

INLAND WATERWAYS AUTHORITY OF INDIA

Ministry of Shipping, Government of India

“CAPACITY AUGMENTATION OF NATIONAL WATERWAY -1”

(Jal Marg Vikas Project)

ENVIRONMENTAL IMPACT ASSESSMENT REPORTS

VOLUME- 1: EXECUTIVE SUMMARY

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Abbreviations			
$\mu\text{g}/\text{m}^3$	Microgram per cubic metre	A	Ampere
AAQ	Ambient Air Quality	AD	Amphibian Dredger
Amsl	above mean sea level	APHA	American Public Health Association
AWPCPL	Allahabad Waste Processing Company Pvt. Ltd	BCM	Billion Cubic Microns
BDU	Below Detection Unit	BDU	Best Designated Unit
BHDs	Backhoe Dredgers	BHU	Banaras Hindu University
BOD	Biochemical Oxygen Demand	BOQ	Bill of Quantity
BTKM	Billion Tonne Kilometres	BUIDCO	Bihar Urban infrastructure development Corporation Ltd.
BWE	Ballast Water Exchange	BWMP	Ballast Water Management Plan
BWP	Ballast Water Performance	CBWTF	Common Bio Medical Waste Treatment Facility
CEC	Cation Exchange Capacity	CERs	Critical Environmental Resources
CGWA	Central Ground Water Authority	CGWB	Central Ground Water Board
CIFRI	Central Inland Fisheries Research Institute	CIWTC	Central Inland Water Corporation Limited
Cm	Centimetre	CNG	Compressed Natural Gas
CO	Carbon Monoxide	COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board	Cr	Crore
CRZ	Coastal Regulation Zone	CSD	Cutter Section Dredgers
CTE	Consent to Establish	CTO	Consent to Operate
Cum	cubic metre	dBs	Decibels
DEAC	District Environmental Impact Assessment Committee	DEIAA	District Environmental Impact Assessment Authority
DEM	Digital Elevation Model	DFCCIL	Dedicated Freight Corridor Corporation of India Limited
DFO	District Forests Officer	DFR	Detailed Feasibility Report
DG	Diesel Generators	DGPS	Differential Global Positioning System
DO	Dissolved Oxygen	DWT	Dry Weight Tonnage
DWT	Dead Weight Tonnage	E	East
EC	Electrical Conductivity	EDFC	Eastern Dedicated Freight Corridor
EHS	Environment, Occupational Health and Safety	EIA	Environmental Impact Assessment
EMoP	Environmental Monitoring Plan	EMP	Environment Management Plan
EPC	Engineering Procurement Contractor	ESAs	Ecologically Sensitive Areas

Abbreviations			
ESC	Environment and Social Cell	ESS	Electrical Sub stations
FBP	Farakka Barrage Project	GHG	Green House Gases
GRIHA	Green Rating for Integrated Habitat Assessment	GIS	Geographical Information Systems
Gm	Gram	GoI	Government of India
GPS	Global Positioning System	GRB	Ganga River Basin
GW	Ground Water	ha	Hectare
HAD	Haldia Development Authority	HC	Horizontal Clearance
HDC	Haldia Dock Complex	HDPE	High Density Poly Ethylene
HFL	Highest Flood Level	hpa	Hectopascal
HPC	Name of a Consultant	hrs	hours
HSD	Hydraulic Surface Dredger	IARI	Indian Agricultural Research Institute
IBA	Important Bird Areas	IESWM	Institute of Environmental Studies & Wetland Management
IITs	Indian Institute of Technology	IMD	India Meteorological Department
IMDG-code	International Maritime Dangerous Goods Code	IMO	International Maritime Organization
INTACH	Indian National Trust for Art and Cultural Heritage	IRS	Indian Remote Sensing Satellite
IS	Indian Standards Published by Bureau of Indian Standards	ISRO	Indian Space Research Organization
IUCN	International Union for Conservation of Nature	IWAI	Inland Waterways Authority of India
IWC	International Whaling Commission	IWT	Inland Waterway Transport
JNNURM	Jawaharlal Nehru National Urban Renewal Mission	kgs	Kilograms
KLD	Kilolitre per Day	km	kilometre
KMC	Kolkata Municipal Corporation	kmph	Kilometre per Hour
KoPT	Kolkata Port Trust	KW	Kilo watt
LAD	Least Available Draft	LC	Level Crossing
Leq	Equivalent continuous sound pressure level in dB	LPG	Liquid Petroleum Gas
M	Metre	M	Million
MARPOL	International Convention for the Prevention of Pollution from Ships	meq	Milli equivalent
mg/l	Milligram per litre	mg/l	Milligram per litre
mL	Millilitre	MLD	Millions of Litres Per Day
mmhos/cm	Mili mho/ centimetre	MoEF&CC	Ministry of Environment, Forests & Climate Change
mpn/100 ml	Most Probable Number/100 millilitre	MSIHC	Manufacture Storage import of Hazardous Chemicals
MSW	Municipal Solid Waste	MT	Metric Tonnes
MT	Metric Tonnes	MTPA	Million Tonne Per Annum
N	North	NAAQS	National Ambient Air Quality Standards
NAAQS	National Ambient Air Quality Standards	NABL	National Accreditation Board for Testing and Calibration Laboratories
NCAER	National Council of Applied Economic Research	NGBRA	National Ganga Basin River Authority
NGO	Non-Government Organization	NH	National Highway
NMCG	National Mission for Clean Ganga	NOC	No Objection Certificate
Nox	Oxides of Nitrogen	NRCD	National River Conservation Directorate

Abbreviations			
NTPC	National Transport Policy Committee	NTU	Nephelometric Turbidity Unit
NW	North West	°C	Degree Celsius
PCC	Portland Cement Concrete	PCCF	Principle Chief Conservator of Forests
PIANC	World Association for Waterborne Transport Infrastructure	PM	Particulate Matter
PMC	Patna Municipal Corporation	PMU	Project Management Unit
ppb	parts per billion	ppm	parts per million
PPP	Public Private Partnership	PWD	Public Works Department
QA/QC	Quality Assurance/Quality Check	RCC	Reinforced Cement Concrete
RET	Rare Endangered and Threatened Species	RIS	River Information System
RTES	Name of Govt. Consultancy Organisation	ROB	Rail Over Bridge
RO-RO	Roll on and Roll Over	RWH	Rain Water Harvesting
S	South	SAV	Submerged Aquatic Vegetation
SC	Schedule Caste	SE	South East
SEAC	State Expert Appraisal Committee	SEIAA	State Environmental Impact Assessment Authority
SH	State Highway	SO ₂	Sulphur Dioxide
SPCB	State Pollution Control Board	Sq.km	Square kilometre
ST	Schedule Tribe	STP	Sewage Treatment Plant
SW	Surface Water	SWDS	Solid Waste Disposal Site
TDS	Total Dissolved Solids	TKM	Tonne Kilometres
TPD	Tonnes per Day	TPP	Thermal Power Plant
TSDF	Treatment Storage and Disposal Facilities	TSHDs	Trailer Suction Hopper Dredger
UNDP	United Nations Development Programme	UP	Uttar Pradesh
USA	United States of America	USDA	United States Department of Agriculture
USEPA	United State Environment Protection Authority	VBREC	Vikramshila Biodiversity Research and Education Centre
VC	Vertical Clearance	VECs	Valued Environmental Components
VMC	Varanasi Municipal Corporation	W	West
WB CZMA	West Bengal Coastal Zone Management Authority	WDSC	Whale and Dolphin Conservation Society
WHC	Water Holding Capacity	WNW	West North West
WWF	Worldwide Fund for Nature		

Disclaimer:

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1. SUMMARY PROJECT DESCRIPTION

a. Need and Rationale for the Project

Inland waterways transport (IWT) is a competitive alternative to road and rail transport, offering an economical, sustainable and environment friendly mode in terms of energy consumption, noise and greenhouse gas emissions. However, IWT in India is underutilised and suffers from unreliability and lack of infrastructure as compared to other large countries and geographic areas like the United States, China and the European Union. This is partly due to investment dedicated exclusively to road and railway development and the weakness in infrastructure, service and market development in making IWT a competitive alternative.

One of the key challenges for India in accelerating economic growth and trade competitiveness remains the congested road and rail systems and the virtual absence of multi-modalism to provide more efficient and flexible supply chains. In order to reverse the decline and build a logistics infrastructure capable of efficient handling of rapidly growing freight traffic, India would need to pursue an integrated and coordinated approach and optimal utilization of all transport modes.

The total cargo moved by the inland waterways was just 0.34% of the total inland traffic in India in 2003-04. However, IWT has shown gradual growth in the last decade, and IWAI aims to capture 2% of total inland cargo by 2025. Through Gol's Twelfth Five Year Plan, and introduction of the National Waterways Bill (2015), there has been increasing commitment to development of IWT, which will increase from nearly 4,400 km to over 18,000 km of India's declared National Waterways, and an eventual ten-fold increase in the share of freight transported through this mode. There are potential economic, environmental and social benefits in using India's inland waterways for transport.

National Waterway 1 (NW-1), located in one of its busiest freight transport corridors, is the longest (1,620 km) of the six existing National Waterways and is a natural river system linking the seaport gateway at Haldia/Kolkata to Allahabad, via the Hooghly/Bhagirathi and Ganga. NW-1 in particular is of enormous national importance, and would play vital role in regional connectivity and bulk cargo movement in a cost effective and environment-friendly manner.

The Jal Marg Vikas Project, with support from the World Bank, is aimed at creating the required infrastructure, connectivity and institutional support for market development on NW-1 focusing on the stretch between Haldia and Varanasi. The project will also contribute to (i) reducing the growth of transport-related greenhouse gas emissions by rebalancing the freight mode shares and by promoting a new and complementary mode of transportation; (ii) national as well as international trade, and regional integration which allows goods to move by coastal shipping from Chittagong Port in Bangladesh and Haldia/Kolkata, and thereafter by inland waterways or road transport to the Nepal, Bhutan, and north-eastern Indian states; (iii) economic integration of four low income states (West Bengal, Jharkhand, Bihar and Uttar Pradesh) and augmentation with Eastern Dedicated Freight Corridor; and (iv) improved safety and environmental protection in IWT minimizing the negative effects of water transport on the river environment.

As stated above, IWT is an environment-friendly mode of transport, and accelerated development of the waterway will be beneficial in a number of ways, particularly in the densely populated and traffic congested region on either bank of the Ganga River. A prominent benefit is the net reduction in GHG emission (estimated at 4.54 million T CO₂e) from the project compared to the business as usual scenario (which is dependent on road transport where augmentation capacity is limited which may result in additional GHG emission in the medium term). Other benefits include avoided

acquisition of forest land and wetlands (for expanding road networks), reduced air pollution (from traffic), improved water quality given that a developed and established IWT would need and secure improved flow regime and prevent further diversion of water from the river Ganga.

b. Project Objective

The Project Development Objective is to enhance transport efficiency and reliability of National Waterway 1 and augment institutional capacity for the development and management of India's inland waterway transport system in an environmentally sustainable manner.

The Project aims at improvement of navigation in the entire stretch of NW-1 and proposes to augment the capacity of entire stretch and continue to maintain the waterways of entire stretch between Haldia to Varanasi. The capacity augmentation would aim for development of all required infrastructure like terminals and ship lock for effective and sustainable navigation throughout the year.

c. Description of the Project

The project area includes the entire reach of the River Ganga from Haldia to Varanasi including the areas proposed for development of project related facilities and infrastructure, i.e. Terminals, Navigation Ship Lock, Ro-Ro jetty and other planned developments. Map showing location of NW-1 stretch from Haldia to Allahabad is depicted in **Figure 1** below.

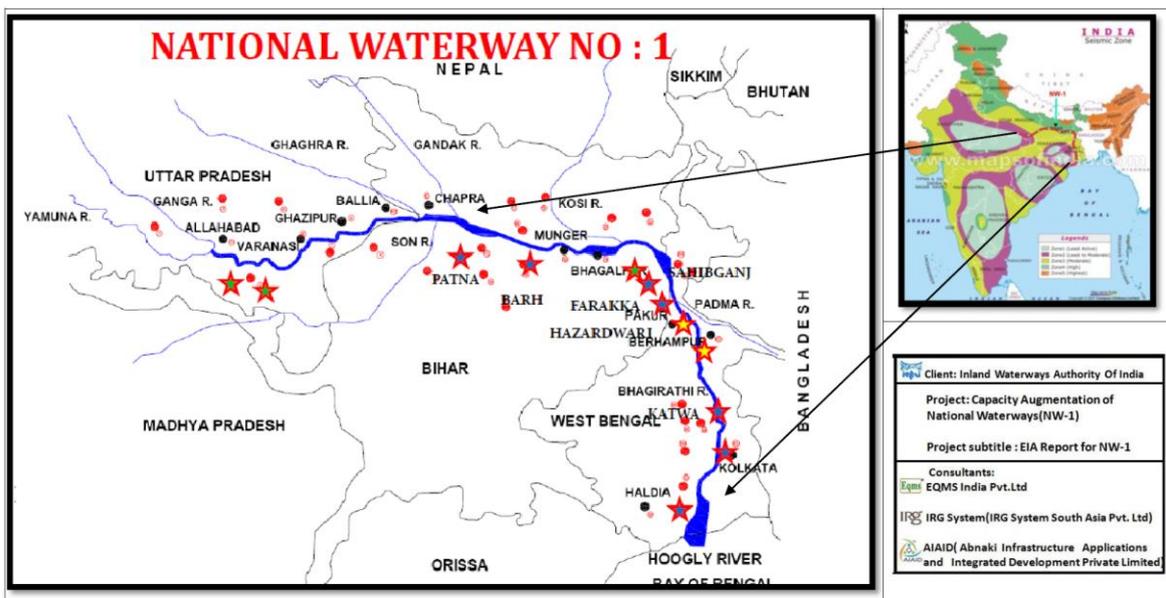


Figure 1: Location Map of NW-1

Environmental sustainability has been weaved into the project design and its components. The design is based on a balanced maintenance and operational strategy to minimize damage to the ecosystem, aligned with the principle of 'working with nature'. No barrages or storage reservoirs will be constructed in the main river and tributaries to maintain water depth and reduce silt charge even though it could have been a more economical option to dredging. Adopting an assured depth dredging contract regime would reduce unnecessary dredging and improve ecological stability with respect to water flow and quality. The design least available depth (LAD) required for sustainable navigation was also reduced by the introduction of shallow draft vessels, avoidance of any constrictions of the river flow, use of low intrusive dredging technology, and restricted operational framework in the eco sensitive zones—, which all lead to environmental sustainability.

The River Ganga has a huge cultural significance and requires sensitive public management of its development. For this purpose, the physical interventions had been kept to a minimum (and noticeably, construction of barrages, diversion structures, and groins has been avoided). The smaller physical interventions – such as vessel berthing platforms at the terminals have been carefully designed not to alter local hydro-dynamics. To meet the objective of project, the project has optimized the dredging requirement for different stretches: Haldia to Farakka (3m, where there is naturally available LAD); Farakka to Barh (3m); Barh to Buxer (2.5m); Buxer to Varanasi (2.2m). The design volume is absolutely minimized, being restricted to a channel of width of 45m in a river where the flow zone is 500m to 1km wide. The overall annual dredging quantity would be less than 1.5% of the overall sedimentation load in the river, would have highly insignificant impact on river morphology and would gradually decline due to introduction of low draft vessels in the waterway.

Opportunities for environmental enhancement were also incorporated in the project design, such as (i) supporting introduction of ‘cleaner’ vessels which will follow international standards for discharge of ballast, waste water, and use of cleaner more efficient fuel (ii) building energy-efficient, (GRIHA certified green building design) terminals and “zero-discharge” infrastructure; (iii) reduction in air pollution in major cities by careful citing of multimodal terminals and thereby reducing potential traffic congestion; (iv) conservation of protected aquatic areas; (v)) the highest health and safety standards for operation of terminal facilities and navigation operations and (vi) and state-of-art river information systems which will decrease the chances of accidents and also provide available LAD to ensure no collisions occur.

The project consists of two main components: (A) Improving the navigability of NW-1 between Haldia and Varanasi at an estimated cost of US\$770 million; and (B) Improving the investment climate, vessel design and construction framework and institutional strengthening at an estimated cost of US\$30 million.

a) Component A: Improving the navigability of NW-1 (Haldia to Varanasi).

Improvement of river fairway through dredging and river conservancy works. These works will be undertaken to provide the target LAD in the various reaches. The works will be executed through a combination of three performance-based ‘assured depth’ contracts and one input based dredging contract (already in place) on the Farakka to Varanasi stretch. IWAI’s internal resources will be used to carry out marginal maintenance dredging in the Haldia to Farakka stretch. Procurement of one assured depth dredging contract (Farakka to Bhagalpur stretch) is currently in progress.

Construction of permanent protection works for erosion prone banks in selected locations, totalling up to 48.168 km. The works will be executed through EPC contracts.

Rehabilitation of the existing ship-lock in Farakka and construction of a new parallel lock to allow concurrent two-way working. The works will be implemented through an EPC contract and procurement is currently in progress.

Multi-modal freight terminals and other facilities: (i) construction of six multi-modal freight terminals with future provision to allow evolution as market clusters ; (ii) one vessel repair and maintenance facility; and (iii) five RO-RO crossings. IWAI would provide land and road access for the RO-RO terminals, while the private sector would build and operate RO-RO facilities. All other works will be executed through EPC contracts. Construction of a multi-modal terminal in Varanasi has been initiated and procurement is currently ongoing for Sahibgunj and Haldia multi-modal terminals. Land acquisition and resettlement, environmental management, utility relocation and independent monitoring and quality assurance are included.

Navigational aids and river information systems: (i) navigational aids in the form of night navigation facilities and channel marking; (ii) enhancement of existing river information system through addition of app-based systems, improved communication platform and expanded user

reach; and (iii) provision of other support services e.g. search and rescue, distress response and casualty incident management, and upgrading vessel and river monitoring systems. These activities will be implemented through a combination of small civil works, services and goods contracts.

b) Component B: Institutional Strengthening and improving the investment climate, vessel design and construction framework

Institutional strengthening of sector institutions and capacity building of the sector is envisaged through: (i) undertaking a review of current IWAI staffing, future institutional options and enhanced staffing/skill needs including in areas such as logistics and marketing, social development, grievance redressal, health, safety and environmental (HSE) management; (ii) undertaking review and alignment of laws and regulations in respect to IWT vessel design, construction, manning, operation, maintenance, insurance and multi-modal transport; and (iii) exploring the option of developing sector institutions including a Research and Development Unit/Centre for IWAI and enhancement of training institutions (NINI). Adequate training, exposure visits and international benchmarking will be supported through this component. The procurement process for activity (i) has been initiated and IWAI has also commenced activity (ii) through the recent initiative in amending the Inland Waterways Act.

The overall investment climate will be improved through (i) undertaking market development studies and preparation of business cases (by location, industry and cargo type); and (ii) investigating arrangements for private sector participation in the construction and operation of terminals. Both of these activities would be executed through service contracts. IFC has been engaged as a transaction adviser to support activity (ii) which is well underway. Activity (i) is also in progress.

Fleet modernization will be undertaken through: (i) vessel design and standardization with a focus on low draft and efficient and clean fuel (LNG) vessels; (ii) public/private stakeholder consultations to encourage investment in modern vessel technology through review of fiscal and other barriers hindering vessel construction; and (iii) leasing of ten low draft vessels to kick-start the use of modern vessels in NW-1. Activities (i) and (ii) would be implemented through service contracts, while activity (iii) will be implemented through goods contracts. Procurement for activity (i) is already underway.

Table 1: Salient Features of Jal Marg Vikas Project

Salient Features	Capacity/Quantity/Nos.			
Facilities Planned	3 Multi-modal terminal sites (Sahibganj, Varanasi &Haldia) 1 new Navigation lock- Farakka River bank protection works at planned terminal sites and along Feeder canal			
Facilities under Planning Stage	3 additional terminal sites (at Ghazipur & Kalughat-site finalized and at Tribeni-under consideration) 5 ro-ro crossings Barge repair and maintenance facilities River training works River bank protection works at the proposed civil intervention sites			
Designed capacity of Terminals	Infrastructural Facility	Projected Cargo-2015 (MTPA)	Projected Cargo-2030 (MTPA)	Projected Cargo-2045 (MTPA)
	Sahibganj Terminal	2.24	4.39	9.00
	Varanasi Terminal	0.54	1.22	1.22

Salient Features	Capacity/Quantity/Nos.			
	(with current land)			
	Haldia Terminal	3.18 MTPA		
Navigation Channel	Channel Width-45 m LAD-3 m from Haldia (0 Km) to Barh (980 Km) , 2.5 m from Barh to Ghazipur (1250 Km) and 2.2 m from Ghazipur to Varanasi (1360 Km) at present			
Design Vessel Specifications	Vessels of maximum length of 110 m, beam of 11.4 m, draught of 2.5 m-2.8 m and air draught of 9 m will be required in NW-1.			
Size of Vessels	1500-2000 dWT			
River Slope	Haldia to Farakka-1 in 11000 Farakka downstream-1 in 18000 Farakka to Allahabad-1 in 17,000			
Maintenance Dredging	Within Navigation Channel-14,850,000 cum/year*			
Type of Dredgers	Cutter Suction dredgers (CSD), Water Injection dredgers, Agitation/Plough dredgers and Back-hoe dredgers			
Dredge disposal	Preferably off-shore, onshore only if sediments are found to be contaminated			

* Quantities are tentative and subject to change with revision in planning

c) Cargo Details

Cargo proposed to be transported in NW-1 includes cement, fly ash, iron ore, iron ore fines, coal, steel shed, tyres, iron fines, iron ingots, galvanized steel plain sheets, stone chips, furnace oil, high speed diesel (HSD), lube oil, boulders, pulses, aluminium block, sand, chips, ship blocks, food grains, manganese ore, petroleum products, coke, cooking coal, rock phosphate, timber, peas, slag oil, and non-cooking coal. As per the survey traffic, current traffic transported via rail & road between Haldia & Varanasi is 121426130 tonne. Traffic projection studies are carried out and as per the study, projected traffic for year 2045 is 4,80,11,367 tonne. Under NW-1, 6 nos of terminals are proposed out of which planning for three nos. terminals are completed. As per the planning, the cargo handling capacity for base year and year 2045 is given at **Table 2**.

Table 2: Traffic Forecast for Planned Navigational Infrastructural Facilities

S. No.	Infrastructural Facility	Projected Cargo-2015 (MTPA)	Projected Cargo-2030 (MTPA)	Projected Cargo-2045 (MTPA)
1	Sahibganj Terminal	2.24	4.39	9.00
2	Varanasi Terminal (with current land)	0.54	1.22	1.22
3	Haldia Terminal	3.18MTPA		

Source: HOWE Engineering Projects (India) Pvt. Ltd. (Design Consultant)

d. Project Implementation Schedule and Implementation Responsibilities

The project being spatially large will be developed in phases. The implementation period of 3 years is anticipated for completion of Phase 1 components of the Project (6 terminal sites, maintenance dredging, vessel management system, shore protection works and river training works). The Project Director and officer of the rank of Vice Chairman of IWAI will be in charge of the implementation programme who will be assisted by Project Management Unit and Regional Directors.

2. ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

This project is classified as Category 'A' operations under the World Bank environmental screening procedures specified under its operation policy (OP) 4.01. The project triggers six of the World Bank safeguard policies and requires comprehensive environmental assessment. Detailed environmental assessment has been undertaken for all the proposed components to identify the environmental issues associated with the project. The environmental impact assessment was carried out in line with World Bank Operational Policies, IFC EHS Guidelines for Ports, Harbours and Terminals, IFC General Guidelines for EHS, and MoEFCC EIA Guidelines for Ports and Harbours.

a. Project Categorisation and Applicable Safeguard Policies

The project is classified as an 'Environmental Category A' project in accordance with OP4.01 due to the nature and scale of the planned civil works, the complexity of environmental issues associated with the river dredging, and the ecological sensitivity of river Ganga. Of the environmental safeguard policies, the project triggers: (i) OP/BP 4.01 - Environmental Assessment, (ii) OP/BP 4.04 - Natural Habitats, and (iii) OP/BP 4.11 – Physical & Cultural Resources. In addition, the Environmental, Health, and Safety (EHS) Guidelines of the World Bank is applicable to the project.

The project also triggers the OP/BP 4.20 Involuntary resettlement.

b. Other Safeguard Policies

Projects on International Waterways (OP/BP7.50): The Bank's Operational Policy OP 7.50 that pertains to Projects on International Waterways is triggered since project activities will take place on the Ganga which is a trans-boundary river flowing through the nations of India, Nepal and Bangladesh. The Bank, on behalf of India, notified the riparian countries - China, Nepal and Bangladesh in June 2016. China issued its no objection to the project on July 27, 2016. Bangladesh Government asked for additional information on July 18, 2016, which was responded by the Bank on August 12, 2016. No communication has been received from Nepal.

All planning and design considerations for proposed infrastructure along NW-1 have been aimed at fully avoiding (or absolutely minimizing) any potential adverse transboundary affects (which could have impacts such as reduction and/or modification of flow of water or sediments; and increased water pollution). The avoidance of any obstruction to or modification of flow, the designs that ensure no pollution of the river, and the limits placed on dredging and disposal of dredged materials mean that there will be no impact on the quality and quantity of flow in the transboundary river.

c. EA Documents: preparation, consultation and disclosure

The following EA documents have been prepared for the Project:

- 1) An executive summary of the entire EA process and documents (Volume 1 of EA Documents)
- 2) A cumulative impact analysis (CIA) report for the Project and other major developments currently implemented or planned along the river Ganga (see Volumes 2 and 2A)
 - a. This CIA includes a study on the critical environmental resources of the Ganges basin in India, to provide guidelines to avoid impacts on these as far as possible, and recommends strategies to manage direct, indirect and induced impacts (which include specific guidance for the Project and its EIA).
- 3) A consolidated environmental impact assessment (EIA) for the Project (see Volumes, 3A, 3B, 3C and 3D)
 - a. This is aimed to avoid, mitigate and/or manage overall potential environmental, health and safety impacts from the Project;

- b. Note that the consolidated EIA was not limited to summation of individual sub-projects (interventions), but is an overall assessment covering all aspects of operation of the waterway.
 - c. The EIA includes specific environmental assessment of all major interventions currently planned in the project (barge operations, maintenance dredging, navigational lock at Farakka, multimodal cargo terminals at Varanasi, Sahibganj and Haldia);
 - d. The EIA includes an environmental management framework (anticipated potential issues and risks, terms of reference including scope of work for the EA to be undertaken) for major civil works interventions that may come up in near future, such as RO-RO jetties, additional multimodal cargo terminals, and vessel repair and maintenance facilities;
 - e. A summary of concerns raised during consultation has been included as a standalone document highlighting the different stakeholder consultations conducted, issues raised and how they have been incorporated in the project's plans and designs.
- 4) Environmental Management Plans (EMPs) suitable for incorporation in the works (or design-build-operate contracts) of planned interventions in the project. (See Volumes 4, 5, 6, 7, 8 and 9). These were prepared for the following:
- a. Multi-modal cargo terminals at Varanasi, Sahibganj and Haldia.
 - b. Navigation lock at Farraka
 - c. Maintenance dredging for the entire waterway (Haldia to Varanasi)
 - d. Barge operations for the entire waterway (Haldia to Varanasi)

Baseline surveys: The baseline surveys were planned considering the requirement of the project level EIA, larger CIA and the basin-level study of critical environmental resources. The baseline surveys were carried out between September 15, 2015 and February 28, 2016. In addition to air, water, noise, soil quality, terrestrial flora and fauna, aquatic flora and fauna, baseline surveys included sampling and testing for riverbed sediments quality and contamination. Baseline studies identified all existing infrastructure on NW-1 (such as existing RO-RO jetties, existing passenger ferries, pontoons, bridges, etc.), the likely intervention places, likely maintenance dredging stretches, and all environmentally sensitive areas. Baseline studies covered project's influence area different for each valued environmental components (VECs) determined by potential pathways and extent of impacts on the specific VECs.

Analysis of alternatives and their incorporation in design of the project: The assessments were carried out in tandem with preparation of detailed engineering feasibility report. This helped to analyse the suggested alternatives from an environmental perspective and in turn allowed incorporation of the environmentally suitable alternative in the project's design. Further, various project proposals were modified during the design stage to mainstream environmental considerations. Examples include incorporation of mechanical conveyance system at Sahibganj, mandatory green plantation all around the periphery of terminals and along the roads, dust suppression system at storage and barge loading areas, and provision of storm water management system separate for buildings and for surface. The basin level study of critical environmental resources identified "No-Go" areas, and other characteristically sensitive locations where construction and dredging is strictly prohibited.

The impact assessment covers all three stages of the project viz. design, construction and operation stages. The impacts are identified from all components and activities of the project on physical, biological (terrestrial and aquatic ecology) and socio-economic environment. The project has the potential, unless managed, to have unintended impacts both in the short and long term. Potential major environmental issues that were examined included: (i) modifications to the riverbed, riverbanks and the flood plains, and the consequent impacts; (ii) potential modifications to the river

and sediment flow, especially during the lean season and the associated impacts; (iii) potential damage to the aquatic fauna including dolphins, turtles, fishes, and to the nesting and breeding grounds and sanctuaries on and along the river bed; (iv) construction related impacts including impacts from dredging, disposal of dredged materials, siting of terminals, logistics parks, bank protection works and jetties, and (v) potential pollution of the waterway, and safety and health issues arising during operation from regular operations or by accidental spills.

Because of the Environmental Assessment, and subsequent incorporation in plans and designs, the project has reduced the risks (by avoiding specific interventions, such as dredging in the critical stretches of protected areas; or by minimizing the interventions). Consequently, no potential large scale, significant and/or irreversible impacts envisaged from the project. The plan for mitigating and managing the residual risks is reasonable and implementable. In addition, the project is aiming at very substantial environmental enhancements (by switching to liquefied natural gas as vessel fuel, by facilitating introduction of "cleaner" vessels, by adopting low-draft vessels, by augmenting riverine fishery or by supporting conservation of protected aquatic areas), and contributing to curbing GHG emission of an order of 4.54 million tCO₂e.

Consultation and Disclosure: The environmental assessments were carried out in substantial consultation with stakeholders, to ensure that the environmental assessment and other compliance requirements are in alignment with the policies and procedures as specified by the Government of India and the World Bank Group safeguard policies. The draft EA documents (the CIA, the Consolidated EA containing the EMPs for maintenance dredging and barge operations; the stand-alone EMPs for Farraka Lock, Sahebganj, Varanasi and Haldia Terminals; and the Executive Summary) were submitted to the Bank's Infoshop on June 2, 2016. All these EA documents along with an Executive Summary in vernacular Hindi and Bengali were disclosed in country (on the IWAI website) on May 22, 2016. The consultation process will continue throughout implementation of the project.

Following disclosure, IWAI has invited stakeholder comments. Based on the comments from stakeholders, the EA documents were revised in September 2016. These revised versions of the EA documents will be redisclosed in country and in the Bank's Infoshop, with stakeholder comments incorporated.

Any new investments in future that require use of a safeguard instrument such as an EA will also follow Bank operational policies for public consultation and for disclosure.

3. ENVIRONMENTAL SUSTAINABILITY & CLIMATE RESILIENCE IN THE PROJECT

Sustainable development and climate resilience were integrated in the project from the project planning stage. The project design was based on a balanced maintenance and operational strategy to minimize damage to the ecosystem, aligned with the principle of 'working with nature'. Adopting an assured depth dredging contract regime would reduce unnecessary dredging and improve ecological stability with respect to water flow and quality. Water Injection dredging/CSD is proposed instead of the traditional dredging techniques. Here the dredged material is transported horizontally along the waterbed and retains the dredged sediments within the ecosystem, which is an important advantage for preserving the water ecology.

The project has adopted a practical approach by planning for potential impacts of climate-induced events. The vulnerability to these potential impacts and the possible risks to both the assets and the services provided were considered. With a view to build climate resilience, selected initiatives were identified for design and implementation to be executed as a part of the project. Taking into account possible climate-induced events such as drought or low water situations, low draft vessels were chosen. These would help continuity of operation in drought or low water situations and help extend

the overall operational window in summer months. Further, the construction of jetties adjustable at variable heights to deal with abnormal changes would help continuity of terminal operations in high and low flow periods. The provision of storm shelters in ship repair facilities and other anchor points / floating jetties has also been included as a community adaptation measure.

Significant enhancement of disaster management services, i.e. rescue boat, patrol boat and oil recovery vessel / attachment and service leasing of salvage tugs, has been planned. Erosion protection for a 40km stretch is being done. This will bring climate adaptation benefits to the community apart from serving the waterway itself. In building software, specific enhancement to the River Information Systems to alert users on climate change events has been planned. The overall strengthening of the assets and information systems will contribute towards building climate resilience for communities near the waterways.

Inland waterways transport has the potential improve the freight transportation efficiency. Using this efficiency in NW-1, the project will substantially reduce the GHG emissions to the tune of 4.54 million tons tCO₂e in part fulfilling India's Nationally Determined Commitments by 2030. This net reduction in GHG emission is expected to be higher with the incorporation of high capacity vessels that will run on LNG and move in low draft.

Another key benefit is the reduction in pressure on land acquisition in the case of agriculture and forestland. IWT is less likely than other transport forms to compete for land area (land is only required for terminal construction, and access to the navigation channel), an important consideration especially in the densely populated areas/cities along NW-1. It is also likely that in the long term, the land use changes will be about agricultural areas or fallow lands (where terminals could be easily located) being converted to commercial transport infrastructure land uses, rather than natural forests or protected terrestrial areas.

Navigation is an ally to enhance environmental flows in the river and consequently improve wetland connectivity. In the main stem of Ganga (until it joins tributaries in Bihar), lack of the needed environmental flow has been a concern for a long time. In part, the water of the Ganges was diverted to irrigation canals, as there was no strong stakeholder for maintaining adequate flow in the river. Development of the project will ensure continuous water flow in the river.

At the project level, through the recommendations of the EA process, a number of measures enhancing environmental benefits have been adopted. These include:

- (i) The promotion of clean fuel (including LNG) vessels and construction of zero discharge terminals and other riverside facilities would reduce the risk of environmental pollution;
- (ii) Introduction of energy efficient (GRIHA certified terminals) to reduce overall energy consumption;
- (iii) Reduction in air pollution in major cities by careful citing of multi-modal terminals and thereby reducing potential traffic congestion;
- (iv) Conservation of protected aquatic areas;
- (v) Supporting introduction of 'cleaner' vessels;
- (vi) Integrating NW-1 with passenger services: a safe and environmentally friendly transport service can also provide effective support to growth of tourism.

4. APPLICABILITY OF LEGAL AND REGULATORY FRAMEWORK IN INDIA

The project has been evaluated for applicability of all National, State Laws, Rules and Regulations. The Acts, rules and guidelines applicable for the project are critically analysed to list out the permits/NOC required to be obtained by IWAI/contractor prior and during the development of the project. Environmental legislations applicable for the project are:

- (1) Environmental Protection Act, 1986**
- (2) EIA Notification, 2006 as amended till date**
- (3) Forest Conservation Act, 1980**
- (4) Wildlife Protection Act, 1972**
- (5) Coastal Regulation Zone Notification, 2011**
- (6) Air (Prevention and Control) of Pollution Act 1981/1987**
- (7) Water (Prevention and Control of Pollution) Act, 1974/1988**
- (8) Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016**
- (9) Construction and Demolition Waste Management Rules 2016**
- (10) E-Waste Management Rules, 2016**
- (11) Plastic Waste Management Rules, 2016**
- (12) The Battery Management and Handling Rules, 2001**
- (13) Ancient Monument and Archaeological Site and Remains Act, 1958.**

As per EIA Notification, 2006 as amended at present the project components like development of terminals & jetties does not require environment clearance. However, environmental clearance will need to be obtained for any project component wherever found applicable due to any amendment to the above notification. The environmental clearance under minor mineral category of EIA notification 2006 should be taken by the contractors as applicable before borrowing the earth and for setting up new quarry site. Consent to establish under Air and Water Acts for setting up batching plant, hot mix plant, DG sets, soak pit & septic tank/STP should be obtained by the contractor from State Pollution Control Boards before setting up these facilities. The contractors / IWAI will ensure compliance to the conditions of these permissions and should abide by the monitoring requirement to be imposed by the permission granting agencies. No diversion of forest land is involved in the project; however cutting of trees will be carried out for construction of terminals and other interventions and permission will be required from concerned authorities or forests departments as per law of respective states. Waste/used oil is the only hazardous waste likely to be generated during construction and operation stage, which should be managed as per Hazardous & Other Waste Management Rules, 2016. Other waste related regulations should also be followed depending on the nature of waste generation during construction and operation stages as defined above.

Permission under CRZ Notification, 2011 is required from West Bengal Coastal Zone Management Authority to establish Haldia Terminal. The process for this permission has already been initiated. Permission for movement of vessel through Kashi Turtle sanctuary and Vikramshila Gangetic Dolphin Sanctuary (VGDS) located under Wildlife Protection Act, 1972¹ will be required. Process has already been initiated for obtaining these permissions. There are nine archaeological sites located within 300m area of river bank on NW-1. No construction activities are proposed close to these sites. Permissions should be obtained from archaeological department if any construction is planned in near future within 300 m of these sites.

Additional international conventions/treaties applicable for the project have been analysed. India as a signatory of International Maritime Organization (IMO), is obligated to follow the environmental and safety guidelines prescribed under various conventions. Some of the regulation and guidelines applicable to vessels plying in Indian inland waterways as per IWAI includes (i) Prevention of Collision on National Waterways Regulations, 2002 (ii) National Waterways, Safety of Navigation

¹As per notification, restrictions are imposed for fishing (larvae of Hilsa & during breeding & spawning season) only in Hilsa Sanctuary

and Shipping Regulations, 2002 (iii) The National Waterway-1 Act, 1982 (iv) New Inland Vessel Act, 2015 & Rules Under IV Act; and (v) other relevant International Environmental Conventions.

5. ANALYSIS OF ALTERNATIVES

Analysis of alternatives is an analytical comparison of the operational effectiveness, costs and environmental and social risks of proposed development options. This helps to analyse the options critically in relation to its impacts on all physical, social and biological environments. For this project, alternative analysis has been made for three considerations, i.e. strategic, planning and technology consideration. The summary of these analyses is presented below:

a. Strategic Consideration (“with” or “without” project)

A comparison is made for “With” & “Without” project scenario for the physical, social and biological environments and status of cargo transport scenario. “With Project Scenario” is considered better for all physical, biological, social environmental and cargo transport scenario compared to “Without Project Scenario”. With Project Scenario will improve the freight transportation efficiency, reduce the GHG emissions, fuel requirement, air emissions, land acquisition, and tree cutting for maintaining and expanding cargo movement requirement. However, impacts are anticipated more on water and aquatic ecology in “With Project” scenario as compared to rail and road modes, for which mitigation and management plans have been prepared to minimize the impacts.

b. Planning Consideration

This involves the consideration of options for location of the proposed interventions, suitability of intervention sites, design of the project layout and dredging extent. Locations are selected for proposed civil interventions (terminals/jetties) based on potential of freight/cargo movement in the area and its connectivity with other modes of transport (Rail and Road). Ten such locations were selected for development of six terminals and one navigational lock. One of the probable locations at Bhagalpur was ruled out due to presence of Vikramshila Gangetic Dolphin Sanctuary and based on “No-Go” areas identified in Basin Level Critical Resources Assessment study. Two sites at Varanasi and Sahibganj were identified few years back where land acquisition process was either completed or nearing completion and thus were not included in the locational alternative analysis. However, acceptability of these sites from environmental aspects was assessed and the sites were found acceptable. The terminal sites at Haldia, proposed to be located on Government land (Kolkata Port Trust Land), which is already being used for shipping and industrial purposes, were considered acceptable from environmental and social aspects. The location of navigational lock at Farakka already exists and navigation lock parallel to existing lock is proposed. The remaining seven sites were analysed from environmental and social design considerations. Based on alternative analysis three terminal sites at Ghazipur, Tribeni (Kalyani), and Kalughat near Doraiganj were considered as preferred sites for these interventions. The other three terminal sites at Barh, Kahalgaon and Balia were not considered feasible due to (i) various environmental considerations including proximity to Vikramshila Dolphin sanctuary and important bird areas, (ii) design issues such as unstable river, presence of navigational hazards and high sedimentation rate, (iii) social issues concerning acquisition of land and (iv) connectivity issues.

Further alternative analysis was carried out for probable two sites at each of the above identified three terminal locations and Farakka lock, based on environmental, social and design consideration. As per this analysis, the preferred sites for these intervention locations were considered for design and environmental impact assessment.

At the time of impact assessment, terminal designs were ready for Varanasi, Sahibganj, and Haldia terminals only. Considering technical feasibility, multiple layout options were available only for Sahibganj terminal and Farakka lock. These layout options were analysed for identification of most suitable design options. In case of Sahibganj terminal, Alternative 1 involves construction of U shaped jetty (25 m), aligned parallel to the river bank and connected to bank by approach trestle of 50 m and Alternative 2 involves construction of jetty at the river bank aligned parallel to it. Both the alternatives were compared on multiple criteria, i.e. Operational considerations, navigational aspects, ease of construction & maintenance, flexibility of expansion, construction cost and environmental considerations. Both the layouts have certain advantages as well as disadvantages. It could be observed that in terms of available required depth throughout the year and marginal cost difference between two alternatives and environmental consideration, Alternative-1 is found preferred alternative for development of IWT Terminal at Sahibganj. In case of Farakka lock, Alternative 1 involves construction of lock parallel to the existing lock and in Alternative 2, lock will be constructed D/S of the existing lock. Considering the design, requirement of land, length of embankment, availability of depth, dredging requirement etc, it is found that Alternative 1 is better than Alternative 2.

To maintain the river navigability, maintenance dredging is required to be planned to maintain the length and width of the channel and maintain LAD near the berths/jetty. IWAI proposed either maintaining 3m LAD throughout the NW-1 stretch or different LAD in different stretches (3 m Haldia to Barh, 2.5 m from Barh to Ghazipur and 2.2 m from Ghazipur to Varanasi). Width of 45m will be maintained throughout the navigation channel with side slope of 1:5. Alternative analysis was carried out for both these options considering environmental (dredge quality, impact on aquatic ecology and water quality); social (cultural and aesthetic value, employment and socio-economic consideration) and technical feasibility (dredge quantity, navigation feasibility, economic aspects, dredgers and other infrastructure requirements). As per analysis, the option of maintaining different LAD at different stretches was found the most preferred option.

c. Technological Consideration:

The technological aspects were analysed in terms of dredging technology. Five types of dredgers namely cutter suction dredgers (CSD), hopper dredgers, grab/bucket dredgers and backhoe dredgers were analysed. These were analysed based on safety, accuracy, turbidity, spills and noise criteria as well as operational feasibility. The CSD was considered as most preferred option due to least associated environmental impact and operational feasibility. Typically, CSDs have least effect on turbidity at the dredging site. Grab dredgers and TSGDs when used with overflow; produce significantly high turbidity throughout the water column near the dredging site than do CSDs. Underwater noise generation in CSDs is comparatively lesser than other dredgers. As per experience of KoPT and IWT also, CSD has proven to be the best option and is considered for maintenance dredging planning and environmental impact assessment. Additionally, to reduce disturbance to the riverbed sediments, water injection dredgers would be used in the project.

d. Integration of Analysis of Alternatives into Project Design

Since studies were being carried out along with the feasibility report preparation, the output of alternative analysis and design consideration was discussed with the design team and incorporated in the project design. Some of the design changes include provision of mechanical material handling system at Sahibganj Terminal, dust suppression system at each terminal, provision of green belt all along the terminal boundary, integration of green building concept in terminal buildings, adoption of zero discharge concept at terminals and barges, rain water harvesting, emergency response planning, exploring feasibility of using low draft vessel and alternative fuels for

large operations. The project description details presented below includes the above considerations.

6. PUBLIC CONSULTATION AND DISCLOSURE

Stakeholder's view and perception was assessed through informal and formal public consultation meetings. The different stakeholder's viz. government officials, NGOs, village panchayats (village administration), people (male, female) were contacted and consulted during the course of the study. Stakeholders were informed about the project components and likely environmental impacts before seeking their views. In each consultation, all efforts were made to have adequate participation from women as well. Consultations have been carried out for the project in two stages. First stage consultation was undertaken during impact assessment process to identify the concerns of people, which were duly addressed through appropriate mitigation measures. Second stage consultation was undertaken after preparation of EIA report to assess the adequacy and acceptability of the proposed mitigation measures and management plan. Public consultations ensured involvement of public, NGO, experts in the project's pre-planning stage itself and addressal of their concerns and expectations from the project.

The community members, government officials and NGO members opined that the proposed project would contribute to social and economic development of the region. The proposed project would contribute to increased employment opportunities for the local people during and after project implementation. The communities welcomed the project and all were in favour of the project. However, some of the fishermen and land holders have raised some concerns about the fishing activities/yield and the compensation to be given. Major issues highlighted during consultations were adequate compensation against the land, loss of livelihood, provision of alternate employment, river water pollution, fish yield and disruption of fishing activities. Each of the issues raised by stakeholders was analysed for practical and scientific basis, and for developing an appropriate mitigation, management and monitoring plan, depending on its importance and practicality.

An executive summary of consolidated EA report is available for public scrutiny in local language (Hindi and Bengali) versions at IWAI website. EIA report for entire Jal Marg Vikas Project and its executive summary is also disclosed at IWAI website and as per provisions of World Bank disclosure policies. A brief table illustrating the key concerns of the informal stakeholders is given below in **Table 3**.

Table 3: Summary of Key Concerns rose by stakeholders and its redressal

S.	Key Concerns	Redressal
1	Fishing community raised concern regarding effect on fish productivity and demanded support from project for the same.	<ul style="list-style-type: none"> Such impacts are unlikely from this project. However, mitigation, enhancement measures are proposed under EMP for reduction of impacts if any due to construction & operation of NW-1 and its components. Some of the measures include: Technical support for enhancing fish productivity by setting up demonstration nurseries and training centre through institute of repute like CIFRI Regulated/slow speed of vessel at select locations and Zero Pollution approach from vessel and terminals Intimation of dredging/piling plan to fishermen community prior to carrying out any activity

S.	Key Concerns	Redressal
		<ul style="list-style-type: none"> Provision of sirens and strong searchlights in vessels/barges to pre-warn the fishermen.
2	Provision should be made for adequate compensation for land acquisition wherever applicable.	SIA and RAP has been prepared for Sahibganj and consolidate SIA/RAP for NW-1. Provision of due compensation has been made as per these plans which are prepared as per applicable R&R policies.
3	People desired to have the relocation site for the people likely to be displaced near river Ganga.	Relocation site is proposed to be selected by the concerned authorities responsible for land acquisition in consultation with people concerned.
4	People demanded support for the improvement in and around local immersion Ghats at Durgachak (near Haldia terminal in West Bengal) to reduce congestion, especially during the local festival.	Budgetary provision is made under EMP for improvement of Ghats as an enhancement measure. Additional enhancement measure has been proposed for small-enclosed areas dedicated for female bathing in every village along the NW-1 to allow females maintain their privacy while fulfilling their religious belief of bathing in river Ganga.
5	People raised concern that the terminal development may lead to increased traffic on the connecting roads, which are not suitable for such an increased load, and needs to be upgraded.	Project design has considered this aspect and adequate provision is made for developing access road to the terminals to avoid any kind of congestion at each terminal site.
6	Turtles will be affected due to regular movement of vessels in river in Kashi Turtle Sanctuary.	Maximum of 1-2 vessels per hour are expected to move in the sanctuary area. Speed of vessels shall be maintained to 5 kmph/2.7 knots in turtle sanctuary area. Barge movement at this speed generates noise in order of 110-140 dB. Threshold noise level of turtles for change in behavioural response is 150 dB which is above the noise expected to be generated by moving barges and the impact on turtles behaviour responses is anticipated to be insignificant. Other measures are also being proposed in the EMP to minimize impact of barge movement on turtles.
7	Dolphins will be affected due to barge movement during the operation phase of the project.	Adequate mitigative measures have been proposed in the project design which includes provision of propeller guards to prevent entangling of dolphins and other mammals, speed restriction in the sanctuary area and a restrictive buffer zone of 100m horizontally and 500m longitudinally on either side of the river confluence areas for any dredging activity. Other measures are also proposed in the management plan to reduce the impact on dolphins and other aquatic fauna.
8	Oil spillage from ships during accident may impact the aquatic flora, fauna, water quality and anti-bacterial properties of river Ganga.	Such situations are remote. Safety measures are proposed in the EMP for vessels as well. No vessels are expected to discharge any of its liquid or oily waste in the river. Emergency response plan would deal with emergency situations to minimize the impact of such situations. It is also proposed that each vessel would have appropriate sewage treatment, treated sewage storage and waste management facilities to prevent water pollution.

S.	Key Concerns	Redressal
9	People raised concerns regarding the likely impact on water quality due to construction and operation of terminal facility and cargo movement.	Environment management plan has incorporated the measures for prevention of water pollution from terminals, and barge operations. Zero discharge approach is proposed for terminals development and barge operations.
10	People raised concern about cutting of large no. of trees at Sahibganj site.	Compensatory tree plantation (1:7 basis) at Sahibganj and additional plantation is proposed to be undertaken. At all the terminals/jetty sites green belt will be developed to the extent possible. This will help in minimizing the impact and will lead to reduced impact of CO ₂ .
11	The varying LAD may lead to grounding of vessels.	LAD is proposed to be maintained in the stretch between Haldia to Varanasi during entire lean period
12	Dredging may have significant impact on breeding and spawning season of fishes.	Dredging is proposed to be regulated during breeding and spawning season of the fishes.
13	People have pointed out the existing erosion problem in the Farakka feeder canal and voiced the apprehension that the NW-1 development and barge movement may escalate this problem.	Provision has been made in the project design for bank protection work of 9.438 km; it is proposed to be undertaken on banks of feeder canal to prevent the erosion.
14	People have suggested that appropriate parking facilities be made inside the proposed terminals for better management of goods carriers and to reduce traffic on existing road due to inappropriate parking on the public roads.	Adequate parking provisions are proposed in each terminal site design.
15	People have proposed adequate provisions for prevention of water logging in and around the terminals, and for firefighting.	Adequate drainage provision is made for channelizing the rain water at each terminal site. Fire-fighting facility is also proposed at each terminal site.

7. SALIENT ENVIRONMENTAL FEATURES OF NW-1

The salient features of environmental resources within influence area (10 Km) of NW-1, are presented at Table 4. Topography of the whole of NW-1 (Allahabad to Haldia) falls within a relatively flat terrain of the Indo-Gangetic plain. The elevation within the influence area of the NW-1 stretch, ranges between 1 m amsl (meter above sea level) and 321 m amsl. Highest elevation levels were observed at Sahibganj area (Jharkhand) due to presence of small hillocks. Land use within influence area of the NW-1 is majorly dominated by agricultural land. About 78.9 % of the land is under cultivation; about 7.18% land is under settlement; 7.21% of the land is under water bodies; about 3.59% land is under vegetation; 2.82% land is under dry river bed and rest of the land falls under other uses.

Table 4: Salient Environmental Features along NW-1 Alignment

S. No.	Environmental Features	Within 500 m influence area around NW-1	Within 2km influence area around NW-1	Within 10km influence area around NW-1
1	Ecological Environment			
A	Presence of National Park/Biosphere Reserves, Tiger Reserve etc.	None	None	None
	Presence of Wildlife Sanctuary	Yes Kashi Turtle Sanctuary at Varanasi Vikramshila Dolphin Sanctuary Kahalgaon to Sultanganj Hilsa Sanctuary stretch in West Bengal	None	Yes Udhwa lake sanctuary in Jharkhand (about 9 km away from NW-1)
B	Reserved /Protected Forests	None	None	Yes (Bethuadahari RF, Bahadurpur RF & RF near Rajmahal Hills)
C	Wetland of state and national interest	None	None	Yes (Udhwa Bird sanctuary)
D	Migratory route for wild terrestrial animals	None	None	None
E	Presence of Schedule-I (Wildlife Protection Act, 1972) Terrestrial Fauna	None	Yes Migratory birds near Farakka Barrage and surrounding area	Yes Migratory birds at important birds' areas
F	Presence of Schedule-I (Wildlife Protection Act, 1972) Aquatic Fauna	Yes Dolphin, and Turtle (more frequently sighted) Smooth Coated Otter and Crocodile (very rarely seen in the main stem of the river Ganga)	None	None
G	Important Bird Area	Vikramshila sanctuary area	Yes Danapur Cantonment area Mokamatal Kurseala river course and	Yes Udhwa lake sanctuary

S. No.	Environmental Features	Within 500 m influence area around NW-1	Within 2km influence area around NW-1	Within 10km influence area around NW-1
			diyara flood plain. Farakka Barrage and surrounding areas	
H	Seismicity	NW-1 falls in Zone-III (moderate risk) and zone IV (high damage risk zone) as per Seismic Zonal Map of India		
B.	Social Environment			
I	Physical Setting	Rural, Industrial and Urban		
J	Densely populated area	Allahabad, Sirsa, Mirzapur, Chunar, Varanasi, Zamania, Ghazipur, Gahmar, Buxar, Ballia, Chappra, Patna, Barh, Bihat, Munger, Bhgalpur, Kahalgaon, Sahibganj, Farakka, Berhampore, Katwa, Kalna, Kolkata and Haldia are densely populated areas.		
K	Physical Sensitive Receptors	Yes Ghats at Varanasi, Patna, Temples, Schools, College and Hospital. Details are provided at section 4.7		
L	Archaeological Monuments	Yes There are 9 archaeological sites located within 300 m area of the NW-1 and these are KardmeshwarMahadevaMandir, Ramnagar fort, archaeological excavation site, Varanasi, Manmahal and observatory, St. John's Church, Temple of Gour Chandra and Krishnachandra at Chatra (Gaur Chandra Ghat), Hazardwari Palace, SinghiDalan and Jami Masjid Details provided in section 4.7, Chapter-4 of EIA report.		

8. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Environmental impacts have been assessed considering present environmental setting of the project area, nature, and extent of the proposed activities. Suitable qualitative and quantitative approach was followed for identification of likely impact on each value components of environment for design, construction and operation stage. The impacts were analysed under three broad categories, namely (i) Impacts due to dredging operations (ii) Impacts due to barge operations (iii) Impacts due to civil interventions. Additionally, impact was analysed for climate change and riparian issues. Impacts due to land acquisition are covered under separate Social impact assessment and Rehabilitation Action Plan report and not included under this summary.

Maintenance dredging & dredge disposal will be carried out during the operational phase of the project to maintain continued navigability throughout the year from Haldia to Varanasi in NW-1. Dredging of 14.85 million cubic meter will be undertaken from Haldia to Varanasi to maintain LAD of 3 m upto Barh, 2.5m upto Ghazipur and 2.2 m upto Varanasi. Impacts of the dredging are analysed for *Physical Environment*: on water quality and land, *Ecological Environment*: on aquatic ecology and avi-fauna (6 Important bird areas, VGDS, Kashi turtle sanctuary and Hilsa sanctuary), and *Socio-Economic Environment*: cultural (Ghats at Patna and Varanasi), archaeological (9 sites) and livelihood of fishing community

IWT mode, though the safest and most environmental friendly mode of transportation, may have impacts on valued/critical environmental components. Barge movement may impact the water quality, river bank and bank structures, air quality, noise level, aquatic ecology, health & safety, livelihood of fishermen and socio-cultural aspects.

The civil interventions will have largely construction and operation related impacts. Impacts are summarized based on the impact assessment carried out for Varanasi, Sahibganj and Haldia terminals and Farakka navigational lock. The impacts identified for these four sites are likely to be the similar for other intervention sites barring a few site-specific issues related to tree cutting, land acquisition, muck disposal and construction material sourcing.

The impacts are summarized below for valued/critical environmental components in two categories (a) impacts due to dredging and barge operations and (b) impacts due to civil interventions. The baseline conditions are summarized under first category itself. The impacts on climate change and riparian issues are summarized and discussed briefly thereafter.

(a) Impacts Due to Maintenance Dredging and Barge Operations

Baseline Soil and River Bed Sediment Quality: Soil quality monitoring was carried out as per CPCB guidelines along NW-1 and within the critical impact zones considered for planned civil interventions. Soil type in influence area is dominated by alluvial soil. Soil texture varies from sandy clay to clayey loam type and soils are marginally acidic to slightly alkaline with pH ranging from 6.62 to 7.86. Electrical conductivity ranges between 135.4 & 360.5 $\mu\text{mhos/cm}$. Soils in the influence area are moderately fertile.

The concentration of heavy metal and pesticides in river bed sediments was found low in concentration at each sampling location and are within acceptable limit for off-shore disposal as per "Criteria for Off-Shore Dumping of Dredged Material", USA except for cadmium which is slightly above the prescribed limit in the UP stretch. Cadmium levels are high perhaps due to industrial effluent discharge in this section.

Baseline Ground and Surface Water Quality: Ground water quality monitoring was carried out as per CPCB guidelines along NW-1 and within the critical impact zones considered for planned civil interventions. TDS, total hardness and chloride values at Haldia and Sahibganj, Howrah and Kolkata are slightly above the desirable limit but are within the permissible limits specified of IS: 10500. Fe and Zn were detected in water samples but in lower concentration. Arsenic was detected in samples collected from Bhagalpur and Munger but in lower concentration.

River water quality monitoring was carried out along NW-1 and u/s & d/s of planned civil interventions as per CPCB guidelines. River water qualities meet BDU Class 'D' Criteria of CPCB barring few parameters pH & DO which meet class 'A' criteria, i.e. for propagation of Wild life and fisheries

Impact on water quality and land due to dredging operations: Impacts of dredging on water quality are increase in turbidity; reduced light transmittance; reduced DO; changes in salinity, temperature, pH & concentration of nutrients and release of heavy metals/chemicals. As per one study, DO level comes down suddenly by 2 to 2.5 mg/l for maximum of two minutes only at the dredge plume arrival point which is regained within 3-4 minutes as the plume passes. As per baseline study, river bed sediments are non-toxic except in Allahabad to Buxar stretch where cadmium level is found marginally higher compared to US standard for off-shore sediment disposal. However, this higher level is unlikely to have a toxic effect on aquatic life considering the sensitivity level to cadmium exposure (short terms at LC50 level) of aquatic life as per Canadian Guidelines (Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment, 2014). Pesticides are present in traces but much below the safe limit for off-shore disposal. Turbidity of water also increases substantially close to dredging point but it reduces with distance

and almost gets normal at a distance of 700m from dredging point. Coarser sediments settle much faster and at shorter distance. Presence of iron in sediments enhances settling of fine sediments as it acts as coagulant. Land disposal of sediments is anticipated only when sediments are contaminated and in the case of Haldia terminal dredging. When the dredged material is disposed on land in form of slurry, excess water drains back to the water body which can affect the water quality.

Key Mitigation Measures: Key mitigation involves reduction in dredging quantity by studying thalweg profiles, bandalling and usage of low draught vessels. Sediment loss can be minimized by wise selection of dredger depending on strata and depth and use of Cutter Section Dredgers (CSDs) are proposed accordingly. Selection of size of cutter head and other technical specifications can further help to reducedredged sediment loss.

Impactson water quality due to barge operations: Vessels generate garbage, oily waste, sewage, bilge water & ballast water which can affect the water quality of the river. Usage of anti-fouling paints may also impact the water quality as the paints may contains toxins. Settling of the dust of the material transported on river surface again can impact the river water quality. Ship accidents/collision may lead to spillage of the commodities transported including oil which may impact the water quality of the river.

Key Mitigation Measures: Management of wastewater, oily waste, bilge water, noxious waste (if any), air emissions andgarbage from vessels as per MARPOL can prevent the water quality pollution. All maintenance & repair works should be carried out at designated locations only. Only toxin-free paints should be used for anti-fouling purpose. Experienced crew should be hired to minimize the possibility of accidents.. Information of available LAD in the form of electronic charts should be made available to navigators and intimation of navigational hazards in the form of cautionary signage should be displayed at required locations to minimize accidents and spillage of material in river. Oil carrying ships (>5000 dwT) should be double hulled as prevention against oil spills.

Impactsonriver bank& river bank structures due to barge operations: Wave generated due to vessel movement may lead to bank erosion. Impacts are anticipated to be minimal except at the feeder canal near Farakkawhich is narrow and haserodible banks.

Key Mitigation Measures: Restricting speed of vessels in narrow stretches andalong sharp bends may minimize the erosion. Bank protection and bend straightening works can protect banks from erosion.

Impact on Air Quality and Noise Level.

Baseline Meteorology: The predominant wind direction in all IMD stations located along NW-1 is from North and Northwest direction in winters and South and Southeast direction during rest of the season. The wind speed in the area ranges between 1.9 kmph (Patna) and 8.7 kmph (Kolkata). December and January constitutes winter months with daily mean minimum temperature of around 9.1°C at Patna and daily mean maximum temperature of around 26.9°C at Kolkata. April and May are the hottest months with daily mean minimum temperature of 24°C at Malda and daily mean maximum temperature of 40.4°C at Varanasi. Relative humidity ranges between 25%and 84%. The annual rainfall in the project area ranges between 1000.3 mm (Varanasi) and 1728.5 mm (Kolkata).

Baseline Air Quality: Ambient air quality monitoring (PM_{2.5}, PM₁₀, SO₂, NO₂ and CO) was carried outas per CPCB guidelines along NW-1 and within the critical impact zones considered for planned civil interventions. PM₁₀ level varies from 39 to 145 µg/m³. PM₁₀ levels are within 100 µg/m³ at all

the locations except Varanasi (near bridge), Patna and Howrah. PM_{2.5} levels ranges from 16 to 58µg/m³ and are within the CPCB limit of 60 µg/m³. Level of SO₂andNO_x ranges from 4.4 to 35.6µg/m³ and 9.0 to 48µg/m³ respectively and are within the prescribed limits of NAAQs, 2009. CO is detected at Haldia, Howrah, Patna and Varanasi only. The 8hrs CO level at these locations ranges from 0.18 to 1.2 mg/m³ and are within limits of NAAQs, 2009.

Baseline Noise: Noise level monitoring was carried out along NW-1 and within the critical impact zones considered for planned civil interventions as per CPCB guidelines. Ambient noise levels at all monitored locations were found within the prescribed standards of CPCB as per land use except at Kashi turtle sanctuary because of anthropogenic activities like worship, bathing, etc.

Impacts on Air Quality due to dredging and barge movement: Barges also generate emissions but this is far less as compared to road and rail for transportation of same quantity of cargo for the same distance. Thus impacts on air quality are anticipated to be positive. As per analysis there is reduction in emission generation of all the pollutants. Emission savings in “With project” scenario is given in **Table 5**.

Key Mitigation Measures: Material generating dust should be transported in covered conditions. Regular maintenance of vessels engine and propellers may significantly cut down air emissions. Adaptation of cleaner fuels like LNG can be explored.

Table 5: Emission Savings Due to Shift of Freight from Road & Rail to IWT Mode

Year	SO ₂ emissions (Tonne/Yr.)	NO _x emissions (Tonne/Yr.)	CO emissions (Tonne/Yr.)	HC emissions (Tonne/Yr.)	PM Emissions (Tonne/Yr)
2016	0	0	0	0	0
2025	176.547	1305.17	511.9684	365.981	215.8993
2035	242.8597	1772.377	695.3507	495.2122	292.4799
2045	365.2669	2508.429	986.5775	684.3006	404.4284
Net Savings Estimated (Tonnes) from 2016-2045	5874.205	42201.2	16575.06	11700.31	6901.329

Impact on Noise Levels due to dredging and barge movement: Impact on noise quality due to barge movement will be negligible and will be far less when compared to road and railways. Intermittent noise of high level may be generated only when hooters are used as warning during navigation. Noise levels with regard to air generated due to dredging operations at source will vary from 80-90 dB(A). Noise levels reduces to 70 dB(A) at distance of 100 m, 64 dB(A) at distance of 200 m and to 56 dB(A) at distance of 500 m from source. Dredging will be carried out within the navigation channel only; therefore the impacts of the dredging noise on the nearby settlements are insignificant only. Also dredging operations will not be carried out after 10:00 pm. Several measures are proposed to manage the noise environment of the area.

Apart from noise levels, high level underwater noise is generated due to dredging and barge movement. This noise has impact majorly on aquatic flora and fauna and underwater noise impacts are discussed in detail in the section on impact on aquatic ecology

Key Mitigation Measures: Apart from regulation of the dredging operations between 6:00 am to 10:00 pm only, dredgers will be regularly serviced to prevent noise generation due to friction. Dredgers will be fitted with noise masking equipment to reduce the noise levels, barges would use hooters as and when required, i.e. for safety of fishermen and other ships.

Noise from dredgers can be reduced at source (dredger) by various measures such as isolation of exhaust system, keeping engine room doors shut, and by shielding.

Impact on terrestrial and aquatic ecology

Biological Critical Environmental Resources: The wildlife sanctuaries namely Kashi Turtle Sanctuary (Varanasi, U.P.), and Vikramshila Gangetic Dolphin Sanctuary (Bihar) are located within the NW-1 stretch. Hilsa Sanctuary notified under Fisheries Act with the aim of increasing productivity of Hilsa fishes are located at four locations in West Bengal Stretch. Apart from this there are six important bird areas including Udhwa bird sanctuary located within influence area (10 km) of the NW-1 stretch. RET species like Gangetic dolphin (Schedule-1) fresh water turtle species (frequently sighted), The Smooth coated Otter and crocodile (very rarely sighted) are present in the river stretch of the NW-1.

Terrestrial Flora: There is no major forests area present along the NW-1. The riparian flora consists of commonly found trees, shrub and herb species. No rare and endangered plant species have been observed in the riparian area of the NW-1.

Terrestrial Fauna: As no major forest area is present along the NW-1 stretch the terrestrial fauna is restricted to commonly found terrestrial faunal species. No Schedule-I terrestrial mammals' species observed along the NW-1 stretch. However, six IBA located within influence area of NW-1 are the major wintering site for many of migratory water birds. Some of the rarer/endangered/vulnerable avifauna has been reported in these IBAs.

Aquatic Flora & Fauna: The aquatic floral and faunal diversity of NW-1 stretch comprise phytoplankton, zooplankton, zoo-benthos, fish and higher vertebrates. Phytoplankton is represented by Chlorophyceae, Bacillariophyceae, Cyanophyceae, Euglenophyceae, Xanthophyceae and Rhodophyceae groups. Dominance of Bacillariophyceae members followed by Chrophyceae and Cyanophyceae was observed in NW-1 stretch. Zooplankton comprises of Protozoans, Rotifers and Crustaceans. Phytoplankton and zooplankton diversity is a little higher in Farakka to Haldia stretch in comparison to Allahabad to Farakka stretch. Macro benthos and Macro-invertebrates constitute Annelida, Arthropoda insects and Mollusca. Fish in the NW-1 stretch is represented by total of 106 species. The higher aquatic vertebrates' mammalian fauna present in NW-1 stretch (Allahabad to Haldia area are Gangetic dolphin (*Platanistagangeticagangetica*) and the Smooth Coated Otter (*Lutrogaleperspicillata*) which are categorized as endangered species (Schedule-I). Dolphin is found routinely moving between Allahabad to Farakka and post Farakka region of NW-1. However, these mammals are rarely sighted in Allahabad and Varanasi region. The Smooth Coated Otter is found throughout the length of the Gangetic system but in very poor numbers and it is one of the endangered category animals as per IUCN list. Though it was not sighted during our study period but fishermen at Bhagalpur and Sultanpur reported its sighting. Its number has depleted fast due to it being one of the most hunted animals because of its precious skin. The reptile fauna found in Gangetic system are variety of fresh water turtle species, water snake (*Xenochrophispistator*), Mugger Crocodile (*CrocodilusPaluspris*), estuarine (East Coast) Crocodile (*C. porosus*) and Indian Gharial (*GavilialisGangeticus*). The Mugger, Crocodile and Indian Gharial are very rarely seen in NW-1 stretch. Its presence is more reported in tributaries (Chambal river) of the Ganges. The turtle and water snake are found more commonly in the NW-1. Other than water snake, other reptile faunal species are classified as endangered species. There are unconfirmed presence of Ganges Shark (*GlyphisGangeticus*) in the Hoogly river region; however, this species has not been reported in river Ganga (including in the Hooghly river region) in last about 50 years.

Impact on Aquatic Ecology due to maintenance dredging: Impact of dredging on aquatic ecology include change in diversity of benthic habitat, impact on behavioural response and tissue injury of aquatic organism due to increased noise levels, blocking of fish gills due to increased sediments, intake of toxic pollutants by aquatic fauna as released during dredging, smothering of benthic flora & fauna due to dredge disposal and loss of Submerged Aquatic Vegetation (SAV). Noise generation from CSD is 160-180 d(B) and behavioural disturbance criteria for dolphins, turtles, fishes (>2 gm) and fishes (<2 gm) from any continuous noise exposures are 177 dB, 150 dB, 186 dB & 183 dB respectively. Noise sensitivity reference are not available for other crocodile and Smooth Coated Otter but these animals are rarely sighted. It is assumed that these animals will also have similar sensitivity range. In any case these animals prefer to stay more on banks or on wet land near banks and are unlikely to be impacted due to dredging which is most likely to be undertaken in the deep stream of river. In addition, no dredging operations are proposed within or in the vicinity of Kashi Turtle Sanctuary and Vikramshila Gangetic Dolphin Sanctuary (VGDS) that minimize the possibility of the impact of dredging on such vital sensitive organisms. Thus the dredging operations noise will not lead to any significant impact on aquatic organisms.

Key Mitigation Measures: Restricting dredging in biological sensitive locations like VGDS & Kashi Turtle Sanctuary; confluence zone of major rivers (100 m horizontally and 500m either side of major river confluence location) and during breeding and spawning season of fishes and migratory bird season may minimize the impact on aquatic fauna significantly. Reduction in dredging noise through regular servicing and maintenance of dredgers and use of bubble curtains can significantly reduce underwater noise. Use of bubble curtains can reduce underwater noise by approx. 10 dB.

Impact on aquatic ecology due to barge operations: Impact of barge movement on aquatic ecology can be due to speeding vessels, spillage of material transported (oil majorly) and generation of high level underwater noise. Vessels if moving in high speed can collide with aquatic organisms leading to mortality and injury to aquatic organisms. Spillage of material transported can impact the habitat of the aquatic species. Oil spills are most significant among all spills as oil can form a layer breaking contact between water and air and reducing DO level, block gills and skin pores of aquatic organisms leading to mortality. Barge of size 1500-2000 dWT are expected to move in the waterways which generate noise levels of 110-180 dB as per speed. Speed is however restricted in sanctuary area to 5 kmph and noise levels will be maximum 140 dB. Tolerance level for behavioural response of turtles and fishes are 150 dB and 177 dB. Thus impact of vessel movement on dolphins and turtles is not anticipated. However underwater noise modelling, considering noise generation of 160 dB was carried out and it was found that noise levels will attenuate to 150 dB at distance of 4.6 m from vessel. Smooth Coated Otters and crocodiles are rarely sighted as they prefer to rest on wet lands of river banks; noise impacts are likely to be negligible due to its fast attenuation. Accidental impact cannot be ruled out; however, same precautions as for dolphin will apply for these animals as well. Another impact on aquatic species is masking of biologically important sounds. Echolocation clicks of dolphins have dominant energy around 65 kHz and are beyond the man-made frequency range and thus impact is not significant. However, when communication signals lie in same frequency range as of man-made noise it can be masked but they are anyway masked often by the natural noise environment of water.

Key Mitigation Measures: Restricting speed of vessels in sanctuary area can maintain noise levels lower than 140 dB which are lower than tolerance levels of turtle and dolphins thus minimizing impact of noise on turtles and dolphins. Vessels should be fitted with propeller guards and dolphin deflectors to minimize dolphin accidents.

Impact on Avifauna due to maintenance dredging: Impact on avifauna is anticipated due to disturbance of the habitat due to dredging and disposal of dredged material on banks/shallow waters and increased ambient noise levels due to dredging operations. Noise level of 85 dB(A) are generated during dredging which dissipates within 500 m distance making impact localized.

Key Mitigation Measures: Restricting dredging operations during day time (6:00 am-10:00 pm) and during migratory season of birds near locations of IBAs will minimize the disturbance to resting avifauna during night time. Regular maintenance and servicing and usage of noise mufflers with dredgers can significantly reduce noise levels. By isolation of exhaust system, by keeping engine room doors shut and by shielding dredging, noise can be reduced further. Onshore disposal, if required, should be undertaken only at TSDF.

Impact on Socio economic and cultural aspects

Baseline conditions: NW-1 traverses through four states: Uttar Pradesh, Bihar, Jharkhand, and West Bengal. There are various densely populated areas located along NW-1 such as Allahabad, Farakka, Sahibganj, Berhampur etc. As per the Census, 2011, population of the major cities and towns along NW-1 is 1,28,75,343 (67,82,150 male & 60,93,193 females) and the total numbers of households are 25,62,165, population between 0-6-year age is recorded as 13,08,682. Being a project of such large spatial dimension, NW-1 interfaces with various archaeological, social and cultural sensitive and important locations. There are nine archaeologically important sites along NW-1 but no activity at present is proposed to be undertaken within 300 m of these sites. Ghats at Patna and Varanasi are another socially important feature which will be impacted due to project. However, measures are proposed to minimize such impacts. Several festivals are celebrated on a large scale on the banks of river Ganges at different locations and time periods of the year along NW-1. These locations and period of celebrations are Kumbh Mela at Allahabad (between Jan-Feb), Ganga Mahotsav at Varanasi (between Oct-Nov), Dhruv Mela at Tulsi Ghat of Varanasi (between Feb to March), Chatt Pooja at various locations all along the river stretch passing through Bihar and Jharkhand state (between Oct-Nov) and Ganga Sagar Mela at Sagar (in January). Due to barge operation and dredging activities there could be interference in these celebrations. Mitigation measures are proposed to be undertaken to minimize such impacts. There are only a few archeologically protected monuments located along the NW-1 (See Table 4).

Impact socio-economic and cultural aspects due to maintenance dredging: Impact of dredging & disposal of dredged material are anticipated on cultural and archaeologically important locations and on livelihood of fishing community. Dredging operations may impact socio-economy by disrupting fishing and boat movement, generating high noise levels near dredging location, increased river water pollution, by disturbing the pleasant view and increased air pollution. These impacts are however short term and localized and will be restricted to dredging locations only. Dredging activity also pose threat to health and safety of the workers and other waterway users. No construction or interventions are planned within 300m of any of archeologically protected monuments. The Ramnagar Fort is one of the protected monuments. IWAI has undertaken a study with the help of Indian Institute of Technology (IIT) Roorkee to establish the effect of development of Varanasi terminal and NW-1 development. IIT in its study has established that these developments will have no impact on this protected monument. No direct impact is anticipated on any such protected monuments or other culturally important structures due to dredging activity.

Key Mitigation Measures: Dredging will be restricted in biological and socially sensitive locations and at time of important religious and cultural festivals, during breeding & spawning season of fishes and during migratory bird season to minimize impact on socio-cultural life. A minimum of 100 m buffer zone from the religious Ghats at Varanasi and Patna (the

cultural heritage locations) is proposed to be maintained as restricted area for dredging for the protection of Ghats. Precautions followed for archeologically protected monuments should also be followed for any intervention near any culturally important heritage structures. It is also proposed to report to IWAI and ASI for any chance finding of valuable artifacts during excavation and construction stage. Timely intimation about dredging operation and location can minimize the disturbance to fishermen. As enhancement fishermen can be provided with training by institutions like CIFRI to learn better fishing practices and available aids for fishing which will help them to improve their livelihood. Measures to reduce accident risks during dredging will be taken and arrangement of first-aid would be available at dredging locations at all times.

Impact on Socio-economic and Cultural Aspects due to barge operations: Vessel movement are vulnerable to accidents related to natural disasters like flood or cyclonic and operational hazards like Collision, fires and spillages. However, these accidents and accident intensity can be minimized with appropriate preventive measures.

Key Mitigation Measures: Provision of night time navigation system, maintenance dredging, adequate and efficient river information system, vessel tracking system, and Electronic Charts Display Information System - ECDIS, and Automatic Information System – AIS can minimize the accidents. Most of these measures are already under implementation by IWAI in some stretches of the NW-1 and there is a proposal for extending these facilities to the entire NW-1. All safety regulations as per SOLAS should be followed to maintain safety during navigation and minimize accidents. Barge operations should be regulated in consultation with local bodies during religious and culturally important festivals.

Enhancement Measures: Support for promoting fish productivity through setting up or supporting existing fish nurseries. Also training and awareness support through reputed institutes or experts like CIFRI for better fishing techniques and provision for supporting studies for Dolphin conservation and other sensitive studies should be made.

(b) Impact Due to Civil Interventions, and Mitigation

Impacts due to civil interventions are expected to occur during the design, construction and operation stage of the project. These impacts during different phases are discussed below

Impact during design phase: Activities to be carried out during design phase which can impact the physical, biological and social environment are site clearance & preparation, acquisition of land and change in land use and land cover. Major impacts anticipated are removal of vegetation and tree cutting, an unpleasant view, increasing GHG emissions due to operation of construction vehicle/machinery and removal of trees, impact on regular day-to-day activities in area of development due to shifting of utilities, impact due to change in land use, impact on drainage, loss of households, land and assets and loss of income source and impact on overall quality of life

Key Mitigation Measures: Tree cutting should be minimized by efficient planning of the interventions. Permission from forest department is essential prior to cutting of trees besides, compensatory plantation is to be carried out as per respective state forest policy. Restoration and rehabilitation of locations occupied or used for construction purposes immediately after the given task(s) is over. Dedicated approach roads and improvement of haul roads should be considered to minimize the traffic congestion and air emissions. Traffic management should be undertaken to avoid peak hour congestion. Utility shifting should be carried out during or prior construction phase but without disrupting common public services. Necessary permissions from the area development authorities and local bodies should be obtained prior to development of proposed interventions. Natural drainage pattern should be

maintained by provision of adequate drainage. Compensation should be given to affected households as per R & R Act, 2013.

Impact during construction phase: Activities to be carried out during design phase which can impact the physical, biological and social environment are construction activities, material transportation and operation of machinery & construction equipment. Major impacts due to these activities are loss of top soil, soil contamination due to spillage of material, bank erosion/bed scouring, surface water contamination due to increased run-off from construction site, high noise levels and disturbance to nearby habitation, traffic jams, wear and tear of existing roads, increased accidents and air pollution, unpleasant view due to construction activities, construction material storage and waste storage, health & safety of workers and people in nearby areas, impact on quality of life, mortality, disturbance to habitat and change in behavioural response of aquatic fauna and tree cutting and vegetation removal.

Key Mitigation Measures: The top soil should be preserved and used for landscaping purpose and should be given to farmers in nearby areas, if they so desire. Clean up operations should be taken up immediately after spillage of any material. Debris and excavated earth should be disposed-off as per defined plan. Provision should be made for Septic tank and soak pit/STP, maintenance waste collection and treatment before reuse. Concreted floor for storage of fuel and oils should be considered. Excavated earth should be reutilized to the extent possible in the construction activity and balance maybe used for road construction or disposed of at designated places like mines in case of Sahibganj. Bank/scour protection works are required at planned and under planning civil intervention locations. Adequate shore & scour protection measures should be taken up at Sahibganj terminal, Varanasi terminal and Farakka Lock site. Provision of acoustic enclosures for DG sets should be constructed to reduce noise levels. Noise causing activities should not be carried out close to settlement areas and during night hours. Haulage roads/approach roads to be used should be maintained regularly. Restoration and rehabilitation will be done of the areas occupied or used for construction purpose immediately after use is over. Preparation and implementation of emergency preparedness and response plan and contingency plan should be prepared by the contractor. Implementation of proposed environment management plan should be taken up to minimize the environmental pollution and stress on existing infrastructure resources. There is need to manage surface run-off to prevent from mixing with contaminant, apart from provision of storm water management system, provision of sediment traps, oil interceptors with storm water drains in parking areas etc. Impact of piling and construction dredging should be managed by adoption of vibratory piling and usage of bubble curtains to disperse the fauna and reduce the noise level.

Impact during operation phase at intervention sites: Activities to be carried out during design phase which can impact the physical, biological and social environment are barge mooring & berthing, operational activities at terminal sites and discharge of waste/water from intervention sites. Major impacts anticipated are increased GHG emissions near the terminal/jetty locations due to increased material transportation and dredgers operation, increased pollutant emissions near the terminal/jetty locations due to material transportation and dredgers operation, increased run-off from site, increased noise levels and disturbance to nearby residents and water pollution. Positive impacts would include employment generation and infrastructure development.

Key Mitigation Measures: Development of thick green belt area and avenue plantation at all proposed intervention sites would be very helpful. Provision of sprinklers and dust suppressors at terminal sites for dust suppression should be made.. Employment should be given to local people preferably. Skill development training can be undertaken for locals to train them for jobs. Storm water drainage should be collected and reused for dust

suppression. Sewage should be treated in STP constructed at site and treated water should be used for dust suppression and horticulture.

(c) Impact related to Climate Change:

IWT mode is the most efficient and environmental friendly mode of transportation, involving least CO₂ generation when compared to rail and road transport. Analysis was made to estimate the CO₂ emissions from different modes of transportation for transportation of same quantum of cargo for similar distance. From the analysis, it is learned that the IWT mode generates the least GHG emissions and the net GHG savings in With Project scenario will be for 4544037.4 tonnes (4.54 million tonnes). Thus positive impacts are anticipated on the climate due to reduction of GHG emissions. A further reduction in GHG emissions is anticipated with the adoption of cleaner fuel for vessels, as well as energy efficiency in terminal design.

(d) Impact on Indo-Bangladesh Water Sharing Treaty (Riparian Treaty)

In recognition that the Ganga (NW-1) is an international waterway, all requisite planning and design considerations were aimed at fully avoiding (or absolutely minimizing) any potential adverse transboundary effects. These transboundary impacts could be impacts such as reduction and/or modification of flow of water or sediments apart increased water pollution. There is no chance of flow modification as the project (i) will not have any barrages, dams or any other water retention structures, (ii) does not include any water diversion, or consumptive use, and (iii) does not involve any construction on the flood/flow zones of the entire river so as to impede any flood flow. The project includes annual/regular maintenance dredging in selected locations (mainly across the shoals that are formed intermittently along the river) to maintain the least available draft during the lean flow season for a navigable channel of 45m width with side slopes of 1:10. To minimize volume of maintenance dredging, options for drafts lower than 3m were considered, and the project opted for the choice of low-draft vessels. The maximum volume of annual dredging is expected to be 11 million m³ (which is lower than 1.5 percent of the 750 million m³ average annual sediment volume in the project stretch). Further, closer to Farakka barrage (both upstream and downstream), the naturally available draft is already near 3m, and the maintenance dredging requirement is comparatively much lower. In fact, upstream of Farakka, and up to Barh, in a stretch of 347km, the annual maintenance dredging requirement has been minimized at about 3.5 million m³. No disposal of sediment away from the river is planned. Dredging will be done using cutter suction dredgers which will dispose the dredged volume sideways (maximum 200m away from the 45m wide navigation channel within the wide flow zone of the river, (which for example is 2.24km wide at Farakka) not exceeding 20m downstream. As a result, no longitudinal change in current/natural sediment flow is expected at any stretch of the river.

Careful examination of the possibility of increased pollution due to downstream dispersal of dredged material plumes was undertaken in the project. Dredging may result in reduction of dissolved oxygen levels 2-2.5 mg/l at the dredging plume points, but the levels become normal 4 minutes after the plume passes. To examine the issue of release and dispersal of heavy metals, pesticide residues and other hazardous chemicals, 110 river bed samples, from up to 3m depth, were collected and analyzed for the stretch between Varanasi and Farakka. Except for cadmium in the stretches between Allahabad-Varanasi and Varanasi-Buxar stretches (more than 600km upstream of the international border), all other heavy metals, chemicals and pesticide content were found to be within safe limits. Additional primary surveys and investigations were conducted to understand

the increase of turbidity resulting from dredging and disposal. These investigations suggest that turbidity of water will increase substantially close to dredging point but is reduced with distance from the dredging point, and becomes normal at a distance of 700m downstream from dredging point. These results are comparable to other such examinations elsewhere in the world, where the expectation is that the effects of suspended sediments and turbidity from dredging are generally short term (less than one week after activity) and near field (less than 1km from activity). No dredging is expected to occur immediately upstream of Farakka Barrage (which itself is 16.5km upstream of the international border; and the route of the NW-1 is the feeder which is further upstream of the barrage), and in no case, the temporarily increased turbidity is expected to disperse across the international border.

9. ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan (EMP) is a plan of action for avoidance, mitigation and management of the negative impacts of the project and enhancement of positive impacts. The detailed intervention and activity specific plans for maintenance dredging, barge operations, civil interventions are given at Chapter 6 in EIA Report. EMP includes the environmental monitoring plan (specifying the parameters, frequency and responsibilities of monitoring), institutional framework, reporting requirements, auditing requirements, training awareness and capacity building programme, grievance redress mechanism and environmental budget. Consolidated EIA provides institutional mechanism, budgetary provisions and other systems and plans which are commonly applicable to all interventions and operations of NW-1. The EMPs prepared for dredging and barge operations are commonly applicable to the terminal development and operation and other intervention sites. Consolidated EIA also provide generic EMP for the interventions such as RO-RO Jetties, embankment protection. Additionally, standalone EMPs have been prepared based on site specific terminal developments at Varanasi, Sahibganj and Haldia and Navigational Lock at Farakka.

Recommendations flowing from the cumulative impact assessment. IWAI has carried out a Cumulative Impact Assessment (CIA) covering the full project area of influence of NW-1 encompassing the effects of the broader programme of investments within the Ganga Basin over a longer period of time. The main recommendations of the CIA include measures for planning, and management/mitigation of all such impacts, besides sustainable development considerations. Recommendations proposed include (i) No barrages or storage reservoirs in the main river and tributaries to maintain water depth and reduce silt charge even though it is a more economical option to dredging (ii) critical environmental resources and natural habitats have been identified as no-go zones for dredging (iii) all terminals will be built keeping world class infrastructure standards; viz. GRIHA certification, zero liquid discharge technologies, installation of dust suppressors, development of green belt development along periphery & roads and waste management through best management practices. In addition to this, the project will introduce (i) the highest health and safety standards for operation of terminal facilities and navigation operations (ii) the vessel fleet proposed will follow international standards for discharge of ballast, waste water, and use of cleaner, more efficient fuel. Locations for terminals will be based on proximity to inter-modal connectivity, at the same time reducing air pollution and congestion impacts within cities, and integrating passenger services wherever possible. It is also proposed through CIA that IWT will incorporate high capacity vessels that will run on LNG and will move in low draft so as to reduce the dredging requirement and further reduce GHG emissions. Impacts on adjacent bird areas and fish habitats in the floodplains which include habitat disturbances and human interferences (air and noise pollution) will be minimized and prevented wherever possible. These habitats will be mapped

and integrated in the overall information system to avoid further impacts due to increase in navigation volume, and structural modifications to NW-1 and to respond to any observed negative impacts on aquatic or avifauna species. The environmental objectives of NW-1 augmentation should be aligned and integrated with the National Ganga River Basin Authority, and institutions should interact cooperatively. Provision of a safe and environmentally friendly transport service can also support growth of tourism.

Environment Health & Safety (EHS) Policy and Management System: An effective environmental health and safety policy is essentially to demonstrate top management's commitment to environmental protection and occupational health and safety. The policy should be communicated to all stakeholders including workers and should be freely available to them on demand.

For effective and systematic implementation of the project, it is suggested that IWAI (The EA) develops its Environmental and Social management systems which are auditable and effectively enforceable. Parallels can be drawn from the experiences of National Highway Authority of India or Delhi Metro Rail Corporation and an EHS system similar lines should be adopted. Each contractor should be contractually bound to follow such system and must have EHS management system in line with EA's management system. IWAI should also develop its standard technical guidelines for Environmental Assessment, Management and Reporting. Training and awareness will be an essential component of the EMP and EHS management system. It should include use of posters, bill boards/glow boards around the project site and barge NW-1 alignment in Hindi, English and regional language so as it can be understood by the workforce and community as well. Celebration of some of the important days such as Environment Day (June 5), Red Cross Month (March), Emergency Preparedness Week (May 1-7), National Safety Day (4th April), National Health Day (7th April), Fire Safety Day (14th April), 20th April (Earth Day) can be planned for spreading awareness on environment protection, cleanliness and safety among work force and community through campaigning.

Emergency Response and Preparedness Plan and Contingency Response Plan:

Risks and hazards are associated with every construction site as it involves use of heavy machinery and equipment. Similarly, risks are also associated with the operation phase. These are listed below:

- Vessel accidents and spillage of commodities (especially oil)
- Leakage or spillage of oil from ships and barges at terminal/jetty
- Drowning in river during material handling and vessel movement
- Hazard to fishing vessels/gears

IWAI will (and must) equip itself with guidelines and equipment for handling the emergencies. PMU should evolve its environmental, occupational health and safety guidelines and performance protocol. Budgetary provision has been made under environmental budget. The same should be developed with the help of reputed institutions. It should also follow the system of emergency response; suggested emergency response and management plan.

Responsible Carrier Programme of IWAI²: It is proposed that IWAI develops Indian Waterways Operations Responsible Carrier Programme which should be developed as part of its EHS Management Systems and Emergency Response Plan and Protocols Development. The programme should have the following components as well:

²Reference is drawn to the successful similar programme of American Waterways Organization's Responsible Carrier Programme. <http://www.americanwaterways.com/rcp-2016>.

- Protocol for speed control, monitoring, and vessel tracking
- Protocol of waste management for barge operations and terminals management. (including zero discharges and waste disposal to river by barges and terminals. This protocol should also define about waste handling facilities at barges and waste disposal facilities at terminals to maintain zero discharge.
- Biodiversity protection including accident reporting with aquatic mammals (dolphin)
- Oil spills reporting and control and remediation
- Near-miss reporting/lessons learned and corrective actions programme
- Risk assessment procedures to assess and manage risks to personnel, vessels and the environment
- Identification of critical or essential equipment/systems
- Authority of the master, crew and shore side personnel
- Addition of document control procedures
- Tracking of number and volume of spills in performance measurement requirements
- Internal and external audit procedures and frequency.

Institutional Framework of IWAI: IWAI has set up a project management unit (PMU) which is staffed with Environmental and Social specialists. These specialists would work as an environment and social cell (ESC) within the PMU. It is proposed that each field unit have one designated officer responsible for environment and social aspects who will also coordinate with ESC. The responsibility of ESC will be (i) development of mechanism to ensure implementation of suggestive management plans and to integrate this at policy level so that the measures can be mandated for compliance during respective project stage (ii) to review, monitor and inspect implementation of the EMP during design, construction and operation stages; (iv) implementation of the environmental capacity building and awareness programme; (v) coordinating with field units (iv) reviewing and ensuring effective implementation of EMP and regulatory compliance by contractor, and IWAI, and (v) managing the environmental reporting, and audit process. Contractor will be responsible for implementation of Environmental Management Plan and ensuring health and safety of the construction workers at site during pre-construction & construction phase of the project

Environment & Safety Compliance and Monitoring Responsibility : Project design and implementation stage: The respective contractors will be liable for implementation of suggestive EMPs and IWAI will be responsible for monitoring the contractor's performance and adequacy of implementation of EMPs directly or through third party (PMC).

Environment & Safety Compliance and Monitoring Responsibility: During Operation Phase and Emergency Situations: IWAI should be solely responsible for implementation of the EMP and emergency response. IWAI will ensure that mitigation measures are taken up by the shippers, dredgers and other stakeholders in time and adequately. IWAI should develop the mechanism so as to ensure the adherence and compliance of the EMP. It is proposed that IWAI will have a dedicated department adequately staffed and equipped with speed monitoring, vessel positioning, and emergency response equipment like oil spills control and remediation systems. IWAI may also adopt a mechanism for involving barge operators on the line of Responsible Carrier Programme of American Waterways Operators.

Reporting Requirements: Contractor would be required to submit monthly and six monthly reports containing the status of environment, health & safety at site to the PMC (Project management consultant) & PMU of IWAI. PMC will be responsible for construction supervision and ensuring effective implementation of EMP by the contractor. PMC should report to PMU monthly about the performance and effectiveness of the EMP implemented by contractor on site and coordinate with field units and PMU for necessary corrective actions as may be required. IWAI will also organize an independent Environment Audit which will be submitted to The World Bank within 3 months of completion of the second and fourth year of implementation period.

Training & Capacity Building Programme: IWAI has already taken actions to augment the capacity of project management unit (PMU). A capacity building and training programme has been prepared which includes training of staff of Environmental and Social cell of PMU, contractor's staff (labour & engineers), PMC staff and IWAI staff on environmental management, regulatory compliance and safety aspects.

Environmental Budget: Adequate environmental budget provision has been made for the implementation of the EMP. The EMP budget is proposed for environmental management for all of the proposed activities under the project. The overall budget is INR 49.91 Crore. Summary of the environmental budget is given in **Table 7**. Detailed environmental budget component-wise for civil interventions is given in the respective EIA reports. Lump sum budget for each of the planned civil intervention areas is given in **Table 8** below. For detailed budget of each component, the individual EIAs prepared for each of the proposed civil interventions may be referred to.

Table 7: Summary of Environmental Budget for NW-1

S. No.	Description	Amount (INR)
1.	DESIGN AND CONSTRUCTION STAGE	
	Technical Support for preparation of guidelines, bio-diversity conservation plan for turtle and dolphin sanctuary and performance indicators	9,000,000
	Compensatory tree plantation (7000 trees) including after care and monitoring Additional tree plantation for GHG sink (18000) including after care and monitoring	15,000,000
	Measures to Reduce GHGs by Green buildings certification & additional tree plantation under plantation head	9,000,000
	Storm-water and wastewater management/ Construction of soak pits/ clean drinking & domestic water facility/ STP construction, Zero Discharge management	44,000,000
	Provision of training and PPE to workers	17,200,000
	Health check-up camps for construction workers	32,000,000
	Enhancement Measures Institutional Support for Vikramshila Wild Life Sanctuary through reputed institutions Support Fish productivity enhancement through fish nursery development and training fishermen Bath shelter for women along NW-1 for maintaining privacy from vessel movement Support for cleanliness at Ghats and improvement of Ghats	126,000,000
	Environmental Monitoring in the construction phase: Terrestrial and Aquatic Fauna, Ambient Air Quality, Surface Water Quality, Drinking Water Quality, Noise & Vibration, Soil Quality, Erosion & Siltation and River Bed Sediment	58,080,000

S. No.	Description	Amount (INR)
	Drainage Congestion and disposal of accumulated water/ Erosion & Sedimentation/ Reduction in dredging requirement Land/ Soil/ Noise/ Air Quality -Dust Management during construction Appointment of Safety Officers, Safety signage, fire-fighting measures & water ambulance etc.	Covered in project design and engineering cost
	SUB TOTAL (Design & Construction stage)	310,280,000
2.	OPERATION STAGE	
	Monitoring of performance indicators viz. Terrestrial and Aquatic Fauna including surveillance audit, Ambient Air Quality, Surface Water Quality, Ground Water /Drinking Water Quality, Noise & Vibration, Soil Quality, River Bed Sediments, Soil Erosion & Siltation, Integrity of embankments	59,040,000
	Emergency Preparedness: Accident Response: Ambulance equipped with requisite emergency medical aid facility, First Aid Facility, Fire-fighting Equipment, Safety Trainings, Mock Drills etc.	67,900,000
	Waste Water Management (STP Operation, rainwater harvesting management and maintenance)	21,600,000
	Storm Water Management System & Waste Management System, Erosion Control and landscaping, Reduction in GHGs	To be part of OM cost
	SUB TOTAL (Operation stage)	148,540,000
3.	ESTABLISHMENT & TRAINING and MANAGEMENT SYSTEM)	1,65,00,000
4.	SUB TOTAL (Construction + Operation + Establishment)	47,53,20,000
5.	CONTINGENCIES @ 5 % on total Environmental Costs	2,37,66,000
6.	GRAND TOTAL (in INR)	499,086,000
		(US\$ 7.34 m)

Table 8: Environmental Budget of Planned Civil Interventions

Civil Intervention	Amount (INR million)
Varanasi Terminal	1.0029
Farakka Lock	13.7466
Haldia Terminal	12.0246
Sahibganj Terminal	16.4136