Potential Environmental Impacts and Their Mitigation an the Construction of Bridge Structures: a case study in Raipura, Narshingdi

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Abstract: *Normally, Bridge activities involve the construction of permanent engineering designed structures made of steel or reinforced concrete slab arranged across at the sides of water courses and larger rivers. This construction of Bridges and its associated activities may interrupt upon the local environment, overall ecosystem functions of water bodies, river dynamics and obstructs the flow of watercourses and channels, particularly where in-stream pier supports are required. Construction of these types of structures has the potential to affect the environment in many ways, can diverge widely in terms of their mode of function and location. Therefore, thorough environmental mitigation measures and careful considerations of alternatives are of prime consequence in constructing the bridge structures as well. Hence, this study attempts to trace the potential environmental impacts and their mitigation measures in the construction of bridge structures during different phases of construction in the selected study area in Raipura, Narshingdi. In this study, a direct field observation through snapshot case studies in the selected study areas and literature review from some of the relevant articles, journals and reports.*

Key words: Environmental impacts, construction, bridge structures, raipura, narshingdi.

Introduction

Construction of Bridges and connecting approach roads on both banks of the watercourse bring about significant economic and social benefits to the local people of any country. These constructions contribute on improved connectivity with direct road communication to nearby towns and economic centers and develop livelihood of the people in the community. It helps the people by providing time-saving and effortless travel means and lowering the transportation costs. Potential benefits include an increase of access to markets, generation of employment opportunities, improve admittance to educational and health services etc. According to Bayes (2007), infrastructure plays a pivotal role in uplifting rural livelihood and reducing poverty as well. On one way, this construction of Bridges has various development effects in developing country like Bangladesh and on the other way, the environmental components as physical, biological and socio-economic environment largely impacted due to these different project construction activities during various stages. According to Environment Agency (2002), massive potential impacts may arise during different phases of construction on diverse sectors are as air and climatic factors; water quality and soil environment; biodiversity and ecological environment etc. Local air quality and climate may decline as a result of gaseous and particulate emissions from vehicle movements on and off-site. Doo (2013) stated that the emissions in the air during three phases of construction will appear as a result of the exhaust gases from the constructional mechanization. Within these emissions will appear polluters as SOx, NOx, CO, VOC etc. Dust will appear as a result of the soil works and the activity of the

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preparation of the field and clearance, excavation, mining in rock etc. Water environment as surface water hydrology can be affected during all phases of activities. These activities can result in compaction of soils and an increase in impermeable surfaces. The subsequent increase in surface runoff may, in turn, increase the risk of flooding, can potentially alter the flow regimes of the river thereby affecting water velocity, depth, depositional patterns and channel morphology (Environment Agency, 2002). During the preparation of the field for new access roads and the establishment of constructional zones around the route of the expressway, there can be pollution of the surface waters and groundwater of temporary character in shape of erosion and disposal of sediments and surrounding stream flows. The erosion appears mostly because of the removal of the soil cover. The pollution of the stream flows can occur as a result of leakage of the fuel and oil from the equipment and the vehicles, as well as different waste which is created during these activities (Doo, 2013).

Construction activities may also have significant impacts on groundwater hydrology and quality. The site may need to be drained to provide suitable conditions for the engineering works to occur, resulting in temporary changes to ground flow (Environment Agency, 2002). The activities of construction and setting on the expressway directly will damage the soil quality and it will reflect on the change of the specific geological characteristics (Doo, 2013). Soil contaminated from a previous land use may be disturbed during construction works, causing pollutants such as heavy metals to enter ground and surface water. The removal of native vegetation and its replacement with bridge engineering structures can cause direct damage, disturbances, fragmentation or loss of terrestrial and aquatic habitats and ecology. Construction and decommissioning activities could also result in the increased sediment loading of streams and changes in turbidity which may impact adversely upon aquatic species. In addition to this, the local ecological environment may be adversely affected by pollution incidents attributed to fuel leaks and oil spills associated with construction, maintenance, and decommissioning operations on site. The physical presence of the Bridge structures may affect ecology in a number of ways. The local ecology may be disrupted and habitat corridors become severed. Bridges, in particular, cause some shading of the river bank and bed thereby potentially altering the aquatic flora and fauna present in the river bed. Ecological impacts may operate over a longer timescale, as populations take time to respond to environmental changes (Environment Agency, 2002). According to Bayes (2007), many of the impact studies on infrastructure in Bangladesh do not seem to have taken this environmental aspect into consideration during three phases of construction.

Available empirical studies are based on information collected only after the completion of the project, and hence, seems to be flawed with a failure to take cognizance of the tracing out effects. According to Works Division Highways Department, (2016), mitigation measures may propose to avoid or minimize these environmental nuisances from dust, noise, water quality, waste management, ecology and landscape and visual aspects during construction of new Bridge. Under this circumstance, considering environmental impacts, careful environmental mitigation measures are urgent need before construction. This study entails the potential environmental impacts and their mitigation in the construction of Bridge structures: A case study in Raipura, Narshingdi. Under these consequences, the study aims at fulfilling objectives as to identify the potential environmental impacts of Bridge structures during different phases of construction and

based on the overall observations of the study, to elicit mitigation measures in the selected study area.

Methodology of the study

The methodology followed a direct field observation survey through snapshot case studies (primary data sources) in the selected study area of Raipura Upazila, Narshingdi district in Bangladesh and secondary data sources e.g., literature review from the relevant articles, journals, reports.

The Study sites

The study area that had chosen will represent the basic and typical characteristics of the whole structure of this study. Study areas were taken where there is the availability of Bridge construction project sites. Considering above criteria, a 240.25m long RCC Girder Bridge in Raipura Upazila at Narshingdi district is selected for this study (Figure 1).

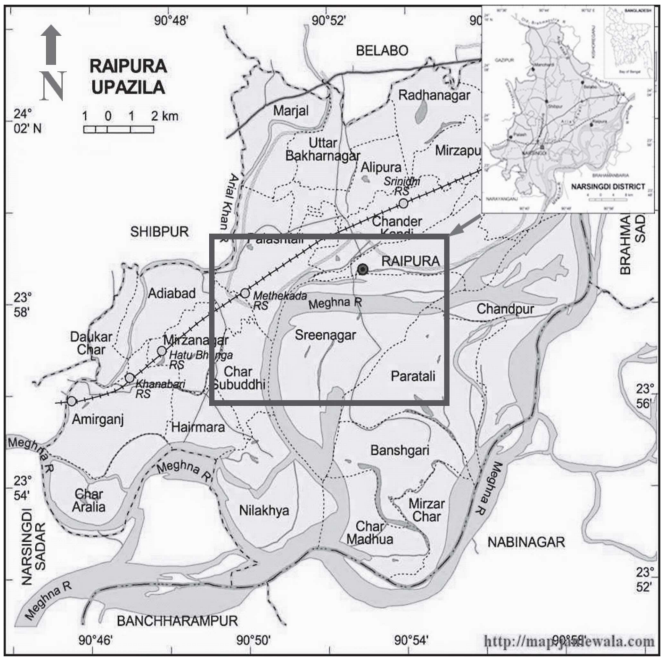

Figure 1. Above map showing the location of study area of Raipura Upazila within Narshingdi District (Source: Google Image, 2017).

This 240.25 m long RCC Girder Bridge over the branch of Meghna is situated on Sreerampur - Banshgari GC Road at Ch.00+108km is located in Raipura Upazila, Narsingdi district. The road along with this long Bridge and other small Bridges and culverts was funded by the ADB and KfW and implemented by the Local Government Engineering Department (LGED) under the project Rural Infrastructure Improvement Project (RIIP - II) in 2013. The southern part of the Upazila Raipura is mostly char area composed of sedimentation of the river Meghna and its offshoots. The road Sreerampur - Banshgari on which the Bridge constructed passes mainly through the low lying char land. Bank spillage of the river Meghna and its tributaries along with intense rainfall during monsoon inundates the char and the vast low lying areas every year. Considering the upstream and downstream morphological condition of the branch, its width, flood discharge, velocity, scour depth, location of approaches, classification of road and other

technical aspects by hydrological and morphological studies, a 240.25m long double lane RCC Girder Bridge with footpath and along with construction of 34m long approach road on both banks has been designed at the location. The road Sreerampur - Banshgari is an important road in the area. Earlier there was no road linkage of the area with the Upazila HQ. People of the locality had no quick access and facilities to the urban areas in case they require going to school/collages, to go for any emergency medical treatment or any other important activities. The agricultural products produced in the char villages could not be brought to the nearby towns to compensate even their production costs. The improvement of the road along with construction of the Bridge created good communication network as well as an opportunity for marketing the agricultural products of the area and played a vital role in the socio-economic and livelihood development of the region. To establish and uninterrupted communication road network from Raipura HQ to Banshgari via Sreerampur along Bridge (approx. 700m long) need to be constructed over the main Meghna River located nearly 2 km away from the end of this 240.25m long Bridge and expected to be constructed by another project. Presently a ferry service has been established by the Roads and Highways Department (RHD) to cross the River Meghna by the motorized vehicles.

Results and Discussion

From the field observation, it was identified that the topography of the Bridge construction site is almost flat. It is a gently undulating landscape of floodplain ridges and situated in surrounding char areas of both banks of the river. No residential settlement has been found adjacent to the site along the existing alignment of the road, though some agricultural land and wetlands are found along and near the alignment. This Bridge is located on the branch of Meghna River. The river inundates fully up to the bank regularly during peak monsoon months (mainly in July and August). In the dry season, water flows through the deep channels of the river. Boats and small launch/cargoes ply the river throughout the year (Figure 2).

Figure 2. Above pictures showing the Branch of Meghna River.

Different aquatic flora and fauna are observed in this study area. Those include dhol kolmi, helencha, kochuri pana (water hyacinth), etc. Among aquatic fauna, various kinds of fish, frogs, snails and a few water birds are found in this area, although most of them are decreasing in numbers. According to the information of local people, various kinds of fish are available in the branch of this Meghna River. In the cultivated agricultural areas,

various fish species are also available, especially in the monsoon season. It is observed that different timber trees such as sissoo, rain trees and different fruit trees are as mango, banana and jackfruit extensively grown in the area for quick commercial returns. It is a common environmental understanding that biodiversity has been on a decreasing trend, threatening the extinction of many species, and causing an imbalance in the natural environment. During the field observation with the local population, it has been confirmed that the bridge site has also seen a reduction trend of many species to some extent because of overexploitation, excessive human habitation, development of agricultural lands, lack of local people's awareness, and other human- related factors.

Project components and activities

This project has three main components: a) The Main Bridge, b) Approach roads on both banks and c) Embankment Protection Works (Figure 3).

Figure 3. Above pictures showing different components of the study area.

Construction of the Main Bridge, Approach roads and Embankment Protection Works will result in following activities those cause major positive and negative impacts given in (Table 1) below:

Table 1: Activities that cause major positive and negative impacts for construction of the Main Bridge, Approach roads and Embankment Protection Works

Activities	**Construction of the Main Bridge**	Mobilization of manpower, construction equipment, vehicles, materials, construction of Engineer's sheds, labor sheds, stack yard, storage of cement, fabrication yard, concrete batching plant etc. for construction of the foundation (pile driving, sediment disposal etc.), sub-structures (pier column, tie beam and pier cap construction etc.), super-structures (different member's construction staging as railing, rail posts, deck slab, girder etc.), construction materials transportation, construction wastes disposal etc.
	Construction of the Approach Roads	Mobilization of equipment for earthworks and its compaction for construction of road embankment, road pavement, waste disposal, clearing of sites, removal of top soils etc.
	Construction of the Embankment Protection Works	Construction material transportation, earth cutting and placing layer by layer for approach road embankment and smooth slope preparation, disposal of dredge materials, embankment protection preparation against wave actions etc. by different techniques.

Potential environmental impacts and mitigation measures in the study area

The study area, the air quality of the Bridge construction site was considered to be better during pre-construction stage as few motor vehicles pass through the area to reach the bank of the river. Motor vehicles of the other types of cars or trucks seldom passed through the area and they could not go across the river due to absence of ferry services. During the construction phase, a considerable amount of air pollutants emitted mainly due to the operation of vehicles, heavy construction machinery along with mobilization and dumping of materials (Figure - 4). However, the number of motor vehicles gradually increased after the construction of the bridge (Figure - 5).

Figure 4. Above pictures showing dumping of construction materials in the study area (during construction phase).

The quality of surface water affected during and after the construction of the Bridge site in the study area. There was also a possibility that the construction work may change the quality of groundwater hydrology as well.

Figure 5. Above pictures showing post-construction phase of the Bridge in the study area.

This study identified potential environmental impacts on physical and biological resources of the project area during pre-construction, construction and post-construction or operation & maintenance stages. Sectors those have been identified where potential environmental impacts may arise are air and water quality; noise quality; soil erosion; riverbed sedimentation; wastes; ecosystem and wetland; wildlife; fisheries and aquatic life; agriculture; landscape; regional hydrology and drainage; navigation; topography and geology etc. Those have been enumerated in (Table 2) given below:

Table 2: Potential environmental impacts and mitigation measures of Bridge structures during pre-construction, construction and post-construction phases

	Phases	Potential impacts	Mitigation measures
Air quality	Pre-construction	Negligible impacts	-
	During construction	A minor amount of air pollutants may release mainly due to: -Movements of vehicles carrying construction materials. -Operation of boring equipment for pile construction under the abutments and the piers. -Operation of mechanical equipment for concreting. -Generation of dust due to earth moving and pavement construction works. -Heating of bitumen and stone chip aggregates for construction of bituminous carpeting approach roads. -Constructions labors using temporary latrines pollute the air as well as water at the construction site.	Mitigation measures against the negative impacts may be initiated by adopting the following activities: -All the vehicles, construction equipment etc. should be kept in good working conditions and maintained properly; their exhaust gases should be within the acceptable limit; -Vehicles carrying construction materials should be covered to prevent leakage and spreading of dust. -Water should be sprayed regularly on the construction sites, in particular, earthwork sites, construction of dry and dusty road embankment sites, brick crushing sites, asphalt mixing sites to reduce the effects of dust; -Asphalt mixing plants and concrete batching plants should be properly equipped with dust removal device; -Should monitor the air quality after every six months during construction. If the pollution exceeds the air quality standards, further preventive measures should be undertaken. - Sanitary latrines with proper water supply should be ensured at the work site.

	Phases	Potential impacts	Mitigation measures
	Post-construction	When the bridge will be opened for traffic, air pollutants may be increased since the traffic volume is expected to increase in comparison to the other two phases of construction.	Should monitor air quality on the site properly. The first monitoring should be done 6 months after the completion of the bridge; If monitoring result exceeds the air quality standards, periodical monitoring should be continued every year.
Water quality	Post-construction	Negligible impacts	-
	During construction	Quality of the river water is affected by the proposed Bridge construction works. Erection of temporary islands/cross-dams on the river bed during construction of piles, caps, piers, girders approach roads etc. may cause hindrance to the free flow of water in the river deteriorating water quality especially in dry season. Slippage of soil from the road embankment slope during construction eventually turbid water. Such risk may increase if the works are carried out during rainy season. There is also a risk of accidental spillage of fuels, lubricants, chemicals, solvents and construction waste into the river resulting in the contamination of the river water.	Proper arrangements should be made to prevent soil erosion that may result in water quality deprivation; Should control disposal of any construction waste into the river or nearby water bodies; Waste substances must be properly collected, stored and disposed of, according to GoB regulations; Equipment maintenance and refueling should be confined to the designated areas with sealing to prevent the leakage of fuels; Every six months, the surface water quality at site should be monitored through the construction period. If the quality exceeds the water quality standards then preventive measures should be taken.
	Post-construction	There is a low risk of the accidental spillage of chemicals and resulting water quality deterioration during the periodic maintenance period.	Water quality of the nearby water bodies and the river should be monitored regularly. The first monitoring should be done nearly 6 months after the completion of works; If the monitoring result exceeds the water quality standards, periodical monitoring should be continued every 6 months to take necessary measures.
Soil erosion/deposition	Post-construction	Negligible impacts	-
	During construction	Dumping of earth for making earthen islands (artificial island) on the river bed at the pier locations, and construction of approach roads may cause easily soil deposition and erosion. If the construction works are implemented in the rainy season, soil/silt deposition at the Upstream and erosion at the Downstream may take place significantly.	Earth filling and cutting should be restricted to the dry season only; Soil should be collected from nearby borrow pits as for as possible; topsoil should be eluded for earthwork compaction; Should maintain proper embankment slope in relation to the soil properties e.g. clayey, silty or sandy; Approach road embankments need to be properly compacted to ensure its stability; Different types of grass and tree plantation on approach slopes should be done to prevent soil erosion and slope failure; If any sites are identified vulnerable to erosion those sections should be protected by the installation of low-cost piles with RCC or brick walling, brick guide walls, placing of sand-filled bags/cement concrete blocks (CC Blocks) on the embankment slope over geo-textile mats.

	Phases	Potential impacts	Mitigation measures
	Post-construction	Soil erosion may occur along the approach roads especially in the rainy season if the maintenance works are not properly undertaken.	Should begin proper monitoring and to undertake maintenance works of the roads especially after the monsoon.
Noise quality	Post-construction	Negligible impacts	-
	During construction	During the construction phase, severe noise and shaking/vibration may produce due to the operation of heavy equipment used for pile driving works for the foundation, concrete mixer machine etc. which may disturb nearby residents temporarily.	Construction works should perform during daytime; Should ensure that heavy equipment and vehicles to be used are maintained in good condition and their exhaust gases are within acceptable ranges; Should monitor the noise level after every six months during construction. If the level exceeds the standard levels, further preventive measures should be taken.
	Post-construction	A certain level of noise may anticipate at the operational phase, since the traffic volume of motor vehicles on the Bridge and roads may increase after the construction of the bridge.	Monitor the noise and vibration level along and around the construction site. The first monitoring should be done 6 months after the completion of works; If the monitoring result exceeds the noise quality standards or baseline noise level data, periodical monitoring should be continued every year to take necessary measures.
Bottom sediments	Post-construction	Negligible impacts	-
	During construction	Piling activities at abutments and different piers and their bases may cause disturbance of bed sediments. There is a risk of contamination of river bed sediments by the accidental spilling of construction materials such as cement slurry, bituminous materials and other chemicals.	Should control disposal of any construction materials into the river or nearby water bodies; Waste chemicals must be properly collected, stored and disposed of, according to Government regulations; Equipment maintenance and refueling should be confined to the designated areas with sealing to prevent the leakage of lubricants and fuels; Should prevent soil erosion that may results in water quality deprivation and bottom sediment disturbance; Should monitor the river bed sediment quality every six months during the construction period. If the level exceeds the permissible levels, should take further preventive measures. Suitable water management actions should be used as well;
	Post-construction	There is low risk of the accidental spillage of chemicals and resulting bottom sediment contamination during the periodic maintenance.	Should monitor the bottom sediment quality of the river bed regularly. The first monitoring should be done 1 year after the completion of subproject; If the monitoring result exceeds the bottom sediment quality standards, further periodical monitoring should be continued every year and to take necessary actions accordingly.

	Phases	Potential impacts	Mitigation measures
Wastes	Post-construction	Negligible impacts	-
	During construction	A huge amount of wastes may produce during construction. Solid, liquid and other wastes may also be generated from the construction sites, labor camps, those may negatively affect the surrounding environment if they are left untreated at the construction sites.	All wastes should properly be collected and disposed off inappropriate places to avoid further contamination of surrounding environment and water bodies; Should clean up the construction waste and unused materials regularly during construction works and should clear and remove fully after completion of overall construction works; Should prepare low cost composting facilities of all degradable and biodegradable wastes where possible.
	Post-construction	A slight amount of wastes may be generated from periodic maintenance works but the impacts are little.	Should dispose of the waste generated during monitoring and maintenance works.
Ecosystem and wetland	Post-construction	Negligible impacts	-
	During construction	Construction work may involve the removal/cutting of trees and vegetation. There is a limited risk of disturbing valuable ecosystems such as protected areas and others.	Should mark the areas to be cleared before the clearing work starts; Vegetation or trees should not be cleared outside the designated areas; Should minimize the clearing activities and re-vegetate and re-plant trees over the cleared land in the site after completion of construction for ecosystem conservation; Should avoid disposal of any construction material including soils into nearby water bodies or wetlands.
	Post-construction	There is low risk of the accidental spillage of chemicals and resulting bottom sediment contamination during the periodic maintenance.	Should monitor the bottom sediment quality of the river bed regularly. The first monitoring should be done 1 year after the completion of subproject; If the monitoring result exceeds the bottom sediment quality standards, further periodical monitoring should be continued every year and to take necessary actions accordingly.
	Post-construction	Negligible impacts	-
Wildlife	Post-construction	Negligible impacts	-
	During construction	Pile driving for foundation works may cause the habitat loss or disruption of some wildlife species.	Should reduce vegetation and tree clearance to conserve habitats of wildlife and re-vegetate and re-plant trees over the cleared land; Should create awareness on wildlife conservation among construction workers and local people.

	Phases	Potential impacts	Mitigation measures
	Post-construction	Some adverse impacts on wildlife species around the Bridge site may be anticipated due to constructed Bridge-related structures and increased traffic volumes. Such impacts, however, can be mitigated by re-vegetation and re-planting of different tree species.	Should create awareness on wildlife conservation among local people surrounding the Bridge site; If planted trees and vegetation are found decaying or in poor conditions, re-vegetation and replanting of trees should be done immediately.
Fisheries and aquatic life	Post-construction	Negligible impacts	-
	During construction	Construction works of sub-structures and foundation work, in particular, erection of artificial islands/cross dams for pile driving and other works may disturb the movement of fish species and other aquatic species temporarily. Habitats of some fishes and aquatic species may be affected by these works as well.	Should avoid the construction activities, mainly pile driving, during the peak fish migration period; Should avoid complete closing of the river channel that affects migration and production of fish and aquatic life; Should avoid the filling of low floodplain areas around the construction site; Minimize noise and disturbances to conserve the habitats of fish and other aquatic flora and fauna.
	Post-construction	Low adverse impacts on fishes and aquatic life around the Bridge site may be anticipated due to the constructed Bridge-related structures and increased traffic volumes.	Should create awareness on aquatic lives conservation among local people.
Agriculture	Post-construction	Acquisition of agricultural land may be necessary depending on the detail design of the proposed Bridge and thus certain negative impacts are anticipated.	- Planning and Design of the bridge and the approaches should be such that no acquisition or minimum acquisition of land is required.
	During construction	Some agricultural land may be temporarily occupied for the storage of construction materials and equipment and the construction of labor camps. This will negatively affect the agricultural production temporarily.	Should reduce temporal occupation of agricultural land or another land as much as possible;
	Post-construction	Negligible impacts	-
Landscape	Post-construction	Negligible impacts	-
	During construction	The Bridge structures to be constructed may alter the landscape around the proposed site.	Should minimize the unnecessary use of surrounding area as much as possible to maintain the natural/ existing landscape of the sites.
	Post-construction	After construction of the Bridge, there may be a risk of people's gathering and squatting on the bridge and the approach embankments and this may affect the landscape beauty.	Should prevent road embankment and nearby vacant places from the construction of commercial structures.

	Phases	Potential impacts	Mitigation measures
Regional hydrology and drainage	Post-construction	Negligible impacts	-
	During construction	Construction works may include dredging for river training and the construction of Bridge structures over the river may have a temporary influence on the regional hydrology. Storage of soils, sand and construction materials along the river may obstruct natural drainage as well.	Should avoid complete closing of the river channel by providing alternative drainage. To minimize this problem, should set up adequate number of efficient cross drain (brick or reinforced cement concrete drainage structures), culverts and other drainage facilities; Should maintain cross drainage systems to avoid these congestion during construction period; Should select separate place for the storage of soils and other construction materials to avoid disturbance of natural drainage;
	Post-construction	Negligible risk of drainage congestion.	Should perform proper maintenance of subprojects on a regular basis to prevent the drainage clogging.
Navigation	Post-construction	Negligible impacts	Proper planning of navigational clearance (distance between the highest flood levels to Bridge middle span girder soffit clearance) before construction for small boats and launches pass under the Bridge should follow strictly; Adequate horizontal and vertical navigation clearance should be maintained; Should avoid vertical support as pier in middle point of the Bridge, waterways or rivers for boat obstacles; Distance between soffit level of the Bridge and highest flood level should be at least one meter to allow floating debris to pass easily through the structure;
	During construction	Negligible impacts	-
	Post-construction	Negligible impacts may occur if the planning was done on proper navigational clearance during pre-construction phase.	-
Topography and Geology	Post-construction	Negligible impacts	-
	During construction	The topography of the site may slightly change due to earth cutting and filling works for the construction of approach roads and other related structures, but such impacts are considered very negligible.	-
	Post-construction	Negligible impacts	-

Conclusion

To construct different structures, their proper planning and design with environmental considerations should be the primary importance. The physical presence of both Bridge and other engineering structures may affect the ecological environment in a number of ways. These may cause direct damage, disturbances, fragmentation or loss of aquatic, terrestrial ecology and habitats. So, the integration of environment with Engineers planning and social concern is a must to provide sustainable economic development of the country. For time constraint, this study could not perform in other study areas in the country. Moreover, this study can serve as a source of baseline information and future planning for future researchers interested in similar research in the country as well.

The study entails following recommendations:

- Infrastructure development activities will trigger several environmental issues at local and regional level. Thus proper coordination among Government, Environmentalists, Engineers, Socio-economists, and Stakeholder should exist.
- Environmental considerations should be given an integral part of the overall scheme planning and design process of any infrastructure development. On this regard, environmental enforcement, laws, policies, standards, taxes, and regulations; Pollution Abatement Strategy; Environmental Impact Management Framework, Climate Protection Strategy etc. should be maintained properly.
- Construction of bridge structures that may cause adverse environmental impacts and therefore need strict initial environmental screening in order to identify all potential environmental issues and to obtain the Site Clearance Certificate, Furthermore, detailed Environmental Impact Assessment (EIA) report should be implemented.
- Importance should be given on areas like effective application of the annual renewals of Environmental Clearance Certificates, solid waste management and recycling activities, ban of non-recyclable materials, treatment of wastewater effluent before disposal in water bodies to develop low cost Water Treatment Plant, introduction of green transport network, conservation of biodiversity and ecosystem and demonstration of renewable energy etc.
- With the main aim of limiting the volume and concentrations of pollution discharged into the environment, environmental quality standards should be strictly followed on water sources, ambient air, noise, odor, industrial effluent and emission discharges, vehicular emission etc. Water quality parameters as Biochemical Oxygen Demand, Chemical Oxygen Demand, Dissolved Oxygen, Total Suspended Solids etc. are specified in terms of concentration of water quality discharged in case of wastewater and solid waste.
- The reduction trend of biodiversity can be reversed by undertaking different environmental mitigation measures and increasing people's awareness on the importance of biodiversity and its restoration and may establish eco-parks or sanctuaries. The Environmental Management and Monitoring Plan is a tool to implement the proposed mitigation measures and minimize potential adverse impacts and that should be prepared properly. For buildup people's awareness, focus group discussions in the project area particularly with the affected population should be made.

- Selection, planning, design and implementation of different infrastructure schemes and to ensure that they are environmentally sound and sustainable, it should ensure to incorporate surrounding local community-based people who live project areas and directly affected by the environmental impacts.
- Careful planning and design of the construction work with a goal to decrease the negative effects and to provide preventing erosion should ensure.
- Restriction of the movement of the vehicles and usage of mechanization which put a smaller pressure on the area. The vehicles should be constantly maintained to prevent leakage and spillage.
- Minimizing the loss of vegetation along the construction site and should plant a green belt in both sides of the road which will prevent wider dispersion on air pollution caused by the traffic along the route of the road.
- The measures for the protection of the surface and groundwater are reduced to the consistent application of good construction practice during the construction. Construction works should not run in heavy rains.
- Preventing measures for landslides, soil erosion etc. should be implemented. For reducing the impacts on the soil, measures for preventing leakage of polluting materials and oils from constructional mechanization in the surrounding soil, eroded areas should be rehabilitated and safely stored and the construction materials and construction waste should be removed.
- Measures during three construction phases should be implemented in order to keep a minimum impact on wildlife habitats, flora and fauna. Strict regulation and plan should be implemented to reduce the waste for proper waste management in order to enable recycling of recyclable materials. The measures for mitigation of the impacts caused by noise and vibrations in different construction phases should be implemented.

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