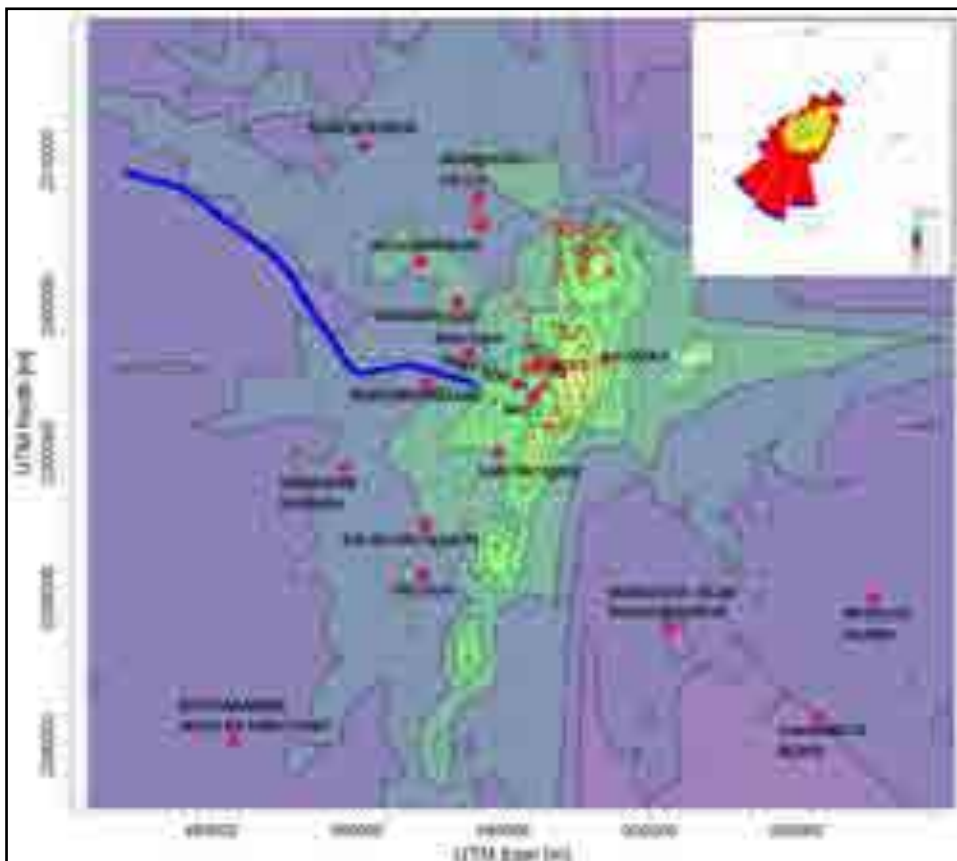


Figure 5-181: Isopleth for 1st 24-Hr Average Incremental Concentration of PM_{2.5}

5.6.2.6 Observations at Receptors

The 1st highest 24 Hour average and annual average resultant concentrations of NO₂, PM₁₀, PM_{2.5} and SO₂ for AAQ monitoring receptors locations are found to be well within the National Ambient Air Quality Standards (NAAQS), 2009.

Also, incremental concentration for the sensitive receptors is well below the National Ambient Air Quality Standards (NAAQS), 2009.

Sensitive receptors such as mangroves are present in the study area. The Maximum Predicted incremental concentration of PM at all locations is less than 12.52 µg/m³.

It is suggested to carryout Ambient Air quality monitoring. Based on the results, additional measures if any such as, wind screen/wind shield shall be provided along the periphery of stockyard. However, Wind screens will be provided along stack yard. Particulate Emissions from the dry bulk stockyard will also be minimised by providing greenbelt around the stockyard and boundary wall apart from dust suppression by water sprinklers.

According to a Report published by the European Environment Agency in 2014 It is recommended that NO_x levels be no greater than 30 µg/m³ and SO_x levels be no greater than 20 µg/m³ in a calendar year in order for protection of ecosystems and vegetation. Annual Average incremental concentrations for SO₂ and NO₂ at all locations are less than 2.65 µg/m³ and 6.27 µg/m³.

5.6.2.7 Mitigation Measures

- Ambient air quality monitoring will be carried out regularly at selected locations in the predicted maximum impact zone in order to check and compare the predicted concentrations with the measured concentrations.
- Water sprinkling will be carried out on road surfaces in the project area.
- Greenbelt of adequate width will be developed around the cargo storage areas in particular and along the boundary of project area to minimize the likely impacts due to air pollution.
- The open stockpile of the other Project/ Break cargo if any shall be covered with Tarpaulin sheets
- The Annex VI of MARPOL Convention deals with the “Regulations for the Prevention of Air Pollution from Ships”. It sets limits on NO₂ and SO_x emissions from ship exhausts, and prohibits deliberate emissions of ozone depleting substances. It also prohibits the incineration on board ships of certain products, such as contaminated packaging materials and polychlorinated biphenyls (PCBs). The vessels are required to comply with the regulations and should have the “International Air Pollution Prevention Certificate”. The project proponent will take all appropriate measures to comply exhaust emission from vessels in accordance with MARPOL regulations and Euro Emission standard norms so as to reduce pollution load in the air environment.
- Mechanized loading/ unloading system from the loading/unloading area to the stocking yards and in to the vehicles is proposed
- All trucks before leaving the storage yard will be showered with water with adequate system as shown in **Exhibit 5-4**, will be covered with tarpaulin or any other effective measure/device completely and also that trucks are not over loaded as well as there is no spillage during transportation
- Wagons will be covered with tarpaulin before leaving the coal terminal yard as shown in **Exhibit 5-5**.
- Vehicle carrying the bulk cargo should not be overloaded by raising the height of carriage
- Plantation/Greenbelt shall be considered all along the periphery of the dusty cargo handling premises.
- Atomized water sprinkling shall be carried out on the top of the heap at regular intervals to prevent dusting, fire & smoke
- Regular sweeping of bulk cargo dust from internal and main road and also ensure that there is adequate space for free movement of vehicles
- All the engineering control measures and state of art technology including covered conveyer belts & transfer points, mechanized loading and unloading, provision of silo etc. will be provided for curbing the pollution
- Adequate fire fighting measure to avoid any fire or related hazards including adequate water storage facility, and the premises shall be exclusively used for storage of the coal.
 - Dust suppression measures as committed (such as at Ship unloader discharging in to hoppers, Stockyards, Discharge and feeding points of conveyors, Rapid loading system etc.,) shall be implemented.

**Exhibit 5-4: Automatic Tyre Wash System****Exhibit 5-5: Covered Coal Wagons**

Construction activities increase ambient noise levels. There would be impact on noise levels due to the following:

- Vehicles transporting construction material
- Diesel run engines of construction machinery and dredgers
- Pile driving activities during construction of cargo berths.

Noise is an inherent part of construction activity and response of species / communities would be either attracted or diverted away from the region. Noise generated from diesel engines of dredgers, workboats, etc. could result in movement of mobile faunal species away from area of operation.

There would be a degree of avoidance behaviour (flight) exhibited by marine species initially and they would eventually be expected to return once they become accustomed to increased

noise levels or once the noise source has moved or ceased. Noise generating sources are mobile and the impact will be short-term in nature.

Noise generated from construction activities will be predominantly confined within port site and will impact construction workers at site. Impacts due to these activities would be short-term in nature and localised.

5.7.1.2 Mitigation Measures

The following mitigation measures will be followed to minimise the noise generation and the associated impacts.

- During construction, noise levels will be maintained below threshold levels stipulated by Central Pollution Control Board (CPCB) by selecting appropriate equipment, machinery and using enclosures. Procurement of machinery / construction equipment will be done in accordance with specifications conforming to source noise levels less than 75 dB (A).
- Only well-maintained construction equipment, which meets the regulatory standards for source noise levels, will be used. Any equipment emitting high noise, wherever possible, will be oriented so that the noise is directed away from sensitive receptors.
- Noise attenuation will be practised for noisy equipment by employing suitable techniques such as acoustic controls, insulation and vibration dampers. The attenuation devices will be properly maintained throughout the construction period.
- High noise generating activities such as piling and drilling will be scheduled to minimise noise impacts.
- Personnel exposed to noise levels beyond threshold limits will be provided with protective gear like earplugs, muffs, etc. especially construction personnel involved in pile driving operations. Rotation of personnel will also be adopted.
- Periodic maintenance of the equipment to be used in the developmental works will be carried out. Worn out parts will be replaced and rotating parts will be lubricated to minimise noise emissions.
- Ambient noise levels will be monitored at regular intervals during construction phase of the project.
- All haul roads (for truck transport and other vehicles) within the boundary and outside will be maintained properly to avoid excessive noise levels from Engine acceleration and deceleration.

5.7.1.3 Impact due to vibration

During the construction activities, vibrations may be envisaged. The vibrations could be result of activities like excavation, piling, blasting (if required), movement of heavy equipments, etc. Mitigation measures as given in the **Section 5.7.2.3** will be followed as appropriate during the construction phase also.

5.7.2 Potential Impact due to Port Operation

During the operational phase, noise will be generated due to the operation of the generators, pumps, engines of boats and ships, cranes for handling of goods, cargo and shipment vehicles. Noise will also be generated considerably from the warehouse, repair and maintenance block, service area, goods loading and unloading point. Activities like container handling, container storage, periodic dredging, vehicle movement on internal road etc. will also contribute in increase in ambient noise levels.

5.7.2.1 Mitigation Measures

- Major noise generating equipment shall be designed with 85 dB(A) ensuring cumulative noise at a distance of 1.0 m remains at 75 dB(A).
- The occupational noise exposure to the workers in the form of 8 hourly time weighted average will be maintained within the prescribed OSHA standard limits.
- Noise attenuation will be practised for noisy equipment by employing suitable techniques such as acoustic controls, insulation and vibration dampers. The attenuation devices will be properly maintained.
- Workers exposed to excessive noise will use appropriate Personal Protecting Equipment (PPE) including ear plugs, muffs, or both when engineering or administrative controls are not feasible to reduce exposure.
- Rotation of personnel will be adopted to minimize the exposure to high noise levels.
- Periodic maintenance of the equipment to be used will be carried out. Worn out parts will be replaced and rotating parts will be lubricated to minimise noise emissions.
- Ambient noise levels will be monitored at regular intervals during operation phase of the project.
- Greenbelt will attenuate the increase in noise levels at landside facility.
- To ensure that all the transportation vehicles construction machinery will be periodically checked for minimal noise generation to comply OHSAS and ambient noise standards in the surrounding area.
- Labelling equipment at a prominent location to indicate the approximate level of noise it generates in operation will also be done. Where the reading is less than 85 dB, then the equipment should be labelled using the green coloured label with no specific noise exposure precautions required for usage of less than 8 hours. Where the reading is equal to or greater than 85 dB, then the equipment should be labelled using the red coloured label and the operator should wear hearing protectors. In addition, those persons working within 5 m of the equipment should also wear hearing protectors or take other appropriate control measures to protect against noise. Suggested formats for these labels are shown in the **Figure 5-182**.



Figure 5-182: Format of Noise labels

5.7.2.2 Impact due to Vibration

Vibrations are expected to be generated by various activities associated with the proposed project operations. Heavy machinery and equipments such as cranes, pumps, conveyor belt, unloaders/loaders etc., are likely to generate vibrations during operational phase and may cause exposures to the workers/operators in those areas. The impact of vibrations beyond

the site would be negligible during normal operation phase. However, the impacts on workers engaged in the operational areas would be considerable due to occupational exposure. The impacts shall be minimized with appropriate mitigation measures.

5.7.2.3 Mitigation Measures

- Machines, equipment's and vehicles must have criteria's to control noise and vibration
- The machine and equipments likely to generate vibration shall be fixed based on the detail designing of foundation.
- The machinery equipped with latest vibration-reduction technology shall be used which will help minimise the vibrations.
- The vibration dampers shall be provided around the source of generation.

5.8 Solid Waste Management

5.8.1 Potential Impact due to Port Construction

Solid waste is likely to be generated during the construction phase of the development. Improper solid waste disposal may also lead to skin diseases. Moreover solid waste will attract vermins, rats and deteriorate the general aspect of the site and its surroundings. Organic wastes generated during construction will be minimal and will comprise mainly of domestic refuse like food, fallen leaves, branches, etc. and waste by workers on site. The inorganic waste likely to be generated during construction include

- Concrete rubbles and blocks
- Cement sheets
- Wooden and metallic beams
- Paper, plastic, cartons
- Blocks, rocks, boulders
- Broken tiles, glass debris
- Metal debris, cans and tins
- Wood, straw and timber remains

Poor construction procedures generate excessive wastes increasing the construction costs and results in disposal of otherwise valuable resources. The solid waste generated during construction phase may impact soil quality, water quality and public health if not regulated properly. Improper solid waste disposal may also lead to skin diseases. Moreover solid waste will attract vermins, rats and deteriorate the general aspect of the site and its surroundings. Appropriate measures need to be taken for adequate disposal of solid wastes generated during construction phase of the project.

5.8.1.1 Mitigation Measures /Solid Waste Management

The various types of solid wastes generated during the construction phase will be segregated into two main categories, viz., non-hazardous and hazardous. All non-hazardous waste will be covered under solid waste management.

- Dredged material will be used for reclamation and any excess/unused dredge material will be disposed at an offshore dumping site
- Construction waste will be used within port site for filling of low lying areas. Other wastes which can be re-cycled will be sold.

- General refuse generated on-site will be collected in waste skips and separated from construction waste.
- A local authorised waste recycler will be employed to remove general refuse from the site, separately from construction waste and hazardous wastes, on regular basis to minimise odour, pest and litter impacts.
- The burning of refuse at construction sites will be prohibited.

5.8.1.2 Hazardous Materials Management

- Hazardous materials such as lubricants, paints, compressed gases, and varnishes etc., will be stored as per the prescribed/approved safety norms.
- The construction site will be secured by fencing with controlled/limited entry points.
- Hazardous wastes will be disposed at nearest Treatment, Storage and Disposal Facility (TSDF) through approved OSPCB vendors. Hazardous materials will be stored as per prescribed safety norms in locations with restricted entry and with fire-fighting facilities.
- Medical facilities including first aid will be available for attending to injured workers Occupational Health Construction Equipment and waste.

The solid waste generated during the construction phase of the revised master development will be managed as per the latest regulations such as Solid Waste Management (SWM) Rules, 2016; Construction and Demolition (C&D) Waste Management Rules, 2016, Hazardous and Other Wastes (Management and Transboundary Movement) Rules 2016 etc.

5.8.2 Potential Impact during Operation

Waste generated from cargo operations such as remains of bulk cargo storage, rubbish from unpacking, treatment plant wastes and canteen wastes from daily activities. The quantity of municipal solid waste generated from canteen and administrative areas is estimated at about 7.92 TPD for 5 Years development and 14.4 TPD for 30 Year development, of which 60% will be bio-degradable and 40% non-biodegradable. These wastes will generate odour and health impacts if not managed properly.

5.8.2.1 Mitigation Measures

- 5 R (Reduce /Reuse/Recover/Recycle and Re Process) principles shall be explored.
- Proper collection and disposal of solid waste from office establishment and town ship based on the Central Public Health and Environmental Engineering Organization (CPHEEO) manual on "Municipal Solid Waste Management, 2014.
- The solid waste from the utilities like canteen shall be segregated as biodegradable and non-biodegradable waste and collected separately by providing bins at respective places.
- The collected biodegradable waste shall be subjected to composting and the compost will be used as manure for the development of green belt within the port.
 - The non-biodegradable waste like plastic shall be handed over to approved vendors of OSPCB or can be handed over to authorized cement industry for co processing.
- Used oil/Spent oil & Used Battery, Containers/Barrels/liners Contaminated with HW/Chemicals and Sludge from oil water separator will be collected and disposed to OSPCB/CPCB approved vendors or nearest TSDF/CHWIF.
- Hazardous wastes will be handled as per Hazardous and Other Wastes (Management and Transboundary Movement) Rules 2016. Hazardous wastes will be disposed through approved OSPCB vendors.

5.9 Socio-Cultural Impact

5.9.1 Potential Impact due to Port Location

5.9.1.1 Relocation of Local People

Hence, no rehabilitation and resettlement (R&R) is envisaged and this impact is completely avoided.

The revised master plan of Dhamra Port will be developed in an area of about 2013.4 ha which is majorly reclaimed land and balance is vacant government land. Careful site selection for the proposed project ensured that the land is uninhabited. Hence, there will be no direct Project Affected People (PAPs)/Project Affected Families (PAFs) due to the proposed project development and no Resettlement and Rehabilitation (R&R) is envisaged.

5.9.1.2 Fishing Activities

The construction of cargo berths, approach trestle and activity of capital dredging, etc are likely to impact the fishing activity near Dhamra port. . The nearest fishing hamlets are Dosinga, Amarnagar and Rabindra Nagar is located at about 0.08 km, 0.1 km and 0.1 km from the Port boundary. Fishermen in the study area operate motorised and non- motorised fishing boats. Fishermen with motorised boats generally go up to 50 miles in the sea for fishing.

The nearest landing centre for the fishing boats is fishing harbour is located in Dhamra River at 6.5 km southwest of the port. The fishing boats travels all through the Dhamra River and enter into sea. The approach channel of the port is oriented from south to north east whereas fishing boats travels from south to east and some fishing boats travel through port channel. Fishing is being carried out at deep sea. At present, fishermen are well aware about the vessel movements route at Dhamra Port.

Safe navigation routes will be earmarked for movement of fishing vessels and the route will be finalised in consultation with fish landing authorities and fishing communities. However, necessary sign boards and marker buoys shall be installed and interactions shall be initiated with the fishing community about the marker buoys indicating the areas of operation so that they may avoid those areas during construction period. Storm water drainage network is planned to facilitate the proper drainage pattern of the area and the requirements of local villagers for tide water and boat movement has been duly considered in the drainage plan. Hence, no hindrance to fishing activity is anticipated during construction and operation phases.

5.9.1.3 Enhancement of Local Economy

It is anticipated that the proposed development will generate and support diverse economic development during its construction and operation. Economic benefits, direct and secondary, will include job creation and increased business spending throughout the construction and operation phases. Secondary economic impacts will be created through the provision of goods and services to the port and the subsequent increase in employment and business activity necessary to produce these goods and services.

Port activities may result in the hiring of local labour and procurement of various commodities from a local market. The local economy will be boosted by port-related activities and be greatly involved in urbanization and industrialization

5.9.2 Potential Impact during Port Operation

5.9.2.1 Impacts due to Inland Cargo Movement

Proposed project will handle different types of cargo which will be transhipped majorly through rail and remaining by road to the respective destinations. Traffic predictions show that additional traffic loads due to operations as well as on road users due to revised master plan. Hence the existing and proposed road connectivity will be able to handle the cargo movement and not envisaged to create adverse impacts and congestion to existing public infrastructure.

5.9.2.2 Impact due to Vessel Movement

The vessels visiting the Port may discharge the wastewater, oily wastes and bilge water which can impact the nearby beaches, if not properly controlled. Ship traffic may disturb fishing activities like fishing nets getting entangled with the moving vessels in outer harbour areas which may cause financial losses to fishing communities. The possibility of accidents in the ship traffic may affect local people.

5.9.2.3 Mitigation Measures

- Port will ensure the ships to follow MARPOL convention to prevent the discharges into harbour areas.
- In case of accidental spill, contingency plan will be followed.
- Safe navigation routes will be earmarked for movement of fishing vessels and the route will be finalised in consultation of fishing harbour authorities and fishing communities.

5.9.2.4 Navigation Aspects and Impact due to Approach Channel

The general bathymetry within the survey area presents a gradual increase in water depth. The slope is gentle throughout from the coast up to 20m contour. The 10m, 15m, 20m contour lies about 7.0km, 20.3 km, 24.3 km away from the coast.

Navigability of the Approach Channel has been analysed and found that the channel is operable safely to accommodate the designed traffic. Other than fishing vessels in the project region, no other major vessels movement are envisaged near proposed approach channel. Regular interactions will be carried out with the fishing community on importance of channel marker buoys and other navigational aids.

5.9.2.5 Employment Potential

During operational phase, the port is likely to generate employment of 2200 people on direct basis and around 11000 people will get employment indirect basis during 5 year development and 4000 people on direct basis and around 20000 people will get employment indirect basis during 30 year development.

5.9.2.6 Public Health and Safety

The proposed revised master plan development of Dhamra Port is to be developed considering the latest and relevant safety guidelines, codes and manuals. Hence the risk associated with public health and safety due to the operation of the proposed project is negligible. An effective Disaster Management Plan (DMP) which includes Onsite and Offsite emergency plan is prepared and will be followed to minimize the probability of occurrence of emergency situations and mitigate the impacts.

Chapter 6 Environmental Monitoring Programme

In this chapter, environmental monitoring programme for the proposed Revised Master Plan of Dhamra port is discussed. Environmental Monitoring Programme is an important component during environmental management of the project. The institutional mechanism to implement the planned mitigation and monitoring measures during all stages of the project is discussed in **Chapter 9**. The project management especially the Environmental Management Cell (EMC) (described in **Chapter 9**) should always go for a rational approach with regards to environmental monitoring. This includes judicious decision making in consultation with institutional stakeholders such as Odisha State Pollution Control Board (OSPCB) or reputed environmental consultants for appropriate changes in the monitoring strategy, i.e., changes in the sampling frequency, sampling location, monitoring parameters and any new/additional requirements.

Following are the main objectives of the environmental monitoring program:

- Provides information for documentation of monitoring of mitigation measures and impacts
- To act as a tool for the statutory authorities for unanticipated adverse impacts or sudden changes in the environmental condition due to the proposed project
- Provides information that could be used for evaluating the effectiveness of implemented mitigation measures
- Provides information that could be used to verify predicted impacts and thus validate impact prediction techniques
- Effectiveness of the mitigation measures being followed during construction and operational phases can be assessed and the measures can be revised, made more stringent and reinforced based on the monitoring results
- Provides guidance to comply with relevant environmental rules/regulations
- Environmental Monitoring can also serve a basic component of a periodic environmental regulatory auditing program for the proposed project
- Serves as a tool to monitor and modify the mitigation measures and implementation arrangements, if any

The environmental monitoring programme for construction as well as operation phases shall be implemented by project proponent. Besides the monitoring, compliances to all Environmental Clearance and CRZ conditions and permits from OSPCB/MoEF&CC shall be monitored and reported periodically. The likely significant impacts and mitigation measures will also be monitored.

Since it is existing port, the environmental monitoring is being carried out as a part of Phase I & II compliance and the latest compliance report submitted to regional office of MoEF&CC is given as **Appendix A**. Hence Construction Phase monitoring plan is prepared for revised Master Plan development in line with existing/approved monitoring activities and Operation Phase monitoring plan is prepared based on the revised master plan development activities. The environmental attributes to be monitored during construction and operational phases of revised master plan of the project, sampling locations and frequency of monitoring, applicable standards, etc. are presented in **Table 6-1**.

6.1 Environmental Monitoring Programme

Table 6-1: Environmental Monitoring Programme for Construction and Operation Phase

S. No.	Environmental Attributes	Parameters to be Monitored	No. of Sampling Locations	Frequency of Monitoring	Standards Methods for Sampling & Analysis	Compliance
Construction Phase						
1	Air Quality	As per NAAQS, CPCB 2009.	Five (05) - Colony Area within Port - Kanakaprasad - BMH I – Wagon tippler area - Jetty area - Dosinga	Twice a month	Fine Particulate Samplers, Respirable Dust Sampler fitted with Gaseous sampling arrangements, CO analyser/ portable CO meter, etc., and methods of measurements as suggested in NAAQS (2009). As per the CPCB Manual (Volume-I): Guidelines for the Measurement of Ambient Air Pollutants.	National Ambient Air Quality Standards, November, 2009 given as Appendix H .
2	Noise Levels	Day and night noise levels	Five (05) - Colony Area within Port - Kanakaprasad - BMH I – Wagon tippler area - Jetty area - Dosinga	Once a month	Portable hand-held noise level meter.	National Ambient Noise Standards given as Appendix I . Noise Limit for Generator Sets is given as Appendix J .
3	Water Quality	Physical, Chemical and Biological	Groundwater (Three - 03) - Kanakaprasad - Balisahi - Dosinga Surface water (02) - Matai River near DPCL Intake Point - Raw water reservoir	Once in a quarter of the year	Grab sampling and analysis by using standard methods.	IS10500:2012 drinking water standards which is given as Appendix K . ISI-IS2296-1982 standards for use based classification of surface water given as Appendix L .
4	Soil	Soil texture, type, electrical conductivity, pH, infiltration, porosity, etc.,	Three (03) - Port Site - Kanakaprasad	Once a year	Collection and analysis of samples as per IS 2720.	Baseline Soil Quality data as provided in Section 4.4.8 of Chapter 4.

S. No.	Environmental Attributes	Parameters to be Monitored	No. of Sampling Locations	Frequency of Monitoring	Standards Methods for Sampling & Analysis	Compliance
			Dosinga			
5	Meteorology	Wind speed, wind direction, rainfall, temperature, humidity.	Project site	Hourly measurement during construction	IMD/CPCB guidance manual.	-
6	Marine Water Quality/ Plankton and Benthic Communities/ Sediment Quality	Physical, Chemical and Biological/ Phytoplankton, Zooplankton and Benthic Communities	Six (06) - Marine Sampling Location 4 - Between marine sampling location 4 and 6 - Marine sampling location 6 - Dhamra River mouth - Multipurpose Cargo berth face - Liquid/Gas/Cryogenic berth face	Quarterly Once	Bottom sampler (using NISKIN Sampler) and analysis by using standard methods. Plankton net of diameter of 0.35 m, No.25 mesh size 63 μ and analysis by using standard methods. Grab Sampling and analysis by using standard methods.	Primary water quality standards for coastal water (SW-IV) for harbour water given as Appendix M . Baseline marine Plankton and Benthic Community data as given in Section 4.6 of this CEIA Report.
7	Stack Monitoring	PM, SO ₂ , NO ₂ , NMHC (as C) and CO and CO	DG sets used for Construction	Once in a year	Standard Stack emission monitoring and analysis methods.	Emission limits for new diesel engine more than 800 kW for generator set Appendix N .
8	Coastal Shoreline	Erosion/accretion	7 km stretch / radius on either side of port developmental area/backup area	Once a Year	Satellite imagery, GIS, remote sensing techniques and ground verification.	Baseline Satellite imagery shall be procured before commencement of construction.
9	Bathymetry (During Dredging and Disposal)	Changes in Sea Bed Levels	Dredge Spoil Disposal Site	Once in Six months	Standard Bathymetric Survey using The ECO Sounder: ODOM Echotrac CVM dual frequency Echo Sounder.	Baseline Bathymetry shall be carried out before commencement of dumping.
10	Drinking Water Supply	Physical, Chemical and Biological	Drinking Water supply Source within Project Site And at Construction Camp.	Once a month	Grab Sampling and Analysis.	IS10500:2012 drinking water standards which is given as Appendix K .
Operation Phase						
1	Air Quality	All Twelve (12) parameters as per NAAQS, CPCB 2009. PM ₁₀ , PM _{2.5} , SO ₂ ,	Six (06) - Port Site/Water Treatment Plant (WTP)/Proposed Desalination Plant area - Narsinghprasad	Twice a week	Fine Particulate Samplers, Respirable Dust Sampler fitted with Gaseous sampling arrangements, CO analyser / portable CO meter, etc.,	National Ambient Air Quality Standards, November, 2009 given as Appendix H .

S. No.	Environmental Attributes	Parameters to be Monitored	No. of Sampling Locations	Frequency of Monitoring	Standards Methods for Sampling & Analysis	Compliance
		NO ₂ , CO, O ₃ , Pb, NH ₃ , C ₆ H ₆ , BaP, As and Ni, VOCs	- Sabitri Sarai - Bali Sahi - Kanakaprasad - Kishorprasad		and methods of measurements as suggested in NAAQS (2009). As per the CPCB Manual (Volume-I): Guidelines for the Measurement of Ambient Air Pollutants.	
2	Noise Levels	Day and night noise levels	Seven (07) - Port Site/Water Treatment Plant (WTP)/Proposed Desalination Plant area - Narsinghprasad - Sabitri Sarai - Bali Sahi - Kanakaprasad - Kishorprasad - Rabindranagar	Once a month	Portable hand-held noise level meter.	National Ambient Noise Standards given as Appendix I . Noise Limit for Generator Sets is given as Appendix J .
3	Water Quality	Physical, Chemical and Biological	Groundwater (Five - 05) - Kanakaprasad - Port Site - Balisahi - Sabitri Sarai - Narsinghprasad Surface water (02) - Matai River near DPCL Intake Point - Raw water reservoir	Once a month	Grab sampling and analysis by using standard methods.	IS10500:2012 drinking water standards which is given as Appendix K . ISI-IS2296-1982 standards for use based classification of surface water given as Appendix L .
4	Soil	Soil texture, type, electrical conductivity, pH, infiltration, porosity, etc.,	Seven (07) - Port Site - Narsinghprasad - Sabitri Sarai - Bali Sahi - Kanakaprasad - Kishorprasad - Rabindranagar	Once a year	Collection and analysis of samples as per IS 2720.	Baseline Soil Quality data as provided in Section 4.4.8 of Chapter 4.

S. No.	Environmental Attributes	Parameters to be Monitored	No. of Sampling Locations	Frequency of Monitoring	Standards Methods for Sampling & Analysis	Compliance
5	Meteorology	Wind speed, wind direction, rainfall, temperature, humidity.	Project site	Hourly measurement	IMD/CPCB manual.	-
6	Marine Water Quality/ Plankton and Benthic Communities/ Sediment Quality	Physical, Chemical and Biological/ Phytoplankton, Zooplankton and Benthic Communities	Seven (07) - Near Existing berths - Southern side reclamation area - Northern side reclamation area - Near Northern Side Mangrove area entrance - Proposed Turning Circle - Between marine sampling location 4 and 6 - Marine sampling location 6	Quarterly once	Bottom sampler (Niskin Sampler) and analysis by using standard methods. Plankton net of diameter of 0.35 m, No.25 mesh size 63 μ and analysis by using standard methods. Grab Sampling and analysis by using standard methods.	Primary water quality standards for coastal water (SW-IV) for harbour water, given as Appendix M . Baseline marine Plankton and Benthic Community data as given in Section 4.6 of this CEIA Report.
7	Stack Monitoring	PM, SO ₂ , NO ₂ , NMHC (as C) and CO and CO	DG sets	Once in a year	Standard Stack emission monitoring and analysis methods.	Emission limits for new diesel engine more than 800 kW for generator set Appendix N .
8	Coastal Shoreline	Erosion/accretion	7 km stretch/radius on either side of port developmental area/backup area	Once a Year	Satellite imagery, GIS, remote sensing techniques and ground verification.	Baseline Satellite imagery procured before commencement of construction.
9	ETP/STP	Physical, Chemical and Biological Parameters	Four (04) - ETP Inlet/outlet - STP Inlet/outlet	Once in a month	Grab Sampling and analysis by using standard methods.	As per OSPCB stipulation in CTE/CTO/ General standards for discharge of Environmental Pollutants, G.S.R 422 (E) - The Environmental (Protection) Rules 1986 given as Appendix O .
10	Desalination Plant and LPG/LNG regasification Plant - Inlet & Outlet	Physical, Chemical and Biological Parameters	Four (04) - Desalination Plant Inlet/Outlet - LPG/LNG regasification Plant Inlet/outlet	Once in a month for all Physical, Chemical and Biological Parameters. Only Temperature, Salinity, EC and TDS shall be monitored	Grab Sampling and analysis by using standard methods.	As per OSPCB stipulation in CTE/CTO.

S. No.	Environmental Attributes	Parameters to be Monitored	No. of Sampling Locations	Frequency of Monitoring	Standards Methods for Sampling & Analysis	Compliance
				through a continuous monitoring system (During the operation of the plant only)		
11	Bathymetry (During Disposal)	Changes in Sea Bed Levels	Dredge Spoil Disposal Site	Once in Six Months	Standard Bathymetric Survey using The ECO Sounder: ODOM Echotrac CVM dual frequency Echo Sounder.	Baseline Bathymetry
12	Light Glare	Light Glare	Nesting location site	Once in a year, on operation and nonoperation nights	Visual inspection	Dark Sky Association Recommendations.
13	Fugitive emissions	Methane and non methane hydrocarbons	Three(03) - Near LNG/LPG Handling areas - Near LNG/LPG Storage Areas - Near LNG/LPG Regasification areas	Daily (depends on the operation)	Gas detection System	Shall be compared with Baseline and adhere as required by codes, standards and specifications for safety.

6.2 Compliance Reports

As a part of environmental monitoring programme, following compliance reports shall be submitted to OSPCB and Regional Office of MoEF&CC:

- Half yearly compliance report on 1st June and 1st December of each calendar year
- Environmental statement for the financial year ending 31st March to OSPCB on or before 30th September every year
- Annual returns in Form 4 as per Hazardous and other Waste (Management and Transboundary movement) Rules, 2016 on or before 30th June
- Format for maintaining records of hazardous and other waste in Form 3 as per Hazardous and Other Waste (Management and Transboundary movement) Rules, 2016
- Safety data sheet for hazardous chemicals shall be maintained as per schedule 9 of MSIHC rules, 1989 (amended 2000)
- Format for maintaining notification of major accident in schedule 6 as per MSIHC rules, 1989 (amended 2000)
- Half-yearly return in Form VIII as per Batteries (Management and Handling) Rules, 2001 and amendment thereof
- Format for maintaining records of E waste in Form 2 as per E-Waste (Management) Rules, 2016.

A MoEF&CC and NABL accredited Laboratory has been appointed by DPCL for conducting regular monitoring of air quality, noise levels, water quality, sediment quality, biological parameters, primary conductivity, chlorophyll estimation and bacterial estimation during Phase I & II activities. Monitoring during construction and operation phases of revised master plan will be carried out by engaging authorized agencies.

6.3 Plantation Monitoring Programme

• Development of nursery	• Fencing of plantation area
• Treatment and sowing of seeds	• Weeding and soil working
• Survival rate of plant	• Replacement/Inter planting
• Planting of seedlings	• Watch and ward of plantation

During operation phase periodic monitoring of plantation growth, manuring, watering, pruning, and replacement will be performed in order to properly maintain vegetation, greenbelt and green cover.

DPCL has established a large nursery of multi species as a part of green belt development which is being continuously monitored.

6.4 Mangrove Conservation Programme

Mangroves area in an identified location of 9.0 ha: Scattered mangroves are identified near the southern boundary of the port in Phase I development, these mangroves are scattered in an area of 9 ha. DPCL has excluded these mangroves from the port activity by fencing and implementing the conservation measures. During the planning stage, a channel for seawater influx is considered to the mangrove area.

Mangroves near northern boundary i.e., between land side and reclaimed land: Minimum 50 m buffer has been provided near the Northern mangrove area and all the construction will be limited as per plan. Revised Master Plan ensures the Tidal exchange near the mangrove areas

6.5 On-site Mock Drills Requirements

On-site mock drills are very important as it helps employees to be aware of the safety procedures and how to react at the time of crisis. Conducting mock drills at regular intervals enhances preparedness and checks the viability of environmental/Disaster Management Plan (DMP). Mock drills are essential for the following reasons:

- Helps in revising/improving the environmental/disaster management plan
- Helps evaluate whether responsible officials are trained efficiently for unforeseen events
- Helps in evaluating whether adequate/appropriate emergency equipment are being maintained

To ensure efficient environmental/disaster management, project proponent shall conduct periodic on-site mock drills in case of occurrence of activities, such as:

- Fire
- Collision/Grounding of vessels calling at port
- Power breakdown
- Bomb threats
- Oil spill
- War alerts/terrorist attacks
- Natural calamities (cyclones, floods, earthquakes)

Mock drills should also involve fire department, police, municipal authorities, hospitals and other department/agencies that are mandated to provide emergency support. Documenting the outcome of mock drills is an important aspect as this helps in revising the existing plan more efficiently.

The details of the mock drills undertaken by DPCL are given in **Table 6-2** and shown in **Exhibit 6-1**.

Table 6-2: Details of Mock Drills

S. No.	Description of Mock Drills and Training	Numbers of Training and Mock Drills Conducted	Number of Participants
1.	Emergency Rescue Mock Drill	4	104
2.	Safety Induction Training	182	1466
3.	Portable Fire Extinguisher Training	33	1197
4.	Contractor Safety Training	25	710
5.	Defensive Driving Training	43	682
6.	Tool Box Training	25792	183283
7.	On the Job Safety Awareness	122	2329



Exhibit 6-1: On-site Fire Mock Drills

Chapter 7 Additional Studies

7.1 Public Consultation

In line with the requirements of EIA Notification, 2006 (as amended) for Category A projects, Public Consultation was conducted for the proposed Revised Master Plan development of Dhamra Port. The Public Hearing (PH) was held on April 11, 2018 at 11.00 hrs at village Kanak Prasad (near DRDO helipad), under Tahsil Chandbali in the district of Bhadrak.

M/s DPCL had submitted letter of request of PH, with 10 hard copies and equivalent soft copies of draft EIA report, as per generic structure including summary EIA report in English and in local language, to State Pollution Control board. M/s DPCL had also submitted one hard and one soft copy of draft EIA report along with summary of EIA to

- District Collector's office, Bhadrak
- District Industries Center, Bhadrak
- In the office of the Chief Executive Officer, Zila Parishad, Bhadrak
- In the Head Office of the State Pollution Control Board, Odisha, Parivesh Bhawan, A/118, Nilakanthanagar, Unit – VII, Bhubaneswar - 12
- Regional Office, State Pollution Control Board, Odisha, Balasore
- Department of Forest & Environment (Environment), Govt. of Odisha, Bhubaneswar

OSPCB had arranged to publish notices inviting comments, views, objection and suggestions from the public, in respect of the project, in newspapers namely English Daily - "The Times of India" dated 08/03/2018 and Odia Daily - "Dharitri" dated 08/03/2018.

The Public Hearing was presided by the Collector & District Magistrate of Bhadrak assisted by the Regional Officer, OSPCB Balasore and the meeting was attended by the local Public, public representatives, NGOs, other stake holders and the local officials. The proceedings were recorded and videographed by OSPCB official

The Public Hearing proceedings are attached as **Appendix P**.

Point wise response to issues raised during Public Hearing and replies for written representations are furnished in **Table 7-1** to **Table 7-7**. Some of the Public Hearing photographs are shown in **Exhibit 7-1**.

	
Public Hearing Conducted by the Collector and R.O. OSPCB	Participants/Stakeholders at the Public Hearing

	
Representative of M/s DPCL Explaining about the Proposed Development	Stakeholders – offering their views
	
Representatives of M/s DPCL	Stakeholders – seeking Clarifications
	
Hon'ble MLA briefing the local issues	CEO M/s DPCL responding on issues raised by the public

Exhibit 7-1: Public Hearing Photographs**Table 7-1: Responses to Issues Raised during Public Hearing**

S. No.	Name and Village	The points represented	Replies from Project Proponent/ DPCL
1.	Sri Ugrasen Madhual, Chhadag Bansada village	Sri Madhual told for development of green belt on environmental aspect. He however told that local leaders have recently conducted a meeting welcoming the expansion project for benefit of all. He also expressed that loss of income from sea fishing by local poor villagers shall be considered by Dist. Administration and Port Authority.	It is proposed to develop Green belt in an area of 129 Ha as a part of Revised Master Plan (5 Year) and 258.9 Ha (Cumulative) as a part of Revised Master Plan (30 Year). The details of proposed greenbelt development, is mentioned in Section 9.3 of Chapter 9 of the CEIA/EMP report. DPCL is thankful to all the community for their necessary support in development of Dhamra Port. Fisher folks are allowed to access the sea through earmarked water route around the port area, under safety consideration. Section 7.8.1.3 of CEIA/EMP report deals regarding the impact on Fishing activity and concerns likely to arise due to expansion of Dhamra port.
2.	Sri Bana Bihari Maity, Kaitha Khola village	Sri Maity told on afforestation against deforestation activity on environmental aspect. He referred that the public hearing for the second expansion programme is being held at Kanak Prasad village and Dist. Administration and Port Authority shall consider loss of income from sea fishing by local poor villagers.	It is proposed to develop Green belt in an area of 129 Ha as a part of Revised Master Plan (5 Year) and 258.9 Ha (Cumulative) as a part of Revised Master Plan (30 Year). District administration has been kind enough to allot village forest land for taking up plantation. Fisher folks are allowed to access the sea through earmarked water route around the port area, under safety consideration. Section 7.8.1.3 of CEIA/EMP report deals regarding the impact on Fishing activity and concerns likely to arise due to expansion of Dhamra port.
3.	Sri Balabhadra Lenka, Jagula village	Sri Lenka told on loss of green area due to development of the port, dust pollution due to spread of coal dusts, deposit of dust layer on village ponds and drainage of storm water to sea relating environmental aspect of the area. He also told on rehabilitation activities and constitution of local committees to find out permanent solution of local problems.	It is proposed to develop Green belt in an area of 129 Ha as a part of Revised Master Plan (5 Year) and 258.9 Ha (Cumulative) as a part of Revised Master Plan (30 Year). The details of proposed greenbelt development are provided in Section 9.3 of Chapter 9 of the CEIA/EMP report. Effective dust suppression measures such as water sprinkling and greenbelt plantations are being taken up to control fugitive coal dust. Wind screens will be provided along stack yard. Other dust control measures, mentioned as a part of Environment Management Plan will be implemented. Storm water drainage network has been planned to facilitate proper drainage of the area. The proposed project will ensure water passage and access to the sea by implementing appropriate storm water management plan. No R&R is proposed as a part of this project. Private land will not be acquired for this project. Reconstitution of local coordination committee will be taken up in consultation with district administration.
4.	Sri Amiya Mohapatra, Kaitha Khola village	Sri Mohapatra told on peripheral problem on spread of coal dust and non development of green belt to control dust spreading	Effective dust suppression measures such as water sprinkling and greenbelt plantations are being taken up to control fugitive coal dust. Wind screens will also be provided along stack yards. Other dust control measures, mentioned as a part of Environment Management Plan will be

S. No.	Name and Village	The points represented	Replies from Project Proponent/ DPCL
		relating environmental aspect of the area. He also told on peripheral development on medical facility, supply of drinking water, engagement of local poor villagers, village road development etc.	implemented. Green belts as discussed above will be developed. The issues such as medical facility, supply of drinking water, engagement of local poor villagers, village road development etc. will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration
5.	Sri Ashok Kumar Jena, Bidyutprava village	Sri Jena told only on peripheral development relating rehabilitation, employment opportunity, construction of over-bridge near old G.P. office, development of fish drying area, safe movement of fishing trawlers, providing deep tube well, cremation palace, veterinary hospital, engineering school/college, meeting place in Dosinga High School etc.	DPCL has complied with the guideline of Government of Odisha R&R Policy with regards to employment of local people. Proposed expansion will generate direct and indirect employment opportunities. Based on skill, qualification & experience, priority will be given to the local people. Eligible persons shall be trained in skill development centre to enable employability in different sectors. DPCL will develop the fish drying area on allotment of land by the district administration. Solar drying process will also be explored. Fisher folks are allowed to access the sea through earmarked water route around the port area, under safety consideration. The CSR activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration.
6.	Mr. S. K. Malikuddin, Kanak Prasad village	Mr. Malikuddin welcomed the expansion project on behalf of the village and G.P. and told only on social and education development matters.	DPCL is thankful to all the community for their necessary support for development of Dhamra Port. DPCL being a socially and Environmental responsible Organisation, will always be committed for working towards betterment of the society and surrounding environment.
7.	Sri Jayanta Behura, Guansol village	Sri Behura only told to constitute a committee of all parties to sort out the misunderstandings and set a healthy environment.	Reconstitution of local coordination committee shall be taken up in consultation with district administration.
8.	Mr. Mujibar Ali Khan, Sabitrisarasi (Dosinga) village	Mr. Khan told on pollution due to spread of coal dusts and deposit of these on village ponds relating environmental aspect of the area. He also told on peripheral development relating educational facility, providing deep tube well, shifting road side wine shops, problem on movement of coal trucks etc.	Effective dust suppression measures such as water sprinkling and greenbelt plantations are being taken up to control fugitive coal dust. Wind screens will be provided along stack yard as committed during public hearing. Other dust control measures, mentioned as a part of Environment Management Plan will be implemented. The CSR activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration. Shifting road side wine shops is not relevant to the proposed project activity.
9.	Sri Ashok Kumar Pandit, Balisahi village	Sri Pandit only told on employment of land losers, loss of income from sea fishing, providing equipments in schools etc.	DPCL has complied with the guideline of Government of Odisha R&R Policy with regards to employment of local people. The proposed Revised Master plan does not envisages any private land acquisition and hence no R&R. Fisher folks are allowed to access the sea through earmarked water route around the port area, under safety consideration.

S. No.	Name and Village	The points represented	Replies from Project Proponent/ DPCL
			The CSR activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration.
10.	Sri Pradeep Behera, Laxmiprasad village	Sri Behera told only on permanent solution of rehabilitation problem, protection of income from sea fishing etc.	No R&R is proposed as a part of this project. Private land will not be acquired for this project. Reconstitution of local coordination committee will be taken up in consultation with district administration. Fisher folks are allowed to access the sea through earmarked water route around the port area, under safety consideration.
11.	Sri Maniklal Dinda, Jyostnamaye e village	Sri Dinda told on coal dust pollution and development and maintenance of green belt relating environmental aspect of the area. He also told on rehabilitation of skilled and unskilled ones, peripheral development on black topping roads, providing deep bore well, shukhua or fish drying area etc. Two nos. of women from local villages intervened without registration and told on their personal and local problems where the Collector assured to listen personally towards this month end.	As suggested in preceding paragraphs, effective dust suppression measures shall be implemented and the green belts will be developed. Employment and CSR issues will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration.
12.	Sri Digambar Das, Bansada village	Sri Das told on coal dust pollution relating environmental aspect of the area. He also told on rehabilitation matter of the project and supported the expansion project.	Effective dust suppression measures such as water sprinkling and greenbelt plantations are being taken up to control fugitive coal dust. Wind screens will be provided along stack yard as committed during public hearing. Other dust control measures, mentioned as a part of Environment Management Plan will be implemented. No R&R is proposed as a part of this project. Private land will not be acquired for this project. Reconstitution of local coordination committee will be taken up in consultation with district administration. DPCL is thankful to Sri Das for his support for development of Dhamra Port.
13.	Mr. S. K. Bakar Alli, Kanak Prasad village	Mr. Alli told on survival of plantations claimed to be done relating environmental aspect of the area. He also told on rehabilitation matters and peripheral development related matters the Collector then assured to listen to their rehabilitation matters in his office later and requested them to continue the hearing.	The details of the greenbelt development including monitoring programme to ensure high survival rate are discussed in Section 9.3 of Chapter 9 of the CEIA/EMP report and the same will be implemented. Other issues raised by Mr. Alli have already been clarified.
14.	Sri Pramod Kumar Nayak,	Sri Nayak told on coal dust pollution and non covering of	Effective dust suppression measures such as water sprinkling and greenbelt plantations are being taken up to

S. No.	Name and Village	The points represented	Replies from Project Proponent/ DPCL
	Jagula village	coal carrying trucks relating environmental aspect of the area. He also told on medical facility, educational development, aid to govt. & non govt. schools, supply of drinking water, development of Maa Dhamrai Temple, road communication to Chandbali, employment opportunity, skill development centre, police station, souchalaya at bus stand, street lights, wine shop, stadium etc.	control fugitive coal dust. Wind screens will be provided along stack yard as committed during public hearing. Other dust control measures, mentioned as a part of Environment Management Plan will be implemented. The CSR activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration.
15.	Sri Debendra Nayak, Dosinga village	Sri Nayak told on road side plantations relating environmental aspect of the area. He also told on accusation and arrest of villagers wrongly out of last 15 th August issue.	It is proposed to develop Green belt in an area of 129 Ha as a part of Revised Master Plan (5 Year) and 258.9 Ha (Cumulative) as a part of Revised Master Plan (30 Year). District administration has been kind enough to allot village forest land for taking up plantation. The law and order issue raised is not under the purview of Ms. DPCL.
16.	Sri Trilochan Pradhan, Jagula village	Sri Pradhan personally supported the project only	DPCL is thankful to all the community for their necessary support in development of Dhamra Port.
17.	Sri Chandrasekh ar Jena, Jagula village (B.M.S.)	Sri Jena only told on area development due to the project and supported it	DPCL is thankful to all the community for their necessary support in development of Dhamra Port.
18.	Mrs. Khata Biwi, Balisahi village	Mrs. Khata Told One earlier woman intervened and told to excuse her earlier expression and expressed on local problems like no school in Balisahi village.	Her concern is well taken and the suggestion will be considered under CSR programme.
19.	Sri Ranjan Sahoo, Guahala village	Sri Sahoo told only on water problem in the 8 nos. of local G.P.s and providing proper medical treatment facility.	These CSR activities will be taken up in a phased manner.
20.	Sri Ramesh Chandra Nayak, Dhankota village	Sri Nayak told on sound pollution caused due to vehicular horns relating environmental aspect of the area. He also told on peripheral development matters on educational facility, socio-economic improvement, road widening, speed reduction of transport vehicles etc.	Potential impacts on noise due to port operation are discussed in Section 5.7.2 and mitigation measures suggested are in Section 5.7.2.1 of Chapter 5 of the CEIA/EMP report. The CSR activities will be taken up in a phased manner as discussed.
21.	Sri Kiran Kumar Behera,	Sri Behera told on peripheral development matters like dependant villagers on sea	The peripheral development and rehabilitation issues have been settled as per government guidelines by the competent authority and DPCL has abided by the orders of the

S. No.	Name and Village	The points represented	Replies from Project Proponent/ DPCL
	Bhubaneswar (OMF)	fishing, poor house conditions, rehabilitation etc. When peripheral development from 2011-18 with rupees 8 crores per annum has not been appreciative, 15 crores per annum in future is doubtful for further development.	authority.
22.	Sri Surendra Jena, Dosinga village	Sri Jena told on village pond water problem for drinking due to spread of coal dusts relating environmental aspect of the area. He also told on peripheral development matters on development of fish drying area, employment of fishermen etc.	These issues have been clarified in preceding paragraphs.
23.	Mr. Abdul Rehman, Bidyutprava village	Mr. Rehman did not tell on any environmental matter.	-
Sri Byomakesh Ray, Hon'ble M.L.A, Chanbali then addressed on the area development and supported the project. He also told on different peripheral development matters of the area and assured the public on the conditional support to fulfil the commitments by the port authority.			DPCL is thankful to the Hon'ble MLA for his presence and guidance. His advice and suggestions will be implemented with due regards.

No other people present in the public hearing delivered his/her views. The President and Collector, Sri Das then read over the summary of the proceedings reflecting the views and concerns expressed by all the persons in local language and asked the project proponent to explain on the issues raised by the public.

Sri Subrat Tripathy, Chief Executive Officer, M/s Dhamra Port Company Ltd. commented and responded on the issues.

The response to the written representation made during the process of public consultation is furnished below:

1) Sri Narendra Maity, Dosinga Gram Panchayat

Table 7-2: Replies to Written Representation - I

S. No.	The points represented	Replies from Project Proponent/DPCL
	With due respect and humble submission we, the people of Dosinga Panchayat would like to state that we welcome the second expansion of the Dhamra port, but we request you to kindly put your attention to the following development programs	DPCL is thankful to all for their extending support in development of Dhamra Port.
1.	Displacement & land losers: The families which are displaced due to the Dhamra Port from Dosinga to Bhadrak, that should be enquired properly and the steps should be taken to help those. The families which have lost their lands, they should be given proper regeneration accordingly to proper category which is to be investigated as soon as possible.	There won't be any land acquisition or displacement for this project. The issues raised relate to Phase-I land acquisition process, which is being settled by district administration. Some of the matters are pending in the court of law. DPCL will abide by the orders of the authorities and court

S. No.	The points represented	Replies from Project Proponent/DPCL
2.	Health: The primary health center which was present in Dosinga Panchayat sponsored by Dhamra port, was closed after the incident happened in Dhamra port on 15 th August, 2017. After that a health center is opened at Dosinga Panchayat office, but it is only for sake of name due to unavailability of doctors. You are requested to take necessary steps to appoint good doctors as soon as possible because five panchayat is totally dependent on it for the health issues.	These activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration
3.	Environment Pollution: Due to the Dhamra port, the lives of people is severely affected by heavy coal dust. The coal dust affects the agriculture, environment which creates different health hazard the people as unable to use to pond water	Effective dust suppression measures such as water sprinkling and greenbelt plantations are being taken up to control fugitive coal dust. Wind screens will be provided along stack yard as committed during public hearing. Other dust control measures, mentioned as a part of Environment Management Plan will be implemented.
4.	Roads: The main road of dosinga panchayat is said to be from Chandanipal chhak to Dosinga market and from the Dhamra port main gate to Balisahi. Thousands of people as well as school children depend on these roads for their daily transportation. The irrigation roads which are present at the north and south side of the company is too poor to transport over those. You are kindly requested to take necessary action to complete these roads.	These activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration
5.	Electricity: The electricity provided in Dosinga Panchayat remains only connected two to three days a week i.e. frequent disruptions of electricity takes place, so that people faces a lot of problem due to it. Your are kindly requested to take possible steps provide electricity from the Dhamra Port Grid.	
6.	Drinking Water: There is only one borewell in the Dosinga market on which five villages are dependent named Balisahi, Dosinga, Pradyatnag, Samapatia and Rabindra nagar. But it is a matter of regret that due to the spread of rail iron plates the water pipe is affected. So that the people of Amanagar and Balisahi are unable to get water from it. Kindly take possible steps to install a new borewell at either Amanagar or Balisai	
7.	Dry Fish Ground: The four villages of dosing panchayat named Amanagar, Rabindra nagar, Dosinga, Balisahi depend on dry fish business which is their primary occupation. But the land used by these people is acquired by the Dhamra port and No solution (Permanent land for dry fish) is entitled to these people by company till now.	DPCL will develop the fish drying yard on allotment of land by the district administration. Solar drying process will also be explored.
8.	Recruitment to Local People: Permanent recruitment should be given to the local people of eight panchayat according to their qualification	DPCL has complied with the guideline of Government of Odisha R&R Policy with regards to employment of local people. Proposed expansion will generate direct and indirect employment opportunities. Based on skill, qualification & experience, priority will be given to the local people. Eligible persons shall be trained in skill development centre to enable employability in different sectors

S. No.	The points represented	Replies from Project Proponent/DPCL
9.	Drainage of Water: Water drainage system of villages named Amannagar, Dosinga, Pradyat nagar, Rabindra nagar, Chianipali, Balisahi is exported through Dhamra port (temporarily). Your are requested to take permanent steps to build new water drainage system.	Storm water drainage network is planned to facilitate proper drainage of the area. The proposed project will ensure water passage and access to the sea by implementing appropriate storm water management plan.

2) Kanchanbala Mohanti

Table 7-3: Replies to Written Representation - II

S. No.	The points represented	Replies from Project Proponent/DPCL
	In my opinion shared by many in the community, Adani Dhamra Port is the most significant industrial development in Odisha in the last 50 years. The immediate periphery has been greatly benefited and the entire hinterland today stands in the cusp of an industrial boom. Most socio-economic indicators in the neighbourhood show dramatic improvement and it is a matter of pride and common sense to support the port's expansion.	DPCL is thankful to all the community for their necessary support in development of Dhamra Port. DPCL being a socially and Environmental responsible Organisation, will always be committed for working towards betterment of the society and surrounding environment.

3) Er. Kiran Kumar Behara, Odisha Matshyajibi Forum State Executive Member & President District Committee

Table 7-4: Replies to Written Representation - III

S. No.	Concerns of Odisha Matsyajibi Forum	DPCL Replies
	We, on behalf of Odisha Matshyajibi Forum (OMF) a trade union of small and traditional fishworkers of Odisha, are deeply concerned about the "Revised Master Plan Development of Dhamra Port, Odisha". We have minutely studied the Executive Summary and found that the proposed project, if goes ahead will severely and irreparably affect the environment and ecology of the Bhadrak-Kendrapara coastal area, including the fish resources. It will eventually inflict large scale damage to the livelihood of the fisher folk living in the 72 coastal fishing hamlets of the -districts of Bhadrak and Kendrapara. We have also observed that the Executive Summary document, since placed in the public domain, faults to provide a lot of vital information and/or clarification on a number of important issues pertaining proposed project. Our objections to and queries regarding the proposed "Revised Master Plan Development of Dhamra Port, Odisha" are placed below.	Based on ToR granted by MoEF&CC, EIA Studies have been carried out for the development of Revised Master Plan Development of Dhamra Port. All the probable impacts associated with construction and operation phases on all the environmental (Terrestrial/ Marine) and social parameters have been studied and appropriate mitigation measures were proposed for sustainable development. Dhamra port is an existing port which is operational since 2011. Dhamra port and fishing harbour are coexisting in the area and fishermen are well aware of the Dhamra port. Impact on Fishing activity & mitigation measures as required due to expansion of Dhamra port are studied in detail and covered under Section 7.8.1.3 of Social Impact Assessment in the CEIA/EMP report.
(A) Environmental impact of port and harbour:		
1.	The various activities such as capital dredging, reclamation and construction of breakwaters would result in varying potential impacts on the seawater quality and marine biology of the coast. The direct impacts on seawater quality from construction would be increased turbidity due to suspended sediment, which would result in indirect impacts on marine biology.	The site provides natural protection for a tranquil harbour where no breakwater is required. Impact due to capital dredging and its disposal along with mitigation measures is addressed in Section 5.4.2 of CEIA/EMP report of Revised Master Plan development of Dhamra port. Marine Ecology of this environment is already subjected to the changes due to maintenance dredging activities and hence the net impact will be minimal. It can be inferred that dredging would cause a short-term and localised impact on marine water quality.

S. No.	Concerns of Odisha Matsyajibi Forum	DPCL Replies
		However regular monitoring of Marine water quality and sediments will be carried out. Environment management plan is proposed and details are provided in Chapter 9 of the CEIA/EMP report. Impact due to reclamation along with mitigation measures is addressed in the Section 5.2.1.4 of Chapter 5 of CEIA/EMP Report.
2.	The seawater quality will be impacted through discharge of oil and oily wastes, sanitary wastes, spillage from the dredgers, barges and workboats involved in capital dredging, reclamation and construction of breakwaters. The impacts on seawater quality would in turn result in impacts on the marine biology of the Dhamra coast.	No discharge from the dredgers or work boats shall be allowed into marine waters. It will be ensured that barges/workboats have slop tanks for collection of liquid/solid waste generated on board and Oil spill control measures will be adopted Spills if any while fuelling dredgers, barges, workboats, etc. Capital dredging is a short term activity, however all the dredged material shall be utilised for reclamation and creation of back up area. However regular monitoring of Marine water quality and sediments will be carried out. The impact and mitigation measures are discussed in Section 5.4 of Chapter 5 in CEIA/EMP Report. Environment management plan is proposed and details are provided in Chapter 9 of the CEIA/EMP report.
3.	There would be a number of vessels in the Dhamra Port offshore area during construction. The operation of diesel engines of dredgers, barges and workboats involved in the construction activities would generate underwater noise. The capital dredging, reclamation and construction of breakwaters would also generate underwater noise, relatively to a lesser extent compared to the operation of diesel engines.	The impact due to Noise during construction and operation phase and mitigation measures is addressed in Section 5.7 of CEIA/EMP report of Revised Master Plan development of Dhamra port.
4.	The natural setting of the seabed and benthos will be impacted (or disturbed) by capital dredging, reclamation and construction of breakwaters. The impacts would be manifested in the form of changes to the seabed, beach profile and reduced photosynthesis activity.	Further, Impact due to capital dredging and its disposal along with mitigation measures are addressed in Section 5.4.2 of CEIA/EMP report of Revised Master Plan development of Dhamra port.
5.	Port pollution and impacts of ancillary industrial development in the region will increase the pollution load. During the operation of ports, spillage or leakages from the loading and unloading of cargo and pollution from oil spills are common due to poor adherence to environmental laws and standards. This along with ancillary industries in and around the port also can contribute to pollution thus affecting fisheries.	The Comprehensive EIA/Studies have been carried out for the development of Revised Master Plan Development of Dhamra Port All the probable impacts associated with construction and operation phases on all the environmental (Terrestrial/ Marine) and social parameters have been studied and appropriate mitigation measures were proposed for sustainable development. The effective implementation and close supervision of the environmental management to mitigate the environmental impacts, which are likely to arise due to the construction and operational phases of the project could be achieved through a suitable institutional mechanism. The same was already provided in Chapter 9 of the CEIA/EMP report including Environmental Management Cell to ensure the adherence to environmental laws and standards.

S. No.	Concerns of Odisha Matsyajibi Forum	DPCL Replies
		Based on Air Quality Modelling studies, it is found that the resultant concentrations are well within the NAAQS at all receptors. Provision of STP, ETP, Storm water management system, Settling Ponds, Desalination Plant, Intake/Outfall System, Recycle and Recuse of Treated Water, Ballast water Management, Prohibited discharges of Bilge water & exploring the option to provide of reception facilities etc., are made to minimise the impact due to discharges., Spills do not occur during normal operations including during normal fuelling operations, as the cargo will be handled by mechanised ship-loaders/unloaders. Oil Spill contingency plan will be updated inline to the expansion and will be implemented. Presently, there are no Ancillary Industries present around the Dhamra Port. However, the ancillary industries development in future shall add additional socio-economic benefits such as employments etc., and also all those industries will have necessary clearances and an effective environmental management measures to adhere with the State/Central statutory regulations requirements.
6.	Bilge and ballast water will destroy the local marine environment. The water discharged during the cleaning of a ship and the discharge of ballast water is a well-known threat to marine ecosystems. In fact the introduction of invasive marine species into new environments (from ballast water or from organisms attached to ships' hulls and via other vectors) has been identified as one of the four greatest threats to the world's oceans.	Ships are prohibited from discharging wastewater, bilge, oil wastes, etc. into the near-shore as well as harbour waters and ships would also comply with the MARPOL regulation. In Dhamra port, provision of reception facilities will be explored to receive the residues and oily mixtures generated from ship operations according to provisions of the International Convention for the Prevention of Pollution from Ships, 1973/78 (MARPOL). In addition, reception facilities for garbage, waste oil and bilge water from the ships shall also be provided. The bilge water will be collected by authorised waste recyclers and taken for further treatment. Ballast Water Management was discussed in Section 5.4.3.2 of Chapter 5 of the CEIA/EMP report of Revised Master Plan development of Dhamra port. Ballast water management guidelines are applicable for ships and there are no guidelines for ports and harbours. The guidelines to ships issued by DG Shipping vide Merchant Shipping Notification No. 13/2001 requires the ships to follow guidelines promulgated through International Maritime Organisation (IMO).
It is to be noted that the Dhamra port is situated on a most ecologically sensitive area that not only has mudflats and mangroves that provides a nursery of fish. The eco-sensitive area also harbours Bhitarkanika Wildlife Sanctuary, Bhitarkanika National Park and Gahirmatha (Marine) Wildlife Sanctuary. The Executive Summary states that the proposed project is only 1.5		Revised Master Plan Layout is outside the Eco Sensitive Zone of Bhitarkanika Sanctuary & National Park. It is pertinent to mention that Dhamra Port is operational since 2011, without having any adverse impact on the national Parks and Sanctuaries.

S. No.	Concerns of Odisha Matsyajibi Forum	DPCL Replies
	kilometers from the Bhitarkanika National Park. It goes beyond doubt that the environmental impact on air, water and marine life will have adverse effect on the eco-system of the National Park and Wildlife Sanctuaries. The proposed project is absolutely impermissible on these grounds	The CEIA Studies have been carried out for the development of Revised Master Plan Development of Dhamra Port. All the probable impacts associated with construction and operation phases on all the environmental (Terrestrial/ Marine) and social parameters have been studied and appropriate mitigation measures were proposed for sustainable development. The impacts on the mangroves were studied and presented in Section 5.5.1.1 and mitigation measures were suggested in Section 5.5.1.2 of CEIA/EMP report.
(B) Impact on the Livelihood of the Traditional fishermen community:		
1.	Restrictions of fisherman to marine will result in loss of livelihood: Besides displacement, the other important concern expressed by fishing communities is the restriction of access to fishing grounds around a port. The extent of such restrictions varies but this usually involves denying access to the near-shore waters, area of the main port channel and parts of shipping routes around the port as well as passage across the port area and shipping routes.	No R&R is envisaged for the expansion of Dhamra port. In CEIA/EMP report, Under Social Impact Assessment (7.8), the Section 7.8.1.3 detailing out impact on Fishing activity and concerns/impacts likely to arise due to expansion of Dhamra port. Fishing harbour is located in Dhamra River at 6.5 km southwest boundary of the port. The fishing boats travels all through the Dhamra River and enter into sea. The approach channel of the port is oriented from south to north east whereas fishing boats travels from south to east. Fishing is being carried out at deep sea. Therefore, significant impact on fishing is not envisaged. Fisher folks are allowed to access the sea through earmarked water route around the port area, under safety consideration.
2.	Ship traffic will have negative impact on fisherman. Ship traffic near the port is a source of danger to fishing vessels and fishing nets. Due to the risk of destruction and loss of nets by ship traffic, fishermen often don't fish near port waters. It is a common experience that ports have negative impacts on marine life due to pollution and traffic. There is reduction of fish resources around the port areas.	Dhamra port is an existing port which is operational since 2011. Dhamra port and fishing harbour are coexisting in the area and no adverse impact has been reported so far.
3.	Impact of loss of beaches due to shoreline impact of ports. This is perhaps the most long-term, permanent and perhaps irreversible impact of ports. This threatens not only fisher folk and coastal community housing but also fishing livelihoods as the beach space is integral to the fishing occupation.	Shoreline change modelling studies were carried out by premier scientific institutions and no such impact has been predicted.
(C) The queries: We need the following information to further assess the proposed project.		
1.	A copy of the draft EIA report	As prescribed under EIA notification 2006, & subsequent amendment, the soft and hard copy of draft EIA report and Executive Summary were made available in the offices within whose jurisdiction the project is located during the stipulated period. Same could have been obtained for inspection during normal office hours till the date of public hearing.
2.	A copy of the physical and land use map of the area with the layout of existing port facilities and proposed expansion clearly indicating the land water areas both under use by existing port facilities and to be used by the proposed expansion including shipping	Layout of the Dhamra port and proposed expansion including Proposed area to be reclaimed is given as Figure FD0202 and Figure FD0203 along with co-ordinates.

S. No.	Concerns of Odisha Matsyajibi Forum	DPCL Replies
	routes to and from the port	
3.	The details of the mangroves, mudflats, and the saltpans reclaimed for the port activities from construction/ commencement of the port till date	No mangroves, mudflats and the saltpans are reclaimed for the port activities from construction/ commencement of the port till date.
4.	The details of the creek and mudflats reclaimed, trained, altered and diverted for the proposed port activities construction/ commencement till date	No creek and mudflats reclaimed, trained, altered and diverted for the proposed port activities construction/ commencement till date.
5.	The total area proposed to be reclaimed along with the GPS coordinates for the same along with the present land use	The Proposed area to be Reclaimed is given as Exhibit 1-2 of Chapter 1 of CEIA/EMP report. Layout of the Dhamra port and proposed expansion including Proposed area to be reclaimed is given as Figure FD0202 and Figure FD0203 along with co-ordinates
6.	The approved CZMP Maps as per 1991 and 2011 CRZ Notification on 1:4000 scale demarcating the existing and proposed project activities and project boundaries	The project layout superimposed on HTL, LTL and CRZ setbacks is given as Figure FD0204 of CEIA/EMP report.
7.	Data on capacity utilisation of the existing Dhamra Port cargo handling facilities.	Presently M/s Dhamra Port Company Ltd has got the permission to handle 96.30 MTPA (break bulk, general, break bulk, liquid & gas) + 1 MTEU container cargo.
We would like to know if the port authorities have any record regarding:		
1.	How and to what extent the local people (fishermen community) were affected (meaning displacement, loss of livelihood etc.) by Dhamra Port and have been compensated/benefitted by the port authorities till date?	DPCL has complied with the guideline of Government of Odisha R&R Policy during earlier phase of development. No R&R is envisaged for the expansion of Dhamra port
2.	How and to what extent the fisher folk have got benefits from the Port Authority CSR schemes on Education, Health care, rural infrastructure?	In CEIA/EMP report, the Section 8.6 on Corporate Social Responsibility (CSR) detailing out the activities taken by M/s DPCL in the region for local community including the fisher folk in the various heads such as Education, Community Health, Sustainable Livelihood Development and Rural Infrastructure Development.
3.	How many displaced traditional fishermen were employed by the port authorities?	There has been no displacement of traditional fishermen
4.	How the DPCL provided the alternative sustainable livelihood for the affected fisher people till date?	Not relevant as the livelihood of fisher people has not been impacted.

4) Sri. Prasad Khale, Conservation Officer, Conservation Action Trust

Table 7-5: Replies to Written Representation - IV

S. No.	Concerns of CAT	DPCL Replies
1.	Please furnish us with the copy of the draft EIA report	As prescribed under EIA notification 2006, & subsequent amendment, the soft and hard copy of draft EIA report and Executive Summary were made available in the offices within whose jurisdiction the project is located during the stipulated period. Same could have been obtained for inspection during normal office hours till the date of public hearing.
2.	Has the EIA report prepared in full compliance with the TORs issued by the Ministry?	Yes
3.	Has the EIA been prepared in line with MoEF	Yes

S. No.	Concerns of CAT	DPCL Replies
	guidelines for ports and harbours?	
4.	Furnish a legible copy of the port layouts, proposed activities, etc.	All the information requested were part of the draft EIA report submitted for Public Consultation.
5.	Please furnish full details of the field visits conducted to undertake the ecological study including copies of the field notes. Please mention full details of the team members, their qualifications, and the number of man-days spent on the ecological data collection.	The studies were conducted by NABET accredited team of experts and the details are given at the beginning in the CEIA/EMP Report.
6.	Please furnish full details of the field visits conducted by Consultants to undertake the marine ecological and hydrology studies including copies of the field notes. Please mention full details of the team members, their qualifications, and the number of man-days spent on the ecology and hydrology data collection.	The details given in CEIA/EMP report along with their period of involvement.
7.	Please furnish copies of all the environmental, Stage 1 and 2 forest clearances and CRZ clearances granted for the existing Port.	Available in Appendix A of the CEIA/EMP report.
8.	Kindly furnish the port present and proposed expansion map demarcating the ESZ of the Bhitarkanika National Park as per the Notified ESZ, as well as the other Sanctuaries and their ESZs.	Layouts of the Dhamra port and proposed expansion are given from Figure FD0202 and Figure FD0203 of Chapter 2 of the CEIA/EMP report and is outside the Eco Sensitive Zone of Bhitarkanika Sanctuary & National Park.
9.	Have all the clearance conditions laid down by the MoEF&CC, OSPCB, OSCZMA Forest Department etc. being complied with? Please provide the compliance and monitoring reports of the same	Yes. Details furnished at Appendix A of CEIA/EMP report.
10.	Kindly furnish us with the details of the mangroves, mudflats, and the saltpans reclaimed for the port activities from construction/ commencement of the port till date.	No mangrove, mudflats and the saltpans reclaimed for the port activities from construction/ commencement of the port till date.
11.	Kindly furnish the details of the creek and mudflats reclaimed, trained, altered and diverted for the proposed port activities construction/ commencement till date.	No creek and mudflats reclaimed, trained, altered and diverted for the proposed port activities construction/ commencement till date.
12.	The total area proposed to be reclaimed along with the GPS coordinates for the same along with the present land use.	Proposed Expansion area to be Reclaimed is given as Exhibit 1-2 of Chapter 1 of CEIA/EMP report.
13.	Please provide the details on heavy metal content in the mangroves, Mudflats, water and surrounding areas due to the port activities till date. What is the expected deterioration of water quality after the expansion of the port?	Heavy metal content of marine water around the Dhamra port is given in Table 4-21 of Section 4.6.4.1 and of marine sediment around the Dhamra port is given in Table 4-22 of Section 4.6.5 of Chapter 4 of CEIA/EMP report. Impacts on water quality is provided in CEIA/EMP Report and Appropriate remedial measures have been considered and marine water quality monitoring shall be carried out regularly to check any deterioration of water quality.
14.	What studies has been conducted to ascertain the presence of heavy metals in the study area?	A reputed academic and research institute was engaged to carry out the marine environment surveys to monitor the marine environmental attributes in the project region in terms of seawater quality including heavy metals, sediment quality including heavy metals and marine biology (plankton and benthos).
15.	Kindly provide the approved CZMP Maps as per	The project layout superimposed on HTL, LTL and

S. No.	Concerns of CAT	DPCL Replies
	1991 and 2011 CRZ Notification on 1:4000 scale demarcating the existing and proposed project activities and project boundaries.	CRZ setbacks is given as Figure FD0204 of CEIA/EMP report.
16.	What is the drainage pattern of the port area? Kindly provide the colour copies of the maps/ diagrams of the same.	Details and the Drainage plan of the project study area with 15km buffer are shown in Figure 4-12 of Chapter 4 of CEIA/EMP report.
17.	Kindly provide us with the copies of the Site inspection reports carried out by various authorities like Forest department, OSCZMA, OSPCB or any other monitoring authorities.	With reference to Revised Master plan, RO-MOEF&CC, Bhubaneswar has carried out site visit on 12 th Feb 2018 to check the status of compliance to the conditions of existing unit. Inspection report is awaited
18.	Have there been any studies conducted to study the impact of the port operations on the surrounding areas since its commencement till date? Kindly provide us with the copy of the same.	Required studies have been conducted by reputed institutions and their reports are appended to CEIA/EMP report.
19.	Kindly provide us with the list of industries present or proposed within 10 km of the port boundaries along with GPS coordinates.	As on now, no details of proposed industries are available. However The proposed project shall further act as a catalyst to industrialization and urbanization of the region.
20.	Have there been any carrying capacity study of the region undertaken by the project proponent? Kindly provide us with the copy of the same.	Based on the ToR granted by MoEF&CC, CEIA study for the Revised Master Plan development of Dhamra port including Anticipated Environmental Impacts and Mitigation Measures has been carried out covering the extreme impacts (considering 30 Year Development Plan) with quantification wherever possible and management plan is given in Chapter 5 and Sections 9.4, 9.5 and 9.6 of Chapter 9.
21.	Kindly provide Comprehensive Cumulative Impact Assessment report of the industries and infrastructural activities taking place within 10 km of the port boundaries. If the study has not been undertaken, kindly provide the reasons for the same.	Studies have been conducted as per ToR guidelines.
22.	Kindly provide the total area, GPS coordinates and land use patterns of the areas proposed to be reclaimed for the entire project.	A view of the Proposed Expansion Site area to be Reclaimed is given as Exhibit 1-2 of Chapter 1 of CEIA/EMP report. Layout of the Dhamra port and proposed expansion including Proposed area to be reclaimed is given as Figure FD0202 and Figure FD0203 along with co-ordinate.
23.	Details of the total mangroves that will be cleared, mudflats and sea that will be reclaimed should be provided.	Utility Corridor is passing through a patch of sparse mangroves beyond the northern boundary of the project. It is estimated that about 0.1 ha area will come under the utility corridor. As per prevailing CRZ guidelines the corridor will be over piles without affecting tidal flow of water.
24.	What will be the impact of reclamation on tidal and current patterns? What areas will face erosion due to this reclamation?	The summary and details of Flow modelling are provided in Section 2.7.1 of Chapter and Section 5.4.1.1 of Chapter 5 respectively. The summary and details of shoreline changes study are provided in Section 2.7.5 of Chapter and Section 5.2.3.4 of Chapter 5 respectively. As per the modelling studies, variation in the flow regime (in the current speeds) after the expansion is limited to the development location mostly and found to be very much local in nature.

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		The shoreline modelling studies shows mostly accretion in the stretches studied, whereas erosion was observed on the north side of expansion area and on the south side of River Dhamra. However periodically monitoring of shoreline with the help of high resolution satellite imageries during operation will be carried out and based on the results appropriate remedial measures such as beach nourishment/ creation of sand trap/ any other suitable methods will be done to maintain the stability of coast.
25.	Please give full details of new roads and railway lines to be constructed for the proposed project and roads to be widened, including details of forest lands, CRZ areas, ESZs, etc. impacted by the new roads and rail lines or by road widening. Kindly furnish the environment impact assessment report of all the infrastructural proposals to be developed for the port passing through agricultural areas, forest areas, wildlife corridors, etc. along with the mitigation measures for the same.	Dhamra port has already constructed a rail link of 62.5 Km with single line track, connecting the port with the Indian Railway network near Bhadrak railway station. The port has acquired 125 m wide land corridor from Dhamra to Bhadrak for providing exclusive connectivity with the hinterland. Approval has already been obtained for 4 lane road and 2 rail tracks (as a part of Phase I & II Clearance). EC/CRZ Clearance Letters for Phase I Development, Phase II & Amendment to Phase II are given in Appendix A of the CEIA/EMP report. As a part of Revised Master Plan, it is to further develop additional 2 lane road and 1 rail tracks in the existing corridor. In addition, for easy evacuation of cargo, a new rail, road and utilities corridor (12 km x 125 m wide) is proposed from Northern side development of Dhamra Port. This corridor will connect Dhamra port with existing rail-road corridor near Bansada, Bhadrak. Number of lanes and tracks will be finalised during detailed engineering by using the entire available width. Development of Norther UC (mostly Rail corridor) beyond the project area on the northern side will be taken up as a separate project. Necessary clearances from the relevant authorities such as Department of Railways etc. will be carried out after finalisation of route up to Bansada, Bhadra (where it shall meet existing rail route). Proposed north side road/rail/utility corridor falls under CRZ-IB, CRZ-III and partly passing through sparse mangroves (CRZ IA).
26.	Furnish the details of the coal theft that the port faces while transporting coal from the port to the users. What measures have been taken till date to address the same?	The administration in charge of law and order are aware of the situation and are addressing the issue.
27.	Have there been any incidents of fire at the port? If yes, kindly furnish the details of the cause and the loss incurred by the port due to the same. Did the fire cause death of any persons?	No such incident occurred.
28.	Have there been any other accidents at the port causing oil spills chemical leak etc.	No
29.	Please furnish the details of the impact of coal dust from coal and open storage of the coal on mud flats,	The impact on air environment due to the operation of Dhamra port during the Revised Master Plan has

S. No.	Concerns of CAT	DPCL Replies
	mangroves, corals and other ecologically sensitive areas around the port within 10 km distance.	been predicted based on air quality modelling studies. The AAQ modelling studies carried out and mitigation measures is discussed in Section 5.6.2 Chapter 5 of CEIA/EMP report.
30.	Please furnish a copy of Cumulative Impact Assessment Report.	The possible impacts have been dealt in Chapter 5 and Sections 9.4, 9.5 and 9.6 of Chapter 9 of CEIA/EMP report.
31.	Using the satellite data, kindly furnish the land use changes due to the port operations	Land use/Land cover of Project site/area is discussed in Section 4.4.2.3 and provided in Figure 4-7 of Chapter 4 of the CEIA/EMP report.
32.	Please furnish data on the flora and fauna found in the area.	The details of the same are discussed in Section 4.7 of Chapter 4 of CEIA/EMP report.
33.	What measures have been taken to protect the diversity of the area?	The Detailed Environmental Management Plan is given as Chapter 9 of CEIA/EMP Report which includes measures for protection of biodiversity of the locality.
34.	Are there any near threatened, vulnerable, endangered, critically endangered species of flora and fauna found in the area? Please furnish with details of same.	The details of the same are discussed in Section 4.7 of Chapter 4 of CEIA/EMP report.
35.	Are there any species under Schedule 1 and II of the Wild Life Protection Act (1972) observed in the area? Please furnish with the details of same.	The details of the same are discussed in Section 4.7.3 of Chapter 4 of CEIA/EMP report.
36.	Are there any marine mammals in the study area? Please furnish the details of the same	The details of the same are discussed in Table 4-57 of Section 4.7.3 of Chapter 4 of CEIA/EMP report.
37.	Provide the shoreline change maps of the coast from the date of commencement of port operation till date	The Shoreline change status in 15 km radius of Dhamra Port is shown in the Figure 5-1 of Chapter 5 of the CEIA/EMP report.
38.	Furnish the details of the mangroves within the port premises and within the study area. In case the mangroves have been destroyed for the port related activities, construction of breakwaters and other ancillary activities, kindly furnish all the forest clearances, permissions from the requisite authorities.	No mangroves have been destroyed during port development. The site provides natural protection for a tranquil harbour where no breakwater is required. 9 Ha scattered mangroves in the port premises have been excluded from the port activity and conserved by fencing the area. Mangrove present in the study area has been detailed in the CEIA/EMP report. Forest clearance is not applicable
39.	Please furnish a complete list of mangroves found in the study area along with the photographs and GPS Coordinates.	Mangrove species in the Core and Buffer zones is given in Table 4-53 of Chapter 4 of the CEIA/EMP report.
40.	What is the change in Mangrove cover in the study area from the date the project was established till today? Kindly furnish earliest available satellite data with mangrove areas and the recent most satellite data.	Land use/Land cover of the study area including mangrove cover is discussed in Section 4.4.2.2 and Figure 4-5 of Chapter 4 of the CEIA/EMP report.
41.	Please furnish data on the present status of the number of ships/cargo/container operating daily at the Port.	The details are discussed in Section 2.3 and Table 2-1 of Chapter 2 of the CEIA/EMP report.
42.	What will be the impact of the proposed expansion on the livelihoods of the coastal communities?	In CEIA/EMP report, Under Social Impact Assessment (7.8), the Section 7.8.1.3 detailing out

S. No.	Concerns of CAT	DPCL Replies
		impact on Fishing activity and concerns/impacts likely to arise due to expansion of Dhamra port.
43.	Please provide details of the fish catch available in the area over the past 10 years.	The details about the fish catch for the fish landing at Dhamra Fishing harbour is given in Table 4-24 of Section 4.6.6.3 of the CEIA/EMP report.
44.	What impacts will the proposed project have on the fish catch and diversity? What are the mitigation measures for the same?	In CEIA/EMP report, Under Social Impact Assessment (7.8), the Section 7.8.1.3 detailing out impact on Fishing activity and concerns/impacts likely to arise due to expansion of Dhamra port. Marine Biodiversity Management Plan is provided as Section 9.4 of Chapter 9 of CEIA/EMP report.
45.	How many fisher folks are dependent on traditional fishing around the proposed project area?	The details are provided in Table 4-37 of Section 4.6.6.2 of Chapter 4 of the CEIA/EMP report.
46.	Are there any compensation plans for the local fishermen? Please furnish details of the same.	In CEIA/EMP report, the Section 8.6 on Corporate Social Responsibility (CSR) detailing out the activities taken by M/s DPCL in the region for local community including the fisher folk in the various heads such as Education, Community Health, Sustainable Livelihood Development and Rural Infrastructure Development. No compensation plan is envisaged.
47.	Have any studies been undertaken to check presence of invasive fish species in the proposed area? Please furnish details of the same.	No
48.	Please furnish data of the increase in the number of ships and barges after the proposed expansion of the port.	Total Number of vessels expected to be berthed continuously for 30 Year revised Master Plan are around Fifteen to Sixteen (15 to 16) ships per day and around Seven (07) for 5 Year revised Master Plan.
49.	Please give details of the capital dredging and the maintenance dredging. Will the dredged materials be used or will be disposed of? Please provide the details in case of the location of disposal of the dredged material and the impact of the same.	The details of the capital dredging, maintenance dredging, reclamation with the dredged material and offshore disposal are provided in Section 2.8.17 and Section 2.8.18 of Chapter 2 of the CEIA/EMP report. Impact due to Dredging and Disposal of Dredged Material is provided in Section 5.4.2.1 of Chapter 5 of CEIA/EMP Report.
50.	Please furnish details of how dredging will be carried out to reduce the turbidity.	Dredge material from the area of proposed development of offshore facilities is initially collected in a hopper bottom dump barge/ Trailer Suction Hopper Dredger (TSHD) without affecting the morphology/ecology of the adjacent area. It is proposed to dump the collected material at identified location in the offshore of Dhamra region. Dredge Management Programme / dredging protocol will be implemented to reduce the impact of dredging on marine environment. Regular monitoring of marine water quality shall be carried out to study the turbidity levels and accordingly dredging and disposal will be regulated.
51.	What steps will be taken to ensure that the turtle nesting is not adversely impacted by dredging or by shipping activities?	Details are provided in the Section 9.5 of Chapter 9 of CEIA/EMP report.
52.	Please also give full information about the marine biodiversity and the currents and tidal patterns at the proposed location for disposal.	The marine biodiversity details and current and tidal patterns are discussed in Section 4.6 of Chapter 4 of the CEIA/EMP report.

S. No.	Concerns of CAT	DPCL Replies
53.	What will be the impacts of the disposal on the tidal flow, marine ecosystem and mangroves in the area where the dredged material will be disposed?	The impacts due to disposal of dredged material are discussed in Section 5.4.2.1 of Chapter 5 of CEIA/EMP report.
54.	Is there any specific time allocated for dumping the dredged material at the disposal site, based on the current patterns and the tidal patterns. What would be the best time to dump the dredged material at these locations?	Dredge Disposal modelling studies were carried out for a period of 12 months and accordingly the period of disposal have been fixed for 8 months from December to July. It was observed that the sediment plume from disposal site moves towards north and south and not reaching to the coast or any other eco-sensitive area.
55.	Are there any turtle nesting sites in the study area? Are there any turtle nesting sites where the dredged material is proposed to be disposed of? Please furnish the details.	Dhamra Port is located outside turtle congregation area and the nesting beach. No turtle nesting sites are present where the dredged material is proposed to be disposed off.
56.	What measures have been undertaken by the project proponent to ensure that light pollution, ship movement and port activities of any kind do not impact the turtle nesting in the region? Kindly furnish the studies and reports relied upon.	Details are provided in the Section 9.5 of Chapter 9 of CEIA/EMP report.
57.	What mechanisms/ techniques are proposed to be used for dredging the channel? What impacts will this machinery have on the geology and marine life in the area?	Dredging management plan / dredging protocol will be followed. Dredge material from the channel area of proposed development of offshore facilities is initially collected in a hopper bottom dump barge/ Trailer Suction Hopper Dredger (TSHD) without affecting the morphology/ecology of the adjacent area. It is proposed to dump the collected material at identified location in the offshore of Dhamra region
58.	What is the maximum quantity of explosives that will be used for blasting at any one time? What kind of explosives will be used? Where will they be stored? How will they be transported?	No blasting activities envisaged.
59.	Will the proposed dredging/ blasting be undertaken at night time?	No blasting activities envisaged. Depending on the activity requirements, dredging will be carried out for 24x7, by following dredge management programme.
60.	What attempts will be made to minimize the noise and vibrations caused by the blasting?	No blasting activities are envisaged.
61.	Has the coastline witnessed any erosion and accretion in the port area or in the study area? If yes, what are the reasons or causes of the same? Please furnish the studies or reports relied upon regarding the same.	The summary and details of shoreline changes study are provided in Section 2.7.5 of Chapter and Section 5.2.3.4 of Chapter 5 respectively.
62.	Furnish the details of the sea walls, groins or any other anti-sea erosion measures undertaken in the port premises or in the study area. Please furnish the GPS Readings and the requisite permissions sought for the same.	No sea walls, groins are constructed
63.	Has a Marine Impact Assessment study been conducted to ascertain the impacts of the ongoing and proposed activities?	Yes. The impacts associated with the development of Revised Master Plan of Dhamra port have been studied and presented in Chapter 5 of CEIA/EMP report.
64.	What is the area of forest lands that has been used for the existing port project? Has forest clearance been sought for the same?	No forest land has been used for the existing port project.
65.	What is the additional forest land required for this project?	No forest land required for Revised Master plan development of Dhamra port.

S. No.	Concerns of CAT	DPCL Replies
66.	Please furnish copies of the NBWL clearances if any, and copies of application made to NRWI if any	Revised Master Plan Layout is outside the Notified Eco Sensitive Zone of Bhitarkanika Sanctuary & National Park and hence NBWL clearance not required.
67.	Furnish the details of the compensatory afforestation undertaken by the project proponent till date along with GPS Coordinates and the present status.	Not applicable
68.	Please furnish the GPS co-ordinates where the mangroves in the proposed reclamation area will be replanted. How much will this cost? And when will the mangrove plantation be complete? What species will be planted? Are there any existing mangroves in the site where the replantation is proposed? Please furnish geo-referenced colour photos of this site.	The details of mangroves abutting the project site, excluded mangrove area and mangrove under Utility corridor etc., and mitigation measures are provided in the Section 5.5.1.1 of Chapter 5 of CEIA/EMP report.
69.	What will the impact of the proposed reclamation on the marine ecology and the shoreline of the area?	Impacts due to Reclamation along with mitigation measures are provided in Section 5.2.1.4 and Section 5.2.1.5 of Chapter 5 of CEIA/EMP Report.
70.	How much time will be required to complete the entire proposed project?	DPCL proposes Revised Master Plan on Five (05) Years and Thirty (30) Years Development Plan.
71.	Kindly furnish the details of the ancillary activities proposed by the project proponent along with the port expansion pertaining to the residences, offices, parking spaces, toilets, light house. etc.	The details are provided in Section 2.8.5.3 of Chapter 2 of the CEIA/EMP report and the respective layouts are presented as Figure FD0203 and Figure FD0204 .
72.	What studies have been conducted to ascertain the impacts of proposed increase in coal transportation and/or storage?	The AAQ modelling studies carried out and mitigation measures is discussed in Section 5.6.2 Chapter 5 of CEIA/EMP report.
73.	Have there been studies conducted on the radioactivity and the heavy metal content in the coal?	No
74.	What are the impacts envisaged on the local communities by the proposed port expansion?	In CEIA/EMP report, Under Social Impact Assessment (7.8), the Section 7.8.1.2 detailing out the impacts on nearby settlements and associated mitigation measures were suggested. Section 7.8.1.3 detailing out impact on Fishing activity and concerns/impacts likely to arise due to expansion of Dhamra port. The positive impacts due to the Revised Master Plan development of Dhamra port is provided in Chapter 8 as Project Benefits.
75.	Are there any plantations or green belt developed by the project proponent? If yes, please provide the details of the species used along with the GPS coordinates of the plantations. The details of the number of saplings planted and the number of saplings that survived should also be furnished.	The details of the greenbelt development including existing greenbelt, species and exhibit showing the plantation are provided in Section 9.3 of Chapter 9 of the CEIA/EMP report.
76.	Please furnish details of the ecological impacts caused by the ballast water from the large ships/ vessels.	Ballast Water Management has been discussed in Section 5.4.3.2 of Chapter 5 of the CEIA/EMP report of Revised Master Plan development of Dhamra port.
77.	What is the impact of ballast water on marine biodiversity? What provision is being made in this project to handle ballast water, bilge water, etc? Does the port comply with the national and international standards for Ballast water management?	The port complies the national and international guidelines for ballast water management. Ballast Water Management has been discussed in Section 5.4.3.2 of Chapter 5 of the CEIA/EMP report of Revised Master Plan development of Dhamra port.
78.	What facilities are provided in the port as required under the MARPOL convention and for ballast water?	Ships visiting the port have to comply with MARPOL convention.

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79.	Please provide the details on the expected deterioration of water quality	Regular monitoring of marine water quality shall be carried out. Based on the monitoring results and if required, appropriate remedial measures will be taken.
80.	What is source of water during construction and operation? How are the sewage and the effluents of the port being treated?	Water during the construction and operation phases of the project will be sourced from existing intake point at Matai River. STP of 1 MLD capacity during 5 year development and 2 MLD (Cumulative) capacity during 30 year development and ETP of 3 MLD capacity during 5 year development and 5 MLD (Cumulative) capacity during 30 year development will be developed. Treated Sewage and effluents shall be reused for dust suppression, irrigating greenbelt and other requirements.
81.	Please furnish a list of complaints regarding pollution caused by the Port and its related activities.	Nil
82.	What steps are being proposed to reduce the existing and proposed pollution?	Anticipated Impacts and Mitigation measures have been proposed in Chapter 5 of the CEIA/EMP report.
83.	Please provide complete details of the Environment Management Plan to be undertaken	Environment Management Plan of the Revised Master Plan development of Dhamra port is provided in Chapter 9 of the CEIA/EMP report.
84.	Are there any traffic studies that have also been undertaken? Please furnish details of the same.	Yes. Traffic and Transportation Study for the Revised Master Plan development of Dhamra port is given in Section 7.4 of Chapter 5 of the CEIA/EMP report.
85.	What is the expected increase in the marine traffic in the area? What will be the impact of the pollution due to increased marine traffic?	Marine Traffic projection has been worked out and detailed in Section 1.6.3.1 of Chapter 1 of the CEIA/EMP report. Anticipated Environmental Impacts and Mitigation measures are suggested in Chapter 5 of the CEIA/EMP report.
86.	Please furnish copies of the transportation studies conducted.	Traffic and Transportation Study for the Revised Master Plan development of Dhamra port is given in Section 7.4 of Chapter 5 of the CEIA/EMP report.
87.	Please furnish copy of the Social Impact assessment study report of the project	Social Impact Assessment is provided in Section 7.8 of Chapter 7 of the CEIA/EMP report.
88.	Were any measures undertaken presently to safeguard the diversity? Please provide details for the same.	The details are provided in Section 9.4 (Marine Biodiversity Management Plan), Section 9.5 (Wildlife Including Turtle Conservation Awareness Programme) and Section 9.6 (Kanika Sand Island Conservation) of Chapter 9 of the CEIA/EMP report.
89.	Kindly furnish us with the Risk assessment of the proposed project.	Risk Analysis is provided as Section 7.2 of Chapter 7 of the CEIA/EMP report.
90.	Does the risk assessment cover the possibility of explosion of the ships transporting gas or the gas storage facilities?	Yes
91.	How many jobs were provided to locals living with 25 km of the existing port during the construction of the existing port?	More than 500 persons are currently being working in the construction areas.
92.	How many locals are currently working in the port, and what kind of jobs have they been given? How many of these jobs are permanent?	Around 1000 persons (within 25 KM radius) are currently working in the Operations & Maintenance areas. In the current operating conditions, these jobs are regular in nature.
93.	Please furnish details of meetings held with fisher folk and their representatives, and how their	Regular interaction are being held by CSR team to understand their grievances

S. No.	Concerns of CAT	DPCL Replies
	grievances have been resolved. How many meetings have been held since 2011?	
94.	Please provide details on the change in noise levels during the operation phase of the proposed project. Please furnish with mitigation measures of same.	Potential impacts on noise due to port operation are discussed in Section 5.7.2 and mitigation measures suggested are in Section 5.7.2.1 of Chapter 5 of the CEIA/EMP report.
95.	What are the dust control measures that will be used to suppress the fugitive dust emissions from the cargo, vehicles and DG sets etc. kindly provide the details of all the machinery that will be used for the same?	The details are provided in Section 5.6.2.7 of Chapter 5 of the CEIA/EMP report.
96.	Would the proposed project be Zero wastewater discharge project after modernization?	No
97.	What are the measures that will be used to treat water used for fugitive dust emission control measures? Please provide the details of the CETPs (existing or proposed) that will be set up for handling the same.	The details of the treatment of water used for dust control are provided in Section 2.8.24.2 of Chapter 2 of the CEIA/EMP report. DPCL has installed a Sewage Treatment Plant (STP) to handle 140 KLD of sewage. No CETP is proposed as a part of Revised master plan.
98.	Where and how is the sewage water disposed? Kindly provide the details of the STPs operational or proposed, if any. What will the STP discharges be used for during the monsoons?	The details are provided in Point no. 97 above.
99.	How is the ambient air quality being monitored in the port area as well as the study area? Kindly provide the readings of the ambient air monitoring in the port area.	Regular Ambient Air quality is being monitored as part of Post-EC monitoring plan. The details are provided in Compliance to the conditions of EC/CRZ in Appendix A of the CEIA/EMP report.
100.	It is observed that Odisha coast is prone to cyclones. How many cyclones have affected the port areas till date? provide the details of the same.	The details for the same are given in Section 4.9 of Chapter 4 of the CEIA/EMP report.
101.	What are the threats to the port from the constant sea level rise and global warming?	Risks associated with the natural disasters such as Tsunami, Cyclone, Hurricane and Earthquake etc., are discussed in Risk Analysis provided in Section 7.2.1.7 of Chapter 7 of the CEIA/EMP report.
102.	In the event of an oil spill or any other chemical spill including the coal dust the mangroves and marine biodiversity would be impacted. What steps are proposed to be undertaken to prevent such incidents? What will be the mitigation measures that the project proponent will undertake in case such incidents occur?	Oil spill contingency plan is discussed in Section 7.3.19 of Chapter 7 of the CEIA/EMP report. Chemical spills will not occur in normal operation and in the event of accidental spills, as the accidental spills will be in harboured waters, it would not spread spatially and the response time for shutting down the fuelling, containment and recovery will be quicker. The mitigation measures for air impacts including coal dust are provided in Section 5.6.2.7 of Chapter 5 of the CEIA/EMP report. The impacts associated with the development of Revised Master Plan of Dhamra port have been studied and presented in Chapter 5 of CEIA/EMP report along with the necessary and appropriate mitigation measures to be followed.
103.	Please furnish a list of existing equipment available at Dhamra port for disaster management.	The details are discussed in Section 7.3 under Disaster Management Plan of Chapter 7 of the

S. No.	Concerns of CAT	DPCL Replies
		CEIA/EMP report. List of Oil Spill Response Equipments are given in Section 7.3.19.11 of Chapter 7 of CEIA/EMP report.
104.	What are the existing facilities for the parking, washing, repairs and maintenance of trucks and other heavy equipment?	We have one washing ramp for cleaning heavy equipment and trucks with ETP facility. For company own equipment repair purpose workshop facility available.
105.	How can the brine discharged from the desalination plant have lower TDS than the receiving waters?	This is because the intake for the Desalination plant will be from the existing intake point of DPCL at Matai River and discharge of the Desalination plant will be into the sea.
106.	Why is the intake of the desalination plant from the river and not from the sea?	DPCL already has an intake point at Matai river for existing WTP.
107.	Please furnish full details and show on a map the area allotted for parking of trucks and storage of containers both inside and outside the port based on the assessment of the maximum number of trucks and containers that will be handled at any given point of time.	Layouts of the Revised Master Plan development of the Dhamra port are provided in Figure FD0202 and Figure FD0203 of Chapter 2 of the CEIA/EMP report.
108.	What facilities will be provided for the drivers and cleaners?	Separate rest rooms and dining rooms with all adequate facilities will be provided.
109.	Have the requisite permissions for the desalination plant at the port premises been sought? Please furnish us with the copies of the clearances.	Desalination Plant is being proposed as a part of Environmental and CRZ clearances of Revised Master Plan Development. Hence necessary permission from MoEF&CC for the entire project components has been sought.
110.	What will be the concentration of salts and other minerals in the rejected water from the desalination plant?	The details of the Desalination Plant System are discussed in Section 2.8.22.1.1 of Chapter 2 of the CEIA/EMP report.
111.	What will be the impact of the desalination plant on the marine biodiversity? Kindly furnish us with the studies and reports relied upon for the same.	Water of river Matai remains potable from July to February. During the remaining four months, the water of Matai is saline in nature due to tidal influx. The reject brine will be discharged into the sea through an outfall arrangement. The reject TDS from the desalination plant discharged into the sea will be much lesser than the TDS value observed for the seawater in the region. Hence no/negligible impacts are envisaged due to discharge of reject brine from the outfall arrangement. However regular marine monitoring will be carried out to ascertain that no impacts are envisaged because of this activity.
112.	Please give details of existing and proposed mitigation measures to protect the flora and fauna of the area	The details are discussed in Section 5.5 of Chapter 5 of the CEIA/EMP report.
113.	What are the implications of this increased traffic on the defence installations?	No effect is envisaged as the Integrated Test Range (ITR) of DRDO is located at Wheeler Island which is at about 13.0 km towards south-south east of port site.

5) Sri. Priyaranjan Jena, Sarpanch, Dhamara Gram Panchayat

Table 7-6: Replies to Written Representation - V

S. No.	The points represented	Replies from Project Proponent/DPCL
	Adani Dhamra Port is the pride of Bhadrak district and it is with a deep sense of satisfaction that I convey my support to the Port's expansion. The sleepy and poverty stricken area of	DPCL is thankful to all the community for their necessary support in development of Dhamra Port. DPCL being a socially and Environmental responsible

S. No.	The points represented	Replies from Project Proponent/DPCL
	Dhamra today bubbles with prosperity and energy and such growth engines are the need of the day for the state of Odisha. I support the expansion plans of the Port.	Organisation, will always be committed for working towards betterment of the society and surrounding environment.

6) Mr. Debendra Kumar Nayak, Pramod Kr. Nayak, Trilockram Pradhan and Saroj Leme (Villagers, Land loser & project effected persons, Dhamra and surrounding villages)

Table 7-7: Replies to Written Representation - VI

S. No.	The points represented	Replies from Project Proponent/DPCL
	A civilization on the coast of Bay of Bengal in blessing of Goddess MaaDhamarai called as Dhamra in Bhadrak District. Even after 71 yrs of independence, we the poor people are struggling to maintain our life due to lack of facilities. Since 10 years ago a biggest port DPCL operating his business successfully at Dhamra, still than the land looser & project effected persons are facing a lot off difficulty in their day to day life. Kindly look into these matters seriously &take necessary action at earliest.	There won't be any land acquisition or displacement for this project proposal. The issues raised relate to Phase-I land acquisition process, which is being settled by district administration. Some matters are pending in the court of law. DPCL will abide by the orders of the authorities and court. Further, as a socially and Environmental responsible Organisation, DPCL will always be committed for working towards betterment of the society and surrounding environment
1.	Medical Facility: There is no medical facilities to the poor peoples in this area. Even also for any type of common diseases we are travelling a long distance without any care for which there is always panic of serious condition. For serious patients only GOD knows, what will happen?	These activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration
2.	Education: There are primary & secondary schools in our area. But lack of facilities, poor quality infrastructures & campus, shortage of teachers badly effect the quality of education for which the future of the students will effect.	
3.	Drinking Water: Due to salty area, we are facing a lot of problems for drinking water in summer. Even also there so many deep bore wells in this area but they are supplying the water to port area illegally & violating the contracts of DPCL Sweet water level going down as a result, we the poor people facing serious problems.	
4.	Pollution: DPCL stock yard of coal & coal transport by train without cover accumulating huge dust in this area. It is very difficult to breathe even also our house, open ponds, shops & all the area effecting severely	Effective dust suppression measures such as water sprinkling and greenbelt plantations are being taken up to control fugitive coal dust. Wind screens will be provided along stack yard as committed during public hearing. Other dust control measures, mentioned as a part of Environment Management Plan will be implemented. The AAQ modelling studies carried out and mitigation measures is discussed in Section 5.6.2 Chapter 5 of CEIA/EMP report.
5.	Dhamerei Temple: We have a strong faith on our Goddess Dhamarei & she is the only care taker of our present and futures. A sorrowful matter is that even also DPCL operating its business in the name of Maa Dhamarai but no developmental work in temple campus, We are requesting for rest room, garden, flood light & Temple area development	These activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with district administration.
6.	Communication: Choudhary Ghat is the main source of communication to Tahasil head quarter	These activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the

S. No.	The points represented	Replies from Project Proponent/DPCL
	but 1000 of villagers are travelling without any proper communication. Our demand to construct a bridge over Choudhary Ghat.	District Administration
7.	Upgrade the Police Station: Due to rapid industrialization, so many antisocial person are moving in night & breaking the peace of normal life. Even also population is increasing rapidly for which so many cases registering. Continues night patrolling & upgrading the police station is necessary to maintain the law & order in this area.	Issues are related to District Administration
8.	Employment: Our demand is to engage the local people in DPCL as per their qualification & experience. Land looser as well as project effected person should be get the first preference but DPCL engaging outsiders for which it will be a big issue in future,	DPCL has complied with the guideline of Government of Odisha R&R Policy with regards to employment of local people. Proposed expansion will generate direct and indirect employment opportunities. Based on skill, qualification & experience, priority will be given to the local people. Eligible persons shall be trained in skill development centre to enable employability in different sectors
9.	Skill Development Centre: A well skilled development centre or ITI should be open in Port area at earliest so that the local children will gate the facility to build their career. DPCL should take interest and do the needful.	DPCL shall soon be starting Skill development centre & Eligible persons shall be trained to enable employability in different sectors.
10.	Bus Stand: There is no drinking water facility, rest room, bath room in bus stand. Passengers are facing difficulties & polluting the bus stand area Dhamara. We are requesting to upgrade the bus stand & facilitate the Passengers requirement at earliest.	These activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration
11.	Street Light: To avoid any antisocial works, smooth movements & making the peace in our area. We demand to fix the street lights on village roads, PMRY road.	
12.	F. L Shop to close: Liquor use in this area is growing up due to rapid industrialization. It is essential to take step to close the F L Shop permanently & awareness programme should be conduct for ban of consumption of tobacco & liquor.	Issues are related to District Administration
13.	Environment: Road side plantation is necessary for which the pollution control & area beautification will attract the visitors to Dhamra. Area people also save their life from pollution & safe from hot environment.	It is proposed to develop Green belt in an area of 129 Ha as a part of Revised Master Plan (5 Year) and 258.9 Ha (Cumulative) as a part of Revised Master Plan (30 Year). Green Belt plantation will be developed around the port and in the nearby villages.
14.	Stadium: We need a stadium at Dosinga to encourage the sporting life of the children as well as the local peoples. As Dosinga is growing to proud as a port city, a playground is essential for the socio cultural function to maintain a good relationship	These activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration
15.	Road barrier: Main communication Roads to Dosinga gram panchayat in front of port gate are not to be closed	
16.	RPDAC Meeting: Rpdac meeting are to be held Regularly	These issues will be taken up in consultation with district administration
17.	Electricity: use the high voltage Electricity to the Adani Company are to be Connected in 8 Panchayat	Not related to DPCL. Power supply is regulated by Government department.

S. No.	The points represented	Replies from Project Proponent/DPCL
18.	Dry fish: Levying Hood of poor Fishery man Dry Fish yard are to be installed at Chandani pal (Dosi nga)	DPCL will develop the fish drying area on allotment of land by the district administration. Solar drying process will also be explored.
19.	Display Board: Peripheral Development Project Amount are to be display in Name plate for public information	These activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration
20.	Manifesto: it is essential to print a manifesto about the past, present & future plans for 8 GPS contribution of DPCL for the development should be maintained	DPCL will abide by the decisions and plans of the RPDAC committee regarding local area development.

7.1.1 Action Plan from the Project Proponent

The details of the major issues raised during the public hearing and with the written representations are compiled below along with the Action Plan and cost associated for the fulfillment of the action plan.

Table 7-8: Action Plan

Major Issues	Action Plan/Replies of Project Proponent	Financial Allocation
Greenbelt Development	It is proposed to develop Green belt in an area of 129 Ha as a part of Revised Master Plan (5 Year) and 258.9 Ha (Cumulative) as a part of Revised Master Plan (30 Year). The details of the greenbelt development, species and exhibit showing the plantation are provided in Section 9.3 of Chapter 9 of the CEIA/EMP report.	Capital cost for 5 Year Revised Master Plan (including immediate development plan) is INR 71.0 crores and Annual recurring cost for maintenance of greenbelt is INR 7.1 crores.
Impact on Fishing Activity and safe movement of fishing trawlers/ Restrictions of fisherman to marine will result in loss of livelihood	Fisher folks are allowed to access the sea through earmarked water route around the port area, under safety consideration. Section 7.8.1.3 of CEIA/EMP report deals regarding the impact on Fishing activity and concerns likely to arise due to expansion of Dhamra port.	DPCL is committed to carry out CSR activities and will spend INR 15 Crores for next three years. Same will be reviewed on yearly basis and accordingly implemented. CER activities as a part of Revised Master Plan development will be implemented as per MoEF&CC Office Memorandum F. No. 22-65/2017-IA.III dated May 01,2018.
Forest Land	No forest land required for Revised Master plan development of Dhamra port.	-
Queries related to EIA and Public Hearing/Baseline/Impacts and mitigation measures/environment pollution/RA&DMP etc.,	All the queries related to EIA and Public Hearing has been answered in the above responses.	The budgetary estimate for Capital Environmental Management Cost for 5 Year Revised Master Plan (including immediate development plan) is ~INR 1264.2 crores and the annual budgetary estimate during operational phase is ~INR 69.5 crore under different heads such as Greenbelt, Solid Waste Management, Capacity Building, Marine life protection (Oil Spill

Major Issues	Action Plan/Replies of Project Proponent	Financial Allocation
		Management resources), Air Pollution Control, Environmental Monitoring, Effluent Treatment Plant, Sewage Treatment Plant and Settling Pond for Bulk Cargo.
Coal Dust/Fugitive Emission Management including impact on air environment	Effective dust suppression measures such as water sprinkling and greenbelt plantations are being taken up to control fugitive coal dust. Wind screens will be provided along stack yard. Other dust control measures, mentioned as a part of Environment Management Plan will be implemented.	Environment Management Capital cost for 5 Year Revised Master Plan is INR 1067.5 crores which includes (Sprinkler System, Conveyor Belt with hood, Wagon loading, truck loading with Silos) and Annual recurring cost for maintenance of Air Pollution Control system is INR 7.1 cores. Over and above wind screen will be provided.
Employment	DPCL has complied with the guideline of Government of Odisha R&R Policy with regards to employment of local people. Proposed expansion will generate direct and indirect employment opportunities. Based on skill, qualification & experience, priority will be given to the local people. Eligible persons shall be trained in skill development centre to enable employability in different sectors.	During the construction phase there will be large-scale employment generation in the form of skilled, semiskilled laborers and technical staff. During operation phase, direct and indirect employment generation expected is approximately 2200 and 11000 for 5 year development and 4000 and 20,000 for 30 year development respectively.
CSR Activities such as school, roads, Community, Training, Hospital, Veterinary facility, Sanitation, Irrigation facility, Rural Infrastructure, education, drinking water, communication, bus stand, street light etc./Local Problems	The CSR activities will be taken up in a phased manner as a part of DPCL's CSR initiative in consultation with the District Administration. Other local issues such shifting of wine shops, security are related to district administration.	DPCL is committed to carry out CSR activities and will spend INR 15 Crores for next three years. Same will be reviewed on yearly basis and accordingly implemented. CER activities as a part of Revised Master Plan development will be implemented as per MoEF&CC Office Memorandum F. No. 22-65/2017-IA.III dated May 01,2018.
Land Acquisition and Displacement/Land Loser/R&R	There won't be any land acquisition or displacement for this project proposal.	-
Dry Fish Ground	DPCL will develop the fish drying area on allotment of land by the district administration. Solar drying process will also be explored.	DPCL is committed to carry out CSR activities and will spend INR 15 Crores for next three years. Same will be reviewed on yearly basis and accordingly implemented. CER activities as a part of Revised Master Plan development will be implemented as per MoEF&CC Office Memorandum F. No. 22-65/2017-IA.III dated May 01,2018.
Storm Water Drainage Network	Storm water drainage network is planned to facilitate proper drainage of the area. The proposed project will ensure water passage and access to the sea by implementing appropriate	

Major Issues	Action Plan/Replies of Project Proponent	Financial Allocation
	storm water management plan.	
Ecological Sensitivity of the Area/Eco Sensitive Zone	Revised Master Plan Layout is outside the Eco Sensitive Zone of Bhitarkanika Sanctuary & National Park.	Environmental Management Cost for 5 Year Revised Master Plan (including immediate development plan) is ~INR 1264.2 crores and the annual budgetary estimate during operational phase is ~INR 69.5 crore Over and above, DPCL to create a corpus fund of Rs. 30 Crores for conservation of wildlife and marine life including Olive Ridley turtles, environmental development / sustenance and livelihood measures of local population and other related activities in cooperation with concerned government authorities.
Impact on Turtle Nesting	Dhamra Port is located outside turtle congregation area and the nesting beach. No turtle nesting sites are present where the dredged material is proposed to be disposed off.	DPCL to create a corpus fund of INR 30 Crores for conservation of wildlife and marine life including Olive Ridley turtles, environmental development/sustenance and livelihood measures of local population and their related activities in cooperation with concerned government authorities.
Presence of Mangroves/Cutting of Mangroves/Mangrove Conservation	DPCL is committed for protection and conservation of natural mangrove in and around the Port.	~3 lac / year will be spend for protection and conservation of South side mangroves
Construction of Roads and Railway lines/ Road Connectivity & Traffic Management	Jhamujhadi – Dhamra widening of road is under progress by Govt. Of Odisha. DPCL has contributed INR 20 Crore as first instalment towards 1/3rd of its share or expenses. Beside, DPCL will develop additional 2 lane road and 1 rail corridor along the rail corridor, during the course of the project. A new Road/rail / utility corridor shall also be developed on the north side of Revised Master Plan.	-
Community utility area development	These issues will be taken up in consultation with district administration.	-

7.2 Risk Analysis

Risk Assessment study was carried out to assess risks associated with the construction and operation of the Revised Master Plan of Dhamra Port. A systematic Risk Analysis/Assessment (RA) will help in identification of the hazards and associated risk. The RA thus carried out also provides inputs for formulating the onsite Disaster Management Plan (DMP). The RA can be broadly divided into three basic steps:

- Hazard Identification
- Risk Analysis
- Discussion and Recommendations/Risk Mitigation Measures

7.2.1 Hazard Identification

Identification of hazards is of primary significance in the analysis, quantification and cost effective control of accidents. Potential Hazards identified in the proposed project have been broadly classified as below:

- Hazards during Construction Phase
 - Mechanical Hazards
 - Transportation Hazards
 - Physical Hazards
 - Storage and Handling of Hazardous Materials
- Hazards during Operation Phase
 - Material Hazards
 - Handling Hazards
- Hazards due to Natural Calamities
 - Earthquake
 - Tsunami
 - Cyclone/Flood

7.2.1.1 Hazards during Construction Phase

Potential hazards during the construction phase of the project could be due to the mechanical hazards, navigation/ transportation hazards, physical hazards and storage and handling of hazardous materials.

Mechanical Hazards: Mechanical hazards during the construction phase arise due to the moving parts in the machinery, especially the belts and bolts of the construction equipment, which are heavy and pose a threat to the work personnel. Other hazards include falling (during working at heights), falling objects like hand held tools, etc., failure of slips and traps created for scaffolding; and due to faulting of electrical equipment.

Navigation/ transportation Hazards: The planning of access/egress to the construction site also plays a significant role in minimizing the associated hazards such as vehicles/ barges collision.

Physical Hazards: The noise and vibrations generated during the construction phase may affect the worker's health, hinder effective communication and may jeopardise sensitive organs. In addition to noise and vibration, hot works also pose a considerable hazard to the workers.

Storage and handling of hazardous materials: During the construction period, storage of hazardous materials like fuel for the engines, lubricants, paints and other flammable materials is likely to pose a fire and explosion risk. Due care shall be taken in locating these

materials away from the work place, free of any influence of temperature or sparks or fire. Proper wiring of the electrical appliances like lights, exhausts, etc., would be made to ensure that there are no live wires causing short circuits to ignite these materials.

7.2.1.2 Hazards during Operational phase

The following are the cargo proposed to be handled at Dhamra port and its storage type during revised master Plan development (**Table 7-9**).

Table 7-9: Cargo to be Handled and Storage Details

S. No.	Cargo Type	Cargo Mix	Storage Type	Other Process
1.	Multipurpose (Including Liquid Cargo)	Coal / Iron ore / limestone / Mines & Minerals & other dry bulk	Open	-
		Fertilizers and raw materials for manufacture of fertilizer / food grains / sugar / clinker / cement / Project cargo / timber & wood / machines/ Iron steel products / Break Bulk etc.	Open/Covered	-
		Container (4.66 m TEUs)	Open	-
		All Class A, B, C petroleum products, excluded petroleum products Including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos. PoL Such as LPG, Motor Spirit, Naphtha, High Speed Diesel, Crude Oil, Aviation Fuel, Kerosene, Low Sulphur Heavy Stock/ Furnace oil, Carbon Black Feedstock (CBFS), Paraffin, Bitumen, Lube oil, Asphalt, etc.,	Tank Farms / Bullets/ etc., and Handling & Transportation by Pipeline	-
2	Gas / Cryogenics/Liquid,	LNG, Propane, Butane, LPG, CNG, NG and All Class A, B, C petroleum products, excluded petroleum products Including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos, List includes but not limited to the following: LNG, Ethylene, Propylene (Propene), Propane, Butadiene, Butane, LPG, Pentane, Ethyl Mercaptan, Motor Spirit, Propylene Oxide, Hexane, Naphtha Acetone, Methyl Chloride / Chloro Methane, Cyclohexane, Benzene, Ethyl Acetate, Acrylonitrile Acetonitrile, Methyl Methacrylate, Methyl acrylonitrile, Methanol (Methyl Alcohol), Isopropyl Alcohol, Ethyl Alcohol (Ethanol), Ethylene di chloride, Methyl Isobutyl Ketone, Ethyl Benzene, N-Butyl Acetate, Isobutyl Alcohol (Iso Butanol), N-Butyl Alcohol (N-Butanol), Epichlorohydrin, Styrene, O-Xylene, High Speed Diesel, Cumene, Crude Oil, Aviation Fuel, Kerosene, Acetic Acid, Acetic Anhydride, Non-edible/Mentha Oil, Low Sulphur Heavy Stock/ Furnace oil, Carbon Black Feedstock (CBFS), Aniline, Methyl Ethyl Ketone Peroxide, Ethyl Hexanol-2, Vinyl Chloride, Phenol, Naphthalene, Ethylene Glycol, Mono Ethylene Glycol, Toluene 2.4 -di isocyanate, Diphenyl Methane Di-Isocyanate, Edible oil/Palm Oil, Paraffin, Bitumen, Sulphur, Lube oil, Asphalt, Coal, CNG, NG, Ammonia (NH3), Diammonium Phosphate, Muriate of Potash (MOP), Soda Ash (Sodium Carbonate), Urea, Limestone, Caustic Soda, Sulphuric acid, Phosphoric acid, Piperine/ Piperidine, Chloroform, Hydrochloric Acid (HCL)	Tank Farms/Bullets/Full Containment tanks and Handling & Transportation by Pipeline	LNG/LPG Regasification

Material Hazards: The above mentioned cargo/materials will be handled at the Dhamra Port facility as a part of revised Master Plan development. The Cargoes such as Dry bulk cargo, Multipurpose & General Cargo and Container are mostly Non-Hazardous in nature except impact due to Particulate matter which was studied already as a part of Air Quality modelling.

Liquid cargo and Cryogenic Gases can be classified as hazardous Cargo based on its Characteristics such as flammability, explosiveness, toxicity or corrosiveness etc. Hence these cargoes are considered for Quantitative Risk Assessment.

The ratings for a large number of chemicals based on flammability, reactivity and toxicity are given in NFPA (National Fire Protection Association) Codes and Material Safety Data Sheets (MSDS). The properties, NFPA classification and hazards due to exposure of cargo handled are presented in **Appendix Q**.

Handling Hazards: Dhamra Port Revised Master Plan Development involves handling of various materials in the form of Solid and Liquids. The hazards related to material transport and (un)loading may be due to accidents of vehicles, breaking of (un)loading arms, failure in mechanical transmission components, etc. The handling hazards include:

- Insufficient knowledge on hazardous nature of chemical in use leading to inappropriate handling of the chemical
- Failure to use appropriate control measures and Personal Protective Equipment (PPE)
- Use of expired/worn Personal Protective Equipment (PPE)
- Failure of liquid/solid delivery tools
- Possible hazards during ship movements at the port are collision, grounding, etc.
- Likely hazards during loading and unloading of cargo
- During ship unloading operations, the possible hazard may arise due to collision by another vessel and others

Cargo handling: A fully mechanized ship loading/unloading system is planned at the berths. The major components of the mechanised ship loading/unloading system are: Ship unloaders, loaders and connected conveyor system/ pipelines etc.

Ship movements/Navigation Hazards: The navigation hazards during operation phase are grounding and collision of vessels at Dhamra Port area. However, these would be controlled by suitable vessel traffic management by Dhamra Port.

Ship (un)loading: During ship unloading operations, the possible hazard may arise due to collision by another vessel and others.

Transfer operation: The transfer operation involves transfer of cargo from (un)loaders to the belt conveyor through chutes/ marine (un)loading arms in to Pipelines. During this operation there is a possibility of mal-operation / non-synchronisation / misalignment leading to cargo spillage.

Conveyor system: The main hazards related to belt conveyors are mechanical. Other hazards are produced by non-compliance with ergonomic principles when workers operate near the conveyor (operation station, control of the process, loading and unloading); failure or malfunction or safety-related control systems; electrical hazards; and thermal phenomena (such as heat, fire or explosion). The mechanical hazards are mostly related to:

- Mechanical power transmission components (e.g., drive shaft, reducing gears) that can cause damage by entrainment (by a belt or on nip points), crushing or entanglement (human body entangled around a rotating part) on contact with rotating components;
- Other moving components (e.g., idlers, pulleys, belt) that can cause damage by entrainment in nip points, abrasion and burns;

- Pinching zones (e.g., feeder, skirt-board, skirt-board seal) that can cause damage by shearing and crushing;
- Moving loads that can cause damage by shearing and crushing between the load and a fixed component, or an impact;
- Moving sub-assemblies (e.g., ejectors, switches, transfer mechanism) that can cause damage by shearing and crushing;

Slip and Trip Hazards: Workers performing cleaning operations are exposed to slippery working surfaces and tripping hazards. This places workers at risk of:

- Slipping off oily and greasy ladders
- Slipping and falling on oily decks
- Tripping over equipment, hoses, and vessel structures

7.2.1.3 Hazardous Material Inventories

Identification of hazards is the most important step to improve the safety of any process /operation. The hazard study is designed to identify the hazards in terms of chemicals, inventories, and vulnerable processes/operations.

Except (un)loading, transfer and storage of Liquid cargo such as petroleum products and other chemicals, no manufacturing process or reaction is involved in the operations at Dhamra port. LNG Regasification & NG Compression to CNG and LPG Blending & Regasification and are envisaged as a part of LNG Terminal/FSRU and LPG Terminal/FSO. The operations at Dhamra port expansion project involves transfer of various petroleum and other products from ships to storage tanks with the help of pumps installed at ships with the help of mechanical (un)loading arms at jetties.

The primary step in hazard analysis of any process is to know the chemical inventories and hazardous properties. Some of the important liquid cargos to be stored³⁸ in the Dhamra Port, along with hazardous properties, are given in **Table 7-10**.

Table 7-10: Flammable and Toxic Properties of Chemicals

Cargo Name	Flammability Limits %age		Details of Tank				Operating conditions	
	LEL	UEL	Capacity KL/MT/M ³ and Nos.	Dia (m)	Ht (m)	Type	Temp. °C	Pressure atm
Ammonia	15	28	10000 MT/1	26	20	Double Wall Double Integrity	-35	1.0
Butane	1.8	8.5	25000MT/2	61	18.6	Double walled, full containment, Refrigerated	-5	1.0
Crude oil	0.7	7	25000 m ³ /16	81	15	Floating/ Fixed roof	40	0.6
LNG	5	15	180,000 m ³ /4 (FSRU Storage b/w 125000 – 216000 m ³ (Avg. 170000 m ³))	84	45	Fixed tank-Full Containment Type (Moss or Membrane)	-162	1.1

³⁸ Storage of cargo in the CRZ area will be as per the CRZ Notification 2011 (as amended)

Cargo Name	Flammability Limits %age		Details of Tank				Operating conditions	
	LEL	UEL	Capacity KL/MT/M ³ and Nos.	Dia (m)	Ht (m)	Type	Temp. °C	Pressure atm
LPG	1.8	8.5	5000 MT/Barge (FSO each compartment storage of max. 25000 MT)	-	-	Double walled, full containment, Refrigerated	Ambient	8
All Class A, B, C petroleum products, excluded petroleum products Including Petrochemical products (Representative PoL Naphtha)	1	7.6	10000 KL/24	30	16	Floating/ Fixed roof/ Fixed Cone	Ambient	0.6
Propane	2.1	9.5	25000 MT/2	61	18.6	Double walled, full containment, Refrigerated	-45	1.1
Propylene	2	11	25000 MT/2	61	18.6	Double walled, full containment, Refrigerated	-47	1.1
Diesel	0.5	5	20 m ³ /2	2.25	5.5	Floating/ Fixed roof	70	0.6

Chemical process industries and petroleum refineries use checklists as a first step in the hazard evaluation procedure. Dow and Mond Fire and Explosion Indices, which make use of past experience to develop relative ranking of hazards are also extensively used. For predictive hazard analysis, Hazard and Operability Studies (HAZOP), Fault Tree Analysis, Event Tree Analysis, Maximum Credible Accident and Consequence Analysis etc. are employed.

In the present study the following procedures are used to identify the hazards.

- Preliminary Hazard Analysis (PHA)
- Maximum Credible Accident and Consequence Analysis (MCACA), which is used for determining the damage distances

7.2.1.4 Preliminary Hazard Analysis (PHA)

A Preliminary Hazard Analysis is carried out initially to identify the major hazards associated with storages and the processes at Dhamra Port. This is followed by consequence analysis to quantify these hazards. Finally the vulnerable zones are plotted for which risk reducing measures are deduced and will be implemented.

Table 7-11: Preliminary Hazard analysis for Process and Storages Area

Equipment	Process/Operation	Potential Hazard	Provision
Pipelines/ Marine (Un) Loading arms	Transportation of material from Jetty to Storage tanks in Tank Farm Area (TFA)	Fire & Explosion and Toxic	Regular maintenance and inspection of pipelines as per OISD-124 and 140
Storage tanks including FSRU and FSO	Storage of material for import and export	Fire & Explosion and Toxic	Tanks design as per IS code & Other prevailing norms and fire protection facilities as per OISD-156

Equipment	Process/Operation	Potential Hazard	Provision
Barge Facility – 5000 MT LPG	Storage and Transportation of LPG	Fire & Explosion	Design as per IS code & Other prevailing norms and fire protection facilities as per OISD-156
Regasification of LNG/ LPG (Blending)	Liquid Form to Gaseous Form/ Blending	Fire & Explosion	Regasification terminal Design as per applicable standards.

7.2.1.5 Maximum Credible Accident (MCA) Analysis

MCA stands for Maximum Credible Accident or in other words, an accident with maximum damage distance, which is believed to be probable. In this revised master plan development, the proposed cargos (Liquid/Gaseous/Cryogenic) are divided into different class i.e. (i) Class - A Petroleum (ii) Class - B Petroleum (iii) Class - C Petroleum (iv) Excluded Petroleum (v) Other Gaseous Cargos and (vi) Other liquid Cargos. In case of accident, all the above cargo likely to cause Fire & Explosion and Toxic effects except other liquid cargos. Among these cargo, representative items from each class which cause maximum damage distances based on NFPA hazard classification have been selected and risks associated were quantified.

The cargos listed in Class (iv) are not considered for QRA, as cargo from other classes (Class A/B/C) which will represent worst scenarios have already been considered. Also, scenarios from other cargos have health hazard as the most probable hazard. The necessary measures will be taken during handling, transfer and storage of such cargos.

The mentioned list in the **Table 7-12** is representative only. However all the Classified and non-classified hydro carbons, Hazardous and Non Hazardous Chemicals/cargos other liquid cargo etc., having lesser risk than the representative list considered can be handled at DPCL. Storage of cargo in the CRZ Area shall be as per prevailing CRZ guidelines.

Table 7-12: Representative List of Liquid and Cryogenic Gases Cargos

S. No	Classification	Chemical	Flash Point	H - Health	F - Flammability	R/I – Reactivity / Instability
1	Chemical Flash Point < 23 deg C	LNG	-187.8	2	4	0
2		Ethylene	-136.6	2	4	2
3		Propylene (Propene)	-107.8	2	4	1
4		Propane	-104	1	4	0
5		Butadiene	-76	2	4	2
6		Butane	-60	1	4	0
7		LPG	-60	1	4	0
8		Pentane	-49	1	4	0
9		Ethyl Mercaptan	-48.3	1	4	0
10		Motor Spirit	-42.7	1	3	0
11		Propylene Oxide	-37	3	4	2
12		Hexane	-22.5	1	3	0
13		Naphtha	-21.7	1	3	0
14		Acetone	-20	1	3	0
15		Methyl Chloride / Chloro Methane	-20	2	4	1
16		Cyclohexane	-18	1	3	0
17		Benzene	-11.1	2	3	0
18		Ethyl Acetate	-4.4	1	3	0
19		Acrylonitrile	-1.1111	4	3	2
20		Acetonitrile	2	2	3	0

S. No	Classification	Chemical	Flash Point	H - Health	F - Flammability	R/I – Reactivity / Instability
21		Methacrylonitrile	12	3	3	0
22		Methanol (Methyl Alcohol)	12	1	3	0
23		Isopropyl Alcohol	12.778	1	3	0
24		Ethyl Alcohol (Ethanol)	12.78	2	3	0
25		Methyl Methacrylate	13	2	3	2
26		Ethylene di chloride	13	3	3	0
27		Methyl Isobutyl Ketone	14	2	3	1
28		O-Xylene	17	2	3	0
29		Ethyl Benzene	21	2	3	0
30	Chemical Flash Point >23 deg C <65 Deg C	N-Butyl Acetate	23.9	1	3	0
31		Isobutyl Alcohol (Iso Butanol)	28	1	3	0
		N-Butyl Alcohol (N-Butanol)	28.9	1	3	0
32		Epichlorohydrine	31	3	3	2
33		Styrene	31.1	2	3	2
34		High Speed Diesel	35	1	2	0
35		Cumene	36	2	3	1
36		Crude Oil	38	2	3	0
37		Aviation Fuel	38	1	2	0
38		Kerosene	38	1	2	0
39		Acetic Acid	39	3	2	0
40		Acetic Anhydride	49	3	2	1
42	Chemical Flash Point >65 Deg C <93 deg C	Non-edible/Mentha Oil	65	1	2	0
43		Low Sulphur Heavy Stock/ Furnace oil	66	2	2	0
44		Carbon Black Feedstock (CBFS)	66	1	2	0
45		Aniline	70	3	2	0
46		Methyl Ethyl Ketone Peroxide	75	3	2	2
47		Ethyl Hexanol-2	77	2	1	0
48		Vinyl Chloride	78	2	4	1
49		Phenol	79	4	2	0
50	Chemical Flash Point > 93 deg C	Naphthalene	88	2	2	0
51		Ethylene Glycol	111	1	1	0
52		Mono Ethylene Glycol	111	2	1	0
53		Toluene 2,4-di isocyanate	127	3	1	2
54		Diphenyl Methane Di-Isocyanate	135	3	1	1
55		Edible oil/Palm Oil	162	0	1	0
56		Paraffin	199	0	1	0
57		Bitumen	204	2	1	0
58		Sulphur	207	2	1	0
59		Lube oil	210	0	1	0
60		Asphalt	>230	1	1	0
61		Coal	>127	1	1	0
62	Other Gases	CNG	-	-	-	-
63		NG	-	1	4	0
64		Ammonia (NH ₃)	-	3	1	0
65	Other	Diammonium Phosphate	-	2	0	0

S. No	Classification	Chemical	Flash Point	H - Health	F - Flammability	R/I – Reactivity / Instability
66	Cargos	Muriate of Potash (MOP)	-	1	0	0
67		Soda Ash (Sodium Carbonate)	-	2	0	1
68		Urea	-	2	1	0
69		Limestone	-	1	0	0
70		Caustic Soda	-	3	0	1
71		Sulphuric acid	-	3	0	2
72		Phosphoric acid	-	3	0	0
73		Piperine	-	2	1	0
74		Chloroform	-	2	0	0
75		Hydrochloric Acid (HCL)	-	3	0	1

A disastrous situation is the outcome of fire or explosion of the released gas in addition to other natural causes, which eventually leads to loss of life, damage to property and/or ecological imbalance.

Crude oil, LPG (Propane/Butane), LNG and Naphtha are mixture of different components/composition. The pressure in the pipeline varies from 8bar (g) (Near jetty) to 1bar (in the tank farm area near the storage tanks). Also other components such as Ammonia and MEG have different composition.

Most of the scenarios are considered for the marine unloading arm, pipelines and storage tanks for the facility and presented in the **Table 7-20** to **Table 7-27**. However, only 5mm, 25mm leaks (small and medium) will be responsible for 75% of the incidents occurring at the site. Whereas 100mm leak will be responsible for 15% of the cause for any incident and catastrophic failure/rupture will be responsible for 10% of the incidents. This is based on (From 1970) the data is collected by the International Association of Oil & Gas Producers (IOGP) from its member companies and published in the form of report at an interval of five years.

The accident scenarios expected in this facility are given below:

1. Catastrophic failure of Acrylonitrile M(U)LA @ 8 atm (g) and 25⁰C
2. Catastrophic failure of Ammonia M(U)LA @ 8 atm (g) and -35⁰C
3. Catastrophic failure of Butane M(U)LA @ 8atm (g) and -4.4⁰C
4. Catastrophic failure of Crude oil M(U)LA @ 8atm (g) and 40⁰C
5. Catastrophic failure of Diesel M(U)LA @ 8atm (g) and 50⁰C
6. Catastrophic failure of Ethylene M(U)LA @ 8atm (g) and -103.7⁰C
7. Catastrophic failure of Ethyl Mercaptan M(U)LA @ 24.2 atm (g) and 15⁰C
8. Catastrophic failure of Isobutanol M(U)LA @ 8 atm (g) and 25⁰C
9. Catastrophic failure of LNG M(U)LA @ 6.2 atm (g) and -162⁰C
10. Catastrophic failure of LPG (export) M(U)LA @ 15 atm (g) and 16⁰C
11. Catastrophic failure of Cryogenic LPG (import) line M(U)LA @ 15 atm (g) and -55⁰C
12. Catastrophic failure of N-Butanol M(U)LA @ 8 atm (g) and 25⁰C
13. Catastrophic failure of Naphtha M(U)LA @ 8atm (g) and 25⁰C

14. Catastrophic failure of Phenol M(U)LA @ 8 atm (g) and 50 °C
15. Catastrophic failure of Propane M(U)LA @ 8 atm (g) and -44.4 °C
16. Catastrophic failure of Propylene M(U)LA @ 8 atm (g) and -46.4 °C
17. Catastrophic failure of Propylene oxide M(U)LA @ 8 atm (g) and 20 °C
18. Catastrophic failure of Styrene M(U)LA @ 8 atm (g) and 25 °C
19. Catastrophic failure of Vinyl Chloride M(U)LA @ 8 atm (g) and 20 °C
20. 18" Acrylonitrile Pipeline from Jetty to Tank Farm Area
21. 18" Ammonia Pipeline from Jetty to Tank Farm Area
22. 18" Butane Pipeline from Jetty to Tank Farm Area
23. 18" Crude oil Pipeline from Jetty to Tank Farm Area
24. 18" Diesel Pipeline from Jetty to Tank Farm Area
25. 18" Ethylene Pipeline from Jetty to Tank Farm Area
26. 8" Ethyl Mercaptan Pipeline from Jetty to Tank Farm Area
27. 18" Isobutanol Pipeline from Jetty to Tank Farm Area
28. 36" LNG Pipeline from Jetty to Tank Farm Area
29. 18" Motor spirit Pipeline from Jetty to Tank Farm Area
30. 18" N-Butanol Pipeline from Jetty to Tank Farm Area
31. 18" Naphtha Pipeline from Jetty to Tank Farm Area
32. 18" Phenol Pipeline from Jetty to Tank Farm Area
33. 18i" Propane Pipeline from Jetty to Tank Farm Area
34. 18" Propylene Pipeline from Jetty to Tank Farm Area
35. 18" Propylene Oxide Pipeline from Jetty to Tank Farm Area
36. 18" Styrene Pipeline from Jetty to Tank Farm Area
37. 18" Vinyl Chloride Pipeline from Jetty to Tank Farm Area
38. Butane vessel at Tank Farm Area (TFA) @ -5 °C and 1.0 atm pressure
39. Propane vessel at TFA @ -45 °C and 1.1 atm pressure
40. Propylene vessel at TFA @ -47 °C and 1.1 atm pressure
41. Crude at TFA @ 40 °C and 0.6 atm pressure
42. Naphtha/MS/AF/Kerosene at TFA @ ambient temperature and 0.6 atm pressure
43. Diesel/FO/LO at TFA @ 70 °C and 0.6 atm pressure
44. Ammonia at TFA @ -35 °C and 1.0 atm pressure
45. LNG at TFA @ -162 °C and 1.1 atm pressure
46. Barge Facility at Jetty (LPG barge handling system)
47. 8inch Pipeline from Butane bullet
48. 8inch pipeline from Propane bullet

49. 8inch Pipeline from Propylene bullet
50. LNG Pipeline Network
 - a) 14" Pipeline from LNG Storage Tank to Recondenser Header
 - b) 6" Pipeline from LNG Storage Tank to Tanker Lorry Filling Facility
 - c) 14" Pipeline from Booster Pump to Recondenser Header
 - d) 14" Pipeline from HP pump to STV
51. LNG Tanker Lorry Filling
 - a) 3inch Hose failure during Tanker filling
 - b) Catastrophic failure of 20m³ LNG Road Tanker
52. Natural Gas Network
 - a) 16" Pipeline from STV outlet header to Tie-in point
 - b) 16" Pipeline from STV outlet header to NG Compressor inlet
 - c) 14" Pipeline from STV outlet header to NG Compressor inlet
53. CNG Gas Pipeline Network
 - a) 16" Pipeline from NG Compressor to Tie-in point
 - b) Rupture of CNG Storage Cylinder
54. LPG Pipeline Network
 - a) 8" Butane Pipeline to LPG Blender
 - b) 8" Propane Pipeline to LPG Blender
 - c) 12" Butane Pipeline from LPG Blender
 - d) 6" Pipeline from LPG Blender to TLF
55. Toxic damage distances (IDLH) for marine (un) loading arm, storage tank and pipeline failure for Ammonia and Acrylonitrile.

The most credible cases like 5mm, 25mm, 100mm and catastrophic failure for pipelines are considered whereas 10 minutes discharge and catastrophic failure for storage tanks are also taken into consideration. Catastrophic failure of marine unloading arm for unloading various materials at jetty are considered for the study. Toxic release scenarios are considered for failure in marine loading arm, storage tank and leak in pipeline from jetty to tank farm area.

FSRU is planned as a part of the interim requirement for handling of LNG, therefore, the risk scenarios pertaining to FSRU such as transfer, storage, regasification, transportation etc., need to be considered for the Risk Assessment. As the capacity of the onshore LNG terminal planned as a part of the Revised Master Plan development of Dhamra port is more than the FSRU capacity (2.5 MMTA), hence, the various scenarios considered for carrying out the Risk Assessment for the onshore LNG terminal such as Catastrophic failure of LNG M(U)LA; Pipeline from Jetty to Tank Farm Area; LNG at Tank Farm Area; LNG Pipeline Network; CNG Gas Pipeline Network etc., will meet the requisite scenarios of FSRU. Also the maximum inventory considered as a part of onshore Terminal is around 1,80,000 m³ where the the average parcel size of FSRU is estimated to be around 1,70,000 m³ only and it is assumed that at any point of time the FSRU will not exceed this capacity. Hence the risk associated with FSRU inventory is less than predicted for onshore terminal.

Similarly, FSO is planned as a part of the interim requirement for handling of LPG, therefore, the risk scenarios pertaining to FSO such as transfer, storage, heating, transportation etc., need to be considered for the Risk Assessment. The FSO storage capacity (each compartment) is limited to (same as) onshore LPG terminal storage (25,000 MT each) planned as a part of the Revised Master Plan. Hence, the various scenarios considered for carrying out the Risk Assessment for the onshore LPG terminal such as Catastrophic failure of Butane, LPG (export) and Propane Marine Loading/unloading Arm (MLA); Pipeline from Jetty to Tank Farm Area; Butane and Propane at Tank Farm Area; LPG Barge Facility at Jetty; Butane and Propane Bullets and Associated pipelines; LPG pipeline network etc., will meet the requisite scenarios of FSO. Also the maximum inventory considered as a part of onshore Terminal is around 25000 MT (each tank) where as the the average parcel size of FSO at any point of time will not exceed these capacities. Hence the risk associated with FSO inventory is same as onshore terminal.

7.2.1.6 Ignition sources

As the pipeline route is from jetty to storage tanks will be provided with sufficient buffer on reclaimed land, no sources of ignition are identified. However at jetty where working personnel and hot surfaces will be available (chimney of ship), pose a threat as ignition source.

7.2.1.7 Natural disasters

Natural disasters are inevitable in nature. In case of natural disasters occurring at the Dhamra port site such as Tsunami, Cyclone, Hurricane and Earthquake etc., no source of software exists for calculation of damage zones. However, scenarios leading to fire & explosions / toxic gas release for complete rupture of the pipeline, storage tanks and other equipments can be estimated. The damage consequences will be same as domino effects (cascading effects) as one scenario will lead to initiation of another scenario of catastrophic failure of storage vessels and pipelines. The only recommendation to avoid the maximum damage due to natural disasters is to design and construct the facility and equipments as per the international standards by taking maximum allowance for natural disasters into consideration.

7.2.2 Software

PHA 6.53.1 is a software product designed to provide a total service for chemical process hazard analysis to DNV Technica's customers in industry. PHAST provides the most advanced collection of consequence models for hazard analysis which have been derived from the industry standard risk analysis program PHAST.

7.2.3 Risk Analysis

7.2.3.1 Failure Frequency

The release scenarios considered earlier can be broadly divided into two categories (i) catastrophic failures which are of low frequency and (ii) ruptures and leaks which are of relatively high frequency. Vapor or liquid releases from failure of gasket, seal and rupture in pipe lines and vessels fall in second category whereas catastrophic failure of vessels and full bore rupture of pipelines etc. fall into first category. Typical failure frequencies are given in **Table 7-13**.

Table 7-13: General failure frequencies

Item	Mode of failure	Failure Frequencies
LNG Refrigerated Atmospheric Vessel	Serious leak catastrophic	1×10^{-6} /yr 5×10^{-8} /yr (double containment)
Full containment type		Same as double walled containment type (Ref.-HSE, UK)
Pressure vessel	Serious leak Catastrophic	1.0×10^{-5} /yr 3×10^{-6} /yr
Road Tanker Failure		1.1×10^{-8} per delivery
Process pipe lines		
=50 mm dia	Full bore rupture	8.8×10^{-7} /m.yr
	Significant leak	8.8×10^{-6} /m.yr
> 50 mm = 150 mm dia	Full bore rupture	2.6×10^{-7} /m.yr
	Significant leak	6×10^{-5} /m.yr
> 150 mm dia	Full bore rupture	8.8×10^{-8} /m.yr
	Significant leak	6×10^{-6} /m.yr
Hoses	Rupture	3.5×10^{-2} /yr
Check valve	Failure on demand	1×10^{-4} /demand
Motor operated valve	Failure on demand	1×10^{-3} /demand
Flange	Leak	3×10^{-4} /yr
Pump	Casing failure	3×10^{-5} per pump/yr
Pump seal single	Leak	5×10^{-4} per pump/yr
Pump seal double	Leak	5×10^{-5} per pump/yr
Process Safety Valve	Lifts heavily	4×10^{-3} /yr
	Blocked	1×10^{-3} /yr
	Lifts lightly	2×10^{-2} /yr
Articulated loading/unloading arm failure		3×10^{-8} /hr of operation
Full bore vessel connection failure		Failure frequency/ 10^6 years
<25		30
40		10
50		7.5
80		5
100		4
>150		3

Reference source:

- HSE UK- Failure Rate and Event Data for use within Risk Assessments
- OGP-Risk Assessment Data Directory
- OGP-Process Release Frequency
- Loss Prevention in the Process Industries -Frank P.lees.Vol.2 & 3, 2nd edition.
- TNO communication

These failure rates are, for non- corrosive systems like hydrocarbon industry and well suited for the present case. Due attention is to be given for materials of construction and design conditions. Details of Equipment Failures reasons are given below:

S. No	Reason	%
1.	Defective Pipeline	10
2.	Hose Failure	09
3.	Loading Arm Failure	09
4.	Open Valve	05
5.	Leaking Valve	64

6.	Manifold Failure	03

Source: International Tanker Owners Pollution Federation

7.2.3.2 Consequence Analysis

The accidental release of hazardous chemicals leads to subsequent events which actually cause the damage. The damages are caused by

- Heat radiation
- Toxic effects
- Overpressure effects from explosions.

The nature of damage and extent of damage resulting from an accidental release of a chemical depends on several factors like nature of material, storage conditions, release conditions, atmospheric conditions etc. The sequence of probable events following the release of a hazardous chemical is schematically shown in **Figure 7-1**.

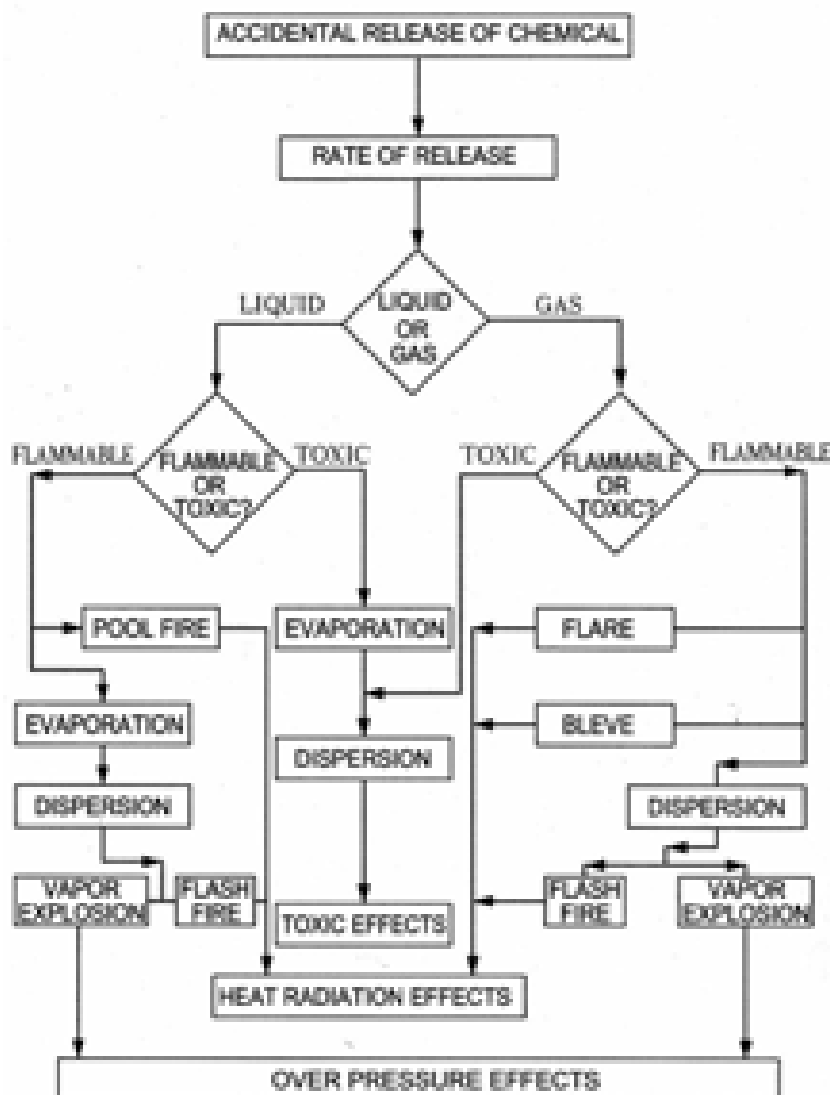


Figure 7-1: Steps in consequence calculations

The best way of understanding and quantifying the physical effects of any accidental release of chemicals from their normal containment is by means of mathematical modelling. This is achieved by describing the physical situations by mathematical equations for idealized

conditions and by making corrections for deviation of the practical situations from ideal conditions.

7.2.3.3 Release Models and Source strength

From the flowchart (**Figure 7-1**) it is clear that the first aspect to be considered is modelling the release and source strength of hazardous substances. This depends on the nature of failure of the unit and content of the unit and operating temperature and pressure of the unit. The release may be instantaneous due to total failure of storage unit or continuous due to leakage or rupture of some component of the storage facility. The material discharged may be gas or liquid or the discharge could be manifested through two-phase flow. For cases of outflow where two-phase flow can occur, the calculation possibilities are as follows:

- Liquid outflow
- Vapor outflow
- Gas outflow

The models that are used to calculate the quantity of liquid/vapor released are:

Turbulent free jet: When gas flows out of an opening from a high-pressure container or a pipeline, a free jet, independent of weather conditions can form. If the gas is flammable and a source of ignition is available within the distance for its Lower Flammability Level (LFL) it will result in a flare.

Two-phase outflow: If a liquefied pressurized gas escapes rapidly from a fractured pipeline or vessel, there is a possibility of liquid flashing into vapour because of pressure reduction. This vapour formed influences the amount of two-phase outflow because of two-phase conditions in a pipeline or vessel.

Vapour/liquid outflow: In a vessel when liquid and vapour co- exist, the type of release depends on the position of the leak. Leak in vapour space results in vapour release and leak in liquid position results in liquid release. The rates of discharge for these cases are calculated based on idealised models. Corrections are applied for practical situations.

Evaporation Models: The liquefied materials when released will evaporate and disperse into the atmosphere. The rate of evaporation depends on various factors. The liquefied gas whose atmospheric boiling point is less than the ambient temperature will partly flash into vapor instantaneously taking the required heat of evaporation from the remaining liquid. Cryogenic liquids receive heat from the surface of the land and evaporate. Liquids with boiling points above ambient temperature evaporate only because of the influence of wind. The rate of evaporation depends on the wind speed and size of the pool. The possibility of pumping the spillage back to storage is much higher if the liquid is neither cryogenic nor flashing type, provided it is confined in the bund/dyke of the respective storage tank.

Table 7-14: LNG Release Event Frequencies

LNG Release Event Frequencies					
Equipment	Release Scenario	Release Phase	Release Frequency	Unit	Reference
Process Vessels	(i) 10 ft 20mm hole	Liquid	0.001-01	per year	Consolidation et al. (2)
	(ii) 10 ft 10mm hole	Liquid	0.001-01	per year	Consolidation et al. (2)
	(iii) Fuel tank rupture	Liquid	0.001-01	per year	Consolidation et al. (2)
Pumps	(i) Leak	Liquid	0.001-01	per year	CONV Study (3)
	(ii) Fuel tank rupture	Liquid	0.001-01	per year	CONV Study
Unloading Arm	(i) Leak	Liquid/Gas	0.001-01	per year	CONV Study
	(ii) Fuel tank rupture	Liquid/Gas	0.001-01	per year	CONV Study
Pipe size: 600mm to 750mm	(i) 10 ft 20mm hole	Liquid/Gas	0.001-01	per year	Harbinger (4)
	(ii) 10 ft 10mm hole	Liquid/Gas	0.001-01	per year	Harbinger
	(iii) Fuel tank rupture	Liquid/Gas	0.001-01	per year	Harbinger
Pipe size: 150mm to 500mm	(i) 10 ft 20mm hole	Liquid/Gas	0.001-01	per year	Harbinger
	(ii) 10 ft 10mm hole	Liquid/Gas	0.001-01	per year	Harbinger
	(iii) Fuel tank rupture	Liquid/Gas	0.001-01	per year	Harbinger
LNG Storage Tank	(i) Rupture	Liquid	0.001-01	per tank per year	People Book (2)

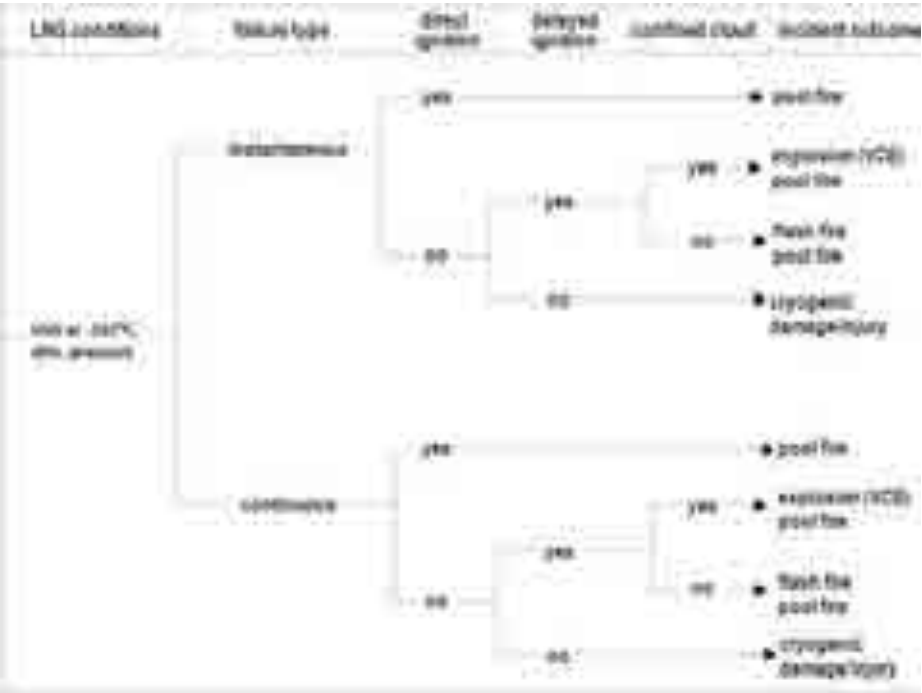


Figure 7-2: Event tree for release of LNG stored at atmospheric pressure

Gas/Vapor Dispersions: Vapor clouds are one of the major sources of worst chemical disasters. These may result from direct release of gas or vapors from flashing liquids or evaporation of spilled liquids. Vapour clouds may give rise to large fires, explosions or toxic effects depending on the nature of the chemical.

Gaussian dispersion models are useful for neutrally buoyant gases with densities equivalent to that of air at the release conditions. For gases/vapours heavier than atmospheric air, Box models are useful. Box models assume that mass transfer occurs by entrainment across the density interface of a cloud with an assumed shape and that internal mixing is fast enough that concentration within the cloud is uniform.

Heat Radiation Models: When flammable liquid is released into atmosphere, and immediate source of ignition is available, it may result in BLEVE, pool fire or flash fire. In the event of delayed ignition, the flammable material release may result in flash fire or vapour cloud explosion. Each of these scenarios is described below in detail.

Pool fires: When a flammable liquid spills, it spreads into a pool. The size of the pool depends on the availability of bund and obstacles. If there are no obstacles or bund, it can spread into a thin film on flat land/floor and upon ignition a pool fire will result. The size of the pool gradually increases with time but it will reach an equilibrium size shortly after ignition when burning rate matches with the release rate. Since most of the liquid cargos handled at Dhamra port are liquids at room/operating temperatures (Except LNG/Butane/Propane/etc.), pool fires are the most probable scenarios in this case.

'BLEVE' and fire balls: A catastrophic failure or total loss of containment (TLOC) of the pressurized liquefied gas vessel can take place for a variety of reasons, including flawed material, fatigue, corrosion, poor manufacture, thermal stresses, pressure stresses and reduction in material strength due to high wall temperatures. Any of these factors could result in a TLOC. However, in most of the accidents, several of these factors combine to cause failure of a vessel leading to a BLEVE. The acronym 'BLEVE' stands for Boiling Liquid Expanding Vapour Explosion. Even though BLEVEs were recorded at temperatures far below the atmospheric superheat limit, the superheat in the liquid helps violent or explosive boiling to take place. This incident occurs upon rupture of a vessel containing a liquid with vapour pressure well above atmospheric pressure such as LPG in case of an external fire. Such a rupture can be initiated by several mechanisms.

- Overpressure of a vessel due to overfilling, too small a relief valve and high pipeline pressures.
- Heating of the vapour space of the vessel by an external fire or a flame impingement on a specific spot. Although the relief valve may function according to its set pressure, the tank ruptures because of weakening of steel. This type of BLEVE may occur in a few minutes after the initiation of fire.
- Heating the wetted surface of the vessel through fire underneath. In this case it may take hours to initiate a BLEVE.
- A missile (a portion of a vessel for example) hitting the LPG storage.

According to a recent study the energy necessary for catastrophic failure must come from the vapour and liquid in the tank. The vapour space energy is available immediately on initial failure of the vessel. However, the liquid energy is available only after a phase change, which requires a finite time period. With rapid depressurization, the boiling process is in non-equilibrium and as a result very large liquid superheats are possible. These are strongly related to PRV setting because this setting ultimately determines the liquid temperature. It was reported that if the PRV setting is near or above the superheat limit, then the boiling process is likely to push the event to BLEVE conditions. The chances of BLEVEs caused by

rapid failure of a weakened tank may be reduced by making the tanks stronger. The BLEVEs resulting from high energy can be reduced by limiting the liquid temperature by careful selection of PRV settings.

In BLEVE pressure wave effects are of minor importance particularly in small storages like 30T and 150T bullets. The damage is mainly due to heat radiation. The duration of fireball is about 20-50s whereas the metal of the storage vessel and structural supports can withstand intense heat radiation for much longer duration e.g. flares – 5min, pool fires – 20min, heat radiation level of 37.5 kW/m^2 –60 min. Hence heat radiation of BLEVE in one of the bullets is very unlikely to lead to BLEVE of the adjoining bullet. However, the fragments of a bullet on BLEVE may lead to BLEVE in the neighboring bullet. Considering the duration of BLEVE itself and other factors, BLEVE in other adjoining bullets may be regarded as relatively low probability sequential event/events.

Flares: In case of leak of gas from high pressure container, a turbulent free jet results; if a source of ignition is available within its LFL distance, it will result in a jet or flame close to the point of release whose length extends a little beyond LFL distance. It can continue for much longer duration than BLEVE.

Flash fires: Flammable vapour clouds form as a result of release of flammable gas/vapour, flashing liquids or evaporation from boiling liquid pools. These vapours/gas get dispersed into atmosphere forming explosive/ flammable vapour clouds where the concentration will be within the flammable limits. If there is no source of ignition, the cloud gets further diluted and passes away without causing any damage. However, if the mixture in explosive range comes in contact with a source of ignition, it may result in a flash fire or vapour cloud explosion depending upon the level of turbulence. In flash fire the flame front travels through the flammable mixture and stabilizes at the release point resulting in either a pool fire or jet fire. Any person caught in the cloud envelope is likely to suffer fatal burn injuries. Secondary fires may follow if combustible material is present in the cloud envelopes. Further, instrument and power cables may get burnt, but steel structures are not likely to be damaged.

Explosion models: If a volatile flammable material is released, this will disperse into atmosphere. The concentration of the material in the atmosphere is determined using appropriate dispersion models. The cloud within the upper and lower explosion limits is in flammable range. If this cloud comes into contact with ignition source, it may result in a flash fire or vapour cloud explosion depending on the degree of confinement. The overpressure effects resulting from vapour cloud explosion are calculated using TNT equivalence model. Peak over pressures measured from TNT explosion have been used to estimate those generated by unconfined vapour cloud explosions.

Toxic load models: Whenever there is an accidental release of volatile toxic material into atmosphere, it gets dispersed into the atmospheric air. The concentration of the material in space with respect to time is determined using appropriate dispersion models. The combined effect concentration and exposure time are determined using probit function explained in more detail in the next subsection under impact criterion.

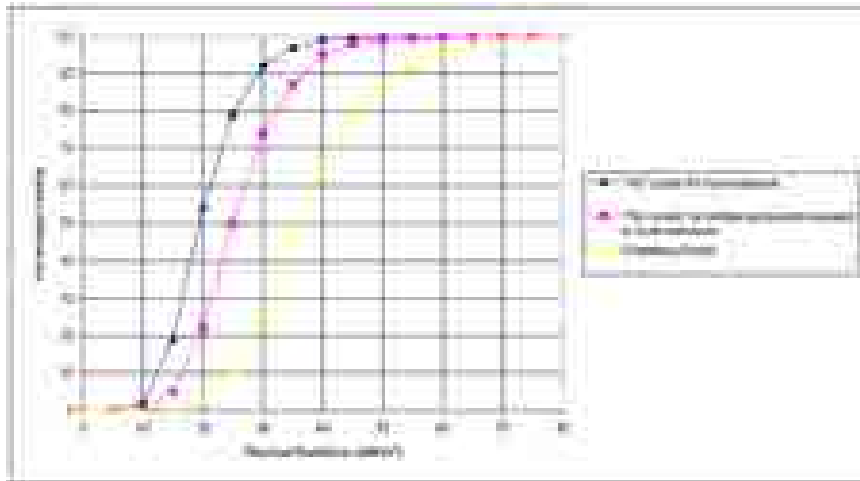
Impact of Thermal Radiation: Damage due to heat radiation to both human beings and process plants are given in **Table 7-15**.

Table 7-15: Damage due to incident radiation

Radiation level (within the fire)	Damage to Equipment	Damage to People
37.5 kW/m ²	Damage to process equipment	100% lethality in 1 min. 1% lethality in 10 sec.
12.5 kW/m ²	Minimum energy to ignite with a flame; melts plastic tubing.	1% lethality in 1min
4.0 kW/m ²	Injury to people	
1.75 kW/m ²	-	Pain threshold reached after 60 seconds.
0.7 kW/m ²	-	Exposed skin reddens and burns on prolonged exposure.

Thermal radiation and the extent of burn injury depend on the time duration of exposure. Exposure time thermal load and lethality are calculated by Probit equation.

Where $Y = -36.8 + 2.5 \ln(t I^{4/3})$
 Y is the probit value
 t is time in seconds
 I is radiation in W/sq. m

**Figure 7-3: Percentage Fatality for 20 Second Exposure based on Thermal Probits**

The lethality levels for different thermal loads and different exposure times are given in **Table 7-16**.

Table 7-16: Exposure time, heat radiation and damage levels

Intensity of radiation in kW/m ²	Exposure time in sec	% Lethality	% First degree burns
37.5	28	100	
12.5	120	100	
4.0	550	100	
37.5	4	1	
12.5	15	1	
4.0	66	1	
37.5	7	-	100
12.5	27	-	100
4.0	123	-	100
37.5	1	-	1
12.5	5	-	1
4.0	21	-	1

The above times are for unprotected persons. For protected persons the corresponding times will be 50% to 60% higher.

The probit relation for first degree burns are given by the relation

$$Y = -39.83 + 3.0186 \ln(t I^{4/3})$$

Where Y is the probit value

t is the time in seconds and I is the radiation in(W/sq. m)

Impact of Overpressure: When a flammable vapour cloud ignites, under certain conditions it may result in deflagration thus causing damage due to over pressure effects. The damage depends on the level of over pressure as indicated in **Table 7-17**.

Table 7-17: Effect of over pressure

Overpressure	Damage	Human Injury
0.3 bar	Heavy structure damage	100% lethality
0.1 bar	Repairable structure damage	50% lethality
0.03 bar	Major glass damage	Threshold lethality
0.01 bar	10% glass damage	Severe lung damage

Toxic release model: Toxic models are employed to assess the consequences to human health as a result of exposure to toxic gases. When IDLH concentrations (Immediate Danger to Life and Health) are used in conjunction with air dispersion modelling, the resulting analysis can help evaluate the potential consequences of any toxic chemical release from point of view of public health and welfare.

Impact of Toxic Effects: A material may be considered as toxic or poisonous, when a small quantity can cause injurious effect on an average normal adult human being. Almost all materials are injurious to living organisms in case of overdoses. However certain materials are injurious to health and life even at small doses. There are several ways of expressing the severity of the toxic nature of the chemicals. These are:

TLV - Threshold Limit Value: The maximum concentration limit for a normal eight-hour workday and 40 hours per week to which nearly all workers may be repeatedly exposed day after day without any effects on health.

IDLH - Immediately Danger to Life and Health: The maximum concentrations to which a healthy worker can be exposed for 30 minutes and escape without suffering irreversible health effects or escape impairing symptoms.

LD₅₀ - Lethal Dose low: The lowest concentration of a chemical at which some test animals die following inhalation exposure.

LD₅₀ - Median lethal dose: The dose at which 50 percent of test animals die following exposure. Dose is usually expressed as milligrams for kilogram of body weight of the test animal.

The most popular way of expressing lethality of toxic loads is to use Probit functions.

$$P = A + B \ln(Cn t)$$

Where P is probit value

A, B and n - constants specific to the chemical

t - Time of exposure in seconds.

c - Concentration in mg/m³ or ppm

Knowing the concentration level and time of exposure, the percentage lethality may be estimated. However for most of the chemicals the characteristic constants are not available and in such cases IDLH values are used.

7.2.3.4 Meteorological conditions

Evaporation and dispersion of hazardous gases are highly dependent on meteorological conditions like wind speed, direction, stability class etc. Hence proper meteorological information is essential for the estimation of affected zones due to accidental release of chemicals. The wind data for Chandbali is provided in **Table 7-18** and **Table 7-19**

Table 7-18: Probability of wind speed (m/s) in 8 directions

Month	0830/ 17.30	Percentage No. of days wind from								
		N	NE	E	SE	S	SW	W	NW	Calm
January	I	30	13	7	2	4	4	4	28	8
	II	4	22	31	23	7	1	1	3	8
February	I	21	8	5	4	9	14	10	22	7
	II	1	11	22	47	12	3	1	1	2
March	I	8	3	3	8	15	34	8	15	6
	II	1	4	12	51	20	8	1	1	2
April	I	1	1	3	12	25	44	5	5	4
	II	0	1	10	45	30	11	2	1	0
May	I	1	2	5	15	26	41	4	3	3
	II	1	2	7	43	27	15	1	3	1
June	I	3	3	5	10	24	35	6	9	5
	II	1	4	8	31	25	20	3	4	4
July	I	4	3	4	9	21	35	11	10	3
	II	1	3	7	21	25	25	7	8	5
August	I	3	5	4	8	18	28	14	15	5
	II	2	4	6	20	25	23	8	7	5
September	I	9	5	5	10	17	19	13	16	6
	II	3	5	11	24	24	13	6	6	8
October	I	21	9	6	6	7	7	11	25	8
	II	8	14	17	17	16	3	3	5	17
November	I	38	9	3	1	2	3	7	33	4
	II	11	23	27	10	6	1	1	4	17
December	I	43	12	4	1	1	1	5	27	6
	II	10	20	36	11	3	1	1	1	17
Annual Total Mean	I	15	6	5	7	14	22	8	17	6
	II	4	9	16	29	18	10	3	4	7

Table 7-19: Meteorological Data at Chandbali (Based on observations from (1951 to 1980))

Month	08.30/ 17.30	No. of days with wind speed (km/hr)			
		62 or more	20-61	1-19	0
January	I	0	0	27	4
	II	0	0	27	4
February	I	0	0	24	4
	II	0	1	25	2
March	I	0	0	28	3
	II	0	3	27	1
April	I	0	1	27	2
	II	0	9	21	0
May	I	0	3	26	2
	II	0	10	19	2
June	I	0	1	26	3

Month	08.30/ 17.30	No. of days with wind speed (km/hr)			
		62 or more	20-61	1-19	0
	II	0	3	26	1
July	I	0	1	29	1
	II	0	1	28	2
August	I	0	1	29	1
	II	0	1	28	2
September	I	0	1	27	2
	II	0	1	27	2
October	I	0	0	28	3
	II	0	0	25	6
November	I	0	0	28	2
	II	0	0	26	4
December	I	0	0	29	2
	II	0	0	26	5
Annual Total Mean	I	0	8	328	29
	II	0	29	305	31

Most probable wind speed = 2 - 5 m/sec.

Most probable wind directions are from South East, South and South West

7.2.3.5 Stability Class

The atmospheric conditions of interest are divided into five categories, A, B, C, D, E and F where A is the most in-stable (strong thermal convection) D represents the neutral condition (purely mechanical turbulence) and F the stable stratified case where the mechanical turbulence is strongly damped. Neutral conditions correspond to a vertical temperature gradient of about 1°C per 100m.

For the present study we have considered D (neutral stability class) and F (more stable class) for damage distance calculations with wind speeds of 2.0, 4.0, 5.0, 7.0 and 11.0 m/s.

7.2.3.6 Results of Consequence Analysis

The materials that are proposed to be stored in the tank farm area and handled at Dhamra port as a part of revised master Plan project are LNG, Propane, Butane, LPG, CNG, NG and All Class A, B, C petroleum products, excluded petroleum products Including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos. These are flammable liquids and any leakage / spillage results in pool fires. The consequence analysis is carried out for all the identified credible scenarios. The results of consequence analysis for all the scenarios are presented in the **Table 7-20** to **Table 7-22** Since the other chemicals/materials are not flammable in nature and do not pose any threat of explosion, it is recommended to follow Material Safety Data Sheets (MSDS) while handling these materials.

7.2.3.6.1 LFL distances

LFL distances are presented in **Table 7-20**, **Table 7-22**, **Table 7-24**, **Table 7-26** and **Table 7-28**. The LFL distances are distances up to which, LFL concentration exists. LFL concentration is the minimum concentration of the flammable chemical in air at which, ignition occurs upon contact with any ignition source.

7.2.3.6.2 Heat Radiation Effects

Heat Radiation is the result of fire or explosion occurring upon the ignition of continuous or instantaneous release of flammable materials. Heat radiation effects cause damage to

people and property. In the present study as some of the cargos are flammable liquids; heat radiation effects are due to pool fire and jet fires.

In case of pool fire and jet fire, the damage to people and property depends upon the extent of heat radiation per unit area emitted from certain fire. The heat radiation 37.5 kW/m^2 is considered to be lethal and anyone within this heat radiation zone is likely to die. The persons within 12.5 kW/m^2 heat radiation are likely to be injured severely whereas heat radiation 4.0 kW/m^2 will cause minor injuries. For the present study, the heat radiation damage distances are presented in **Table 7-20, Table 7-22, Table 7-24, Table 7-26 and Table 7-28.**

7.2.3.6.3 Over Pressure Effects

Over pressure effects are due to the vapor cloud explosion. If the leaked flammable cargo is not ignited immediately, the vapors generated from the pool will form an explosive vapor cloud with air and this could upon ignition results in vapor cloud explosion and over pressure effects. The over pressure damage distances are presented in **Table 7-21, Table 7-23, Table 7-25, Table 7-27 and Table 7-29.**

7.2.3.6.4 Toxic Release

The toxic release damage distances are presented in **Table 7-30.**

Table 7-20: Heat Radiation Damage Distances - Marine Loading Arms at Jetty

S. No.	Scenario Description	Release Rate (kg/s)	Heat Radiation Damage Distance (in meter)			LFL Distance (in meter)					
	Marine Loading/unloading Arm (MLA)		4.0 kW/m ²	12.5 kW/m ²	37.5 kW/m ²	D2.0	F2.0	D5.0	F4.0	D7.0	C/D11.0
1	Catastrophic failure of Acrylonitrile @ 8atm (g) and 25 °C	7.1901e+2	387	277	208	219	232	289	245	310	276
2	Catastrophic failure of Ammonia @ 8 atm (g) and (-35) °C	1.446e+03	678	584	499	135	136	124	293	273	250
3	Catastrophic failure of Butane @ 8atm (g) and -4.4 °C	3.465e+03	1205	903	723	755	715	927	1003	830	725
4	Catastrophic failure of Crude oil @ 8atm (g) and 40 °C	1.797e+03	537	395	311	789	754	665	772	574	488
5	Catastrophic failure of Diesel @ 8atm (g) and (50) °C	2.213e+03	242	173	-	100	93	96	86	107	113
6	Catastrophic failure of Ethylene @ 8atm (g) and -103.7 °C	3.547e+2	415	269	184	1059	1380	730	1106	654	568
7	Catastrophic failure of Ethyl Mercaptan @ 24.2atm (g) and 15 °C	1.4817e+3	701	550	458	721	659	753	889	669	574
8	Catastrophic failure of Isobutanol @ 8atm (g) and 25 °C	7.6939e+2	384	276	210	62	61	63	61	63	64
9	Catastrophic failure of LNG @ 6.2atm (g) and (-162) °C	2.835e+03	1434	901	598	1119	1940	956	1884	880	700
10	Catastrophic failure of LPG (export) @ 15atm (g) and 16 °C	6.9666e+2	522	402	330	886	845	839	872	798	631
11	Catastrophic failure of Cryogenic LPG (import) line @ 15atm (g) and -55 °C	8.6845e+2	610	406	290	637	626	388	457	294	250
12	Catastrophic failure of N-Butanol @ 8 atm (g) and 25 °C	7.7522e+2	378	273	208	54	53	54	53	54	52
13	Catastrophic failure of Naphtha @ 8atm (g) and 25 °C	2.044e+03	359	267	212	121	120	131	128	139	156
14	Catastrophic failure of Phenol @ 8atm (g) and 50 °C	9.922e+2	216	123	51	38	38	39	38	39	40
15	Catastrophic failure of Propane @ 8atm (g) and -44.4 °C	3.390e+03	1179	896	727	773	738	907	1046	814	712
16	Catastrophic failure of Propylene @ 8atm (g) and -46.4 °C	2.310e+03	814	619	506	821	873	622	730	558	484
17	Catastrophic failure of Propylene oxide @ 8atm (g) and 20 °C	5.7362e+2	420	273	173	584	652	503	545	446	376
18	Catastrophic failure of Styrene @ 8 atm (g) and 25 °C	8.4458e+2	249	123	87	59	58	61	59	62	62
19	Catastrophic failure of Vinyl Chloride @ 8atm (g) and 20 °C	7.3941e+2	440	350	295	434	426	506	465	557	521

Table 7-21: Overpressure Damage Distances - Marine Loading Arms at Jetty

S. No.	Scenario Description	Overpressure Damage Distance (In meters)								
		D2/F2			D5/F4			D7/(C/D)11		
	Marine loading/unloading arm failure at Jetty	0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar
1	Catastrophic failure of Acrylonitrile @ 8atm (g) and 25 °C	326/315	259/251	235/240	407/366	334/294	307/365	434/413	357/331	328/300
2	Catastrophic failure of Ammonia @ 8atm(g) and (-35) °C	471/472	368/368	329/329	449/467	352/366	316/328	431/385	339/302	305/271
3	Catastrophic failure of Butane @ 8atm (g) and -4.4 °C	1973/1879	1891/1696	1861/1628	1256/1746	1104/1668	1083/1639	1192/1179	1035/951	1013/914
4	Catastrophic failure of Crude oil @ 8atm(g) and 40 °C	1521/1505	1188/1174	1157/1148	1689/1608	1242/1310	1076/1250	1505/1318	1095/964	943/832

S. No.	Scenario Description	Overpressure Damage Distance (In meters)								
		D2/F2			D5/F4			D7/(C/D)11		
		0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar
5	Catastrophic failure of Diesel @ 8atm (g) and (50) °C	109/107	98/97	94/94	100/98	94/88	92/84	126/140	112/123	106/117
6	Catastrophic failure of Ethylene @ 8atm (g) and -103.7 °C	1575/1467	1162/1417	1106/1399	1328/1382	962/1193	828/1147	1213/1030	886/761	768/661
7	Catastrophic failure of Ethyl Mercaptan @ 24.2atm (g) and 15 °C	895/901	795/757	757/703	877/822	702/586	686/577	927/1000	715/743	687/656
8	Catastrophic failure of Isobutanol @ 8atm (g) and 25 °C	86/84	71/71	65/65	89/86	72/71	66/66	92/99	74/77	67/68
9	Catastrophic failure of LNG @ 6.2atm (g) and (-162) °C	2637/5144	2143/5119	2077/5110	2417/4509	1793/4498	1730/4494	2113/1505	1521/1095	1300/943
10	Catastrophic failure of LPG (export) @ 15atm (g) and 16 °C	1152/1154	833/818	779/753	1263/1214	889/893	803/840	1299/1126	1002/842	896/736
11	Catastrophic failure of Cryogenic LPG (import) line @ 15atm (g) and -55 °C	1014/894	751/717	691/669	697/860	509/593	444/522	548/425	400/319	345/279
12	Catastrophic failure of N-Butanol @ 8 atm (g) and 25 °C	73/71	60/59	55/55	76/71	61/59	55/54	78/85	62/65	56/58
13	Catastrophic failure of Naphtha @ 8atm (g) and 25 °C	367/370	300/301	275/276	437/417	364/345	337/317	463/466	387/383	359/352
14	Catastrophic failure of Phenol @ 8atm (g) and 50 °C	41/41	35/34	32/32	42/41	35/35	32/32	42/58	35/48	33/44
15	Catastrophic failure of Propane @ 8atm (g) and -44.4 °C	2003/2017	1910/1864	1875/1807	1335/1748	1292/1646	1276/1608	1198/1158	1148/1015	1134/998
16	Catastrophic failure of Propylene @ 8atm (g) and -46.4 °C	1427/1546	1332/1469	1296/1445	1091/1244	940/1077	890/1024	982/955	855/767	808/724
17	Catastrophic failure of Propylene oxide @ 8atm (g) and 20 °C	920/1160	725/868	653/759	813/845	634/670	567/605	741/638	568/484	504/427
18	Catastrophic failure of Styrene @ 8 atm (g) and 25 °C	68/67	58/57	54/54	80/68	69/58	64/54	82/90	69/73	65/66
19	Catastrophic failure of Vinyl Chloride @ 8atm (g) and °C	740/735	562/554	496/487	796/768	626/591	563/526	838/784	673/633	611/576

Table 7-22: Heat Radiation Damage Distances – Pipelines from Jetty to Storage Tanks

S. No.	Scenario Description	Release Rate (kg/s)	Heat Radiation Damage Distance (in meter)			LFL Distance					
						(in meter)					
	Pipeline from Jetty to Storage Tanks		4	12.5	37.5	D2.0	F2.0	D5.0	F4.0	D7.0	C/D11.0
			kW/m ²	kW/m ²	kW/m ²						
A	18” Acrylonitrile Pipeline from Jetty to Tank Farm Area										
1	5mm Leak in the pipeline	8.49E-01	26	22	18	23	26	17	22	14	10
2	25mm Leak in the Pipeline	2.12E+01	172	122	85	146	149	175	185	159	134
3	100mm Leak in Pipeline	3.39E+02	382	305	257	283	265	349	296	400	381

S. No.	Scenario Description	Release Rate (kg/s)	Heat Radiation Damage Distance (in meter)			LFL Distance					
						(in meter)					
			4	12.5	37.5	D2.0	F2.0	D5.0	F4.0	D7.0	C/D11.0
	Pipeline from Jetty to Storage Tanks		kW/m ²	kW/m ²	kW/m ²						
4	Catastrophic Rupture	3.88E+03	396	272	197	288	283	365	352	336	293
B	18" Ammonia Pipeline from Jetty to Tank Farm Area										
5	5mm Leak in the pipeline	6.96E-01	23	19	NR	9	9	7	8	7	6
6	25mm Leak in the Pipeline	1.74E+01	109	92	NR	62	65	66	68	67	61
7	100mm Leak in Pipeline	2.78E+02	365	311	200	175	174	201	188	221	241
8	Catastrophic Rupture	1.46E+03	269	214	79	46	46	52	49	55	58
C	18" Butane Pipeline from Jetty to Tank Farm Area										
9	5mm Leak in the pipeline	6.19E-01	24	19	16	12	14	8	11	7	7
10	25mm Leak in the Pipeline	1.55E-01	102	79	65	111	144	97	105	83	72
11	100mm Leak in Pipeline	2.48E+02	602	394	265	456	616	402	450	348	290
12	Catastrophic Rupture	8.20E+02	1243	773	504	783	765	356	428	267	187
D	18" Crude oil Pipeline from Jetty to Tank Farm Area										
13	5mm Leak in the pipeline	8.43E-01	83	80	76	11	11	8	9	7	6
14	25mm Leak in the Pipeline	2.11E+01	192	150	134	88	93	92	102	87	81
15	100mm Leak in Pipeline	3.37E+02	349	214	135	307	316	351	374	323	284
16	Catastrophic Rupture	---	408	246	---	509	516	516	522	543	617
E	18" Diesel Pipeline from Jetty to Tank Farm Area										
17	5mm Leak in the pipeline	3.51E-01	113	109	104	11	11	8	9	7	7
18	25mm Leak in the Pipeline	2.13E+01	230	138	52	56	45	66	45	73	77
19	100mm Leak in Pipeline	3.40E+02	415	243	141	109	115	127	129	135	147
20	Catastrophic Rupture	---	455	278	---	208	469	274	495	412	340
F	18" Ethylene Pipeline from Jetty to Tank Farm Area										
21	5mm Leak in the pipeline	5.50E-01	22	18	15	48	54	31	40	23	14
22	25mm Leak in the Pipeline	1.37E+01	94	75	64	289	324	220	227	190	171
23	100mm Leak in Pipeline	2.20E+02	321	255	215	1064	1025	866	1073	756	619
24	Catastrophic Rupture	1.79E+03	473	372	308	1282	1950	818	1511	716	599

S. No.	Scenario Description	Release Rate (kg/s)	Heat Radiation Damage Distance (in meter)			LFL Distance					
						(in meter)					
	Pipeline from Jetty to Storage Tanks		4	12.5	37.5	D2.0	F2.0	D5.0	F4.0	D7.0	C/D11.0
			kW/m ²	kW/m ²	kW/m ²						
G	8” Ethyl Mercaptan Pipeline from Jetty to Tank Farm Area										
25	5mm Leak in the pipeline	1.03E-01	26	21	18	16	18	11	15	9	7
26	25mm Leak in the Pipeline	2.5791	110	88	74	144	189	127	130	110	96
27	100mm Leak in Pipeline	4.13E+02	487	333	250	568	699	514	600	451	376
28	Catastrophic Rupture	7.67E+02	820	536	375	700	713	337	406	254	196
H	18” Isobutanol Pipeline from Jetty to Tank Farm Area										
29	5mm Leak in the pipeline	7.27E-01	63	46	31	19	16	16	18	13	10
30	25mm Leak in the Pipeline	1.82E+01	304	220	168	70	66	90	75	92	92
31	100mm Leak in Pipeline	2.91E+02	416	312	248	73	68	89	69	93	103
32	Catastrophic Rupture	1.36E+03	353	237	167	80	88	46	55	41	35
I	36” LNG Pipeline from Jetty to Tank Farm Area										
33	5mm Leak in the pipeline	4.98E-01	22	18	15	14	16	9	12	8	7
34	25mm Leak in the Pipeline	1.24E+01	91	73	62	126	134	96	98	83	72
35	100mm Leak in Pipeline	1.99E+02	312	248	209	519	533	369	380	326	289
36	Catastrophic Rupture	6.95E+02	1135	700	447	424	1178	339	1038	296	206
J	18” Motor spirit Pipeline from Jetty to Tank Farm Area										
37	5mm Leak in the pipeline	7.63E-01	50	47	42	12	13	9	10	8	7
38	25mm Leak in the Pipeline	1.91E+01	188	105	83	71	75	80	83	72	74
39	100mm Leak in Pipeline	3.05E+02	409	225	167	139	133	165	147	178	168
40	Catastrophic Rupture	---	422	222	---	125	153	149	169	160	195
K	18” N-Butanol Pipeline from Jetty to Tank Farm Area										
41	5mm Leak in the pipeline	7.33E-01	71	51	34	19	16	21	18	17	11
42	25mm Leak in the Pipeline	1.83E+01	324	245	196	64	59	78	66	82	86
43	100mm Leak in Pipeline	2.93E+02	415	311	248	69	63	74	64	78	89
44	Catastrophic Rupture	1.37E+03	341	235	170	80	86	45	53	37	22
L	18” Naphtha Pipeline from Jetty to Tank Farm Area										
45	5mm Leak in the pipeline	7.56E-01	26	24	22	12	13	8	10	7	7
46	25mm Leak in the Pipeline	1.89E+01	104	80	77	101	127	97	106	84	92

S. No.	Scenario Description	Release Rate (kg/s)	Heat Radiation Damage Distance (in meter)			LFL Distance					
						(in meter)					
			4	12.5	37.5	D2.0	F2.0	D5.0	F4.0	D7.0	C/D11.0
	Pipeline from Jetty to Storage Tanks		kW/m ²	kW/m ²	kW/m ²						
47	100mm Leak in Pipeline	3.03E+02	363	273	220	284	278	327	344	292	244
48	Catastrophic Rupture	---	399	201	---	344	340	321	324	337	364
M	18" Phenol Pipeline from Jetty to Tank Farm Area										
49	5mm Leak in the pipeline	8.42E-01	88	66	52	15	13	18	15	14	10
50	25mm Leak in the Pipeline	2.11E+01	201	118	20	32	30	36	31	39	49
51	100mm Leak in Pipeline	3.37E+02	245	152	50	57	54	61	54	63	69
52	Catastrophic Rupture	4.73E+03	202	108	46	25	25	25	25	26	26
N	18" Propane Pipeline from Jetty to Tank Farm Area										
53	5mm Leak in the pipeline	5.93E-01	23	19	16	12	14	8	10	7	7
54	25mm Leak in the Pipeline	1.48E+01	99	78	65	108	140	94	102	82	70
55	100mm Leak in Pipeline	2.37E+02	429	286	201	445	611	386	433	337	282
56	Catastrophic Rupture	8.03E+02	1110	688	447	774	757	383	443	295	218
O	18" Propylene Pipeline from Jetty to Tank Farm Area										
57	5mm Leak in the pipeline	6.14E-01	24	19	16	13	15	9	11	8	7
58	25mm Leak in the Pipeline	1.54E+01	101	79	66	117	148	99	106	85	73
59	100mm Leak in Pipeline	2.46E+02	384	270	223	495	642	404	445	350	294
60	Catastrophic Rupture	8.32E+02	918	575	380	797	770	389	464	302	228
P	18" Propylene Oxide Pipeline from Jetty to Tank Farm Area										
61	5mm Leak in the pipeline	7.84E-01	24	20	17	30	33	21	30	17	11
62	25mm Leak in the Pipeline	1.96E+01	104	83	70	179	199	192	208	168	142
63	100mm Leak in Pipeline	3.13E+02	357	282	236	526	506	694	707	630	536
64	Catastrophic Rupture	4.53E+03	676	528	436	862	843	904	1074	795	647
Q	18" Styrene Pipeline from Jetty to Tank Farm Area										
65	5mm Leak in the pipeline	8.06E-01	57	48	37	19	16	21	18	17	11
66	25mm Leak in the Pipeline	2.02E+01	224	127	53	69	64	86	72	89	92
67	100mm Leak in Pipeline	3.22E+02	287	164	112	75	71	80	72	83	92
68	Catastrophic Rupture	1.49E+03	216	89	21	81	88	42	52	37	37

S. No.	Scenario Description	Release Rate (kg/s)	Heat Radiation Damage Distance (in meter)			LFL Distance					
						(in meter)					
	Pipeline from Jetty to Storage Tanks		4	12.5	37.5	D2.0	F2.0	D5.0	F4.0	D7.0	C/D11.0
			kW/m ²	kW/m ²	kW/m ²						
R	18" Vinyl Chloride Pipeline from Jetty to Tank Farm Area										
69	5mm Leak in the pipeline	7.81E-01	20	16	14	10	11	8	9	8	7
70	25mm Leak in the Pipeline	1.95E+01	86	69	59	79	81	84	86	85	82
71	100mm Leak in Pipeline	3.13E+02	294	236	200	312	313	336	313	378	367
72	Catastrophic Rupture	4.01E+03	923	731	614	703	674	751	695	832	918

Table 7-23: Overpressure Damage Distances – Pipelines from Jetty to Storage Tanks

S. No.	Scenario Description	Overpressure Distance (in meters)								
		D2/F2			D5/F4			D7/(C/D)11		
		0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar
A	18" Acrylonitrile Propane Pipeline from Jetty to Tank Farm Area									
1	5mm Leak in the pipeline	35/36	26/27	23/23	23/34	15/26	13/23	22/21	15/15	13-Dec
2	25mm Leak in the Pipeline	225/231	176/179	158/159	255/274	206/220	188/200	233/207	185/163	168/146
3	100mm Leak in Pipeline	450/425	347/325	308/287	526/472	419/368	380/329	586/570	474/455	432/412
4	Catastrophic Rupture	335/376	253/321	246/300	376/346	311/269	306/264	401/447	352/357	341/323
B	18" Ammonia Pipeline from Jetty to Tank Farm Area									
5	5mm Leak in the pipeline	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
6	25mm Leak in the Pipeline	96/99	75/77	68/68	94/98	75/76	69/68	93/89	74/72	67/66
7	100mm Leak in Pipeline	260/262	208/209	189/190	295/274	240/220	220/200	316/341	261/283	240/262
8	Catastrophic Rupture	130/132	78/79	59/60	132/127	85/77	68/58	130/125	84/82	67/66
C	18" Butane Pipeline from Jetty to Tank Farm Area									
9	5mm Leak in the pipeline	48/50	38/39	34/35	24/37	16/28	13/24	23/-	16/-	13/-
10	25mm Leak in the Pipeline	324/382	253/278	227/239	241/293	177/205	154/173	219/195	163/147	141/129
11	100mm Leak in Pipeline	1370/1624	1072/1215	961/1062	1007/1220	740/859	640/725	884/738	647/544	558/472
12	Catastrophic Rupture	1712/1981	1245/1465	1083/1287	1248/1463	831/928	675/729	1005/724	670/487	545/670
D	18" Crude oil Pipeline from Jetty to Tank Farm Area									
13	5mm Leak in the pipeline	37/39	28/28	24/24	25/37	17/27	14/24	24/--	16/--	13/--
14	25mm Leak in the Pipeline	298/318	236/251	213/225	257/286	196/214	173/187	244/213	184/160	162/140

S. No.	Scenario Description	Overpressure Distance (in meters)								
		D2/F2			D5/F4			D7/(C/D)11		
		0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar
15	100mm Leak in Pipeline	1003/1066	795/839	718/755	879/1004	673/773	597/687	805/726	607/545	534/478
16	Catastrophic Rupture	1471/1445	938/967	791/812	1467/1552	874/940	750/780	1481/1540	892/928	799/831
E	18" Diesel Pipeline from Jetty to Tank Farm Area									
17	5mm Leak in the pipeline	36/37	27/28	24/24	23/35	16/27	13/24	22/--	16/--	13/--
18	25mm Leak in the Pipeline	185/191	131/139	111/120	187/189	132/138	111/119	188/188	132/138	111/119
19	100mm Leak in Pipeline	444/443	333/338	292/299	500/510	391/401	351/361	485/473	373/351	332/306
20	Catastrophic Rupture	964/968	474/616	371/581	998/1048	512/690	438/664	1006/1166	604/635	576/471
F	18" Ethylene Pipeline from Jetty to Tank Farm Area									
21	5mm Leak in the pipeline	62/75	50/61	45/55	47/52	37/39	34/35	35/23	26/16	23/13
22	25mm Leak in the Pipeline	411/477	336/387	308/354	343/380	273/288	246/254	303/267	238/212	214/191
23	100mm Leak in Pipeline	1326/1248	1036/917	928/857	1358/1462	1072/1111	966/1024	1211/998	947/775	848/693
24	Catastrophic Rupture	1545/1759	1357/1748	1318/1744	1444/1582	1080/1541	945/1525	1336/1037	977/781	843/685
G	8" Ethyl Mercaptan Pipeline from Jetty to Tank Farm Area									
25	5mm Leak in the pipeline	22/23	15/16	13/13	21/22	15/15	Dec-13	-/-	-/-	-/-
26	25mm Leak in the Pipeline	220/276	174/221	157/200	197/227	153/171	136/151	175/158	132/119	116/104
27	100mm Leak in Pipeline	904/1084	707/858	633/774	866/1025	662/781	586/691	799/681	599/502	524/436
28	Catastrophic Rupture	1503/1651	1014/1088	835/879	823/1156	540/722	435/561	620/417	408/287	329/238
H	18" Isobutanol Pipeline from Jetty to Tank Farm Area									
29	5mm Leak in the pipeline	22/23	15/15	12/13	19/21	14/15	12/12	19/-	14/-	12/-
30	25mm Leak in the Pipeline	122/112	92/82	81/71	147/123	114/93	102/81	151/155	116/118	103/104
31	100mm Leak in Pipeline	145/128	102/89	86/75	166/128	117/89	98/74	177/198	127/142	107/121
32	Catastrophic Rupture	123/116	98/90	89/80	77/96	56/70	48/60	74/59	55/43	47/36
I	36" LNG Pipeline from Jetty to Tank Farm Area									
33	5mm Leak in the pipeline	48/51	38/39	34/35	24/37	16/28	13/24	22/-	15/-	13/-
34	25mm Leak in the Pipeline	321/374	246/263	218/222	239/279	177/194	154/162	215/191	161/145	141/128
35	100mm Leak in Pipeline	1292/1448	970/1002	850/836	940/1128	688/791	594/666	826/723	605/544	523/477
36	Catastrophic Rupture	1759/4084	1221/3279	1020/2979	1238/3298	872/2640	736/2395	1072/772	530/285	440/238
J	18" Motor spirit Pipeline from Jetty to Tank Farm Area									
37	5mm Leak in the pipeline	38/50	28/39	24/35	24/37	16/28	13/24	23/--	16/--	13/--

S. No.	Scenario Description	Overpressure Distance (in meters)								
		D2/F2			D5/F4			D7/(C/D)11		
		0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar
38	25mm Leak in the Pipeline	253/271	200/213	180/192	214/215	160/161	140/141	203/189	150/138	130/119
39	100mm Leak in Pipeline	448/402	352/315	316/283	494/470	394/378	357/344	463/434	358/329	319/290
40	Catastrophic Rupture	463/510	283/335	251/289	512/527	309/339	265/285	527/542	321/335	279/303
K	18" N-Butanol Pipeline from Jetty to Tank Farm Area									
41	5mm Leak in the pipeline	22/23	15/15	12/13	30/22	24/15	22/13	19/17	14/13	12/12
42	25mm Leak in the Pipeline	107/97	80/70	70/60	122/108	92/80	81/70	136/143	104/107	92/93
43	100mm Leak in Pipeline	121/122	86/86	73/73	144/121	102/86	86/73	143/161	101/114	85/97
44	Catastrophic Rupture	120/115	97/89	88/82	76/92	55/68	48/59	63/46	44/31	37/26
L	18" Naphtha Pipeline from Jetty to Tank Farm Area									
45	5mm Leak in the pipeline	38/50	28/39	24/35	25/37	17/28	14/24	23/--	16/--	13/--
46	25mm Leak in the Pipeline	315/359	249/274	225/242	249/277	187/199	164/170	220/198	163/148	142/129
47	100mm Leak in Pipeline	972/992	770/779	695/700	829/866	623/649	547/570	714/624	534/467	467/401
48	Catastrophic Rupture	949/980	646/664	549/556	908/949	584/617	492/506	909/903	583/592	499/543
M	18" Phenol Pipeline from Jetty to Tank Farm Area									
49	5mm Leak in the pipeline	15/16	12/13	11/11	14/15	12/12	11/11	14/15	12/12	11/11
50	25mm Leak in the Pipeline	51/35	39/27	35/23	51/52	39/39	34/35	51/64	39/50	34/45
51	100mm Leak in Pipeline	77/77	61/62	56/56	94/77	74/62	67/56	93/91	74/73	67/67
52	Catastrophic Rupture	26/26	23/23	21/21	26/26	23/23	21/21	26/27	23/23	21/21
N	18" Propane Pipeline from Jetty to Tank Farm Area									
53	5mm Leak in the pipeline	47/50	38/39	34/35	24/36	16/27	13/24	23/-	16/-	13/-
54	25mm Leak in the Pipeline	322/372	252/268	226/229	238/280	176/194	153/162	208/183	152/136	131/118
55	100mm Leak in Pipeline	1341/1594	1048/1173	939/1017	990/1187	626/828	628/694	852/720	622/531	461/583
56	Catastrophic Rupture	1904/2003	1333/1468	1136/1284	1314/1594	882/1032	721/836	1074/812	716/553	583/457
	Long Pipeline Failure	1426/1409	1136/1100	1028/985	1227/1418	936/1104	828/987	1102/924	832/693	731/606
O	18" Propylene Pipeline from Jetty to Tank Farm Area									
57	5mm Leak in the pipeline	49/51	38/39	34/35	24/37	16/28	13/24	23/-	16/-	13/-
58	25mm Leak in the Pipeline	328/394	255/283	228/242	254/296	189/207	165/174	221/196	163/147	142/129
59	100mm Leak in Pipeline	1403/1661	1092/1219	976/1055	1007/1223	739/855	640/717	886/755	648/557	559/484
60	Catastrophic Rupture	1916/2026	1353/1487	1157/1298	1354/1661	911/1069	745/889	1111/835	744/569	607/470

S. No.	Scenario Description	Overpressure Distance (in meters)								
		D2/F2			D5/F4			D7/(C/D)11		
		0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar
P	18" Propylene Oxide Pipeline from Jetty to Tank Farm Area									
61	5mm Leak in the pipeline	37/48	27/38	24/34	34/36	26/27	23/23	23/22	16/15	13-Dec
62	25mm Leak in the Pipeline	270/304	212/239	191/214	286/315	231/249	210/224	252/223	199/175	180/158
63	100mm Leak in Pipeline	835/776	648/618	579/559	1013/937	822/755	751/722	957/849	764/666	692/598
64	Catastrophic Rupture	1328/1376	1059/1068	966/954	802/1331	744/1181	741/1125	798/756	759/676	749/658
Q	18" Styrene Pipeline from Jetty to Tank Farm Area									
65	5mm Leak in the pipeline	23/24	16/16	13/13	31/23	25/16	22/13	20/18	14/13	12-Dec
66	25mm Leak in the Pipeline	114/110	83/81	72/71	140/125	106/94	93/82	145/159	108/120	94/105
67	100mm Leak in Pipeline	134/131	97/96	84/83	143/131	101/96	86/83	155/177	112/127	96/109
68	Catastrophic Rupture	129/116	101/89	91/81	81/100	57/71	49/61	67/63	46/44	38/38
R	18" Vinyl Chloride Pipeline from Jetty to Tank Farm Area									
69	5mm Leak in the pipeline	18/18	13/14	12/12	-/-	-/-	-/-	-/-	-/-	-/-
70	25mm Leak in the Pipeline	117/131	90/102	80/91	126/128	100/101	90/90	124/121	99/97	89/89
71	100mm Leak in Pipeline	491/506	387/394	349/352	514/505	409/393	369/352	554/541	448/437	409/399
72	Catastrophic Rupture	912/833	790/731	745/700	900/927	814/791	782/741	910/966	859/828	845/814

Table 7-24: Heat Radiation Damage Distances (HRDD) – Tank Farm Area (TFA)

S. No.	Scenario Description	Release Rate (kg/s)	Heat Flux Damage Distance (in meter)			LFL Distance (in meter)					
			4.0 kW/m ²	12.5 kW/m ²	37.5 kW/m ²	D2	F2	D5	F4	D7	C/D11
A	Butane vessel at Tank Farm Area (TFA) @ -5 °C and 1.0 atm pressure										
1	5mm Leak from vessel in 12" pipeline	7.045e-01	25	19	16	12	13	8	10	7	7
2	25mm Leak from vessel in 12" pipeline	1.761e+01	105	81	67	99	124	97	109	85	73
3	100mm Leak from vessel in 12" pipeline	2.818e+02	589	386	268	401	484	415	485	365	303
4	Catastrophic rupture of 12" pipeline	2.536e+03	2744	1741	1129	1815	2180	1052	1303	858	663
5	Catastrophic rupture of Butane vessel	---	1338	663	299	1885	1927	1556	1693	1548	1605
6	10 minute release from Butane vessel	4.167e+04	1779	1331	1062	2176	2474	1192	1575	1005	785
B	Propane vessel at TFA @ -45°C and 1.1 atm (pressure										
1	5mm Leak from vessel in 12" pipeline	6.836e-01	24	19	16	12	14	9	11	8	7

S. No.	Scenario Description	Release Rate (kg/s)	Heat Flux Damage Distance (in meter)			LFL Distance (in meter)					
			4.0 kW/m ²	12.5 kW/m ²	37.5 kW/m ²	D2	F2	D5	F4	D7	C/D11
2	25mm Leak from vessel in 12" pipeline	1.709e+01	104	81	68	105	140	100	110	87	75
3	100mm Leak from vessel in 12" pipeline	2.734e+02	462	308	221	430	584	417	481	369	305
4	Catastrophic rupture of 12" pipeline	2461e+03	2421	1536	997	1826	2122	1060	1266	862	683
5	Catastrophic rupture of propane vessel	---	3712	1994	670	1170	1104	1038	925	1021	1119
6	10minute release from Propane vessel	4.167e+04	1572	1191	961	1868	2143	1066	1353	902	717
C Propylene vessel at TFA @ -47 °C and 1.1 atm pressure											
1	5mm Leak from vessel in 12" pipeline	7.123e-01	25	20	17	13	15	9	12	8	7
2	25mm Leak from vessel in 12" pipeline	1.781e+01	105	83	70	114	151	106	115	93	79
3	100mm Leak from vessel in 12" pipeline	2.849e+02	396	271	196	464	641	434	503	382	319
4	Catastrophic rupture of 12" pipeline	2.564e+03	2050	1314	873	1901	2187	1082	1296	894	699
5	Catastrophic rupture of Propylene vessel	---	3563	1908	625	1731	1801	1505	1645	1543	1650
6	10 minute release from Propylene vessel	4.167e+04	1503	1143	925	1808	2075	1036	1283	878	707
D Crude at TFA @ 40 °C and 0.6 atm pressure											
1	Catastrophic rupture of Crude vessel	---	128	55	-	159	150	152	123	163	203
2	10 minute release from Crude vessel	3.144e+01	106	77	60	143	145	101	103	93	83
E Naphtha/MS/AF/Kerosene at TFA @ ambient temperature and 0.6 atm pressure											
1	Catastrophic rupture of Naphtha/MS/AF/Kerosene vessel	---	101	38	-	27	25	30	25	34	41
2	10 minute release from Naphtha/MS/AF/Kerosene vessel	2.937e+01	107	51	41	27	30	30	33	32	30
F Diesel/FO/LO at TFA @ 70 °C and 0.6 atm pressure											
1	Catastrophic rupture of Diesel/FO/LO vessel	---	54	25	-	19	10	20	18	22	33
2	10 minute release from Diesel/FO/ LO vessel	2.813e+01	92	52	18	19	18	19	18	21	23
G Ammonia at TFA @ -35 °C and 1.0 atm pressure											
1	Catastrophic rupture of 10000MT Ammonia vessel	-	1245	990	790	799	2184	878	2172	1025	1203
2	10 minute release from Ammonia vessel	1.6666e+04	1151	892	704	85	84	98	93	105	116
H LNG at TFA @ -162 °C and 1.1 atm pressure											
1	Catastrophic rupture of 180,000M3 LNG vessel	---	5025	2742	1027	682	1996	529	1307	562	455
2	10 minute release from LNG vessel	1.369e+05	1617	1259	1037	1638	2000	1175	1875	1094	902

S. No.	Scenario Description	Release Rate (kg/s)	Heat Flux Damage Distance (in meter)			LFL Distance (in meter)					
			4.0 kW/m ²	12.5 kW/m ²	37.5 kW/m ²	D2	F2	D5	F4	D7	C/D11
I	Barge Facility at Jetty (LPG barge handling system)										
1	Catastrophic rupture of Barge Vessel of 5000MT capacity	---	5827	3179	1159	1250	2598	2473	4947	3326	4501
2	5mm leak at Barge vessel	5.499e-01	20	16	13	8	9	7	7	6	6
3	150mm leak at Barge vessel	4.949e+02	427	328	269	421	431	518	507	501	427

Table 7-25: Overpressure Damage Distances (OPDD) – Tank Farm Area (TFA)

S. No.	Scenario Description	Overpressure Distance (in meters)								
		D2/F2			D5/F4			D7/(C/D)11		
		0.03Bar	0.1Bar	0.3Bar	0.03Bar	0.1Bar	0.3Bar	0.03Bar	0.1Bar	0.3Bar
A	Butane vessel at TFA @ -5 °C and 1.0 atm pressure									
1	5mm Leak from vessel in 12" pipeline	37/49	28/38	24/34	24/37	16/27	13/24	23/-	16/-	13/-
2	25mm Leak from vessel in 12" pipeline	326/375	260/286	235/253	248/297	186/213	163/182	220/197	163/147	142/129
3	100mm Leak from vessel in 12" pipeline	1372/1596	1090/1243	985/1112	1056/1280	783/919	682/785	924/774	681/571	591/496
4	Catastrophic rupture of 12" pipeline	4813/5821	3584/4232	3127/3641	2979/3812	2097/2612	1768/2166	2482/1909	1747/1354	1147/2235
5	Catastrophic rupture of Butane vessel	4693/4835	3251/3354	2758/2831	4209/4487	2765/3004	2287/2494	4092/3948	2670/2594	2235/2247
6	10minute release from Butane vessel	4162/4397	3437/3952	3238/3786	3272/4235	2319/2988	1964/2524	2759/2168	1963/1562	1666/1336
B	Propane vessel at TFA @ -45 °C and 1.1 atm pressure									
1	5mm Leak from vessel in 12" pipeline	48/50	38/39	34/35	24/37	16/28	13/24	23/-	16/-	13/-
2	25mm Leak from vessel in 12" pipeline	330/389	262/293	236/256	250/303	187/215	164/183	221/197	163/147	142/129
3	100mm Leak from vessel in 12" pipeline	1401/1643	1108/1257	999/1114	1044/1284	772/915	671/778	928/772	683/570	591/495
4	Catastrophic rupture of 12" pipeline	4774/5666	3510/4063	3040/3466	2976/3765	2101/2593	1775/2156	2459/1850	1737/1340	1469/1150
5	Catastrophic rupture of propane vessel	3083/3042	2083/2035	1743/1675	2871/2764	1848/1777	1537/1432	2708/2722	1750/1769	1508/1635
6	10minute release from Propane vessel	3825/3919	3055/3327	2797/3155	2896/3791	2055/2678	1743/2264	2451/1957	1751/1420	1490/1220
C	Propylene vessel at TFA @ -47 °C and 1.1 atm pressure									
1	5mm Leak from vessel in 12" pipeline	49/51	38/39	34/35	35/38	27/28	24/24	24/-	16/-	13/-
2	25mm Leak from vessel in 12" pipeline	347/402	274/298	247/259	266/309	200/218	175/184	236/211	176/159	153/140
3	100mm Leak from vessel in 12" pipeline	1468/1729	1160/1317	1045/1163	1096/1331	812/946	706/803	961/805	708/596	614/518
4	Catastrophic rupture of 12" pipeline	4935/5844	3625/4179	3137/3559	3053/3875	2151/2668	1815/2219	2557/1990	1808/1423	1529/1211
5	Catastrophic rupture of Propylene vessel	4415/4578	3023/3157	2545/2652	4027/4269	2643/2875	2202/2398	3922/3841	2580/2565	2187/2270
6	10minute release from propylene vessel	3740/3834	2969/3222	2699/3031	2818/3632	1999/2582	1695/2191	2395/1923	1710/1394	1455/1197

S. No.	Scenario Description	Overpressure Distance (in meters)								
		D2/F2			D5/F4			D7/(C/D)11		
		0.03Bar	0.1Bar	0.3Bar	0.03Bar	0.1Bar	0.3Bar	0.03Bar	0.1Bar	0.3Bar
D	Crude at TFA @ 40 °C and 0.6 atm pressure									
1	Catastrophic rupture of Crude vessel	509/513	318/316	252/248	485/482	288/280	230/210	481/479	287/305	239/292
2	10minute release from Crude vessel	367/399	277/285	244/243	263/297	193/207	167/174	248/218	180/156	155/133
E	Naphtha/MS/AF/Kerosene at TFA @ ambient temperature and 0.6 atm pressure									
1	Catastrophic rupture of Naphtha/MS/AF/Kerosene vessel	124/127	67/70	52/50	123/126	67/68	58/49	119/122	68/78	56/74
2	10minute release from Naphtha/MS/AF/Kero sene vessel	86/102	72/84	66/77	87/92	72/74	66/67	91/80	73/63	67/57
F	Diesel/FO/ LO at TFA @ 70 °C and 0.6 atm pressure									
1	Catastrophic rupture of Diesel/FO/LO vessel	138/138	71/71	46/46	133/141	68/72	44/46	129/123	67/64	44/44
2	10minute release from Diesel/FO/LO vessel	24/24	16/16	13/13	26/25	17/17	14/14	45/43	31/30	26/25
G	Ammonia at TFA @ -35 °C and 1.0 atm pressure									
1	Catastrophic rupture of Ammonia vessel	1251/1325	734/806	542/613	1286/1409	780/899	595/709	1320/1333	823/873	664/837
2	10minute release from Ammonia vessel	365/360	202/199	141/140	350/355	201/203	145/146	351/349	207/212	154/161
H	LNG at TFA @ -162 °C and 1.1 atm pressure									
1	Catastrophic rupture of LNG vessel	2008/4711	1465/4120	1262/3900	1557/3375	1100/2736	930/2498	1561/1159	1159/873	1010/767
2	10minute release from LNG vessel	3962/4217	2825/3141	2402/2740	3282/5243	2427/4571	2108/4320	3003/2390	2256/1782	1978/1556
I	Barge Facility at jetty.									
	LPG barge handling system									
1	Catastrophic rupture of Barge Vessel of 5000MT capacity	8608/8998	4183/4846	2600/3939	8930/9932	4748/6733	3822/6501	9242/9482	5397/6283	4798/5884
2	5mm leak at Barge vessel	22/23	16/16	13/13	21/22	15/15	13/13	-/-	-/-	-/-
3	150mm leak at Barge vessel	1321/1390	1034/1075	927/957	1328/1540	1037/1219	929/1100	1215/1034	931/785	826/693

Table 7-26: Heat Radiation Damage Distances – Bullets and Associated Pipelines

S. No.	Scenario Description	Release Rate (kg/s)	Heat Radiation Damage Distance (in meter)			LFL Distance (in meter)					
	Bullet area		4.0 kW/m ²	12.5 kW/m ²	37.5 kW/m ²	D2.0	F2.0	D5.0	F4.0	D7.0	C/D11.0
A	8" Pipeline from Butane Bullet										
1	5mm leak in pipeline	5.91e -01	21	17	14	9	10	8	8	7	6
2	25 mm leak in pipeline	1.477e+01	92	71	59	76	84	79	99	74	65

S. No.	Scenario Description	Release Rate (kg/s)	Heat Radiation Damage Distance (in meter)			LFL Distance (in meter)					
	Bullet area		4.0 kW/m ²	12.5 kW/m ²	37.5 kW/m ²	D2.0	F2.0	D5.0	F4.0	D7.0	C/D11.0
3	100 mm leak in pipeline	2.362e+02	321	246	202	192	173	202	169	197	201
4	Catastrophic rupture of pipeline	7.51e+02	547	416	339	220	191	224	184	220	229
B	8" Pipeline from Propane bullet										
1	5mm leak in pipeline	5.817e-01	19	15	13	8	8	6	7	6	6
2	25 mm leak in pipeline	1.454e+01	81	64	54	51	54	50	54	50	47
3	100 mm leak in pipeline	2.327e+02	285	222	186	181	174	203	187	205	207
4	Catastrophic rupture of pipeline	6.105e+02	440	343	285	215	202	238	211	241	247
C	8" pipeline from Propylene bullet										
1	5mm leak in pipeline	5.737e-01	19	15	13	8	8	7	7	6	6
2	25 mm leak in pipeline	1.434e+01	80	64	54	52	56	52	56	53	49
3	100 mm leak in pipeline	2.327e+02	285	222	186	181	174	203	187	205	207
4	Catastrophic rupture of pipeline	6.106e+02	440	343	285	215	202	238	211	241	247

Table 7-27: Overpressure Damage Distances – Bullets and Associated Pipelines

S. No.	Scenario Description	Overpressure Distance (in meters)								
		D2/F2			D5/F4			D7/(C/D)11		
A	8" Pipeline from Butane bullet	0.3Bar	0.1Bar	0.03Bar	0.3Bar	0.1Bar	0.03Bar	0.3Bar	0.1Bar	0.03Bar
1	5mm leak in pipeline	24/35	16/27	13/24	22/23	16/16	13/13	22/-	15/-	13/-
2	25mm leak in pipeline	220/212	174/154	166/135	214/224	166/165	148/143	201/183	155/141	138/126
3	100mm leak in pipeline	292/291	239/231	234/214	310/298	250/228	235/205	308/302	246/248	233/239
4	Catastrophic rupture of pipeline	325/324	271/256	260/233	342/325	276/247	263/222	341/341	273/277	256/264
B	8" pipeline from Propane bullet									
1	5mm leak in pipeline	21/21	15/15	13/13	--/21	--/15	--/13	--/--	--/--	--/--
2	25mm leak in pipeline	174/190	137/150	124/135	181/198	146/159	133/145	169/155	136/124	123/112
3	100mm leak in pipeline	261/263	220/218	210/213	275/170	241/226	231/217	282/280	247/255	239/253
4	Catastrophic rupture of pipeline	299/296	263/245	257/238	317/304	278/255	269/245	325/328	295/293	288/287
C	8" Pipeline from Propylene bullet									
1	5mm leak in pipeline	21/21	15/15	13/13	20/21	15/15	13/13	--/--	--/--	--/--

S. No.	Scenario Description	Overpressure Distance (in meters)								
		D2/F2			D5/F4			D7/(C/D)11		
2	25mm leak in pipeline	184/190	148/150	134/135	182/209	147/170	134/155	170/156	136/124	123/112
3	100 mm leak in pipeline	261/263	220/218	210/213	275/270	241/226	231/217	282/280	247/255	239/253
4	Catastrophic rupture of pipeline	299/296	263/245	257/238	317/304	278/255	269/245	325/328	295/293	288/287

Table 7-28: Heat Radiation Damage Distances – LNG, CNG and LPG Pipeline network

S. No.	Scenario Description	Release Rate (kg/s)	Heat Radiation Damage Distance (in meter)			LFL Distance (in meter)					
	Pipeline from Jetty to Tank Farm Area		4.0 kW/m ²	12.5 kW/m ²	37.5 kW/m ²	D2.0	F2.0	D5.0	F4.0	D7.0	C/D11.0
LNG Pipeline Network											
A	14" PL from LNG Storage Tank to Recondenser Header										
1	5mm Leak in the pipeline	5.2295 e -1	21	17	15	29	35	16	24	12	8
2	25mm Leak in the Pipeline	1.3073 e +1	89	72	62	206	203	140	148	129	117
3	100mm Leak in Pipeline	2.0918 e +2	303	244	207	817	822	541	613	471	432
4	Catastrophic Rupture	1.4680 e +3	1511	960	624	1626	4307	1215	3551	1060	701
B	6" PL from LNG Storage Tank to Tank Lorry Filling Facility										
1	5mm Leak in the pipeline	5.0459 e -1	21	17	14	29	35	16	24	12	8
2	25mm Leak in the Pipeline	1.2614 e +1	88	71	61	202	198	137	144	127	115
3	100mm Leak in Pipeline	2.0183 e +2	300	241	205	798	797	529	601	462	423
4	Catastrophic Rupture	1.5225 e +2	526	330	204	526	1244	393	1119	338	239
C	14" PL from Booster Pump to Recondenser Header										
1	5mm Leak in the pipeline	5.2295 e -1	21	17	15	29	35	16	24	12	8
2	25mm Leak in the Pipeline	1.3073 e +1	89	72	62	206	203	140	148	129	117
3	100mm Leak in Pipeline	2.0918 e +2	303	244	207	817	822	541	613	471	432
4	Catastrophic Rupture	1.2267 e +3	577	890	1406	1445	3769	1084	3262	939	612
D	14" PL from HP pump to STV										
1	5mm Leak in the pipeline	1.1595 e -1	26	22	19	34	39	28	36	23	16
2	25mm Leak in the Pipeline	2.8989 e +1	113	92	79	272	305	224	253	202	185
3	100mm Leak in Pipeline	4.6383 e +2	387	314	268	1063	1056	893	1064	780	670
4	Catastrophic Rupture	2.7138 e +3	1788	1149	759	2221	2359	1690	4582	1529	1205

S. No.	Scenario Description	Release Rate (kg/s)	Heat Radiation Damage Distance (in meter)			LFL Distance (in meter)					
	Pipeline from Jetty to Tank Farm Area		4.0 kW/m ²	12.5 kW/m ²	37.5 kW/m ²	D2.0	F2.0	D5.0	F4.0	D7.0	C/D11.0
E	LNG Tanker Lorry Filling										
1	3inch Hose failure during Tanker filling	5.0312e+1	303	190	124	320	742	225	665	189	129
2	Catastrophic failure of 20m ³ LNG Road Tanker	-	256	172	118	404	1103	393	1246	314	231
Natural Gas Network											
F	16” PL from STV outlet header to Tie-in point										
1	5mm Leak in the pipeline	3.6905 e -1	10	8	NR	9	9	7	8	7	6
2	25mm Leak in the Pipeline	9.2264	54	46	41	79	85	84	90	86	83
3	100mm Leak in Pipeline	1.4762 e +2	193	149	129	405	430	472	491	467	446
4	Catastrophic Rupture	1.3118 e +3	526	385	320	1227	1276	1484	1480	1424	1344
G	16” PL from STV outlet header to NG Compressor inlet										
1	5mm Leak in the pipeline	2.6056 e -1	8	5	NR	8	8	6	7	6	5
2	25mm Leak in the Pipeline	6.5141	45	39	35	62	68	65	71	65	62
3	100mm Leak in Pipeline	1.0421 e +2	165	130	113	339	363	396	414	397	380
4	Catastrophic Rupture	8.3381 e +2	426	314	263	1001	1046	1180	1210	1154	1096
H	14” PL from STV outlet header to NG Compressor inlet										
1	5mm Leak in the pipeline	3.0436 e -1	9	7	NR	8	8	7	7	6	5
2	25mm Leak in the Pipeline	7.6091	49	42	38	69	75	73	79	74	71
3	100mm Leak in Pipeline	1.2174 e +2	177	138	120	368	392	428	447	427	408
4	Catastrophic Rupture	7.2938 e +2	401	295	248	430	971	1102	1124	1070	1017
CNG Gas Pipeline Network											
I	16” PL from NG Compressor to Tie-in point										
1	5mm Leak in the pipeline	3.2961 e -1	9	7	NR	8	9	7	7	6	5
2	25mm Leak in the Pipeline	3.0511 e +1	117	91	77	233	267	203	227	177	161
3	100mm Leak in Pipeline	4.8817 e +2	407	315	261	878	845	819	994	719	595
4	Catastrophic Rupture	1.0573 e +3	475	349	291	1133	1180	1334	1365	1302	1234
5	Catastrophic rupture of 13m ³ CNG cylinder	-	312	171	77	36	38	56	54	72	107
LPG Pipeline Network											
J	8” Butane Pipeline to LPG Blender										

S. No.	Scenario Description	Release Rate (kg/s)	Heat Radiation Damage Distance (in meter)			LFL Distance (in meter)					
	Pipeline from Jetty to Tank Farm Area		4.0 kW/m ²	12.5 kW/m ²	37.5 kW/m ²	D2.0	F2.0	D5.0	F4.0	D7.0	C/D11.0
1	5mm Leak in the pipeline	7.9649 e -1	25	19	16	29	38	19	27	15	10
2	25mm Leak in the Pipeline	1.9912 e +1	105	82	68	230	245	160	173	140	127
3	100mm Leak in Pipeline	3.1859 e +2	364	281	232	974	1094	638	745	553	466
4	Catastrophic Rupture	5.2197 e +2	844	544	353	1143	1172	689	740	593	509
K	8" Propane Pipeline to LPG Blender										
1	5mm Leak in the pipeline	7.2581 e -1	21	17	14	19	21	13	17	11	8
2	25mm Leak in the Pipeline	1.8145 e +1	93	74	62	169	190	152	172	136	123
3	100mm Leak in Pipeline	2.9032 e +2	322	253	212	664	654	634	748	558	471
4	Catastrophic Rupture	4.9365 e +2	415	325	272	928	887	820	994	719	597
L	12" Butane Pipeline from LPG Blender										
1	5mm Leak in the pipeline	6.4550 e -1	23	18	15	28	35	16	24	13	8
2	25mm Leak in the Pipeline	2.0119 e +1	106	82	69	232	247	161	174	141	128
3	100mm Leak in Pipeline	2.5820 e +2	339	262	215	876	957	561	632	487	416
4	Catastrophic Rupture	1.2851 e +3	1120	722	487	1725	1878	988	1130	838	692
M	6" Pipeline from LPG Blender to TLF										
1	5mm Leak in the pipeline	7.4308 e -1	23	18	15	25	32	16	24	13	9
2	25mm Leak in the Pipeline	1.8577 e +1	99	78	65	217	237	155	170	136	124
3	100mm Leak in Pipeline	2.9723 e +2	344	267	221	914	1025	623	734	542	457
4	Catastrophic Rupture	2.0938 e +2	309	239	197	785	845	502	558	435	376
5	3inch Hose failure during Tanker filling	8.4166 e +1	205	159	132	489	478	320	325	279	252
6	Catastrophic failure of 20m ³ LPG Road Tanker	-	338	179	59	317	297	340	299	374	451

Table 7-29: Overpressure Damage Distances – LNG, CNG and LPG Pipeline network

S. No.	Scenario Description	Overpressure Distance (in meters)								
		D2/F2			D5/F4			D7/(C/D)11		
		0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar
LNG Pipeline Network										
A	14" PL from LNG Storage Tank to Recondenser Header									
1	5mm Leak in the pipeline	36/48	27/38	24/34	23/35	16/27	13/23	22/-	15/-	13/-
2	25mm Leak in the Pipeline	325/374	253/274	227/237	244/281	184/200	162/170	215/192	160/145	140/128
3	100mm Leak in Pipeline	1378/1584	1052/1146	931/983	985/1193	730/859	635/734	857/748	635/565	553/498
4	Catastrophic Rupture	3172/6172	2282/5098	1951/4699	2208/5044	1635/4187	1422/3868	1938/1372	1434/987	1247/843
B	6" PL from LNG Storage Tank to Tank Lorry Filling Facility									
1	5mm Leak in the pipeline	36/48	27/38	23/34	23/35	15/26	13/23	22/-	15/-	12/-
2	25mm Leak in the Pipeline	326/366	254/265	227/227	233/279	174/199	152/170	214/191	160/145	140/127
3	100mm Leak in Pipeline	1359/1555	1033/1116	911/953	959/1177	707/846	613/723	842/733	623/553	541/487
4	Catastrophic Rupture	1021/1914	734/1528	627/1384	744/1689	541/1357	465/1233	637/473	461/333	395/282
C	14" PL from Booster Pump to Recondenser Header									
1	5mm Leak in the pipeline	36/48	27/38	23/34	23/35	16/27	13/23	22/-	15/-	13/-
2	25mm Leak in the Pipeline	325/374	253/274	227/237	244/281	184/200	162/170	215/192	160/145	140/128
3	100mm Leak in Pipeline	1378/1584	1052/1146	931/983	985/1193	730/859	635/734	858/ 748	635/565	553/498
4	Catastrophic Rupture	2784/5407	2013/4462	1726/4111	1990/4669	1468/3861	1274/3560	1732/1217	1272/869	1101/739
D	14" PL from HP pump to STV									
1	5mm Leak in the pipeline	48/50	38/38	34/34	36/48	27/38	23/34	35/23	26/16	23/13
2	25mm Leak in the Pipeline	392/440	322/360	296/330	341/391	272/310	246/280	317/288	250/226	225/203
3	100mm Leak in Pipeline	1585/1622	1284/1294	1172/1172	1423/1653	1117/1313	1004/1186	1274/1106	985/856	877/763
4	Catastrophic Rupture	4571/5001	3222/3480	2721/2914	3147/6605	2306/5444	1992/5011	2766/2203	2051/1628	1785/1414
E	LNG Tanker Lorry Filling									
1	3inch Hose failure during Tanker filling	631/1168	453/923	386/831	430/1023	310/815	265/737	361/261	257/180	219/150
2	Catastrophic failure of 20m³ LNG Road Tanker	546/1146	459/1120	429/1110	586/1272	437/1254	409/1247	560/451	405/324	347/277
Natural Gas Network										
F	16" PL from STV outlet header to Tie-in point									
1	5mm Leak in the pipeline	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-

S. No.	Scenario Description	Overpressure Distance (in meters)								
		D2/F2			D5/F4			D7/(C/D)11		
		0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar
2	25mm Leak in the Pipeline	111/124	87/99	79/89	119/133	97/108	88/99	117/115	96/95	88/87
3	100mm Leak in Pipeline	590/631	481/510	441/465	660/700	551/579	510/535	649/626	541/519	500/480
4	Catastrophic Rupture	1828/1915	1479/1545	1349/1407	2086/2116	1738/1751	1609/1616	2024/1930	1678/1592	1549/1466
G	16" PL from STV outlet header to NG Compressor inlet									
1	5mm Leak in the pipeline	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
2	25mm Leak in the Pipeline	93/95	74/75	67/68	91/104	73/85	67/77	90/87	73/72	66/66
3	100mm Leak in Pipeline	488/536	397/435	364/397	547/585	457/485	424/447	547/522	457/435	423/402
4	Catastrophic Rupture	1483/1554	1206/1259	1103/1149	1658/1709	1384/1417	1282/1308	1627/1558	1354/1290	1252/1190
H	14" PL from STV outlet header to NG Compressor inlet									
1	5mm Leak in the pipeline	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
2	25mm Leak in the Pipeline	96/109	75/87	68/78	104/108	85/86	77/78	103/100	84/83	77/76
3	100mm Leak in Pipeline	532/580	434/471	397/430	591/630	493/521	456/480	590/567	493/471	456/436
4	Catastrophic Rupture	1367/1452	1111/1176	1015/1073	1545/1596	1290/1323	1195/1221	1515/1447	1260/1197	1165/1103
CNG Gas Pipeline Network										
I	16" PL from NG Compressor to Tie-in point									
1	5mm Leak in the pipeline	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
2	25mm Leak in the Pipeline	348/395	280/318	255/289	316/357	249/278	225/249	283/263	218/204	194/182
3	100mm Leak in Pipeline	1368/1371	1082/1066	976/953	1322/1532	1028/1221	919/1105	1203/1020	920/774	815/682
4	Catastrophic Rupture	1676/1760	1363/1427	1246/1303	1873/1934	1561/1605	1446/1482	1841/1760	1531/1456	1415/1343
5	Catastrophic rupture of 13m ³ CNG cylinder	332/333	159/159	94/95	326/329	156/157	94/94	322/336	159/166	99/104
LPG Pipeline Network										
J	8" Butane Pipeline to LPG Blender									
1	5mm Leak in the pipeline	37/49	27/38	24/34	25/37	16/27	13/24	23/-	16/-	13/-
2	25mm Leak in the Pipeline	353/396	282/307	256/273	264/319	199/234	174/202	245/212	185/159	162/140
3	100mm Leak in Pipeline	1495/1696	1194/1348	1082/1219	1134/1372	845/1009	737/874	1006/838	745/621	647/541
4	Catastrophic Rupture	2212/2583	1597/1773	1368/1471	1408/1729	990/1156	835/943	1208/959	854/696	722/598
K	8" Propane Pipeline to LPG Blender									
1	5mm Leak in the pipeline	23/34	16/26	13/23	22/23	15/15	12/13	21/-	15/-	12/-

S. No.	Scenario Description	Overpressure Distance (in meters)								
		D2/F2			D5/F4			D7/(C/D)11		
		0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar	0.03 Bar	0.1 Bar	0.3 Bar
2	25mm Leak in the Pipeline	246/276	197/221	178/201	233/265	185/211	168/211	212/194	165/152	147/136
3	100mm Leak in Pipeline	1034/1052	819/821	740/736	1010/1149	792/915	711/827	920/796	708/609	629/539
4	Catastrophic Rupture	1435/1430	1140/1115	1030/997	1348/1554	1045/1231	932/1110	1213/1025	925/776	817/683
L	12" Butane Pipeline from LPG Blender									
1	5mm Leak in the pipeline	37/48	27/38	24/34	24/36	16/27	13/23	23/-	15/-	13/-
2	25mm Leak in the Pipeline	353/396	282/307	256/273	274/319	209/234	184/202	245/213	185/160	162/140
3	100mm Leak in Pipeline	1397/1623	1095/1237	982/1093	1033/1256	762/897	661/763	897/754	658/557	569/483
4	Catastrophic Rupture	3169/3506	2338/2473	2029/2171	2048/2576	1436/1747	1207/1438	1728/1379	1213/984	1021/837
M	6" Pipeline from LPG Blender to TLF									
1	5mm Leak in the pipeline	36/47	27/37	23/34	23/35	16/26	13/23	23/-	15/-	13/-
2	25mm Leak in the Pipeline	319/364	257/287	233/258	253/294	194/217	172/188	227/207	171/157	151/139
3	100mm Leak in Pipeline	1383/1552	1112/1247	1011/1133	1085/1297	818/972	719/851	969/809	723/603	631/526
4	Catastrophic Rupture	1278/1505	992/1124	886/982	932/1126	684/796	592/673	815/683	594/504	512/437
5	3inch Hose failure while Tanker filling	817/982	624/688	552/579	601/708	440/485	380/403	518/456	376/338	323/294
6	Catastrophic failure of 20m ³ LPG Road Tanker	615/619	416/414	354/347	625/632	412/413	353/342	638/664	428/462	374/430

Table 7-30: Toxic Release Damage Distance (IDLH)

S. No.	Scenario Description1	Toxic damage distances (IDLH)					
		D2.0	F2.0	D5.0	F4.0	D7.0	C/D11.0
1	Failure of 8" Acrylonitrile marine loading arm - 85ppm	3084X1085@1050	7894X1736@1440	2720X448@744	8544X783@890	2586X348@742	2072X264@750
2	5mm leak of 18" Acrylonitrile pipeline from jetty to tank farm	311X96@138	700X193@128	239X39@98	621X85@105	213X29@97	143X16@72
3	25mm leak of 18" Acrylonitrile pipeline from jetty to tank farm	1449X650@598	3569X1140@595	1180X243@423	3286X474@444	1081X173@417	821X109@412
4	100mm leak of 18" Acrylonitrile pipeline from jetty to tank farm	5342X2421@1931	15000X3508@2189	4581X819@1106	15931X1433@1099	4138X579@975	2968X371@905
5	Catastrophic rupture of 18" Acrylonitrile pipeline from jetty to tank farm	6135X1829@757	19485X3021@1373	5000X710@116	18755X1002@816	4040X671@93	2649X602@91
6	Failure of 12" Ammonia marine loading arm - 300ppm	6235X660@1043	22563X859@1116	4354X336@1708	17316X540@6570	3835X294@161	2588X272@133
7	5mm leak of 18" Ammonia pipeline from jetty to tank farm	262X80@120	567X161@120	198X35@107	480X75@100	180X27@111	262X80@120
8	25mm leak of 18" Ammonia pipeline from jetty to tank farm	1281X481@483	3811X785@396	1007X193@392	2956X375@367	930X148@359	698X95@352
9	100mm leak of 18" Ammonia pipeline from jetty to tank farm	6558X1397@1448	24678X1689@1609	4979X553@844	22709X702@9268	4298X398@789	2834X263@1009
10	Catastrophic rupture of 18" Ammonia pipeline from jetty to tank farm	11418X770@4101	38723X860@15907	6418X658@100	26430X746@9058	5067X652@57	2858X618@48
11	Catastrophic rupture of 10000MT Ammonia storage tank	43445X2230@15291	50242X2135@30077	24257X1865@8280	49482X2102@24765	18598X2060@393	13374X1911@317
12	10minute release of 10000MT Ammonia storage tank	41987X2183@15439	49147X2103@27932	23232X2040@307	49040X2071@24840	17770X1992@230	9302X1950@118

7.2.3.7 Observations

7.2.3.7.1 Damage Contour Mapping

Damage contouring is the representation of damage distances of hazardous scenarios at identified locations on plot plan. Damage contours are drawn for the most credible scenarios as well as for such scenarios which can pose maximum damage to the site and its surrounding area in any study.

However, handling and storage of particular liquid cargo/chemicals/Gas/ Cryogenics etc., will depend on the business requirement as well as readiness of the infrastructure therefore Quantitative Risk Assessment will again be carried out once the exact location for handling and storage is finalized for a particular cargo. This will enable DPCL to obtain required approvals from competent Authority to facilitate the specific operation.

In the present study, the damage contours are drawn for the following scenarios.

Heat Radiation:

- (i) Catastrophic Failure of Butane Marine Loading/Unloading Arm at Jetty
- (ii) Catastrophic Failure of LNG Marine Loading/Unloading Arm at Jetty
- (iii) Catastrophic Failure of Propane Marine Loading/Unloading Arm at Jetty
- (iv) 25mm leak of 18" Crude Oil pipeline from Jetty to Tank Farm Area
- (v) 25mm leak of 18" Isobutanol pipeline from Jetty to Tank Farm Area
- (vi) 25mm leak of 18" N-butanol pipeline from Jetty to Tank Farm Area
- (vii) Catastrophic rupture of Ammonia Vessel at Tank Farm Area
- (viii) Catastrophic rupture of LNG Vessel at Tank Farm Area
- (ix) Catastrophic rupture of LPG Barge Vessel
- (x) 3" Hosepipe failure during LNG Tanker Filling
- (xi) Catastrophic Rupture of 13m³ CNG Storage Cylinder
- (xii) 3" Hosepipe Failure during LPG Tanker Filling
- (xiii) Catastrophic Rupture of 12" Outlet Pipeline from Butane Vessel at Tank Farm Area

Vapour Cloud Explosion (Over pressure damage distances):

- (xiv) Catastrophic Failure of Butane Marine Loading/Unloading Arm at Jetty
- (xv) Catastrophic Failure of LNG Marine Loading/Unloading Arm at Jetty
- (xvi) Catastrophic Failure of Propane Marine Loading/Unloading Arm at Jetty
- (xvii) 25mm leak in 18" Butane pipeline from Jetty to Tank Farm Area
- (xviii) 25mm leak in 18" Ethylene pipeline from Jetty to Tank Farm Area
- (xix) 25mm leak in 18" Propylene pipeline from Jetty to Tank Farm Area
- (xx) Catastrophic Rupture of 12" Outlet Pipeline from Butane Vessel at Tank Farm Area
- (xxi) 3" Hosepipe Failure during LNG Tanker Filling
- (xxii) Catastrophic Rupture of 13m³ CNG Storage Cylinder

(xxiii) 25mm leak in 12" outlet pipeline from LPG Blender

(xxiv) 3" Hosepipe failure during LPG Tanker Filling

Toxic Release Damage Distance:

(xxv) 25mm leak of 18" Acrylonitrile pipeline from jetty to tank farm

(xxvi) 25mm leak of 18" Ammonia pipeline from jetty to tank farm

7.2.3.8 Pool fires/Jet fires

The scenario of catastrophic failures of marine unloading arms, pipelines leakage and leaks and catastrophic failure from storage vessels were considered to identify the impact of heat radiation and explosion over pressure on the other units, facility and surrounding area including people living in the vicinity. Damage contours for some of the scenarios not considered as credible were drawn to find out the maximum distances.

In case of catastrophic failure of marine unloading arm for Butane operated at 8atm (g) pressure and -4.4 degree centigrade, the area getting affected due to 37.5kW/m^2 will be around 723m in radius. This scenario will affect the ship and other facilities in the radius of 723m. The damage contours are shown in **Figure FD0701**.

Catastrophic failure of LNG marine unloading arm operated at 6.2atm (g) and -162degree centigrade, the area getting affected due to 37.5kW/m^2 will be around 598m in radius. This scenario will affect the ship and other facilities in the radius of 598m. The damage contours for the scenario is represented through **Figure FD0702**.

In case of catastrophic failure of marine unloading arm for Propane operated at 8 atm (g) pressure and -44.4 degree centigrade, the area getting affected due to 37.5kW/m^2 will be around 727m in radius. This scenario will affect the ship and other facilities in the radius of 727m. The damage contours are shown in **Figure FD0703**.

In case of leakage of 25mm from 18" Crude Oil, Isobutanol and N-butanol pipeline, the crude oil, isobutanol and N-butanol will spread over the land covering an area in 134m, 168m and 196m radius due to 37.5kW/m^2 heat radiation. The damage contours are shown in **Figure FD0704, Figure FD0705 and Figure FD0706**.

The heat radiation damage distance in case of catastrophic rupture of Ammonia and LNG vessel which is a critical issue will extend up to 790m and 1027m due to 37.5kW/m^2 heat radiation. The damage contours are shown in **Figure FD0707 and Figure FD0708**. Similarly, catastrophic rupture of LPG Barge will extend up to 1159m due to 37.5kW/m^2 heat radiation. The damage contours are shown in **Figure FD0709**.

Catastrophic failure of 3" hosepipe failure during LNG tanker filling will spread in area of 124m radius due to 37.5kW/m^2 heat radiation. The scenario is shown in **Figure FD0710**.

Catastrophic rupture of CNG cylinder will extend in an area of 77m radius due to 37.5kW/m^2 heat radiation. The scenario is shown in **Figure FD0711**.

Catastrophic failure of 3" hosepipe failure during LPG tanker filling will spread in area of 132m radius due to 37.5kW/m^2 heat radiation. The scenario is shown in **Figure FD0712**.

Catastrophic Rupture of 12" Outlet Pipeline from Butane Vessel at Tank Farm Area will spread in area of 1129m radius due to 37.5kW/m^2 heat radiation. The scenario is shown in **Figure FD0713**. This scenario will lead to domino effect.

7.2.3.9 Vapour Cloud Explosion (Overpressure)

The overpressure generates due to explosions in a facility. Some of the scenarios which are considered for heat radiation scenarios were considered for overpressure also and the contours are drawn.

In case of catastrophic failure of marine unloading arm for Butane operated at 8atm (g) pressure and -4.4 degree centigrade, the over pressure distances are reaching up to 1861m radius for a value of 0.3bar. The damage contours are shown in **Figure FD0714**. This scenario will lead to domino effect.

Catastrophic failure of LNG marine unloading arm operated at 6.2atm (g) and -162 degree centigrade, the over pressure distances are reaching up to 5110m radius for a value of 0.3bar. Since the leakage is at jetty, the ships and the working personnel at the jetty will be heavily affected. The damage contours for the scenario is represented through **Figure FD0715**. The occurrence of this scenario is having high potential of domino effects.

In case of catastrophic failure of marine unloading arm for Propane operated at 8 atm (g) pressure and -44.4 degree centigrade, the over pressure distances are reaching up to 1875m radius for a value of 0.3bar. The damage contours are shown in **Figure FD0716**. This scenario will lead to domino effect.

In case of leakage of 25mm from 18" Butane, Ethylene and Propylene pipeline, the overpressure damage distance will spread over the land covering an area in 239m, 354m and 242m radius for a value of 0.3bar. The damage contours are shown in **Figure FD0717**, **Figure FD0718** and **Figure FD0719**.

For a catastrophic rupture of 12" Butane pipeline out of storage tank, the damage distances due to 0.3bar will extend up to 3641m in radius. The damage contours are represented in the **Figure FD0720**. This scenario will lead to domino effect

Over pressure damage distances for 0.3bar due to catastrophic failure of 3" hosepipe failure during LNG tanker filling will impact an area of 831m radius. The scenario is shown in **Figure FD0721**.

Over pressure damage distances for 0.3bar due to catastrophic rupture of CNG cylinder will extend in an area of 95m radius. The scenario is shown in **Figure FD0722**.

Over pressure damage distances for 0.3bar due to 25mm leak in 12" pipeline from LPG blender will impact and area of 273m. The scenario is shown in **Figure FD0723**.

Over pressure damage distances for 0.3bar due to catastrophic failure of 3" hosepipe failure during LPG tanker filling will spread in area of 579m radius. The scenario is shown in **Figure FD0724**.

Even though, the over pressure distances are presented, it is to be observed that the chances of vapor cloud explosion in case of flammable liquids are minimum, whereas pool fire occurrence is more likely. The proper action like fire water spray along with aqueous film forming foam (AFFF) during any emergency by the personnel employed at the facility helps in reducing / mitigating / escalation of the event.

7.2.3.10 Toxic Gas Dispersion Effects

The toxic release damage distance (IDLH) for the toxic material handle is given as **Table 7-30**. The damage contour for 25mm leak of 18" Acrylonitrile pipeline from jetty to tank farm and 25mm leak of 18" Ammonia pipeline from jetty to tank farm concentration will extend up

to 3569 m and 3811 m respectively. These toxic release scenarios are shown in **Figure FD0725** and **Figure FD 0726**.

7.2.3.11 Domino Effects

It is observed from the damage contours presented in above sections shows that many scenarios are affecting the other units in the facility. Thermal radiation and overpressure produced during an incident such as heavy leakage and rupture of a pipeline containing flammable material can cause severe damage to nearby storage tanks in the tank farm area leading to another tank on fire and explosion one by one i.e. may initiate a secondary incident in a chain reaction. This phenomenon is called the 'domino effect', 'cascading effect', or 'chain of accidents'. The extent of damage depends on radiation or overpressure intensity, the duration of exposure, the type of material, the response of protection (e.g. water deluge) systems - automatic and manual etc. Practical 'rules of thumb' found in literature, provide values of thermal radiation or overpressure corresponding to a given degree of damage. American Institute of Chemical Engineers (AIChE) considers heat flux of 37.5kW/m^2 as the limit for severe damage to process equipment, while The Netherlands Organization for Applied Scientific Research (TNO) identifies critical radiation intensities of 100kW/m^2 and 25kW/m^2 , for rupture and deformation of structural elements, respectively. In both cases, the duration of exposure is considered to be 15-20minutes. Concerning explosion consequences, TNO suggests the overpressures of 0.5bar - 1bar can cause cylindrical tank displacement or failure of connecting pipes, and overpressures above 1bar can cause failure of spherical tank supports.

Cascade analysis is carried out for all the probable scenarios to know the larger consequences due to these effects. Examining the scenarios with the above criteria, it is observed that all the incidents can cause cascade effects if their affected damage distance are more than 50meters. The damage distance of less than 50m in tank farm area will also create domino effect.

This analysis indicates that the distance between the tanks, trained personnel and the fire-fighting facilities available at the site will play a major role in averting any domino effect. The tanks shall be installed with fire water sprinkler system to provide cooling during fire. Fire hydrants / monitors with remote operation mode at appropriate locations will help in restricting the spread of fire to cover the entire area and prevent the occurrence of the domino effects. By providing fire water sprinkler system in other solid storage (coal) and handling is done will help will avert major fire.

7.2.4 Discussion and Recommendations

7.2.4.1 Discussion

DPCL is proposing to import, store and export cargos as per **Section 7.2.1.5**, at Dhamra port as a part of revised master plan development. Proposed Liquid cargo/PoL storage tanks will be provided with sufficient dyke capacity.

All the credible scenarios such as 5mm, 25mm 100mm and full-bore rupture of transfer lines have been considered. In case of any major pipeline leak / rupture the control valves at ship or near the storage tank close the supply.

- The maximum heat radiation damage distances due to pool fire / jet fire due to catastrophic failure of 18inch butane pipeline from jetty to storage tank area for 37.5kW/m^2 intensity is about 504m and for 12.5kW/m^2 extends up to 773m confined to

the facility boundary. The other material damage distances are much lower than the butane. The impact of the heat radiation will be on port personnel and property.

- The maximum overpressure damage distance for catastrophic failure of 36inch LNG pipeline for 0.3bar overpressure extends up to 2979m and that for 0.1bar up to 3279m.

Most credible scenarios have been considered for storage tanks in the tank farm area are 10 minutes discharge from storage tanks and catastrophic failure.

- For 10 minute discharge from Butane tank in the tank farm area, the heat radiation damage distances are maximum as compared to other materials stored in the tank farm area. The distances due to pool fire / jet fire for 37.5kW/m² intensity is about 1062m and for 12.5kW/m² extends up to 1331m. In the case of catastrophic failure of LPG storage tank, the heat radiation damage distances are found to be maximum in comparison to other materials for pool fire / jet fire for 37.5kW/m² is 1159m and for 12.5kW/m² is 3179m.
- The maximum overpressure damage distance for 10 minutes discharge from Butane from storage tank extends up to 3796m for 0.3bar and that for 0.1bar up to 3952m and in the case of catastrophic failure of LPG Barge vessel 0.3bar overpressure extends up to 3939m and for 0.1bar up to 4846m.

The catastrophic failure of marine unloading arm for all the materials at jetty has been considered as the ultimate scenario effecting the personnel, ship and the facility.

- In the event of catastrophic failure of Butane, the distance due to pool fire / jet fire for 37.5kW/m² intensity is about 723m and for 12.5kW/m² extends up to 903m and catastrophic failure of LNG, the distance due to pool fire / jet fire for 37.5kW/m² intensity is about 598m and for 12.5kW/m² extends up to 901m. For other compounds, the distances obtained for heat radiation are much lower.
- 0.3bar overpressure for LNG extends up to 5110m and that for 0.1bar up to 5119m.

The damage distances for the scenarios like catastrophic failure of storage tank, 100mm leak and 10 minutes discharge are higher than those in case of 5mm and 25mm leakage of transfer lines. The scenario i.e. storage tank failure and pipeline rupture are not much credible as per the historical records obtained from OGP reports. The failure frequency of these scenarios is 5×10^{-6} per year. Whereas scenarios like 5mm, 25mm and 100mm leakage scenarios and leakage from flanges/ gasket and pinhole on storage tanks are much more credible. Regular maintenance, inspection and intelligent pigging of pipelines will help in avoiding any leakage from the pipelines.

Also, it is pertinent to note that the heat radiation and over pressure damage distances due to the FSRU will be less than that of the onshore LNG terminal considering the FSRU capacity of 2.5 MMTPA and the maximum inventory not exceed 1,80,000 m³. Similarly, the heat radiation and over pressure damage distances due to the FSO will be same or less as that of the onshore LPG terminal considering the the maximum inventory not exceed 25000 MT (each compartment).

The damage distances for all the credible scenarios may lead to domino effect and hence there should be necessary arrangement of fire-fighting facility as per various national and international codes for the facility to avoid any major incident.

7.2.4.2 Recommendations

To minimize the consequence effects if any accident takes place and for the safe storage and handling of the hazardous products the following are recommended.

- 1) Storage tanks, pipelines and other components should meet OISD / prevailing standards for structural design integrity and operational performance to avoid catastrophic failures during normal operation and during exposure to natural hazards and to prevent fires and explosions. Applicable standards typically include provision for overfilling protection, metering and flow control, fire protection (including flame arresting devices), and grounding (to prevent electrostatic charge). Overfill protection equipment include level gauges, alarms, and automatic cutoff systems.
- 2) It is recommended to have a detailed disaster management plan prepared for the site with the facilities available and to be provided in future to handle any untoward incident and actions to be taken by the responsible authorities. It should be revised for any modifications in the installation.
- 3) It is recommended to follow all the applicable Indian laws such as MSIHC Rules; CA (EPPR) Rules; PLI Act & Rules; Explosives Act & Rules; SMPV Rules; Gas Cylinder Rules; Factories Act & Rules; ODS (R&C) Rules; Petroleum Act & Rules; Port Act & Rules; Dock Act & Rules
- 4) For any changes/modifications in future for the pipelines/storage tanks etc, it is strongly recommended to conduct the Risk Assessment study for the final size of the pipeline, storage tanks etc. this will help in preparing a more realistic disaster management plan to avoid occurrence of any major incident. The existing DMP shall be amended on time to time based on the actual implementation plan by incorporating the findings as per the revised risk assessment.
- 5) Floating roof tanks emit VOCs through both storage and working losses. To minimize evaporative losses, both external and internal floating roof systems use decks, fittings, and rim seals to allow the roof to adjust in relation to the liquid level in the tank. Evaporative losses occur through the rim seals and deck fittings and residual liquid on the tank walls that is exposed during liquid withdrawal activities.
 - Installing decks, fittings, and rim seals according to design specifications of prevailing standards to minimize evaporative losses.
 - Protecting rim seals from wind and weather damage and conducting regular maintenance.
- 6) Loading / unloading activities should be conducted by properly trained personnel according to pre-established formal procedure to prevent accidental releases and fire / explosion hazards. Procedures should include all aspects of the delivery or loading operation from arrival to departure, connection of grounding system, verification of proper connection and disconnection of marine loading arm, adherence to no-smoking and no-naked light policies for visiting personnel.
- 7) Quick isolation of mechanical loading arm in case of spillage from the tanker or pipelines near the jetty to avoid personnel and property loss.
- 8) To identify the hazards present in the system, a detailed hazard identification study such as Hazard and Operability study (HAZOP) should be undertaken. All hazards identified should be examined and appropriate mitigating measures developed and implemented. HAZOP close out report should be prepared.
- 9) For all the tanks where there is a single in/outlet line, an ROV (or an equivalent design to allow isolation of the tank from the line in an emergency) should be provided.

- 10) The remote operable tank isolation valves should be operable locally, from the unloading ship and from the control room. The ROVs should be provided with limit switches. Valve status indication (based on limit switch output) and an emergency shutdown button should be provided in the following locations
 - At the respective ship loading / unloading points, to close the relevant tank valves, also stopping all pumps associated with that loading operation.
 - In the control room.
- 11) DPCL has to ensure that first aid equipment and manpower resources are at place to deal with emergencies, in consultation with emergency services to rescue any personnel, trapped or immobilized by an accident scenario.
- 12) Install hydrocarbon detectors in the tank farm area for any leakage from the flanges / valves.
- 13) Implement and maintain appropriate safety management systems to control the managerial and organizational factors that can impact on the overall risk associated with the hazardous materials.
- 14) Regular checks / maintenance and testing of instruments, valves and flange joints as per strict schedule will enhance the safety in the premises. Pipelines, flanges and valves require special attention to minimize the failure rate.
- 15) All components (e.g. roofs and seals) should undergo periodic inspection for corrosion and structural integrity and be subject to regular maintenance and replacement of equipment (e.g. pipes, seals, connectors, and valves). A cathodic protection system should be installed to prevent or minimize corrosion, as necessary. Epoxy coating for the pipelines may be provided for protection against external corrosion.
- 16) Guidelines and procedures for entering and cleaning the storage tanks are to be followed as per API RP 2016 / OISD 129 / IS 9964 Part I and II.
- 17) Prevention of potential ignition sources such as:
 - Proper grounding to avoid static electricity buildup and lightening hazards (including formal procedures for the use and maintenance of grounding connections)
 - Use of intrinsically safe electrical installations and non-sparking tools.
 - Implementing permit systems and formal procedures for conducting any hot work during maintenance activities, including proper tank cleaning and venting.
- 18) Fire-fighting equipments shall be provided as per API RP 2021 and API RP 2030/ OISD 117 & 156.
- 19) Consider linking foam and fire water system. Considerations should be given to directly inject AFFF foam compound into the respective fire mains (at 6 percent strength), which can act as a vehicle to transport foam solution to user points on either site for mobile response foam branches / cannons.
- 20) Facilities should be properly equipped with fire suppression equipment that meets internationally recognized technical specifications for the type and amount of flammable material stored at the facility.
- 21) Preparation of a fire response plan supported by the necessary resources and training, including training in the use of fire suppression equipment and evacuation. Procedures may include coordination activities with local authorities or neighbouring facilities.

- 22) Provide drainage around POL tanks to assure spills collect away from tank. Provide bund to assure that spill areas are minimum in size.
- 23) The Cascade effects may be caused mainly due to various scenarios mentioned earlier Sections. The probabilities of occurrence of such an incident's are 8.8×10^{-8} per meter per year and 3.3×10^{-7} per meter per year respectively and hence are remote. Even in the event of such an incident occurring, the presence of an ignition source can only lead to fire and explosion hazards. The probability of the presence of an ignition source is also very remote and the probability of ignition with no ignition sources is about 0.1 and the probability of explosion given an ignition is also about 0.1 (Lees, 1996). Hence the risk for cascade effects is negligible.
- 24) Onsite emergency plan should be fine-tuned if required taking into consideration the hazard potential due to proposed pipelines and storages as indicated by the present report. This will help in handling the actual emergencies efficiently and in keeping the damage to minimum extent possible.
- 25) Provision of fire safety training and response as part of workforce health and safety induction/training, including training the use of fire suppression equipment and evacuation, with advanced fire safety training provided to a designated fire-fighting team.
- 26) Safety measure as given in **Section 2.8.15.11** of Chapter 2 of this EIA report shall be ensured
- 27) Do's and Don'ts shall be displayed prominently in the site near the pipelines and at all workplaces. Regular maintenance shall be carried out under the supervision of an authorized person.
- 28) Important telephone numbers of emergency shall be displayed prominently in bold letters in the plant site and administration building.
- 29) Caution boards shall be displayed near the pipelines for all working person.
 - No smoking signs
 - No flames or pilot lights or electrical gadgets.
 - Emergency contact numbers.
 - Keep distance from pipelines. Pipeline is guarded during any maintenance work to avoid hitting any object to it.

7.3 Disaster Management Plan (DMP)

The Disaster Management Plan (DMP) for the existing Dhamra port is already in place and will be used and improved suitably to match the requirements of Port Expansion Plan. The disaster management plan mainly deals with continuous and integrated process of planning, organising, coordinating and implementing measures for

- Prevention of danger or threat and loss of life
- Mitigation or reduction of risk of any disaster or its severity or consequences
- Capacity building
- Preparedness to deal with any disaster
- Prompt response to any threatening disaster situation or disaster
- Assessing the severity of magnitude of effect of every disaster
- Evacuation rescue and relief
- Rehabilitation and reconstruction

- Continuity of business during the crisis
- Return of normal working after the crisis
- Plan also delegates specific assignments to available manpower with a view to avoid over-lapping of activities between various groups

The sign boards in the project site displaying the precautionary measures for visitors and employees are shown in **Figure 7-4** and **Figure 7-5**.

The key objectives of the plan are:

- Provide the framework for an integrated multi-agency crisis response to a significant disaster incident within the Port of Dhamra
- Clarify specific roles and responsibilities
- Port community preparedness for any emergency incident
- Provide members of the port community affected by a significant emergency incident with
- Timely advice
- Safest possible environment during the resolution of the incident
- Reduce the adverse impacts of an emergency incident on personal, business and the general port community
- Provide a management framework for the sub plans and associated specific response plan
- Provide continued education review and testing



Figure 7-4: Precautionary Measures for Visitors

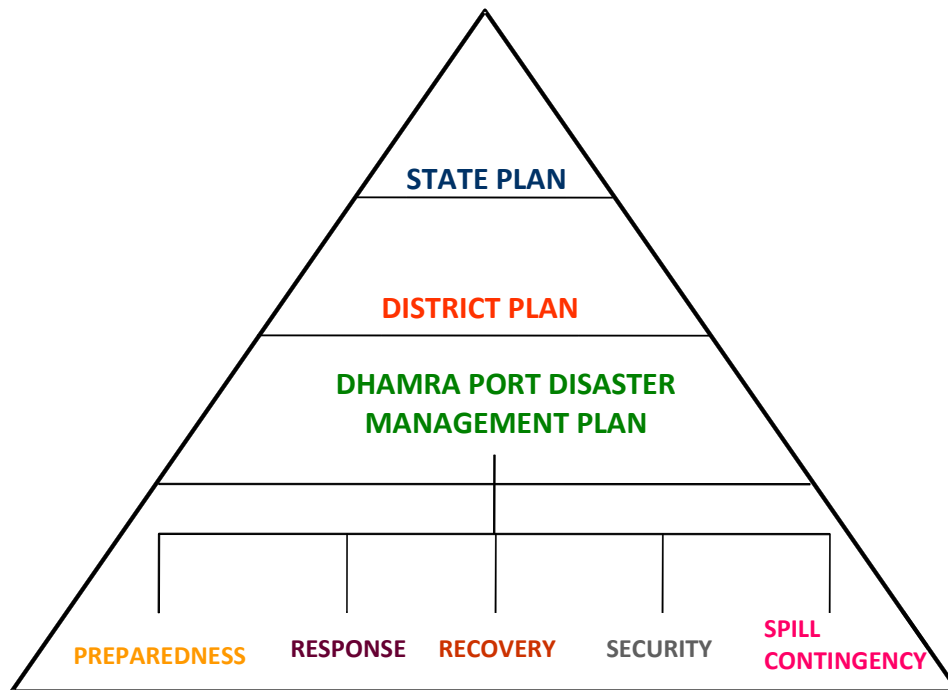


Figure 7-5: Precautionary Measures for Employees

7.3.1 Assumptions

The plan assumes;

- That the arrangements are already in place in relation to counter terrorism and disaster management
- Adequately address state responsibilities in relation to responses and recovery from such incidents. This plan does not address consequence management responsibilities and arrangements.
- In relation to mass warning and mass communication that a variety of technological systems will be progressively implemented to provide information to both community and general population when required.
- All buildings in port will have in place accurate and practiced fire and evacuation plan.
- All owners, managers, operators and tenants will be provided with information via an education strategy regarding their responsibilities during a significant emergency incident including an evacuation.
- Those stakeholder agencies have sufficient trained and equipped personnel to perform the roles and responsibilities identified in the plans.
- The stakeholder agencies have in place effective operational plans, standard operating procedures which detail the specific responses of that agency in support of the plan.
- Those stakeholder agencies have in place redundancy plan to provide a response in the event that particular resources are unavailable.



Hierarchy of Plan

Disaster arising from human activities and shipping incidents

- Handling and storage of dangerous goods
- Collision of ships
- Grounding of ships
- Sinking of ships
- Oil spillage

Disaster due to natural calamities

- Cyclones
- Floods
- Earthquakes
- Tsunami

- Incident within port area
- Minor in nature
- Low level of personnel injury
- Business discontinuity up to 06 hours
- Within port community resources
- Emergency Management group leader is Department Head
- Nature of disaster – Building/ shed fire, electric supply disruption, labour accident, vessel accidents

7.3.3.2 Level 2

- Incident within port area
- Limited and moderate level of personnel injury, possible death(s)
- Business discontinuity from 06 to 24 hours
- Damage to port infrastructure
- Outside assistance may be required
- The crisis management group leader is CEO
- Nature of disaster – gas leaks/ chemical discharge/ oil spills/ terminal fires/ explosions/ industrial unrest/ intrusion/ sabotage/ hostage situation/ collisions/ grounding

7.3.3.3 Level 3

- Disaster of a severe and critical nature within and beyond port area
- High level of personnel injury (and deaths)
- Business discontinuity, damage to port infrastructure and loss of capability beyond 24 hours
- Affecting port and contiguous areas
- Besides port resources, assistance from outside agencies is required
- The crisis management group leader is Chief Executive Officer (CEO)
- Information to external agency
- Nature of disaster – gas leaks/ chemical/ oil spills, fires/ explosions/ cyclones/ Tsunamis/ terrorist attack/ sedition or mutiny by security personnel/ collisions/ groundings

7.3.3.4 Initiation of Central Control Room- On Disaster Level II or III

Conservator DPCL will decide when members of the Central Disaster Management Group will operate from their respective department control rooms and attend joint meetings at the Central Disaster Management Control Room or when total central control room attendance is required. Whenever the Central Disaster Management Centre takes over responsibilities the On Site Action Group now reports to the central control room.

7.3.4 Degree of Disaster

7.3.4.1 On-site Disaster

On-site disaster concerns the port area and port authority. These disasters will be addressed by the port authorities and if necessary external help will be taken under mutual-aid arrangements to keep control over the activities.

Basic functions of On-site action group are given below:

- Assess and classify the nature, location, severity, casualties, resource requirement and time of control of the incident
- Activate elements of the disaster management plan and decide which plan to implement
- Combat emergency with resources at disposal, conduct search, rescue and evacuation operations
- Manage incident operations and terminate plan
- Provide medical aid
- Give alert signal in liaison with Conservator
- Give input to crisis management group with kind of external help required

7.3.4.2 Off-site Disaster

Off-site disaster concerns the area beyond the port limits, affecting environment and neighbouring population. The role of government authorities is involved and their support is frequently needed. The decision to designate and declare such emergency and implementing DMP is prerogative of CEO, DPCL.

7.3.5 Flow of Incident Stages

Response to major incident typically will move through following phases:

First Stage (CRISIS)

This stage involves the initial crisis management response. This stage will predominantly involve the first response agencies security, fire, rescue and ambulance. It will focus on

- Prevention of loss of life
- Gathering of intelligence to give appropriate response
- Isolation and containment of incident to prevent the spread of the hazard
- Activation of the resources to incident site
- Establishing command control and coordination structure
- Commencement of the combat of incident
- Evacuation of person at immediate risk
- People who are affected by the incident and not at immediate risk moved to shelter in place
- Business as usual in unaffected area

Second Stage (Immediate Consequences)

It commences when the parameters of the incident are better understood. The incident is isolated and contained, and a command and control structure is in place. Responses in the second stage involve:

- Coordinated combat of the incident
- Involvement of supporting agencies (eg., Inter Department, Police, Local Government, Community Groups and Media)
- Large scale evacuation
- Identification and triage of injured person
- Establishment of support to affected persons and responding agency personnel

Subsequent Stages

It focuses on

- Resolution
- Investigation
- Recovery; Shelter
- Rehabilitation and return
- Evacuation of the affected area

7.3.6 Roles and Responsibilities

EXTERNAL

1. District Disaster Coordinator (District Magistrate-Bhadrak)

In the event of activation of DMP the District Collector Bhadrak is the first point of contact for managing the impact of an event on the community.

2. Indian Navy (NOIC Odisha) at INS Chilka Coast Guard (COMDIS 7) at Paradeep

The Navy and Coast Guard to assist as follows

- Sanitation of port channel and anchorage area
- Assist in evicting vessel in event of collision, grounding and explosive condition
- Countering oil spills
- Assist with divers and diving equipment

3. Coastal Police Station, Dhamra (Under Superintendent of Police-Bhadrak)

The police outpost-Dhamra will be an early public and agency contact point and the first respondent to an incident scene first point of contact. The initial stages of response to an incident the Dhamra Police Station (DPS) carried out the “First Response Management” role.

The Dhamra police is responsible for coordination and security of an incident site including

- Establishing and manning incident onsite manning post
- Establishing major incident centre (on port Administrative building)
- Security issue including security and security support for all involved agencies
- Crowd and traffic control
- Rendering safety of explosive devices
- Establishing victim registration
- Controlling entry/ exit points to and at relevant areas (i.e., incident scene, emergency situation specified area, potential evacuation area)
- Staging and marshalling areas off site for supporting agencies/ resources
- Coordination of public protection strategies including evacuation
- Intelligence collation and dissemination
- Investigation

4. Dhamra Fire Station Service

- Adequate number of fire tender for fighting fires and controlling pollution
- A senior officer will join the Base Control to co-ordinate the action
- Incident control of all fire tenders
- In the event of hazard material incident-establishing hazard material zone
- Safety of personnel
- Responsibility for operation within hazards material zone

5. Health Services (Chief Medical Officer)

- On site medical care and clinic coordination arrangements
- Establishment of casualty collection, initial triage, treatment and transport areas
- On site medical support to other incident responders
- Casualty treatment information to offsite health facilities
- To assist Port Health service on activation

6. Odisha State Electricity Board

To ensure continuous supply of electrical power in and around the affected area for smooth combating of emergency, OSEB will be contacted.

7. Odisha State Pollution Control Board

- Collection and analysis of spilled oil/chemical
- Recommended the steps necessary to remove or disperse or otherwise deal with such articles
- Assist with anti-pollution machinery and personnel

8. Bhadrak Municipal Corporation

To ensure uninterrupted supply of water in the affected area and also help in rehabilitation of evacuated persons.

9. Mercantile Marine Department

Mercantile Marine Department will assist in:

- Evaluation of damages to the port
- Negotiating with ship owner regarding demurrage charges
- Finalising penalty & clean-up charges regarding chemical/ oil-spill contingency

10. Ship Owners/ Agents

Ship owners/agent will help in:

- Provide resources within their capacity in combating emergency
- Devising ways for early settlement of claims
- Inform Base Control about their cargo and crew which is stranded in the affected area
- In case of oil spillage arranging empty tanker for storing and transformation of fuel

INTERNAL DEPARTMENT

1. Specific Responsibilities – Response Phase

- Activate the disaster management response team and also crisis response team
- Activate the relevant/ workplace emergency team for the first strike response including traffic and pollution
- Thereafter assist emergency services to respond to the event
- Assist with providing relief for persons affected by disaster

2. Specific Responsibilities – Recovery Phase

- Satisfy immediate, essential personnel and port community needs to extent of port capability
- Maintain liaison and timely communication with district disaster coordinator
- Contribute to the recovery function coordinated by District Disaster coordinating authority
- Coordinate the recovery of physical infrastructure
- Coordinate activities with relevant Disaster district initiatives and plans
- Participate in long term recovery, reconstruction and rehabilitation
- Communicating regarding restoration of Port activities

7.3.6.1 Central Disaster Management Group-Basic Functions

Team Leader: Chief Executive Officer(Conservator)/ Chief Operating Officer
Members: Conservator, CFO, Harbour Master, DGM (Admin), GM(Security), CMO
Basic Functions
1- Monitor and analyse reports from the Onsite action team and identify the area/ population in the emergency zone
2- Activate the response plan
3- Support the action group with materials, equipment, information and human resources
4- Monitoring and analysing reports from action team and making alterations in the current mode of action if deemed necessary
5- Adjust the disaster classification of the incident and actuate the central control room
6- Coordinate with external organizations, state government as deemed necessary
7- Make the necessary arrangements and funds for evacuation, transportation, food & supplies
8- Make media statements and reports to state government/ MOS

Team Leader: Chief Executive Officer(Conservator)/ Chief Operating Officer
Members: Conservator, CFO, Harbour Master, DGM (Admin), GM(Security), CMO
Basic Functions
9- Situation, draw conclusions and make necessary amendments to the plans

7.3.6.2 On site Action Group – Basic Functions

Team Leader: COO/HM – emergency related to ship safety and stability PFSO/Dy. PFSO- all other cases
Members From Departments: ME/CE/Electrical/Administration/Marine/Security/Medical/(Mutual Aid Agency representative if required)
Basic Functions
1- Assess and classify incident- nature-location-severity-causalities-resource requirement- time to control
2- Activate elements of the disaster management plan and decide which plan to implement
3- Combat emergency with resources at disposal, conduct search, rescue and evacuation operations
4- Manage incident operations and terminate plan
5- Provide medical aid
6- Give alert signal in liaison with conservator
7- Give input to crisis management group with kind of external help required

7.3.6.3 Crisis Management Group Responsibilities

Position	Port Position	Alternative
Team Leader	CEO	COO
- Monitors Disaster Management Action Plan - Ensure state of emergency preparedness is maintained all times. - Authorises release of required funds - Leads Crisis Management group to direct operations from the emergency control centre at Level 2 & 3. - Confirms level of crisis, - Monitors the shutting down, evacuation and other operations as necessary. - Activates the offsite emergency plan if the disaster is spreading to/from outside port boundary in consultation with Conservator, CFO, DGM (Admin), Jt. GM B & D and PSO. - Approves information to the media. - Liaises with the secretary, Jt.Secy (Ports) of the MOS (Ministry of shipping), Chief Secretary. - Confirms the termination of the emergency. - Leads the Crisis Management Group for early restoration of facilities and port activities. - Provides timely required status reports to the State Authorities. - If emergency affects surrounding population, evacuation of persons will be affected in-consultation with Municipal Authority of Bhadrak. - It is perceived that not all personnel will be evacuated, at any one time. Thus persons may be evacuated to other part of the port areas. - However, if whole Port is affected, evacuation will have to be done in consultation with the State Government and other mutual-aid agencies.		

Group Position	Port Position	Alternative
Welfare & Media Coordinator	DGM-CSR	DGM-Admin
- Prepare duty roster for manning of Crisis Management centre by officers of the Administration, Finance & Accounts and Materials Management. - Mobilises and monitors vehicles. - Arranges food and water to the personnel on roster duty		

Group Position	Port Position	Alternative
Welfare & Media Coordinator	DGM-CSR	DGM-Admin
• Liaises with MOS and communicates inputs from the Chairman. • Liaises with media as spokesman under guidelines of the Chairman. • Co-ordinates and keep in constant touch with the local and District Administration to render assistance. • Arrange for evacuation from township and port areas. • Maintains list of missing persons.		

Group Position	Port Position	Alternative
Head Finance	FC	DGM (F&A)
• Maintains cash/ funds for disbursement to all the dept. • Disburses cash/ funds to different departments • Provides Disbursement Statement for processing claims. • Depute officer to each dept. to assess the requirement and needs of affected dept. • Assist in procurement and process purchasing/ leasing of equipment. • Hiring of specialist services, food, shelter and transport arrangements, as the situation demands. • Depute officer to documents all events, damages and claims.		

Group Position	Port Position	Alternative
Chief Incident Controller	CEO /Conservator	COO
• Ensures that the applicable implementation procedures are reviewed and revised annually. • Assists CMG to Direct operations from the emergency control centre. • Monitors and tracks cyclone originating in Bay of Bengal. • Ensures stoppage of shipment operation & evacuation of vessel during disaster. • Monitors & directs site incident controller from control room. • Monitors on site personal protection, safety. • Monitors the search & rescue operation. • Coordinates, organizes and obtains additional resources for operation. • Liaisoning with operating staff of Fire, Police, Coast Guard, Navy, etc., • Advises Central Disaster Group for the termination of the emergency situation. • Assist in assessing damages together with the CE, EE, ME & HM. • Assist in the supervision & reconstruction of affected areas post disaster. • Preserves evidence and assist Secretary in the submission of logs for the claim process. • CONTROL OF SHIPPING: PORT CONSERVATOR EMPOWERED FOR MOVEMENT OF SHIP during emergency. • Eviction of vessel during emergency and route to be followed. • Declaring the SI. No. of ship to be moved out during emergency.		

Group Position	Port Position	Alternative
Marine Department	Harbour Master	Asst.Harbour Master
• Ensures evacuation of all dock workers and private labour, visitors, shippers, consignees from port area • Prepares vessels to vacate from berth to open sea. • Arranges to protect cargo in port custody from damage by shifting. • Arranges to segregate dangerous cargo in sheds during fire. • Submits consolidated list of dangerous goods in port including tankers in port and tank farms in port area.		

Group Position	Port Position	Alternative
Marine Department	Harbour Master	Asst.Harbour Master
- Ensures his department implements the disaster response plan and assist in segregating and shifting cargo and co-ordinating with the Fire Fighting Authorities. - Informs all cargo interests, Port Agents, stevedores regarding restoration of the port operation. - On alarm ceasing all loading, unloading of cargoes, discharging and bunkering operations will cease. - Disconnect all hoses and vessels are prepared to proceed for anchorage. - Operations will resume after specific approval of Conservator. - Hazardous cargo and explosives are to be shipped out immediately. - Mobilisation of manpower and cargo handling equipment from port, Stevedores and C & F agents to segregate unaffected cargo and make arrangements to protect such cargo.		

Group Position	Port Position	Alternative
Engineering Dept.	Engineer I/C- Civil	Asso.Manager-Civil
- Mobilises on-site action group to ensure proper functioning of the creek/ culverts/ Roads/ drainage system/ Water supply system. - Ensures proper manning of the pump houses during the disaster. - Ensures proper functioning of the drinking water supply to the relief/ cyclone shelter. - Assists in recovery and port restoration activities. - Strengthening of shoreline, buildings and other civil works, including housing colonies. - Co-ordinate evacuation of Port areas with the mutual aid agencies. - Mobilise diving personnel and equipment. - Mobilise, collect and distribute material to control damage.		

Group Position	Port Position	Alternative
Logistics Co-ordinator	Materials Manager	Store I/C
- Arranges purchase of stores and supplies. - During cyclonic season sufficient stock of stores like GI corrugated sheets, J.Hooks, screw hinges, gunny bags, tarpaulins, ropes and wires for Port Crafts, diesel oil, kerosene oil, hurricane lantern, petromax lamps, torch lights with batteries and bulbs, electrical items etc., are kept in stock. - All the materials which are likely to get damaged with rain are protected by a tarpaulin cover and raised above ground level. - One stores Supdt., one store keeper and the other minimum staff are required to issue materials including POL are kept during emergency. - Informs CFO the approximate funds required. - Replenish stock if possible.		

Group Position	Port Position	Alternative
EHS Department	DGM-ES	Sr.Manager-ES
- Mobilises field groups for Onsite Action - Monitors implementation of plans for providing continuity of emergency supplies and services i.e., electric power, emergency lighting, pump, bulk material handling equipment etc. - Co-ordinates with materials manager to procure essential materials - Arranges for the fabrication of any specialised equipment required for the emergency - Ensure secure of loader, conveyors, mobile equipment, bulk material handling equipment, locomotives, cargo handling equipment, etc., - Monitors the appropriate procedures to isolate damaged units without introducing new hazards and providing resources both in terms of personnel and equipment to accomplish it.		

Group Position	Port Position	Alternative
EHS Department	DGM-ES	Sr.Manager-ES
- Activates the necessary utilities during emergency, i.e., activating back up emergency generators for general lighting purpose, pumps, welding services etc., - Monitors the rendering of assistance for rescue of trapped personnel by cutting structures, wires etc., - Ensures the dept. group remain alert on duty for any electrical isolation of equipment during an emergency. - Assess damages and provide technical assistance to determine the operability of damaged units		

Position	Port Position	Alternative
Security Co-ordinator	PFSO	DY. PFSO
- Traffic control and its regulation in port area. - Cordoning of the affected area. - Assist the affected dept. in fighting and managing the disaster. - Deploy fire-fighting team for fighting fire and rescue. - Clear all internal roads within port area for smooth traffic. - Keep extra watch and intensity patrolling over stores, sub stations berths, transit, transit sheds, warehouses, administrative building, loco sheds. - Controls the entry of unauthorized persons and vehicles – disperses crowd – cordons off restricted areas prevent looting. - Permits the entry of authorized personnel and outside agencies for rescues operations without delay. - Allows the entry of emergency vehicles such as ambulances without hindrances. - Ensures that the people are as per the head count available with the assembly point section of that area to arrange for orderly evacuation. - Monitors that Dy. PSO completes a reconnaissance of the evacuated area, to enable declaration of the same as evacuated and report to the CMG. Assist in evacuating casualty. - Participates in recovery and re-entry activity. - Inform PHO about the fire and nature of casualty. - Mobilising manpower and keep them at standby. - Mobilisation of oil spill containment team. - Liaison and assist with police/ Navy/ Coast Guard/ Fire Dept. and mutual aid agencies.		

Position	Port Position	Alternative
Medical Aid Co-ordinator	CMO	Medical Officer

Position	Port Position	Alternative
Medical Aid Co-ordinator	CMO	Medical Officer
- Set up casualty collection centre and arrange first aid posts - Arrange for adequate medicine, antidotes, oxygen, stretchers etc., - Advise CMG on industrial hygiene and make sure that the personnel on duty are not exposed to unacceptable levels of toxic chemicals. - Maintains a list of blood groups of each employee with special reference to rare blood groups. - Arranges additional medicine and equipment as required. - Liaises with selected NGO's under instructions of the CEO. - Arrange equipped Ambulance in ready state. - Ensures that the casualty section of port hospital has specialists. - Arrange for extra beds and in emergency contact with the state Govt. Hospital for extra medical supplies. - Make arrangements to treat casualty at incident sites and transporting for further treatment. - Depute first doctor to onsite team who acts as liaison officer for all medical services.		

7.3.6.4 Disaster Management On site Action Group Responsibilities

Group Position	Port Position	Alternative
Site Incident controller	Harbour Master	AHM
Directs and co-ordinates all field operations at the scene of the accident		
- Monitors early warning for cyclones and rescue operations. - Assesses the level of incident –nature-location-severity-casualties and resource requirement. - Classifies the incident – Advises Pilot at Signal Station to convey to Conservators about Crisis Severity Status and Emergency level, resource requirements etc. - Activates elements of the terminal emergency plan / site response actions. - Co-ordinates all functional heads in field operations group to take action. - Arranges tugs, mooring boats and pilot(s) for un-berthing vessel(s) - Arranges for additional resources and periodic tactical and logistical briefings with (Conservator) of CMG (Central Management Group). - Liaises with Coastal Guard, Navy and PSO. - Co-ordinate with the search and rescue operations of PSO. - Manages incident operations to mitigate for re-entry and restoration including channel hydrography survey and navigation aids survey in liaison. - Arranges survey of damaged marine flotilla for necessary repairs - Makes claims if the incident is due to the vessel from owners, P&I Club or agents.		
Co-ordinates – in combating operation of fire fighting and toxic gas leakage with the PSO, if Oil spillage with PSO & Coast Guards, if Vessel accidents with Conservator, Navy & Coast Guard, if Natural calamities like cyclone and floods, tsunami with the CE & ME, for Cargo operation shutdown with the Traffic Manager, for Search & rescue with PSO, for First aid and hospitalisation with Dy CMO.		

Group Position	Port Position	Alternative
Communications Officer	HM/AHM	Traffic Officer
• Maintains 24 hour vigilance towards the channel/ anchorage & port • On receipt of instructions from the chief Incident controller, informs the fire brigade/ PSO/ Conservator • Refrains from exchanging any information with unauthorized persons unless authorized to do so by the Conservator. • Maintains contact with vessels on VHF.		
Group Position	Port Position	Alternative
Cargo Storage, Sheds & Labour co-ordinator	GM-Operation	Sr.Manager-Operation
• Co-ordinate with HM in de-berthing vessel to vacate the berth • Arranges to segregate and protect cargo in sheds • Submits consolidated list of dangerous goods in port including tankers in port during fire. • Co-ordinates with ship owners/ agents/ C & F agents/ stevedores and with labour Officer to arrange and ensure evacuation. • In case of Fire at Jetty or BMH area – liaises with PSO to extinguish fire and in search and Rescue Operations.		

Group Position	Port Position	Alternative
First Aid	CMO	Medical Officer
• Maintains a list of blood groups of each employee with special reference to rare blood groups – Liaises with CMO as necessary • Sets up a casualty collection centre, Arranges first aid posts at assembly points • Arranges for adequate medicine, antidotes, oxygen, stretchers etc., • Contacts and co-operates with local hospitals and ensure that the most likely injuries can be adequately treated at these facilities e.g. burns • Advises incident Action Group not to be exposed to unacceptable levels of toxic exposure • Submits reports-indents to replenish medicines, resources used.		

Position	Port Position	Alternative
Fire/ SAR/ Sec/ Pol	Fire I/c	Medical Officer
• Keeps all firefighting appliances and resources in readiness • Maintains patrols and ensure unsafe practices are eliminated • Liaises with site Incident controller (HM) and is responsible for keeping the fire Dept in a state of alertness on a 24 hour basis. • Sounds action alarm at the Fire station. Keeps CMG Conservator, PSO and etc., informed the level of crisis & leads team directly to incident site • Initiates firefighting procedures immediately and ensures firefighting team reaches the incident location with the correct resources. • Assist in the evacuation of workers to the assembly points in liaison with the team • Informs site Incident Controller (HM) if external fire tender/ firefighting equipment/ materials is required • Arranges safety equipment e.g. fire suites, protective gloves and goggles, breathing apparatus as required. • Controls the entry of unauthorized persons and vehicles • Permits the entry of authorized personnel and outside agencies for rescues operations without delay. • Allows the entry of emergency vehicles such as ambulances without hindrances • Ensures that all people are aware of the assembly points, where the transportation vehicles are available. • Ensures that the people are as per the head count available with the assembly point section of that area • Liaises with the addl. TM for transport arrangements of the people at assemble point • Carries out reconnaissance of evacuated area before declaring the same as evacuated and report to PSO. • Submit report to PSO, Conservator & CEO. • Deploy craft- and mobilise resources to confine and clean up spill.		

Position	Port Position	Alternative
EHS DEPT.	Sr.Manager-Electrical	Manager-Electrical
- Suggests optimal strategies for conducting emergency isolation of damaged equipment, the emergency transfer of materials etc. - Provides the necessary utilities during the emergency like back up emergency generators for general lighting purposes, pumps, welding services. - Renders assistance for extricating trapped personal by cutting structures, wires etc. - Recommends the appropriate procedures to isolate damaged units without introducing new hazards and provides resources both in terms of personnel and equipment to accomplish this. - Assess damages and provide technical assistance to determine the operability of damaged units. - Assists in the re- entry and restoration process of the port operation. - Assist in the accident investigation. - Take charge of all communication systems of Port fixed and portable both. - Ensure availability of sufficient numbers of electronic communication equipment to the port control station, Base Control and anywhere else as necessary. - Ensure port exchange operator to keep constant watch and relay messages as required by CMG, onsite, signal station & security centre. - Availability of portable lighting arrangement to the accident site. - Adequate workshop personnel are available to keep all vehicles and floating crafts, required to tackle an emergency, in good condition during the course of emergency. - Maintaining liaison with electricity board for emergency supply of power for running essential installations to meet emergency.		

Position	Port Position	Alternative
Civil	Asso.Manager-Civil	Incharge -Civil
- During cyclones/ floods arranges sand bags & develop methodologies to control hazardous spills. - Co-operate with on-site action group to conduct the clean-up work during and after the disaster. - Assist in the restoration and recovery activities.		

Position	Port Position	Alternative
Admin	DGM-Admin	Incharge-Admin
- Co-ordinate evacuation with local transport and PSO in township areas. - Liaison arrangements for shelters and food for evacuated persons. - Collecting details of evacuated people. This will be necessary to settle claims, if any, at a later date. - Consult legal advisor and obtain their advice for legalising all the port's actions. - Mobilise vehicles for onsite action team and support services. - Prepare lists of port personnel affected and involved in an incident and informing NOKIN. - Food arrangement and rest for personnel engaged in combating emergency. - Document all events and actions for future reference		

7.3.7 Communication System

Vulnerability is partly a function of the degree of protection available to potential victims as a result of a disaster. Improved warning reduces vulnerability. Warning incorporates the communication of risk in times of impending emergencies, with the purpose of obtaining public protective actions through the implementation of the DMP. The contingency plan that

includes the telephone numbers of key personnel during the time of crisis is shown as **Figure 7-6**.

Communication Network Elements within the Port on site	
Internal fire service	Special fire alarm and normal communication system- VHF-TELEPHONE-EPABX-WALKIE TALKIE- MOBILE
Forward control	UHF/VHF Transceivers-normal communication systems in reserve
Personal and internal Medical services	Normal communication services
Fire fighting crafts & Rescue launches	UHF/VHF Radio telephones, Via port authorities as reserve
Ships at berth	Normal UHF/VHF Radio telephone link used in cargo operations.
Civil authorities including fire services, Police and medical services	Direct telephone link with failure alarm, UHF/VHF radio telephone or public telephone system. Cascade system to be used i.e., through dept heads to subordinates. Enable keep lines clear
Harbour authorities, pilots, tugs and harbour craft	UHF/VHF Radio telephone or public telephone
District collector or state secretary	UHF/VHF Radio telephone or public telephone
Jt secretary-MOST New Delhi	Public telephone-hot line for emergency level 2&3

In case of emergency, an alert alarm for 5 (five) seconds with a gap of 5 (five) seconds for 1 (one) minute will be given during a prolong blast and at termination of emergency a continuous sounding for 45 seconds will be given.

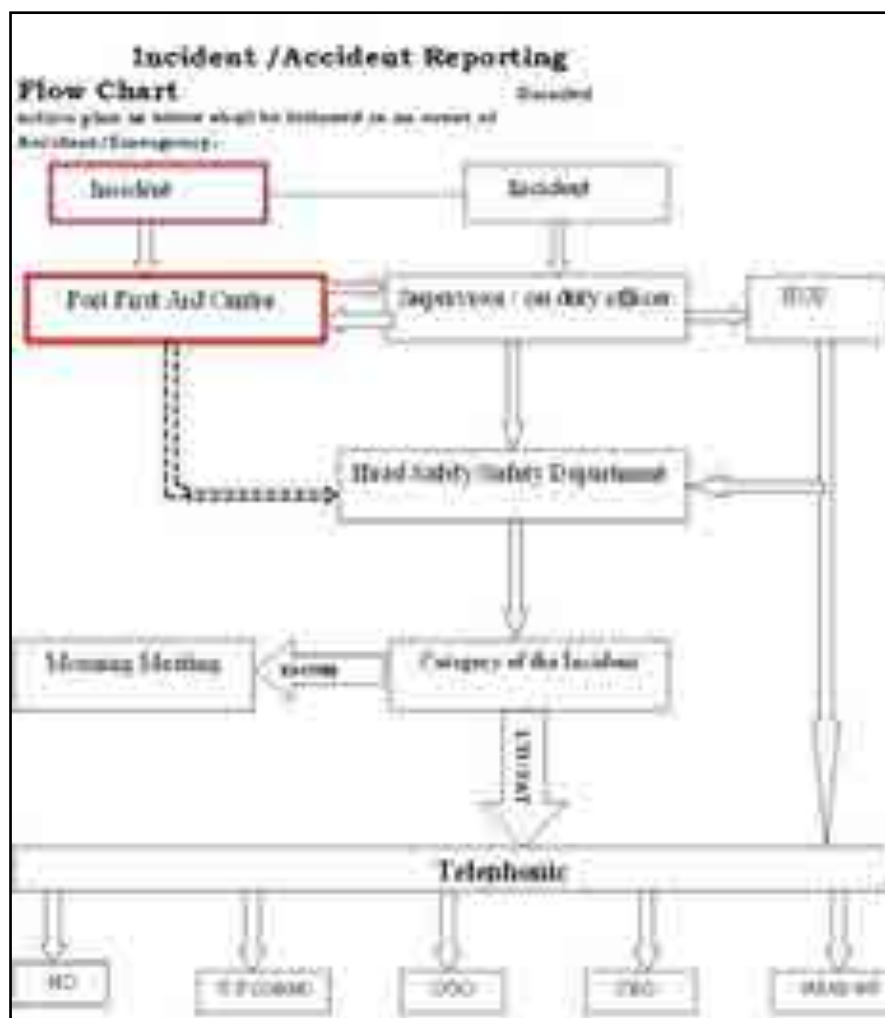


Figure 7-6: Contingency Plan**7.3.8 Fire and Explosion Response Plan**

The DPCL Fire Fighting Service is operated under PSO and is assisted by fire fighting teams which operates on 8 (eight) hour shift round the clock. The location of main fire station is the main gate. During discharge of fuel 01 Fire tender always to be stand by.

Table 7-31: Methods of Dealing with Different Types of Fire & Leakages

Fires from minor oil spillage on deck or jetty	Use dry chemical or extinguishers or water fog or water spray
Fire from large spillage of oil or burst hose on deck or jetty	Use large dry chemical appliance and follow up with foam or water fog/spray. Cool surrounding area/risks with water spray
Fires from spillage of oil on surrounding waters	Emulsification of oil with water jets or apply foam coverage as appropriate
Ammonia gas	Use dry chemical, carbon dioxide, water spray or alcohol resistant foam from upwind position
Phosphoric/Sulphuric Acid	Dry powder, carbon dioxide (CO ₂), water fog or spray
Electrical fires	Switch off power-use CO ₂ or dry chemical extinguishers
Fire in buildings-canteen	
Fire in office involving combustible material	Use dry powder fire extinguishers-water spray, use breathing apparatus.
LPG and LNG fires	Should not be extinguished until source of leakage is under control. Dry chemical is the most effective. Cover affected area with water spray to reduce radiant heat.
Fire in cargo tanks	Use foam or steam smothering.

Table 7-32: Departmental Action during Fire at Jetty

DEPT	ACTION
Harbour Master & Vessel	1. Signal station informs conservator, Harbour Master and PSO on VHF 6/14/12/Land line/Mobile. 2. Master of the vessel ceases all cargo or bunker operations close the manifold valves 3. Disconnected hoses and consults with conservator and Harbour Master for un berthing & also ensures the immediate action of the vessels fire fighting squad. 4. If necessary Master may request for additional resources and/ or- evacuation of injured. 5. SIGNAL STATION informs conservator, Deputy Conservator, Harbour Master, PSO & Fire station of incident. 6. Conservator assesses works together with Harbour Master, PSO and Master of vessel to ascertain in the status and crisis level. 7. HM informs crisis management group the status and crisis level. 8. Pilots on standby for shifting out vessel – directs fire fighting tugs – keeps mooring crew and launch standby to un berth vessel. 9. DC maintains close liaison with HM and monitors progress and strategy of containment and extinguishing. 10. Reconfirms stoppage of cargo operations.
PSO	1. Ensures that fire tenders are ready at the jetty and takes over action group. 2. Ensures area cordons off. 3. Executes search & rescue with fire fighting team. 4. Inform conservator and need for additional resources.
E&M Dept.	1. Ensures isolation of the electric power on berth.
Medical	1. CMO keeps ambulance standby at berth and provides first aid and burn treatment to the injured.

Table 7-33: Action Plan during Fire at Administration Building

DEPT	ACTION
Administration	1. First sight-Raises alarm (break glass – uses fire extinguishers to extinguish fire). 2. Head admin supervises the action. 3. Overall in charge of action group. 4. Switch of electric supply. 5. Never throw water on electric box.

	6. Inform fire station / PSO / Signal station / Conservator. 7. Evacuate people in orderly manner 8. Sr. most section head shall be last to leave premise. 9. Muster all people and confirm head count for any missing people 10. On incident termination arrange alternative office space.
PSO	1. Deploy fire tender. 2. Assist transfer of sensitive documents. 3. Assist in evacuation / search & rescue of personnel. 4. Cordoning off area. 5. Apprise conservator of the area.
Civil Engg. Dept.	1. Assess cost to rectify damage portion of building.
E&M Dept.	1. Ensures isolation of electric power to admin building.
Medical	1. Keeps ambulance standby. 2. Provide first aid victim.

Table 7-34: Action Plan during Fire at Bulk Material Handling Area

DEPT	ACTION
HARBOUR MASTER	1. BMH in charge raises alarm by informing port signal station & fire station simultaneously uses fire extinguishers to extinguish fire. 2. Switch off power supply and all cargo operation ceases. 3. Informs on-site action group, conservator and PSO 4. Shed I/c mobilises all manpower in the area surrounding the site to bring the firefighting appliances in the area, to extinguish the fire. 5. The senior most traffic official on site will mobilise all the work force, labour and cargo handling appliances available in the area. 6. TM ensures the removal of all the unaffected cargo from the shed to a safe place. 7. TM ensures that the details of types of cargo and quantity of cargo in the shed should be kept ready and given to of port fire service that comes first to the scene of the fire. 8. TM shall ensure that the labour working inside the shed is assembled for a head count. 9. Keeps all tugs and craft on standby. 10. Recall pilots for movement of vessels. 11. Inform all vessels to be standby.
PSO	1. Arrives with fire tenders and resources and takes over fire fighting. 2. Conducts search and rescue and evacuation of affected person. 3. Cordon off the affected area. 4. Apprise conservator and resources required.
Civil Dept.	1. Survey and assess the cost to rectify the damage portion of the cargo storage shed.
E&M Dept.	2. Ensures isolation of the electric power to cargo storage shed.
Medical	3. Keeps ambulance standby by off administration building. 4. Provides first aid to the injured.

Table 7-35: Action Plan during Fire/ Explosion off Berth

SHIPBOARD EMERGENCY PLAN		FIRE / EXPLOSION OFF BERTH
Action to be considered	Port	Responsibility
IMMEDIATE ACTION - Consider sounding emergency alarm - Initiate vessel emergency response procedure - Inform port signal station about nature of explosion.	Port signal station	Informs PSO, HM & conservator and vessels on jetty about incident
INITIAL RESPONSE - Cease all cargo and / or bunkering operation - Close manifold valves - Fire squads to position deemed best for fighting the fire - Inform terminal/loading master/bunkering personnel	PSO	- Place fire tender next to ship - Cordon off jetty - Inform conservator and assess resources required - Oil spill team standby
SECONDARY RESPONSE - Stop air intake into accommodation - Consider to stop non-essential air intake to engine	HM	- Keep pilot & tug ready - Stop all cargo operation - If required vacate ship from jetty

room • Determine the extent of the damage, and decide what damage control measures can be taken • Determine whether there are casualties • Contain the fire and prevent it from spreading to other parts of the vessel • Assess health hazards from smoke • If possible, position the vessel to minimise the wind effect • Start recovering of any casualties • Notify authorities and outside organisation, as appropriate • Evaluate evacuation of non-essential crew		
FURTHER RESPONSE • Assess the possibility of pollution from leakage • Fit scupper plugs if spillage on deck • Check all tanks and compartments • Alter trim if necessary • Transfer bunker internally, if required • Require assistance as deemed necessary • Comply with reporting procedures • If required, obtain permission from local authorities and/or the terminal to continue normal operation	CMO	• Ambulance and first aid team standby on jetty

7.3.9 Action Plans for Vessel Collisions/Grounding/Sinking at Port

7.3.9.1 Collision of Vessels Calling at DPCL Port

SHIP BOARD-PORT EMERGENCY PLAN		COLLISION	
Action to be taken	Action by port	Action by vessel	
1. Slow down and stop main engines 2. Sound emergency alarm 3. Check for possibility of oil pollution		Master	
1. Establish communication with other vessel and exchange information 2. Advise other vessels to keep clear-hoist NCU lights 3. Advise port for assistance 4. Advise agents of status requests surveyors-class-P&I-salvage association 5. Secure evidence and maintain adequate records	Harbour master Along with on site action group. Inform conservator Inform CEO Inform IN + CG		
1. Inspects/assesses damaged area & in case of oil leakage determine whether de-berthing of the vessels will increase oil spill rate. 2. Ascertains oil pollution-ascertains leak source 3. Harbour master and master of vessel to inspect vessels 4. Sounds all bilge, ballast and fuel tanks 5. Transfer oil from leaking tanks 6. Effects damage control and temporary repairs to stop oil leakage if any with the assistance of port action group and underwater welding team or salvage group	Harbour master with on-site action group Inform conservator Inform coast guard + salvage efforts	Vessel emergency Action group team	
1. Provides first aid	CMO		
1. Attend engine room controls and services 2. Investigate engine room for damages and water ingress 3. Check steering gear 4. Reports status of the main engine and auxiliaries to port signal station		Vessel engineering team	

7.3.9.2 Vessel Grounding in Port

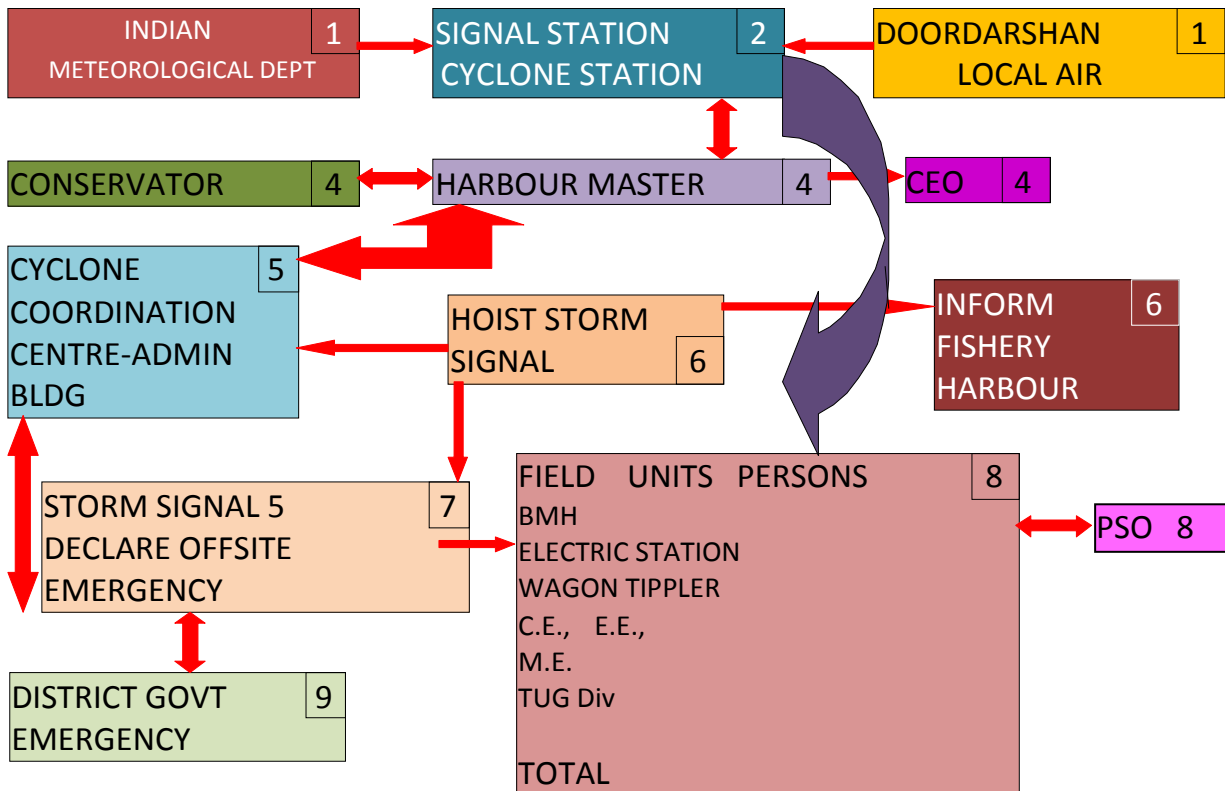
ACTION BY MARINE DEPT.	DETAILS OF SPECIFIC ACTION
Master/pilot	Contacts signal station on VHF Ch 16 or Ch 14 and informs position of incident
Signal station	- Informs conservator, HM & PSO; Stop all vessel movement - Conservator informs CEO and crisis Management team who inform mutual aid agencies for assistance required - All vessels arriving and departing Dhamra port will be informed of the incident
Harbour master	- Activates the on-site action group and assesses the situation, tide, wind direction, & inform DC. - Through the signal station advises all pilots to report on duty, all tugs stand by
Sr. pilot	Organises available tugs, launches, and keeps crew standby and awaits instructions of the conservator
Sr. hydrography surveyor	Proceeds by survey launch to vessel and obtains soundings around the vessel by the echo sounder and the hand lead line
Master of grounded vessel	- Records soundings of all tanks and also records draft, arrange soundings by hand lead around the vessel - Examines the soundings and draft around the vessel for transfer of bunkers, ballast or shift cargo to refloat vessel - TOW ropes to be kept ready
Master of vessel and harbour master	- Commence preparations for towing operations two hours before high tide - Vessel engines to be kept standby to assist in the refloating operations - Takes all anti oil pollution measures
Port, navy or coast guard & salvage efforts	Hull leakages to be attended to by underwater welding by the navy/coast guard or other available diving firms.

7.3.9.3 Sinking of Vessel in Port

ACTION BY PORT MARINE DEPARTMENT	DETAILS OF SPECIFIC ACTION	ACTION BY VESSEL
Harbour master	Ensures vessel is cleared of the channel/ turning basin or berths to suitable area for normal traffic	Activates the vessel action group
Signal station	Informs HM, conservator & PSO of the accident	
Conservator and pilots	Proceeds to the area with tugs and conducts rescue operations	Lower life boats
conservator	Apprise the CEO and members of crisis management group about the incident	
HM/ Navy/ Coast Guard	PSO to initiates the rescue operation of the person on board	

7.3.10 Cyclone Contingency Plan

CYCLONE ALARM AND RESPONSE

**Table 7-36: Classification of Tropical Disturbances over the Indian Seas**

Classification of Tropical Disturbances	Speed kmph	Speed knots
Low	< 31 kmph	< 17 knots
Depression	31 – 51	17 – 27 knots
Deep depression	52 – 62	28 – 33 knots
Cyclone	63 – 87	34 – 47 knots
Severer Cyclone	88 – 117	48 – 63 knots
Very severe cyclone	118 – 221	64 – 119 knots
Super cyclone	222 kmph & above	120 knots & above

The cyclone contingency plan will come into force as soon as the storm warning signal No. 5 or higher is hoisted or when the Port organization has gathered enough data to forecast that a cyclone threat is close.

- The cyclone station will come into operation at the Signal Station
- The Conservator will be in charge of the Cyclone Station
- Storm warning signals will be hoisted at the Cyclone Station
- Conservator will inform the CEO and Heads of Departments by telephone/ Mobile the status of worsening weather conditions and storm signals
- A cyclone coordination centre will be made functional in the Administrative Building headed by DGM Administration
- The Cyclone Coordination Centre will be in constant touch with Signal Station and District, Local Administration for rescue and relief operation
- All other departments to operate their respective control rooms. Signal Station, cyclone co-ordination centre and control rooms will function round the clock and will be closed only after obtaining the necessary orders from the CEO

(I) Responsibilities of Traffic Department: Under the overall supervision and responsibility of the HM, the specific duties of marine personnel will be as below:

- Responsible for the operation of the signal station and will issue necessary standing orders for the purpose

- Close liaison with radar station, police wireless station, coast guard, Indian navy and ships in port regarding weather conditions
- Prepare special signals and promulgate them to the masters of the vessels, dredgers, tugs and any other crafts in port. He will inform the masters of all vessels at the berths to double the moorings, put out insurance wires and to keep engine ready to proceed out to sea if situation warrants. Decision regarding sending ships to the anchorage will be taken depending on the strength of the wind likely to be encountered and number of vessels in the port.
- He will maintain a close liaison and co-ordination with the tug engineer for arranging staff for manning the port crafts.

(II) Responsibilities of Signal Station

- The staff of signal station will remain on duty until they are relieved by next shift staff or till alternative arrangements are made or till the storm has passed or as per the conservator instruction.
- Every two hourly barometer reading will be recorded after cyclone warning signal No.3 is hoisted but the same will be made hourly if further upward signal is placed. Any drop of 2 mb in barometer to be informed to Conservator / HM / PSO
- One Aldis lamp with battery will kept ready at signal station.
- The signal station will maintain a continuous watch on channel 16. Signal station will keep Conservator, HM and PSO informed of all the messages received by telephone, VHF sets or by messenger.
- Signal station will inform the Conservator / HM of any buoys or crafts are seen adrift or any Port installation is seen or informed to be in danger.
- The staff on duty will have sufficient provisions to stay on duty for a period ranging from 24 hours to 48 hours.
- Signal station receiving any weather related facsimile report will pass on to the Conservator / HM / PSO.
- Continuous watch to be kept on movement of depression. On receipt of any warning, the same shall be reported immediately to the cyclone co-ordination centre.

(III) Responsibilities of Tidal Observatory: The Traffic office will record the range of tides, times and heights of high and low water who will in turn apprise the Conservator / HM and or Sr. Pilot on duty of the actual and predicted tides.

(IV) Responsibilities of Hydrography Surveyor/ Pilot: The above officers will assist the Conservator at the Cyclone Station. One Pilot has to be kept standby to proceed on board anywhere in the Port as required.

(V) Responsibilities of Berthing Master

- Berthing Master will detail one berthing team to remain on duty as emergency duty squad unit being relieved by the next shift staff or until Head Marine instruction.
- Berthing Master will take all necessary steps for the safety of the Port crafts and should ensure that all other crafts are placed at safe place and properly secured excepting one pilot launch and one stand by launch used for inspection and emergency duties.
- He along with emergency squad will make frequent round to check the safety of Port Crafts.
- Extra Fenders and Hawasers of ropes/wires will be kept ready so as to attend to any craft whose moorings may part.
- Berthing master will inform the cyclone station immediately in the event any craft is seen adrift or any other Port installation is seen in danger.
- He will also keep a listening watch on his walkie talkie set for information.

(VI) Responsibilities of Master of Tug/ Pilot Launches

- Master of respective crafts will instruct their staff to remain on board until they are relieved by next shift staff or HM release them from duty.
- Master will shift their respective crafts at suitable places as directed by the Traffic Manager and will secure them suitably with additional moorings. Masters of respective crafts will be responsible for proper securing and safety.
- Masters will keep the engines of their crafts ready to proceed at short notice as per the instructions of the HM.
- Extra fenders will be kept ready on the board of the Tug for use as required.
- If any craft is seen adrift or any other port installation is seen in danger, the Master of the crafts will immediately inform the cyclone station.

The cyclone mitigation team shall be headed by C.E. & M. E. with SM (Electrical), as his assistants in the control room. The Departmental vehicles as well as the hired taxis of the department shall be deployed for the above purpose.

PRECAUTIONARY MEASURES

- Cyclone warning signals shall be communicated to all field units from the control room
- The field units shall communicate the signal to all the staff of the divisions

GENERAL FUNCTIONS OF FIELD UNITS

- All the equipment shall be properly secured
- Safety of workmen on duty shall be given priority during work
- Operator's cabin doors of all the equipment and vehicles shall be kept shut
- Important documents/ files/ records at site must be stored well above the floor

SPECIFIC DUTY(i) Wagon Tippler

- Electrical Control Panel of the Wagon tippler/ RRS to be properly shut off.
- Wagons to be taken out of the tippler table / RRS table and no empty wagons should be kept in the inner line.
- Power breaker to be made off.

(ii) All conveyors, Stackers, Stacker-Cum-Reclaimers, Reclaimers

- Machine to be travelled to designated position.
- Tie down the belts, locking of travel wheel, locking of boom conveyor
- Slewing locking bolts to be fitted.
- Rail clamps to be tightened
- Booms are to be properly clamped.
- Power to be shut off – outgoing feeder from sub-station to be switched off
- Control room of the machine should be properly locked.
- All conveyors should be tied down at the head end and tail end.

(iii) Main Control Room

- Power should be shut-off, breaker should be made-off and doors should be closed.

(iv) Ship Loader

- Conveyors to be cleared of all cargo.
- Belt to be tied down at the tip on both sides of the ship loader.
- Blocking of travel wheels after latching of the booms.
- Diesel generating set should be tied and kept ready for supplying power wherever necessary.

- Anchoring of the Ship loader at its parking position.
- Rail clamp to be tightened.

(v) Site Store

- All the doors and windows should be locked up and power should be made off.
- All the equipments like cranes, etc. In working condition should be sent to Marine/Central work shop for safe.
- Welding generator should be kept inside the store and locked up.
- Communication system should be tested for operation.
- Battery charging point should be operated through a DG Set.
- A vehicle should be available at the control room
- Head store will have a temporary advance if required for contingency expenditure.

(vi) Port Electrical Division

- On receipt of the directive about cyclone warning, the power supply of main sub-station to be made off and communication system from control room to the substation to be kept operative.
- 132 KV Control Room will be manned during the cyclone.
- Walkie talky handsets must be made available in all the substations for establishing communication.
- Two emergency vehicles should be kept standby for attending to various duties.
- Head Electrical Division will have a temporary advance if require to meet the contingency expenditure.

(vii) Marine Division

- Engine room entrance doors, sky lights etc., of all the floating crafts to be kept shut.
- All the heavy earth moving equipment and vehicles must be stored in sheltered locations and operator's cabin must be kept shut.
- Special care shall be given for securing the crane boom.
- Marine Engineer will have a temporary advance if required to meet contingency expenditure.
- Crafts are to be manned all time.

(viii) Tug Engineering Division

- EICs (Engineer in Charge) of all tugs on receiving the cyclone warning must ensure that tugs are in readiness for operation.
- Tugs will be operated as per the Traffic Manager Department's requirement.

(ix) Loco Shed

- Loco engineers to be parked inside the shed.
- The point to the shed line to be blocked.
- All derailing equipment, batteries and tools shall be kept ready for emergency use.
- Two groups of wagon staff to be kept as standby.
- The cross and long travel of the EOT crane to be blocked and hook to be anchored.

(x) Engineering Services-Central Workshop

- The centre Workshop shall be manned by one group of staff consisting of one Machinist, one Fitter, one Welder and three Helpers to attend to emergency requirement.
- Power supply to all the machineries and equipment to be shut off.
- Doors and windows of the Central Workshop to be kept shut.

(xi) Cargo Handling Division

- All mobile cranes to be kept at stowing area with booms of cranes lowered and clamped. The cabin doors and panels to be kept closed.
- All cranes on jetty are properly anchored on rail, slewing to be blocked and booms are secured. Booms are secured in the direction of the track.
- Forklifts and all heavy earth moving equipments are parked inside the shed.
- 3 crane operators and 6 helpers to be available on duty during cyclone period.
- Head Cargo division will have temporary advance, if required to meet the contingency expenditure.

Civil Engineering Department

- The staffs as per usual shifts are deployed at each of pump house during cyclone.
- A sufficient quantity of bleaching powder, alum etc. and the water treatment plant is kept ready for water treatment during cyclone period.
- As soon as the contingency plan is made operational all the water tanks should be filled up and standby arrangement for supply of water to be made with special provision for the hospital.
- Position one Engineer exclusively to look after navigational aids, fenders; transit shed doors and roofs etc. along with necessary staff.
- Position one Engineer along with necessary staff to look after the sea wall condition & if any breach is noticed along the side of the sea-wall, immediate steps should be taken up for its repair.
- Keep ready 3,000 to 4,000 empty cement bags for use.
- All measures to be taken to minimise uprooting of trees.

Marine Department

(i) Operation

- All loading/unloading of cargo operations to be ceased.
- All the cargoes under Port's custody, lying outside and likely to get damaged, will be shifted to Transit Sheds/Ware Houses.
- Doors of the sheds will be closed and properly secured.
- He will visit the site and inspect the arrangements.

(ii) Railways

- Yard master personally takes over the charge of yard supervision instead of leaving the same to shift staff.
- Movement of wagons is stopped when wind speed exceeds the operational limit (70 KM per hour).
- All the rolling stock on tracks is clamped / chained both in Port area and exchange yard and the locomotives are returned to the Loco Shed.

Administration Department

- The DGM Administration will remain overall in-charge of the Cyclone Co-ordination Centre.
- He shall make a duty roster for the manning of the cyclone co-ordination centre by the officers of Administrative, Finance & Accounts and Materials Management department.
- The Co-ordination Centre will keep constant touch with the Local & District Administration for rendering necessary assistance.
- The port Public Relations Officer will ensure announcement by the mike in the township indicating the precautionary measures to be taken.
- He will hire basic transport and will detail Officers to remain in-charge of various relief centres.

- He will make necessary arrangement in co-ordination with the local administration for evacuating people from the low lying area. They will be shifted to relief centres as indicated below:

AREA	RELIEF CENTRE
Dhamra GH	Cyclone Centre
Scot Wilson GH	Cyclone Centre
L&T GH at Karanjamal	Cyclone Centre

Help of the following voluntary organizations may be taken for the rescue and relief operation

Finance & Accounts Department

All departments may inform the Finance & Accounts Office the amount of the cash required by them so that the same can be kept in advance and can be disbursed by one of the Officers of the Finance & Accounts Department as per need.

Medical Department

- The Casualty ward is to be manned by one Specialist in addition to the regular doctors attending.
- The Ambulance has to be kept standby near the casualty ward.

Material Management Department

- During cyclone season sufficient stock of stores like Polythene, J.Hooks, screw hinges, gunny bags, tarpaulins, ropes and wires for Port Crafts, diesel oil, kerosene oil, petromax lamps, torch lights with batteries and bulbs, electrical items etc. are kept.
- All the materials which are likely to get damaged with rain are covered with tarpaulin.
- One Stores Supdt., one Store Keeper and the other minimum staff required to issue materials including POL are kept during emergency.

Port Facility Security Officer

- Intensive vigil on stores/buildings which are likely to be affected by Cyclone.

• Central Stores • BMH • Jetty	• WTP • Transit Sheds • Fuel Depot	• Ware Houses • Administrative Building

- Thorough checks on all out-going vehicles to guard against pilferage.
- A special task force to be set up for the rescue operation.

- All departments will ensure that the doors and windows are properly closed prior to leaving the office.
- All important files are stored in secure cupboards
- All HODs are required to assess the damage and submit a detailed report indicating the estimate to the conservator. A team may be formed comprising HM, EE (Elect, Mech., and Civil) and assisted by one representative from the Finance Department. The preliminary report is to be submitted within 48 hours and detailed report within four days from the date of normalcy.
- Hydrography survey is to be conducted to assess the channel condition and ensure resumption of shipping as early as possible.
- In case of any small craft sunk or grounded the same to be removed to make the channel/berth safe for navigation. Conservator will detail a salvage party headed by the HM.

- A team of Officers to be nominated by the Administrative Department to supervise the rescue and relief operation and disposal of animal carcasses in coordination with the local and District Administration.
- Preventive measures for epidemics to be taken by the Medical Department.
- All the operating systems to be attended urgently and made operational as early as possible on a war footing basis to resume operation.
- Sport tendering procedure for repair up to Rs.2 Lakhs by concerned Dept
- Water supply and electricity to be given priority. The electrical cabling network to be checked area-wise. The inspection team to be decided by the CE & ME for obtaining clearance to resume power supply.
- All damaged temporary roofed houses in the port premises are to be attended.
- The Manager Materials will nominate a team for procurement and supply of essential materials for repair of various structures and equipment as reported.
- To assess the progress of repair works, HODs meeting will be held daily till normalcy is restored.

7.3.11 Floods Similar to Cyclone

DEPT	ACTION
HM	• Signal Station passes weather message to HM and DC • HM places on-site action group alert • Conservator apprises Chairman of weather developments who places CMG on alert if necessary.
Civil Dept.	• Drainage system of the port i.e inside harbour area & outside harbour area should be cleared. • Trailer mounted portable Diesel pump sets to be made standby with sufficient length of hose pipes. • Sand bags to be used around sensitive areas including water supply • Pump stations electric sub stations
E & M Dept.	• All the outside installations and equipment shall be properly secured. • Cyclone field units to be made alert
Administration	• To make standby arrangements for transportation to evacuate population to cyclone centres and relief centres. • Arrange food and water.

7.3.12 Tsunami

Characteristics: Tsunamis are a series of enormous waves created by an underwater disturbance such as an earthquake, landslide, volcanic eruption, or meteorite. A tsunami can move about 500 miles per hour in the open ocean. Once the wave approaches the shore, it builds in height. The topography of the coastline and the ocean floor will influence the size of the wave. There may be more than one wave and the succeeding one may be larger than the one before. Tsunami waves and the receding water are very destructive to structures. The Tsunami warning is issued on earthquake having intensity of more than 6.5 on Richter scale.

Warning/Confirmation

- Met. Station
- TV and radio News

DEPT	ONSITE ACTION GROUP
Harbour Master	• Cease cargo operations immediately. • Through Signal Station informs all the ships to evacuate from the berth to open sea. Signal Station keeps in touch with all vessels on VHF. • Move tugs and launches to safe areas or deep water anchorages • Crew to wear life jackets.
Administration	• Arrange transport to evacuate to safer inland areas

Civil Engineering Department	Keep sand bags and other transport logistics ready
E & M Department	- Ensure proper secure of the cargo handling equipment and the shore cranes. - Anchorage of cranes
PFSO	Evacuation of Personnel and cordoning off the area
CMO	Treatment of injured personnel

	CRISIS MANAGEMENT GROUP
CEO	Activates CMG
Harbour Master	Conservator to apprise the CEO of any developments and early Warning Systems.
Administration	Keep in constant touch with state Govt.

7.3.13 Earthquake

Earthquake Predictions: Local earthquakes are difficult to predict. Dhamra is in Seismic Zone 2 (lowest risk) which is quite safe as compared to Gujarat which is in zone 4 & 5 (highest risk).

- Frequency of tremors as reported in the newspapers, TV and radio
- Rattling of doors and windows

Characteristics-quake

- Magnitude
- Focal depth
- Location of epicentre
- Rupture length
- Rupture orientation

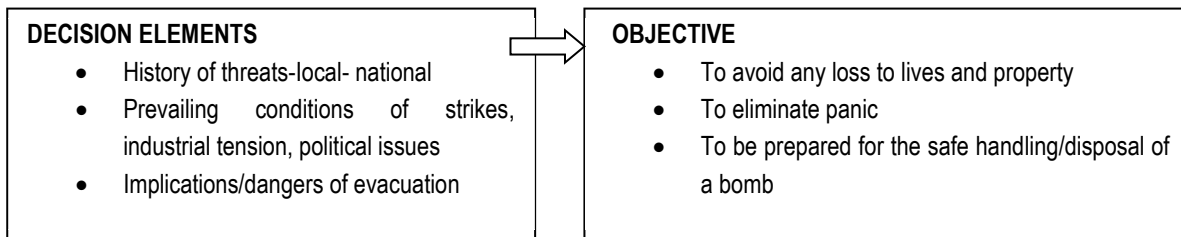
Property-Characteristics

- Distance from focus
- Soil conditions
- Geology

Table 7-37: Relief Work after an Earth Quake

DEPT	ACTION
CEO	To contact the District Collector, Relief Commissioner, Army, Navy, Coast guards and seek assistance for Port Town ship.
Administration	To assist the Chairman to assess relief requirements. Arrange Food, shelter & transportation
E & M Dept.	To provide and hire if necessary, earthmoving equipments, cranes, forklifts, bulldozers etc.
Civil Eng Dept	Deploy engineers to direct or guide earth moving equipment and cranes to remove the debris
Harbour Master	Ensure safety of cargo in cargo sheds and at rail siding. Ensure the safety of port marine craft and vessels alongside
PFSO	To organise Search and Rescue of persons trapped under debris.
Medical	CMO/PHO to ensure provision of proper Medical Aid to the injured

- If outdoors, find a clear spot away from buildings, trees, streetlights, and power lines. Keep lying on the ground and stay there until the shaking stops. Injuries can occur from falling trees, street-lights and power lines, or building debris.
- If on vehicle, pull over to a clear location, stop and stay with your seatbelt fastened until the shaking has stopped. Trees, power lines, poles, street signs reduce your risk. Once the shaking has stopped, proceed with caution. Avoid bridges or ramps that might have been damaged by the quake.
- If indoor – Go below bed / table until the shaking stops. Avoid lift and staircase.



Dept	Action
PFSO	1 - Mobilise man power from off duty personnel and detail them for a thorough search/combining operation of premises where the bomb is planted and its adjacent areas.
	2 - Ensure that the information has been passed to all concerned.
	3 - Recommends emergency classification II or III to conservator
	4 - Will ensure that panic is not created and situation is kept under control
	5 - Requisitions of fire tender and ambulances and positioning them at a safe distance from the threatened or suspected area.
	6 - Ensures evacuation of the workmen working inside the port area, if the threat is inside the prohibited area.
	7 - Requisitions of BDDS (Bomb Detection & Disposal Squad) from Cuttack.
	8 - Cordoning off the entire area.

Checklists-Questions to Ask Bomb Threat Caller

- Threat received in – writing or telephone
- On phone keep caller on line as long as possible
- Ask colleague to inform security to trace call-tape recorder
- Ask for – bomb location, time of detonation, type of a bomb, How does it look, How do you know so much about bombs?
- Advise caller of the loss of innocent lives as a consequence of bomb detonation
- Could he live with this guilt for the rest of his life
- Whom does he represent & why is he doing this?
- Background Noises – music, airport, railway, factory, tel. Booth, trace place of call
- Check voice characteristics – Male, Female, Voice Quality, Calm, excited, Anger
- Age, Accent – local, out state, foreign, disguised
- Speech Impediment, stammer, slow, educated, laughing, deliberate, familiar
- Inform PSO immediately

Preventive Steps

- Explosives – Difficult to detect. Easy to explode remotely/timed.
- BE PREPARED – Prevent Self loss & Port's loss.
- Prevention is better than Cure.
- Check & Prevent unknown entry.
- Control access of men, material in port areas.
- Check all items/stores thoroughly before accepting them.
- Report presence of suspicious unattended items, cycle, 2/4 wheelers, persons.
- Good House Keeping is important.

Types of suspicious objects: On sighting an object containing suspicious device i.e. Scooter/ Cars / Transistors / Suitcases / Brief Cases and other traps like trip wire, doll, and electronic IED's etc. The measures to be taken are

- Nobody to go near the suspected objects.
- The areas to be evacuated includes up to the safety area.
- A protective wall of sand bag to be arranged around the suspected article.
- If the electric wire to the battery and a switch connects the IED's / objects, it is not to be operated.

- If any visible wires are hangings from the abandoned / parked vehicle is noticed, it should not be touched.
- Do not put suspected article in water.
- Do not take fire or inflammable object nearer to the suspected object.
- If suspicious items found in a room, all windows and doors of the room should be kept open. Electric switches should not be operated. Gas connection to be removed.
- Do not touch suspected bomb to the Police Station.
- Prohibit the entry into the area and set up a cordon.
- If possible the suspected object be dragged to safety place with help of rope (Fish Hook)
- Do not use radio / wireless equipment (at least 50 m within the suspicious objects or bombs)
- Do not pick up attractive items lying at odd places like transistors, toys, suitcases and dolls etc.
- Do not assume only one device is planted.

Precaution on finding suspected objects in Port areas

(i) Car Bombs

- Do not open the door, bonnet or dickey of the abandoned vehicle as there may be release type device planted in.
- Do not start the vehicle under any circumstances as explosive material / IED may be planted inside connecting the ignition apart from a device and remote system for its blasts.

(ii) Transistor Bombs

- The transistor bomb should not be operated as there is possibility of its mechanism connected to the on-off switch to explode.
- It should not be lifted from its place or tilted as it may be fitted with release or anti disturbance mechanism.
- If any wires coming out of the IED should not be connected together.

(iii) Suitcase / Briefcase Bomb

- Suspicious / abandoned or left over suitable or briefcase should not be opened as it may be fitted with release or pressure control switch.

What to look for

- Recently disturbed area.
- Saw dust, brick dust, wood chips.
- Greasy paper wrapping.
- Out of place object.
- Disturbed carpeting.
- Tin foils.
- Partly open windows / doors / drawers.
- Fresh plaster / cement.
- Loose electric fittings.
- Fish line, dirty ropes electric wires.
- Cut vegetation
- Military containers of ammunition and explosives.
- Dusty foot prints. Scorched or new prints or timber.

Where to look for

- Sanitary towel dispenser.
- Lavatories and cisterns.

- Rest rooms and lounges.
- Trash baskets and receptacles.
- Store rooms and boilers rooms.
- Excreta, dead bodies, motors or other victims.
- Open lockers.
- Auditoriums and recreational rooms.
- Unoccupied office and rooms.
- Basements.
- False ceilings, decorations light panels.
- Space under stair walls and stair ways.
- Elevator shafts and area used as access to plumbing fixtures, utility and other areas.
- Air conditioning plants and over-head water tanks.
- Telephones.
- Pornographic books.
- Flower beds and pots.
- Inflammable storage areas.
- Main switch boards and valve.
- Record storage and mail rooms.
- Drains, sewage and main holes.
- Chairs platforms and PA systems.
- Rooms below, up and surrounding area where a VIP is expected to address the public.

Points to remember

- Do not touch or remove packet unless duty bounds.
- Do not open the package with hands.
- Do not open the package.
- Do not submerge the package in water.
- Do not pull out the strings or wires.
- Do not pass the metallic object over the package.
- Handle the package alone.
- Do not accept the identification marks on the package on the face value.
- Do not bring a bomb or suspected object in a station house or inhabited buildings.
- Do not use radio in the vicinity of bomb.
- Evacuate the people to safe distance. Always evacuate the people and NOT the BOMB.
- Do not direct a flash light on the bomb.
- Remove all inflammable items.
- Open windows and doors to minimize the blasts effects.
- Place sand bag around the object. Do not cover the object.
- Do not permit re-entry of people until objects are removed.
- Do not be DEAD HERO. You can construct a building or house but you cannot make dead man alive.

7.3.15 War Alerts

DEPT	ACTION
PRESIDENT & PM	DECLARATION OF WAR
CEO	• To activate CMG and ON SITE ACTION GROUP • Contact and co-ordinate with Navy, Coast Guard & Local Police.
PFSO	• Implement blackout in port • Intensify patrolling • Place additional guards. • All security personnel on standby.

DEPT	ACTION
PRESIDENT & PM	DECLARATION OF WAR
	Initiate Security level as per directives.
TRAFFIC	- Ensures all vessels at anchorage to observe blackout - No night movements - Ensures proper following of the Naval Instructions to inbound vessels. - Ensures shut down of all cargo operations after sunset. - Ensure workers within perimeter of dangerous/chemical tank farms shifted to safer perimeters. - All other workers to move out of port prohibited area as per directives.
ELEC & MECH Dept.	Ensure essential services working during day and night.
MEDICAL	Ensure ambulances and first aid staff kept in readiness on 24 hour basis.

7.3.16 Terrorist Attacks/ Hostage Situations

If any personnel observe terrorist or hostage situations then immediately remove yourself from any danger and notify Conservator / Port Security Officer with following Information

- Location place & time of incident
- Number of terrorist / possible hostage takers
- Physical descriptions of terrorist i.e. Height / Weight / Hair colour / Eye colour / Complexion / types of clothes wearing.
- Names of hostage takers (If possible)
- Language spoken by them
- No. of possible hostages
- Type and number of weapon carried by them
- Your name & details



Plate 7-1: Security Display Boards

PSO	- On receipt of message immediately inform CEO / Conservator. - Advise to Upgrade Security level - Cordon off concerned area - Assist Police and law enforcing agency.
Harbour Master	- Stop or continue as per Conservator orders - Stop or continue cargo operation as per conservator order.
CMO	- Keep all Hospital staff on standby. - Ambulance standby.
Administration	Advise CEO and seek help from mutual aid agencies.

In Hostage Situations

- Remain calm, be polite & cooperate with your captors.
- Do not attempt escape unless there is an extremely good chances of survival. It is safe to be submissive & abiding to the captors.
- Speak normally, do not complain, avoid being belligerent and comply with all orders and instructions of captors.
- Do not draw attentions to yourself with sudden body movements, statements, comments or hostile look.
- Observe captors & try to memorize their physical traits, voice patterns, clothing or other details that can help to provide a description later.
- Avoid getting into political or ideological discussions with the captors.
- Try to establish relationship with captors and get to know them, captors are less likely to harm if you respect them.
- If forced to present terrorist demands to authorities either in writing or on tape, state clearly that demands are from your captors. Avoid making plea on your behalf.
- Try to stay low to the ground or behind cover from windows or doors, if possible.

In Rescue Situations

- Do not run or drop to the floor. Remain still, if that is not possible, cross your arms bow your hand & stand still, make no sudden moves that a tense rescuer may interpret as hostile or threatening.
- Wait for instructions and obey all instructions that are given.
- Do not be upset, resist, or argue if a rescuer isn't sure whether you are a terrorist or a hostage.
- Even if you are handcuffed and searched do not resist. Just wait for the confusion to be cleared.
- You will be taken to safe area, where proper search and identification will be carried out.

7.3.17 Handling Violent Activities of the Workers

Normally violent activities arise out of anger on the spur of the moment and such violence exists for a short time. The aim is to contain such activities at nascent stage & without any damage to property and person.

- The Security team confronting such elements to solve and defuse the situation, in an amicable manner.
- If situation goes beyond control and show of force required then PSO to take action to meet the situation by forcible removal of person from site.
- In the meantime the officer in charge of the spot will inform the Commandant who will if necessary send additional man power by mobilizing off duty personnel.
- Simultaneously control room will inform the local police.
- Depending on the gravity of the situation alert following:
 - Inform Conservator / Harbour Master / PFSO / IR Officer
 - Dhamra Police Station
 - Port Fire Station
 - Port Hospital
 - Industrial Relations Officer & Dept. Head – To be present at the scene of incident.
- The Security Shift in Charge will use PA system and siren to disseminate correct information with appeals for calm and reason.
- The Security Command centre will record the riot for collecting vital information and pictures for use when the perpetrators of crime are prosecuted as per the provisions of the law.

- All Heads of Dept. to recognize the potential trouble makers and prepare list of such employee, keep them under constant surveillance and have frequent interaction with them. It is imperative to nip the evil in bud.

7.3.18 Ship Security Alert in Port Limits

The Ship Security Alert System (SSAS) is part of the ISPS Code is a system that contributes to the efforts to strengthen maritime security and suppress acts of terrorism and piracy against shipping. The system is a joint project between COSPAS & SARSAT and the IMO. In case of attempted piracy or terrorism, the ship's SSAS beacon can be activated and appropriate law enforcement or military forces can be dispatched. The alarm is a covert signal, which will have no sound and no flashing lights so that it is in no way obvious to any intruders on board the ship. When an SSAS alert is triggered:

- The Rescue Coordination Centres or SAR Points of Contact (SPOCs) for the country code the beacon is transmitting is notified discreetly
- National authorities dispatch appropriate forces to deal with the terrorist or pirate threat.
- SSA alerts are not transmitted to ships in vicinity

Action

- PFSO will receive SSA alert from DG shipping.
- On receipt of alert inform – CEO / Conservator / Harbour Master.
- Implement Security Level – III
- Action should not jeopardise concerned ship security. All action to be discreetly taken.
- Inform – Police / Navy / Coast Guard.
- Vessels at Anchorage then keep under surveillance. Prevent vessel from entering the navigable channel.
- Vessel at jetty, then keep under surveillance till arrival of law Enforcement Agencies arrival.
- All tugs, craft and Pilot to be stand by.

7.3.19 Oil Spill Contingency Plan

Oil Spill Contingency Plan (OSCP) and preparedness for oil spill response in all major ports, is a mandatory requirement as per the Navigational Safety in Ports Committee of Govt of India, headed by DG Shipping.

DPCL is committed to integrate in its operations, ways to identify oil spill risks, prevent oil spills, and to implement appropriate changes in its contingency plan for spill response and clean-up strategies with the following activities:

- Respond immediately to any spill incident with the objective of protecting human & marine life and to minimise environmental damages
- Work with appropriate government bodies, NGOs and the local community to address any issues relating to oil spills on a continuous basis and in a timely manner;
- Provide adequate training and information to enable employees and contractors to adopt environmentally responsible work practices, and to be aware of their responsibilities in the prevention and clean-up of oil spill;
- Develop plans and procedures so that incidents (accidental releases) can be responded to in a timely manner;
- Implement management system to identify, control and monitor risks and to comply with Statutory Regulations and industry guidelines;

- Assess the situation and take timely and appropriate action where third party interests are involved, such as chartered vessels, nearby DRDO installation etc.
- Ascertain that each identified employee is responsible for the implementation of this policy in association with his specific duties. This includes Port Management, Shipping Agents, contractors and employees

7.3.19.1 Oil Spill Classification and Tiered Response

The size, location and timing of an oil spill are unpredictable and different situations require different responses. The severity of an oil spill incident is largely based on the quantity of oil spilled and the distance from the shore. With increasing size of spill and decreasing distance from shore the number of outside agencies involved and urgency of their notification increases. DPCL has formulated following tiered response plan:

Tier 1 (Within Local Capability)

(a) Mobilization of oil spill response equipment stored on tug boat and ERT personnel from Port Office and vessel itself to the spill site will take roughly 15 to 20 minutes, i.e., travel time from Port Office to vessel at jetty, arranging of suitable boat and personnel required on board vessel for commencing spill response operations.

(b) Mobilization of shore clean up equipment stored at Port Control Office to vehicles and smaller vessel for shore protection where the spill might hit the land, may take about 30 to 40 minutes. Time taken for reaching at the spill site / area likely to be hit by the spill, will depend upon speed of the watercraft / vehicle and road/ sea conditions, and distance of the oil spill site from the port.

Tier 2 (Beyond Local Capability)

(a) Mobilisation of equipment to the site, will take Four to Six hours at least by the sea route from Coast Guard District Headquarters-7 Paradip; mainly due to preparation and passage.

(b) Mobilization of Coast Guard Air Efforts will take about 3-4 hours from Coast Guard Air Enclave, Bhubaneswar and (Rotatory wing aircraft for aerial application of Oil Spill Dispersant (OSD) to reach the site and commence the operation).

(c) Mobilization of oil spill response equipment on board Coast Guard vessel from Haldia (Coast Guard District Headquarter-8), to reach the site and commence the operations will require considerable time (about 15 hours), as the shipping traffic is heavy and distance is also involved, Pilot requirement, selection of vessel, positioning of equipments and Normal Starting of main engines may take some more time, due to technical reasons.

Tier 3 (Beyond National Resources)

Tier 3 is concerned with a major spill requiring the mobilization of all available national resources and depending upon the circumstances, will likely involve mobilization of regional and international systems. It is this tier of response where positive advance customs arrangements are critical to facilitate a successful effort.

The Combat Agency will require local, regional, national and possibly international assistance. International resources will be facilitated by the Statutory Agency through the Ministry of External Affairs.

7.3.19.2 Authorities and Responsibilities

DPCL Authority's approach to an oil spill is based on the following:

- Tactical response to a spill will be carried out by the operating unit which is nearest to the emergency location
- The Harbour Master is designated as Incident Controller (IC) and will co-ordinate all the activities offshore and onshore. He will coordinate and supervise the response activities along with the Emergency Control Team (ECT)
- Asst. Harbour Master is designated as On Scene Commander (OSC). The OSC is responsible for coordinating the on-site tactical response to an oil spill emergency.
- ECR will be located at Port Signal Station's Conference Room and will co-ordinate the strategic response and mobilization of equipment, materials, services and technical support as required to support the offshore resources and will manage follow up actions.
- The Emergency Response Team (ERT) will be picked up from the Marine, Security, Safety & Fire and Production departments and trained to respond to all oil spill incidents by IC and OSC. The ERTs will report to OSC for all response related activities from the time the response has started & response has been closed down.

The Emergency Response Organisation Chart is shown below:

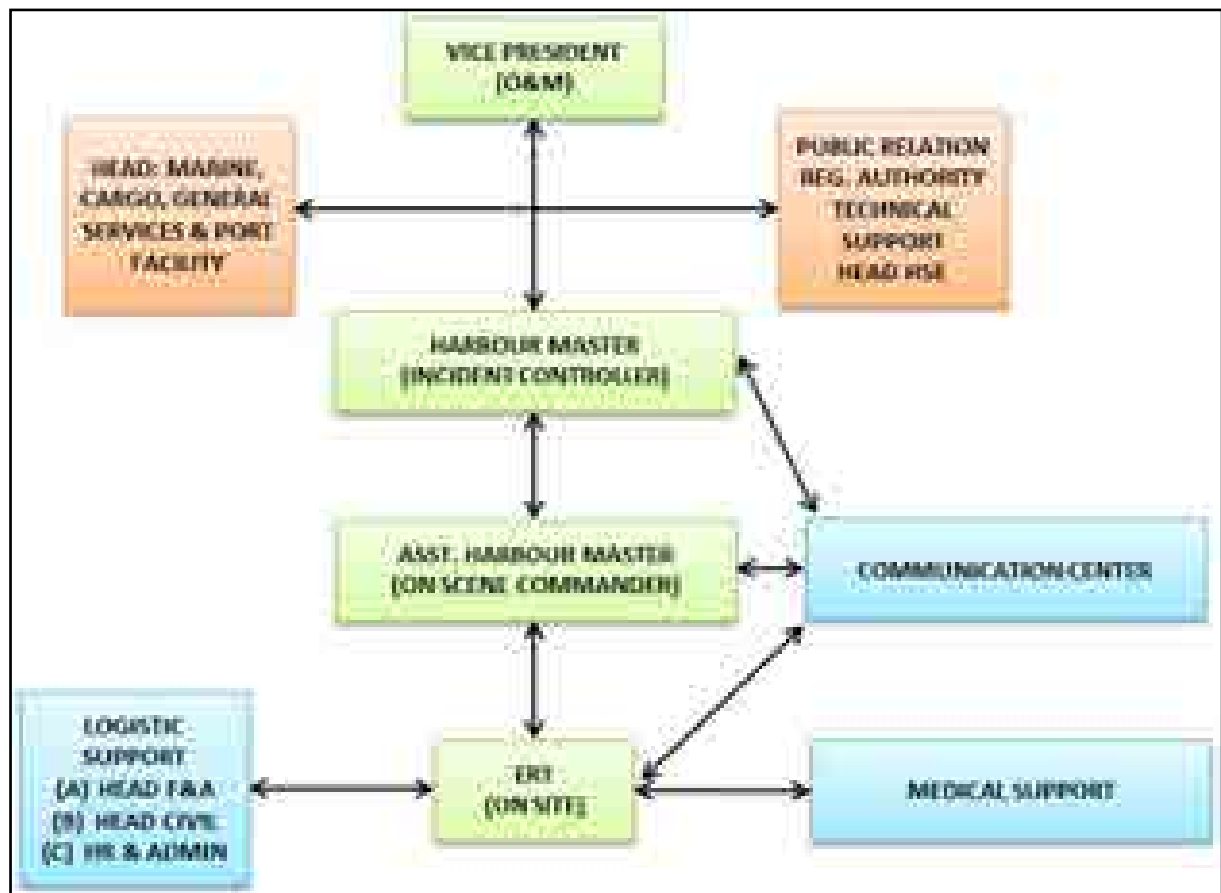


Figure 7-7: Emergency Response Organization Chart

7.3.19.3 Spill Scenarios

The spill scenario also has been looked into at two different places:

- At Anchorage, and
- From / To the Jetty

If the vessel arrives when another vessel is alongside, the vessel arriving has to go to anchorage. The vessel at anchorage does not perform any work except waiting for the berth

to be available. Complete navigation and seamanship is followed in ship's movement and ship handling, hence the chance of any oil spill is ruled out. However the only remote chance of spill is due to collision with the other vessel at anchorage and the other vessel, which may be entering / leaving Dhamra Port anchorage area.

Similarly, the chances of any oil spill in or near the jetty area is remote, due non-bunkering policy of the management for the bigger vessels at this port jetty and handling of small quantity of oil for tugs and harbour crafts are carried out with utmost care and under SOP's. The only chances of oil spill are collision of the vessel with the jetty while coming along side or with the other vessel already berthed there or when the vessel is berthed and is continuously banging on her side on her Wing Tanks due to the strong wind, inclement weather and uncomfortable swell from cyclonic weather conditions. The chances of spill at anchorage are ruled out.

TYPES OF OIL LIKELY TO BE SPILLED

Existing Port activities is not handling any liquid cargo and only accidental release of bunker oil from the vessels visiting DPCL and HSD fueling to dredgers and Port Craft berths are envisaged. However, existing approved Oil Spill contingency plan will be able to handle up to Tier I Spill.

As a part of approved immediate development plan and revised master plan envisages handling of liquid cargo also. The details of liquid cargo are being handled and to be handled is given in **Section 2.8.10** of chapter 2 and the NFPA properties of the same is given as **Appendix Q**. The maximum size of the Liquid carrier visiting DPCL is about 1,50,000 DWT with an average parcel size of about 40,000 MT – 60,000 MT.

7.3.19.4 Probable Fate of Spilled Oil/Liquid Cargo

The chances of oil spill in this harbour due to ship collision are very low. If it takes place, it will be very rare and disastrous. Spill of HSD/Bunkering Oil is more likely during fuelling. However, this will be of small quantity and not of much consequence. Other PoL cargo and cryogenic cargos are volatile; it would evaporate very fast from the water surface. Even if it hits the shore; would evaporate very fast and not cause much damage to the soil or environment. Other acid liquid cargo spill occurs due to accidents; it will be diluted vigorously as water column availability is high in harbour basin and in other areas.

Any oil spill will move south towards Dhamra river mouth with flood tide and towards north with ebb tide. In both the cases the spilled oil is likely to be in the channel only due to high rate of current in flood and ebb tides and hence can be responded to.

During Non-monsoon Period

During non-monsoon periods, weather conditions are quiet fair and normal. Wind speeds are mild and favourable. Any spill will move along the tide and will have the tendency to head to the nearby shores, towards Dhamra river mouth area anywhere along the shore, depending upon the place where the spill has taken place.

Any occurrence of spill from the berth (due damage to tanks or any other reason) would be affected by the winds, swell caused by it initially and once the high tide starts, the oil spill would start moving gradually to southern, south western side from the jetty in a vector direction formed by the tide, sea swell and wind direction. Thus the spill is likely to move towards south side of the jetty i.e. towards the Dhamra river mouth and will take about 30 minutes to reach the river mouth. The deployment of OSR equipment and OSR team in such

water has to be done very quickly and with precision as the area is deep up to turning circle and shallow patches start after the boundary marker buoy. The endeavour would be to contain the spill within port's boundary area. Also chances of spill entering to Dhamra river mouth are quiet likely if the spill is substantial and tide is strong.

During SW-monsoon Period

The SW monsoon is very active in this area. Heavy rains with gusty winds are quiet common along with cyclones during this monsoon. This area receives chief amount of annual rain during this time. The ebb current will be unpredictable and stronger than normal due to heavy out flow of the rainwater. Range of flood tide may also be higher than normal due to regular flood tide water and some accumulation of outflow of river water.

Therefore, in the event of spill during flood tides; the tendency of spill moving towards south western side of the jetty is most likely. And if the timely action not initiated then the spill is likely to hit the shore.

During the ebb tide, the current will be quiet strong due strong tidal current generated by heavy out flow of monsoon water. In this scenario the spill taking place as described above will move out of the harbour area and follow the path of stronger current waters.

7.3.19.5 Shoreline Sensitivity Mapping

The Eco-Sensitive areas near to Dhamra port is given in **Figure 4.3** of Chapter 4.

The shore line has been surveyed extensively, by water craft and road as well. The famous Gahirmata Marine Sanctuary is highly sensitive area but it is fully protected by the islands and is on the extreme southern end of the river mouth and well protected by land.

However, some other minor sensitive areas found are:

- (a) Patch of scattered grownup mangrove trees south of port jetty within the port premises.
- (b) Dhamra river mouth, DRDO jetty, thick mangrove vegetation adjacent to it and fisheries harbour; all inline adjacent to each other.

7.3.19.6 Response Strategy

Containment and recovery is the main strategy of the port, as areas all around are quite sensitive and hence any oil spill cannot be allowed to hit shore line.

It is also observed from the current and wind characteristics that the spill alongside berth is likely to hit the western coast of the channel towards the southern side of jetty during the flood tide and the north of jetty in the ebb tide. The time taken for the spill to hit the river mouth /shores will vary from time to time and with speed of wind and current. Therefore no time frame can be assigned to this. The strategy has been formulated with the above observation in mind.

The strategy is also governed by the international consensus of not using Oil Spill Dispersant (OSD) in less than 20 meters depth of water that is slowly gaining momentum in India also.

7.3.19.6.1 Philosophy and Objectives

Strategies to deal with different oil spill scenarios have been developed keeping in view the following factors:

- Most probable discharge scenarios.

- Oil spill trajectory and possible fate of oil spilled.
- Time window available since the spill and likely time of it hitting the coastline.
- Nature of shoreline and priority for protection.

7.3.19.6.2 Immediate Response Plan

These will be same for anchorage and inside the harbour (alongside berth). Strategy during First 4 Hours:

- Recovery of spilled oil
- Booming of the sensitive areas, to be protected on assigned priority

7.3.19.6.3 Long Term Response Plan

Response equipment such as booms (currently) stored on the tug boat, and the boom vane will be deployed to protect the coast line and other sensitive areas such as river mouth south of Dhamra Port by deflecting spills towards other designated collection points on the shoreline where it will cause less harm to the environment.

Objective of spill response is to reduce the overall environmental impacts on natural and economic resources. Response strategy is mainly aimed at preventing entry of oil into the following areas that are deemed to be very sensitive:

- Western river bank, south of adjoining Port Jetty (Patch of mangrove trees)
- Dhamra river mouth near the DRDO jetty (entrance to DRDO area and Fisheries Harbour)
- Western river bank, north western side of existing port jetty

7.3.19.7 Oil Spill Response in Offshore Zones

The strategies are as follows:

- **Monitor and Evaluate:** Once the oil spill is reported, it will be monitored continuously by vessels deployed in that area. The Emergency Control Room (ECR) will start plotting the position and tracking the oil slick every 15 -30 minutes or as directed. The Emergency Control Team (ECT) would study the inputs received from various sources, evaluate the size of oil spill. ECT is also to predict the fate and track of spilled oil based on weather conditions and likely action to be initiated
- **Recovery, Storage and Disposal:** The spill occurring through the stranded vessel involved in the accident is most likely to move towards north easterly side away from the shore due to the vessels position, wind direction and prevailing currents in cyclonic conditions. In such conditions it will be quiet difficult to recover the Spilled Oil by normal methods
- **Dispersant Spraying:** In adverse weather conditions, when deployment of OSR equipment is not possible, the ECT may decide to commence OSD spraying, with the permission and help of Coast Guard helicopter
- **Protection of Sensitive Areas:** If the danger of oil spill entering the river mouth persists then in that case the protection of sensitive areas i.e., areas south of mangroves or Dhamra river mouth area; has to be done by diversion / protection booming with the help of booms and boom vane

7.3.19.8 Oil Spill in Coastal Zones

There will be a need to immediately respond to the spill, so that the spill or residue after evaporation does not reach the sensitive areas. Suitable protection and diversionary booming are to be effectively carried out for protecting the southern end of the jetty. Diversionary booms at the river mouth or protection and collection booming near the shore / beach in the shallow water area.

7.3.19.9 Shoreline Oil Spill Response

Oil and oily mud collection will be manually done on shore with the help of temporary storage tanks and the disposal will be as per IMO and SPCB guidelines in force.

The OSR team is to prepare itself for shore clean-up activities. In the process the Shore Clean-up, equipments are to be arranged and kept ready for deployment in such a way that the OSR Team spends very little time in transportation and subsequent deployment of the equipments. The potential impact areas being predominantly river bank between Port jetty and DRDO Jetty; and south-western side of the Port jetty. To conduct shoreline clean-up operations will not be much difficult task except on the south western side of the port; which is low lying mud flats with upcoming vegetation of mangroves and fishing areas.

The priority for protection of shoreline zone areas is to protect those areas which have great economic, environmental and social importance, and following figure in this list:

- Dhamra river mouth
- DRDO Jetty area, adjoining Mangroves between DRDO Jetty and Fisheries harbour and Fisheries Harbour of Odisha govt. at northern bank of River Dhamra
- Banks, south and north of the jetty facility

7.3.19.10 Storage and Disposal of Oil and Oily Waste

Spilled oil and water mixture recovered from sea with the help of recovery devices will be recovered in the Extra storage tank positioned on board OSR support vessel or a floating tank. Recovered oil mixture will be pumped to onshore in open storage tank or tanker lorries for storage. Additional suitable tanks may also be used for collection of recovered oil if required or considered appropriate. Separated oil will be given to approved recyclers of CPCB/OSPCB (M/s Raj Lubricants, M/s N.S. Chemicals, M/s Namita Lubes, M/s Ratna Industrial and M/s Maa Chandi Indus, Odisha). A range of options for shoreline clean-up and waste disposal methods as per IMO guidelines are given in **Table 7-38**.

Table 7-38: shoreline clean-up and waste disposal methods

Type of Material	Separation Methods	Disposal Methods
Liquids		
Non-emulsified oils	Gravity separation for free water	Use of recovered oil as fuel or refinery feedstock
Emulsified	Emulsion broken to release water by heat treatment emulsion breaking chemicals mixing with sand	Use of recovered oil as fuel or refinery feedstock. Return of separated sand to source
Solids		
Oil mixed with sand	Collection of liquid oil leaching from sand during temporary storage. Extraction of oil from sand by washing with water or solvent. Removal of solid oils by sieving.	Use of recovered oil as fuel or refinery feedstock. Direction disposal – Stabilization with inorganic material; Degradation through land farming or composting burning.

Type of Material	Separation Methods	Disposal Methods
Oil mixed with cobbles, pebbles or shingle	Collection of liquid oil leaching from sand during temporary storage. Extraction of oil from beach material by washing with water or solvent.	Direct disposal – burning
Oil mixed with wood, plastic, seaweed and sorbents	Collection of liquid from debris during temporary storage. Flushing of oil from debris with water	Direct disposal – burning Degradation through land farming or composting for oil mixed with seaweed or natural sorbents
Tar balls	Separation from sand by sieving	Direct disposal – burning

7.3.19.11 Oil Spill Response Equipment

The list of marine oil spill response equipment is given in **Table 7-39**.

Table 7-39: Marine Oil Spill Response Equipment

Resources with Port for Combating Spill		
S. No.	Description	Quantity
1.	Fence boom with accessories	300 m
2.	Multi Skimmer of capacity 30 cum/hr	1
3.	Floating Tanks of 12 cum/hr	2
4.	Oil Spill Dispersant	1000 Litres
5.	Tugs with OSD spray system & laying booms	3
6.	Boats in assisting for application of oil spill equipment	2
Recommended List of Offshore OSR Equipment in Addition to Supplement the Existing Ones		
1.	Foam Filled of 1000 mm width with all accessories like reel, power pack, anchors, marker buoys. towing line etc.,	300 m
2.	Boom Vane with accessories	One
3.	Shore Sealing boom	100 m
4.	Multi skimmer 20 tons capacity with Power Pack	01
5.	Open Storage tank of 10 tons capacity	03
6.	Manual Oil Spill Dispersant spray system	01 Set
7.	OSD 10x25 Litres can (for shore application)	250 Litres
8.	Transfer pump of 30 tons capacity	02
9.	PVC rope of 25 mm	440 m

The list of suggested onshore equipment is given in **Table 7-40**.

Table 7-40: List of Suggested Onshore Equipment Related to Oil Spill Response

Recommended List of Offshore OSR Equipment in Addition to Supplement the Existing Ones		
S. No.	Description	Quantity
1.	PVC hand gloves – small 14"	10
2.	PVC hand gloves – small 16"	10
3.	PVC hand gloves – small 18"	10
4.	Mops with handle	10
5.	Hand shovel with wooden handle	10
6.	Wheel Barrow	05
7.	Rake with handle	10
8.	Tarpaulin-standard size 30' x 27'	2
9.	Gunny bags	50
10.	HDPE bags	50
11.	Safety Helmets	14
12.	Liquid Soap (in canes)	20 L
13.	Water Flask 20 Litres	02

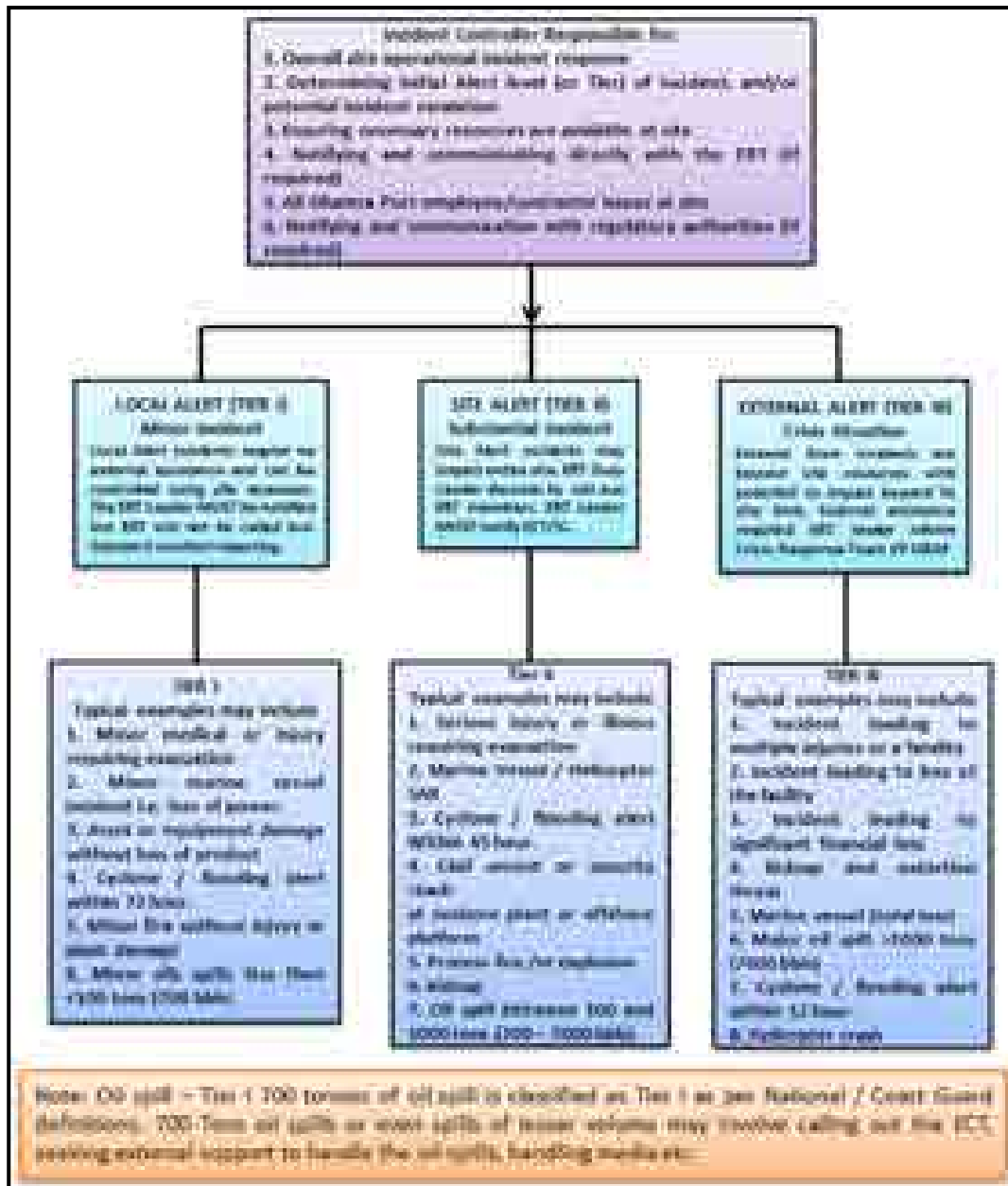
Recommended List of Offshore OSR Equipment in Addition to Supplement the Existing Ones		
S. No.	Description	Quantity
14.	Saw Dust packed in gunny bags	50 kg
15.	Disposable Coveralls - Small	10
16.	Disposable Coveralls – Medium	10
17.	Disposable Coveralls - Large	10
18.	Gum Boot - Small	10
19.	Gum Boot – Medium	10
20.	Gum Boot - Large	10
21.	Plastic Buckets – 10 Litres	10
22.	Plastic Buckets – 20 Litres	05
23.	Plastic Mug – 1 Litre	10
24.	Cotton Rag – in bags	50 kg
25.	Trolley	01
26.	Detergent Powder	25 kg
27.	Work/Life vests	06
28.	Disposable cups/glasses	200
29.	Plastic chairs	06
30.	Folding Tables	02
31.	First Aid Kit	01 set

7.3.19.12 Actions and Operations

7.3.19.12.1 Initial procedures

The initial procedures to be followed are given below:

- **Notifying of Oil Spill to concerned authorities:** Person initially sighting the spill will inform the Port Signal Station/Jetty In charge Shipping Movement, who in turn will intimate OSC. The IC and his ECT members are to follow the procedure outlined in OSCP document to the greatest extent possible. However they are permitted to take action in variance with OSCP subject to prevailing conditions with proper information to the management
- **Preliminary Estimate of Response Tier:** On getting the spill information the OSC will inspect the area or on the basis of information received; would estimate the quantum of approximate spill. Thereafter he will consult IC about the gravity of the situation and accordingly arrive to the conclusion of Spill Response Tier to be adopted. The concept of Tiered Response is shown below.



- **Notifying Key team Members and Authorities:** The OSC is to inform IC of the incident who in turn is to inform all the concerned members and the authorities as per the existing Information System prevailing. IC will also take steps to notify the concerned regulatory authorities including Coast Guard.
- **Manning Control Room:** On receipt of information, Emergency Control Team will assemble.
- **Collecting Information (Oil Type, Sea /Wind Weather Forecast, Aerial Surveillance, Beach Reports):** The OSC is to collect the following information immediately in case of oil spill, with the help of Master of the vessel:
 - Time spill occurred
 - Position in Latitude/ Longitude and also with reference to any prominent landmark
 - Visual appearance, apparent thickness of oil and extent of area covered
 - Percentage cover of various thickness of oil
 - Existing weather condition and weather forecast
 - Current, tide and wind conditions

Immediate availability of support vessels, equipment and manpower specifying time factor as well

- Estimate oil spill trajectory and likely area and time of its landfall
- **Estimating Fate of Slick:** In the event of the spill reaching the shoreline, the time interval after which the spill is likely to reach the coast, its probable location and the length of impacted shoreline can be predicted on the chart available in ECR. Since the time interval after which the spill reaches the coast is more or less independent of its magnitude, the extent of impacted coastline for spill of various magnitudes can readily be estimated from the plotted position. The study results indicate that an oil spill in the North East monsoon is likely to reach faster to the coastline (in bad weather conditions) if the spill has taken place at anchorage / out of harbour or alongside berth, during the period of shipping operation i.e. when the current direction is from N, NNE, the spill reaches the coast in 15 minute to one hour depending on the position, current and wind speed. For the current directions in the South West monsoon periods, which is quiet strong in this area, the spill is likely to move in an N, NNE direction due to prevailing wind and current.
- **Identifying Resources Immediately at Risk, Informing Parties:** Depending on the area likely to be affected as per the Oil spill tracking studies, concerned local Port authorities, Coast Guard and other authorities / agencies as applicable are to be informed. Details of address and telephone numbers are to be placed at all the prominent places. Also Launching a boom vane during and flooding and ebbing are discussed in detail in the OSCP. Emergency Contact Numbers in Emergency is given in **Table 7-41** and **Table 7-42**.

Table 7-41: Emergency Contact Numbers – Local Level

S. No	Dhamra Port	Number	S. No	Dhamra Port	Number
1	CEO	7894443132	11	Dhamra Port Control	9937287436
2	Harbour Master	9937006052	12	AMBULANCE(DPCL)	7381261111
3	Fire Brigade	7381251111	13	DPCL, Fire Control	7381251111
4	Communication Command Center	9937287436	14	Security (DPCL)	9937287436
5	PFSO	7894408123	15	DY PFSO	7894408123
6	IR , Admin&HR	07064460333/ 7894433334/ 9925150075	16	RAILWAY	7894400733
7	PHO, DPCL	7894009673	17	Port EHS	7064460327, 09937029626, 7894406589
8	Health Centre	7894409102	18	EHS Manager	7064460327
9	M/s Ion-Exchange	09938699838, 8018664054	19	M/s Sai Port	8339966031
10	Manager Electrical	9937036478	20	Operation Control (MCC-1)	7752029166

Table 7-42: Emergency Contact Numbers- State and National Level

S. No	Outside Dhamra Port	Number	S. No	Outside Dhamra Port	Number
1	Dhamra Fire Station	06786-222771, 9778096881	19	Bhadrak Fire Station	06784-231444
2	Tihidi Fire Station	06786-275901	20	Marine P.S, Dhamra	06786-250737, 9438322929, 8018566135
3	Dhamra Out Post	8908831037	21	Bansada P.S.	06786-293609/ 9437436075
4	Tihidi P.S.	9439297201/ 06784-	22	PIRHAT Outpost	9438757110

S. No	Outside Dhamra Port	Number	S. No	Outside Dhamra Port	Number
		274421			
5	SDPO, Chandbali	06786-220264, 9439274673	23	Basudev Pur P.S.	06784-271228
6	Bhadrak P.S.(Town)	06784-250434/ 9437002137/ 9437179192,100	24	SUPDT.of Police,Bhadrak	06784-242035/ 242120, 9437136498/ 9668817035
7	IB, Dhamra	94385103237	25	Sarpanch, Dhamra	9437206666
8	Chandbali Tehsildar	9437417179/ 06786- 220255	26	Basudevpur Govt. Hospital	9439993208
9	Bhadrak Hospital	06784-250220	27	District Emergency Officer	06784-251881, 09438544941,1077
10	District Collector	06784-250436,240220	28	ASDM,Bhadrak	06784-251888, 243033,9437215788
11	DRDO Office, Dhamra	7381873568	29	Asst. Conservator, Dhamra Fishing Harbour	9437159669
12	Director of ports, govt of Odisha	0674-2390355	30	MMD PARADIP	06722-2220053
13	MMD, Kolkata	033-22230236/ 37/38/0229	31	DG Shipping, Mumbai	022-25752040/ 41/ 42/ 43/ 45
14	DG Shipping, COMM. Center	022-22614646 / 022- 22610606	32	Coast Guard,PARADIP	06722-222712, 222215
15	NAVY INS Chilka	06756-227087	33	PARADIP Port Control	06722-222137,222771
16	Meteorological Station, Chandbali	06786-220319	34	Met Centre, BBSR	0674-2596093
17	Indian tsunami early warning Centre INCOIS,Hyderabad	+91-40-23895000	35	Relief commissioner	0674-2536721(O), 0674- 2532080(R), 943701719
18	State Govt Secy Food Supply	0674-2536892	36	National Disaster Management Group	011-25655014

7.3.19.12.2 Operation Planning

For effective control of the operations, reliable communication among various agencies involved is a must. Initial pollution report format such as Oil Spill report Form and POLREP are provided in the OSCP.

- **Assembling Full Response Team:** Once response priorities are established, OSC in consultation with IC will assemble personnel at the pollution response centre at Port Signal Building or at the jetty and conduct thorough briefing about their role and responsibilities. The required extra equipments are also simultaneously embarked on board support vessel and are available for deployment
- **Identifying Immediate Response Priorities:** ECT with the help of oil slick movement track & prevailing weather condition would priorities which area to be protected first
- **Mobilising Immediate Response Team:** The OSR equipments kept by Dhamra Port Authorities have been procured keeping in mind a tier 1 response. These equipments will be operated keeping existing weather conditions in mind
- **Media Briefing:** It is of prime importance that initial press statement for media briefing be prepared with utmost care
- **Planning Medium Term Operations:** Medium term operations would depend upon the size of oil spill occurred. Since, recovery of some oil would have started right in the beginning itself, the fate of balance of spilled oil will depend on prevailing weather conditions and can be either towards or away from the shore. In case oil slick hits the

shore, Shore Cleanup is the only alternative and in case of slick remains away from the coast, recovery has to be continued with the help of booms and skimmer. However the use of dispersants may also be resorted to as per the demand of the situation

- **Deciding to Escalate Response to Higher Tier:** When the spill response action has been initiated by ECT and ERT has started the recovery action, spill incident reporting has been made to concerned authorities, and then if OSC feels that quantum of oil spilled appears to be much more than what was reported earlier and the oil spill needs to be re assessed and deserves a higher response, he will inform the same to ECT. At this juncture, the OSC and members of ECT may re inspect the spill site and assess the oil slick thickness, its size, status of spilled oil and decide accordingly. If ECT is convinced that spill report deserves upwards revision and the level of Tier Response needs to be raised, it will take necessary steps to raise the oil spill reporting level. This decision will help to initiate higher oil spill response activities as well as alert other helping agencies, for example Coast Guard Authorities Paradip / Kolkata and Paradip / Haldia Port authorities, State Pollution Control Board, Hospitals etc.
- **Mobilising or Placing on Standby Resources Required:** When the decision to raise the Tier level of oil spill has been / is being taken, a review of Dhamra Port's own spill response capability is also to be done simultaneously. Once it is felt that additional resources are required, the concerned agencies are to be alerted immediately, and mobilization action for those equipments / items should be initiated without losing any time
- **Establishing field Command Post and Communication:** The OSC will be equipped with portable VHF and mobile phone. The ERT leaders would also be having hand held VHF sets and or with mobile phones. All these will be in regular communication with ECR.

7.3.19.12.3 Control of Operations

The following points need to be followed for control of operations:

- Establishing a management team with experts and advisors
- Upgrading information (sea/wind/weather forecasts, aerial surveillance, beach reports)
- Reviewing and planning operations
- Obtaining additional equipment, supplies and manpower
- Preparing daily incident log and management reports
- Preparing operations accounting and financial reports
- Preparing releases for public and press conferences
- Briefing local and government officials

7.3.19.12.4 Termination of Operations

During any oil spill response operation, even if majority of the oil is collected at sea, some amount of oil tends to reach the shoreline. In unfavourable weather condition a good amount of oil reaches the shoreline. Hence, the termination of the operations will always be with the shoreline clean-up operation. The following points need to be followed:

- Deciding final and optimal levels of beach clean-up
- Standing down equipment, cleaning, maintaining & replacement
- Preparing final detailed report
- Reviewing plans and procedures from lessons learnt

7.3.20 Tentative Evacuation plan for Emergency and Assembly Points

Best assembly point can be identified during the disaster by proper planning within the Emergency Team. The basic idea is to use an algorithm for finding the paths in the network from the disaster area (origin) to each shelter (destination). The route with the smallest travel time and based on the capacity of evacuation associating to each path will help to evaluate each route with one another. For the same reason Six Assembly point from 1 to 6 and Six Emergency Exit from 1 to 6 with recommended routes are given above covering all the areas of revised master plan.

Each route is mentioned by different colour codes. It will be insisted to all those who gather at the emergency assembly points, to take a route of specific colour to reach the exit during emergency conditions. Diversion of group of employees from each assembly point will help in reducing time than diverting individuals or smaller groups towards exit during disaster. Escape routes are arranged such that from each area, escape is possible in two directions



Figure 7-8: Tentative Emergency Evacuation Plan and Location of Assembly Points**7.4 Traffic and Transportation Study**

The detailed traffic survey was conducted for the road connectivity in the Rail-Road-Utility Corridor from NH-5 (near Bhadrak railway station) to Dhamra Port. The intent of the study conducted involved assessment and evaluation of feasibility for proposing an appropriate category of new road link to connect Bhadrak and Dhamra Port.

7.4.1 Project Location

The Project road starts from Bhadrak town on NH-5 and ends at Dhamra port. An existing Railway line connecting Bhadrak Railway station and Dhamra port is present which is presently catering to the movement of Cargo in and out of Port. The project road runs parallel to the existing Bhadrak Dhamra Railway line. The Project road passes through Kuntala, Nachhipur, Taragana, Gopa, Kanchanpur, Charitaraf, Narendrapur, Jaleshwarpur, Bansada and Dosinga. The location map showing the project stretch is presented in **Figure 7-9**.

**Figure 7-9: Location Map of the Project Stretch****7.4.2 Traffic Surveys**

An accurate assessment of the traffic that is likely to use the Project road has an important bearing on the project potential, as it forms the basic input in planning, design, operation and financing. A thorough knowledge of the travel characteristics of the traffic, likely to use the Project road as well as other major roads in the influence area of the study corridor is essential for future traffic estimation. Hence, traffic surveys were carried out to assess the baseline traffic characteristics on the project road.

7.4.2.1 Classified Traffic Volume Count

In order to capture the entire traffic, Classified Traffic Volume Count surveys at 2 strategic points i.e. at Km. 25.000 on SH Dhamra port road and at Km. 153.000 on NH-5 near

Charampa Village of Bhadrak district for a period of 3 days. Axle Load survey was conducted at one location i.e. at Km 1.300 on NH-5A of Paradip Port road. Since there is no existing link from Bhadrak to Dhamra port, the axle Load surveys were conducted on Paradip Port road to know the loading pattern and freight movement. The details of the traffic surveys conducted are given in **Table 7-43** and shown in **Figure 7-10**.

Table 7-43: Details of Traffic Surveys

Type of Survey	Location	Duration of Survey
Classified Traffic Volume Count	Km. 25000 on SH Dhamra Port Road	3 Days
	Km. 153000 on NH5	3 Days
Axle Load	Km. 1300 on NH5A	24 Hours



Figure 7-10: Location of Traffic Surveys

7.4.2.2 Average Daily Traffic (ADT)

The classified traffic volume count data collected was analyzed to assess the traffic intensity along the project corridor and to assign the traffic on to the proposed road link. **Table 7-44** presents the Average Daily Traffic (ADT in number of vehicles) at the two survey locations with salient findings as shown below.

Table 7-44: Average Daily Traffic (ADT)

Vehicle Type	Km. 25000 on SH Dhamra Port Road	Km. 153000 on NH5
Two Wheelers	1539	4899
Three Wheelers	99	921
Car/Jeep/Van	218	1795
Car Yellow Board	113	831

Vehicle Type	Km. 25000 on SH Dhamra Port Road	Km. 153000 on NH5
Tata Magic	85	362
RTC Bus	6	4
Private Bus	53	466
School/College Bus	2	22
Mini Bus	23	81
2 Axle	85	2320
3 Axle	32	2718
M Axle	11	1519
HEM	4	12
LCV/LGV	11	257
Mini LCV	121	901
Three Wheeler Goods	10	97
Tractor	9	23
Tractor with Trailer	2	50
Non-Motorized Vehicles	746	845
Government Exempted Vehicles	18	58
Total Vehicles	Motorized	2441
	Non-Motorized	746
	Total Traffic	3187
Total PCUs	Motorized	2113
	Non-Motorized	453
	Total Traffic	2566

7.4.2.3 Annual Average Daily Traffic

The Annual Average Daily Traffic (AADT in no. of vehicles) at the survey locations is obtained by multiplying the Average Daily Traffic (ADT) with the Seasonal Variation Factor (SVF). The SVF of 1.0 has been assumed for the present study. The AADT at two survey locations are given in **Table 7-45**.

Table 7-45: Annual Average Daily Traffic (AADT)

Vehicle Type	Km. 25000 on SH Dhamra Port Road	Km. 153000 on NH5
Two Wheelers	1539	4899
Three Wheelers	99	921
Car/Jeep/Van	218	1795
Car Yellow Board	113	831
Tata Magic	85	362
RTC Bus	6	4
Private Bus	53	466
School/College Bus	2	22
Mini Bus	23	81
2 Axle	85	2320
3 Axle	32	2718
M Axle	11	1519
HEM	4	12
LCV/LGV	11	257
Mini LCV	121	901
Three Wheeler Goods	10	97
Tractor	9	23
Tractor with Trailer	2	50
Non-Motorized Vehicles	746	845
Government Exempted Vehicles	18	58
Total Vehicles	Motorized	2441
	Non-Motorized	746

Vehicle Type		Km. 25000 on SH Dhamra Port Road	Km. 153000 on NH5
Total PCUs	Total Traffic	3187	18171
	Motorized	2113	31680
	Non-Motorized	453	551
	Total Traffic	2566	32231

7.4.2.4 Axle Load Surveys

Axle load surveys were conducted at one location as mentioned in **Table 7-43** and Shown in **Figure 7-10** of this report. The random selection of vehicles for axle load measurement was done, ensuring suitable sample for each category of commercial vehicles consisting of overloaded and empty vehicles. The Vehicle Damage Factor (VDF) is an index characterizing the traffic loading for a highway and is defined as a multiplier for converting the number of commercial vehicles of different axle loads to Standard Axle Loads (SAL). Equivalency factor (EF) is normally worked out by using the Fourth Power Rule derived by AASHTO and approved by CRR. With the help of equivalency factors and frequency distribution of axle loads, Equivalent Axle Loads (EAL) are computed.

$VDF = \text{Total EAL} / \text{Number of vehicles weighed}$

The standard axle loads and the legal axle loads considered while calculating the equivalency factors for various axles are furnished below.

S. No.	Type of Axle	Standard Load (Ton)	Legal Load (Ton)	Reference
1.	Single Axle (Single Wheel)	6.6	6.6	HDM-4/IRC-3
2.	Single Axle (Dual Wheel)	8.16	10.2	HDM-37/IRC-3
3.	Tandem Axle (Dual Wheel)	14.97	19	HDM-37/IRC-3
4.	Tridem Axle (Dual Wheel)	22.83	24	HDM-37/IRC-3

Equivalency factors as recommended by IRC have been used to convert the axle load spectrum into an equivalent number of standard axles using the relationship as given below.

Equivalency Factor for Single Axle Single Wheel Load = $(\text{Axle Load}/6.600)^4$

Equivalency Factor for Single Axle Load = $(\text{Axle Load}/8.160)^4$

Equivalency Factor for Tandem Axle Load = $(\text{Axle Load}/14.968)^4$

Equivalency Factor for Tridem Axle Load = $(\text{Axle Load}/22.830)^4$

The VDF calculated for different categories of commercial vehicles are given in **Table 7-46**.

Table 7-46: Vehicle Damage Factor (VDF)

Mode	Maximum Load Perceived during survey in tons		Km. 1.300 on NH5A		Adopted in Design for Dhamra Port Road
	Towards Paradip	Towards Chandikhol	Towards Paradip	Towards Chandikhol	
2 Axle Truck	26	23	7.77	1.39	8.0
3 Axle Truck	45	38	13.45	3.12	14.0
M Axle Truck	40	-	8.43	0.00	9.0
LCV	-	-	-	-	1*

*During survey LCV's were not encountered hence, a value of 0.9 was adopted for LCV's

7.4.2.5 Traffic Growth Rates

The past motor vehicle registration data at the state level provides a valuable indication regarding the trends in the traffic growth and presents a dependable tool for estimating future growth rates in different categories of vehicles. A more rational method will be to establish a relationship between the socio-economic variables such as Population, Net State Domestic Product (NSDP) and Per-Capita Income (PCI) on the one hand and the past registration data of different categories of vehicles on the other to determine the elasticity of transport demand with respect to different categories of vehicles.

For proposed Dhamra Port Road since, the existing road link and traffic are not present to estimate and arrive suitable growth rates, the Dhamra Port Cargo handling capacity data has been analyzed. Based on the increase in the cargo handling capacity of the port in future years (design period - 30 years) the same increase in port traffic was used for the proposed Dhamra Port road from Bhadrak to Dhamra. The adopted traffic growth rates for local traffic are taken as 5%. Also, the year of operation for 5 Year development and 30 Year development plan have been considered as 2023 and 2048. Considering above the normal traffic growth for 5 Year plan and 30 Year plan are given in **Table 7-47**.

Table 7-47: Normal Traffic Projections

Vehicle Type	Normal Traffic Growth (5 Year Plan)	Normal Traffic Growth (30 Year Plan)
Two Wheelers	2387	7693
Three Wheelers	154	493
Car/Jeep/Van	338	1090
Car Yellow Board	175	566
Tata Magic	132	421
RTC Bus	9	30
Private Bus	82	268
School/College Bus	3	10
Mini Bus	36	115
2 Axle	132	432
3 Axle	50	161
M Axle	17	56
HEM	6	20
LCV/LGV	17	55
Mini LCV	188	610
Three Wheeler Goods	16	50
Tractor	14	45
Tractor with Trailer	3	10
Cycle	1100	3528
Cycle Rickshaw	51	163
Animal Drawn	6	21

7.4.2.6 Cargo Handling Capacity of Dhamra Port

The cargo handling capacity and the details of mode of transport for different commodities during 5 year plan and 30 year plan is given **Table 7-48** to **Table 7-50**.

Table 7-48: Details of Cargo Handling Capacity and Range of Mode of Transportation

Dhamra Port – Road-Rail Traffic							
S. No.	Commodity	Master Plan (30 Years)	5 Year Plan	Rail (%)	Road (%)	Pipeline (%)	Transshipment (%)
Dhamra – South Port							
1.	Dry Bulk Import	32	32	80%-90%	20%-10%	-	-

Dhamra Port – Road-Rail Traffic							
S. No.	Commodity	Master Plan (30 Years)	5 Year Plan	Rail (%)	Road (%)	Pipeline (%)	Transshipment (%)
Dhamra – South Port							
2.	Bulk Berth Export	64	47	80%-90%	20%-10%	-	-
3.	Limestone Import	12	12	80%-90%	20%-10%	-	-
4.	Container (mTEU)	2.16	1.45	50%-55%	45%-45%	-	5% - 0%
5.	Multipurpose & General cargo	22.5	4.5	30%-40%	70%-60%	-	-
6.	Liquid	9	4.5	5% - 10%	45%-50%	50% - 40%	-
7.	LNG	10	10	0%	0% - 10%	100%-90%	-
8.	LPG	2.5	2.5	0%	20%-30%	80% - 70%	-
9.	Barge	12	6	-	-	-	-
	Total	194.2	138.8				
Dhamra – North Port							
1.	Dry Bulk Import	34	0	80%-90%	20%-10%	-	-
2.	Bulk Berth Export	17	0	80%-90%	20%-10%	-	-
3.	Container (mTEU)	2.5	1.68	50%-55%	45%-45%	-	5% - 0%
4.	Multipurpose & General cargo	9	0	30% - 40%	70% - 60%	-	-
5.	Liquid	13.5	0	5% - 10%	45%-50%	50% - 40%	-
6.	LNG	4.25	4.25	0%	0% - 10%	100%- 90%	-
7.	LPG	3.25	3.25	0%	20%-30%	80% - 70%	-
8.	Transloading	3	0	-	-	-	-
	Total	119	31				
	Grand Total (North Port + South Port)	313.2	169.7				

Table 7-49: Details of 5 Year Plan

Dhamra Port – Traffic for 5 Year Plan						
S. No.	Commodity	5 Year Plan	Rail (MMTPA)	Road (MMTPA)	Pipeline (MMTPA)	Transshipment (MMTPA)
Dhamra – South Port						
1.	Dry Bulk Import	32	25.6 - 28.8	6.4 - 3.2	-	-
2.	Bulk Berth Export	47	37.6 - 42.3	9.4 - 4.7	-	-
3.	Limestone Import	12	9.6 - 10.8	2.4 - 1.2	-	-
4.	Container (mTEU)	1.45	10.13	9.12	-	1.01
5.	Multipurpose & General cargo	4.5	1.35 - 1.8	3.15 - 2.7	-	-
6.	Liquid	4.5	0.23 - 0.45	2.25 - 2.03	2.03	-
7.	LNG	10	0	1 - 0	9 - 10	-
8.	LPG	2.5	0	0.75 - 0.50	1.75 - 2.0	-
9.	Barge	6	-	-	-	6
	Total	138.8	84.51 - 94.28	34.47 - 23.44	12.78 - 14.03	7.01
Dhamra – North Port						
1.	Dry Bulk Import	0	0	0	-	-
2.	Bulk Berth Export	0	0	0	-	-
3.	Container (mTEU)	1.68	11.73	10.55	0	1.17
4.	Multipurpose & General cargo	0	0	0	-	-
5.	Liquid	0	0	0	0	-
6.	LNG	4.25	0	0.43 - 0	3.83 - 4.25	-
7.	LPG	3.25	0	0.98 - 0.65	2.28 - 2.60	-
8.	Transloading	0	-	-	-	0
	Total	31	11.73	11.95 - 11.20	6.10 - 6.85	1.17
	Grand Total (North Port + South Port)	169.7	96.23 - 106.01	46.42 - 34.64	18.88 - 20.88	8.19

Table 7-50: Details of Master (30 Year) plan

Dhamra Port – Traffic for 5 Year Plan						
S. No.	Commodity	Master Plan (30 Years)	Rail (MMTPA)	Road (MMTPA)	Pipeline (MMTPA)	Transshipment (MMTPA)
Dhamra – South Port						
1.	Dry Bulk Import	32	25.6 - 28.8	6.4 - 3.2	-	-
2.	Bulk Berth Export	64	51.2 - 57.6	12.8 - 6.4	-	-
3.	Limestone Import	12	9.6 - 10.8	2.4 - 1.2	-	-
4.	Container (mTEU)	2.16	15.12	13.608	-	1.512
5.	Multipurpose & General cargo	22.5	6.75 - 9	15.75 - 13.5	-	-
6.	Liquid	9	0.45 - 0.9	4.5	4.05	-
7.	LNG	10	0	1 - 0	9 - 10	-
8.	LPG	2.5	0	0.75 - 0.5	1.75 - 2	-
9.	Barge	12	-	-	-	12
	Total	194.2	108.72 - 122.22	57.208 - 42.458	14.8 - 16.05	13.512
Dhamra – North Port						
1.	Dry Bulk Import	34	27.2 - 30.6	6.8 - 3.4	-	-
2.	Bulk Berth Export	17	13.6 - 15.3	3.4 - 1.7	-	-
3.	Container (mTEU)	2.5	17.5	15.75	-	1.75
4.	Multipurpose & General cargo	9	2.7 - 3.6	6.3 - 5.4	-	-
5.	Liquid	13.5	0.675 - 1.35	6.75 - 6.075	6.075	-
6.	LNG	4.25	0	0.425 - 0	3.825 - 4.25	-
7.	LPG	3.25	0	0.975 - 0.65	2.275 - 2.6	-
8.	Transloading	3	-	-	-	3
	Total	119	61.675 - 68.35	40.4 - 32.975	12.175 - 12.925	4.75 - 4.75
	Grand Total (North Port + South Port)	313.2	170.395 - 190.57	97.608 - 75.433	26.975 - 28.975	18.262

7.4.2.7 Dhamra Port Traffic Projections

The total numbers of commercial vehicles (Port Traffic) which shall use the proposed project stretch are calculated based on the cargo handling capacity. The cargo handling capacity which is given in million metric tonnes per annum was converted into average daily traffic.

For calculating road traffic, the corresponding road share of each commodity is taken into consideration and Port Traffic is arrived by considering average load carrying capacity of 2 axle trucks as 30 tonnes and 40 tonnes for 3 axle and multi axle vehicles. As per the data of Axle Load Survey conducted on nearby port i.e. Paradip Port, local enquiry and general scenario of port commercial traffic, the percentages of vehicles mode wise was considered as for 2 Axle - 30%, 3 Axle – 60% and Multi Axle vehicles is 10%. Also, it has been assumed that 70% of the trucks for the cargo dry bulk import and limestone import will be used for the cargo bulk berth export and remaining 30% of the trucks will return empty.

The project stretch traverses through villages/towns namely Kuntala, Nachhipur, Taragana, Gopa, Kanchanpur, Charitaraf, Narendrapur, Jaleshwarpur, Bansada and Dosinga. The development of the proposed road link from Bhadrak on NH-5 to Dhamra port will induce the local traffic movement from the villages situated on either sides or in the vicinity of the project stretch since presently there is no existing road. The project stretch increases the connectivity and boosts the travel characteristics of the people residing in nearby villages and thus contributes to the economic development of the region.

The assessment of the future travel characteristics of the local traffic about to use the road is estimated by assuming the local traffic movement 100% of the ADT of Jamujhadi - Dhamra Port Road (Km. 25000 on SH Dhamra Port Road).

The details of Traffic due to Dhamra Port for 5 year plan and 30 year plan is given in **Table 7-51**.

Table 7-51: Details of Traffic of Dhamra Port due to Cargo Projections

S. No.	Commodity	No. of Vehicles for 5 Year Development			No. of Vehicles for 30 Year Development		
		2-Axle	3A-Axle	Multi-Axle	2-Axle	3A-Axle	Multi-Axle
1	Dry Bulk Import	388	582	97	800	1200	200
2	Bulk Berth Export	197	295	4	226	339	57
3	Limestone Import	145	218	36	145	218	36
4	Container (mTEU)	1192	1788	298	1779	2669	445
5	Multipurpose & General Cargo	191	286	48	1336	2005	334
6	Liquid	136	205	34	682	1023	170
7	LNG	87	130	22	86	130	22
8	LPG	105	157	26	105	157	26
Total		2441	3661	565	5160	7740	1290

7.4.2.8 Total Traffic Projections

The total traffic projections i.e. local traffic and the traffic due to the Dhamra port is given in **Table 7-52**.

Table 7-52: Total Traffic Projections

Vehicle Type		5 Year Plan	Master (30 Year) Plan
Two Wheelers		2387	7693
Three Wheelers		154	493
Car/Jeep/Van		338	1090
Car Yellow Board		175	566
Tata Magic		132	421
RTC Bus		9	30
Private Bus		82	268
School/College Bus		3	10
Mini Bus		36	115
2 Axle		132	432
3 Axle		50	161
M Axle		17	56
Cargo Traffic	2 Axle	2441	5160
	3 Axle	3661	7740
	M Axle	565	1290
Over Sized		6	20
LCV/LGV		17	55
Mini LCV		188	610
Tractor		14	45
Tractor with Trailer		3	10
Three Wheeler Goods		16	50
Cycle		1100	3528
Cycle Rickshaw		51	163
Animal Drawn		6	21
Total Vehicles		11583	30026
Total PCUs		24790	57250

7.4.2.9 Conclusion and Recommendations

IRC: 64-1990 Guidelines for Capacity of Roads in Rural Areas, National and State Highways are given in **Table 7-53**.

Table 7-53: IRC: 64-1990 Guidelines for Capacity of Roads

S. No.	Number of Lanes	Capacity (PCU's/Day)
1.	Single Lane Road	2000
2.	Intermediate Lane Road	6000
3.	Two Lane Road	15000
4.	Two Lane Road with Paved Shoulder	17250
5.	Four Lane Road with Paved Shoulder	40000
6.	Six Lane Road with Paved Shoulder	57000

Traffic survey conducted for assessment & evaluation of feasibility of Four Lane road (which is already approved as a part of Phase –II clearance) with future provision of Two lane, to be developed as a part of Revised Master Plan to connect Bhadrak & Dhamra Port. The study reveals the following.

- Both Normal traffic + Generated traffic (due to proposed expansion) considered for the study.
- Four lane (which is already approved as a part of Phase –II clearance) with future provision of 2 lane road, to be developed as a part of Revised Master Plan is proposed, which shall be sufficient to meet the Port Requirement as per the IRC guidelines.
- Existing approach road from Jamujhadi to Dhamra will be utilized during construction phase (apart from proposed NW-5) which is being widened by GoO which will improve the traffic conditions
- Proposed road link will induce local traffic movement on either side and boost the travel characteristics of the people residing in nearby villages

In addition, for easy evacuation of cargo, a new Rail/Road/Utility Corridor (12 km x 125 m wide) is also proposed from Northern side of Dhamra Port.

7.5 Vessel Traffic Management Systems (VTMS)

The purpose of the VTMS is to provide a clear and concise real time representation of vessel movements and interaction in the Vessel Traffic Service (VTS) area. In Dhamra Port case, the service area will be the approach channel, harbour basin area etc. This system will be used for marine operations and will also be linked to the PMIS (Port Management and Information System). The information provided by VTMS system allows the operator or user of the system to following facilities.

- Provide the required level of VTS: Information, Assistance or Organization
- Enhance safety of life and property
- Reduce risks associated with marine operations
- Enhance efficiency of vessel movements and port marine resources
- Distribute VTS related information
- Provide Search and rescue assistance
- Provide VTS data for administrative purposes, analysis of incidents and planning

The VTS in recent years has changed from Traffic Monitoring to Traffic Planning by introduction and interconnection of databases and expert systems. It allows access of static and dynamic information about ships, their cargo and port service requirements. Together with an automatic update of traffic information the VTMS provides a powerful tool for

programming of traffic movement within the surveillance area. Operators can associate tracked targets with vessels registered in the database, which makes the data readily available and allows the system to automatically provide pertinent voyage information to other port service providers.

7.6 Storm Water Drainage System

Natural drainage of the Dhamra surrounding area is through Matai river, Brahmani river, tributaries of Brahmani and through direct discharge to Bay of Bengal. Dhamra port back up area falls between Matai river and Bay of Bengal. Based on existing drainage pattern and catchment area, main outfall drains are proposed to carry storm water discharge from village area and port area and discharging into sea. The requirements of local villagers for tide water and boat movement are also considered.

7.6.1 Assumptions

The following are the assumptions considered:

- Rainfall intensity considered is 35 mm/hr
- From tidal data it is observed that 3.2m to 3.4m tide level is consistent throughout the year and 4.1m is the highest tide level twice in a year 2015.
- As per local requirement, it is required to keep provision for tidal water to the west side villages. Hence it is proposed that maximum I.L of 2.8m is to be kept at start of Main outfall drains, so that 3.4m tide water will be available at west side boundary drains

7.6.2 Design Parameters

The design parameters are as followed:

- The tide levels are as follows:
 - Extreme High Water (EHW): (+) 4.0m
 - Mean Higher High Water (MHHW): (+) 3.6m
 - Mean Sea Level (MSL): (+) 1.9m
 - Mean Lower Low Water (MLLW): (+) 0.6m
 - Extreme Lower Low Water (ELLW): (+) 0.0m
- At shore protection area FGL is +6.0 m. At village side average ground level is +4.0m. Which is lower than port FGL.
- Manning friction coefficient "n" for RCC drains area considered as 0.015 and for pitched drain it is 0.020.
- Minimum velocity 1 m/sec and maximum velocity 2.5 m/sec is considered in design of the drains.
- Runoff Coefficient for village side and port side catchment area is considered as 0.4 and 0.8 respectively. Refer below table for various area wise runoff coefficients in percentage.

S. No.	Type of Area	Percentage of Imperviousness
1.	Commercial and Industrial Area	70-90
2.	Residential Area	
	• High Density • Low Density	61-75 35-60
3.	Parks and undeveloped areas	10-20

Source: CPHEEO, 1993

7.6.3 Drainage Pattern and Catchment Area Analysis

Considering the existing drainage pattern, the port is divided into Four (4) main outfall drains. The details are as given below:

- Outfall 1A: At North port
- Outfall 1: In-between LNG/LPG 1
- Outfall 2: Near BB4
- Outfall 2A: Near BB1 (not for tidal water supply to local villagers)
- Outfall 3: Behind SS6
- Outfall 4: South side Rail dead end

These outfall drains will receive storm runoff from port and some part of village (through external drain). These outfall drains are also required to be designed for tide water to local villagers. In outfall 4, provision for boat movement has been kept. For North area of the port, suitable storm drainage plan (with outfall 1A) will be developed considering existing drainage pattern and catchment area. Also, requirements of local villagers for tide water and boat movement will also be considered. The drainage pattern and the catchment area inside and outside the port are shown in **Figure 7-11**.

Based on the study, part of village side area is considered to contribute runoff into port external drainage. The details of catchment areas and the runoff coefficients is given in **Table 7-54**.

Table 7-54: Details of Catchment Areas and Runoff Coefficient

Area	Catchment Area (Ha)	Location	Runoff Coefficient
A1	340	Outside Port	0.4
A2	155	Inside Port	0.8
A3	164	Inside Port	0.8
A4	44	Inside Port	0.8
A5	14	Inside Port	0.8
A6	42	Inside Port	0.8
A7	160	Outside Port	0.4
A8	33	Outside Port	0.4
A9	54	Inside Port	0.8
A10	73	Outside Port	0.4
A11	36	Inside Port	0.8
B1	240	Outside Port	0.4
B2	15	Inside Port	0.8
B3	43	Inside Port	0.8

The catchment area contribution and the quantity of storm water into respective outfall drains are given in **Table 7-55**.

Table 7-55: Catchment Areas Contribution and Quantity of Storm water

Name of Drain	Area	Catchment Area (m ²)	Weighted Average of Runoff Coefficient	Quantity of Storm Water (m ³ /sec)
Outfall Drain 1	B1 + B2 + B3	298	0.48	13.90
Outfall Drain 2	A1 + A2 + A3 + A4	703	0.61	41.69
Outfall Drain 3	A6 + A7 + A8 + A9	289	0.53	14.89
Outfall Drain 4	A10 + A11	109	0.53	5.61



Figure 7-11: Drainage Pattern and Catchment Area

7.6.4 Settling Pond

Settling ponds are proposed for dru bulk cargo such as Coal and iron ore stack yard side storm drains to settle coal and iron ore particles which would otherwise pollute the stream water.

The size of the Settling pond is determined from Detention of 2.5 hours. The Sludge depth is considered as 0.25m and FB as 0.5m. Settling pond will be of PCC lined surface with side slope of 1:2.5. Inlet and outlet chambers with sluice gates are proposed for operation and maintenance of settling pond is shown in **Figure 7-12**.

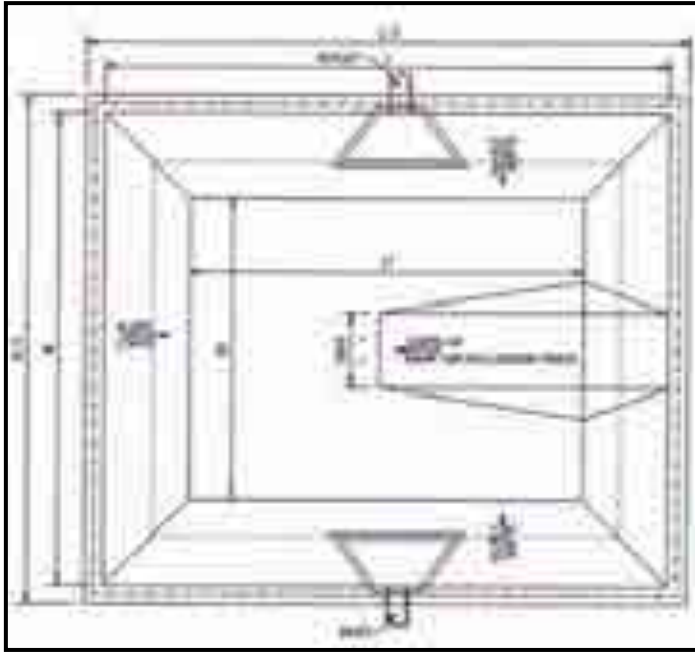


Figure 7-12: Design of Settling Pond

7.6.4.1 Yard Storm Water Drains

Dry bulk cargo such as Coal and Iron ore stack yards are provided with storm water drains on both sides. The cross slope of the stack yard is considered as 2%. Hence the Drain FGL is proposed as +6.0m. The drain will have longitudinal slope of 1:1000 and starting depth to invert as 0.5m and maximum depth of the drain is 1.9m. The width of the drain is varying from 0.6m to 1.2m as per hydraulic design. Stack side wall of the drain is raised to 1m height above FGL to avoid fall of the stacked material into the drain. This raised wall is provided with 90 dia PVC pipes for drainage of water into the drain. Road and rail side storm water drains are of RCC channel with 1m width and 1:1000 longitudinal slopes. Road side drains are provided after footpath and utility corridor which will serve road as well as open space along the road; hence chute drains are to be provided across footpath and utility corridor at 20m interval to drain road surface runoff. Typical section of yard side RCC lined drain is shown in **Figure 7-13**.

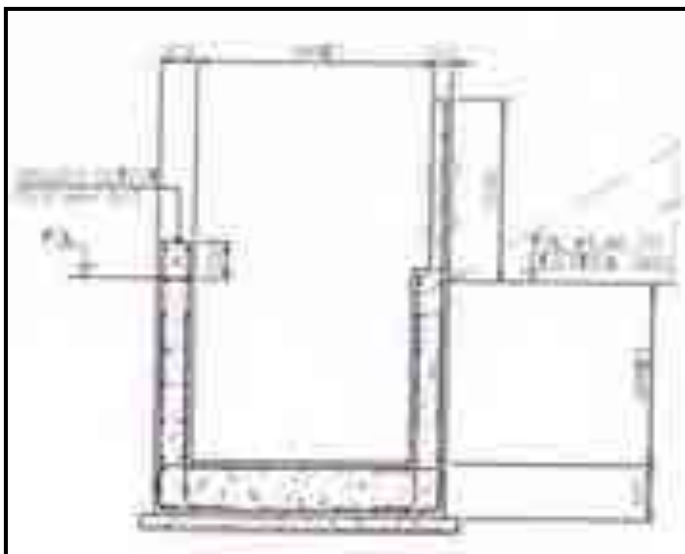


Figure 7-13: Typical Design of Yard Side Drain

7.6.5 Boundary/External Drains

All boundary drains are provided with trapezoidal section with 300 thick pitching for slope protection with side slope of 1:1.5 and longitudinal slope of 1:1500. The port side slope of the pitched drain is to be match with FGL and village side slope is to be match with EGL. The typical section of pitched drain is shown in **Figure 7-14**.

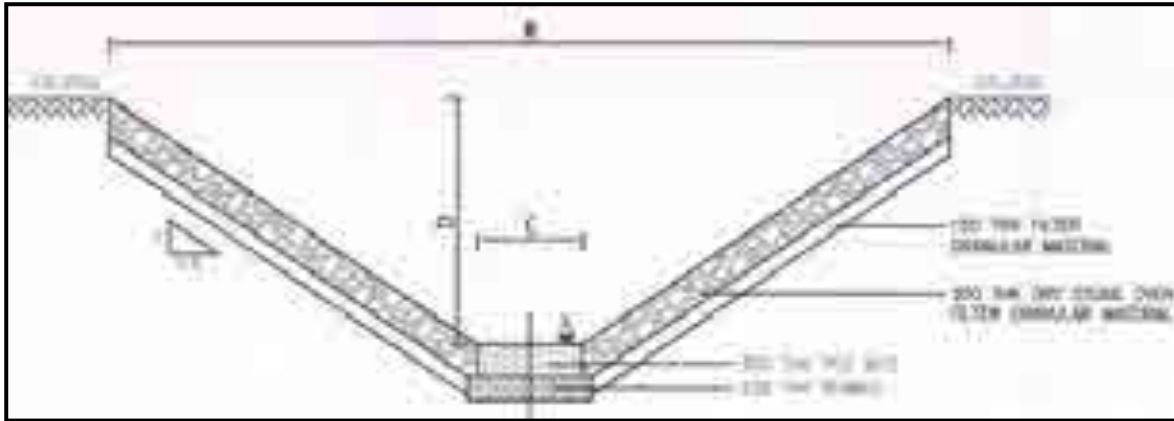


Figure 7-14: Typical Design of Pitched Drain

7.6.6 Fencing Requirement

The width of the main outfall drains are in the range of 3 to 6m. Hence there is a possibility of unauthorized movement from these drains and culverts. To avoid this, fencing requirement of some culverts is to be evaluated.

7.6.7 Boat Movement Requirement

Outfall 1A (towards north port) and Outfall 4 (outside of south boundary) are proposed considering the requirements of local villagers by maintaining the tide levels. The same is shown in **Figure 7-15**.



Figure 7-15 Stormwater Outfall Location 1A (towards north port) and 4 (towards south boundary)

7.7 Dredge Material Utilization and Disposal Plan

The estimated quantity of total dredged material during 5 year plan will be around 110 MCM and 140 MCM (-19 m CD) & 185 MCM (-22 m CD) for 30 year plan. Approximately 100 to 110 MCM will be utilised for reclamation of proposed backup area and level rising up to 5 to 7 m CD. The remaining dredged material will be disposed-off at the disposal ground beyond (-) 20 m depth offshore at MoEF&CC approved location.

7.8 Social Impact Assessment

7.8.1 Social Impacts during Construction Phase

7.8.1.1 Land Acquisition

Revision of master plan development will be carried in total area of 2013.4 ha. This includes Phase I (234 ha), Phase II (456 ha) including basin area, proposed reclamation of Sea/Submerged intertidal area (1075.7 ha), proposed applied vacant government land (247.7 ha).

Present land uses of the expansion site are Dry Barren Mud, Dry Mud with Giria Grass, Thorny scrub, Sea/Submerged land which falls in inter tidal zone without any macro vegetation. . This will be developed as per proposed revised master plan land use plan.

No land acquisition and hence no Resettlement and Rehabilitation (R&R) is envisaged during revision of master plan for Dhamra Port as the site selected is without habitation.

A new rail, road and utilities corridor (approx. 12 km x 125 m wide) is also proposed from Northern side development of Dhamra Port for easy evacuation of cargo. Development of Northern UC (mostly Rail corridor) beyond the project area on the northern side will be taken up as a separate project. Necessary clearances from the relevant authorities such as Department of Railways etc. will be carried out after finalisation of route up to Bansada, Bhadrak (where it shall meet existing rail route).

7.8.1.2 Impact on Nearby Settlements

The anticipated impact on nearby settlements during construction phase will be due to air pollution and the noise generating activities. The dust suppression measures and enclosures around the high noise generating areas will be provided.

The noise generating equipment will be provided with enclosures such that cumulative noise will be within permissible limits.

However, the activities are limited to the construction phase and will cease upon completion of the construction. Hence, this impact is insignificant.

Dust suppression measures and enclosures around the high noise generating areas within construction area will be provided.

Ambient noise levels will be monitored at regular intervals. Noise generating equipment will be provided with suitable enclosures such that cumulative noise will be within permissible limits. Operation of vehicles shall be carried out only during non-peak hours and Speed limits shall be restricted and will be within limits. Noise and pollution generated from construction activities will be predominantly confined within project site. Impacts due to these activities would be short-term in nature and localised.

7.8.1.3 Fishing Activity

The following are the observations made in the socio-economic profile of the fishermen in the PIA region:

- Total of 72 fishing hamlets (FH) are falling in PIA under Three (03) Tehsil and Two (02) Districts viz. Basudevapur and Chandbali Tehsil in Bhadrak district and Rajnagar tehsil in Kendrapara district.

- Group I (G1) covers Three (03) villages, Group II (G2) comprises of Fourteen (14) villages, Group III (G3) comprises of Thirty Eight (38) villages and Group IV (G4) comprises of Seventeen (17) villages respectively.
- Total fishermen families are 7532 i.e. 23.44 % of total households in PIA and Total fishermen population is 42896 in numbers in PIA i.e. to 25.63% of the PIA population covering 22,245 numbers of male fisherflok population and 20,651 numbers of female fisherflok population
- Average fisherflok family size is 5.7 and Sex ratio (females per 1000 males) is 928 for entire fisherflok population
- Overall status of education of the fishermen communities shows that on an average, only ~37.98% of the people have attended schools and forms only 13.81% of total literates in PIA and Iliterates are forming 62.02% of the total fishermen population
- Altogether 11,708 fishermen are active in fishing including both fulltime and part time participation in fishing activity and forming 27.29% among the total fishermen population
- Work participation rate among fishermen is 45.65% out of which 59.79% are involved in Actual Fishing followed by 30.97% are labourers, 3.86% are engaged in Marketing of fish, 2.42% are involved in other than fishing and the remaining 1.75%, 1.02%, 0.19% and 0.01% are engaged in Making/Repairing Net, Curing/Processing, Peeling and Others respectively
- There are 526 motorised and 861 non- motorised crafts operating in the area

The Dhamra fishing harbor located at 6.5 km southwest of the project. Besides almost all the above mentioned fishing hamlets have direct access to the sea except the few adjacent to the project. The construction activities which are essential for the development of Ports and Harbours such as dredging, reclamation, berths, installation of handling equipments, back up area development for storage and for other facilities and expansion of access channel, etc., will be carried out. These activities may disturb the existing fishing activity of the area adjacent to the project if not planned properly. The following are the concerns/impacts likely to arise due to expansion of Dhamra port.

- Displacement of house holds
- Restriction of Access to Sea
- Reduced fish catch/ income
- Forced Migration towards employment
- Inadequate skills towards new changes / Cultural lag
- Loss of beach and landing centres
- Loss of fishing grounds
- Conflicts
- Deterioration of quality of marine environment/Affects biodiversity
- Waste and effluent discharge
- Air and water quality deterioration
- Changes in geomorphology of the Dhamra river

The above aspects were carefully studied and following mitigation measures were suggested:

- No R&R is envisaged for the expansion of Dhamra port
- Development of Revised Master Plan development of Dhamra Port will neither affect the fishing activities nor restrict movement of local fishermen and boats. The Dhamra fishing harbour is located at a distance of 6.5 km towards southwest of the port in Dhamra River and this a perfect example where fishing harbour and port coexist without any conflicts. The fishing harbour contains fish cleaning and landing facility. The local fisher folk use this harbour for regular fishing. There is a small fish landing centre near Chandnipal

towards south of the port boundary. The fisher folk using this facility and fishing harbour will move to the sea by the side of port approach channel, port authority allows fishing vessels to use the port area by maintaining safety measures to avoid any accident. The port management conducts regular consultation with fishermen associations reading safe navigation. Hence, development of Dhamra port will not affect the fishing activities. Conflicts, if any, with fishing community will be amicably resolved in all cases

- To avoid any disturbance to the fishermen movement, signboards will be placed at the construction activities in order to make fishermen aware of the ongoing activities.
- For declaring the channel area, necessary marker buoys shall be installed. Interactions shall be continued with the fishing community about the marker buoys indicating the areas of operation so that they may avoid those areas during the construction period. Hence, no hindrance of fishing activity is anticipated during construction phase of the Dhamra port expansion.
- Proper Planning execution of offshore construction activities to ensure completion of the construction as per schedule
- Ensure that slop tanks will be provided to barges/ workboats for collection of liquid/ solid waste during construction Phase
- All the discharges and Air Emissions will be maintained within the stipulated standards by adopting appropriate methods as committed.
- All the motorised crafts using the Dhamra fishing harbour go deeper in to the sea, however Dhamra port operational activities is restricted to maximum depth of 22m
- No fishing grounds are reported in the proposed areas for revised master Plan development.
- Dredge Spoil disposal studies with continuous disposal of dredged material for 8 months at selected location (Disposal Point) have been conducted. The result shows that the sediment plume moves towards north and south side of the Dhamra and not reaching to the coast or any other eco-sensitive area and bed level change is limited to a small area. Bed level change is of the order of 0.16m and reduces to 0.011m at DP within 4 months. The maximum concentration levels in and around the dumping location varies between 9000 mg/l to 13000 mg/ and just after 1 day of ceasing the disposal of dredge material, the sediment concentration attains ambient condition (50mg/l – 60 mg/l) after 4000 m from the DP location.
- Mathematical Model studies for the revised master Plan layout show that
 - Flow regime changes for various tidal conditions in the study domain after the proposed expansion development of the Port are predicted to be not of much significance. Variation in the flow regime (in the current speeds) after the expansion is limited to the development location mostly and found to be very much local in nature. No change in the flow regime of the rest of the domain is observed.
 - Changes in the sedimentation processes was localized due to proposed developments and no impact on the other than development area
 - Minimal Erosion and accretion on the study area is reported and which can be taken care by implementing proper mitigation measures.
 - The simulation of the dispersion pattern of the return cold water discharges from LNG/LPG Plant indicates that no significant change in the ambient qualities of the surrounding waters was predicted beyond a maximum distance of 600m from the point of disposal

Positive Impacts – Education facilities, Better health care facilities, Rural Infrastructure Development and Sustainable Livelihood Development. The same is discussed in the CSR activities carried out by DPCL below.

7.8.1.4 Employment Potential

During construction phase, approximately 500 workers will be employed respectively.

7.8.2 Social Impacts during Operational Phase

7.8.2.1 Fishing Activity

In addition to the discussion of section 7.8.1.3 above, safe navigation routes shall be earmarked for movement of fishing vessels. However, the port activities involved in operation phase will be confined to the project area and hence no hindrance to fishing activity is anticipated.

7.8.2.2 Employment Potential

There will be a huge demand for skilled, semi-skilled and unskilled work force during the operation phase of the Port and it is imperative that mostly local people would be employed based on their skills and educational qualification.

The expected direct and indirect employment will be 2200 persons and 11000 persons during 5 year development and 4000 persons and 20000 persons during 30 year development respectively. The proposed project is likely to have positive impact on socio-economic condition of the region overall.

7.8.2.3 Public Health and Safety

The proposed expansion of Dhamra port will handle dry bulk, break bulk/general, container and liquid/gas cargo which can be classified as non-hazardous and hazardous materials. Handling and transportation of dry bulk cargo to and from project site and exposure to dry bulk dust are likely to have minimum impacts on public safety and health. However, suitable safety procedures will be followed by DPCL during handling, transportation and storage of cargo.

The Disaster Management Plan (DMP) for Dhamra port is already in place and will be used and improved suitably to match the requirements of revised master plan to minimize the probability of occurrence of emergency situations and to mitigate the impacts.

Chapter 8 Project Benefits

8.1 Introduction

A number of steel plants, thermal power plants and mineral based industries are located in Odisha, Jharkhand, Chhattisgarh and West Bengal and many more are proposed. Expansion of Dhamra Port offers an efficient and cost effective supply chain/ value proposition to the local importers and exporters. One of the main aims of the proposed project is to bring significant benefits to the local people and also to the region as a whole. The various project benefits are discussed in this chapter.

8.2 Infrastructure Facilities

The port has acquired 125 m wide land corridor from Dhamra port to Bhadrak for providing connectivity with the hinterland. Approval has already been obtained for 4 lane road and 2 rail tracks (as a part of Phase I & II Clearance). As a part of Revised Master Plan, it is to develop further additional 2 lane road and 1 rail tracks in the existing corridor. The road traverses through villages/towns namely Kuntala, Nachhipur, Taragana, Gopa, Kanchanpur, Charitaraf, Narendrapur, Jaleshwarpur, Bansada and Dosinga. The development of the proposed road link from Bhadrak on NH-5 to Dhamra port will induce the local traffic movement from the villages situated on either sides or in the vicinity of the project stretch since presently there is no existing road. The proposed port road provides connectivity to NH-5 for around 72 villages along the corridor. The project stretch increases the connectivity and boosts the travel characteristics of the people residing in nearby villages and thus contributes to the economic development of the region.

Dedicated rail link provides connectivity to Howrah-Chennai main railway line and road connectivity to NH-5 offers an efficient and cost effective supply chain/ value proposition to the local importers and exporters in the states of Odisha, Chhattisgarh and Jharkhand. It will also serve as an alternative gateway to ports on the west coast of India for trade between north east India and Asia.

8.3 Induced Development

Due to the proposed expansion of Dhamra port, apart from the surrounding region adjoining states would also get maximum benefits. The benefits may be realized either as upcoming of industries such as thermal power plants, mineral based plants, small scale industries and their allied ancillary units. Other benefits would be generation of either direct or indirect employment, self-employment and start-up skill development opportunities to the local people. The new connectivity through rail and road there will be a facility to improve the trading and marketing of local products as well as value addition of the local products. The connectivity will also improve the eco-tourism facility which will provide employment to the local people. The development of Dhamra Port will be a boon for the development of the region.

8.4 Improved Socio-economic Conditions

The proposed project is likely to have a positive impact on the socio-economic conditions of the region. The social structure in the region is likely to change due to the creation of more job opportunities and avenues for income generation. People are expected to have higher

incomes due to direct as well as indirect employment and will have higher earning and buying capacities.

8.5 Quality of Life

The quality of life in the region is likely to improve due to increase in percapita/perfamily earning and value appreciation of local resources that would provide economic freedom and facilitate a higher standard of living. DPCL has taken up activities in the field of Education, Community health, Sustainable livelihood development and Rural infrastructure development to improve the quality of the in the nearby villages.

8.5.1 Education

DPCL is keen in developing quality of education in schools of the Dhamra Port periphery. With that view, the following initiative and activities are performed:

- Merit Scholarship Programme
- Rural Knowledge Centre
- Summer Camp for Rural Students
- Maritime Inter School Quiz
- Turning Point
- Project Uddan
- Guru Samman
- Distribution of school Bags and Study Materials to Poor and Orphan Students
- School Awareness Programme
- DPCL DAV Public School
- Uniform to School Children

8.5.2 Community Health

Dhamra Port strives to develop a disease-free society by providing quality healthcare services as well as by creating massive awareness among the communities on health and hygiene matters. With that view, the following initiative and activities are performed:

- Community Health Centre
- Mobile Health Unit
- School Health Check-up Programme
- Fishermen Training on First Aid and Rescue
- First Aid Kits to fishing trawlers and schools
- Awareness on Epidemic Prevention
- Blankets to AIDS Patients
- Blood Donation
- Yoga Camp for Senior Citizen

8.5.3 Sustainable Livelihood Development

Improving the socio-economic conditions of the people through better livelihood methods, adding sustainability to good livelihood earning practices and through encouragement to self-employability has been a major focus of the CSR by Dhamra Port. With that view, the following initiative and activities are performed:

- Support to Women SHGs
- Farmers Group Initiatives

- Livestock Healthcare
- Prakruti Sathi Award
- Fisher Folk Welfare Project
- Annual Volleyball Tournament
- Adani-DPCL Cricket Match
- Tailoring Training for Women
- Khel Samman
- Fisherman Exposure Visit
- Solar Fish Dryer

8.5.4 Rural Infrastructure Development

Improving the rural roads, drinking water facility, rural electrification etc., has been a priority of Dhamra Port. With that view, the following initiative and activities are performed:

- Tube Wells
- Black-top Road in Dosinga
- Improvement of Village Roads
- Classroom for School
- Village Crematorium
- Construction of College Building

8.6 Corporate Social Responsibility (CSR)

CSR is a process to achieve sustainable and equitable development in societies. It is about how companies manage the business processes to produce an overall positive impact on society. CSR is a practice that holistically integrates an organization's core business with the social and environmental concerns of the community impacted. It gives impetus to economic development and improves the living standards of neighbourhood community members and society at large. With the introduction of the Companies Act, 2013 (Section 135), the disclosure of CSR activities was made mandatory for those companies which meet the prescribed criteria. It has been mandated that the corporate houses must contribute two percent of their profits for CSR. Thus, the Act encourages transparency in the CSR activities and bestows greater responsibility on the companies to have a clear framework for their CSR interventions.

The Schedule VII of Section 135, Companies Act, 2013, has listed the interventions that qualify as CSR activities:

- Eradicating hunger, poverty and malnutrition; promoting health care including preventive health care and sanitation; and making available safe drinking water;
- Promoting education, including special education and employment enhancing vocational skills especially among children, women, elderly, and the differently able; and livelihood enhancement projects;
- Promoting gender equality; empowering women; setting up homes and hostels for women and orphans; setting up old age homes, day care centres and such other facilities for senior citizens; and taking measures for reducing inequalities faced by socially and economically backward groups;
- Ensuring environmental sustainability, ecological balance, protection of flora and fauna, animal welfare, agro-forestry and conservation of natural resources and maintaining quality of soil, air and water;

- Protection of national heritage, art and culture including restoration of buildings and sites of historical importance and works of art; setting up public libraries; promotion and development of traditional arts and handicrafts;
- Measures for the benefit of armed forces veterans, war widows and their dependents;
- Provide training to promote rural sports and nationally recognized sports, Paralympics sports and Olympic sports;
- Contribute to the Prime Ministers' National Relief Fund or any other fund set up by the Central Government for socio-economic development and relief and welfare of the Scheduled Castes, the Scheduled Tribes, other backward classes, minorities and women;
- Contribute or provide funds for technology incubators located within academic institutions which are approved by the Central Government;
- Take up rural development projects.

It is also important that the community members are held collectively responsible and encouraged to take ownership of the development, thus promoting the agenda of sustainability for future generation.

The Adani Foundation is the Corporate Social Responsibility arm of Adani Group, an integrated infrastructure conglomerate that is committed to inclusive growth and sustainable development in not only the communities it operates in, but also in contributing towards nation building.

DPCL commits itself to SA-8000, Social Accountability Systems:

- To stimulate infrastructure growth of the state, especially, developing the area into an economically bustling zone.
- To develop the port area with top-class residential, water & power supply facilities.
- To enrich people's life in the area/periphery in every possible way.

The company's CSR planning and its activities is in line with the Schedule VII of Section 135, Companies Act, 2013 such as Health, Education, improving the economic conditions, women empowerment and child development, sustainability etc.

As a part of Corporate Social Responsibility (CSR), DPCL has taken up following activities to achieve its objectives.

- Education
- Community Health
- Sustainable Livelihood Development
- Rural Infrastructure Development

8.6.1 Education

Education is every child's right and development of any society is often backed by a high literacy rate and quality education. Keeping this in mind, the Adani Foundation, Dhamra Port has taken up various educational activities in the three blocks Chandbali, Tihidi & Bhadrak of Bhadrak District.

8.6.1.1 Project Udaan

Project UDAAN is learning based initiative for young students, inspired by the life changing story of the Hon'ble Chairman, Mr. Gautam Adani, where children from different high schools along with their faculties come to visit the Port as well as the Operation works of the ports.

Almost 1200 students from the immediate periphery area have already visited the Port under this project and 5000 students are targeted in the upcoming year.

- Schools/Colleges covered – 14
- Students covered – 1240



Exhibit 8-1: Students from Dosinga High School Attended Project Udaan

8.6.1.2 Rural Knowledge Centre

The Rural Knowledge Centre is situated adjacent to the Port Gate, have started running with 08 students from the nearby villages with two Computer Trainers where the students are provided with basic computer skills of MS-office. The aim is to train the rural students on Information Technology as well as Personality Development, Spoken English etc. to match with the present scenario of globalization.



Exhibit 8-2: Students taking Computer Knowledge at Rural Knowledge Center

8.6.1.3 Support to Schools

Adani Foundation, being the CSR arm of Adani Dhamra Port, provides all sorts of support to the rural schools with Bench-Desks, Science Lab Equipment, School Uniforms , Basic needs of the students i.e. School Bags, Study Materials etc.

As this year 06 schools have been provided with 90 numbers of Bench & Desks and 04 schools have got Science Lab Equipment support, the CSR team will be setting up Kitchen Garden & providing Utensils as Mid-day Meal Support, School Bags ,Uniforms as well as setting up E-learning facilities in the Schools in order to bring in change in the current educational scenario in Odisha.

- Schools covered – 10
- Students/Beneficiaries – More than 5000 students



Exhibit 8-3: Bench and Desk Support to Schools

8.6.1.4 Merit Scholarship

Adani Foundation started providing Merit Scholarship since 2009 to the students who secure 75% marks or more than that in the Matriculation examination to boost up their spirit and start over new innings of Career with monthly assistance of Rs. 1000/- for consecutive two years. 104 students have been benefitted from this venture of Adani Dhamra Port till date.

- Total schools covered – 32 High Schools
- Students covered – 104

8.6.1.5 Awareness Programme in Schools

Adani Foundation Dhamra Port conducts Awareness Programmes in different rural schools on 'Awareness Generation Programmes on Conservation of Marine Turtle. This Year they have plan for conducting different social issues to generate awareness among the students on Health, Basic Hygiene, Environment, Sanitation, Water Management, Menstrual Hygiene of Adolescent Girls etc.

- Total schools covered – 10
- Students covered - 2500

8.6.2 Community Health

Dhamra Port strives to develop a disease-free society by providing quality healthcare services as well as by creating massive awareness among the communities on health and hygiene matters. Keeping in mind the remote locations and scattered population of port periphery, attempts were also made to take the healthcare services to the doorsteps of people.

8.6.2.1 SuPoshan Project

The program is to help & fight with Malnutrition and Anaemia with a planning to reduce 95% of malnutrition and 70% of Anaemia with the community participation. In the month of October 2016, the volunteers called Sanginis given their effort to collect the basic family data from each household from their respective villages. And they collected the malnourished children list from the Anganwadi Centres. The plan is to help the Severely Acute Malnourish (SAM) children by linking with government services including Nutritional Rehabilitation Centre at Bhadrak.



Exhibit 8-4: Health Check-up and RUTF Distribution to SAM Child



Exhibit 8-5: HB Testing and FGD on Anaemia



Exhibit 8-6: RUTF Distribution to SAM Child



Exhibit 8-7: Identification of SAM & MAM Children by MUAC Tape

8.6.2.2 Mobile Health Unit (MHU)

In the year of 2016-17, 13 Panchayats have been covered to serve the patients with the help of our Mobile Health Unit team. Our team of doctors and support staff organized the Mobile Health Camps in coordination with community, public representative, opinion leaders etc.

About 1438 patients including women, children and old age persons were treated through MHU.

8.6.2.3 Adani Community Hospital

Adani Community Hospital started to serve the community which includes free check-up, free medicine, free counselling etc.

8.6.2.4 First Aid Kits to Schools

First aid kit is being provided to 35 schools on regular basis from last few years. This is one of the key help to the schools to manage any kind of injuries or small accidents.

8.6.2.5 World Aids Day Observed

Nearly 100 AIDS and HIV infected persons of Bhadrak district were distributed blankets on the occasion of World AIDS Day – 2016. Dhamra Port had associated with the Odisha State AIDS Control Society (OSACS), Government of Odisha to create mass awareness on AIDS prevention. A rally of college students was taken out in Bhadrak town to create public awareness. A slogan competition among the students was also held on the theme “Getting to Zero” on AIDS prevention.



Exhibit 8-8: Adani Foundation Distributing Blankets to AIDS Affected Persons



Exhibit 8-9: World AIDS Day Observation in Presence of District Magistrate

8.6.2.6 First Aid Kit to Trawlers

There are 260 registered fishing boats & trawlers under Maa Dhamarai Fishing Association. Under the community health program Adani Foundation extends its support to the trawlers by providing the First Aid Kit & information to use the Kit.

8.6.2.7 School Health Check-up

With an idea to maintain good health of students, a school health check-up programme was undertaken in the port periphery areas. 14 health check-up cum blood group determination camp organized at the School level in the year of 2016-17. Later camp was organized at a common place to involve parents of the students in the camps. On February 25, 2017, a mega health cum blood group determination camp was organized at Dhamra in which 640 students participated from Dosinga UGME School, Phulamani ME School, Sukhchandmanna UGME School, Narsingprasad Project UPS, Jagula Project UPS, Narsinghpur Project UPS, Dhamarai Project UPS.



Exhibit 8-10: Distribution of Health Tonic at School Health Check-up

8.6.2.8 Basic Support to ICDS

Adani Foundation has organized a CSR program to strengthen the basic needs of Anganwadi Centres from the Block of Chandbali & Tihidi. For the same one Water Filter & one Sitting Mat was provided for each centre.



Exhibit 8-11: Basic Support at Aanganwadi Center

8.6.2.9 Mega Health Camps

Adani Foundation initiatives to save life and to help the rural community to access the health services near to their door step is one of the very relevant work for the benefit of the community. Mega Health Camp is one of the steps to help the local community to access good renowned doctors, free medicine, counselling, diagnosis testing facility and referral services. Through Mega Health Check-up Camp, Adani Foundation tries to reach to the needy people & provide them a better treatment facility in their locality. This time Adani Foundation organized a Mega Health Check-up Camp in Koithakhola Market near to Gram Panchayat office.



Exhibit 8-12: Awareness for Mega Health Check-up Camp



Exhibit 8-13: Dental Treatment at Mega Health Camp

8.6.2.10 Sapling Distributed among Community

Almost 77,500 nos. of saplings were distributed amongst villages. The details of the same is given in **Table 8-1**.

Table 8-1: List of Villages and Number of Saplings Distributed

S. No	Name of Panchyat	Nos of Saplings Distributed	Date of Distribution
1	Karanpalli	7100	25.08.2016
2	Jagula	8200	28.08.2016
3	Dhamra	7000	29.08.2016
4	Barapada Eng College (as request by Dist. Admin)	5500	30.08.2016
5	Panchutikiri	10500	06.09.2016
6	Bansada	8400	07.09.2016
7	Karnjmal	10500	08.09.2016
8	Kathakhol	10300	08.09.2016
9	Dosinga	10000	10.09.2016

**Exhibit 8-14: Distribution of Saplings**

The summary of the CSR Activities under Community Health is given in **Table 8-2**.

Table 8-2: Summary of CSR Activities under Community Health

Sl. No	Date	Program/Activity	Place	Beneficiaries
1	July 2016 - March 2017	SuPoshan	Chandbali Block	42 SAM Children
2	April 2016 - March 2017	Mobile Health Unit Service	Chandbali, Tihidi & Bhadrak Block	-
3	April 2016 - Mar 2017	Adani Community Hospital	Dosinga, Dhamra, Kaithakhola, Jagula	-
4	April 2016 - Mar 2017	First Aid Kit Support to Schools	Chandbali	35 Schools
5	1/12/2016	World Aids Day Observation	Bhadrak	
6	28/12/2016	Basic Support to AWCs	Chandbali	44 AWCs
7	13/01/2017	Support to Makar Sakranti Festival	Dhamra	20000
8	21/01/2017	Mega Health Camp	Kaithakhola	450
9	25/01/2017	Health Camp for School Students	Dhamra	650
10	26/01/2017	Grand Mega Health Check-up Camp	Dhamra	3300
11	19/01/2017	First Aid Kit support to 100 Trawlers	Dhamra	100

8.6.3 Sustainable Livelihood Development

Improving the socio-economic conditions of the people through better livelihood methods, adding sustainability to good livelihood earning practices and through encouragement to self-employability has been a major focus of the CSR by Dhamra Port. Besides, in the sustainable livelihood development initiatives we also look at protection of the environment and promotion of rural sports for an all-round development of the community and society at large.

8.6.3.1 Adani Dhamra Port Volley Ball Tournament

Adani Foundation with the CSR team organized day and night 9th Volleyball Tournament 2016 at Dosinga Market ground on December 20-21, 2016. 10 teams from 8 Panchayats i.e. Dosinga, Dhamara, Jagula, Karanapalli, Bansada, Kaithakhola, Panchutikri and Karanjamal participated enthusiastically for the tournament. The teams were provided with Jersey, Track suit, net and Volley ball. And the winning team was presented with trophy and cash prize of Rs.10, 000/- and runners up team with trophy and cash prize of Rs.8000/-.



Exhibit 8-15: Volley Ball Tournament

8.6.3.2 Adani Inter School Girls Athletic Meet

Adani Dhamra Port with the CSR team, school and community involvement organized a Adani Inter School Girls Athletic Meet 2017 on February 07, 2017 at Dosinga ground. The students (girls) from nine high schools from 8 panchayats participated in the meet. The 9 schools participated for the Annual Inter School Athletics Meet are Dosinga HS - Dosinga, G.P. HS - Jagula, Maa Dhamarai HS - Narasinghprasad, Bansada HS - Bansada, J.N. HS - Kaithakhola, V.N Uchavidyapithe - Kaithakhola, S.S. Nigamananda Uchavidyapithe - Sashikadeipur, Panchutikiri G.P HS – Panchutikri and Gram Panchayats HS - Karanpali.



Exhibit 8-16: Inter School Girls Athlete Meet

8.6.3.3 Adani Inter School Girls Kabbadi Tournament

Adani Dhamra Port with the CSR team and with the support of Dolosahi school management organized Adani Inter School Girls Kabaddi Tournament 2017 on February 09, 2017 at

Ramnarayan High School Dolosahi, Bhadrak. The students from 8 High Schools, 7 panchayats participated in the Tournament i.e. Rambhila H.S, Rambhila, Ranital H.S, Ranital, Bania H.S, Bania, Bramhapur H.S, Bramhapur, Ramnarayan H.S, Dolosahi, Ramanuja Vidyapitha, Paliabindha, Achak H.S, Achak, and C.R.S HS, Tihidi.



Exhibit 8-17: Inter School Girls Kabbadi Tournament

8.6.3.4 Animal Health Camp/Vaccination Camp

The CSR team with the help of community mobilisers and village volunteers conducted Animal Health Camp/Vaccination Camp on November 27, 2016 in Dosinga village of Dosinga gram panchayat. The village comprises of 143 households with 1032 total population and around four hundred cattles including large and small animal. Another camp was organized on November 29, 2016 in Kuntala, Bhadrak.

**Exhibit 8-18: Livestock Health Care Programme**

8.6.3.5 Supporting Aahar Scheme

The Aahar scheme consolidated month wise beneficiary for the year 2016-17 is given below.

Months	Working Days	Non-Working Days	No. of Beneficiaries	Amount Collected from Beneficiaries	Amount Spent by AF	Remarks
April	12	1	600	30000	90000	Started on 18 th April
May	26	5	13000	65000	195000	
June	26	4	13000	65000	195000	
July	26	5	13000	65000	195000	
August	27	4	13500	67500	202500	
September	26	4	13000	65000	195000	
October	26	5	13000	65000	195000	
November	26	4	13000	65000	195000	
December	27	4	13500	67500	202500	
January	26	5	13000	65000	195000	
February	24	4	12000	60000	180000	
March	27	4	12000	60000	180000	
Total	299	49	148000	740000	2130000	

8.6.3.6 Tailoring Training for Women

In order to make the rural women self-sustainable and given them a scope for income generation, a tailoring training unit has been set up in Dosinga village. Dhamra Port has created the necessary infrastructure and appointed trainer for the unit. In each batch 10 women or, young girls from the community villages can avail training and start earning which can support their and the family's financial needs.

8.6.4 Rural Infrastructure Development

Improving the rural roads, drinking water facility, rural electrification and the health and education related infrastructure has been a priority of Dhamra Port CSR. With the suggestions of Rehabilitation and Periphery Development Advisory Committee (RPDAC), a government body created for looking into R & R of the project, several infrastructure

development works were taken up by the port during the year. Besides, on request from local PRI members and village committees, works such as sinking up of tube wells in water scarcity areas, construction of village road and moorum roads, excavation of creeks were taken up.

Details of Activity	Items	Name of Block
Fitting Street Light (MM:SFSS-150W HPSV)	Light	Dosinga
Consultancy charges tubewell Kuamara	Tubewell	Karanpali
Drain Work at Kaith Khola	Drain	Koithakhola
Main road to Giripada	Road	Jagula
Laten Mandal house to mandal Pada	Road	Jagula
Gaurahari jena house to Bandhamala	Road	Jagula
Tubewell-Barikpada	Tubewell	Jagula
Tubewell-Ashok Bera	Tubewell	Jagula
Tubewell-Gurupada Maity	Tubewell	Jagula
Tubewell-Oramal-Dalapati sahi	Tubewell	Dosinga
Tubewell-Bhuyan Sahii	Tubewell	Dosinga
Bagchati Road Repair	Road	Dosinga
Road Repairing - Pradyutnagar	Road	Dosinga
Sabitrisarai PMGSY road to Parida Sahi	Road	Dosinga
Jayadurgapatana SatyaSethi house	Road	Jagula
Dosinga to Balisahi salt embankment	Road	Dosinga
Tubewells at Nuagaon Panchayat-03	Tubewell	Nuagaon
Renovation of Jenasahi-Bhatatira Road	Road	Rail Corr.
Const. of RCC drain and Fndtn of L. Post	Drain	Rail Corr.
Renovation of CADA nala at Tihiri Canal	Canal	Rail Corr.
Repair to Bania-Berhampur Panchayat Road	Road	Rail Corr.
Road restoration from Manipur level cros	Road	Rail Corr.
Renovation of Sapanbindha-Darpur canal a	Canal	Rail Corr.
Renovation of Tihiri Canal to DPCL road	Road	Rail Corr.
GSB for village road	Road	CSR Work
Dredged Sand	Road	CSR Work
Supply of moorum	Road	CSR Work
Supply & installation of Flood Light	Light	Nuagaon
Tubewell	Tubewell	Koithakhola
Tubewell at GP High School, Karanpalli	Tubewell	Karanpali
Tubewell at Gurudaspur	Tubewell	Gurudaspur
Hatapur Nala	Canal	Nuagaon
LED light for Dhamra Bus Stand	Light	Dhamra

Fifteen numbers of tube wells were sunk in water scarcity habitation areas of Dosinga, Koithakhola, Jagula, Karanpalli, Gurudaspur etc. While the work was executed by Foundation, the respective PRI members and beneficiaries of the tube wells monitored and certified about the quality of work. Cemented base was constructed for each tube well and responsibility of the proper usage of the tube wells was given to respective village committees.

8.6.4.1 Improvement of Village Roads

For providing better communication facilities to the people of remote village locations, total 7 village roads were improved by metal moorum filling and levelling. These roads were in deteriorated conditions and forced the commuters suffer heavily during the monsoon being situated in a low lying area, every year during the monsoon, the earthen road to the village was getting washed away. The construction of the concrete road was monitored by the villagers and done as per their requirement.

S. No.	Name of Block	New Schools	Vendor
1	Basudevpur	Ghanteswar	Maa Manasa Associates
2	Bhadrak	Berhampur High school	Tapan Kumar Roul
3	Bhadrak	Erain ME School	Suryamani Panda
4	Chandbali	Ghanteswar High School	Mitra Engineering
5	Chandbali	B.B.C. Vidyapitha, Totapada	Suryamani Panda
6	Chandbali	Achaka High School, Achak	Suryamani Panda
7	Chandbali	Phulamani UGME School	Maa Manasa Associates
8	Chandbali	B.S.C. HIGH SCHOOL	Maa Manasa Associates
9	Chandbali	BALISAHU PROJECT U.P.S.	Maa Manasa Associates
10	Chandbali	Karanpalli HS	Maa Manasa Associates
11	Chandbali	S S Nigamananda Ucha Vidyapitha	Maa Manasa Associates
12	Chandbali	GP High School, Jagula	Maa Manasa Associates
13	Chandbali	Dhamarai High School	Maa Manasa Associates
14	Chandbali	Dosinga High School	Maa Manasa Associates
15	Chandbali	G.P. High School, Panchutikiri	Maa Manasa Associates
16	Chandbali	Trust High School, Jasipur	Maa Manasa Associates
17	Chandbali	Rabindra Nagar Project PS	Maa Manasa Associates
18	Chandbali	Somipatia Project P.S.	Maa Manasa Associates
19	Tihidi	Saya High School	Suryamani Panda
20	Tihidi	Ramanuja Vidyapitha, Palia	Suryamani Panda
21	Tihidi	Shanti Sailendra HS, Bindha	Mitra Engineering
22	Tihidi	Rajnagar P.S.	Mitra Engineering
23	Tihidi	Samantaraypur High School	Mitra Engineering
24	Tihidi	Kolha High School	Suryamani Panda
25	Tihidi	Ram Narayan High School	Suryamani Panda

8.6.4.2 Community Engagement Programme

The activities under community engagement programme includes Support to Boita Bandana Mela, Support to Makar Mela, Support to National Live Stock Fair and Support to Dry Fish Association



Exhibit 8-19: Boita Bandana Utsav Celebration

8.6.5 Corpus Fund for Environment Conservation

DPCL to create a corpus fund of **Rs. 30 Crores** for conservation of wildlife and marine life including Olive Ridley turtles, environmental development/sustenance and livelihood measures of local population and other related activities in cooperation with concerned government authorities.

8.6.6 Budgetary Provision for CSR Activities

INR 8.0 Crores has been budgeted for 2016 – 17 under Education, Community Health, Sustainable Livelihood Development, Environment Programme and Rural Infrastructure Development. The CSR is one of the mandatory and regular activities of DPCL and the same shall be implied for revised master plan. DPCL is committed to carry out CSR activities in above all focussed areas and will spend INR 15 Crores for next three years. Same will be reviewed on yearly basis and accordingly implemented.

The Government of Odisha vide their order dated July 6th, 2006 have constituted the peripheral development advisory committee of the projects in pursuance to the Odisha Resettlement and Rehabilitation Policy. The revenue divisional commissioner is the chairman of the committee. The committee includes the concerned members of Parliament, Members of the Legislative Assembly, President Zilla Parishad, Chair Persons of the affected Panchayats, NGO representatives, local women self-help groups, representatives of affected families along with others. This committee regularly reviews the CSR and periphery development activities and recommend the project specific issues to be undertaken by the project proponent. Accordingly, the funds budgeted for the purpose is utilised for the CSR and periphery development activities.

8.7 Corporate Environment Responsibility (CER)

CER for the proposed project will fall under the Brownfield category of MoEF&CC Office Memorandum F. No. 22-65/2017-IA.III dated May 01,2018, 0.125% of project cost, i.e INR 48,933 Cr. (30 Year Revised Master Plan Development) i.e. ~INR 61.66 crores need to be invested as capital investment over a period of time.

DPCL is contributing in the areas of Education, Community health, Sustainable livelihood development, Rural Infrastructure and restoration and conservation of ecosystem and environmental conditions in the vicinity of the Dhamra Port. CER activities will be implemented as a part of Revised Master Plan development. The entire activities proposed under the CER shall be treated as project and shall be monitored. The monitoring report shall be submitted to the regional office as a part of half yearly compliance report, and to the District Collector

8.8 Employment Opportunities

The proposed expansion project will provide direct as well as indirect employment to the locals.

The employment potential from the construction phase of expansion plan is estimated as 500 workers.

There will be a huge demand for skilled, semi-skilled and unskilled work force during the operation phase of the Port and it is imperative that mostly local people would be employed based on their skills and educational qualification. The expected direct and indirect employment will be 2200 persons and 11000 persons during 5 year development and 4000 persons and 20000 persons during 30 year development respectively. The proposed project is likely to have positive impact on socio-economic condition of the region overall. With the addition of this employment potential, the indirect employment will be increased by many folds.

8.9 Revenue Generation

The project construction and operation will generate revenue for State and Central Government by way of payment of royalty, tax and sharing of port revenue.

In addition to the above, port development will attract investments into the region and thereby contribute to economic growth of Bhadrak District and Odisha State.

Chapter 9 Environment Management Plan

The main objectives of Environmental Management are to:

- Identify key environmental issues envisaged to be encountered during construction and operation phases of the project
- Provide guidelines for appropriate mitigation measures
- Establish systems and procedures for implementing mitigation measures
- Ensure that the mitigation measures are being implemented
- Monitor the effectiveness of mitigation measures
- Take necessary prompt action when unforeseen impacts occur

9.1 Components of EMP

The environmental impact mitigation and avoidance measures for each likely impact on the prevailing environment have been discussed in detail at the respective sections in **Chapter 5**. The Environmental Monitoring Programme has been discussed in **Chapter 6**. Various project activities, associated impacts and mitigation measures are summarised in **Table 9-1**.

Table 9-1: Project Activities, Associated Impacts and Mitigation Measures

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
Construction Phase					
1.	Capital dredging/ Reclamation/ Disposal/ Construction of Approach Trestle/Berths and other offshore structures such as seawater intake/marine outfall	Marine water quality Marine ecology Mangrove area	– Increase in turbidity – Change in marine water quality due to aqueous discharges (oily waste, sanitary wastes) from dredgers, barges and workboats – Spill of Bentonite Clay during pile driving Marine Ecology of this environment is already subjected to the changes due to maintenance dredging activities and hence the net impact will be minimal. Some of the likely impacts are: – Decrease in DO levels – Increase in noise levels – Disturbance to benthic communities – Changes in species diversity and density in areas adjoining dredging site – Smothering or blanketing of sub-tidal communities – Impact on 9ha mangrove near the southern boundary – Impact on mangroves near northern boundary – Impact on mangroves at Kanika Island	– Check turbidity levels with baseline levels as reference during entire monitoring programme – Dredge Management Programme – Discharge of waste into sea will be prohibited – Oil Spill control measures will be adopted – Ensure that slop tanks are provided to barges/ workboats for collection of liquid/ solid waste – Recirculation/Reuse of Bentonite clay and adoption of better construction methods to minimise the spill on marine environment. – Adoption Standard Reclamation methods with containment system to retain the solid inside the reclamation area – Disposal of unused Dredged material at the identified offshore disposal area only. – Marine environmental monitoring as per environmental monitoring programme – DPCL has excluded scattered mangroves identified near the southern boundary of the port in phase I development from the port activity and implementing the conservation measures. During the planning stage, a channel for seawater influx is considered to the mangrove area. – Care shall be taken during reclamation near northern and southern side mangroves and reclamation bund shall be constructed to ensure that no impact on them. Construction of Northern rail link will pass through the sparse mangrove	Construction Contractor/DPCL

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				patch. It is estimated that ~0.1 ha of mangrove area will come under the development of utility corridor where the corridor will be developed on piles. Considering the mangrove footprint, 10 times of mangrove plantation will be done. – Minimum 50 m buffer has been provided near the Northern mangrove area and all the construction will be limited as per plan. – Discharge of toxic/hazardous materials during the port construction would not be allowed. – Revised Master Plan ensures the Tidal exchange near the mangrove area which is also ensured by of hydrodynamic modelling studies. – Dredge spoil should not be entered into mangrove area. – Awareness will be imparted to workers in the port about the importance of mangroves and their conservation	
		Impact on turtle/Other Macro Fauna	– Accidental take during dredging – Light Glare on Nesting	– The channel area is well away from the turtle congregation area and hence there is no regular movement of turtle into the channel area. – DPCL to take appropriate measures to avoid accidental take of turtle during dredging. – Install specialised illumination system in line with "International Dark Sky Association (IDA)" to avoid glare to the sky or focusing light towards sea. – Mercury vapour and metal halides will not be used. Sodium vapour lamps will be used	DPCL/Dredging Contractor
		Fishermen and fishing villages	– Local Fishermen approach to sea – Impact on fishing due to Construction works – Fishing harbour is located in Dhamra River at 6.5 km southwest boundary of the port. The	– Proper access to the sea for the local fishermen is considered during planning stage itself. – This is an existing port hence no direct impact is envisaged.	

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
			fishing boats travels all through the Dhamra River and enter into sea. The approach channel of the port is oriented from south to north east whereas fishing boats travels from south to east. Fishing is being carried out at deep sea. Therefore, significant impact on fishing is not envisaged.	– Signboards will be placed at the construction activities in order to make fishermen aware of the on-going construction activities – Necessary marker buoys will be installed – Regular Interactions will be initiated with the fishing community before commencement of construction works – Construction shall be limited to as per development plan.	
2	Material transport and construction activities	Air Quality	– Exhaust emissions from vehicles – Windblown dust during material movement – Fugitive dust during construction material unloading – Dust suspension during site preparation, construction – Emissions from DG Sets	– To reduce impacts from exhausts, emission control norms will be enforced /adhered. – All the vehicles and construction machinery will be periodically checked to ensure compliance to the emission standards. – Construction equipment and transport vehicles will be periodically washed to remove accumulated dirt – Providing adequately sized construction yard for storage of construction materials, equipment tools, earthmoving equipment, etc. – Provide enclosures on all sides of construction site. – Movement of material will be mostly during non-peak hours. – On-site vehicle speeds will be controlled to reduce excessive dust suspension in air and dispersion by traffic – Water sprinkling will be carried out to suppress fugitive dust – Environmental awareness program will be provided to the personnel involved in developmental works – Use of tarpaulin covers and speed regulations for	Construction Contractor/ DPCL

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
		Noise	Noise from following activities – Vehicles transporting construction material – Diesel run engines of construction machinery and dredgers – Pile driving activities during construction of Approach trestle/cargo berths etc.,	vehicles engaged in transportation – Noise levels will be maintained below threshold levels stipulated by Central Pollution Control Board /Odisha State Pollution Control Board (CPCB)/OSPCB – Procurement of machinery / construction equipment will be done in accordance with specifications conforming to source noise levels less than 75 dB (A) – Well-maintained construction equipment, which meets the regulatory standards for source noise levels, will be used – Any equipment emitting high noise, wherever possible, will be oriented so that the noise is directed away from sensitive receptors – Noise attenuation will be practised for noisy equipment by employing suitable techniques such as acoustic controls, insulation and vibration dampers – High noise generating activities such as piling and drilling will be scheduled at daytime (6.00 am to 10 pm) to minimise noise impacts – Personnel exposed to noise levels beyond threshold limits will be provided with personal protective equipment's such as earplugs, ear muffs, etc. – Ambient noise levels will be monitored at regular intervals. – Exercise route selection, traffic regulations, timings etc.,	
		Disturbance to Natural Drainage pattern	– Impact to natural flow of runoff due to reclamation and change of drainage course	– Storm water runoff will be directed as per the storm water drainage network proposed considering the existing drainage pattern and	

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				catchment area to carry storm water discharge from village area and port area into the sea. - Requirements of villagers for tide water and boat movement has been duly considered in the drainage plan - Prudent Planning of Layout - Mathematical Modelling Studies shows Flow regime changes for various tidal conditions in the study domain after the proposed expansion development of the Port are predicted to be not of much significance and is limited to the development location mostly and found to be very much local in nature. No change in the flow regime of the rest of the domain is observed.	
		Vegetation and Strain on existing infrastructure	Loss of vegetation and strain on existing infrastructure.	- The area being highly saline and Sea/Submerged inter tidal zone, no Major vegetation is present in the proposed expansion area except a narrow strip of thorny bushes. - Construction activities shall be limited within the site and dust shall be contained within the construction area.	
		Existing Traffic	Traffic addition	- The existing approach road to Dhamra Port is being widened by GoO which will improve the traffic conditions. - Proposed National Water Way (NW-5) will also be used for the transport of part of construction material which will reduce likely congestion on road. - In addition, approval has already been obtained by DPCL for 4 lane road and 2 rail tracks (as a part of Phase I & II Clearance). As a part of Revised Master Plan, it is to develop further additional 2 lane road and 1 rail tracks.	–

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				– Traffic Wardens shall be deployed for regulating the traffic – Drivers should be sensitized with respect to need to drive carefully while passing village areas. – Speed of the trucks shall be controlled by providing speed breakers, sign boards and other appropriate speed control techniques. – Proper lighting, signboards shall be provided at required locations.	
3.	Land Reclamation	Existing Water Resources like Groundwater and surface water	– Proposed expansion is planned in an additional area of 1323.4 Ha. Out of which approximately 1075.7 Ha land will be reclaimed and 247.7 Ha of land is proposed applied land. The proposed development of master plan site falls in saline and Sea/Submerged intertidal area without any macro vegetation, habitation and built-up area. The applied land to be reclaimed will be saline mud and will be separated from the adjoining land mass through the salt dyke. This being an intertidal zone which is sloping towards sea, therefore, there will be no impact on groundwater quality. – Construction phase water requirement will be met through existing sources .i.e. Matai River	– Existing protective bunds (salt dyke) and slope gradient will prevent inundation of salt water to the adjoining land. – Return seawater from reclamation areas will be channelled back to sea.	DPCL/Construction Contractor.
4.	Solid Waste Management	Soil quality	– Impacts due to disposal of solid waste on ground	– Proper waste Management practice is being followed and shall be extended. – General refuse generated on-site will be collected in waste skips and separated from construction waste. – Other Construction waste will be used within port site for filling of low lying areas. – Solid Waste Management Rules, 2016 and	DPCL/Construction Contractor

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				Construction & Demolition Waste Management Rules, 2016 (as amended) will be followed for environmental sound management of respective waste – Burning of refuse at construction sites will be prohibited.	
5.	Handling of hazardous wastes	Human safety and property/ Environment loss	– Fire accidents due to hazardous material handling – Impact on Terrestrial and Marine Environment	– Hazardous and other waste Management Rules, 2016 (as amended) will be followed for environmental sound management of hazardous waste. – Adequate safety measures as per OSHA standards will be adopted – Construction site will be secured by fencing with controlled/limited entry points. – Hazardous materials such as lubricants, paints, compressed gases, and varnishes etc., will be stored as per the prescribed/approved safety norms. – Construction site will be secured by fencing with controlled/ limited entry points. – Medical facilities including first aid will be made available for attending to injured workers. – Handling and storage as per statutory guidelines. – Positive isolation procedures will be adhered – Hazardous wastes will be disposed through approved OSPCB/CPCB vendors.	DPCL/Construction Contractor
7.	Water Resources	Water scarcity/Pollution	– Impacts to the surface water body	– Water required during construction activity will be met through existing water supply system from Matai River. – Groundwater table at Dhamra is high due to high rainfall. However, optimization of water resource will be done – Prudent Planning of Layout - Based on existing	DPCL

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				drainage pattern and catchment area, main outfall drains are proposed to carry storm water discharge from village area and port area and discharging into seas. – Care will be taken to prevent the runoff from the construction site to the nearby natural streams connecting to rivers. – Construction camp wastewater will be collected and treated. Treated wastewater will be used for Plantation/Greenbelt development.	
Operation Phase					
1.	Cargo handling and Inland Cargo movement and storage areas, Regasification process and equipment operation such as pumps, compressors, etc.,	Air Quality	– Emissions from loading/unloading equipment, DG sets, vehicular dust emissions, fugitive emissions from storage areas, Emissions from vessels visiting Dhamra Port, Vehicular emissions due to cargo transport, emissions from LNG/LPG regasification process, spillage of cargo etc., – Air Quality Modelling study is carried out to Predict the GLCs at the receptors due to Fugitive emissions from Dry bulk cargo stockyard and Vehicular movements, etc., and it is found that resultant concentrations are well within the NAAQs standards at all receptors.	– Most of the cargo transportation through rail and Pipelines (~ 70%). – Use of specialised ship loaders/unloaders, wagon tippler, track Hopper, covered conveyors and rapid loading system through silos – Use of -low sulphur diesel fuel is proposed. – Dust Suppression measures at loading/unloading points, wagon tippler complex, Track Hoppers, transfer points, stock yards, rapid loading system and at internal roads. – Scientific and regulated stacking of cargo piles. – Wind screens will be provided along stack yard. – Periodic cleaning of cargo spills. – Use of tarpaulin covers and speed regulations for vehicles/wagons engaged in transportation. – Greenbelt Development – Proper house keeping – Regularisation of truck movement – Vessels visiting the facility shall meet emission standards as per MARPOL. – Use of Eco friendly regasification technology such as Seawater based/ Ambient Air Based for	DPCL

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				LNG Regasification.	
		Noise	- Due to equipment handling and vehicular movement - Ship (un)loading operations - Due to Regasification Process and equipment operation	- Acoustic Barriers and Enclosures - Personal Protective Equipment (PPE) - Greenbelt Development - Counselling and traffic regulation	
		Traffic Addition	Cargo movement from/to port	- Most of the cargo transportation through rail and Pipelines (~ 70%). - Proposed National Water Way (NW-5) will also be used for the transport of cargos which will reduce likely congestion on road. - Approval has already been obtained by DPCL for 4 lane road and 2 rail tracks (as a part of Phase I & II Clearance). As a part of Revised Master Plan, it is to develop further additional 2 lane road and 1 rail tracks in the existing corridor. 125 m wide corridor is meant to accommodate three rail tracks, a six-lane road, an electric overhead transmission line, utility corridor and side drain. This will be sufficient to cater the DPCL revised master Plan transportation requirements. - In addition, for easy evacuation of cargo, a new rail, road and utilities corridor (approx.12km x 125m wide) is also proposed from Northern side development of Dhamra Port.	
		Fishermen and fishing villages	- Local Fishermen approach to sea - Fishing harbour is located in Dhamra River at 6.5 km southwest boundary of the port. The fishing boats travels all through the Dhamra River and enter into sea. The approach channel of the port is oriented from south to north east whereas fishing boats travels from	- Dhamra Port is an existing port, fishermen in the area are well aware of the existing port activities. Therefore, no direct impact is envisaged - Creation of awareness among the fishermen about proposed master plan activities is being done and will be continued - Marker buoys along the channel	

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
			south to east. Fishing is being carried out at deep sea. Therefore, significant impact on fishing is not envisaged.	– Educate the fishermen about the orientation of approach channel and ships visits etc., – Regular interactions will be initiated with the fishing community – Conflicts, if any, with fishing community will be amicably resolved in all cases.	
2.	Aqueous discharges in harbour basin	Marine water quality and ecology	– Change in marine water quality/ecology due to discharge ship wastes (sullage), sewage, bilge water, Desalination Plant reject water, LNG/LPG regasification return water etc.	– Vessels/Ships will be required to exchange ballast water in a deep sea location prior to arrival in the harbour. – Ships are prohibited from discharging wastewater, bilge, oil wastes, etc. into the near-shore as well as harbour waters. – Ships would also comply with the MARPOL regulation. – As a mitigation measure for spillages an Oil spill contingency plan prepared and will be implemented. – Provision of waste reception facility for bilge water and waste oil will be explored. – Desalination Plant water requirement selected prudently and will be sourced from river Matai which will ensure the reject TDS will be always less than the seawater TDS and hence no significant impact due to reject discharge into marine environment. – LNG/LPG regasification return water with low temperature (<7°C than ambient) will be sent back through marine outfall system with diffusers at identified location through mathematical model studies which will ensures attainment of ambient conditions (within 600 m) in the harbour area – Marine Water Quality monitoring is proposed as a Part of Environmental Monitoring	DPCL to provide regulations to vessel operators

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
3.	Cargo and Oil spills (Accidental)	Marine water quality and ecology	Change in marine water quality	- In case of any cargo spillage during transfer from/to ships, it will be attempted to recover the spills. - Oil spill control equipment such as booms / barriers will be provided for containment and skimmers will be provided for recovery. - Response time for shutting down the fuelling, containment and recovery will be quicker.	DPCL
4.	Maintenance dredging	Marine water quality/Marine Ecology	- Increase in turbidity - Decrease in DO levels	- It will be ensured that dumping of the maintenance dredge material would be uniform at the identified offshore disposal ground. - Dredge spoil disposal studies reveals that the changes in bed level at disposal site due to deposition of dredge spoil is less than 0.011 m. The spread of plume is also ensured that it will never reach the channel, shoreline and other eco sensitive areas. - Pre and post dredge material disposal bathymetry survey at disposal location shall be carried out - Based on the TSS/Turbidity monitoring results during dredging, nearby receptors if any impacted would be provided with suitable mitigations measures such as silt screen to contain the turbidity.	Dredging Contractor/DPCL
5.	Water Supply	Water resources	Impact on existing water resources	- Raw water shall be taken from Matai River (Perennial) at the existing intake location. The maximum water withdrawal shall be 100 MLD (for 40 MLD desalination plant). - No downstream users are observed beyond the Intake Point at River Matai. - Government of Odisha has accorded permission for water intake of 5 MLD from Matai River and	DPCL

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				necessary permission will be obtained from the concerned authorities for revised Master plan requirements.	
6.	Wastewater Discharge	Water Quality	- Impact due to discharge of runoff from stock piles and disposal of untreated sewage. - Impact due to discharge of brine (reject from Desalination plant) runoff from stock piles and disposal of untreated sewage	- Collection of runoff from stock piles and directing into settling ponds for recycling and supernatant water will be used for dust suppression. - Neutralisation using lime to ensure settlement of heavy metals, if any. - STP (1 MLD capacity during 5 year and 2 MLD (Cumulative) capacity during 30 year development) to treat the sewage generated in the premises. - ETP (3 MLD capacity during 5 year and 5 MLD (Cumulative) capacity during 30 year development) to treat the effluents - Storm Water Drainage System - Treated Sewage and effluents shall be reused for dust suppression, irrigating greenbelt and other requirements	DPCL
7.	Seawater withdrawal for Regasification and water withdrawal from River matai for desalination plant	Marine ecology/ River Ecology	Impingement/Entrainment/Entrapment of aquatic life	- Intake with proper screens will be Provided - Maintaining Low Intake Velocity to minimise the Entrainment & impingement - Seawater Intake is proposed in protected harbour basin which will reduce major marine organism entry - Intake is proposed nearer to LNG Terminal and hence entrapment will be insignificant	DPCL
8.	Solid Waste Management	Groundwater and Soil quality	Impact due to disposal of solid waste on ground	5 R (Reduce /Reuse/Recover/Recycle and Re Process) principle shall be explored - STP sludge will be used as manure in green belt. - Organic Waste Convertor will be provided. Composted bio-degradable waste will be used as manure in greenbelt/ gardens	DPCL

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
				- Other recyclable wastes will be sold to OSPCB authorised vendors. - Commercial use will be explored for the materials settled in dump pond	
9.	Handling of hazardous materials/wastes	Fire accidents due to products handling and other health hazards/ Groundwater and soil contamination.	- Human life and loss of property - Impact on Terrestrial and Marine Environment	- Hazardous and other waste Management Rules, 2016 (as amended) will be followed for environmental sound management of hazardous waste. - Adequate safety measures as per OSHA standards will be adopted - Hazardous materials such as lubricants, paints, compressed gases, and varnishes etc., will be stored as per the prescribed/approved safety norms. - Medical facilities including first aid will be made available for attending to injured workers. - Handling and storage as per statutory guidelines. - Positive isolation procedures will be adhered - Hazardous wastes will be disposed through approved OSPCB/CPCB vendors or shall be given to nearby approved cement industry for co-processing. - Risk analysis has been carried out and suggested risk mitigation measures shall be adopted. - Emergency alarms, provision of fire hydrant system and fire station. - Effective Disaster Management Plan (DMP) which covers onsite and offsite emergency plans. - Recovery of spills to the maximum extent possible.	DPCL
10.	Presence of Reclaimed back	– Shoreline Changes	– The shoreline modelling studies shows that mostly accretion in the stretches studies and	– Monitoring of shoreline with the help of high resolution satellite imageries during operation	DPCL

S. No.	Activity	Relevant Environmental components likely to be impacted	Likely Impacts and their significance in the absence of Mitigation Measures	Proposed Mitigation Measures	Responsible Agency for Implementation
	up area or Bund	– Change in Hydrodynamics	erosion in north of revised master pan area at the rates of -4.38m/ year and erosion below the Dhamra river region at the rate of -2.71 m/ year. Suitable mitigation measures will be carried out to maintain the stability of coast – Flow modelling shows that Variation in the flow regime (in the current speeds) after the expansion is limited to the development location mostly and found to be very much local in nature. No change in the flow regime of the rest of the domain is observed.	phase shall be carried out periodically. – Based on the monitoring results and if required, appropriate remedial measures such as beach nourishment/ creation of sand trap/ any other suitable methods shall be carried out to maintain the stability of coast	
11.	Operation of port	Socio-economic conditions of the region	During operational phase the expected direct and indirect employment will be 2200 persons and 11000 persons during 5 year development and 4000 persons and 20000 persons during 30 year development respectively. Local people will be given preference based on their qualification and skill set. Together with this employment potential, project will help to enhance the socio economic conditions of the area with better schooling, communication and transport facilities that will be developed/ triggered as a part of overall economic development of the region.		
		Natural Hazards	Disaster Management Plan (DMP) is already in place and will be continued after expansion also with required revisions. Port Conservator will act as the overall in-charge of the control of educative, protective and rehabilitation activities to ensure least damage to life and property.		
		Induced Development	Offers an efficient and cost effective supply chain/value proposition to the local importers and exporters in the states of Odisha, Chhattisgarh and Jharkhand. Also serves as an alternative gateway to ports on the east coast of India for trade between north east India and Asia.		

9.1.1 Administrative and Technical Setup for Environmental Management

DPCL has appointed a specific management representative, Environmental Head and a Site Environmental Officer who have defined roles, responsibilities and authority for:

- Ensuring that an Environmental Management System is established implemented and maintained in accordance with the requirements of ISO 14001.
- Reporting to top management on the performance of the Environmental Management System for review, including recommendations for improvement.

DPCL's Environmental Department has a team of dedicated staff to:

- Identify environmental aspects, normal, abnormal and emergency conditions
- Ensure implementation of standard operating procedures as updated from time to time
- Evaluate any non-conformity to the environmental standards, as stipulated by different regulatory agencies.
- Ensure and implement necessary corrective actions
- Establish procedures for reporting, document and record control
- Establish and implement procedures for incident and near miss reporting, investigation and root cause analysis and prescribe corrective action.

9.1.2 Institutional Mechanism for Implementation of Mitigation Measures

The effective implementation and close supervision of the environmental management to mitigate the environmental impacts, which are likely to arise due to the construction and operational phases of the project could be achieved through a suitable institutional mechanism. The proposed institutional mechanism recommended for the implementation of the mitigation measures is presented in **Figure 9-1**.

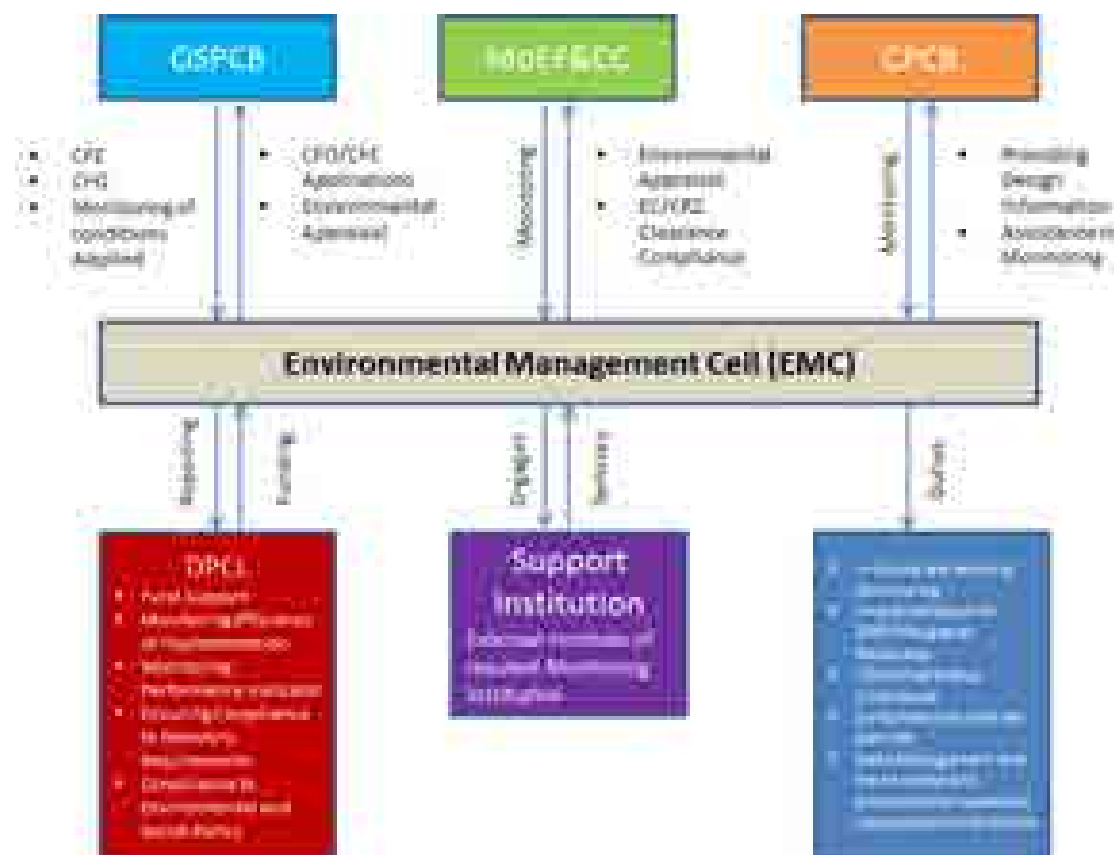


Figure 9-1: Institutional Mechanism for Implementing Mitigation Measures

A proper institutional mechanism to understand and implement appropriate environmental management measures during various stages of the project is a prerequisite and has a strong bearing for the overall success of the project management. Implementation of the Environmental Management measures will become easy once a good project management team is in place.

9.2 Environmental Management Cell (EMC)

The Organizational Setup for Environmental Management Cell (EMC) for DPCL is given as **Figure 9-2**.



Figure 9-2: Organizational Setup for Environmental Management Cell

9.3 Greenbelt Development Plan

With rapid industrialization and consequent deleterious impact of pollutants on environment, values of environmental protection offered by trees are becoming clear. Trees are very suitable for detecting, recognizing and reducing air pollution effects. Monitoring of biological effects of air pollutant by the use of plants as indicators has been applied on local, regional and National scale. Trees function as sinks of air pollutants, besides their bio-aesthetical values, owing to its large surface area.

The greenbelt development not only functions as foreground and background landscape features resulting in harmonizing and amalgamating the physical structures of the project in the surrounding environment, but also acts as pollution sink. Thus, implementation of afforestation program is of paramount importance. It will also check soil erosion, make the ecosystem more complex and functionally more stable and make the climate more conducive.

With a view to attenuate noise propagation and mitigate fugitive air pollution impacts, it is planned to develop a greenbelt in and around the project site. Compatible species identified by DPCL for greenbelt development will be planted. Saplings will be suitably nurtured. Regular watering will be undertaken. Soil conditioning and fertiliser application will be undertaken. If required, suitable soil treatment will be provided to ensure good growth of tree cover. Greenbelt development will be carried out in and around the proposed port along the roadside and on the vacant areas to reduce pollution as well as to improve aesthetic value within port premises. Species recommended by horticulturists will be selected on the basis of air pollution tolerance index of tree. Selection of the plant species will be based on their adaptability to the existing geographical conditions and the vegetation composition of the forest type of the region. During the development of the green belt within the project area, it has to be emphasized that those native plant species should be planted which are good ornamental values and are fast growing with excellent canopy cover.

9.3.1 Objectives of Greenbelt Development Plan

The Greenbelt Development has the following objectives:

- Enhancement of the overall environmental quality
- Provide a shelter belt around the port bulb for dust absorption
- Compliance of the conditions stipulated in the environment clearance
- Improve ambient air quality
- Conserve soil and moisture and provide healthy climatic conditions
- Increase aesthetic value
- Create awareness for environmental conservation and tree planting
- Provide adequate shelter and habitat to the local fauna
- Generate employment for the local people
- Protect human health and prevent pollution

9.3.2 Establishment of Nursery

A large nursery has been established in the port site for production of quality planting material for the plantation. The seedlings of the above mentioned species are raised in the nursery. The nursery is maintained throughout the year and qualified technicians are engaged for production of healthy seedlings. The capacity of the nursery is to produce two lakh seedlings per annum.

9.3.3 Greenbelt Development - Revised Master Plan

Dhamra Port is being developed in various phases. Green Belt development activities were also considered during each phase. Plantation has been carried out on both the edges of the 62.5 km log rail corridor during the Phase I development. Environment / CRZ clearance for phase -II expansion has already been obtained and development has been initiated on the basis of approval. Now, DPCL has proposed for development of Revised Master Plan for which Environment / CRZ clearance process is going on. It is proposed that Greenbelt development plan will be considered inline to the Revised Master Plan layout.

Plantation carried out along Railway corridor (43.0 Ha) during Phase –I operation is given in **Exhibit 9-1**.



Exhibit 9-1: Plantation carried out along Railway corridor during Phase –I Operation

The Phase -I of the Dhamra port has been developed in an area of 234 ha. Phase -II approval has been received to develop additional area of 456 Ha including basin area. Now Revised Master Plan is proposed for total area of 2013.4 ha (including area of Phase I & II).

As part of revised master plan, it is proposed to develop Green belt in an area of 129 Ha as a part of Revised Master Plan (5 Year) and 258.9 Ha (Cumulative) as a part of Revised Master Plan (30 Year). A estimated approx. capital cost of about INR 71.0 Crore will be earmarked for this purpose as a part of 5 Year Revised Master Plan (including Immediate Development Plan). Greenbelt is under development stage. Considering revision in the expansion plan adequate area is kept under consideration for Green belt development. Generic layout plan showing greenbelt development areas in port side under Revised Master planning development is depicted in **Figure FD0901** as Proposed Greenbelt Layout (5 Year Development) including Existing Green Areas and **Figure FD0902** as Greenbelt Layout (30 Year Development).

Based on the availability of area, Greenbelt is normally desirable in 3 tiers i.e. Trees, Shrubs and Small bushes. These 3 tier plantation comprises of native species as lower tier, bushes and shrubs as middle tier and trees as upper tier with an objective to establish biodiversity and food chain; and to improve the local climate regime.

Combination of various species is sought while selecting trees for green belt / vegetation cover. The green belt will be planted close to the source or to the area to be protected to optimize the attenuation within physical limitations.

Locally growing varieties with fast growth rate and ability to flourish even in poor quality soils will be selected for plantation.

9.3.3.1 Species for Plantation

The species proposed will have broad leave. Trees will be selected based on the type of pollutants, their intensity, location, easy availability and suitability to the local climate like coastal adoptability. They have different morphological, physiological and bio-chemical mechanism / character like branching habits, leaf habits, leaf arrangement, size, shape,

surface (smooth / hairy), presence or absence of trichomoes, stomatal conductivity proline content, ascorbic acid content, cationic peroxides and sulphite oxidize activities etc. to trap or reduce the pollutants. Species to be selected will fulfil the following specific requirement of the area “

- Tolerance to specific conditions or alternatively wide adaptability to eco-physiological conditions
- Capacity to endure water stress and climate extremes after initial establishment
- Difference in height and growth habits
- Pleasing appearances
- Should be fast growing and providing optimum penetrability
- Should be wind-firm and deep-rooted
- Should be tolerant to salinity
- Should form a dense canopy
- As far as possible, the species should be indigenous and locally available
- Species tolerant to air pollutants like PM, SO₂ and NO₂ should be preferred
- Should be permeable to help create air turbulence and mixing within the belt
- Introduction of monocultures and alien plant species would be avoided to the maximum possible extent
- Further the plants will:
 - Be fast growing and attaining a height of 5 m or more in 3 to 4 years
 - Have thick canopy cover
 - Be preferably evergreen
 - Have large leaf area index
 - Be resistant to specific air pollutants
 - Maintain species diversity
 - Be able to attenuate noise generated within the area
 - Be well adapted to the existing soil conditions.

The pollutants namely dust/fugitive emissions, sulphur dioxide, smoke and carbon dioxide along with noise pollution can be effectively curbed by planting the below mentioned specific floral species.

Based on the above, the recommended species for greenbelt and plantation are given in **Table 9-2**.

Table 9-2: Recommended Plants for Greenbelt Development

Tier	Types	Proposed Species (Common Name)	Scientific Name	Ecological Significance
1	Bushes	Acalypha	Acalypha sp.	Soil Improver
		Ixora	Ixora chinensis	Soil Improver
		Ficus long island	Ficus oblangeta	Soil Improver
		Inerme	Clerodendrum inerme	Soil Improver
		Eranthemum	Eranthemum sp.	Soil Improver
		Raphais palm	Raphais excelsa	Soil Improver
		Zamia	Zamia furfuracea	Soil Improver
		Kantia palm	Howea forsterana	Soil Improver
2	Shrubs	Kamini	Murraya paniculata	Soil Improver
		Calliandra	Calliandra tweedii	Soil Improver
		Karabira	Nerium oleander	Soil Improver
		Kaniar	Thevetia sp.	Soil Improver
		Tecoma	Tecoma gaudichaudi	Soil Improver
		Bougainvillea	Bougainvillea sp.	Soil Improver
		Tagara	Tabernaemontana spp	Soil Improver

Tier	Types	Proposed Species (Common Name)	Scientific Name	Ecological Significance
		Mandar	Hibiscus rosasinansis	Soil Improver
		Bisnuchuda	Ceasalpenia pulcherima	Soil Improver
3	Trees	Jhaun	Casuarina equisetifolia	Soil Binder & Wind Breaker
		Karanj	Pongamia pinnata	Soil Binder, Noise Abatement, Dust Abatement
		Sunajhari	Acacia auriculiformis	Soil Improver & Wind Breaker
		Neem	Azadirachta indica	Soil Improver & Wind Breaker
		Rupajhari	Acacia mangium	Dust, Particulate & Noise Abatement
		Nilagiri	Eucalyptus sp.	Gases / Particulate Abatement
		Bakul	Mimosops elengi	Noise Abatement, Wind Breaker & Soil Binder
		Radhachuda	Peltophorum ferrugineum	Dust, Particulate & Noise Abatement
		Arjun	Terminalia arjuna	Dust, Particulate & Noise Abatement; Wind Breaker
		Haveli	Thespesia populneoides	Soil Improver & Wind Breaker
		Badam	Terminalia catappa	Wind Breaker & Noise Abatement
		Sirisa	Albizia lebbeck	Soil Binder
		Golden Rain tree	Cassia fistula	Soil Improver & Wind Breaker
		Ou	Dillenia indica	Dust, Particulate & Noise Abatement
		Kaitha	Limonia acidissima	Dust, Particulate & Noise Abatement
		Ashoka	Saraca asoca	Soil Improver & Wind Breaker
		Polanga	Calophyllum inophyllum	Dust, Particulate & Noise Abatement
		Rain Tree	Samania saman	Dust Abatement
		Champa	Michelia champaca	Soil Improver & Wind Breaker
		Mango	Mangifera indica	Dust, Particulate & Noise Abatement
		Shisham	Dalbergia sissoo	Dust & Particulate Abatement
		Bamboo	Bambusa sp.	Soil Binder & Wind Breaker

9.4 Marine Biodiversity Management Plan

Marine Biodiversity Study at Dhamra Port was undertaken by Department of Marine Sciences, Berhampur University, during summer season, 2016. As per the study, 16 species of phytoplankton (5 species of Mediophyceae, 4 species each of Bacillariophyceae and Dinophyceae, 3 species of Coscinodiscophyceae) reported with density of 13 cells/l to 495 cells/l; total of Nine (09) zooplankton forms were recorded during the study with the density of 160 organisms/m³ to 4120 organisms/m³. Lucifer found as the most dominating organism (64%) followed by Copepod (28%), Mysis (4%), Zoea (2%), Chaetognath (1%) and Coelenterate larva (1%). The benthic macrofauna were represented by Polychaets and Nematods only. The Polychaets belongs to family Capitellidae, Cossuridae, Eunicidae, Maldanidae, Nereidae, Poecilochaetidae, Spionidae, Syllidae and Terebellidae. No specimens of priority species were recorded from the study area during field visit

Based on the baseline information, the Marine Biodiversity Management Plan is prepared and the measures suggested may help in minimizing or nullifying the impact of development and extension of the port to the nearby environment. The impacts on the marine diversity should be studied at regular interval to understand the development and its impact on the biodiversity.

The detailed impacts and mitigation measures along with various studies carried out to arrive at the conclusion associated with the marine environment is given in **Section 5.3** of Chapter 5.

Construction and maintenance/operation may lead to short and long term impacts on aquatic and shoreline habitats. Direct impacts may include the physical removal or covering of sea floor, shore, or land side habitat, in addition to changes to water flow patterns and related sedimentation rates and patterns, while indirect impacts may result from changes of water quality by sediment suspension or discharges of storm water and wastewater. The following mitigations shall be followed to minimize the impact of stress factors on the biodiversity and also for their management.

- Data must be collected at regular intervals to evaluate the potential impacts of port construction and operation to shoreline vegetation, wetlands, fisheries, bird life, and other sensitive aquatic and near-shore habitat/habitats (with special consideration for areas of high biodiversity value or those required for the survival of critically endangered or endangered fauna) including Kanika island and nearby mangrove patches.
- Management of Ballast water and tank cleaning will not be allowed during normal operations, however reception facilities in case of emergency will be provided. In such emergency situations Dhamra port should be equipped with adequate reception facilities which can able to prevent the introduction of invasive species. Treatment technologies might include those applied to other effluents accepted in port reception facilities or more specific methods such as filtration, sterilization (e.g. using ozone or ultraviolet light), or chemical treatment (e.g. biocides).
- The green belt area proposed by DPCL, Dhamra is about 129 Ha as a part of Revised Master Plan (5 Year) and 258.9 Ha (Cumulative) as a part of Revised Master Plan (30 Year). The plants which have to be selected for plantation must be indigenous, preferably perennial and evergreen and fast growing trees. Trees should also be planted along the road side in such a way that they act as sink for air pollution.

Priority species (Crocodile, turtle, horseshoe crab): It should be noted that No live specimens were recorded from the study area during field visit. The following measures are provided based on the secondary data information:

- Significant habitats of crocodiles, turtles and horseshoe crab lying outside the protected areas should not be disturbed.
- Low sound producing equipment may be used for the purpose of dredging and other such activities.
- Care should be taken in ship movements with regard to turtle conservation.

Mangroves: The following measures shall be adopted to conserve mangroves:

- Awareness will be given to workers in the port about the importance of mangroves and their conservation
- Discharge of waste/waste water during the construction and operation without treatment in mangrove areas would not be allowed
- Illegal cutting of mangroves for firewood by workers during the construction and operation phases of port would be strictly prevented
- Fuelling stations, petroleum products and hazardous material storage units must be located at minimum 50m distance away from the northern mangrove areas
- Necessary steps should be taken in case of any oil spill or leakage of any hazardous substances in the port area to minimize its impact as per contingency plan.

Protected Faunal Species (species in IUCN and Wildlife Protection Act): The following measures shall be adopted for the protected species.

- Monitoring of occurrence of protected species and their habitat
- Habitat protection
- Awareness among common people
- Conservation of mangrove patches existing in the north of the port, Dhamra estuary and Kanika Island, in support with forest department

The respective government department will take care of the protected faunal species and DPCL will provide the necessary support for the conservation.

Birds: The following measures shall be adopted for birds.

- Avoid using of high sound producing equipment's for longer duration
- Minimise using of light in locations near to mangrove habitats
- Locate dumping sites away from bird residing habitats such as mangrove areas and Kanika island

9.5 Wildlife Including Turtle Conservation Awareness Programme

The DPCL will implement the project in a manner that will not have significant adverse impact on the wild life exists within the study area. The company strives for ecologically sustainable development and has adopted the improved practices to ensure continual improvement of its environmental preferences. It is required to create awareness among the employees of DPCL and the local community regarding importance of wild life in sustenance of life on earth and to be responsible for conservation of nature.

9.5.1 Turtle Conservation

9.5.1.1 Background

Dhamra Port is located outside turtle congregation area and also about 15.0 km north from the nesting beach as the crow flies. The mass nesting and sporadic nesting of Olive Ridley turtle in Odisha occurs at various beach locations to the south of Dhamra river mouth. Beach North of Dhamra river mouth being muddy in nature, there is no scope for turtle nesting in these areas. The forest department continuously monitor and regulate very stringent conservations measures during the congregation and nesting period. As per the requisition of the state government, DPCL provides support to the forest department for patrolling during the period. However, considering the importance of the species and sporadic migration during the congregation period DPCL has designed both lighting and dredging protocol and same is being practiced.

9.5.1.2 Demarcation of Gahirmatha Marine Sanctuary

Major turtle congregation occurs in the Gahirmatha Marine Sanctuary area. As requested by the forest department, DPCL supported demarcation of this protected area by placing marker buoys in the sanctuary boundary. The demarcation has helped the department as well the fisher folk in conserving the turtles.

9.5.1.3 Dredging Management

The channel area is well away from the turtle congregation area and hence there is no regular movement of turtle into the channel area to avoid accidental take, DPCL followed the dredging protocol which may be continued.

9.5.1.4 Awareness Programme for Turtle Conservation

A) Environmental Education for School Students

DPCL has organized an awareness programme on turtle conservation mostly for school children in Dosinga, Dhamra and Chandbali areas of Bhadrak District and Talchua area of Kendrapara District as these schools are situated close to possible turtle nesting areas and the villages inhabited largely by fishing community members.

The main idea of this awareness programme is to spread the knowledge about different species of turtles found world-wide and the arrival of Olive Ridley Turtles to Odisha nesting beaches and about various reasons of their large casualties so that a thought of conservation comes into the minds of young people.

B) Street Theatre for Awareness among Fishermen

DPCL has organized a street theatre programme to sensitise members of fishing community on turtle conservation and teach them about the importance of turtles conservation.

9.5.1.5 Lighting Management

The glare of the port complex lighting system is likely to cause adverse impacts on the Nocturnal fauna and marine creatures. During the hatching of eggs laid by Olive Ridley turtle, the glare of light may destruct their movement to landward side causing desiccations and death. Considering this ecological issues, DPCL has adopted DARK SKY LIGHTING SYSTEM an exemplary activity for the coastal eco system.

This system of lighting doesn't allow the glares to outside and to the sky.

9.5.1.6 Lighting Mitigation Efforts

- All outdoor lighting, roadway lighting, wharf lighting, and lighting mounted on masts or other elevated structures will include no other luminaires except full cut off luminaires. Full cut off luminaires shall meet the (Illuminating Engineering Society of North America) IESNA classification for "full cut off," which describes a luminary having a light distribution with zero candela intensity at or above an angle of 90° above nadir and with no more than 10% of candela intensity at or above a vertical angle of 80° above nadir. All full cut off luminaires will be mounted horizontally so that the angle of 90° above nadir equals the Earth's horizon.
- All outdoor lighting, roadway lighting, wharf lighting, and lighting mounted on masts or other elevated structures will be of the minimum lamp wattage to achieve required safety within the lighted area.
- No area lighting or any lighting mounted on masts or other elevated structures will include fluorescent lamps, mercury vapour (MV) lamps, metal halide (MH) lamps, or other broad-spectrum high-intensity discharge lamp types.
- No lighting of grounds, building walls, signs, cranes, or other elevated structures will employ flood lighting, up-lighting, or other forms of directional lighting aimed above the horizon.

- Lighting of elevated walkways or conveyors will use luminaries that are <70 W HPS and shielded, so that candela intensity above an angle of 90° above nadir is 10% or less.
- Where ever possible, use full cut off fixtures that specify shielding that keeps light at least 15° below the horizontal plane of fixture.
- Where ever possible, use low-pressure sodium vapour lamps or other light sources that exclude wavelengths less than 520 nm.

9.6 Kanika Sand Island Conservation

This island is low lying deltaic mud flat with dense mangrove vegetation. This oval shaped island is roughly 5 km in length and 2.7 km in width. Two small creeks provide access to the interior of the island by small country boats. The sandy beach on the east coast stretches over 6.2 km from north to south with extended sand banks on the south. The width of the sandy beach varies from 50 m to 140 m. The island provides tranquil conditions to the Dhamra port. Kanika Conservation plan has been approved by Department of Forest, Government of Odisha and the funds are being placed for implementation of the same.

9.7 Rainwater Harvesting

The port site falls in a high rain fall zone of coastal Odisha and has also a high ground water table. However, dependable supply of water is linked to surface water sourcing from River Matai and its storage and treatment at the port site. It is therefore necessary to optimally use the available water and augment the same with direct rainwater. The rainwater of the stockyard area is therefore proposed to be drained into the settling pond which can be pumped back for dust suppression and other uses for gardening and plantation.

Direct RWH is not desirable; however suitable measures will be adopted to optimise the water consumption for various operations. The domestic and industrial wastewater will be treated in STP and ETP and treated water will be reused / recycled for horticulture and other purposes, thereby reducing the burden on water consumption.

9.8 Exploring Renewable Source of Energy

9.8.1 Solar Power Harnessing Potential

Solar Power Harnessing has been proposed within the Revised Master Plan of Dhamra port built up areas particularly at available roof tops. The available technologies for generating solar power are mainly Solar Photo Voltaic (PV) Cells and Solar Thermal. Technology of Solar PV Cells is suitable for solar power generation with proper utilization of the roof top areas available on the roofs of buildings/structures within the port premises. The off grid solar PV system will be used for the solar power harnessing in the proposed power plants.

Basic components that are used to build a solar PV system are as follows:

Flat Roof Solar PV Panel mounting systems	Off-Grid Solar PV Power Inverters
Solar PV Panels and solar modules	Solar PV Cables & Connectors
Solar PV Charge Controllers	Solar PV Generation Meters
Solar Batteries	AC & DC Isolators
PV Junction Boxes/PV Combiner Boxes	Solar PV System monitoring

Based on our initial assessment, it is predicted that up to 3MW of Solar energy can be harnessed in this area. Precise capacity will be worked out during detailed engineering of

various structures and will be implemented accordingly. Depending on availability of suitable area, solar power harnessing potential will also be considered during overall implementation of Revised Master Plan.

9.8.2 Wind Energy Harnessing Potential

Wind resource assessment has been done for the Dhamra port and based on the assessment ~40 MW of wind power can be harnessed within the Dhamra port. The tentative location of the Wind Turbine Generators (WTG) within the Dhamra Port is shown in **Figure 9-3**.



Figure 9-3: Identified Wind Turbine Locations within Dhamra Port Area

9.9 DPCL Measures towards India's Commitment for Climate Change

India has in place (since 2008) a **National Action Plan on Climate Change (NAPCC)** aimed to mitigate and adapt to climate change. The NAPCC outlines a number of steps to simultaneously advance India's development and climate change-related objectives. The NAPCC encompasses a range of measures. Table below discusses the NAPCC recommended measures and corresponding measures proposed to be taken up by DPCL as contribution towards meeting the national objectives of NAPCC.

S. No.	NAPCC Measure	DPCL Initiatives
1.	National Solar Mission – promote development and use of solar energy for power	Installation of rooftop solar power projects, Solar Street Lights, etc. Additional details on Solar Power Harnessing potential are provided in Section 9.8.1 .

S. No.	NAPCC Measure	DPCL Initiatives
	generation and other uses	
2.	National Mission for Enhanced Energy Efficiency – energy consumption decreases	Full mechanization of cargo handling and movement, minimise idling time of equipment's, improvement in efficiency in terms of port physical performance indicators such as Average Turn-Round Time, Average Pre Berthing Detention Time, Average Output Per Ship Berth-day, Dwell Time of Cargo, installation of ERTG's etc.
3.	National Mission on Sustainable Habitat – promoting energy efficiency; also emphasizes on waste management and recycling	Proposed development includes setting up a STP and ETP, DPCL will follow 5Rs principles of waste management as part of Swachh Bharat Mission
4.	National Water Mission – improvement in water use efficiency	Optimization. Desalination Plant, Reuse of treated wastewater
5.	Green India Mission – aims at afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23 to 33% of India's territory	Proposed port development includes developing a Green belt area of 129 Ha as per 5 Year Revised Master Plan and 258.9 Ha as per 30 year Revised Master Plan. Distribution of saplings to local people in the surrounding villages as part of CSR activity
6.	Renewable energy – central and the state electricity regulatory commissions must purchase a certain percentage of grid-based power from renewable sources	Explored the opportunities of installing solar and wind based power systems.
7.	Energy efficiency – large energy-consuming industries are required to undertake energy audits and have an energy-labelling program for appliances	Same as Point 2 and 3.

9.10 Occupational Health and Safety

Occupational health and safety are important aspects for any development/industrial/port activity. Occupational health and safety needs attention both during construction, operation and maintenance phases. A broad framework for Occupational health and safety measures is presented in this section.

9.10.1 Occupational Hazards

Occupational health hazards, areas associated with hazards and proposed mitigation measures are given in **Table 9-3**.

Table 9-3: Occupational Health Hazards and Proposed Mitigation Measures

S. No.	Occupational Health Hazard Component	Areas Associated with Hazards	Mitigation
1.	Noise	Construction, operational activities such as cargo handling, storage and transportation, maintenance, and	- Provision of sound-insulated control rooms with noise levels below 60 dB(A) - Procurement of generators to meet applicable

S. No.	Occupational Health Hazard Component	Areas Associated with Hazards	Mitigation
		repair activities like metal working such as welding, cutting; the use of heavy equipment and vehicles, DG sets	occupational noise levels - Identify and mark high noise areas and provision of PPE where people have to enter high noise areas - To reduce the risk of noise exposure isolate noisy equipment and rotate tasks to minimise time spent in a noisy area over an eight hour period.
2.	Confined Spaces	Specific areas for confined space entry.	- Adequate engineering measures shall be implemented to eliminate the degree of confined spaces - Entry into confined spaces should be strictly controlled - Unavoidable confined spaces shall be provided with permanent safety measures - System shall follow "Recommendations for entering enclosed spaces aboard ships" of IMO Resolution A.1050(27) - Local exhaust ventilation shall be installed
3.	Electrical Hazards	Energized equipment, earthing and welding equipments and power lines can pose electrical hazards for workers	- Installation of hazard warning lights shall be taken up - Use of voltage sensors prior to and during workers' entrance - Deactivation and proper grounding of live power equipment and distribution lines according to applicable legislation and guidelines - Provision of specialized electrical safety training to workers - Welding machines and consumables should be kept dry at all times - Adequate earthing for transformers
4.	Fire and Explosion	Handling and storage of fuel, combustible material & products, etc.	- Use of automated fire and safety controls - Implementation of startup and shutdown procedures - Automated sensors and regular cleaning mechanism - Mock Drills
5.	Dust	Dust may arise due to handling of dry bulk cargo	- Use of dust controls such as: - Covered Conveyor - Dust Suppression System at stockyard, Transfer towers, at berth/Unloaders, at wagon (Un) loading, at Truck loading Silos, Discharge and feeding points of Conveyors etc. - Use of Specialised Unloaders - Proper house keeping - Trucks before leaving the loading area shall be covered with tarpaulin and also the railway wagons - Trucks Tyres and areas susceptible for coal dust before leaving premises shall be cleansed washed to remove coal particles. - Use of PPEs
6.	Slip, Trip and Falls	Decks, gratings, ladders and walkways are likely to become slippery or hazardous due to cargo residues, welding rod ends, Spill liquids, scrap metal, etc., Mal	- Good housekeeping practices shall be in place - Adequate lighting shall be provided - Regular maintenance of lifting equipments shall be undertaken - Appropriate fall arrest equipment shall be provided

S. No.	Occupational Health Hazard Component	Areas Associated with Hazards	Mitigation
		operation of lifting equipments	A safe means of access between vessel and shore to prevent falls shall be ensured
7.	Falling objects	Hoisting of material on and off the ship and movement of equipment or material within tanks, engine rooms and pump rooms	- Use of safety helmets - Incomplete works should be stabilized by temporary support and/or bracing systems
8.	Heat	Occupational exposure to heat occurs during operation and maintenance of combustion units, pipes, and related hot equipment like Boilers etc.	- Regular inspection and maintenance of pressure vessels and piping - Provision of adequate ventilation in work areas - Time reduction for work in elevated temperature and ensuring access to drinking water - Shielding surfaces where workers come in close contact with hot equipment - Use of warning signs near high temperature surfaces and personal protective equipment (PPE)

9.10.2 Personal Protective Equipments

The Personal Protective Equipment (PPE) offers protection to worker, co-workers and visitors. Staff should be trained in the correct selection, use and maintenance of PPE. Typically when working at port facilities, minimum PPE should include a long sleeved suit/coveralls, safety footwear, safety helmet, safety spectacles/goggles, torch, gloves and hearing protection. When working aloft, an appropriate safety harness should be utilised. If the work being undertaken could create a potential inhalation hazard then respiratory protection should be worn. It is of paramount importance that prior to use, respirators are checked to ensure that they have been maintained in accordance with manufacturer's recommendations. **Table 9-4** provides list of PPE that shall be used at the port facilities:

Table 9-4: List of Personnel Protective Equipment

Protection For	Equipment	Protection Against
Hand	- Leather gloves - Asbestos gloves - Electrical resistance gloves - Canvas gloves - Hand sleeves	- Cuts due to handling - Heat radiation - Electrical shock - Contact with oil & grease, etc. - Falling of hot slag
Leg	- Leg-guards - Leather safety boots - Asbestos safety boots	- Welding sparks - Striking by objects, fall of objects and stepping on sharp or hot objects - Heat radiation stepping on sharp or hot objects
Eye	Spectacle type goggles with plain shatter proof lens	Foreign bodies entering eyes and reflected arc rays
Head	Fibre Helmet	Fall of objects/hitting against objects during construction, maintenance, etc.
Ear	Ear plugs or muffs	High noise level
Nose	Dust protection mask	Fine dust particles

9.10.3 Occupational Health and Safety Improvement Measures

Following are some of the occupational health and safety improvement measures to be implemented at the port:

- Provision of Personal Protective Equipment (PPE) that is fit for the task to prevent injury and maintain hygiene standards
- PPE should be inspected regularly and maintained or replaced as necessary
- Training of workers in correct use of machinery and safety devices
- Installation of mechanical lifting aids where possible and rotate work tasks to reduce repetitive activities
- Separation of people from moving equipment
- Installation of walkways to separate people from vehicles or moving parts to reduce risk of collision

9.10.4 Health Monitoring

DPCL will establish an occupational health service centre within the port premises to promote and maintain physical, mental and social well-being of the employees. The unit will be equipped to detect and prevent occupational/work related diseases and shall offer effective emergency and injury care. The centre will develop health education training packages including use of PPE for all employees and impart training accordingly. Occupational Health Service shall arrange to provide adequate number of First Aid Boxes with approved contents on the shop floor. Ambulance will also be provided to meet any emergency situations.

The records of health check-up of all employees will be maintained. The occurrence of occupational health hazards and diseases will also be maintained. The records may be reviewed at regular intervals to check the effectiveness of various measures implemented. Based on the review, action plan to improve the effectiveness of occupational health and safety measures shall be prepared.

9.10.5 Safety

Overall safety of men and material is an important aspect of port performance. DPCL shall implement separate safety measures for construction and operation phases and the Safety Engineer shall be engaged to coordinate the safety aspects. All applicable National Safety standards shall be implemented by DPCL to provide safe working environment.

9.10.5.1 Safety Circle

In order to fully develop the capabilities of the employees in identification of hazardous processes and improving safety and health, safety circles would be constituted in each area of work. The circle shall consist of 5-6 employees from that area. The circle shall normally meet for about an hour every week.

9.10.5.2 Safety Training

Safety training shall be provided by the Safety Engineer on a regular basis. In addition to regular employees, contract employees/labours shall also be provided safety training.

9.10.6 Legislations

Legislations relating to Occupational Health & Safety in India (Ref: Report of the Working Group on Occupational Safety and Health – Planning Commission of India, GoI, September 2001) and applicable/relevant to port operations are listed below:

- The Factories Act, 1948 and the State Rules notified there under
- The Dock Workers (Safety, Health & Welfare) Act, 1986
- The Explosives Act, 1884 and the Rules framed there under
- The Petroleum Act, 1934 and the Rules framed there under
- The Indian Electricity Act, 1910 and the Indian Electricity Rules, 1956

9.11 Budgetary Estimates

The budgetary estimate for Capital Environmental Management Cost for 5 Year Revised Master Plan (including immediate development plan) is ~INR 1264.2 crores and the annual budgetary estimate during operational phase is ~INR 69.5 crore. The breakup of cost is given in **Table 9-5** and **Table 9-6**.

Table 9-5: Environmental Management - Capital Cost

S. No.	Purpose	Cost in (Rs.)	Cost (Crores)
1.	Green Belt	710000000	71.0
2.	Solid Waste Management	40000000	4.0
3.	Capacity building	1500000	0.15
4.	Marine life protection - Oil Spill Management resources	801000000	80.1
5.	Air Pollution Control (Sprinkler System, Conveyor Belt with hood, Wagon loading, truck loading with Silos)*	1067500000	1067.5
6.	Environmental Monitoring Construction Phase	24145000	2.41
7.	Effluent Treatment Plant	330000000	33.0
8.	Sewage Treatment Plant	20000000	2.0
9.	Settling Pond for Bulk Cargo	39517500	3.95
Total		12641162500	1264.11625
			1264.2

* **Wind screens will be provided along stack yard.**

Table 9-6: Environmental Management - Annual Recurring Cost

S. No.	Purpose	Cost in (Rs.)	Cost (Crores)
1.	EMC Running expenditure	6900000	0.69
2.	Greenbelt Maintenance	71000000	7.1
3.	Waste Management	9000000	0.9
4.	Awareness campaigns -Training	300000	0.03
5.	Maintenance of tugboat, booms and skimmer etc	40050000	4.005
6.	Maintenance of Air Pollution Control System	533750000	53.37
7.	ETP Maintenance	16500000	1.65
8.	STP Maintenance	1000000	0.1
9.	Maintenance of Settling Ponds for Coal	1975875	0.197
10.	Statutory compliance for environmental protection	14177000	1.4177
Total		694652875	69.46
			69.5

Chapter 10 Summary and Conclusion

10.1 Introduction

Dhamra Port has been developed by “The Dhamra Port Company Limited” (DPCL) by means of Concession granted by Government of Odisha on BOOST basis. The DPCL now is a wholly owned subsidiary of M/s. Adani Ports and Special Economic Zone Limited, who has acquired the entire shareholding of the Company from M/s. Tata Steel Limited and M/s. L&T Infrastructure Development Projects Limited in June, 2014.

DPCL has implemented Phase I facility with two berths and 25 MMTPA capacities to handle Coal, Iron Ore and Lime Stone and has become operational wef May, 2011. Dhamra Port is one of the deepest ports of India with a draught of 18.0 m and can accommodate super cape-size vessels up to 180,000 DWT.

Further to the Phase I development; DPCL has obtained CRZ/EC for Phase II expansion for handling additional 71.3 MMTPA dry bulk cargo, liquid and gas cargo including LNG, POL (LPG), other Break bulk (clean cargo) and 1 million TEUs of containerised cargo. The Consent to establish (NOC) for Phase II expansion was obtained from Odisha Pollution Control Board, vide order no. 2615-IND-II-NOC-5659 dated 19.02.2013. Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India accorded the Environmental and CRZ clearances for Phase II expansion vide their letter no. F. No. 11-104/2009-IA.III dated 1st January, 2014 and further amendment vide letter dated March 25, 2015. Presently DPCL is under process of implementing Immediate Development Plan inline to Phase II EC/CRZ clearance.

With a view to optimize the waterfront area, utilize the maximum marine development potential and Increasing backup area usage to accommodate future cargo projections and business requirement, DPCL proposes to develop Revise the Master Plan based on Five (05) Year and Thirty (30) Year Development Plan.

10.2 Project Site

The Dhamra port is located between Latitude 20° 48'N to 20° 56'N and Longitude 86° 55'E to 87° 16'E on the East Coast of India in Chandabali Tehsil of Bhadrak District in Odisha State. The port is located to the north of Dhamra River mouth. The site provides natural protection for a tranquil harbour where no breakwater is required. The Port limits of DPCL have been defined by Government of Odisha vide Commerce & Transport (Commerce) Department Notification No. 1691-G.P.P.-64/97-com dated the 11th March, 1998.

10.3 Need and Justification for Expansion of Dhamra Port

Seaports play a vital role in overall economic development of the country. About 90% by volume and 70% by Value of the country's international trade is carried on through maritime transport. Realising the need, the Government of India has given adequate thrust to Sea Port infrastructure. In the Maritime Agenda (2010-2020) a target of ~3200 MT Port capacity to handle an expected traffic of ~2500 MT has been set for the year 2020. The Non-Major Ports are expected to play an important role in achieving the target.

The advantages for development/expansion of sea ports in Odisha includes availability of naturally endowed and mineral rich vast hinterland of developing Eastern and Central Indian

States that offers long term potential for cargo shipment. Besides the nearby industrial areas of Odisha and West Bengal, Odisha coast has to serve the land locked States of Jharkand, Chattisgarh, Bihar and Northeastern States.

As a part of National Waterways - 5, MoU (Memorandum of Understanding) with Government of Odisha, Paradip Port and Dhamra Port Company Limited was signed by IWAI on 30th June, 2014 for developing the commercially viable stretch of 332 km in two phases which shows that there is enormous potential of movement of cargo.

Based on the available hinterland the revised traffic forecast for the Dhamra port has been worked out as summarized in **Table 10-1**.

Table 10-1: Phase wise Traffic Forecast in MMTPA

Commodity	Existing	Immediate Phase	5 Year Development	Long Term (30 Year) Development
Dry Bulk Cargo	24.0	62.3	84.0	157.0
Container (MTEU) 1 TEU = 14 MT	-	1	2.15	4.5
Multipurpose & General Cargo	-	8.5	15.0	43.0
Liquid & Gas	-	12.0	21.0	40.0
Total (MMTPA)	24.0	96.8	150.1	303

10.4 Project Benefits

- Probable infrastructure development due to project expansion in the region would facilitate creation of additional/improved communication, health, education, sanitation, hygiene and other basic need of the locality
- Due to proposed project expansion the surrounding population would get maximum benefits from upcoming of industries and its allied ancillary units in shape of direct and indirect employment, self-employment and start up skill development opportunities etc.,
- Improved socio-economic conditions which focused primarily on work force requirements, acquisition of supplies, and increase in industrial activity
- Quality of life in the region is likely to improve due to increase in per capita/per family earning and value appreciation of local resources that would provide economic freedom and facilitate a higher standard of living
- As a part of the Corporate Social Responsibility (CSR), DPCL is strongly committed towards fulfilling its social obligations and has taken up many activities for improving the way of living of people the locality in field of Education, Health care, Rural infrastructure development and Sustainable livelihood development
- The proposed project shall further act as a catalyst to industrialization and urbanization of the region
- During the construction phase there will be large-scale employment generation in the form of skilled, semiskilled labourers and technical staff. During operation phase, direct and indirect employment generation expected is approximately 2200 and 11000 for 5 year development and 4000 and 20,000 for 30 year development respectively.

10.5 Project Description

The Revised Master Plan has been planned for 5 Years and 30 Years. The summary of development proposed is given below:

- Revised master plan development (05 years) – Total quay length will be 6032 m to handle Multi-Purpose and Liquid/Gas/Cryogenic cargoes. Total cargo handling capacity will be approximately 169.5 MMTPA along with increased backup facilities. For easy

evacuation of cargo, a new rail, road and utilities corridor (12 km x 125 m wide) is proposed from Northern side development of Dhamra Port. As a part of Revised Master Plan, it is to further develop additional 2 lane road and 1 rail track in the existing corridor. The Project Cost in line to 5 year Revised Master Plan development is INR 17518 crores.

- Revised master plan development (30 years) – Total quay length will be increased to 11750 m (cumulative) to handle Multi-Purpose and Liquid/Gas/Cryogenic cargoes. Total cargo handling capacity will be approximately 314 MMTPA (Cumulative) by the end of 30 years. The Project Cost in line to 30 year Revised Master Plan development is INR 31415 Crores (additional).

10.5.1 Cargo Mix and Cargo Handling Capacity

As the berths are proposed to be Multipurpose, the various cargos to be handled are combined into TWO broad categories i.e Multi-Purpose (including Liquid) and Liquid/Gas/Cryogenics as represented below.

Table 10-2: Cargo Handling Capacity

Facility/ Component		Immediate Development (MoEF&CC Approved which is under implementation)	Revised Master Plan (First 5 Years)	Revised Master Plan (30 Years)
Capacity (Cumulative)		99.6 MMTPA	169.5 MMTPA	314 MMTPA
Cargo Handling Capacity (Additional)	Multipurpose (including Liquid)	62.08	62.4	143.7
	Liquid/Cryogenic/ Gas	12.5	7.5	-

The details of the cargo proposed to be handled under multi-Purpose and Liquid/ Cryogenic and gas are provided below.

Table 10-3: Cargo mix Details proposed to be handle at Dhamra Port

S. No.	Cargo Type	Cargo Mix
1.	Multipurpose (Including Liquid Cargo)	Coal / Iron ore / limestone / Mines & Minerals & other dry bulk/Fertilizers and raw materials for manufacture of fertilizer / food grains / sugar / clinker / cement / Project cargo / timber & wood / machines/ Iron steel products / Break Bulk etc./Container (3.1 m TEUs for 5 year and 4.66 m TEUs for 30 years) All Class A, B, C petroleum products, excluded petroleum products Including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos. PoL Such as Motor Spirit, Naphtha, High Speed Diesel, Crude Oil, Aviation Fuel, Kerosene, Low Sulphur Heavy Stock/ Furnace oil, Carbon Black Feedstock (CBFS), Paraffin, Bitumen, Lube oil, Asphalt etc.
2.	Gas / Cryogenics/Liquid	LNG, Propane, Butane, LPG, CNG, NG and All Class A, B, C petroleum products, excluded petroleum products Including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos,
		Note: 1. Risk Assessment has been carried out for representative liquid cargos of the above categories keeping in mind NFPA classification to derive worst case scenario. 2. It is implied that any other cargo having lesser risk against the representative cargos considered for RA can be handled. 3. Storage of cargo in the CRZ area will be as per the CRZ Notification 2011 (as amended)

10.5.2 Salient Features

Other Salient features of Revised Master Plan Development are given in **Table 10-4**.

Table 10-4: Salient Features of the Revised Master Plan Development

Features/Description		Unit	Revised Master Plan	
Land		Ha	Total 2013.4 (Cumulative including Phase I (234 ha) and Phase II (456 Ha)) The additional land would include reclamation of Sea/Submerged area 1075.7 Ha and applied vacant Government land of about 247.7 Ha. Total Reclamation will be carried out within a period of 5 years keeping the vision of 30 years	
Diameter of Turning Circle		m	Three (03) Numbers with diameter ranging from 550 – 700m	
Quay Length		-	5 Year Development - 6032m 30 Year Development – 11750m (Cumulative)	
Dredging Quantity		MCM	5 Year development Plan – 110 MCM for (-) 19.0 m CD - Revised Master Plan (30 year) – 140 MCM for (-) 19.0 m CD (Cumulative) - Revised Master Plan (30 year) – 185 MCM for (-) 22.0 m CD (Cumulative)	
Reclamation		MCM	110 (remaining dredged material if any, will be disposed-off at the disposal ground beyond (-) 20 m depth offshore at MoEF&CC approved location)	
Maintenance Dredging		MCM/Annum	~ 16 - 20 MCM/year	
Approach Channel	Outer Channel	Width	-	380 m (one way) for 5 Year; 500 m (two way) for 30 year
		Depth		21.0 km long (total) with 19.0 m depth for 5 year; 21.0 km long (total- 2 way) at (-) 19.0 m CD dredged depth and 24.0 km long (total) at (-) 22.0 m CD dredged depth for 30 year
	Inner Channel	Width		380 m for 5 Year; 500 m for 30 Year
		Depth		19.0 m for 5 Year; 22.0 m for 30 Year
Drinking Water System – Desalination Plant		MLD	<u>Construction Phase</u> 1.95 MLD for both 5 and 30 Year Plan which will be sourced from existing water supply system <u>Operation Phase</u> 21.4 MLD for 5 year and 40 MLD for 30 Year. The maximum water withdrawal for the desalination plant for 5 Years and 30 Years will be 63 MLD and 100 MLD respectively. Up-gradation of Existing Intake on Matai River with Proposed Desalination Plant near existing WTP within the Port premises and Outfall to sea shore near Jetty (same outfall location for LNG/LPG Terminal).	
Seawater Intake and Outfall System for LNG/LPG Terminal		-	Seawater intake quantity of 1,20,000 m³/h and discharge of the same through a pipeline with a diffuser system at outfall location proposed in the harbour basin.	
Power		-	Construction Phase: 6075 kwh/day for 5 year development and 10125 kwh/day for 30 year development Operation Phase: 391000 kwh/day for 5 year development and 816000 kwh/day for 30 year development Odisha Power Transmission Corporation Limited (OPTCL) will provide additional power supply from the Bhadrak substation to the existing substation in the port premises to meet the power demand for the port expansion. The emergency backup of 12 MVA for 5 year development and 30 MVA for 30 year development will be provided by DG sets.	
Greenbelt development		Ha	5 Year – 129 Ha ; 30 Year - 258.9 Ha	

Features/Description		Unit	Revised Master Plan
Connectivity	Dedicated Corridor	-	Dhamra port has already constructed a rail link of 62.5 Km with single line track, connecting the port with the Indian Railway network near Bhadrak railway station. The port has acquired 125 m wide land corridor from Dhamra to Bhadrak for providing exclusive connectivity with the hinterland. Approval has already been obtained for 4 lane road and 2 rail tracks (as a part of Phase I & II Clearance). As a part of Revised Master Plan, it is to develop further additional 2 lane road and 1 rail tracks in the existing corridor. In addition, for easy evacuation of cargo, a new rail, road and utilities corridor (12 km x 125 m wide) is proposed from Northern side development of Dhamra Port. This corridor will connect Dhamra port with existing rail-road corridor near Bansada, Bhadrak. Number of lanes and tracks will be finalised during detailed engineering by using the entire available width.
Environmental / Safety Aspects		-	• Most of the cargo transportation through rail and Pipelines (~ 70%). • Covered Conveyor and Transfer Points • Dust Suppression System at stockyard, Transfer towers, at berth/Unloaders, at wagon (Un)loading, at Track Hoppers, at Truck loading Silos, Discharge and feeding points of Conveyors etc., • Use of specialised ship loaders/unloaders, wagon tippler, track Hopper, covered conveyors and rapid loading system through silos • Proper house keeping • Wind screens will be provided along stack yard • Trucks before leaving the loading area shall be covered with tarpaulin and also the railway wagons • Trucks Tyres and areas susceptible for coal dust before leaving premises shall be cleansed washed to remove coal particles. • Use of -low sulphur diesel fuel is proposed. • Greenbelt Development • Use of Eco friendly regasification technology such as Seawater based/ Ambient Air Based for LNG Regasification. • STP of 1 MLD (5 Year); 2 MLD (30 Year) (Cumulative) • ETP of 3 MLD (5 Year); 5 MLD (30 Year) (Cumulative) • Settling Pond; • Storm Water Drainage System for Inside and some portion of outside port area • Proper Collection, handling and Transport System for Solid Waste Management

10.6 CRZ Compatibility

National Institute of Oceanography (NIO) has carried out demarcation of High Tide Line (HTL), Low Tide Line (LTL) and Coastal Regulation Zone (CRZ) classification of the project site. Based on the survey, CRZ set back lines were demarcated and the project layout was superimposed on CRZ map.

Dhamra Port “Revised Master Plan” facilities falls in CRZ I (B), CRZ III and CRZ IV (A) and the activities proposed in the CRZ area are permissible as per CRZ Notification, 2011, amended till date, as it requires waterfront and foreshore facilities.

The proposed evacuation corridor (Road/ Rail / Pipeline /utility) on the northern side is partly passing through sparse mangroves (CRZ IA). The design of corridor will be as per permissible norms.

Dense Mangroves were observed on the northern side outside the proposed project area and 50 m buffer is ensured. Scattered mangrove trees on the southern side over 9.0ha area are being protected by M/s DPCL. The Revised Master Plan layout is outside the notified Eco Sensitive Zone of Bhitarkanika Sanctuary, Bhitarkanika National Park and Gahirmatha Marine Sanctuary.

10.7 Analysis of Alternatives

As the proposed project has already been established & operational, and this being an Expansion/revision of Master Plan of existing Dhamra port, study of site alternatives has least significance. Various options for layout within the port limits were studied through hydrodynamic and other mathematical modelling with a view to optimise the port design with minimum coastal/environment impact (such as away from ESZ, no R&R and minimal sedimentation in the port) and other suitable operational Conditions.

10.8 Comprehensive EIA/EMP Study

MoEF&CC has approved the ToR vide MoEF&CC letter No: F.No.11-104/2009-IA.III (Pt.) dated February 18, 2016 for Revised Master Plan development of Dhamra port.

DPCL appointed **L&T Infrastructure Engineering Limited, Hyderabad** to carry out the Comprehensive EIA/EMP Study. The EIA study has been carried out comprehensively based on the approved ToR covering both terrestrial and marine environments.

10.9 Description of Environment

Details of the study area and study period considered for the Project baseline data generation is given in **Table 10-5**.

Table 10-5: Study Period and Study Area

Details	Area
Project Influence Area (PIA)/Study Area	An area within 5 km radius from project boundary for primary data generation and 15 km radius as a buffer study area for secondary data generation is considered for baseline environmental surveys.
Study Period	The baseline terrestrial and marine environmental surveys were carried out covering the following seasons: • Summer season, 2014 • Post monsoon season, 2014 • Winter season, 2014-15 • Summer season, 2016

Centre of Envotech and Management Consultancy Private Limited (CEMC), an MoEF&CC and NABL accredited laboratory appointed by DPCL for terrestrial and marine environment during post-monsoon season, 2017 and winter season, 2017-18.

10.9.1 Marine Environment

10.9.1.1 Marine Biodiversity Assessment

Marine Biodiversity Study at Dhamra Port was undertaken by Department of Marine Sciences, Berhampur University, during summer season, 2016. As per the study, 16 species of phytoplankton (5 species of Mediophyceae, 4 species each of Bacillariophyceae and Dinophyceae, 3 species of Coscinodiscophyceae) reported with density of 13 cells/l to 495 cells/l; total of Nine (09) zooplankton forms were recorded during the study with the density of 160 organisms/m³ to 4120 organisms/m³. Lucifer found as the most dominating organism (64%) followed by Copepod (28%), Mysis (4%), Zoea (2%), Chaetognath (1%) and Coelenterate larva (1%). The benthic macrofauna were represented by Polychaets and Nematods only. The Polychaets belongs to family Capitellidae, Cossuridae, Eunicidae, Maldanidae, Nereidae, Poecilochaetidae, Spionidae, Syllidae and Terebellidae. No specimens of priority species were recorded from the study area during field visit

10.9.1.2 Marine Environment Baseline Observation

The marine environment baseline survey observations are provided in the **Table 10-6**.

Table 10-6: Marine Environment – Baseline

Parameters	Unit	Marine Baseline Secondary Data Generated During 2014-2015					
		Summer		Post Monsoon		Winter	
		Min.	Max.	Min.	Max.	Min.	Max.
Phytoplankton	No/ml	4030	8283	3415	7140	2865	7960
Phytoplankton diversity	No of Species	28	42	19	27	15	20
Zooplankton	No/m ³	4257	8283	2495	5720	2505	5310
Zooplankton diversity	No of Species	17	26	12	20	13	19
Salinity	PPT	20.0	34.0	20.4	27.0	30.0	35.0

10.9.2 Terrestrial Environment

The terrestrial environment baseline survey observations are provided in the **Table 10-7**.

Table 10-7: Terrestrial Environment – Baseline

Components	Details
Site Location	Adjoining Villages Amarnagar, Rabindranagar, Dosinga, Balisahi, Kanakprasad, Saratprasad, Kishorprasad and Gourprasad of Chandabali Tehsil, Bhadrak District of Odisha State
Connectivity	Road - Bhadrak – 85km; Bhubaneswar- 220km Rail - Bhadrak – 62km Airport - Bhubaneswar - 220km
Ecologically sensitive zones like wildlife sanctuaries, National Parks and Biosphere Reserves, forests	Bhitarkanika Sanctuary - 2.2 km SSW Bhitarkanika National Park - 1.52 km SSW Gahirmatha Marine Sanctuary - 11.0 km S The Revised Master Plan layout is outside of the notified Eco Sensitive Zone of Bhitarkanika Sanctuary & Bhitarkanika National Park and Gahirmatha Marine Sanctuary, declared vide MoEF&CC Notification No. S.O. 1601 (E) dated the 16 th June, 2015.
Inland, coastal, marine waters	- Bay of Bengal – Abutting E - Dhamra River - 1.6 km South - Matai River - 8.0 km West - Maipura River - 9.3 km South - Galla Nadi - 2.2 km West - Ranhansua River - 12.3 km South

Components	Details
	- Baunsagarh Nadi - 11.2 km S - Bhitra Kanika Nadi - 11.8 km SW - Sanjoga Nadi - 11.1 km SW - Munda Jhor Nadi - 6.6 km SSW - Bhekta Nala - 6.8 km SSW - Mahul Jhor - 3.5 km W - Dosandhi Jhor - 12.4 km NW - Sotra Jhor - 4.9 km WNW - Satabhaya Nala -14 km S - Kanthiakai Nala - 5.5 km S
Archaeological monuments/ Defence installations	Nil
Seismicity	Seismic Zone II – Low Risk Zone
Air Quality	• Ambient concentration of PM₁₀, PM_{2.5}, SO₂ NO₂ and O₃ at nine sampling locations are well within the National Ambient Air Quality Standards (NAAQS), November, 2009 and concentrations of CO, NH₃, C₆H₆, Pb, BaP, As and Ni are found to be Below Detectable Limits (BDL) at all the locations during the Summer 2016 monitoring period. • Ambient Air Quality Status Based on Data Generated During 2014-2015 for all the studied locations shows that concentrations of PM₁₀, PM_{2.5}, SO₂ NO₂ and CO are well within the NAAQS.
Surface Water (SW) Quality	• SW samples monitoring at three sampling locations for Summer 2016 were compared with the Class C, Drinking water source after conventional treatment and disinfection, as Per limits specified in ISI-IS: 2296-1982, and are within the limits except BOD, Fluorides, Cadmium, Chlorides, Chromium, TDS and Sulphate, which might be due to tidal influx, and surface drainage from land area and sewage discharges from nearby habitations. • Surface Water Quality for Data generated during 2014-2015 showed that except Chlorides, TDS, Sulphates, Fluorides, BOD and Arsenic all the parameters are within the limits of Class C, Drinking water source after conventional treatment and disinfection, as Per limits specified in ISI-IS: 2296-1982.
Ground Water Quality	• Ground water monitoring at seven sampling locations for Summer 2016 shows that all Groundwater samples are within the limits specified for drinking water quality standards as per IS: 10500 (2012) • Ground Water Quality for Data generated during 2014-2015 shows that all the samples, except Lead concentrations are within the limits specified for drinking water quality standards as per IS: 10500 (2012).
Soil	• Soil sampling at ten sampling locations are within the study area carried out during the study period. Summer 2016 monitoring results shows that Soil type is mostly Silty Clay to Clay and with slightly alkaline in nature. Soils close to coast have more Conductivity values. • Soil quality data generated during 2014-15 shows that Soil type is mostly clay with normal to slight alkaline in nature
Noise Levels	• Ambient Noise Quality at nine sampling locations for Summer 2016 shows that Day equivalent and Night equivalent noise levels at all locations are within prescribed CPCB standards. • Ambient Noise Quality Status Based on Data Generated During 2014-2015 showed that Day equivalent noise levels equal the standards at two locations and Night equivalent noise levels equal the standards at one location. This might be due to the localised activities at respective location.
Land Use/Land Cover of Project Site	Present land uses of the expansion site are Dry Barren Mud, Dry Mud with Giria Grass, Thorny scrub, Sea/Submerged land which falls in inter tidal zone without any macro vegetation
Land use/ land Cover of the Study area of 15 km radius	Predominantly Sea, Agri- Crop land, Mangrove, Agri- Aquaculture, Built up area, Water Bodies including River/ Stream/ Canals, land with or without

Components	Details
	scrub, sandy area and Scrub Forest.
Topography	Topography of the study area is generally flat and sloping towards East
Meteorology	Predominant wind directions observed are from South west followed by South
Flora and Fauna	Project area was colonized with common halophytic vegetation mainly by <i>Suaeda maritima</i>, <i>Suaeda monoica</i>, <i>Suaeda nudiflora</i>, <i>Sesuvium portulacastrum</i> and <i>Scirpus littoralis</i> and saline adopted species of <i>Acanthus ilicifolius</i>, <i>Prosopis juliflora</i>, <i>Aeluropus lagopoides</i>, <i>Heliotropium curassavicum</i>, <i>Cyperus compactus</i> and <i>Cyperus corymbosis</i>. There are no other notified/declared ecologically sensitive areas such as Nesting areas/Wild life Protected areas/Sanctuaries/National Parks and mud flats in the proposed Port Expansion Area. Scattered (~9 Ha) Mangroves are excluded from the project on the south side. 50m buffer is provided alongside Mangrove patch in the north. Core area (upto 5.0 km) consist of sporadic natural vegetation that include <i>Sesuvium portulacastrum</i>, <i>Suaeda maritima</i>, <i>Suaeda monoica</i>, <i>Suaeda nudiflora</i>, <i>Fimbristylis ferruginea</i>, <i>Acanthus ilicifolius</i>, <i>Aeluropus lagopoides</i>, <i>Avicennia alba</i>, <i>Avicennia marina</i> and <i>Salicornia brachiata</i> are common mangrove species of the core zone (upto 5.0 km). Beside village surrounding has planted trees and farm crop plants. Buffer Area (between 5.0 km to 15.0 km) has more ecologically sensitive areas such as reserve forests, national park and Wildlife sanctuaries. Typical village zones having agricultural activities are predominantly seen in the West side of the project site. Ecologically sensitive areas like Bhitrakanika National Park and Sanctuary and other protected areas (PA) are found within 15 km radius of the project site. Also, there are some Schedule I/IUCN category species reported in the core area (but outside project area) and buffer area. Species belongs to Vulnerable category such as Marsh Crocodile (<i>Crocodylus palustris</i>), and the Olive Ridley Turtle (<i>Lepidochelys olivacea</i>) are reported within core but outside project area and buffer areas respectively.
Fisheries	Total of 72 fishing hamlets (FH) are falling in PIA under Three Tehsils and Two (02) Districts viz. Basudevpur and Chandbali Tehsil in Bhadrak district and Rajnagar tehsil in Kendrapara district. Total fishermen families are 7532 i.e. 23.44 % of total households in PIA. Total fishermen population is 42896 numbers with sex ratio of 928 that forms 25.63% of the PIA population. Nearest fishing harbour is located in Dhamra.

10.9.3 Socio-Economic Conditions

The study area for the socio-economic baseline analysis includes 1 km, 5 km, 10 km and 15 km radius around the Project stretch. As per 2011 Census Handbook of Bhadrak and Kendrapara Districts, Police Station (PS) wise villages coming within the Project Influence area (PIA)/study area are as follows:

- Four (04) PIA Police Station (PS) in Bhadrak district and
- Two (02) Police Station (PS) in Kendrapara district
- A total of Two Hundred and Eighteen (218) PIA villages are falling in the study area.
- In Bhadrak district, One Hundred and thirty Nine (139) PIA villages are falling under Bansada PS, Three (03) PIA villages under Dhamara Marine PS, Twelve (12) PIA Villages in Chandbali PS and Eleven (11) PIA villages under Naikanidihi PS.
- In Kendrapara district, Forty Seven (47) PIA villages under Rajnagar PS and Six (06) PIA villages are getting covered under Jamboo Marine PS.
- Total population of PIA is 1,67,368 with 50.79% Male and 49.21% female population with sex ratio of 969 females to 1000 males
- SC population is 18.01% and the ST population is 1.16% in PIA

- Literacy rate is 70.47% in PIA
- Total workforce in the study area comprises 33.85% of the total population
- As per the District Statistical Data, 2011 almost all the inhabited villages and hamlets in the study area have proper electrification facilities and have access to drinking water sources
- The problem of open defecation is slowly reducing as sincere efforts for construction of toilets are being taken
- Sub-post offices, Branch offices and telephone connections are available in the area
- Nationalised banks are available in big villages and Tehsil headquarters of the study area

10.10 Anticipated Environment Impacts and Mitigation Measures

Anticipated impacts on the environmental and social attributes, which are likely to arise due to construction and operation of proposed project have been identified, predicted and evaluated.

10.10.1 Construction Phase

The development activities such as capital dredging, reclamation, dredge spoil disposal, expansion/modification of navigational facilities, offshore structures will impact marine environment. Site development, civil construction, mechanical erection of infrastructure and backup area development is likely to cause impacts on the terrestrial environment.

Capital / maintenance dredging, reclamation, dredge spoil disposal and development of offshore structures will result in disturbance to marine environment.

Dredge Disposal modelling studies for dumping of about 20 MCM of dredged material at location approved by MoEF&CC vide Phase II EC/CRZ Clearance was carried out. It was observed that the sediment plume from disposal site moves towards north and south and not reaching to the coast or any other eco-sensitive area. The bed level variation over the period of dumping is of the order of 0.16 m and after stopping the disposal of dredge material the bed levels reduces to 0.011m within 4 months which is insignificant.

Most of impacts during construction are short-term in nature and will cease on completion of construction activities.

Summary of possible construction phase impacts and appropriate mitigation measures are discussed below.

10.10.1.1 Impacts due to Capital dredging/ Reclamation/ Disposal/ Construction of Approach Trestle/Berths and other offshore structures such as seawater intake/marine outfall

Possible Impacts:

- Change in marine water quality/Ecology
- Increase in noise levels
- Disturbance to benthic communities
- Changes in species diversity and density
- Impact on nearby mangroves
- Accidental take and light glare on turtle or other macro fauna

Mitigation Measures:

- Dredge Management Programme
- Discharge of waste into sea will be prohibited
- Adoption of standard reclamation and construction methods with containment system
- Slop tanks are provided to barges/ workboats for collection of liquid/ solid waste
- Disposal of unused Dredged material at the identified offshore disposal area only
- Exclusion of scattered mangroves near the southern boundary and care for the mangroves near northern side during reclamation and maintenance of prescribed buffer
- Discharge of toxic/hazardous materials during the port construction would not be allowed.
- Awareness will be imparted to workers in the port about the importance of mangroves and their conservation
- The channel area is well away from the turtle congregation area and hence there is no regular movement of turtle into the channel area.
- DPCL to take appropriate measures to avoid accidental take of turtle during dredging
- Installation of specialised illumination system

10.10.1.2 Material Transport and Construction Activities

Possible Impacts:

- Exhaust emission and noise from vehicles
- Windblown and fugitive emission during material movement and unloading
- Emission and noise from DG sets
- Emission and noise from construction activities
- Disturbance to natural drainage pattern
- Strain on existing infrastructure and traffic addition

Mitigation Measures:

- Impacts during construction phase of the project are temporary in nature and will cease upon completion of construction phase. Necessary measures such as Emission control norms; Periodic checking and washing of vehicles & construction machinery; Adequately sized construction yard; Enclosures on all sides of construction site; Non-peak hour movement and onsite speed control; Water sprinkling; Environmental awareness program; Noise levels to be maintained below threshold levels stipulated by CPCB/OSPCB; Maintenance of construction equipment; Scheduling of High noise generating activities at daytime (6.00 am to 10 pm); Personal protective equipment's etc will be followed/adhered.
- Few natural third/fourth order drains passing through the project site, therefore, storm water drainage network is proposed to facilitate proper drainage of the area by diverting the drains flowing across the project site. Based on existing drainage pattern and catchment area, main outfall drains are proposed to carry storm water discharge from village area and port area into the sea. The requirements of villagers for tide water and boat movement has been duly considered in the drainage plan.
- The area being highly saline and Sea/Submerged inter tidal zone, no major vegetation is present in the proposed expansion area except a narrow strip of thorny bushes.
- Construction activities shall be limited within the site and dust shall be contained within the construction area.
- The existing approach road to Dhamra Port is being widened by GoO which will improve the traffic conditions.
- Proposed National Water Way (NW-5) will also be used for the transport of part of construction material which will reduce likely congestion on road.
- Proper lighting, signboards shall be provided at required locations.

10.10.1.3 Land Reclamation

Possible Impacts:

Impact on the existing water resources such as groundwater and surface water

Mitigation Measures:

- Existing protective bunds (salt dyke) and slope gradient will prevent inundation of salt water to the adjoining land.
- Return seawater from reclamation areas will be channelled back to sea.

10.10.1.4 Marine Side Construction Activities and Fishing

Possible Impacts:

Fishing harbour is located at Dhamra River at 6.5 km southwest boundary of the port. Approach channel of the port is oriented from south to north east whereas fishing boats travels from south to east. Fishing is being carried out at deep sea. Therefore, significant impact on fishing is not envisaged.

Mitigation Measure:

- Proper access to the sea for the local fishermen is considered during planning stage itself.
- This is an existing port hence no direct impact is envisaged.
- Signboards will be placed at the construction activities in order to make fishermen aware of the on-going construction activities
- Necessary marker buoys will be installed
- Regular Interactions will be initiated with the fishing community before commencement of construction works

10.10.1.5 Solid Waste Management including Handling of Hazardous Waste

Possible Impacts:

- Impact on soil quality due to disposal on ground
- Fire accidents
- Impact on terrestrial and marine environment

Mitigation Measures:

- Solid Waste Management Rules, 2016 and Construction & Demolition Waste Management Rules, 2016 will be followed for environmental sound management of respective waste
- Construction waste will be utilized for filling low lying areas
- Hazardous and other waste Management Rules, 2016 will be followed for environmental sound management of hazardous waste.
- OSHA standards will be adopted
- Hazardous wastes will be disposed through approved OSPCB/CPCB vendors.

10.10.1.6 Water Resource

Possible Impacts:

- Water scarcity and pollution on existing surface water body resource.

Mitigation Measures:

- Existing water supply system from Matai river will be utilized
- Groundwater table at Dhamra is high due to high rainfall. However, optimization of water resource will be done
- Based on existing drainage pattern and catchment area, main outfall drains are proposed to carry storm water discharge from village area and port area and discharging into seas.
- Construction camp wastewater will be collected and treated. Treated wastewater will be used for Plantation/Greenbelt development

10.10.2 Operation Phase

The operational phase impacts due to all components of the projects have been identified, predicted and evaluated. Some of the models used for prediction of impacts are given below.

Flow Modelling was carried for neap and spring tide conditions which show that flow regime changes for various tidal conditions in the study domain after the proposed expansion development of the Port are predicted to be not of much significance. Variation in the flow regime (in the current speeds) after the expansion is limited to the development location mostly and found to be very much local in nature. No change in the flow regime of the rest of the domain is observed.

Wave Modelling and tranquillity studies were carried out to establish that tranquillity conditions prevail at the port facility for most of the time in a calendar year. The proposed expansion in the port basin have ensured that the currents and tides around the berths are well within threshold limits applicable for safe berthing of vessels most of the time thus enabling unhindered operations at the port through-out the year.

Sediment transport modelling studies were carried out which show that the changes in the sedimentation processes was localized due to proposed developments and no impact on the other than development area. The change in the bed levels due to the expansion development is not very significant and the change is limited to the basin, berth and approach channel only. The variation in the bed levels before and after development at the port basin location where the berths are located is of the order of 0.42 m over a period of six months & morphological changes around western side of Kanika Island is in the order of 0.3 m over a period of six months. The total maintenance dredged quantity was estimated about 16 Mm³ – 20 Mm³ annually based on the bed morphological studies due to the proposed expansion

Shoreline changes modelling studies were carried out to understand the changes in the nearby shoreline (North & South Side of proposed Expansion, South side of River Dhamra, Kanika Island, Gahirmatha beach, Wheeler Island) due to proposed development with respect to 5 years and 10 years. The shoreline studies shows mostly accretion in the stretches studied, whereas erosion was observed on the north side of expansion area at the rates of -4.38m/ year and on the south side of River Dhamra at the rate of -2.71 m/ year. Suitable mitigation measures will be adopted to maintain the stability of coast.

AERMOD, steady-state" Gaussian model was used to predict the incremental concentration of air pollutants at the receptors in the study area. Results show that predicted incremental/resultant concentrations are within the NAAQS.

All wastewater discharges from the projects will ensure discharge standards stipulated by OSPCB/CPCB.

Some of the operation phase impacts and appropriate mitigation measures during the operation phase of the Revised Master Plan is discussed below.

10.10.2.1 Cargo handling/Inland Cargo Movement/Storage/Regasification/ Equipment Operation

Possible Impacts:

- Emission and Noise due to loading/unloading, DG sets, vehicles, regasification process
- Traffic addition due to cargo from/to port

Mitigation Measures:

- Most of the cargo transportation through rail and Pipelines (~ 70%).
- Use of specialised ship loaders/unloaders, wagon tippler, track hopper, covered conveyors and rapid loading system through silos; Dust Suppression measures; Scientific and regulated stacking of cargo piles; Periodic cleaning of cargo spills; Greenbelt Development; Proper housekeeping; Regularisation of truck movement etc.
- Wind screens will be provided along stack yard
- Use of tarpaulin covers and speed regulations for vehicles/wagons engaged in transportation.
- Acoustic Barriers and Enclosures and Personal Protective Equipment (PPE)
- Proposed National Water Way (NW-5) will also be used for the transport of cargos which will reduce likely congestion on road.
- Dedicated corridor will be sufficient to cater the DPCL revised master Plan transportation requirements.

10.10.2.2 Aqueous Discharges including Accidental Spills

Possible Impacts:

- Impact on marine water quality and ecology due to discharge ship wastes (sullage), sewage, bilge water, Desalination Plant reject water, LNG/LPG regasification return water etc.

Mitigation Measures:

- Ships will exchange Ballast water in deep sea prior to arrival in the harbour; prohibited from discharging wastewater, bilge, oil wastes, etc. into the near-shore as well as harbour waters, Comply with the MARPOL regulation.
- Oil spill contingency plan prepared and will be implemented.
- Desalination Plant reject TDS will be always less than the seawater TDS and hence no significant impact due to reject discharge into marine environment.
- LNG/LPG regasification return water with low temperature (<7°C than ambient) will be sent back through marine outfall system with diffusers at identified location through mathematical model studies which will ensures attainment of ambient conditions (within 600 m) in the harbour area
- Maximum recovery of oil with oil spill control equipment with quick response time

10.10.2.3 Maintenance Dredging

Possible Impacts:

- Impact on marine water quality and ecology

Mitigation Measures:

- Dumping of dredged material will be uniform and at identified location
- Bathymetry monitoring pre and post dumping
- Marine Environment monitoring will be carried out

10.10.2.4 Water Resource

Possible Impacts:

- Impact on existing water resources
- Water quality due to discharge of runoff and brine

Mitigation Measures:

- Raw water from existing intake location at Matai River (Perennial). Maximum water withdrawal shall be 100 MLD (for 40 MLD desalination plant).
- No downstream users are observed beyond the Intake Point at River Matai.
- Government of Odisha has accorded permission for water intake of 5 MLD from Matai River and necessary permission will be obtained from the concerned authorities
- Collection of runoff from stock piles and directing into settling ponds for recycling and supernatant water will be used for dust suppression.
- Neutralisation using lime to ensure settlement of heavy metals, if any.
- STP (1 MLD capacity during 5 year and 2 MLD (Cumulative) capacity during 30 year development) to treat the sewage generated in the premises.
- ETP (3 MLD capacity during 5 year and 5 MLD (Cumulative) capacity during 30 year development) to treat the effluents
- Storm Water Drainage System
- Treated Sewage and effluents shall be reused for dust suppression, irrigating greenbelt and other requirements

10.10.2.5 Seawater (Regasification) and Water (Desalination Plant) Withdrawal

Possible Impacts:

- Impact on marine/river ecology due to Impingement/Entrainment/Entrapment of aquatic life

Mitigation Measures:

- Intake with proper screens and maintaining Low Intake Velocity to minimise the Entrainment & impingement
- Seawater Intake is proposed in protected harbour basin and near to the LNG terminal will reduce major marine organism entry

10.10.2.6 Solid Waste Management including Handling of Hazardous Waste

Possible Impacts:

- Impact on groundwater and soil quality due to disposal on ground
- Fire accidents
- Impact on terrestrial and marine environment

Mitigation Measures:

- 5 R (Reduce /Reuse/Recover/Recycle and Re Process) principle shall be explored
- Solid Waste Management Rules, 2016 will be followed for environmental sound management of respective waste
- Hazardous waste Management Rules, 2016 will be followed for environmental sound management of hazardous waste.
- OSHA standards will be adopted
- Hazardous wastes will be disposed through approved OSPCB/CPCB vendors.

10.10.2.7 Fishing Livelihood

Dhamra port is an existing port which is operational since 2001. Dhamra port and fishing harbour are coexisting in the area and fishermen are well aware of the Dhamra port. Necessary mitigation measures which are being developed will be undertaken during the operation phase of the Revised Master Plan.

10.10.2.8 Presence of Reclaimed Backup Area or Bund

Possible Impacts:

- Impact on Shoreline
- Change in hydrodynamics

Mitigation Measure:

- Variation of flow regime will be limited to development location and localised in nature
- Monitoring of shoreline with the help of high resolution satellite imageries during operation phase shall be carried out periodically.
- Based on the monitoring results and if required, appropriate remedial measures such as beach nourishment/ creation of sand trap/ any other suitable methods shall be carried out to maintain the stability of coast

10.10.2.9 Operation of Port

Possible Impacts:

- Socio-economic conditions of the region
- Natural Hazards
- Induced development

Mitigation Measures:

- Employment generation and local people will be given preference based on qualification and skill. Project will help to enhance the socio economic conditions of the area
- Disaster Management Plan (DMP) is already in place and will be continued after expansion
- Offers an efficient and cost effective supply chain/value proposition to the local importers and exporters

10.10.2.10 Proposed use of LNG FSRU and LPG FSO as an Interim Option

DPCL has an approval to handle LNG of about 12 MMTPA as per Phase II Environmental/CRZ Clearance and the details of LNG Onshore Terminal including Handling, storage and regasification were also given in PFR, ToR and Draft CEIA reports of revised master plan. However, during further review of the LNG Terminal Technical aspects and

development Plan, it has been understood that, Dhamra LNG onshore terminal shall take few years and there is a need for a interim solution to serve the country by alleviating the immediate energy needs. For this purpose FSRU is planned with a maximum capacity of 2.5 MTPA (interim arrangement) as a part of Revised Master Plan. The same was presented during Public Consultation and also can be seen in the public hearing proceedings. This important interim requirement of handling LNG through FSRU is presented in this Final CEIA report for EAC, MoEF&CC kind consideration.

It is pertinent to mention that the impacts and Risks scenarios related to FSRU is much lesser than the impact and Risk predicted for Onshore LNG terminal (as the maximum inventory will not exceed 1,80,000 m³ considered in Risk Assessment) and hence the measures considered for Onshore Terminal will holds good for FSRU .

Similar to LNG, the details of LPG Onshore Terminal including Handling, storage and heating were given in PFR, ToR and Draft CEIA reports of revised master plan. However, during further review of the LPG Terminal Technical aspects and development Plan, it has been understood that, Dhamra LPG onshore terminal shall take few years and there is a need for a interim solution to serve the country by alleviating the immediate energy needs. For this purpose FSO is planned with a maximum storage capacity of the compartments of vessel not more than 25000 MT at a time (interim arrangement) as a part of Revised Master Plan. This important interim requirement of handling LPG thorough FSO is presented in this Final CEIA report for EAC, MoEF&CC kind consideration.

It is pertinent to mention that most of the impacts and Risks scenarios predicted for Onshore LPG terminal will remain same or less compared to FSO and the measures suggested for Onshore LPG terminal will holds good for FSO.

10.11 Additional Studies

10.11.1 Risk Analysis

Risk analysis covering the Hazard Identification including potential release events and Failure Frequency and Consequence modelling of release rate and damage distances was carried out. In this revised master plan development, the proposed cargos are divided into different class i.e. (i) Class - A Petroleum (ii) Class - B Petroleum (iii) Class- C Petroleum (iv) Excluded Petroleum (v) Other Gases and (vi) Other liquid Cargos. In case of accident, all the above cargo likely to cause Fire & Explosion and Toxic effects except other liquid cargos. **Among these cargo, representative items from each class which cause maximum damage distances based on NFPA hazard classification have been selected and risks associated were quantified.** It is implied that any other cargo having lesser risk against the representative cargos considered for RA can be handled. Storage of cargo in the CRZ area will be as per the CRZ Notification 2011 (as amended).

Also, scenarios from other cargos have health hazard as the most probable hazard. The necessary measures will be taken during handling, transfer and storage of such cargos.

10.11.2 Disaster Management Plan

The Disaster Management Plan (DMP) is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in the same order of priorities. For effective implementation of DMP, it should be widely circulated and a personnel training is to be provided through rehearsals/drills.

The Disaster Management Plan (DMP) for Dhamra port is already in place and will be used and improved suitably to match the requirements of revised master plan. The disaster management plan mainly deals with continuous and integrated process of planning, organising, coordinating and implementing measures. An On-Site Emergency Preparedness Plan and Off-Site Emergency Preparedness Plan including Oil spill contingency plan were prepared to deal with emergencies and prevent disasters.

The clear assignment of roles and responsibilities was prepared with which location of Emergency Control Centre and Assembly Points is identified. Communication system and alarm systems for effective communication in the event of a disaster are identified. DMP for natural hazards such as floods, cyclones, tsunami and earthquake was prepared.

10.11.3 Traffic and Transportation Study

The detailed traffic survey was conducted for the road connectivity in the Rail-Road-Utility Corridor from NH-5 (near Bhadrak railway station) to Dhamra Port. The intent of the study conducted involved assessment and evaluation of feasibility for proposing an appropriate category of new road link to connect Bhadrak and Dhamra Port.

Based on the traffic assessment due to the normal traffic and generated traffic due to proposed expansion of Dhamra port and the IRC guidelines the road from Bhadrak to Dhamra port is proposed as Four lane (which is already approved as a part of Phase –II clearance) with future provision of 2 lane road, to be developed as a part of Revised Master Plan. This shall be sufficient to meet the Port Requirement. In addition, for easy evacuation of cargo, a new rail, road and utilities corridor (12 km x 125 m wide) is also proposed from Northern side development of Dhamra Port.

10.11.4 Social Impact Assessment

This assessment is specifically addressing the potential impacts which will be generated as a result of proposed development of Port. It states the following:

- Revision of master plan development will be carried in total area of 2013.4 ha. This includes Phase I - 234 ha, Phase II - 456 ha including basin area, proposed reclamation of Sea/Submerged intertidal area 1075.7 ha, and proposed applied vacant government land 247.7 ha. The site selected is without Habitations hence no R&R issue is envisaged.
- The anticipated impact on nearby settlements during construction phase such as air pollution and the noise generating will be of temporary nature and cease upon completion of the construction.
- Dust suppression measures and enclosures around high noise generating areas will be provided.
- During the construction phase large-scale employment generation in the form of skilled, semiskilled, unskilled and technical manpower is envisaged. During operation phase, direct and indirect employment generation of the proposed revised master plan is expected to be 2200 and 11000 for 5 year development and 4000 and 20,000 for 30 year development.
- A new rail, road and utilities corridor (approx. 12 km x 125 m wide) is also proposed from Northern side development of Dhamra Port for easy evacuation of cargo. Development of Norther UC (mostly Rail corridor) beyond the project area on the northern side will be taken up as a separate project. Necessary clearances from the

relevant authorities such as Department of Railways etc., will be carried out after finalisation of route up to Bansada (where it shall meet existing rail route)

- Development of Revised Master Plan of Dhamra port will not affect the fishing activities nor restrict movement of local fishermen and boats. The Dhamra fishing harbour is located at a distance of 6.5 km from the boundary towards southwest of the port in Dhamra River and this a perfect example where fishing harbour and port coexist without any conflicts. The port management conducts regular consultation with fishermen associations reading safe navigation. Conflicts, if any, with fishing community will be amicably resolved in all cases

10.12 Environmental Monitoring Programme

Environmental Monitoring Programme for construction and operation phases of project has been formulated. The Environmental Monitoring Programme for Both Terrestrial and Marine environment covers the technical and network design of monitoring including measurement methodologies, frequency, location, etc., and budgetary estimates.

10.13 Environment Management Plan

The effective implementation and close supervision of the environmental management to mitigate the environmental impacts, which are likely to arise due to the construction and operation phases of the project will be best achieved through a suitable institutional mechanism.

Environment Management Plan for the revised master plan has been prepared keeping in mind the sensitivity of area in the vicinity of Dhamra port and DPCL commitment towards sound environment management. The environment management plan consists of Greenbelt Development Plan; Marine Biodiversity Management Plan; Wildlife including Turtle Conservation Awareness Programme; Kanika Sand Island Conservations; Exploring Renewable Source of Energy in terms of Solar and Wind; DPCL Measures towards India's Commitment for Climate Change; Occupational health and Safety etc., Apart from these the designed inbuilt components such as Air pollution abatement measures, water and wastewater treatment measures, Storm water management Plan, Stockyard runoff management plan, Noise abatement measures, Solid and hazardous waste management measures, selection of suitable outfall locations etc., which will ensure effective environment management.

10.14 Budgetary Estimate for Environment Management

The budgetary estimate for Capital Environmental Management Cost for 5 Year Revised Master Plan (including immediate development plan) is ~INR 1264.2 Crores and the annual budgetary estimate during operational phase is ~INR 69.5 Crores.

10.15 Corporate Social Responsibility and Corporate Environment Responsibility

DPCL is strongly committed towards fulfilling its social obligations and has taken up many activities for improving the way of living of people of Dhamra and other nearby villages. Major CSR activities are carried out in following areas:

- Education
- Community Health
- Sustainable Livelihood Development
- Rural Infrastructure Development

An amount of INR 8.0 Crores has been budgeted for 2016 – 17 under Education, Community health, Sustainable Livelihood Development, Environment Programme and Rural Infrastructure Development. The CSR is one of the mandatory and regular activities of DPCL and the same shall be implied for Revised Master Plan. DPCL is committed to carry out CSR activities in above all focussed areas and will spent INR 15 Crores for next three years. Same will be reviewed on yearly basis and accordingly implemented.

As a responsible company towards the conservation, restoration and redevelopment of ecosystem and environmental conditions in the vicinity of the Dhamra Port, DPCL shall implement the Corporate Environmental Responsibility (CER) activities as a part of Revised Master Plan development as per MoEF&CC Office Memorandum F. No. 22-65/2017-IA.III dated May 01,2018.

Chapter 11 Disclosure of Consultants Engaged

The Dhamra Port Company Limited (DPCL) would like to optimize the waterfront area to utilize the maximum marine development potential and backup area usage to accommodate future cargo projections and business requirement, therefore, DPCL intends to Revise the Master Plan based on Five (05) Year and Thirty (30) Year Development Plan

They have then appointed L&T Infrastructure Engineering Ltd (LNTIEL), Hyderabad (formerly known as L&T-RAMBØLL Consulting Engineers Limited), to complete the CEIA study due to the proposed expansion of Dhamra Port at Bhadrakh District in Odisha. The nature of consultancy service rendered covers both terrestrial and marine environmental assessment.

Brief Profile of L&T Infrastructure Engineering Ltd.

L&T Infrastructure Engineering Ltd., a subsidiary of Larsen & Toubro Limited is a leading multi-disciplinary Indian Consultancy firm. LNTIEL has made a distinctive mark by creating new standards in providing sustainable solutions. Today, LNTIEL is distinguished from others not limited to its lineage but its relentless quest for quality - a unique tradition of placing client's needs above all.

LNTIEL offers a diverse array of talents together with practical experience. We assure our clients a professional approach by innovation and evolving optimal solutions. At LNTIEL, we recognise that human resources are the key to organisational success. LNTIEL's expertise ranges across a broad spectrum of sectors with special forte in Infrastructure Projects and Industrial Parks/SEZs. LNTIEL has expertise in carrying out Techno-Economic Feasibility Studies, Preparation of Master Plans & Detailed Project Reports and Bid Process Management. LNTIEL is rendering the following services for Specialised Industrial Clusters/s/Industrial Parks/Investment Regions:

- Environmental and Social Impact Assessment including assistance to Client in obtaining necessary clearances/approvals from various statutory authorities: State PCB's, Coastal Zone Management Authorities (CZMA's), MoEF&CC (GoI)
- Field surveys (Terrestrial & Marine Environments) and investigations
- Numerical modelling especially for the marine projects
- Project formulation/conceptualisation & configuration
- Market study and demand assessment
 - Master planning, Urban planning, Environmental planning and Tourism planning
- Infrastructure design and engineering
- Block cost estimation
- Economic and financial analysis
- Bid Process Management
- Assistance in domestic and international marketing including road shows/investors conference (or meet) for marketing the project.
- Assistance to Client in achieving technical and financial closures

Strengths of LNTIEL

LNTIEL has a well-equipped Corporate Office at Chennai. LNTIEL's staffs is replete with a wide range of professionals – Planners, Engineers, Designers, Environmental and Social Specialists, Financial Analysts, Project Structuring, Marketing and Privatisation Experts, Construction Supervision Managers – covering a wide spectrum of services. The skills of the Experts are continuously aligned to suit the changing Client requirements. LNTIEL has strategic tie-ups with Associates for specialized services. Services of an eminent group of

Expert Consultants are also available to LNTIEL. Our clients value the highly motivated and dedicated team of professionals who assure them international quality service through focused and optimal solutions.

LNTIEL provides a stimulating working environment. We have assembled a team of skilled, creative and dynamic professionals who strive to translate the organisational ethos into reality. To enhance the efficiency of the personnel and enable them to be updated with the latest developments in technology, we organise comprehensive technical training programmes and organisational development programmes at regular intervals. A creative work environment, motivated staff, structured training, latest methodologies and tools, continuous adherence to quality, adoption of best ethical standards and a keen client orientation are the factors that spur on LNTIEL's journey into the future. Our driving philosophy is 'Client First'. We work towards complete satisfaction of our clients by adopting good work practices and meeting their requirements through timely delivery of appropriate solutions. Further for achieving this objective, we have acquired state-of-the-art IT facilities and software to ensure quality in all spheres of our activity.

LNTIEL has modern fully computerized offices with latest computational and communication facilities. A large number of high-end computers are available and are connected by a network. Further, data one Internet connectivity enables fast exchange of information with the clients, as well as within the offices and the parent companies. These facilities help us to provide our clients high quality services within the shortest possible time. Besides several expert consultants hired regularly for various highly skilled expertise requirements, LNTIEL has more than 300 regular employees at four offices forming a leading consulting group with extensive operations at Chennai, Hyderabad, Delhi and Mumbai.

Quality Policy of LNTIEL

LNTIEL is committed to achieve and sustain excellence in consultancy services to customers world-wide through an in-house Quality Management System that conforms to ISO 9001:2008. The commitment stated above will be fulfilled by:

- Working towards complete satisfaction of LNTIEL's customers by adopting good work practices and meeting their requirements through timely delivery of appropriate solutions.
- Striving to achieve continual improvement of quality management system through periodic review of quality policy, processes and quality objectives.
- Striving to maintain well-qualified and motivated staff by empowering them and providing a stimulating work environment.
- Adhering to the best ethical standards for business behaviour by respecting the rules of law governing LNTIEL's business and presenting a well-audited financial statement every year.
- Impelling employees at all levels in achieving the objectives of the organisation and ensuring that all employees are aware of and act within the policy framework of LNTIEL.
- Propagating our quality policy and procedures to our sub-consultants and associates and ensuring adherence to the relevant components of the quality system.

QCI-NABET - EIA Accreditation

National Accreditation Board for Education & Training (NABET) is a constituent board of the Quality Council of India (QCI). QCI, NABET has accredited LNTIEL formerly known as L&T-RAMBØLL Consulting Engineers Limited for carrying out EIA studies in the following Ten (10) sectors:

1	Ports, Harbours, Jetties, Marine Terminals, Break Waters and Dredging
2	Industrial Estates/Parks/Complexes/Areas, Export Processing Zone (EPZs), Special Economic Zones (SEZs), Biotech Parks and Leather Complexes
3	Highways, Railways, Transport Terminals, Mass Rapid Transport Systems
4	River Valley, Hydel, Drainage and Irrigation Projects
5	Airports
6	Thermal Power Plants
7	Common Effluent Treatment Plants (CETPs)
8	Common Municipal Solid Waste Management Facility (CMSWMF)
9	Building and construction projects
10	Townships and Area development projects

Further details may be seen on the following URL: www.lntiel.com.

11.1 Sub Consultants Engaged

The environmental impacts due to the expansion of the existing port involve both terrestrial and marine environmental surveys. For these surveys, project proponent/ LNTIEL appointed reputed institutions/agencies as per the guidelines of statutory authorities. The agencies/organizations appointed for conducting the marine and terrestrial environmental surveys during summer season of 2016 are M/s Vison Labs, Hyderabad and Department Of Marine Science, Berhampur University as per the approved ToR and for Three (03) seasons survey i.e. Summer season, 2014, Post monsoon season, 2014 and Winter season, 2014-15 are **Centre for Advanced Studies in Marine Biology** (CASMB), Annamalai University, Parangipettai, Chidambaram and M/s Vitro Labs, Hyderabad.

Risk analysis covering the hazard identification and consequence analysis for handling of hazardous cargo during the Revised Master Plan is done by RS Geoinformatics Solutions Private Limited

These agencies/organizations have been identified based on the credentials, commitment to the quality of output and deliverables, relatively low price, flexibility in fee negotiations, etc.

11.1.1 M/s Vison Labs, Hyderabad

Nature of consultancy service rendered: Terrestrial Environmental Survey

M/s. Vison labs was established in 2002. The agency is offering consultancy services in generation of baseline terrestrial environmental data for the detailed EIA studies. The organization has attained the recognition from the Ministry of Environment Forest and Climate Change (MoEF&CC) and National Accreditation Board for Testing and Calibration Laboratories (NABL). Vison Labs is also an ISO 9001:2000 Certified agency in the fields of environmental monitoring and analytical chemistry and other similar services. Further details on the agency may be seen on the following URL: www.visionlabs.com.

11.1.2 Department Of Marine Science, Berhampur University

Nature of consultancy service rendered: Marine Biodiversity Study

Department of Marine Sciences was established in the year 1978 in Berhampur University. Berhampur University is the only university in the state which offers M.Sc., M.Phil. and Ph. D/D.Sc. courses in Oceanography and Marine Biology. The prime objective to

establish such a department was to prepare quality manpower in the field of Marine Sciences, both through teaching and research, to meet the demand of the state as well the country.

Odisha has a long coastline of 480 Km. and is bestowed with unique ecosystems, estuaries, coastal and marine living and non-living resources and beautiful sandy beaches. Developmental activities such as construction of ports and harbours, aquaculture and other industries, tourism etc. are mostly concentrated along the coastal belt. But coastal hazards such as cyclones and floods, which very often ravage the Odisha coast, retard the developmental activities to a large extent. Keeping in view the strategic importance of the coastal areas of Odisha for defence, tourism etc., the Govt. of Odisha in co-ordination with the Central Government has initiated the integrated Coastal Zone Management (ICZM) programme for all round development of the state.

Therefore to promote such activities and to make sustainable management of the natural and physical resources of the coastal environment, and to provide the right momentum to the developmental activities, there is an imminent need to involve skilled manpower in the field of Marine Sciences. The Department of Marine Sciences has been striving to achieve this goal since its inception. Besides the development of the state, the students of Marine Sciences are actively involved in the national and international development and a few of them have proved themselves as leaders in the field of Marine Sciences and allied subjects. Further details above the agency will be available on the following URL: www.buodhisha.edu.in

11.1.3 M/S. Vitro Labs, Hyderabad

Nature of consultancy service rendered: Terrestrial Environmental Survey

M/s. Vitro labs was set up in the year 1989. The agency is offering consultancy services in generation of baseline terrestrial environmental data for the detailed EIA studies. The organization has attained the recognition from the Ministry of Environment Forest and Climate Change (MoEF&CC) and National Accreditation Board for Testing and Calibration Laboratories (NABL). Vitro Labs is also an ISO 9001:2000 Certified agency in the fields of environmental monitoring and analytical chemistry and other similar services. Further details on the agency may be seen on the following URL: www.vitrolabs.net

11.1.4 Centre for Advanced Studies in Marine Biology, Annamalai University, Parangipettai

Nature of consultancy service rendered: Marine Environmental Surveys

The Centre of Advanced Study in Marine Biology (CASMB) is a reputed Marine Institute in India which is actively engaged in teaching, research and extension activities with an ideal location and easy access to different biotopes such as estuary, mangrove, backwaters and coastal waters. It has made rapid strides in various facets of Marine Science.

Research contribution through the years to Marine Science pertaining to the tropical environment by this Centre resulted in the establishment of exchange programmes with research institutions of the United Kingdom and the United States of America. The major thrust areas identified for the Centre by the experts of the UGC visiting committee are Biological Oceanography, Physical & Chemical Oceanography, Physiology, Biochemistry & Microbiology, Fishery Science and Ecology & Aquaculture.

The ENVIS Centre (Environmental Information System), which is one among the 78 Centres in the country sponsored by the Ministry of Environment Forest and Climate Change (MoEF&CC), Government of India, New Delhi, started functioning from March 2, 1992 at the

Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai, Tamil Nadu, a pioneering Marine Biological Research Institute.

This Centre is meant to collect information on Estuaries, Mangroves, Coral reefs and Lagoons. The Centre has been serving with a motto to "Collect, Collate and Disseminate" and is engaged in several information services viz., query/answer, and abstract service, press clipping service, publication and development of database for the benefit of user community.

In addition to ENVIS Centre, ENVIS Node on the Environmental Management Capacity Building - Technical Assistance Project (EMCB-TAP) on Estuaries, Mangroves, Coral reefs and Lagoons has been established by the Ministry of Environment Forest and Climate Change (MoEF&CC), Government of India, under the World Bank (WB) Assistance.

ENVIS centre has also been selected as one among the 20 Sustainable Development Network Partners (SDNP) of ENVIS under Indo-Canada Environmental Facility (ICEF) Project, India. Further details on the agency may be seen on the following URL: www.casmbenvvis.nic.in.

11.1.5 National Institute of Oceanography (NIO), Visakhapatnam

Nature of consultancy service rendered: HTL, LTL & CRZ Demarcation Studies

The NIO is a constituent laboratory of the Council of Scientific and Industrial Research (CSIR). Founded in 1966, it has its headquarters at Goa and regional centres at Mumbai, Kochi, and Visakhapatnam. NIO has laboratories for oceanographic research, a well-equipped library and a coastal research vessel, CRV Sagar Sukti, which is equipped for coastal studies.

NIO provides services to industrial organisations to address issues that concern marine waters. It offers training in the collection and processing of oceanographic data and in analytical methods. NIO conducts courses on topics in ocean science and technology. A number of students work on their doctoral research under the guidance of NIO researchers.

The regional centre at Visakhapatnam was set up in 1976 is responsible for the research programmes pertaining to Indian coast with special emphasis on Marine Geophysics. Besides geological and geophysical surveys in the near shore regions, the Centre also has contributed to the offshore placer deposits. It has covered entire Bengal Fan region and identified major structural features having relation with hydrocarbon deposits. The Centre has developed capability to monitor pollution and conduct environmental impact assessment related studies. Further details above the agency will be available on the following URL: www.nio.org.

11.1.6 RS Geoinformatics Solutions Private Limited

Since 2007 RS Geoinformatics Solutions Pvt. Ltd. Has been involved involved in providing geospatial solutions to its clients across the world, It is involved in the acquisition, and analysis of geospatial mapping data and how it is applied to meet the needs and challenges of its clients. The services RS Geoinformatics offers are Risk Assessment, Quantitative Risk Assessment (QRA), Digital Aerial Triangulation, Planimetric Mapping, Digital Topographic Mapping, Digital Orthophoto process, LiDAR classification, 2D Mapping & GIS conversion, Training & Development as well as Assistance in dissertation to university students. More information of this agency may be seen in the following URL: www.rsgeoinformatics.com.



L&T Infra Engineering

L&T Infrastructure Engineering Limited

6-3-1192/1/1, 5th Floor, Block No.3,
White House, Kundan Bagh, Begumpet, Hyderabad – 500 016
Ph: 91-040-40354444; Fax: 91-040-40354430

F.No.11-104/2009-IA-III
Government of India
Ministry of Environment, Forest and Climate Change
(IA.III Section)

Indira Paryavaran Bhawan,
Jor Bagh Road, New Delhi - 3

Date: 15th November, 2019

To,

M/s Dhamra Port Company Ltd,
Fortune Towers, 2nd Floor, Chandrashekharapur,
Bhubaneswar - 751023, Odisha
E- Mail: environment.dhamra@adani.com

Subject: Revised Master Plan Development of Dhamra Port in Bhadrak District, Odisha by M/s Dhamra Port Company Limited - Environmental & CRZ Clearance - reg.

Sir,

This has reference to your online Proposal No. IA/OR/MIS/107539/2009 dated 24th June, 2019, submitted to this Ministry for grant of Environmental and CRZ Clearance in terms of the provisions of the Environment Impact Assessment (EIA) Notification, 2006 and Coastal Regulation Zone (CRZ) Notification, 2011, under the Environment (Protection), Act, 1986.

2. The proposal for 'Revised Master Plan Development of Dhamra Port' in Bhadrak District, Odisha by M/s Dhamra Port Company Limited was considered by the Expert Appraisal Committee (Infra-2) in the Ministry in its 44th meeting held during 23-25 September, 2019.
3. The details of the project, as per the documents submitted by the project proponent, and also as informed during the above said EAC meeting, are reported to be as under:-
 - (i) Dhamra Port has been developed by "The Dhamra Port Company Limited" (DPCL) by means of Concession granted by Government of Odisha on BOOST basis. The DPCL now is a wholly owned subsidiary of M/s. Adani Ports and Special Economic Zone Limited. The Dhamra port is located between Latitude 20°48'N to 20°56'N and Longitude 86°55'E to 87°16'E on the East Coast of India in Chandabali Tehsil of Bhadrak District in Odisha State.
 - (ii) DPCL has implemented Phase I facility with two berths and 25 MMTPA capacities to handle Coal, Iron Ore and Lime Stone and has become operational w.e.f. May, 2011. Dhamra Port is one of the deepest ports of India with a draught of 18.0 m and can accommodate super cape-size vessels up to 180,000 DWT.
 - (iii) Further to the Phase I development, DPCL has obtained EC&CRZ clearance for Phase II expansion for handling additional 71.3 MMTPA dry bulk cargo, liquid and gas cargo including LNG, POL (LPG), other Break bulk (clean cargo) and 1 million TEUs of containerized cargo. Presently, DPCL is under process of implementing Immediate Development Plan inline to Phase II EC&CRZ clearance obtained through vide letter F.No.11-104/2009-IA.III dated 01.01.2014 and further amendment vide letter dated 25.03.2015. Out of this approved capacity, 12.0 MMTPA of LNG component has been transferred in favour of M/s Dhamra LNG Terminal Private Limited vide letter F.No.11-104/2009-IA.III dated 29.07.2019.
 - (iv) In Revised master plan development (05 years), the Total quay length will be 6032 m to handle Multi-Purpose and Liquid/Gas/Cryogenic cargoes. Marine structures of the port will be developed with the flexibility to handle various cargos. Type of berth and type of cargo is a commercial and business requirement. So master plan is revised with those flexibilities to accommodate berths as multi-purpose. Total cargo handling

capacity will be approximately 169.5 MMTPA along with increased backup facilities. For easy evacuation of cargo, a new rail, road and utilities corridor (12 km x 125 m wide) is proposed from Northern side development of Dhamra Port. As a part of Revised Master Plan, it is to further develop additional 2 lane road and 1 rail track in the existing corridor. In Revised master plan development for 30 years, the Total quay length will be increased to 11750 m (cumulative) to handle Multi-Purpose and Liquid/Gas/Cryogenic cargoes. Total cargo handling capacity will be approximately 314 MMTPA (Cumulative) by the end of 30 years.

- (v) The cargo mix includes (i) **Multipurpose (Including Liquid Cargo)** (Coal / Iron ore / limestone / Mines & Minerals & other dry bulk/Fertilizers and raw materials for manufacture of fertilizer / food grains / sugar / clinker / cement / Project cargo / timber & wood / machines/ Iron steel products / Break Bulk etc./Container (3.1 m TEUs for 5 year and 4.66 m TEUs for 30 years), All Class A, B, C petroleum products, excluded petroleum products including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos. PoLSuch as Motor Spirit, Naphtha, High Speed Diesel, Crude Oil, Aviation Fuel, Kerosene, Low Sulphur Heavy Stock/ Furnace oil, Carbon Black Feedstock (CBFS), Paraffin, Bitumen, Lube oil, Asphalt etc.) and (ii) **Gas / Cryogenics/Liquid** (LNG, Propane, Butane, LPG, CNG, NG and All Class A, B, C petroleum products, excluded petroleum products including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos).
- (vi) The Outer Navigational Channel dimensions will be 21.0 km long (total) with 19.0 m depth and 380 m (one way) width for 5 year. Outer Channel dimensions for 30 year will be 21.0 km long (total- 2 way) at (-) 19.0 m CD dredged depth with a width of 500 m (two way) and further it will be extended to 24.0 km long (total) at (-) 22.0 m CD dredged depth. The Inner Channel dimensions will be 380 m width with 19.0 m Depth for 5 Year and 500 m width with 22.0 m Depth for 30 Year.
- (vii) Revision of master plan development will be carried in total area of 2013.4 ha. This includes Phase I - 234 ha, Phase II - 456 ha including basin area, proposed reclamation of Sea/Submerged intertidal area 1075.7 ha, and proposed applied vacant government land 247.7 ha.
- (viii) Revised Master Plan consists of Bulk Material Handling Area/ Container Terminal Backup Area/ Multipurpose Cargo Backup Area/ Liquid Tank Farm/ Go down Area/ LNG/LPG/Cryogenic Terminal/ Miscellaneous (Open Storage + recreational facilities + etc.) and Gate Complex & Parking, Greenbelt, Internal Rail and Road Approaches and Corridors, Excluded Scattered Mangrove Area, Desalination plant + ETP + STP + WTP, Buildings + Workshops etc.
- (ix) The Greenbelt development is planned in an area of about 129 Ha during 5 Year and 258.9 Ha during 30 Year.
- (x) Present land uses of the expansion site are Dry Barren Mud, Dry Mud with Giria Grass, Thorny scrub, Sea/Submerged land which falls in inter tidal zone without any macro vegetation. The Revised Master Plan Layout is outside the Eco Sensitive Zone of Bhitarkanika Sanctuary & National Park which was declared as per Gazette Notification dated 16.06.2015.
- (xi) The Dredging Quantity for 5 Year development Plan will be 110 MCM and for Revised Master Plan (30 year) will be 140 MCM (Cumulative)for (-) 19.0 m CD two way channel and 185 MCM for (-) 22.0 m CD (Cumulative). The total reclamation will be carried out with in a period of 5 year keeping the vision of 30 years plan. About 110 MCM dredged material will be utilized for reclamation and remaining dredged material will be disposed-off at the disposal ground beyond (-) 20 m depth offshore at MoEF&CC approved location and the same was selected after carrying out hydro dynamic modeling study. The maintenance dredging quantity is estimated at ~ 16 - 20 MCM/year.

J. K. Singh

- (xii) Estimated water requirement for the construction phase is 1.95 MLD and same shall be met through the bowzers and existing water supply system. The water requirement during operation phase will be 21.4 MLD for 5 year and 40 MLD for 30 Year. The maximum water withdrawal for the desalination plant for 5 Years and 30 Years will be 63 MLD and 100 MLD respectively. Up-gradation of Existing Intake on Matai River with Proposed Desalination Plant near existing WTP within the Port premises and Outfall to sea shore near Jetty. Process water for LNG and LPG will be taken from sea and discharged back in to the sea. Seawater intake quantity of 1,20,000 m³/h and discharge of the same through a pipeline with a diffuser system at outfall location proposed in the harbour basin. The discharge location/outfall point is be finalized after dispersion modelling studies.
- (xiii) Wastewater Treatment facilities such as STP of 1 MLD (5 Year) and 2 MLD (30 Year) (Cumulative) as well as ETP of 3 MLD (5 Year) and 5 MLD (30 Year) (Cumulative) will be developed.
- (xiv) The quantity of municipal solid waste generated from canteen and administrative areas is estimated at about 7.92 TPD for 5 Years development and 14.4 TPD for 30 Year development, of which 60% will be bio-degradable and 40% non-biodegradable. Organic Waste Converter will be provided to treat the bio-degradable wastes. Composted bio-degradable waste will be used as manure in greenbelt/ gardens and Other recyclable wastes will be sold to OSPCB authorized vendors.
- (xv) The hazardous waste such as used oil/spent oil, wastes/residue containing oil/Oil soaked rags/cotton waste, discarded containers/barrels & used battery and sludge from ETP will be handled as per Hazardous Waste Management Rules (as amended). The hazardous wastes generated at the Dhamra Port will be disposed at nearby Treatment, Storage and Disposal Facility (TSDF) or Common Hazardous Waste Incineration facility (CHWIF) and also sent to the approved vendors of Odisha State Pollution Control Board (OSPCB) and CPCB. The nearest TSDF is located at village Kanchichuan, PO Mangalpur, district Jajpur, at a distance ~150km by road.
- (xvi) Operation Phase power requirement will be 391000 kwh/day for 5 year development and 816000 kwh/day for 30 year development. Odisha Power Transmission Corporation Limited (OPTCL) will provide additional power supply from the Bhadrak substation to the existing substation in the port premises to meet the power demand for the port expansion. Renewable energy sources like wind and solar are explored and it is estimated based on initial assessment that about 40 MW from wind energy and 3 ME from solar energy can be harnessed.
- (xvii) Necessary air pollution abatement measures such cargo transportation mostly through rail and Pipelines (~ 70%), Covered Conveyor and Transfer Points, Dust Suppression System, Use of specialized ship loaders/unloaders, Covered wagon tippler and track Hopper, rapid loading system through silos, Wind screens, covered Trucks/ railway wagons, Use of Eco friendly regasification technology etc., are considered.
- (xviii) Dhamra port has already constructed a rail link of 62.5 Km with single line track, connecting the port with the Indian Railway network near Bhadrak railway station. The port has acquired 125 m wide land corridor from Dhamra to Bhadrak for providing exclusive connectivity with the hinterland. Approval has already been obtained for 4 lane road and 2 rail tracks (as a part of Phase I & II Clearance). As a part of Revised Master Plan, it is to develop further additional 2 lane road and 1 rail tracks in the existing corridor. In addition, for easy evacuation of cargo, a new rail, road and utilities corridor (12 km x 125 m wide) is proposed from Northern side development of Dhamra Port. This corridor will connect Dhamra port with existing rail-road corridor near Bansada, Bhadrak.
- (xix) Revised master plan facilities such as construction of berths, creating navigational facilities and back up areas including outfall point of proposed Desalination Plant, pipelines for withdrawal and discharge of seawater for LNG and LPG process and

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fire-fighting purpose will also attract "The CRZ Notification, 2011" in addition to EIA Notification 2006 (as amended).

- (xx) ToR was granted to the project vide letter F.No.11-104/2009-IA.III (Pt.) dated 18.02.2016 and extended its validity till 18.02.2020 vide letter dated 05.12.2018.
- (xxi) Public hearing was held on 11.04.2018 at village Kanak Prasad (near DRDO helipad), under Tahsil Chandbali in the district of Bhadrak.
- (xxii) Odisha Coastal Zone Management Authority has recommended the proposed project vide Letter No. 163/OCZMA dated 10.05.2019.
- (xxiii) The Project Cost for 5 year Revised Master Plan development is Rs. 17,158 Crores.
- (xxiv) Employment Opportunity: During operation phase, direct and indirect employment generation expected is approximately 2200 and 11000 for 5 year development and 4000 and 20,000 for 30 year development respectively.
- (xxv) Benefits of the project: Infrastructure development due to project expansion in the region would facilitate creation of additional/improved communication, health, education, sanitation, hygiene and economic prosperity. The surrounding population would get maximum benefits from upcoming of new industries and its allied ancillary units in shape of direct and indirect employment, self-employment and start up skill development opportunities etc. Improved socio-economic conditions which focused primarily on work force requirements, acquisition of supplies, and increase in business activity. Quality of life in the region is likely to improve due to increase in per capita/per family earning and value appreciation of local resources that would provide economic freedom and facilitate a higher standard of living. As a part of the Corporate Social Responsibility (CSR), DPCL is strongly committed towards fulfilling its social obligations and has taken up many activities for improving the way of living of people the locality in field of Education, Health care, Rural infrastructure development and Sustainable livelihood development. The proposed project shall further act as a catalyst to industrialization and urbanization of the region. Stimulate alternate employment and business opportunities.

4. The project/activity is covered under category 'A' of item 7 (e) i.e. 'Ports, harbours, break waters, dredging' of the schedule to the EIA Notification, 2006 and its subsequent amendments, and requires appraisal at Central level by sectoral EAC.

5. During deliberation, the project proponent informed that following activities will be included in the Revised Master Plan Development of Dhamra Port.

Cargo Handling capacity	169.5 MMTPA (5 Years); 314 MMTPA (30 Years- Cumulative) (12 MMTPA LNG transferred to DLTP)
Quay Length	6032m (5 Years); 11750m (30 Years - Cumulative)
Turning Circle	3 Nos.; 550 to 700m diameter
Approach Channel	380 m wide & 21.0 km long (5 Years); 500 m wide & 24.0 km long (30 Years)
Capital Dredging & Reclamation	(-19.0 m CD) 110 MCM (5 Years) (-22.0 m CD) additional 75 MCM (30 Years)
Maintenance Dredging	~16 - 20 MCM/year
Intake and Outfall System	For LNG/LPG Regasification Terminal (including FSRU & FSO proposed as an interim solution) and Desalination Plant
Dedicated Corridors	Additional 2 lane road & 1 rail track as a part of RMP – within existing corridor of 125m wide & 62.5km long from Dhamra Port

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	New Corridor of 125m wide x 12km long from proposed Northern boundary of Dhamra Port
Project Cost	Rs. 17,518 crore (5 Years); Rs. 31,415 Crore (30 Years-additional)
Desalination plant	21.4 MLD (5 year) and 40 MLD (30 Years - Cumulative)
Marine Outfall	For discharge of cold water from LNG regasification and reject brine from desalination plant

The types of Cargo handled will be as follows:

S. No.	Cargo Type	Cargo Mix
1.	Multipurpose (including Liquid)	Coal / Iron ore / limestone / Mines & Minerals & other dry bulk/Fertilizers and raw materials for manufacture of fertilizer / food grains / sugar / clinker / cement / Project cargo / timber & wood / machines/ Iron steel products / Break Bulk etc./Container (3.1 m TEUs for 5 year and 4.66 m TEUs for 30 years) All Class A, B, C petroleum products, excluded petroleum products including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos), PoL Such as Motor Spirit, Naphtha, High Speed Diesel, Crude Oil, Aviation Fuel, Kerosene, Low Sulphur Heavy Stock/ Furnace oil, Carbon Black Feedstock (CBFS), Paraffin, Bitumen, Lube oil, Asphalt etc.
2.	Gas / Cryogenics/ Liquid	LNG, Propane, Butane, LPG, CNG, NG and All Class A, B, C petroleum products, excluded petroleum products including Petrochemical products, Hazardous, Toxic and Non Hazardous chemicals and other Liquid cargos

It was also informed that Revised Master Plan layout is outside ESZ of Bhitarkanika Sanctuary and Bhitarkanika National Park and Gahirmatha Marine Sanctuary. In support to the claim, the map authenticated by concerned Wildlife Warden has also been submitted.

6. The EAC deliberated upon the issues raised during the Public Hearing/Public Consultation meeting conducted by the Odisha State Pollution Control Board on 11.04.2018. The issues were raised regarding Greenbelt Development, Fishing Activity and safe movement of fishing trawlers, Forest Land, Queries related to EIA and Public Hearing, Coal Dust/Fugitive Emission Management including impact on air environment, Employment, Land Acquisition and Displacement/Land Loser/R&R, Fish drying yard CSR activities, Storm Water Drainage Network, Ecological Sensitivity of the Area/Eco Sensitive Zone, Impact on Turtle Nesting, Mangrove Conservation, Construction of Roads and Railway lines/ Road, Connectivity & Traffic Management and Community utility area development. The Committee noted that issues raised during public hearing have been satisfactorily responded by the project proponent and incorporated in the final EIA-EMP report.

The EAC also deliberated on the certified compliance report letter No. 101-740/EPE dated 27.06.2018 issued by the MoEF&CC's Regional Office (Eastern Zone), Bhubaneswar. As per Compliance report, "Project Authority have complied or are in process of complying with the conditions stipulated by the Ministry. Action plan has also been sought on some points. Further, the Regional Office vide its letter No. 101-740/EPE/463 dated 06.03.2019 have informed that project proponent have submitted action taken report vide letter No. DPCL/ENV/MOEFCC/2019 dated 04.02.2019. The details of action taken by the project proponent were also presented before the EAC.

S. Bose

7. The EAC in its 44th meeting held during 23-25 September, 2019, based on the information submitted and clarifications provided by the Project Proponent and detailed discussions held on all the issues, recommended the project for grant of environmental and CRZ clearance with stipulated specific conditions along with other Standard EC Conditions as specified by the Ministry vide OM dated 4th January, 2019 for the said project/activity, while considering for accord of environmental clearance. As per recommendations of the EAC, the Ministry of Environment, Forest and Climate Change hereby accords Environmental and CRZ Clearance to the project 'Revised Master Plan Development of Dhamra Port' in Bhadrak District, Odisha by M/s Dhamra Port Company Limited, under the provisions of the EIA Notification, 2006 and amendments/circulars issued thereon and CRZ Notification, 2011, and subject to the specific and general conditions as under:-

A. Specific Conditions:

- (i) Construction activity shall be carried out strictly according to the provisions of the CRZ Notification, 2011. No construction work other than those permitted in Coastal Regulation Zone Notification shall be carried out in Coastal Regulation Zone area.
- (ii) All the recommendations and conditions specified by the Odisha State Coastal Zone Management Authority vide letter No. 163/OCZMA dated 10.05.2019 shall be complied with.
- (iii) Consent to Establish/Operate for the project shall be obtained from the State Pollution Control Board as required under the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974.
- (iv) The project proponent shall comply with the air pollution mitigation measures as submitted.
- (v) The Project proponent shall ensure that no creeks or rivers are blocked due to any activities at the project site and free flow of water is maintained.
- (vi) Dredging shall not be carried out during the fish breeding season.
- (vii) Dredging, etc shall be carried out in the confined manner to reduce the impacts on marine environment including turbidity and turbidity should be monitored (preferably monthly) near Kanika island during the dredging.
- (viii) No underwater blasting is permitted.
- (ix) Dredged material shall be disposed safely in the designated areas and also to be utilized for beach nourishment. With the enhanced quantities, the impact of dumping on the coastal environment should be studied and necessary measures shall be taken on priority basis if any adverse impact is observed.
- (x) Shoreline should not be disturbed due to dumping. Periodical study on shore line changes shall be conducted and mitigation carried out, if necessary. The details shall be submitted along with the six monthly monitoring report.
- (xi) While carrying out dredging, an independent monitoring shall be carried out by Government Agency/Institute to check the impact and necessary measures shall be taken on priority basis if any adverse impact is observed.
- (xii) The fresh water requirement of 40 MLD will be met by Desalination plant of 40 MLD which will be developed on modular basis.
- (xiii) The domestic and industrial wastewater will be treated in STP and ETP and treated water will be reused / recycled for horticulture and other purposes.
- (xiv) Marine ecological studies and its mitigation measures for protection of phytoplankton, zooplanktons, benthic macrofauna, etc prepared by Centre of Envotech and Management Consultancy Private Limited (CEMC) as given in the EIA-EMP Report shall be complied with in letter and spirit.
- (xv) A copy of the Marine and riparian biodiversity management plan duly validated by the State Biodiversity Board shall be obtained and implement in letter and spirit.

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- (xvi) A periodic monitoring programme covering all the seasons on various aspects of the coastal environs need to be undertaken by NABL accredited laboratories during construction and operation phase of the project. The monitoring should cover various physico-chemical parameters coupled with biological indices such as microbes, plankton, benthos and fishes. Deviations in the parameters shall be addressed with suitable measures to conserve the marine environment and its resources.
- (xvii) Continuous online monitoring of air and water quality covering the project area shall be carried out and the compliance report shall be submitted to the regional office of MoEF&CC.
- (xviii) Effective and efficient pollution control measures like covered conveyors/stacks (coal, iron ore and other bulk cargo) with fogging/back filters and water sprinkling commencing from ship unloading to stacking to evacuation shall be undertaken. Coal and iron ore stack yards shall be bounded by thick two tier green belt with proper drains and wind barriers wherever necessary. Coal should be handled properly at port limits so that the coal dust will not reach the surrounding areas. Sprinklers shall be used at coal storage regularly and to monitor the coal dust in the air.
- (xix) Sediment concentration should be monitored fortnightly at source and disposal location of dredging while dredging. Online monitoring system should be installed for assessing turbidity during dredging.
- (xx) Marine ecology shall be monitored regularly in terms of water quality (Salinity, temperature, DO, BOD, PHc, nutrients), sediment quality (Metals, PHc, Organic carbon etc) and biological characteristics (phytoplankton, zooplankton, benthic macrofauna and other marine biodiversity components) as part of the environment management plan specified in the report. Any deviations from the baseline should be reported to the OCZMA/OSPCB.
- (xxi) Spillage of fuel / engine oil and lubricants from the construction site are a source of organic pollution which impacts marine life, particularly benthos. This shall be prevented by suitable precautions and also by providing necessary mechanisms to trap the spillage.
- (xxii) Necessary arrangements for the treatment of the effluents and solid wastes/ facilitation of reception facilities under MARPOL must be made and it must be ensured that they conform to the standards laid down by the competent authorities including the Central or State Pollution Control Board and under the Environment (Protection) Act, 1986. The provisions of Solid Waste Management Rules, 2016, E-Waste Management Rules, 2016, and Plastic Waste Management Rules, 2016 shall be complied with.
- (xxiii) Compliance to Energy Conservation Building (ECBC-2017) shall be ensured for all the building complexes. Solar/wind or other renewable energy shall be installed to meet energy demand of 1% equivalent.
- (xxiv) All the recommendations mentioned in the rapid risk assessment report, disaster management plan and safety guidelines shall be implemented.
- (xxv) Measures should be taken to contain, control and recover the accidental spills of fuel and cargo. Tier 1 should be made available with the port for attending the large oil spills. The company should inform the coast guard for availing tier 2 facility.
- (xxvi) Necessary arrangement for general safety and occupational health of people should be done in letter and spirit.
- (xxvii) All the mitigation measures submitted in the EIA report shall be prepared in a matrix format and the compliance for each mitigation plan shall be submitted to the RO, MoEF&CC along with half yearly compliance report.
- (xxviii) The effluent generated by desalination plant and FSRU should be released at designated sites as suggested in the EIA report.

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- (xxix) The company shall draw up and implement corporate social Responsibility plan as per the Company's Act of 2013.
- (xxx) As per the Ministry's Office Memorandum F.No. 22-65/2017-IA.III dated 1st May 2018, project proponent has proposed an amount of Rs. 21.4998 Crores (0.125% of the project cost) under Corporate Environment Responsibility (CER) Plan for the activities such as Biodiversity Conservation, Turtle and Marine life Research Centre, Water Conservation and Water Recharge, Fishermen Alternate Livelihood Development, Agriculture and Horticulture Promotion, Community Infrastructure and Women Empowerment – Promote Entrepreneurship. The activities proposed under CER shall be restricted to the affected area around the project. The entire activities proposed under the CER shall be treated as project and shall be monitored. The monitoring report shall be submitted to the regional office as a part of half yearly compliance report, and to the District Collector. It should be posted on the website of the project proponent.

B. Standard Conditions:

I. Statutory compliance:

- i. The project proponent shall prepare a Site-Specific Conservation Plan & Wildlife Management Plan and approved by the Chief Wildlife Warden. The recommendations of the approved Site-Specific Conservation Plan / Wildlife Management Plan shall be implemented in consultation with the State Forest Department. The implementation report shall be furnished along with the six-monthly compliance report (incase of the presence of schedule-I species in the study area).
- ii. Construction activity shall be carried out strictly according to the provisions of CRZ Notification, 2011 and the State Coastal Zone Management Plan as drawn up by the State Government. No construction work other than those permitted in Coastal Regulation Zone Notification shall be carried out in Coastal Regulation Zone area.
- iii. The project proponent shall obtain the necessary permission from the Central Ground Water Authority, in case of drawl of ground water / from the competent authority concerned in case of drawl of surface water required for the project.
- iv. All excavation related dewatering shall be as duly authorized by the CGWA. A NOC from the CGWA shall be obtained for all dewatering and ground water abstraction
- v. A certificate of adequacy of available power from the agency supplying power to the project along with the load allowed for the project should be obtained.
- vi. All other statutory clearances such as the approvals for storage of diesel from Chief Controller of Explosives, Fire Department, Coast Guard, Civil Aviation Department shall be obtained, as applicable by project proponents from the respective competent authorities.

II. Air quality monitoring and preservation:

- i. The project proponent shall install system to carryout Ambient Air Quality monitoring for common/criterion parameters relevant to the main pollutants released (e.g. PM₁₀ and PM_{2.5} in reference to PM emission, and SO₂ and NO_x in reference to SO₂ and NO_x emissions) within and outside the project area at least at four locations (one within and three outside the plant area at an angle of 120° each), covering upwind and downwind directions.
- ii. Appropriate Air Pollution Control (APC) system shall be provided for all the dust generating points including fugitive dust from all vulnerable sources, so as to comply prescribed emission standards.
- iii. Shrouding shall be carried out in the work site enclosing the dock/proposed facility area. This will act as dust curtain as well achieving zero dust discharge from the site. These curtain or shroud will be immensely effective in restricting disturbance from

J. Rose

wind in affecting the dry dock operations, preventing waste dispersion, improving working conditions through provision of shade for the workers.

- iv. Dust collectors shall be deployed in all areas where blasting (surface cleaning) and painting operations are to be carried out, supplemented by stacks for effective dispersion.
- v. The Vessels shall comply the emission norms prescribed from time to time.
- vi. Diesel power generating sets proposed as source of backup power should be of enclosed type and conform to rules made under the Environment (Protection) Act, 1986. The height of stack of DG sets should be equal to the height needed for the combined capacity of all proposed DG sets. Use of low sulphur diesel. The location of the DG sets may be decided with in consultation with State Pollution Control Board.
- vii. A detailed traffic management and traffic decongestion plan shall be drawn up to ensure that the current level of service of the roads within a 05 kms radius of the project is maintained and improved upon after the implementation of the project. This plan should be based on cumulative impact of all development and increased habitation being carried out or proposed to be carried out by the project or other agencies in this 05 Kms radius of the site in different scenarios of space and time and the traffic management plan shall be duly validated and certified by the State Urban Development department and the P.W.D./ competent authority for road augmentation and shall also have their consent to the implementation of components of the plan which involve the participation of these departments.

III. Water quality monitoring and preservation:

- i. The Project proponent shall ensure that no creeks or rivers are blocked due to any activities at the project site and free flow of water is maintained.
- ii. Appropriate measures must be taken while undertaking digging activities to avoid any likely degradation of water quality. Silt curtains shall be used to contain the spreading of suspended sediment during dredging within the dredging area.
- iii. No ships docking at the proposed project site will discharge its on-board waste water untreated in to the estuary/ channel. All such wastewater load will be diverted to the proposed Effluent Treatment Plant of the project site.
- iv. Measures should be taken to contain, control and recover the accidental spills of fuel and cargo handle.
- v. The project proponents will draw up and implement a plan for the management of temperature differences between intake waters and discharge waters.
- vi. Spillage of fuel / engine oil and lubricants from the construction site are a source of organic pollution which impacts marine life. This shall be prevented by suitable precautions and also by providing necessary mechanisms to trap the spillage.
- vii. Total fresh water use shall not exceed the proposed requirement as provided in the project details. Prior permission from competent authority shall be obtained for use of fresh water.
- viii. Sewage Treatment Plant shall be provided to treat the wastewater generated from the project. Treated water shall be reused for horticulture, flushing, backwash, HVAC purposes and dust suppression.
- ix. A certificate from the competent authority for discharging treated effluent/ untreated effluents into the Public sewer/ disposal/drainage systems along with the final disposal point should be obtained.
- x. No diversion of the natural course of the river shall be made without prior permission from the Ministry of Water resources.

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- xi. All the erosion control measures shall be taken at water front facilities. Earth protection work shall be carried out to avoid erosion of soil from the shoreline/boundary line from the land area into the marine water body.

IV. Noise monitoring and prevention:

- i. Noise level survey shall be carried as per the prescribed guidelines and report in this regard shall be submitted to Regional Officer of the Ministry as a part of six-monthly compliance report.
- ii. Noise from vehicles, power machinery and equipment on-site should not exceed the prescribed limit. Equipment should be regularly serviced. Attention should also be given to muffler maintenance and enclosure of noisy equipments.
- iii. Acoustic enclosures for DG sets, noise barriers for ground-run bays, ear plugs for operating personnel shall be implemented as mitigation measures for noise impact due to ground sources.
- iv. The ambient noise levels should conform to the standards prescribed under E(P)A Rules, 1986 viz. 75 dB(A) during day time and 70 dB(A) during night time.

V. Energy Conservation measures:

- i. Provide solar power generation on roof tops of buildings, for solar light system for all common areas, street lights, parking around project area and maintain the same regularly;
- ii. Provide LED lights in their offices and residential areas.

VI. Waste management:

- i. Dredged material shall be disposed safely in the designated areas.
- ii. Shoreline should not be disturbed due to dumping. Periodical study on shore line changes shall be conducted and mitigation carried out, if necessary. The details shall be submitted along with the six monthly monitoring report.
- iii. Necessary arrangements for the treatment of the effluents and solid wastes must be made and it must be ensured that they conform to the standards laid down by the competent authorities including the Central or State Pollution Control Board and under the Environment (Protection) Act, 1986.
- iv. The solid wastes shall be managed and disposed as per the norms of the Solid Waste Management Rules, 2016.
- v. Any wastes from construction and demolition activities related thereto shall be managed so as to strictly conform to the Construction and Demolition Waste Management Rules, 2016.
- vi. A certificate from the competent authority handling municipal solid wastes should be obtained, indicating the existing civic capacities of handling and their adequacy to cater to the M.S.W. generated from project.
- vii. Used CFLs and TFLs should be properly collected and disposed off/sent for recycling as per the prevailing guidelines/ rules of the regulatory authority to avoid mercury contamination.
- viii. Oil spill contingency plan shall be prepared and part of DMP to tackle emergencies. The equipment and recovery of oil from a spill would be assessed. Guidelines given in MARPOL and Shipping Acts for oil spill management would be followed. Mechanism for integration of terminals oil contingency plan with the overall area contingency plan under the co-ordination of Coast should be covered

VII. Green Belt:

- i. Green belt shall be developed in area as provided in project details with a native tree species in accordance with CPCB guidelines. The greenbelt shall inter alia cover the entire periphery of the plant.

J. Rose

- ii. Top soil shall be separately stored and used in the development of green belt.

VIII. Marine Ecology:

- i. Dredging shall not be carried out during the fish breeding and spawning seasons.
- ii. Dredging, etc shall be carried out in the confined manner to reduce the impacts on marine environment.
- iii. The dredging schedule shall be so planned that the turbidity developed is dispersed soon enough to prevent any stress on the fish population.
- iv. While carrying out dredging, an independent monitoring shall be carried out through a Government Agency/Institute to assess the impact and necessary measures shall be taken on priority basis if any adverse impact is observed.
- v. A detailed marine biodiversity management plan shall be prepared through the NIO or any other institute of repute on marine, brackish water and fresh water ecology and biodiversity and submitted to and implemented to the satisfaction of the State Biodiversity Board and the CRZ authority. The report shall be based on a study of the impact of the project activities on the intertidal biotopes, corals and coral communities, molluscs, sea grasses, sea weeds, sub-tidal habitats, fishes, other marine and aquatic micro, macro and mega flora and fauna including benthos, plankton, turtles, birds etc. as also the productivity. The data collection and impact assessment shall be as per standards survey methods and include underwater photography.
- vi. Marine ecology shall be monitored regularly also in terms of sea weeds, sea grasses, mudflats, sand dunes, fisheries, echinoderms, shrimps, turtles, corals, coastal vegetation, mangroves and other marine biodiversity components including all micro, macro and mega floral and faunal components of marine biodiversity.
- vii. The project proponent shall ensure that water traffic does not impact the aquatic wildlife sanctuaries that fall along the stretch of the river.

IX. Public hearing and Human health issues:

- i. The work space shall be maintained as per international standards for occupational health and safety with provision of fresh air respirators, blowers, and fans to prevent any accumulation and inhalation of undesirable levels of pollutants including VOCs.
- ii. Workers shall be strictly enforced to wear personal protective equipments like dust mask, ear muffs or ear plugs, whenever and wherever necessary/ required. Special visco-elastic gloves will be used by labour exposed to hazards from vibration.
- iii. In case of repair of any old vessels, excessive care shall be taken while handling Asbestos & Freon gas. Besides, fully enclosed covering should be provided for the temporary storage of asbestos materials at site before disposal to CTSDf.
- iv. Safety training shall be given to all workers specific to their work area and every worker and employee will be engaged in fire hazard awareness training and mock drills which will be conducted regularly. All standard safety and occupational hazard measures shall be implemented and monitored by the concerned officials to prevent the occurrence of untoward incidents/ accidents.
- v. Emergency preparedness plan based on the Hazard Identification and Risk Assessment (HIRA) and Disaster Management Plan shall be implemented.
- vi. Provision shall be made for the housing of construction labour within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, crèche etc. The housing may be in the form of temporary structures to be removed after the completion of the project.
- vii. Occupational health surveillance of the workers shall be done on a regular basis.

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X. Corporate Environment Responsibility:

- i. The company shall have a well laid down environmental policy duly approved by the Board of Directors. The environmental policy should prescribe for standard operating procedures to have proper checks and balances and to bring into focus any infringements/deviation/violation of the environmental / forest /wildlife norms/ conditions. The company shall have defined system of reporting infringements / deviation / violation of the environmental / forest / wildlife norms / conditions and / or shareholders / stake holders. The copy of the board resolution in this regard shall be submitted to the MoEF&CC as a part of six-monthly report.
- ii. A separate Environmental Cell both at the project and company head quarter level, with qualified personnel shall be set up under the control of senior Executive, who will directly report to the head of the organization.
- iii. Action plan for implementing EMP and environmental conditions along with responsibility matrix of the company shall be prepared and shall be duly approved by competent authority. The year wise funds earmarked for environmental protection measures shall be kept in separate account and not to be diverted for any other purpose. Year wise progress of implementation of action plan shall be reported to the Ministry/Regional Office along with the Six Monthly Compliance Report.
- iv. Self environmental audit shall be conducted annually. Every three years third party environmental audit shall be carried out.

XI. Miscellaneous:

- i. The project proponent shall make public the environmental clearance granted for their project along with the environmental conditions and safeguards at their cost by prominently advertising it at least in two local newspapers of the District or State, of which one shall be in the vernacular language within seven days and in addition this shall also be displayed in the project proponent's website permanently.
- ii. The copies of the environmental clearance shall be submitted by the project proponents to the Heads of local bodies, Panchayats and Municipal Bodies in addition to the relevant offices of the Government who in turn has to display the same for 30 days from the date of receipt.
- iii. The project proponent shall upload the status of compliance of the stipulated environment clearance conditions, including results of monitored data on their website and update the same on half-yearly basis.
- iv. The project proponent shall submit six-monthly reports on the status of the compliance of the stipulated environmental conditions on the website of the ministry of Environment, Forest and Climate Change at environment clearance portal.
- v. The project proponent shall submit the environmental statement for each financial year in Form-V to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently and put on the website of the company.
- vi. The criteria pollutant levels namely; $PM_{2.5}$, PM_{10} , SO_2 , NO_x (ambient levels) or critical sectoral parameters, indicated for the project shall be monitored and displayed at a convenient location near the main gate of the company in the public domain.
- vii. The project proponent shall inform the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities, commencing the land development work and start of production operation by the project.
- viii. The project authorities must strictly adhere to the stipulations made by the State Pollution Control Board and the State Government.

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- ix. The project proponent shall abide by all the commitments and recommendations made in the EIA/EMP report, commitment made during Public Hearing and also that during their presentation to the Expert Appraisal Committee.
 - x. No further expansion or modifications in the plant shall be carried out without prior approval of the Ministry of Environment, Forests and Climate Change (MoEF&CC).
 - xi. Concealing factual data or submission of false/fabricated data may result in revocation of this environmental clearance and attract action under the provisions of Environment (Protection) Act, 1986.
 - xii. The Ministry may revoke or suspend the clearance, if implementation of any of the above conditions is not satisfactory.
 - xiii. The Ministry reserves the right to stipulate additional conditions if found necessary. The Company in a time bound manner shall implement these conditions.
 - xiv. The Regional Office of this Ministry shall monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the officer (s) of the Regional Office by furnishing the requisite data / information/monitoring reports.
 - xv. The above conditions shall be enforced, inter-alia under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and the Public Liability Insurance Act, 1991 along with their amendments and Rules and any other orders passed by the Hon'ble Supreme Court of India / High Courts and any other Court of Law relating to the subject matter.
 - xvi. Any appeal against this EC shall lie with the National Green Tribunal, if preferred, within a period of 30 days as prescribed under Section 16 of the National Green Tribunal Act, 2010.
8. This issues with the approval of the Competent Authority.

J. Bose
(Dr. Subrata Bose)
Scientist F

Copy to:

- 1) The Secretary, Department of Forest and Environment, Government of Odisha, Bhubaneswar - 23, Odisha.
- 2) The Addl. Principal Chief Conservator of Forests (Central), Ministry of Environment, Forests and Climate Change, Regional Office (EZ), A/3, Chandrasekharpur, Bhubaneswar - 751023.
- 3) The Member Secretary, Odisha Coastal Zone Management Authority, 1st Floor, Administrative Building, Regional Plant Resource Centre Campus, Nayapalli, Bhubaneswar - 751015, Odisha, India
- 4) The Chairman, Central Pollution Control Board Parivesh Bhavan, CBD-cum-Office Complex, East Arjun Nagar, New Delhi - 110 032.
- 5) The Member Secretary, Odisha Pollution Control Board, Paribesh Bhawan, A/118, Nilakantha Nagar, Unit- VIII, Bhubaneswar- 12, Odisha.
- 6) Monitoring Cell, MoEF&CC, Indira Paryavaran Bhavan, New Delhi.
- 7) Guard File/ Record File/ Notice Board.
- 8) MoEFCC website.

J. Bose
(Dr. Subrata Bose)
Scientist F

Monitoring of marine turtles along the Kerala and Tamil Nadu coasts

S. Bhupathy

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Introduction

Among the five species of sea turtles distributed in the Indian region, four of them, the olive ridley (*Lepidochelys olivacea*), green turtle (*Chelonia mydas*), leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*) nest on Indian coasts (Kar & Bhaskar, 1982). All these species are distributed in Tamil Nadu and in the coastal waters of Kerala. The Wildlife Institute of India (WII) recently implemented a UNDP–Government of India sea turtle conservation project. This project (2000–01) evaluated the status of marine turtles and their nesting habitats in all maritime states of India, which included an assessment of threats to turtles. Data on important nesting beaches were generated, which form the benchmark for monitoring (Shanker & Choudhury, 2006). Information on the status of marine turtles along the Tamil Nadu coast was generated as a part of this project (Bhupathy & Saravanan, 2002, 2006a; Bhupathy & Karunakaran, 2003). Among many aspects, monitoring the population trend of a species is critical for the preparation and implementation of conservation programmes. In this context, the Madras Crocodile Bank Trust (MCBT) initiated a countrywide programme for monitoring marine turtles including the islands. As a part of this programme, the Sálim Ali Centre for Ornithology and Natural History (SACON), Coimbatore undertook monitoring of sea turtles along the Kerala and Tamil Nadu coasts during 2003–05. The objective of this project was to assess the conservation status of different species of marine turtles, and to network with and provide training to government officers and non-government organisations (NGOs) in both states to enhance conservation actions. In this paper, we report the major findings of the sea turtle monitoring programme along the Kerala and Tamil Nadu coasts during November to April 2003–04 and 2004–05.

Methodology

Study area

The all-India coordinated UNDP–GOI–WII sea turtle project (2000–2001) suggested that the Nagapattinam and Chennai coasts in Tamil Nadu and the beaches of North Kerala are important marine turtle nesting areas (Bhupathy & Saravanan, 2006b). We monitored turtle nesting and mortality along the south Chennai (12°31'–12°8'N and 80°10'–79°56'E, Fig. 1) and Nagapattinam coasts (11°51'–11°30'N and 79°51'–79°46'E, Fig. 2) which are part of the Palar and Cauveri deltas respectively. The North Kerala coast (approx. Kozhikode–Kannur; 11°41'–12°38'N and 74°55'–75°38'E, Fig. 3) has many west flowing rivers and remnants of mangrove vegetation at the river mouth. The west and east coasts receive major rainfall from the Southwest (May–July) and Northeast (October–November) monsoons respectively.

Field methods

Each study sector was divided into 10-km units and surveyed each fortnight (during 0600–0830 hours) for recording nesting and mortality of turtles (Table 1). Data on nesting intensity was based on tracks found on the beach. As surveys were done at fortnightly intervals, tracks found during each survey were considered as new. Nest predation by animals or exploitation by locals was based on tracks and signs found near exploited nests. The number of carcasses found on the shore was counted as an index of turtle mortality. Carcasses of turtles were marked with paint to avoid repeat count. Researchers appointed by the project surveyed the Mamallapuram–Pondicherry (50 km) and Nagapattinam (30 km) beaches each fortnight by foot. The Chennai (6 km) and North Kerala (20 km) beaches were monitored by local

NGOs on a daily basis. Along the North Kerala coast, the availability of sandy areas for turtle nesting was assessed during February–March 2003. We also interviewed local persons to obtain information on turtle nesting and mortality.

Nesting intensity for the locality studied was calculated based on average nesting during this

study. Total nesting during the season was estimated as:

$$N = n \times d \times t,$$

where N – Estimated nesting,

n – average nesting during sampling,

d – number of 10 km sectors, and

t – duration (90 days – January to March).

Table 1: Sea turtle monitoring schedules along the Kerala and Tamil Nadu coasts during 2003–05

Beach Sector	Distance (km)	Duration	Monitored by
Kerala			
Kozhikode	6	September–December 2003	Theeram
Kasarakod	10	September–December 2003	Naythal
Tamil Nadu			
Chennai	6	January–April 2004 January–April 2005	SSTCN
Mamallapuram– Pondicherry	50	January–April 2004	MCBT–CMS Project
Nagapattinam	30	January–April 2004 December 2004–May 2005	MCBT–CMS Project

Turtle Monitoring

Nesting

Sandy beaches suitable for sea turtle nesting were found on the North Kerala (i.e. Kannur and Kasarkod) coast. A survey conducted for documenting nesting and mortality along the 60 km coast during February–March 2003 yielded no nests. Interviews with fishermen revealed that turtles nest along the west coast largely during September–November with the peak during October. Data collected by NGOs working in this area, namely *Theeram* and *Naythal* supported this. According to them, on an average, about three nests were found per kilometer in the area. These NGOs, in collaboration with the Kerala Forest Department and local communities, especially the fisherman, collect turtle eggs and maintain hatcheries in Kolavipalam, Kozhikode (*Theeram*) and near Kasargod (*Naythal*). The hatchlings are released into the sea. Apart from collecting biological information and protecting nests, these

hatcheries are used for nature education and public awareness programmes.

The Mamallapuram–Pondicherry beach (50 km) was surveyed for only one year (2003–04). In all, 36 olive ridley nests were recorded during the fortnightly sampling from January–March 2004. Peak nesting was observed in the first fortnight of March. Estimated nesting density along this area was about 11 nests per km during January–April 2004 (Table 2).

The Chennai beach has been monitored (on a daily basis) by the Students' Sea Turtle Conservation Network (SSTCN) since 1988 and was continued during this study as well. A total of 50 nests (8.3 per km) were recorded during January–April 2004. During 2005, they recorded 62 nests (10.3 per km; SSTCN data). Average nesting intensity for 16 years was 9.4 nests per km (Shanker, 2003). A hatchery is being maintained by the SSTCN on an annual basis.

Table 2: Nesting of ridleys along the Mamallapuram-Pondicherry coast (50 km), Tamil Nadu during January–March 2004

Fortnight	Number of nests	Average nesting/day/10km
January I	3	0.6
January II	6	1.2
February I	7	1.4
February II	7	1.4
March I	13	2.6
March II	0	0
Total	36	7.2
Average nesting/day/10km		1.2
Estimated nests		540
Nests per km		10.8

The Nagapattinam beach was monitored for turtle nesting during 2003–04 and 2004–05. On the 30 km beach monitored, a total of 17 and 30 nests were recorded during the fortnightly sampling from December–April in 2003–04 and 2004–05 respectively (Table 3). This works out to about 7.5 and 15 nests per km. Nesting along this beach was about 20 nests per km during 2000–01.

Table 3: Nesting of ridleys along the Nagapattinam coast during 2003–04 and 2004–05

Fortnightly survey	2003–04	2004–05
December II	0	0
January I	3	*
January II	3	*
February I	6	8
February II	2	9
March I	3	9
March II	0	2
April I	0	2
April II	0	0
Total	17	30
Estimated nest/ km	7.5	15

*Not surveyed due to disturbance in the area caused by the 26th December 2004 Indian Ocean tsunami.

Turtle nesting along the east coast of Tamil Nadu (Chennai and Nagapattinam) occurred during January to March, whereas it was between September and December along the North Kerala coasts. In other words, turtles nested subsequent to the major monsoon season of the area, namely the northeast and southwest monsoons. Peak nesting along the east and west coasts were during February and October respectively. The intensity of the sea turtle nesting on the Kerala and Tamil Nadu coasts is sporadic, and its density varied from 3 to 15 nests per km. The reasons for the difference in the number of nests observed along the Chennai and Nagapattinam coasts during 2003–04 and 2004–05 are unclear. These variations may be attributed to factors such as annual or cyclic changes in the nesting of turtles (for larger data set, see Shanker, 2003), which has to be investigated further.

Turtle mortality

No sea turtle carcass was observed along the west coast (North Kerala) during both years (i.e. 2003–04 and 2004–05). Interviews with fishermen in the area also revealed that dead turtles get stranded along these beaches only occasionally.

Along the east coast, 139 turtle carcasses (~3 per km) including 134 olive ridleys and five green turtles were recorded on the Mamallapuram-Pondicherry coast during 2003–04. During the same period, 92 carcasses including 90 olive ridleys and two green turtles were observed along the Nagapattinam coast (Table 4). Compared to the previous season, only 21 carcasses (20 olive ridleys and one green turtle) were observed during 2004–05, and all of them prior to the Indian Ocean tsunami on 26th December 2004. No new carcasses were observed during January–April 2005. Fishing activities were halted during this period due to the damage and loss of boats and infrastructure, and the fears and rumours of another tsunami in the area. Hence, it may reasonably be concluded that mortality of turtles in the area was largely due to fishing activities.

Table 4: Olive ridley mortality along select beaches of Tamil Nadu and Kerala during 2003–04

Location	Beach monitored (km)	Turtle Mortality*	Nest predation (%)	Remark
North Kerala	60	Low	Unknown	Single survey
Nagapattinam	30	90 (2)	100	Fortnightly survey
Mamallapuram-Pondicherry	50	139 (5)	69.4	Fortnightly survey
Chennai	6	Low	Low	Daily survey

Number in parenthesis indicate number of green turtles

* total count

Turtle mortality was highest during January on the east coast (Table 5). Prior to and during January, turtles aggregate in the shallow nearshore waters to breed. These areas are also important gill net fishing grounds. Fishermen in the area largely used small (mechanised) boats and *catamarans* for fishing. The density of fishing vessels (both mechanised and non-mechanised) was 26 and 28/km on the Mamallapuram and Nagapattinam coasts respectively. Gill nets were set in shallow

waters for about 8–10 hours. Turtles entangled in the nets died due to drowning, as indicated by the prolapsed internal organs through body openings. The fishermen in the area also chopped off the flippers or clubbed the head of live turtles found entangled in the net. This was done for removing turtles without damage to the nets and fishermen themselves. In all, 70% of the fresh carcasses found on the shore had one or two missing flippers and shell or head injuries.

Table 5: Mortality of olive ridleys along the Chennai and Nagapattinam coasts during 2003–2005 based on carcasses found along the beach

Fortnightly survey	Mamallapuram – Pondicherry	Nagapattinam
December II	0	0
January I	29	26
January II	61	22
February I	19	9
February II	20	14
March I	2	6
March II	3	9
April I	0	4
April II	0	0
Total	134+5*	90+2*

* Green turtles

Exploitation

Inhabitants of these study areas (Chennai, Nagapattinam and North Kerala) do not consume turtles, but they consume turtle eggs. Locals on both Nagapattinam and Mamallapuram-Pondicherry coasts collected eggs of a large number of nests. As the Chennai and North Kerala coast beaches were monitored on daily basis by the SSTCN and other NGOs, exploitation of eggs by

humans were negligible. These NGOs collected turtle eggs to maintain hatcheries with the involvement of students and local communities.

Along the Nagapattinam coast, all the nests found during 2003–04 were predated; 14 (82.5%) by humans and 2 (17.5%) by domestic dogs. Professional poachers traversed the beach extensively on foot during the night to collect eggs. Of the 36 nests observed during January–April

2004 along the Mamallapuram–Pondicherry coast, 25 (69.4%) were predated (Table 6). Among the predated nests, jackal and domestic dog contributed 54.2% and 33.3% respectively. Inhabitants of the area depredated about 12.5 % of the total nests observed in the area. Native

communities such as *Irudas* consume turtle eggs occasionally. Locals collected eggs from almost all nests along the Nagapattinam coast, whereas inhabitants took only 12.5% of them along the Mamallapuram coast. This indicates that the latter beach is relatively less disturbed.

Table 6: Exploitation of turtle eggs along select beaches of Kerala and Tamil Nadu

Location	Beach monitored (km)	Nest predation / exploitation (%)	% of predation		
			Humans	Domestic dog	Jackal
North Kerala	20	Low	Unknown	–	–
Nagapattinam	30	100	82.5	17.5	–
Mamallapuram–Pondicherry	50	69.4	12.5	33.3	54.2
Chennai	6	Low/ Unknown	–	–	–

Suggestions for Conservation

Annual closed season for fishing

As over 50% of the adult turtle mortality occurred during January, a closed period for gill net fishing is suggested in the area for a month (January) along the east coast. During this period, alternate fishing techniques to be used by the fisherman should be explored. Discussions with the concerned departments (mainly Forest and Fisheries Departments) and other stakeholders are required for active participation and effective implementation.

Control of egg depredation

The depredation of turtle eggs is widespread along the entire olive ridley nesting range, and in some areas it is very severe. Depredation is more common where no protected areas or NGO activities are present. Poaching has almost stopped in select sectors of North Kerala, where NGOs such as *Naythal* and *Theeram* are active. These NGOs use the local fishermen to collect eggs for hatcheries. Enhanced beach patrolling by the Forest Department and other agencies during the peak turtle nesting season is crucial for the long-term survival of marine turtles. Intensive beach patrolling for two months (February–March) on the turtle nesting beaches of the east coast of Tamil

Nadu may save as many as 65–90% of the nests from poachers. Beach patrolling during September–October is suggested along the west coast for the conservation of turtles.

Community participation

Awareness programmes and community participation in the conservation efforts are important for getting desired results. Hatchery programmes involving the public with incentives and alternate livelihoods may increase the success of the sea turtle conservation initiatives many fold. Regular egg poachers of an area may be identified and used in the hatchery programme. In this direction, supporting the efforts made by SSTCN (Chennai), Students' Sea Turtle Network (SSTN)(Nagapattinam), *Theeram* (Kozhikode) and *Naythal* (Kasaragod) with both technical and financial inputs are essential.

An ideal location among the current study areas for starting a sea turtle hatchery programme is the Tranquebar–Poompuhar (Nagapattinam) coast. This programme has a network in place with the involvement of Forest Department and local community, and could act as a model nature education and conservation initiative. A hatchery programme is particularly necessary for the Nagapattinam coast, as local people collect the eggs of almost all nests.

Research

The data on turtle nesting along the east coast during 2000-01, 2003-04 and 2004-05 showed high fluctuation in the nesting density. For instance, along the Nagapattinam coast, it varied from 7.5 (2003-04) to 20 (2000-01) nests per km. Data generated for about two decades by the SSTCN on the Chennai coast also showed similar variations (2.8 to 17.5 nests per km, Shanker, 2003). Reasons for these fluctuations need to be investigated. It is necessary to continue the monitoring of turtle nesting and mortality along important areas such as Chennai and Nagapattinam. The nesting season of sea turtles along the east and west coasts was different, and it would be interesting to examine whether the same population nests along both coasts. Tagging programmes along both these coasts simultaneously may provide important information such as breeding stock and movement pattern of turtles.

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Figure 1: Map showing the Chennai-Pondicherry coast and prominent villages

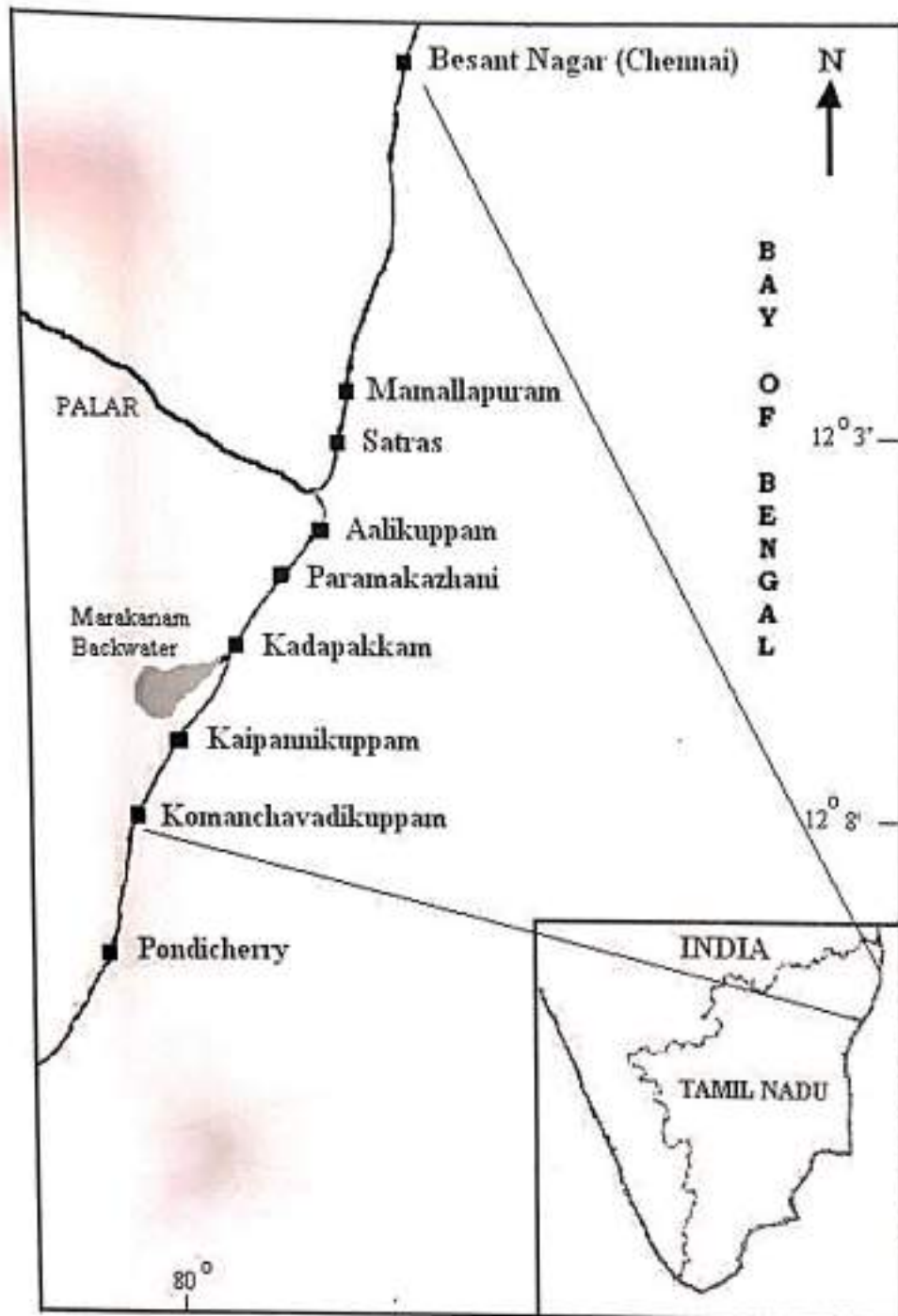


Figure 2: Map showing the study area along the Nagapattinam coast

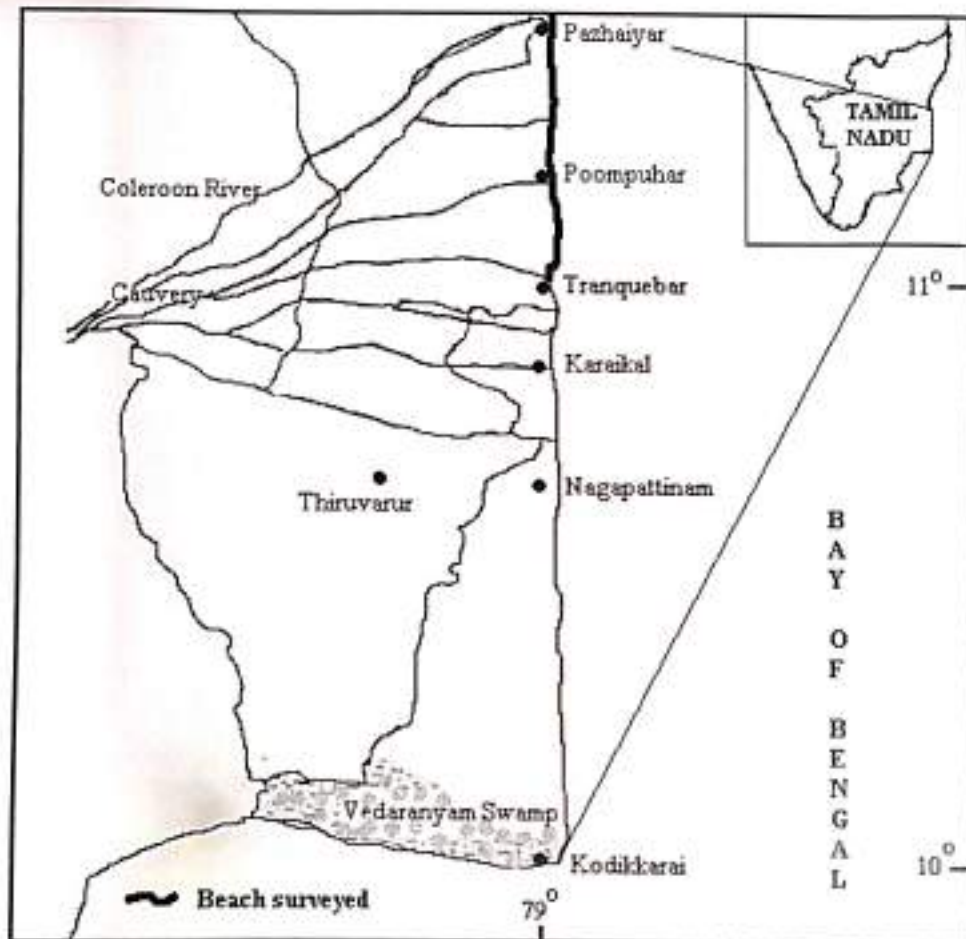


Figure 3: Map of Kerala showing the study area

