Environmental Impact Assessment of Faisalabad-Khanewal Motorway (M-4)

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Thesis submitted to the Lahore School of Economics

in partial fulfillment of the requirements for the degree of

M.Phil. in Environmental Sciences and Policy Studies

2012-2014

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List of Abbreviations

Abbreviation	Description
°C	Degree Centigrade
ADB	Asian Development Bank
APs	Affected People
BDL	Below Detectable Level
CC	Construction Contractor
CO	Carbon Monoxide
COI	Corridor of Impact
dB	Decibel
DC	Design Consultant
DCR	District Census Report
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
Ft.	Feet
GoP	Government of Pakistan
IEE	Initial Environmental Evaluation
IPs	Indigenous People
IUCN	International Union of Conservation of Nature
Km	Kilometers
LAR	Land Acquisition and Resettlement
M-4	Faisalabad-Khanewal Motorway
Mm	Milimeter
MC	Monitoring Consultant
M&E	Monitoring and Evaluation
NDMA	National Disaster Management Authority
NEQS	National Environmental Quality Standard
NESPAK	National Engineering Services Pakistan

NHA	National Highway Authority
NH&MP	National Highway and Motorway Police
Nox	Nitrogen Oxides
NTC	National Trade Corridor
NTCHIP	National Trade Corridor Highway Investment Program
OM	Operation Manual
O&M	Operation and Maintenance
PAPs	Project Affected Areas
PEPA	Pakistan Environment Protection Act
PM_{10}	Particulate Matter (10-micron)
PMD	Pakistan Meteorological Department
PTCL	Pakistan Telecommunication Company Limited
RoW	Right of Way
RAP	Resettlement Action Plan
Rft.	Running Feet
Sft.	Square Feet
SPM	Suspended Particulate Matter
SC	Supervision Consultant
SGS	Société Générale de Surveillance (Society General Services)
SNGPL	Sui Northern Gas Pipe Line
Sox	Sulfur Oxides
USEPA	United States Environmental Protection Agency
WHO	World Health Organization

ABSTRACT

Environmental Impact Assessment (EIA) is the process of analyzing the impacts of a project on the environment. Roads generally play a major role in shaping social and economic structure of a locality thus they have huge impacts on the environment, therefore it important to carry out their environmental assessment. Thus the objective of this thesis is to identify the current environmental conditions and components of the project area and envisioning the impacts this project will have on them during and after construction phase. It also includes proposing appropriate mitigation measures to minimize the negative impacts of the project.

The project taken up was M-4 Motorway from Faisalabad to Khanewal. Under Section 12 of Pakistan Environment Protection Act 1997 any such project requires an Initial Environmental Examination (IEE) or EIA. According to "*Pakistan Environment Protection Agency (Review of IEE/EIA) Regulations 2000",* this project required an EIA. The motorway will be four lane dual carriage way. An area for addition of a lane in future will be reserved on the sides of each carriageway. The Right of Way (RoW) of the project is 100 meters and each lane will be 3.65meters wide. The total length of the road under study is 184km. The project is considered to be of great national and international importance. It is part of National Trade Corridor (NTC) and is proposed to provide easy access to traders and farmers for transportation of goods.

The baseline conditions were studied mainly for physical and ecological environment. The alignment of the road passes through four districts i.e. Faisalabad, Toba Tek Singh, Jhang and Khanewal. The terrain of the project area is leveled and consists of agricultural fields. The climate of the area can be divided into two categories over the year, hot summers and mild winters. The

major Kharif crops of the area are sugarcane, maize, rice and cotton whereas major Rabi crop is wheat.

The probable impacts due to the proposed project were studied under the parameters of land acquisition, change of land use, relocation of utilities, soil erosion, pollution and impacts on flora and fauna and for each impact respective mitigation measures are proposed. The impacts and mitigation are assessed and proposed for different phases of the project like design phase, construction phase and operation phase.

1 INTRODUCTION

1.1 Environmental Impact Assessment

Environmental Impact Assessment (EIA) is the process of analyzing the impacts of a project on the environment. Developmental projects are important for any country and their environmental impacts are inevitable. Therefore they are considered to be antagonist to the environment but with conducting an EIA they are made coherent to the environment. While planning a project mostly two things used to be considered; that a project should be economically viable and technically feasible. But not anymore, because by carrying out an EIA we can make it socially acceptable and environmentally sustainable. This is major consideration while planning any developmental project these days. All over the world no project at a larger scale can now be carried out without an EIA.

1.2 Impacts of Roads

Roads generally play a major role in shaping social and economic structure of a locality thus they have huge implications. For construction of roads the natural flora and fauna is removed and disturbed, it can affect the quality of soil and water bodies in the vicinity. The land has to be acquired from local land owners, the local inhabitants are usually displaced and their everyday activities are disrupted and modified. Economically roads tend to initiate new means of communication which aids in the movement of people and goods, supports different trade activities, connects and make a place accessible to other areas. Roads and highways are considered as a corridor as well as a barrier thus they can transform the environment and social and economic

life of an area. Therefore for roads especially it is very important to study their impacts, assess them on environmental standards and make them socially and environmentally friendly.

1.3 Project Description

National Highway Authority (NHA) has planned to construct M-4 Motorway from Faisalabad to Multan. Under Section 12 of Pakistan Environment Protection Act 1997 any such project requires an Initial Environmental Examination (IEE) or EIA. According to "*Pakistan Environment Protection Agency (Review of IEE/EIA) Regulations 2000"*, this project requires an EIA.

Figure 1.1 National Trade Corridor (Govt. of Pakistan 2007)

This motorway is part of National Trade Corridor (NTC) (Figure 1.1) and is proposed to provide easy access to traders and farmers for transportation of goods. It constitutes the National Trade Corridor Highway Investment Program (NTCHIP) of Asian Development Bank (ADB). This project is not only considered important for local trade but it is along the trade route of access to China and Central Asian states to Karachi and Gawadar ports.

The motorway is an extension of existing Pindi Bhattian – Faisalabad motorway (M3). It will start from the end point of M3 near Sargodha road. Figure 1.2 shows the location of M4 in the National Highway Network of Pakistan.

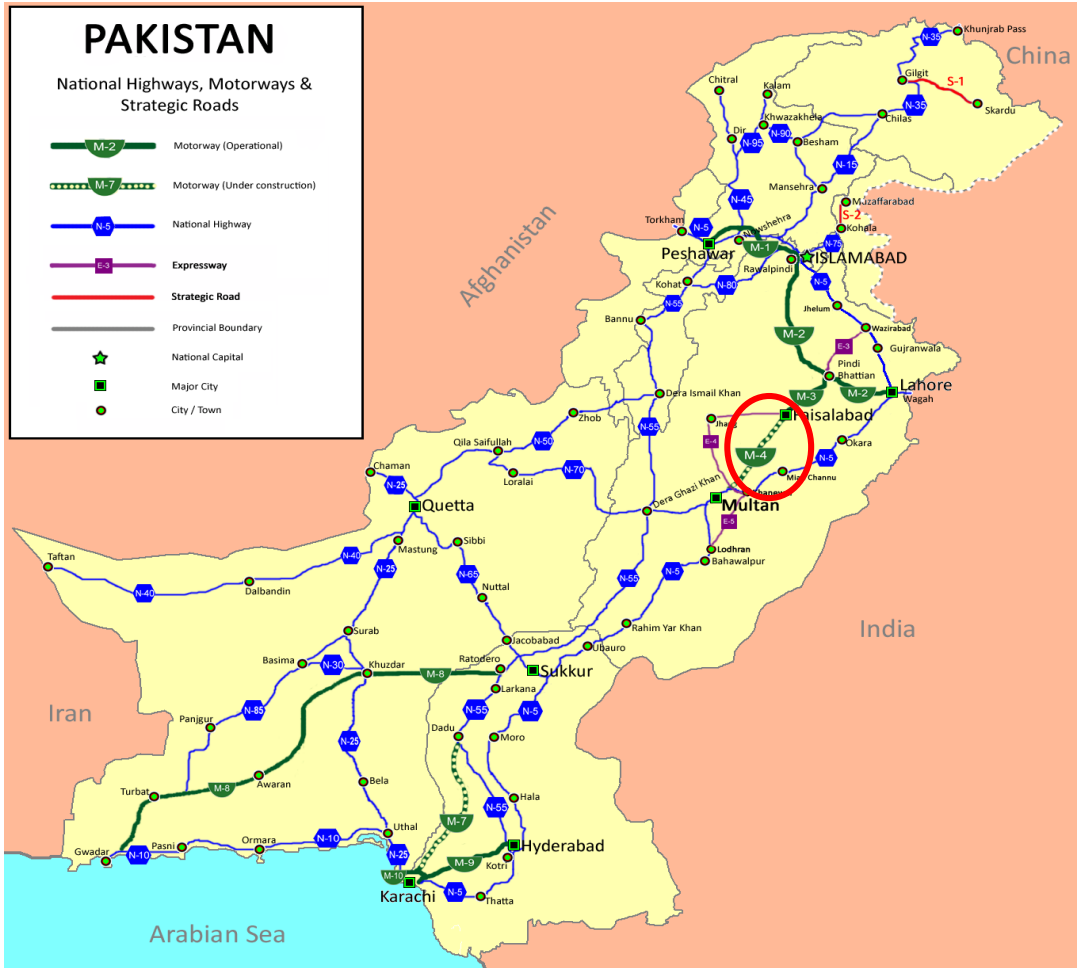

Figure 1.2 ***National Highway Authority 2010***

M4 will be four lane dual carriage way. An area for addition of a lane in future will be reserved on the sides of each carriageway. The total length of the road was initially proposed to be 184km as the motorway was planned up to Khanewal but in July 2014 another 57 km were added to extend it to Multan. However this research will cover EIA only for initial 184 km. Figures 1.3 and 1.4 shows the alignment of M4 for 184 km up to Khanewal and 241 km till Multan respectively.

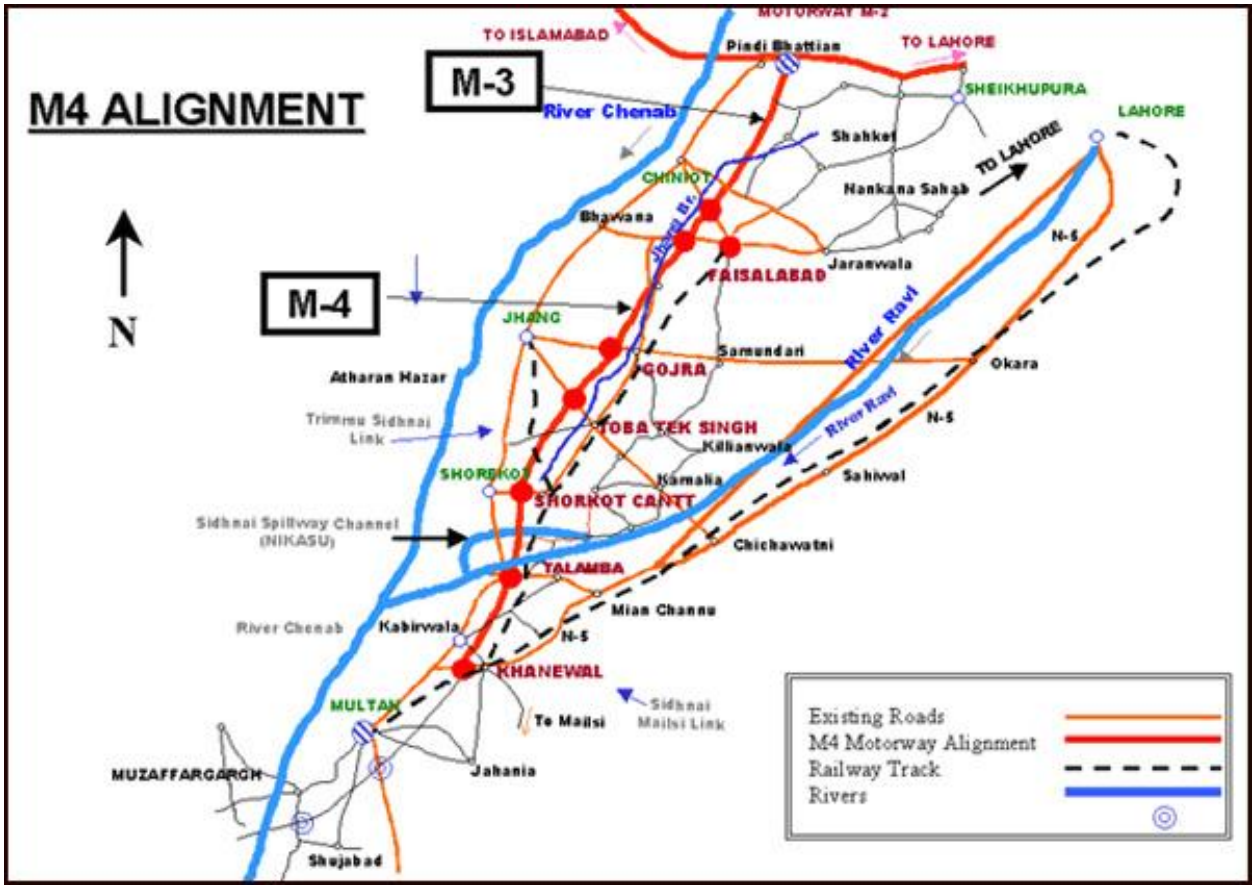

Figure 1.3 Alignment of M-4 from Faisalabad to Khanewal *(NHA)*

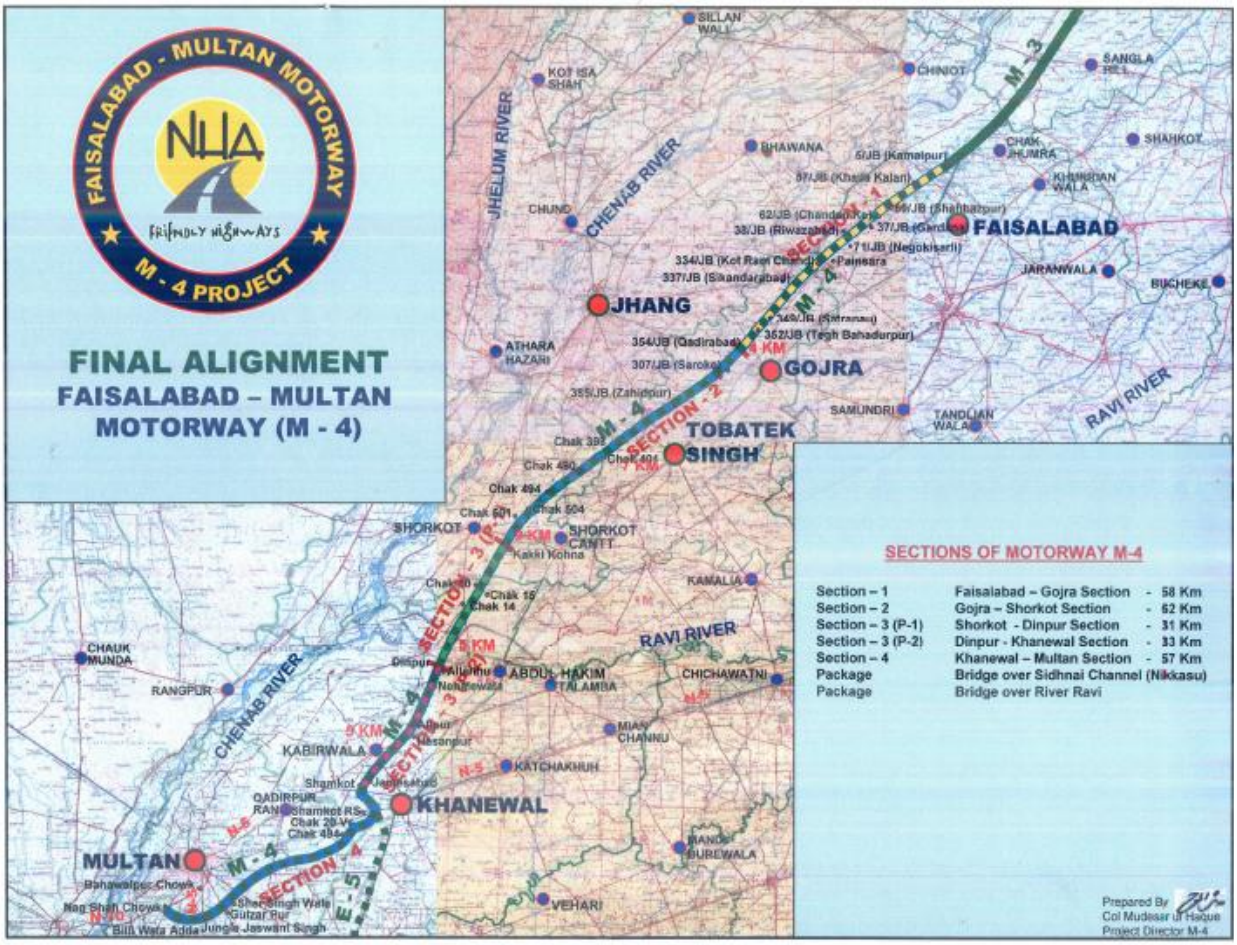

Figure 1.4 Final alignment of M4 along with its different sections *(NHA)*

`The project area falls in four districts of Punjab province – Faisalabad, Toba Tek Singh, Jhang and Khanewal districts. The major cities and towns falling on the route of this motorway are Faisalabad, Painsera, Gojra, Toba Tek Singh, Shorkot, Makhdoompur, Abdul Hakim, Kabirwala, Khanewal, Qadirpur Ran and Multan.

The motorway is divided into following construction sections and packages:

- Section 1 (58km) Faisalabad – Gojra section.
- Section 2 (62km) Gojra – Shorkot section.
- Section 3 (64 km) Shorkot – Khanewal section.

- Section 4 (57km) Khanewal – Multan section.
- Package I Bridge over Sidhnai canal.
- Package II Bridge over River Ravi.

The Right of Way (RoW) of the project is 100 meters and each lane will be 3.65meters wide. The Row at the interchanges will be 300 meters. The RoW describes the Corridor of Impact (CoI) of an area. The components of RoW can be seen in the Figure 1.5.

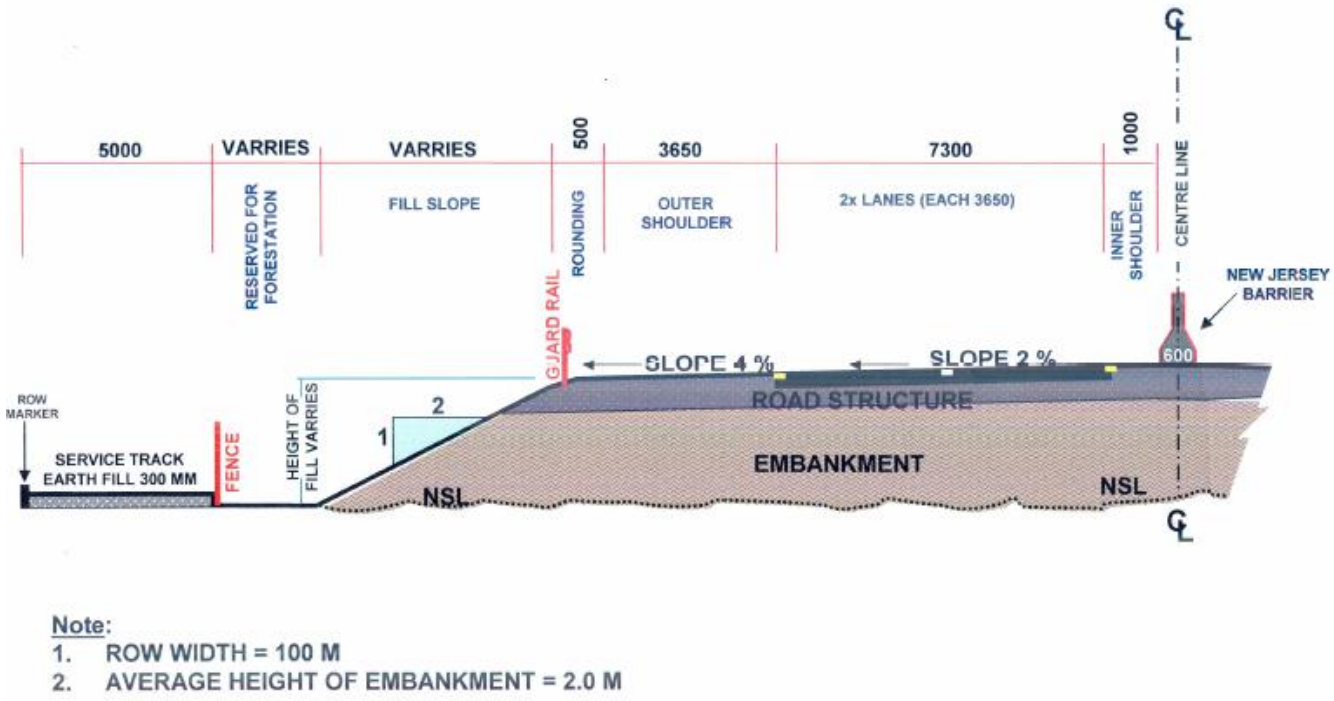

Figure 1.5 The division of RoW in cross-section of the road (*NHA*).

Over the length of the project there will be 12 interchanges to provide access to the major towns and cities on the way. Flyovers will be constructed over major road crossings. Rest areas will be provided after certain distance. For that strip of land 150 meters wide and 200 meters long will be reserved on each side of the motorway. To accommodate travelers multiple service areas

will also be provided at specific distances with facilities of petrol pumps, toilets and restaurants. For that strip of 250 meters width and 700 meters length will be reserved.

The materials used in construction are "coarse aggregates (crush), fine aggregates (sand), soil, water, asphalt cement etc" (NHA). All these materials are available locally close to the project area. The construction material quarries approved by Mines and Mineral Department, Punjab are also present nearby thus no new quarries will be dug for this project. The use of this construction material can be seen in the pavement structure of the road in Figure 1.6.

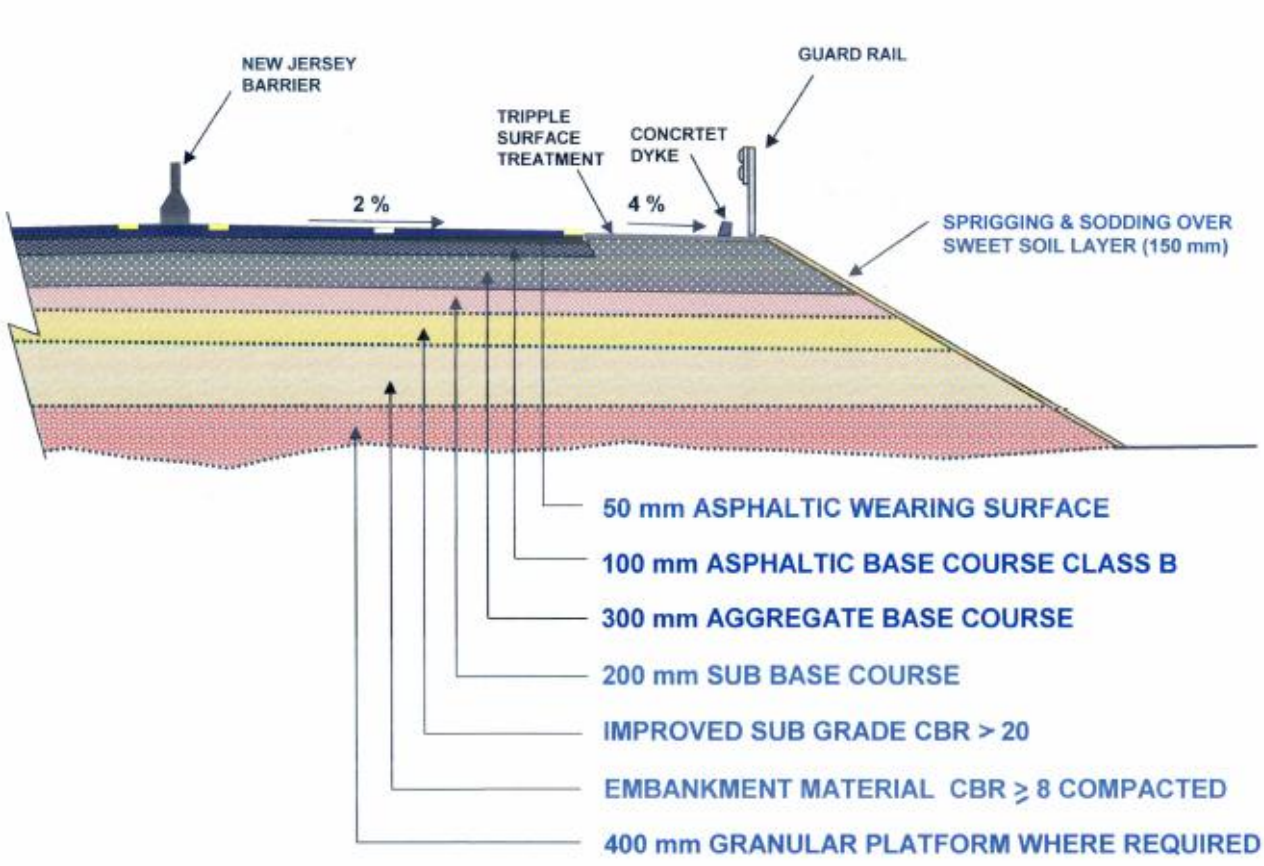

Figure 1.6 Pavement Structure of M4 with description of material used (*NHA*).

1.4 Objectives

Following are the objective of this research:

- Identification of the current environmental conditions and components and envisioning the impacts this project will have on them during and after construction phase.
- Proposing mitigation measures to minimize the negative impacts of the project.
- Development of an effective Environmental Management Plan for the operation phase of the project.
- To bring developmental projects in harmony with environment sustenance.

2 LITERATURE REVIEW

2.1 Environmental Impact Assessment

"EIA is an evaluation procedure that helps planners and decision-makers to understand the environmental impacts of a proposed project or activity" (*Glasson J. et.al 2005*). Environmental impact assessment (EIA) requires considering the environment and public participation in the decision-making process of developing a project. It considers all the direct and indirect benefits that can be achieved from a project and tries to mitigate its impacts on the physical and social environment of the area (UNEP 2002). In this developmental goals could be with minimum or repairable damage to the environment.

2.2 Elements of EIA

There are various steps of EIA process. Their content and order can vary from country to country according to their respective legislation. Following are the steps:

- *Project screening* is a process in which it is decided whether a project will have significant impact to require an EIA. In Pakistan projects falling in listed category of schedule I require an IEE and projects falling in listed category of schedule II require an EIA. *(PEPA, Review of IEE and EIA 2000)*
- *Scoping* identifies the key environmental issues at an early stage. It helps outline the planning of EIA and outlines the proposal.
- *The consideration of alternatives* is the step in which the project proponent consider other possible alternatives to the project such as change in location, design, operating conditions etc of the project. It is advisable to consider "no action" approach as well. (*FAO 2004*)

- *The description of the project includes* an account of different features of the project and its rationale. It includes the description of different stages in which the project will be executed, it location and all the different processes involved. (*Glasson J. et.al 2005*).
- *The description of the environmental baseline* includes the details of environmental conditions prevailing in the project area over a period of time. It considers the future environmental conditions as well in the absence of the project and the changes that can be brought by various natural incidents and anthropological activities (*UNEP 2009*).
- *The identification and prediction of the main impacts* that the project will have on environment. It considers all significant environmental impacts that may be adverse or beneficial.
- *Mitigation* involves the introduction of measures to avoid or reduce all significant impacts that the project can have on environmental components. (*Glasson J. et.al 2005*).
- *"Public consultation and participation* aim to ensure the quality, comprehensiveness and effectiveness of the EIA, and that the public's views are adequately taken into consideration in the decision-making process" (*Govt. of India, 2010*).
- *Preparation of EIS* for review.
- *Decision-making* on the project involves a "consideration by the relevant authority of the EIS, together with other material considerations for carrying out the project".
- *Management and Monitoring* of the impacts on environment during different phases of the project.
- *Auditing* follows from monitoring. It can involve comparing actual outcomes with predicted outcomes, and can be used to assess the quality and effectiveness of mitigations and EMP applied (*Glasson J. et.al 2005*).

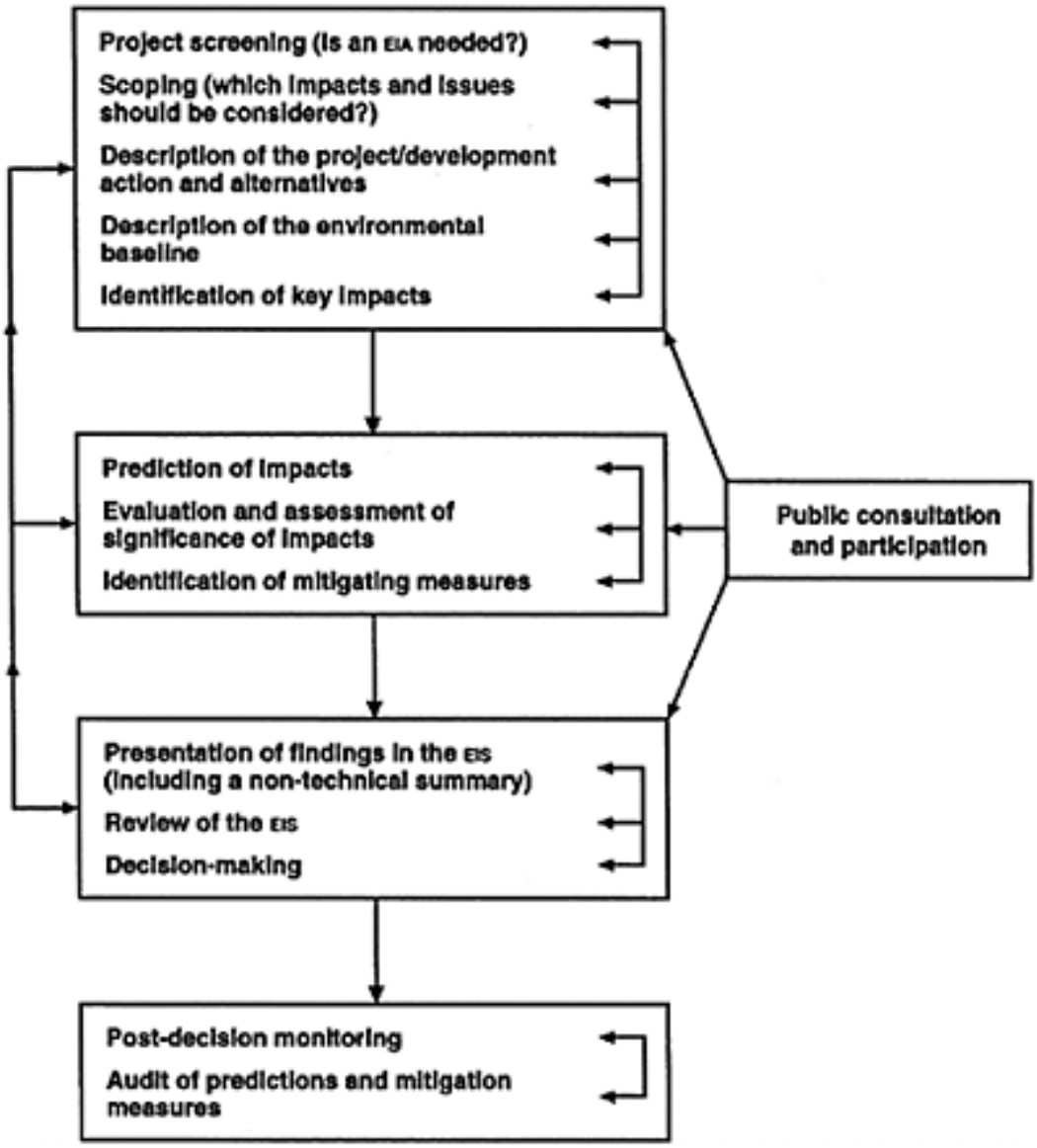

Figure 2.1 Steps in EIA process (*Glasson et.al 2005)*

2.3 Environmental Impacts of Roads

All the projects are planned and justified on the basis of cost-benefit analysis. For highway projects the main benefits considered are time efficiency and safety by being access controlled. These benefits are for the road users mainly those who drive their vehicles over it. "The users of a

highway may or may not be local residents, so that the benefits could be spread out over a large geographic area" (Federal Highway Administration, USA. 1998).

"In addition to economic evaluation attempts have been made to measure the social and environmental impacts of roads using various approaches". Efforts are made to isolate the social and environmental impacts due to roads. In developing countries only a small percentage of projects include formal impact evaluation studies and even those which are conducted are of poor quality (Momtaz S. 2002 and Panigrahi J.K., Amirapu S. 2012).

Although the roads are constructed and planned for all their positive attributes, but the fact remains that they pose significant negative impacts on nearby communities and the natural environment. "People and properties may be in the direct path of road works and affected in a major way. People may also be indirectly affected by projects, through the disruption of livelihood, loss of accustomed travel paths and community linkages, increases in respiratory problems due to air pollution nuisance due to increased noise level and injury from road accidents" (PMDFC, 2002 and Spellerberg I. 1998). Disturbances to the natural environment may include soil erosion, changes to streams and underground waters and interference with animal and plant life (Trombulak S. C., Frissell C. A. 2000).

Project impact may be direct or indirect. The direct impacts can be seen in the direct path of the road or highway and are mostly considered to be positive. These impacts are reduced time in travelling, comfortable drives and journey, fuel efficiency, easier transportation and safety. "Road improvements may also reduce seasonal or other weather-related access closures" (Julieata,P. 2005). In most projects the direct effects are mostly local but in case of highways they can be national and even international. "The composition and distribution of the direct effects depends on the composition of users and the structure of the transport market" (Spellerberg I.

1998). "The indirect effects consist of increases in income and other dimensions of well-being (health, education, social interaction and political participation) brought about by the infrastructure. The roads may increase job opportunities and open up new sources of revenue, leading to a more diversified income structure, which can reduce household vulnerability to economic shocks" (Goffman E. 2005).

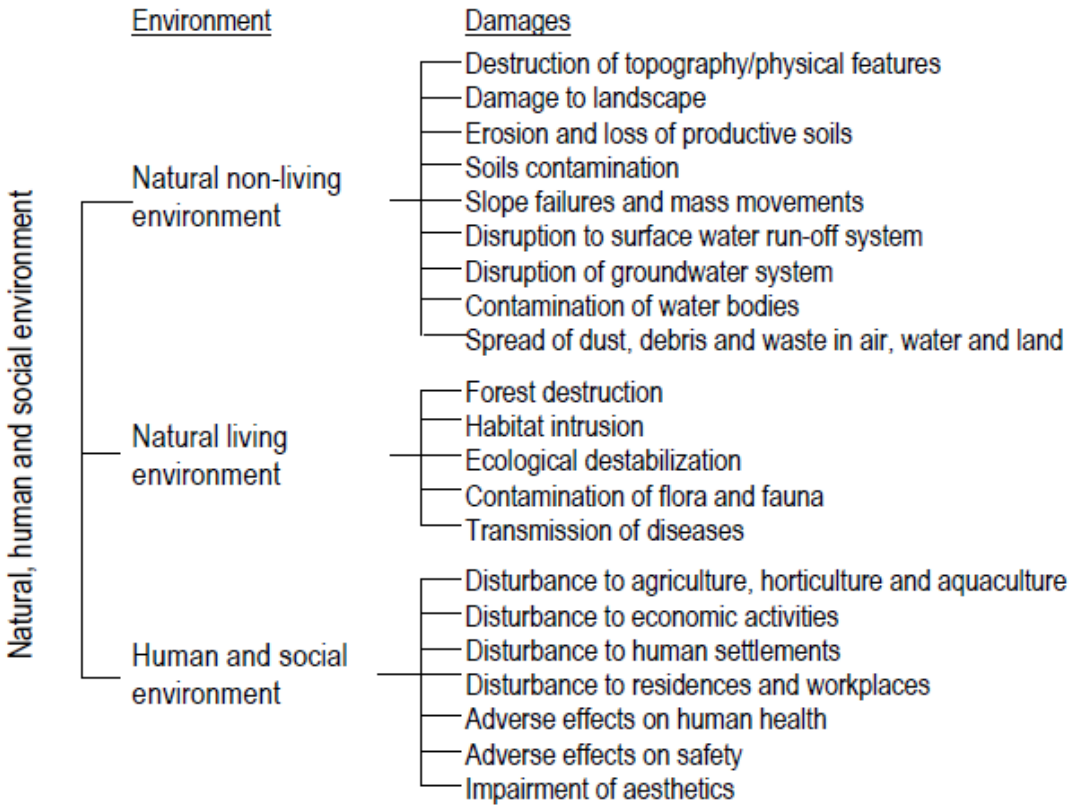

Figure 2.2 Environmental and social damages that are caused by road infrastructure development and traffic operations (UN, 2001)

Some research papers were studied to devise the methodology. For roads and highway the methodology can be divided into three phases: pre-field stage, field stage and post-field stage

(Basahi I. and Levi J. 2002). In pre-field stage different maps are collected of the area and they are studied to determine the impact area. Also some literature is reviewed and data about the area is collected. “The field stage is undertaken along the length of the proposed road corridor for visual assessment and local inquiries and for meeting the critical data gaps, and identifying potential environmental and social impacts” (UNEP, 2009) In the post-field stage the data is compiled and presented. Also possible impacts were deduced and mitigation strategies devised.

2.4 Review of Legislations

The legal documents reviewed for this research are:

- Pakistan Environment Protection Act (1997)
- Pakistan Environmental Assessment Procedure (1997)
- Punjab Environmental Protection (Amendment) Act (2012)
- Guidelines for Preparation and Review of Environmental Reports, Government of Pakistan (1997)
- Sectoral Guidelines for Environmental Reports – Major Roads, Government of Pakistan (1997)
- Pakistan Environment Protection Agency (Review of IEE and EIA) Regulations, 2000
- National Environmental Quality Standards (2000) for Discharge of Municipal and Industrial wastewater and Gaseous emissions
- ADB Guidelines for Environmental Assessment

These documents provide the guide lines regarding how to carry out the environmental impact assessment, what components should constitute the report and its legal requirements. As this

project is funded by ADB therefore the environmental assessment has to comply with the regulations and standards of ADB as well (ADB 2003). Other than environmental assessment ADB emphasizes on development of Land Acquisition and Resettlement Plan (LARP) for projects which require acquiring land from the locals, especially agricultural land. It includes relocation, rehabilitation and income restoration of the people displaced (NHDISP, NHA 2012)

2.5 Project Categorization

Pakistan Environment Protection Agency (Review of IEE and EIA) Regulation, 2000. Schedule II list the projects requiring an EIA study as under:

> "The projects in schedule II are generally major project and have the potential to effect a large number of people. They also include projects in environmentally sensitive areas. The impact of such projects may be irreversible and could lead to significant changes in land use and in the social, physical and biological environment."

Schedule II describes the requirement of EIA for transportation projects as under:

> "Federal or provincial highways or major roads greater than 50 million rupees in value. Maintenance (rebuilding or reconstruction of existing roads) is exempted from requirement of an EIA"

Asian Development Bank (ADB) Guidelines classify the projects requiring an EIA in Category A (OM 20) as under:

> "Projects with potential for significant adverse environmental impacts, an Environmental Impact Assessment EIA is required to address significant impact."

Some EIA reports of other highway projects were studied to formulate and outline of the research. Some research papers on comparison of EIA and EIA process in other countries were also considered (Zubair L. 2001 and Panigrahi J.K., Amirapu S. 2012 and Hameed,R. 2008).

3 METHODOLOGY

The research on this project is based on office studies and foot survey. The environmental impact assessment of any project deals with study and analysis of multiple disciplines and perspectives that will be applied on a project. The methodology or approach of the study can be divided in to following three stages:

1. Initial Stage – This mainly involves analysis of bibliographic and cartographic information.
2. Field Stage – This involves site visits.
3. Final Stage – In this stage all the impacts and mitigation measures are analyzed.

In the initial stage of research all the existing data is collected which includes all the bibliographic and cartographic data.

Cartographic data which includes maps and existing photographs helps to understand the location and alignment of the project. It helps to determine the physical features of the land like its topography, cultivated area, rivers and canals. They also give an idea about the land use such as agricultural land and adjacent rural or urban settlements. Maps also tell us about the existing highways or roads in the project area and how construction of M-4 is going to serve any different purpose. The cartographic information is used to plan the field stage as well as helping to set different locations for data collection and providing information about settlements to help in socioeconomic survey. During cartographic study maps and details of the project are also studied to guide about different features of the highway such as where there will be interchanges, bridges, drainage work etc. which can be aligned along the existing features of the area and that can help determine the direct impacts of the project.

The bibliographic data gives us the information about chemical, biological and socio-economic characteristics of the project area. Baseline studies are carried out and with them we find out as to which are the properties or features of the project area before the project is implemented. In this way a comparison can be drawn that how the existing environment will be altered or effected due to the project. It is used to draw environmental inventory with items from physical environment such as climate, air quality, noise levels and land use etc; ecological environment such as fauna, flora and endangered species etc and socio economic environment such as population, literacy, races and indigenous people etc. Questionnaire for socioeconomic survey was designed following the standard format for roads projects.

All the secondary data was collected from the following:

- NHA, NESPAK and SGS Pakistan.
- It was also established by the review of district census reports, Pakistan Demographic and Health survey.
- Review of reports from Geological Survey of Pakistan, Meteorological Department, Punjab Wildlife Management Board and Economic Survey of Pakistan.

After collecting sufficient secondary data field visits were carried along the length of the project. Following were the purposes of field visits:

- Identifying the prevailing environmental conditions in the project area.
- Cross checking and filling gaps in the baseline developed through bibliographic studies and secondary data.
- Verifying the land use and agriculture patterns.
- Observing the settlement patterns.

- Studying the socioeconomic conditions.
- Discussions and survey with on site NHA officials and their environmental consultants.
- Interviews with the locals.

The visits were scheduled along project area at following sites:

- Faisalabad (chainage 6+530)
- Paisara-Gojra (chainage 65+760)
- Toba Tek Singh (chainage 90+220)
- Shorkot (chainage 110+580)
- Khanewal (chainage 160+400)

After the field visits all the data was compiled and analyzed to deduce the impacts of the project on project area. Impacts of the project on each component of the environment can be characterized in two ways:

1. Magnitude of the impact – which can be quantifiable to a value or just analyzed by the help of earlier studies.
2. Significance of the impact – which can be detected by guideline or standards like NEQS or WHO guidelines etc.

After identifying impacts suitable mitigation measures are suggested for each specific impact in every component of the environment. Mitigation measures are proposed taking in consideration their economic and social viability.

Impacts as well as mitigation measures are worked out for each individual stage of the project which for this project will be:

- Construction phase.
- Operation phase.

4 SCOPING AND BASELINE DATA

4.1 General

The environmental baseline is developed with respect to various aspects of the environment such as physical, ecological and social components of the environment. The direct "Corridor of Impact" (CoI) of the motorway lies within the "Right of Way" (RoW) of the project but the indirect CoI can spread far beyond that. For this project the CoI is about 100 meters.

There was no road existing along the RoW of this Motorway, therefore baseline environment of the Project Area is free from environmental pollution such as dust, noise or vehicular emissions. That helps to outline the naturally existing environmental baseline and the impacts of the project will be analyzed with respect to that.

4.2 Physical Environment

4.2.1 Meteorology

The areas from which the M-4 passes have the climate with two extremes – hot summer and mild winters. The summer season starts from April and continue till October. After that the temperature starts to fall especially with cooler nights. June and July are the hottest months in the year. The onset of winters can be marked with November which continues till March. The coldest months in that region are December, January and February.

"The maximum and minimum temperatures in summer are 41 °C and 27 °C respectively and in winters 19 °C and 4 °C respectively" (PMD).

Table 4.4.1 Mean values of monthly data over 30 years (Faisalabad, Toba Tek Singh and Jhang)

Month	Mean Temperature (°C)		Precipitation (millimeters)	Relative Humidity (%)
	Maximum	Minimum		
January	19.4	4.1	11.5	66.0
February	21.9	7.1	20.1	61.2
March	26.7	12.3	25.7	58.2
April	33.5	18.0	16.9	46.5
May	38.4	22.7	16.1	37.5
June	41.5	31.8	27.9	41.7
July	40.1	32.4	115.0	61.5
August	38.1	26.6	89.8	65.9
September	35.7	23.7	28.6	59.9
October	33.0	17.1	3.8	54.7
November	27.2	10.3	3.0	62.7
December	21.4	5.1	8.6	66.5
Annual (Average)	31.2	17.6	372.3	56.6

Source: Data Processing Centre, Pakistan Meteorological Department.

The data in table 4.1 above represent the temperature, precipitation and relative humidity for Faisalabad, Toba Tek Singh and Jhang. As they are close to one another therefore data given in District census report is same for all three districts.

The project area has very few rainfalls. “The bulk of monsoon precipitation occurs in July and August, with monthly averages of 115.0 and 89.8 mm respectively. Minimum rainfall occurs in the month of November which is 3.0 mm” (PMD).

Table 4.4.2 Month wise 30 year mean and maximum data values (Khanewal)

Month	Mean Temperature (°C)		Precipitation (millimeters)	Relative Humidity (%)
	Maximum	Minimum		
January	21.0	4.5	7.2	62.3
February	23.2	7.6	9.5	56.4
March	28.5	13.4	19.5	51.6
April	35.5	19.5	12.2	40.1

May	40.4	26.4	3.7	33.2
June	43.7	30.6	12.3	39.9
July	41.1	28.0	61.3	56.0
August	38.6	24.9	32.6	59.7
September	37.2	18.2	10.6	56.3
October	34.6	10.9	1.6	51.6
November	28.5	5.5	2.4	51.4
December	22.5	17.8	6.9	66.6
Annual (Average)	35.1	18.9	186.8	52.9

Source: Data Processing Centre, Pakistan Meteorological Department.

4.2.2 Air Quality

Along the project area lies a lot of agriculture fields therefore the atmosphere is relatively free of pollution except dust. The cause of dust is mainly the dry weather of that region and other agriculture related human activities. Due to vehicular movement and due to existing poor road conditions and passageways huge quantities of suspended particulate matter are released into the environment. It is expected that the project will not cause any dust problem due to smooth carpeted road surface and paved shoulders.

Table 4.4.3 Ambient Air Quality

Parameters	Average Test Results at Various Locations					USEPA (standards)
	L1	L2	L3	L4	L5	
CO (ppm)	1.20	0.33	0.70	0.48	1.40	35
NO_2 (ppm)	0.02	<0.01	0.02	0.01	0.02	0.053
SO_2 (ppm)	0.02	<0.01	0.01	0.01	0.01	0.14
PM_{10} (µg g/m^3)	266.3	142.6	228.5	135.2	287.2.8	150
Location L1: Faisalabad-Sargodha road, Location L2: Painsara-Bhawana road, Location L3: Gojra-Jhang road. Location L4: Shorkot Cantt road, Location L5: Khanewal Multan road						

Source: SGS Laboratory Test Results

United States Environment Protection Agency (USEPA) standards are referred for ambient air quality standards as the relevant standards have not yet been developed in Pakistan.

Table 4.3 indicates that at some locations the value of PM_{10} exceeds the USEPA standards. This may be due to PM_{10} emissions from the vehicular traffic and dispersion of dust (deposited on these roads) due to running of the vehicles.

4.2.3 Noise

The project area is mostly agricultural with some road crossings. At major road crossings increased noise levels appear to be a major issue. "The average value of noise along the road crossings was accounted to be close to NEQS and WHO limits" (SGS). However it is expected that the noise levels will increase exceeding those limits, during construction phase of the project and to some extent also in the operation phase.

Table 4.4.4 Noise Levels at Various Locations

	Time	Faisalabad-Sargodha Road dB(A)			Painsera-Bhawana Road dB(A)			Gojra-Jhang Road dB(A)			Toba-Warriam Road dB(A)			NEQS dB(A)	WHO dB(A)
		Avg.	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min.		
1	07:00	63.9	72.1	59.2	67.9	71.1	53.2	69.2	78.8	52.6	79	85	61	70	70(for industrial, commercial, traffic areas) 55(for residential, schools, hospitals)
2	09:00	77.5	94.1	63.6	66.6	70.3	55.9	76.3	85.4	54.3	71	82	62		
3	11:00	78.3	90.3	67.9	65.2	72.7	58.3	75.4	89.6	59.5	73	86	63		
4	13:00	65.5	72.4	58.6	65.8	72.9	58.1	75.1	94.2	63.3	76	91	56		
5	15:00	79.7	95.4	59.8	60.4	73.6	55.7	78.6	92.1	67.7	74	91	66		
6	17:00	78.1	96.4	60.1	62.3	71.4	49.6	74.7	86.9	62.1	71	93	68		
7	19:00	76.3	96.8	61.6	60.1	68.8	51.4	69.8	74.2	56.9	75	92	67		

8	21:00	79.0	98.0	63.4	59.7	69.2	48.9	70.1	84.3	59.8	78	86	61		

Source: SGS Pakistan

Table 4.4 presents the values of range of noise levels as recorded at various locations. The average noise level values vary greatly and mostly exceed NEQS limit i.e. 70 dB(A). However maximum noise levels were in proximity of the WHO and NEQS guidelines value which is 70 dB(A).

4.2.4 Surface and Ground Water

The main sources of water in the project area are River Ravi and River Chenab. The canals and water courses system from these two sources is the main irrigation system in the project area. The Jhang Branch, Guggera Branch and Burala Branch are the major irrigation systems for that area. These systems irrigate the land under project area in districts of Faisalbad, Jhang and Toba Tek Singh. “In Khanewal district the project area is irrigated by Sadhnai canal and Abdul Hakeem Distributary” (Irrigation department). This motorway will cross two major water channels where bridges will be constructed, which are River Ravi at 145+250 km and Sadhnai Canal at and 145+900 km. Construction of two bridges on these locations constitutes Package-IV of this motorway. The land in the project area is also irrigated by tubewells.

In Khanewal district salinity and water logging problems were reported at a smaller scale. The water logged and saline areas lie more than one kilometer away from the alignment of M4.

Ground and Surface water data were collected for different locations along the project area. According to ground water analysis most of the water does not meet drinking water quality

standards as prescribed by WHO. The concentration of Total Dissolved Solids (TDS), Chloride and Sodium was quite high. Faecal Coliform (E.coli.) was also found in ground water. The surface water in project area is good for agriculture and all the parameters are within the limits prescribed by NEQS. The locals use ground and surface water for drinking and everyday needs. The results for ground and surface are presented in table 4.5 and 4.6 respectively.

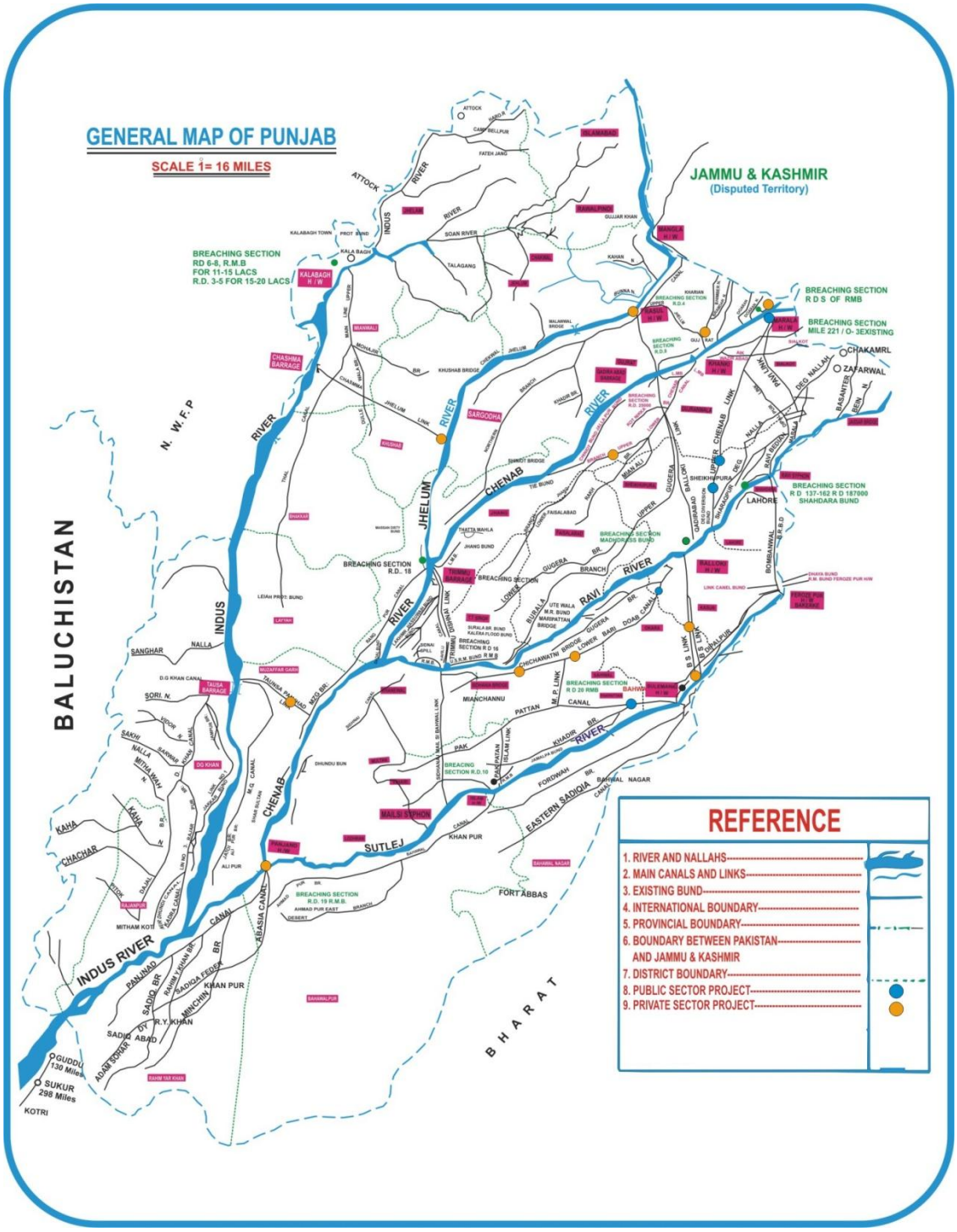

Figure 4.1 Irrigation System in Punjab (*Irrigation Department, Punjab*)

Table 4.4.5 Surface Water Quality

	Parameters	Ameen Pur	Gojra-Jhang Road	Toba-Warriam Road	NEQS Limit
A. Chemical Parameters					
1	pH (mg/L)	8.83	8.93	8.86	06-09
2	Biological Oxygen Demand (BOD)	7	9	12.5	80
3	Chemical Oxygen Demand (COD)	15	16	20	150
4	Total Suspended Solids (TSS)	20	31	45	200
5	Total Dissolved Solids (TDS)	175	150	170	3500
6	Chloride (Cl) mg/L	10.6	9.9	9.7	1000
7	Fluoride (Fl) mg/L	0.1	0.22	0.28	10
8	Dissolved Oxygen (DO)	4	4.5	5	-
9	Conductivity	309	293	288	-
10	Nitrates (NO_3) mg/L	4.5	4.2	4.3	-
11	Sodium (mg/L)	7	8	7	-
12	Total Alkalinity	115	110	125	-
13	Turbidity NTU	10	15	28	-
14	Hardness	130	140	150	-
15	Taste	Tasteless	Tasteless	Tasteless	-
16	Odor	Odorless	Odorless	Odorless	-
17	Color	Colorless	Colorless	Colorless	-
B: Biological Parameters					
1	Total Colony Count	TNTC/ml	TNTC/ml	780/ml	-
2	Total Coli Forms	TNTC/100ml	TNTC/100ml	TNTC/100ml	-
3	Faecal Colony	24/100ml	6/100ml	3/100ml	-
4	Faecal Streptococci/Enterococci	Absent/100ml	Absent/100ml	Absent/100ml	-

Source: SGS, Pakistan

Table 4.4.6 Ground Water Quality at Various Locations

	Parameters	Faisalabad-Sargodha Road	Gojra-Jhang Road	Shorkot-Cantt Road	Khanewal-Multan Road	WHO Limits
A. Chemical Parameters						
1	pH (mg/L)	7.95	8.52	7.88	8.13	6.5-8.5

2	Total Dissolved Solids (TDS)	2023	3915	1495	947	1000
3	Chloride (Cl) mg/L	524.7	825	489	159	250
4	Nitrates (NO_3) mg/L	6.7	14	5.7	18	50
5	Sodium (mg/L)	541	1040	286	187	200
6	Fluoride (Fl) mg/L	0.91	1.04	0.6	0.89	1.5
7	Arsenic (As) mg/L	<0.01	<0.01	<0.01	<0.01	0.01
B: Biological Parameters						
1	Total Colony Count	TNTC/ml	3510/ml	TBTC/ml	1812/ml	-
2	Total Coli Forms	05/100ml	TNTC/100ml	53/100ml	Absent/100ml	-
3	Faecal Colony	Absent/100ml	Absent/100ml	Absent/100ml	Absent/100ml	-
4	Faecal Enterococci	Absent/100ml	Absent/100ml	Absent/100ml	Absent/100ml	-

Source: SGS, Pakistan

4.2.5 Topography and Geology

"Topography of the project area is totally flat with mild slope from north to south" (Pakistan Geological Survey). The area is 500 meters above the sea level. "The soil of all four districts is fertile. The soil in the project area is rich alluvial loam" (Punjab Agriculture Department). The sand is abundant in Ravi and Chenab river bed and this sand is good as building material.

4.2.6 Seismicity

"According to seismic zoning of Pakistan, the project area lies in Zone 1 of Modified Mericalli (M.M.) scale and represents minor damage. Distant earthquakes may cause damage to structures with fundamental period greater than 1.0 second, corresponds to intensity V and VI of the M.M scale" (National Disaster Management Authority).

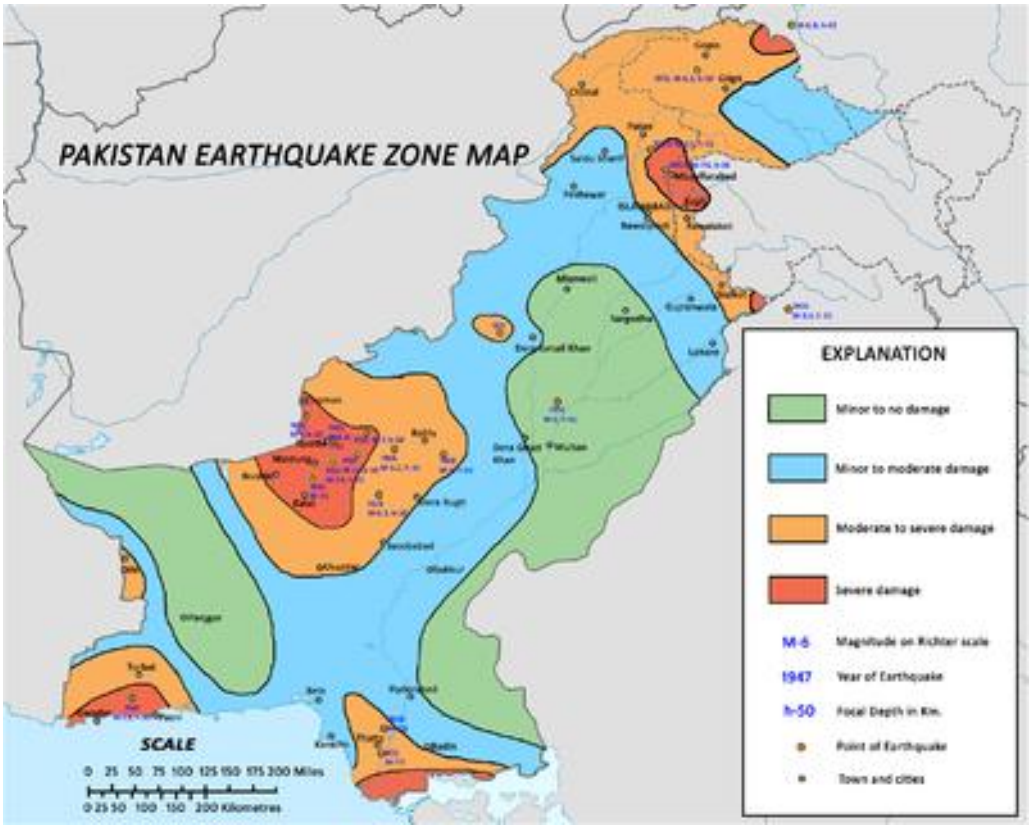

Figure 4.2 Seismic Map of Pakistan (*Geological Survey of Pakistan*)

4.2.7 Agriculture and Crop Pattern

Agriculture along M-4 is mainly by irrigation. The agriculture in Project Area depends upon perennial canals from Sagir Head Works and Abdul Hakeem Head Works. The shortage of water occurs in winter and in sowing season it effects Kharif cultivation. M-4 passes through four districts and cropping pattern in these districts are different from each other.

Table 4.7 gives the major crops in respective Tehsils of project area. Other than these crops vegetables are also grown in some parts of Faisalabad and Toba Tek Singh. Citrus orchards are found in district Toba Tek Singh and mango orchards are found in district Khanewal.

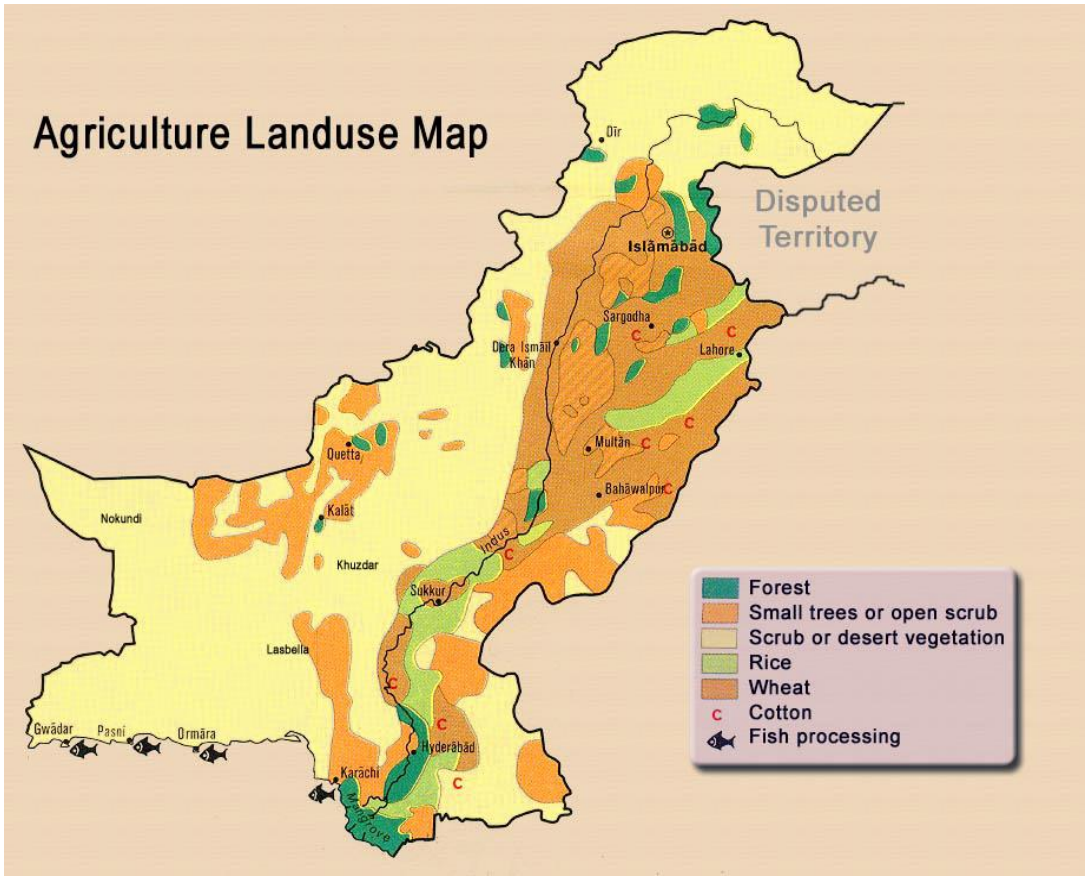

Figure 4.3 Agriculture and Land use Map of Pakistan (*Pakistan Meteorological Department)*

Table 4.4.7 Major Crops/Cropping Pattern in the Project Area

	Tehsil	Cropping Pattern	
		Rabbi	Kharif
1	Faisalabad	Wheat, Fodder	Sugarcane, Fodder, Rice. Potato
2	Gojra	Wheat, Vegetables	Sugarcane, Potato, Cotton, Fodder
3	Toba Tek Singh	Wheat, Fodder	Sugarcane, Cotton, Fodder
4	Shorkot	Wheat, Fodder	Sugarcane, Cotton, Rice
5	Kabirwala	Wheat, Gram	Rice, Cotton, Fodder, Vegetable
6	Khanewal	Wheat, Gram	Cotton, Rice, Sugarcane, Maize

Source: Agriculture Department

4.2.8 Industrial and Commercial Activities

The route of M-4 is designed through the agricultural fields therefore commercial units along the route are negligible. Faisalabad is known for its textile industry but no unit falls along the route of M-4. Similarly in other districts no commercial units fall under the RoW of M-4.

4.3 Ecological Resources

4.3.1 Flora

Naturally the project area was vegetated by Tropical Thorn Forest, however the natural vegetation have long ago been replaced completely by agricultural crops.

i. **Crops:** Major crops grown and cultivated in these districts vary seasonally. In winter season wheat and fodder are grown and during summer sugarcane, rice, cotton and maize are grown.

ii. **Trees:** Citrus and guava orchards are common towards the north eastern side and mango orchards towards south western end. Tree plantation is also found along the field borders and along the water channels. Among trees Shisham (*Dalbergia sisso*) and Kikar (*Acacia nilotica*) are the main species. Other species growing in this area are Eucalyptus (Eucalyptus camaidulensis), Semul (Bombax ceiba), Bakin/Dharek (Melia Azerdarac), Jaman (Syzigium cumini), Sukhchain (Pongamia glabra), Mulberry (Morus alba), Beri (Zizipus mauritiana) and Khajoor (Phoenix dactilifera). Roadside plantation running across or parallel to the project area include Shisham, Kikar, Farash (Tamarlx aphylia) and Eucalyptus. Bohr (Ficus

bengalensis), Neem (Azadiraccta indica), Beri and Bakain are commonly planted at the farm houses.

iii. **Natural Vegetation:** "Natural vegetation includes Karir (Capparis apnylla), Aak (Calotropis procera), Kana (Saccharum bengalensis), Khabbal (Cynodon dactylon), Lamb (Aristida depressa), Gorkha (Lasiurus sindicus) which are present in graveyards or in the open area along the roads and also along some canals. Koondar (Typha angustata) grows along water ponds and wet places" (Pakistan Wildlife Department).

4.3.2 Fauna

Most of the natural fauna has also been eradicated with the removal of natural Tropical Thorn Forest.

i. **Mammals:** Among mammals only the agriculture related species are present. "Jackal (Canis aureus), Mongoose (Herpestes janvanicus), Jungle cat (Felis chaus), Hedgehog (Hemiechinus collaris), and Five Stripped Palm Squirrel (Funambulus pennantii) commonly occur. Porcupine (Hystrix indica) also exists in this area. Small mammals including Indian mole rat (Bandicota bengalensis), Soft Furred Rat (Millardia mettada), Field mouse (Mus musculus), Indian gerbil (Tatera indica), and House shrew (Suncus marinus) are the common pests of agriculture crop that are present there" (Pakistan Wildlife Department).

"Domestic livestock include buffalo, cattle, goats and sheep. Donkeys are kept to pull carts in the area. Some farmers are also engaged in horse breeding" (Livestock Department). Camels are found occasionally. Livestock are mainly farm fed.

ii. **Reptiles:** Cobra (Naja naja), Saw scale viper (Echinus carinatus), Russell's viper (Daboia russelii russelii), Du-muhi (Eryx johnii) and striped keelback (Amphiesma stoiatum) are known to occur in the area. Common tree lizard (Calotes versicolor), Monitor lizard (Varnus bengalensis) and Fat tail lizard (Uromastix hardwickii) occur in orchards and open areas. Two species of fresh water turtles were also reported, Indian soft-shell turtle (Aspideretes gangeticus) and Indian flapshell (Lissemys punctata andersoni) have been reported which are present in ponds, canals and in the fields during wet season.

iii. **Amphibians:** Bullfrog (Hoplobatrachus tigerinus), Pahari tidda maindak (Fejervarya limnocharis) and Indus valley toad (Buffo stomaticus) are also present in the area

iv. **Birds:** The intensive agriculture pesticide use has impacted bird population adversely. Black and grey partridges (Francolinus francolinus and F. pondicerianus) are the most affected as they are also hunted and captured to be kept as pets. "Other bird species known to occur in this area are Cattle egret (Bubulcus ibis), pond heron (Ardeola grayii), Myna (Acridotheres tristis) Red vented bulbul (Pyaonotus cafer), Jungle babbler (Tordoides striatus), Bluth's reed warbler (Acrocephalus dumetorum), Indian great reed warbler (A. stentoreus), Black kite (Mivus migrans), Black shouldered kite (Elanus caeruleus), Koel (Eudynamys scolopacea), King crow (Dicrurus macrocersus), Common crow (Corvus splendens) and house sparrow (Passer domesticus)" (Pakistan Wildlife Department).

4.3.3 Wetlands

There are no significant wetlands in the vicinity of Project area. Sidhnai Barrage on River Ravi is located about 4km from the RoW but it hardly gets any migratory waterfowls.

4.3.4 Aquatic Biota

Aquatic fauna reported from canals and rivers in project area are mainly fish, which includes carps such as “mori (Cirrhinus mrigala). Thaila (Catla catla), Rohu (Labeo rohita) silver carp (Hypophthalmichthys molitrix), gulpham (Cyprinus carpio), grass carp (Ctenopharyngodon idella) catfish like khagga (Rita rita), macchva (Bugarius bugarius), sanghara (Mystus sienghala) and exotic fish that are now naturalized tilapia species (Tilapia mozambica, T. nilotica)” (Wildlife Department). The welfare of fish depends on the availability of food which occurs in water as phytoplanktons and zooplanktons.

The aquatic fauna of invertebrate group include Rotifers, Oligochaetes, Crustaceans and Insects. Their quantity and species hugely vary.

“The aquatic flora in the project area consists of species that are usually found in standing water along canals or fish pond. According to Wildlife department no rare or endangered aquatic species inhabit in the project area” (Wildlife Department).

4.3.5 Endangered Species

There are no floral or faunal species inhabiting the project area that are included in the Red Data Book of IUCN. The populations of birds are reported to be reduced over time due to pesticide sprays in agricultural crops. Population of Shisham tree is also reported to be reduced mainly due to drought conditions.

4.3.6 Sensitive Areas

Shorkot and Khanewal Irrigated Forest Plantations are the two protected areas located in the surrounding of project area. But both are located eight to ten kilometers away from the alignment of the M-4.

"Shisham and Eucalyptus are grown there as commercial crops and the plantations have been declared as wild life sanctuary" (ADB). Black and grey partridges, song birds, wild boar, Jackal, wild cat, Desert hare, Mongoose and Porcupine commonly occur there. Among snakes are Cobra, Viper and Krait. Hunting is not allowed in the wildlife sanctuaries, but poaching is not uncommon.

Archeological Sites or Wetlands: "There are no known sites of Archeological or Cultural importance located within 1km of the Project Area. Also there are no major wetlands in the project area" (ADB).

4.4 Socio-economic Environment

M-4 is aligned in rural areas of four districts of Punjab and the socio-economic conditions of all districts are almost same. Most of the people living in the surrounding villages are farmers. *Punjabi* is their mother tongue. In some areas *Siraiki* is also spoken as mother tongue. In all the areas dress pattern is the same. "*Shalwar kameez* and *dhoti kurta* are common dresses of males and females there. Some modern young males also wear pant and shirt" (Demographic Survey of Pakistan). A common culture has evolved in this area and there is no evidence of domination of tribal system. Most of the locals are engaged in agriculture or agro-based businesses. Apart from huge land owners majority of the people inhabiting along the project area belong to lower or lower middle class.

4.4.1 Demographic Profile

a. Faisalabad Tehsil: Total population of “Faisalabad Sadar Tehsil was 924,110 with growth rate of 1.94% as recorded in 1998 census. Population composition was 108 females as compared to 100 males. 97% of the population resided in urban areas and just 3% lived in rural areas. Average house hold size was 7.4.

b. Gojra: This tehsil had total population of 495,096 with growth rate of 1.94% as recorded in 1998 census. Population composition was 105 females as compared to 100 males. 24% of the population resided in urban areas and 76% lived in rural areas. Average house hold size was 7.2.

c. Toba Tek Singh: Total population of this tehsil was 617,035 with growth rate of 2.07% as recorded in 1998 census.” “Population composition was 107 females as compared to 100 males. 10% of the population resided in urban areas and 90% lived in rural areas. Average house hold size was 5.2.

d. Shorkot: Total population of this tehsil was 670,255 with growth rate of 2.23% as recorded in 1998 census. Population composition was 108 females as compared to 100 males. 85% of the population resided in rural areas and just 15% lived in urban areas. Average house hold size was 6.9.

e. Kabirwala: This tehsil had population of 659,612 with growth rate of 2.19% as recorded in 1998 census. Population composition was 107 females as compared to 100 males. 15% of the population resided in urban areas and 85% lived in rural areas. Average house hold size was 7.3” (Pakistan Demographic and Health Survey, District Census Resport).

4.4.2 Settlement Patterns

M-4 starts from Faisalabad and passes from tehsil areas of Faisalabad, Gojra, Toba Tek Singh, Shorkot, Kabirwala, and Khanewal. In tehsil of Faisalabad, Gojra and Toba Tek Singh majority of people live in villages and a few live in their farm houses (Deras) therefore no houses or civic structures are located in the RoW. On the other hand in tehsils of Shorkot, Kabirwala and Khanewal there is no formal pattern of settlements and people make their homes on their agriculture lands. Therefore in this portion some housing and residences were in the RoW.

4.4.3 Races and Tribes

The population of all these districts derived from Semitic or Indo-Aryan races. Most of these tribes are predecessors of different attackers from Afghanistan and Central Asia. In colonial age British government developed canal command systems in these districts and carried out first land reforms in 1902. At that time British allotted agricultural land to different farmer tribes and settled them here after bringing them from central districts of combined Punjab. At the time of Indo-Pak partition in 1947 many group of people migrated to these areas and settled ever since. Thus by living in same place for so many years, homogeneity of culture and races has been developed among these people. Generally their tribes can be divided in to two classes; farmers and non-farmer tribes. Farmers' tribes are those who are involved directly in farming and non-farmer tribes are involved in other agro based professions.

4.4.4 Indigenous People

The people living around project area belong to different races and different cast patterns but no such community has been identified which has closed culture, close economy and closed community. Therefore there is no danger of elimination or damage of any indigenous community

4.4.5 Caste System

Project area lies in rural areas of Punjab. Following caste and tribes were identified during the field survey:

Table 4.4.8 List of Different Castes in Respective Tehsils

	Tehsil	Castes
1	Faisalabad	Sayyed, Jatt, Arain, Malik, Rajput, Sheikh
2	Gojra	Sayyed, Jatt, Arain, Malik, Rajput, Sheikh
3	Toba Tek Singh	Sayyed, Jatt, Arain, Malik, Rajput, Sheikh
4	Shorkot	Sayyed, Mughal, Naul, Sheikh
5	Kabirwala	Sayyed, Gill, Mughal, Bandash, Wahlas, Noon, Mohanas. Sheikh, Haraj
6	Khanewal	Sayyed, Gill, Mughal, Bandash, Noon, Sheikh, Haraj

Source: NESPAK

4.4.6 Religion

Religion plays a very important role in the social structure of society. Majority of population in the project area are Muslims. The only minority identified are Christians which are only about 1% of the total population.

5 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1 General

After establishing the baseline studies this section determines the impacts the project will have on different components of environment like physical, ecological and socio-economic environment in the project area. The impacts are predicted not only for the construction of the motorway but also for its operation phase. This assessment also includes the recommendation of appropriate and effective mitigation measures to eliminate or reduce those impacts.

5.2 Project Corridor

The Project corridor for determining the impacts is defined and studied according to two criteria, Corridor of Impact (CoI) and Right of Way (RoW). Corridor of Impact is the width along and beyond the corridor that will be directly or indirectly impacted by the project work. Right of Way is the corridor width which the NHA is legally entitled to.

a) Project Right of Way (RoW)

The Project corridor has a well defined RoW that will be 100 meters (328 ft) for the entire length of the Motorway except interchanges where RoW will be 500 meters (984 ft). Major construction works generally remain confined within the RoW. All the infrastructure and commercial activities within the existing or proposed RoW will be relocated as they will have direct impact of the Project.

b) Corridor of Impact (CoI)

The corridor of the proposed impact (CoI) is delineated as the extent, which has direct or indirect impact of Project. Direct impacts of the Project are relocation of the houses, utilities and air & noise pollution impact on workers during construction. All direct impacts are constrained within the RoW. Indirect impacts caused by noise and dust emissions, camp sites and borrow sites could be beyond the RoW. The direct CoI of surface water bodies will be confined within the RoW of the proposed Project and will be temporary only for the construction period.

5.3 Pre-Construction / Design Phase

5.3.1 Topography

Due to construction of road and its related components like embankments, shoulders, culverts etc., the topography of the project area will change to some extent. These visual changes to the topography would have permanent but minor negative impact. However, the aesthetic elements (such as plantation) should be incorporated in the design to overcome the impacts.

5.3.2 Soil Erosion and Contamination

Soil erosion will take place around road cuttings and embankments, which will be mitigated by incorporating the following measures in the design.

- “The provision for vegetation with a fast growing crop and a native seed mix immediately after the placement to prevent scour and to encourage stabilization will be made in the design” (ADB). Use of stone pitching or riprap will also be provided in the design at appropriate places, especially around flyovers, bridges, culverts, etc.
- Provision for riprap in discharge zones from drainage structures will be made in the design to reduce erosion.

- Dow drains/chutes will be lined with riprap / masonry or concrete to prevent erosion.
- "Side slopes will be adjusted to a gradient necessary to reduce erosion potential or if steeper, stabilized, covered with riprap or other material to prevent soil erosion" (NHA).
- The Project site through which the alignment is proposed, should be investigated for the presence of naturally occurring contaminants, such as asbestos, arsenic, likelihood of erodibility of soil, contours, terrain stability, slope gradient, physical and chemical properties of soil, such as soil depth, particle size distribution, permeability, dispersibility, pH, salinity and likelihood of seismic activity. If any contaminated soils are found, they shall be removed and deposited in a sealed pit in an area agreed with the concerned authority. The seismic factor shall also be considered at the design stage.

5.3.3 Land Acquisition and Resettlement

The major issue in the Project site will be land acquisition and resettlement. This will result in landlessness, homelessness, joblessness, marginalization, loss of access to common property resources, food insecurity, morbidity and mortality, and social disarticulation due to land acquisition and severance (blocking access across it due to fencing on both sides). Efforts should be made to avoid relocation of the houses while selecting the alignment of the Motorway. Even then land acquisition and resettlement takes place only for those affected by the loss of agricultural land (most of the owners with small land-holdings) and associated infrastructures (farm houses, tube-wells, poultry farms, etc.) but the people who are employed there are not compensated.

M-4 will be constructed on a new alignment for which about 4794 acres of land will be acquired. The current land acquisition process and procedures are not adequate enough to ensure

fair and justifiable compensation to the affectees. Serious negative impacts may result if proper mitigation measures are not adopted.

The most significant impact of the Project is the taking of about 4794 acres of agricultural land out of production. The loss in production can be met with increasing the yield from the fields in agricultural sector. Orchards lost to the Project will also have to be raised by the private owners of land whose land is to be acquired and the neighboring farmers can be helped to gain access to modern technology to increase production from their land. Similarly the deficiency in livestock feed / fodder will have to be met from the adjoining areas.

These impacts of the project on the inhabitants of the project area will be permanent and major negative in nature. The mitigation measures for such impacts should be incorporated during the design phase of the project and it should involve careful alignment and route selection by the designer to minimize the impact. "Adequate budget should be provided in the Project cost for the compensation to the affected people as per Land Acquisition Act 1894 and ADB's Resettlement Guidelines for the lost assets and restoration of their livelihood" (ADB 2010).

According to the design entire Motorway Project will be fenced except at the interchanges, therefore, it will not cause substantial increase in the prices of land. It is expected that land values will increase near interchanges.

During the field visits to the Project Area, resettlement issues were critically observed. According to the statistics 200 mud brick structures in the will be pull down. During visits to project area and from interviews with the locals, it was found that no archaeological site or graveyard, nor any other structure of religious value or cultural significance is going to be demolished due to the execution of the proposed Project.

The mitigation measures include:

- Developing proper judicious compensation package for affectees, in accordance with the guidelines from ADB.
- Giving compensation amount before the affectees shifting.
- Providing underpasses at the existing crossings so that movement across the motorway is not halted.

5.3.4 Flora

According to an estimate total of 18,000 trees will be felled from the agricultural fields in the Project Area. This loss will be compensated by planting strips on both sides of Motorway which, on an average, are estimated to be about 25 meters wide.

Compensatory Planting shall be done in rows (avenues). Eight avenues with a row to row distance of 3 meters should be planted for a length of 50 KM near the habitations and four avenues with row to row distance of 6 meters in the rest of 134 KM long strip thus covering the whole length of Motorway section. Planting should go hand in hand with the construction of the road structure. Planting of this nature and extent shall be a huge task and will have to be outsourced. The executing agency is advised to plan in advance for the procurement of planting stock in consultation with the Provincial Forest Department. Permission from Forest Department should be sought for cutting of trees from the roadside or along the water courses if these fall within the RoW. Planting should be done as soon as the construction of the road is completed. Maintenance is the key to the establishment of the plantation. Regular monitoring of the plantation should be carried out by the executing agency.

After the Project Area is fenced, the natural vegetation is expected to establish itself. The indigenous trees most suited to the tract like Shisham, Kikar, Bakain, Dharek, Siris (Albizzia Procera), Farash, Sukh-Chain, Jaman Bohar, Peepal (Ficus reliogosa), Gullahr (Ficus glomerate) Sohanjana (Moringa oleifera), Karir and Wan (Salvadora Oleoides) are helpful in providing shade, ground cover, aquifer recharge and habitat (including shelter and food) for the wildlife. The compact plantation shall be effective as screens against night glare, dust, noise and pollutant emissions. These vegetated strips shall develop into a complete ecosystem. Flowering and fruiting shrubs can be planted along the road to beatify the landscape. Planting should however be done keeping in view the principles of landscape designing.

- A total of 623,984 (311,992 in each strip on both sides of the road) saplings are proposed to be planted.
- The compact plantation needs to be done on both sides.
- The indigenous trees most suited to the tract like Shisham, Kikar, Bakain, Dharek, Siris (Albizzia Procera), Farash, Sukh-Chain, Jaman Bohar, Peepal (Ficus reliogosa), Gullahr (Ficus glomerate) Sohanjana (Moringa oleifera), Karir and Wan (Salvadora Oleoides) will be planted.
- If a tree of rare species is growing within the RoW and is required to be removed. It will not be felled but uprooted and transplanted in consultation with the Forest Department.
- All old and mature trees falling in 25 meters wide proposed planting strips should be saved (ADB). The first priority should be to save as many trees as possible even if they are at a young stage. Proper irrigation and maintenance of the plants must be ensured.
- An awareness campaign targeted on the neighborhood farmers should be carried out to popularize the planting of trees, and saplings should be provided on subsidized costs

- Organic farming has to be encouraged to minimize the chemical fertilizers and pesticides.

5.3.5 Change in Hydrologic Regime

As the Motorway does not pass through any flood prone area, therefore no change in hydrological regime is expected to occur. The Motorway will cross Ravi River and Sadhnai Canal, while this crossing will be carried out by bridges it is expected to cause no change in water flow pattern. For crossing of canals and drains, small bridges should be constructed. For crossing of water courses, culverts and other possible arrangements should be done. The direct CoI of surface water bodies will be confined within the RoW of the Project and it is expected to be minor and temporary in nature.

Possible impacts are temporary and minor negative, however following mitigation measure should be incorporated.

- During design phase of the project, to ensure the unobstructed flow of water, there should be a proper design of bridges for Ravi River and Sadhnai Canal.
- Even for canals and drains falling in the RoW, small bridges should be constructed to accommodate their flow.
- Box Culverts and safe embankments should be provided to avoid and control flood damages.
- Drains should be provided to safely discharge rain water.
- The slope of the road should be built with precision.

5.3.6 Water Logging and Salinity

The areas with issue of water logging were accounted to be present more than a kilometer away from motorway alignment; therefore it is predicted not to be effected by the project. However

to keep effective drainage system pipe and box culverts at suitable locations should be built as provided in the design.

5.3.7 Restricted Access Problem

As the proposed Motorway will be fenced therefore the communities along the alignment will face crossing problems. This is a major negative impact due to the proposed Project. To mitigate this impact, underpasses and flyovers will be provided in the design at the shorter distances and at places wherever there are existing crossing paths.

5.3.8 Public Utilities

Public utilities which fall in the RoW of the project will be affected. That can cause disruption of public services and inconvenience to the local residents. This impact is expected to be temporary and can be considered as moderately negative in nature. Mitigation measures can include:

- During the design phase along with the construction of motorway, the necessary infrastructure for public utilities should also be designed and relocated.
- Water pipes, power and telephone lines all the utilities that are expected to be affected and fall in the ROW should be relocated much ahead of time.
- The relocation of public utilities should take place even before the commencement of construction work for the highway.

5.3.9 Noise Problems

Fast moving vehicles on the Motorway will create excessive noise for the communities along the alignment, which will be a cause of disturbance for them. This will be moderate negative impact. To mitigate this impact noise barriers have to be constructed wherever there is populated

area within 500 meters along the route by thick plantation or constructing sound barriers wherever possible.

5.4 Construction Phase

Following is the brief description of impacts envisaged during the Construction Phase.

5.4.1 Topography

During the construction phase of the project the topography of the project area will face a lot of changes. The changes will occur as the result of demolition of existing infrastructure, removal of agricultural fields and establishing of borrow areas.

This impact is expected to be temporary and moderately negative in nature. The most important mitigation measure for this impact is proper landscaping and efficient design. All the affected areas should be restored to the original levels after completion of the construction.

5.4.2 Borrow / Open Pits

Borrow/open pits are the sites which are dug to excavate different construction materials. The location of borrow pits and its excavation cause many problems such as “land disputes, soil erosion loss of potential cropland, loss of vegetation, landscape degradation and damage to road embankments” (NHA).

“Borrow/Open Pits can become a potential source of mosquito breeding and other biological contaminants, especially if it rains and water accumulate in them. Therefore they can prove to be a hazardous to human beings, livestock and wildlife. These major impacts will degrade hygienic condition of the Project Area” (NHA).

The impact of borrow/open pits is suspected to be permanent and negative in nature. Mitigation measures can include:

- The borrow pits should be sited and dug after taking necessary permits from the regulating authorities.
- "In Borrow pits, the depth of the pits has to be regulated so that the sizes of excavation will have a slope not steeper than 1:4" (ADB 2010).
- The borrow pits should be monitored regularly especially for soil erosion along its margins to prevent its impacts on the adjacent areas.
- If the borrow pits get filled with water tests should be carried out to check for mosquito breeding and other pathogens.
- The water should be taken our using water pumps and it can then be sprinkled to avoid dust.
- Borrow pits can later be used for construction waste, "but during the excavation top 20 cm soil cover should be preserved for vegetation after the filling of the pits. This will be best way to restore the flora of that area" (ADB guidelines).

5.4.3 Air Quality

Following are the factors and sources that affect air quality:

- Heavy construction vehicles and machinery.
- The dust emissions caused by movement of construction machinery and vehicles on unpaved service roads and site camps.
- "Hydrocarbons pollutants released from asphalt plants and vehicular traffic.
- Dust emissions from crushers and borrow pits" (ADB).

"Impacts of air emissions may be carried over long distances depending upon the wind speed, direction, temperature of the surrounding air and atmospheric stability" (ADB 2009). All these air emissions can cause a lot of changes in the environment effecting weather, health of plants and humans etc. Dust emissions can have immediate impact on health of workers and locals causing coughs, breathing issues, flue, irritation in eyes and throat and reduction in visibility. This impact is predicted to be temporary and major negative in nature.

Mitigation measures can include:

- "Dust control by equipping asphalt hot mix and batching plants with fabric filters or wet scrubbers to reduce the level of dust emissions" (ADB).
- Quarry sites, asphalt hot mix and batching plants should be located at least a kilometer away from the residential area, schools & hospitals.
- The haul trucks that carry aggregate and crush materials should be covered with sheets, in order to avoid dust emissions and to contain all the material inside while transporting it from camps to sites and between sites.
- All the "NEQS applicable to gaseous emission generated by construction works should be enforced.
- Dust mask should be provided to the workers. Proper dust collection system should be ensured at crushers and continuous sprinkling of water should be carried out" (ADB).
- Air Quality monitoring has to be carried out as per schedule given in Environmental Monitoring Plan.

5.4.4 Construction Waste Disposal

Due to construction activities different kind of waste is generated at construction and camp site. The types of waste generated include solid waste, wastewater, oil spillage etc. The improper management of this waste can cause unhygienic conditions and health risk to workers and locals.

Following can be the mitigation measures applied:

- Waste has to be disposed at designated sites and no waste should be disposed in the productive agricultural field.
- All sorts of wastewater effluents from cam site workshops and equipments should be passed through beds of sand/gravel in order to remove greasy oil contaminants before it is released into natural streams.
- The hazardous waste should be incinerated at nearby incineration facility.
- "Solid waste generated during construction should be safely disposed in approved and demarcated waste disposal site and the contractor cannot dispose waste into productive agricultural sites and should also provide a proper waste management plan" (ADB 2009).
- The sanitary waste generated from site and labor camps should be disposed properly in sanitary drains and septic tanks should be built for toilet wastes.
- Aggregate waste material should be tried to reuse in other facilities.

5.4.5 Siting of Construction Camps and other Facilities

The location for construction camps and other facilities such as workshops, equipment washing yards, construction material storage areas, crushing plants, asphalt plants, batching plants, borrow pits, quarries, haul routes and disposal sites for construction waste is decided by the project proponent i.e. NHA in consultation with their Contractors. However the siting of these facilities

may cause a number of issues such as loss of plantation and vegetation, permanent physical and visual impact on the area, siltation and pollution risks if construction materials are extracted from the River Chenab bed. The impacts of these facilities are predicted to be temporary and moderate negative in nature, which can be mitigated by adopting the following measures:

- The construction camps and workshops should not be located in sensitive areas and shall not be within 500 meters distance from the existing settlements.
- Efforts have to be made to minimize vegetation loss while making site arrangements for construction camps and other facilities.
- Cutting of trees shall be prohibited by contractors and workers near camp sites failing which three new trees will be planted by contractors for each tree cut.
- The crushing plants shall not be located in environmentally sensitive areas or existing settlements.
- "The sites for borrow pits shall be selected on the basis of type of soil strata, depth of water table, ground topography, prevalent vegetation state, etc. and shall not be located within 100 meters from RoW of the proposed Project" (NHA). They shall be prohibited where they might interfere with the existing or designed drainage pattern. The River locations shall be prohibited where there is greater likelihood of damaging the River banks or carrying fine material downstream. The borrow pits should be designed properly with slopes and drainage to avoid accumulation of water which can be a favorable site for mosquito breeding. They should also be regularly monitored. The depth of construction materials such as sand removed from the river bank shall be kept within one tenth of the total width of the River, not interrupting in the river flow or undermining river banks.

- Asphalt hot mix and batching plants shall not be located within 1000 meters of the existing settlements and shall be located sufficiently away from agricultural activities, industrial establishments and sensitive areas including but not limited to educational and health facilities.
- For construction material sources only licensed quarries should be used after taking permit from the regulating authorities.
- The construction material storage areas shall not be located in sensitive areas and proper covered storage space should be built to avoid dust and seepage.
- For transportation of construction materials only designated routes should be used.
- The material should be transported responsibly without any spillage on the way and the trucks should not be overloaded.
- "Landowners shall be compensated according to the terms of the lease agreements negotiated with them for constructing camps and other facilities" (ADB).
- The sites for camps and associate facilities shall be reinstated by the contractors after decommissioning of the proposed Project

5.4.6 Soil Erosion and Contamination

The project area is aligned along fertile agricultural belt. It has very fertile soil which will be completely lost of not preserved properly and will cause soil erosion. Soil erosion occurs when the top soil cover is removed irresponsibly and is failed to re-establish. Due to construction activities soil erosion take place near to borrow pits, road embankments, in workshop and storage areas, due to asphalt and batching plants etc. Soil erosion in return cause a lot of impacts such as it affect road stability, silting of water bodies, flood risk and can also result is loss of productivity of land.

The impacts of soil erosion and contamination would be temporary and negative. The following mitigation measures are proposed to reduce or avoid these impacts.

- "Non-productive barren lands in broken terrain, nullahs and publically recognized waste lands shall be used for borrowing materials" (ADB Guidelines).
- The excavation of earth fill shall be limited to approximate depth of 50 to 100 cm.
- "In case the use of agricultural land is unavoidable the top 30 cm of the plough layer shall be stripped off and stockpiled. Where deep ditching is to be carried out the top 1 meter layer of the ditching area shall be stripped and stockpiled for redressing the land after the required borrow material has been removed. This top soil is the real asset for arable lands" (ADB Guidelines).
- The land which is stripped for construction activities should be re-vegetated as soon as possible.
- The road along the embankment should be vegetated with fast growing plants for stabilization. At necessary places such as bridges and culverts for further stabilization stone pitching or ripraps should be built.
- Drainage structures should also be lined with ripraps to reduce soil erosion.
- Along the roads the gradient of the side slopes should be adjusted to reduce erosion potential and if the slope is steep it should be stabilized by ripraps.
- The construction activities should be concentrated to dry season in order to avoid flood risk, surface run off and soil erosion.
- Checking measures for soil erosion such as the formation of sediment basins etc. shall be taken.

- Bitumen, fuel and stored chemicals can cause soil contamination that can be minimized by siting them on imperious floor or base and the storage area should be secured by an embankment or fence. “The base and walls of the embankment shall be impermeable and of sufficient capacity to contain 110 percent of the total volume of the stored fuels and chemicals” (NHA).
- “The waste asphalt should be disposed at designated and approved borrow pits away from the RoW. Unless located in areas with impervious soils, encapsulation with pre-laid impervious liners, including wall and capping is required with the objective to prevent water percolating through the waste materials and leaching toxic chemicals into the surrounding soils” (ADB). “On completion of disposal at the site, the area shall be capped with a compacted thickness of a at least 0.5 meter of impermeable soil covered with at least 200 mm of top soil and shall be finally landscaped” (NHA).

5.4.7 Noise

Noise is the most pervasive and inevitable environmental problem in urban areas along the road side. Increase in vehicular movement and construction activities will result in noise pollution. The impact of noise pollution is expected to be temporary and moderately negative in nature. Following mitigation measures can be taken to reduce the impacts of noise in the Project area:

- Latest equipment and machinery should be used, in which the noise levels are reduced by in-built muffling devices and damping techniques.
- The excessively noisy work should be limited to normal working hours in the day. It should be avoided before or after the working hours.
- The construction workers should be provided with suitable hearing protections like ear caps and ear muff etc.

- The use of heavy and noise machinery should be avoided during night time.
- The concrete mixing, rock crushing and material shipment yards should be located away from the residential areas, schools and hospitals etc.
- Noise quality monitoring should be carried out regularly as per scheduled in Environmental Monitoring Plan.

Table 5.5.1 Maximum Limits of Noise Levels

Noise Level dB (A)	Situation
194	Lung damage
180	Ear Drum Rupture
150	Absolute limit with ears protected
150	Maximum instantaneous noise
135	Absolute maximum with ears unprotected
100	Prolonged noise causing permanent damage
90	Factory work for an 8-hour day, 5 days a week
85*	Ear protection should be worn
80	Noise on building or construction sites
70	Normal road traffic near residential areas

Source: EPA Punjab

* Above 85 dB(A) ear protection devices should be used.

Table 5.5.2 General Noise Levels of Machinery and Equipment

Sr. No	Equipment	Noise Level in dB(A)
1	Earth Moving Machinery	75 – 85
2	Material Handling Equipment	75
3	Stationary Equipment	75
4	Tools, Hammers and Drivers	80 – 95

Source: The General Services Administration, Construction Noise Specifications, USEPA-1972

Table 5.5.3 Construction Equipment Noise Levels

Sr. No	Equipment	Observation Point to Source (M)	Noise dB (A)
1	Wheeled loading	5	90
2	Grader	5	90
3	Vibration pavement roller	5	86
4	2-wheel vibration pavement roller	5	81
5	3-wheel pavement roller	5	81
6	Tire pavement roller	5	76
7	Bulldozer	5	86
8	Wheeled pneumatic dredger	5	84
9	Sprayer	5	87
10	Power Generator	5	98
11	Impact Drill	5	87
12	Impact pile driver	5	112
13	Truck	5	92
14	Concrete Mixer	5	91
15	Concrete Pump	5	85
16	Mobile lift	5	96
17	Pneumatic hammer and rock crusher	5	98
18	Breaker	5	84
19	Pneumatic spanner	5	95

Source: Environmental Assessment Report (1997)

5.4.8 Surface and Ground Water

The surface water contamination is usually caused due to improper disposal of construction waste that is generated from construction activities in the project area. The impacts of this contamination can be widespread, affecting not only the aquatic life but also risking the health of local inhabitants and their domestic cattle that use this water for fulfilling their everyday needs.

This contaminated water, if used for irrigation can also have a huge impact on natural and cultivated vegetation. The impact on these water bodies will be only for the period of construction and will vanish as the construction work is over. Apart of contamination caused by direct disposal of construction waste in water bodies, it can also be caused if the waste is left unattended. It can result in forming up of leachate which seeps in to the ground through the soil and reaches underground water table. Thus leaving deep soil layers and ground water contaminated.

This impact can be permanent and severe negative in nature. Following are the mitigating measures:

- The surface and groundwater reserves have to be adequately protected from any source of contamination such as the construction and oily waste that will degrade its potable quality.
- The proponent should ensure that the construction work is confined within the RoW and water bodies are prevented from pollution during construction.
- All the construction waste should be disposed of in selected landfill sites with proper lining to avoid leachate formation.
- Water quality should be monitored regularly according to a definite sampling schedule to sustain water quality for domestic requirements.
- The contractor should be obligated to make sure that construction waste and debris do not reach water channels like canals and river.
- The water channels should be monitored regularly to check for any blockage or clogging caused by the deposition of waste.
- Embankments should be built for irrigation canals.
- Along with the construction of road, proper drainage structures should also be built to regulate drainage and to maintain the flow of surface water.

- Proper workshops should be built for washing of machinery and vehicles. The waste water from washing should be collected in sedimentation pond.
- In the monsoon season or rainy weather construction work should be minimized especially near the water bodies.
- Even waste water from construction camps and sites should not reach any water channel.

5.4.9 Flora and Fauna

It has been estimated that a total of 18000 trees will have to be felled from agricultural fields in the Project Area. This loss will be more than compensated by planting strips on both sides of the motorway which, on an average, is estimated to about 25 meters wide. After project is fenced, the natural vegetation should be able to establish itself. "The indigenous trees most suited to the tract like Shisham, Kikar, Bakain, Dharek, Siris (Albizzia Procera), Farash, Sukh-Chain, Jaman Bohar, Peepal (Ficus reliogosa), Gullahr (Ficus glomerate) Sohanjana (Moringa oleifera), Karir and Wan (Salvadora Oleoides) should be planted" (Wildlife Department). These trees shall be helpful in providing shade, ground cover, aquifer recharge and habitat (including shelter and food) for the wildlife. Following mitigations can be adopted:

- The compact plantations will be effective screens against night glare, dust, noise and pollutant emissions.
- For the aesthetic beauty of the motorway flowering and fruiting shrubs should be vegetated along the motorway.
- The entire plantation should be done keeping in consideration the principles of landscape designing.

- At few sections of motorway raised median will be planted with grasses and shrubs which cannot attain height more than two meter. This planting could provide any effective protection against night glare besides beautifying the area.
- All old and mature trees falling in the 25 meter wide proposed planting strips will be saved. Effort will be made to save as many trees as possible even if they are young or poll stage. Proper irrigation and maintenance of plants will be ensured.
- An awareness campaign targeted on the neighborhood farmers shall be run to popularize the planting of trees
- Instead of use of industrial pesticides and fertilizers, to minimize that organic farming should be encouraged.

Black and Grey Partridges are the only hunt-able species that might occur in the Project Area. Their hunting is allowed as per legislation during the hunting season to a fixed bag limit in open area on Sundays and holidays. Any hunting outside of this is liable to be checked by the Wildlife Department staff. However such hunting shall hardly impact the wildlife populations in the area.

No rare or endangered aquatic faunal or floral species occur in the area. The Provincial Fisheries Department auctions fishing rights in the rivers and canals. The water reservoirs like Sidhnai are stocked with carp fingerlings. The canals are not stocked but the fish stock from the rivers escapes to canals. Fishing is not allowed without a permit and any illegal catch is liable to be punished. Reports about illegal fishing in these areas are almost non-existent. Occasional cases may be reported which may not have any significant impact on the biodiversity of the wetlands.

The Project will pose minor negative impact on the fauna present in the area. There is no presence of any game reserve or wildlife sanctuary along the proposed alignment, therefore no negative impact will happen. However following mitigation measures will be taken:

- Illegal animal and fish hunting will not be allowed and punishment will be enforced in case of violation.
- The Wildlife department should get involved to keep a check that no illegal hunting is done.
- Advance and efficient machinery should be employed for construction work in order to keep a check on noise pollution that affects fauna negatively.
- In order to avoid disturbance loud and noisy construction activities should not be carried out at night or early morning.
- The contractor should be obligated to ensure that no local birds or animals are hunted or trapped during construction phase of the projects.
- There should be a barrier around borrow

5.4.10 Social and Cultural Problems

Due to construction of the proposed Project and exit / entry problems, the movement of residents to carry out their everyday activities – access to their fields, schools, hospitals, masjids/shrines etc will be disturbed. However the major issue in this project is land acquisition which will take place in the project affected areas. This will result in loss of agricultural land, infrastructure (farm houses, tube wells, poultry farms), livelihood, loss of fertile plough layer (top soil) at camp sites and associated facilities (workshops, asphalt plants etc.).

"National Environmental Policy of the Government of Pakistan emphasizes the achievement of environmental sustainability and poverty reduction to enhance the economic growth" (Govt. of Pakistan, 2001). This can be achieved by involving the local inhabitants in the project activities. Local labor should be employed in construction activities that can help them develop various skill and capabilities, so that even after the project is completed they can utilize these skills elsewhere in the future.

Due to this project the land prices are expected to increase especially near interchanges and service areas. Hence compensations should be made considering this factor. It can be a positive impact for affluent landowners. After the construction is completed, there will be several business opportunities for locals to open shops and hotels nearby. This can aid in developing the economic profile of the area. It is expected to be a minor positive impact.

During the construction phase of the project there will be a lot of in-migrant workers and professionals that can contribute in changing the lifestyle of the locals because of their contact with those in-migrants. This impact is predicted to be minor positive and negative.

"Regarding the resettlement issue, it is required that these settlements should be relocated and handled in such a way that those affectees might not be turned into poor or vulnerable groups" (LARP - ADB).

People will face minor exit / entry problems during construction activities. Only one big Masjid falls in the RoW and that is Jamia Masjid situated in Tehsil Shorkot. The impact of construction on entry/exit problem is of minor nature as there is no major shrine located in the immediate vicinity of RoW.

The impact is temporary and minor negative in nature. Mitigation measures will include:

- “Timely completion of the construction and provision of alternative routes during the construction” (ADB).
- Providing alternative ways in order for the local people to perform their routine tasks.
- Timely and adequate compensation package to the Project Affected Persons (PAPs).
- Adding appropriate clauses in the construction contracts to avoid any law and order situation.
- Timely and full public consultation and announcement of mobilizing equipment
- Establishment of formal links with affected communities.
- Plan for social grievance redress mechanisms,
- Seek assistance and cooperation from local NGOs.
- Familiarize outside labourers on local etiquettes.
- Local Labour shall be employed with an agreed ratio (>75%) for construction works.
- An agreed minimum unskilled labour employment for women and equal remuneration as men, agreed at an early stage
- The drinking water requirements shall be met preferably by resorting to other sources rather than using community resources.

5.4.11 Traffic Management

During the construction phase of the project traffic management can be a serious problem in the project area. The problems can be due to hindrance in commuting routes of the locals. These problems can lead to traffic congestion and hazards to pedestrians and cyclists. The construction vehicles carrying materials can also cause inconvenience to the local commuters.

These impacts are expected to be temporary and moderately negative. They can be mitigated by provided proper alternate routes to the traffic. These alternate routes should be clearly marked and the traffic should be guided by signs and boardings.

5.4.12 Utilities

Various utilities such as electrical poles, transmission lines, telephone lines and wells are situated within the Row of the proposed Motorway. These utilities will be relocated before the start of construction activities. These utilities if not handled properly will cause difficulties to the people of Project and Area. To handle this problem following mitigation measures should be taken.

- "Close coordination with the concerned departments to curtail inconvenience to the residents of the Project Area" (ADB).
- Strengthening of utilities, wherever required.

5.5 Operational Phase

5.5.1 Noise

Due to increase in traffic volume, noise is expected to increase. As presently Project Area is free from noise pollution. Therefore this impact is permanent and major negative in nature. "To mitigate this issue, adequate noise barriers such as indigenous tree species has to be planted along the fence to reduce the noise pollution. Further improvement can be made with the help of National Highway and Motorway Police (NH&MP) by enforcing the laws and getting the vehicles tested regularly after a specific time period, by some vehicle testing authority and obtaining a clearance certificate" (NHA). Noise monitoring should also be carried out regularly as per Environmental Monitoring Plan.

5.5.2 Deterioration of Vehicles

The Motorway, due to being a smooth road source will result in less wear and tear of vehicles, it will also result in less fuel consumption. The impact is permanent and major positive in nature.

5.5.3 Soil Erosion and Contamination

During the operational phase soil erosion may take place at different road structures (bridges, embankments, culverts, etc.), which may increase the flood risk by rapid flash of storm-water runoff and also undermine these structures. Soil contamination can take place on border area by road run off containing heavy metals (e.g. lead). If these areas are used for growing vegetables for human consumption, it can have adverse impacts on human health. The research has shown that the increase in heavy metals is generally limited to a narrow border along the edge of the road contamination rapidly fall away with distance from the hard shoulder. The following mitigation measure are proposed to reduce the impacts on soil

- In case soil erosion takes place proper remedial measures will be undertaken to stop future impacts on soils and the associated impacts caused by soil erosion.
- Vegetation and cultivation for human use should be banned within the proposed RoW.

5.5.4 Road Safety

The increased vehicular movement and speed can result in road safety issues, like traffic accidents. The accidents may also be due to tiredness. The impact on road safety would be permanent and moderate negative. These should be mitigated by enforcing speed limits and imposing penalties on the traffic violators. Rest areas will be provided for those in need of rest during travel. Traffic signs will be provided to facilitate road users about speed, rest areas, eating establishments, etc. All the lanes, median, sharp bends will be reflectorized to facilitate the

travellers during night time. Proper lighting arrangement on the proposed Motorway will be done at required places.

5.5.5 Landscaping

The settlements in the immediate vicinity of the proposed Motorway will be directly affected due to the Project, which would be minor negative impact and can be mitigated by the plantation along the proposed corridor. It would also serve as physical barrier between the road and the existing settlements as well as future developments.

5.5.6 Land Use

The Project may induce land use change in the form of development of commercial establishments (restaurants, petrol and gas filling stations), educational institutes, etc. The changes in land use may affect the land value, which will vary depending upon he location. The impacts on land use would be permanent and both moderate negative especially for those whose land values have not increased and medium beneficial for businessmen and those having escalated land values (especially near the interchanges). However, all the facilities with the exception of restaurants and petrol/gas filling stations likely to pop up in the future will be prohibited within the RoW. Permission has to be sought from the concerned authority for the development of any establishment along the proposed Project corridor.

5.5.7 Air Quality

The existing status of the project area is that there are agricultural fields due to this there is no or minor air pollution in the Project Area. Therefore this impact is permanent but negative.

Mitigation measures include:

- "Setting up of system to monitor air quality along the Project Area in accordance with acceptable international standards" (ADB).
- Monitoring emissions of vehicles as per NEQS.
- Trees should be planted along the fence of the Motorway that acts as noise barrier. For suitable plantation, Forest Department has to be consulted. This plantation will also help to improve the air quality.

5.5.8 Time Saving

Due to increase in speed and access control, the travelling time to reach to the destination on motorway will decrease significantly. Trade in the project region will improve due to better transport opportunities. This impact is expected to be permanent and major positive in nature.

5.5.9 Socio-economic Conditions

The operation of the proposed Motorway would lead to opening up markets to rural economic activities by reducing the production and transportation cost thereby stimulating agricultural production. The Project is expected to promote better business opportunities such as new petrol pumps and hotels. This impact is permanent and major positive in nature.

This would be a high beneficial impact but at the same time, it would be major negative for those who cannot access the Motorway except from interchanges. To overcome the problem, interchanges at the existing important routes will be provided in the design.

5.5.10 Water Quality

a) Surface Water

The surface water bodies may get flooded and polluted due to uncontrolled release of contaminated storm-water/road runoff from road surfaces. The pollutants associated with

the road-runoff include: (a) Hydrocarbons such as fuel and polycyclic aromatic hydrocarbons from wear and tear of the road surface, tyres, lubricants, leaking from vehicles and from unburnt fuels (b) Heavy metals including cadmium, copper, zinc, iron, derived from unburnt fuels, corrosive products from vehicles wear and tear of tyres and road surfacing. Some heavy metals are largely soluble (copper for example) and insoluble (zinc for example), and (c) Suspended solids including insoluble heavy metals as colloidal materials. The worst contamination generally takes place during the first flush of runoff from roads after a spell of dry weather. The level of pollution is directly related to the traffic volume.

The pollution risk from accidental spillage may increase moderately in the long run. The increased traffic volume and faster traffic speeds would increase the risk of accidental spillage, which could have medium adverse impact on surface water quality. The natural drainage of road runoff across embankments or discharge of runoff into water bodies from large area of carriageway may have medium adverse impacts and the flood risk to downstream locations. The following mitigation measures are proposed to attenuate surface water quality related impacts.

- In order to discharge rapid removal of storm water / road runoff, cross slopes and longitudinal drainage has to be provided in the design. Well designed cross drainage structures limit ponding across embankments.
- Retention basins with reedbeds provided in the design will improve the quality of polluted storm water / road runoff.
- Cleaning of drainage structures will be carried out in case they are blocked by debris etc.

- The water quality monitoring should also be carried out at defined intervals and for environmental quality monitoring parameter and planned in the Environmental Monitoring plan. If the parameters are above the prescribed limits, suitable control measures can be taken.

b) Ground Water

Groundwater may get polluted due to contaminated road runoff on earthen shoulders and embankments planted with grasses. Groundwater quality monitoring should be scheduled in the Environmental Monitoring Plan.

6 ENVIRONEMTAL MANAGEMENT AND MONITORING PLAN

6.1 Environmental Management Plan

Environmental management plan (EMP) is the most important step in the EIA process. It involves the management of the proponents and consultants to ensure application of mitigation measures during different stages of the project. The EMP is designed for the three different stages of the project:

1. Pre-construction or design phase
2. Construction phase
3. Operation phase

6.1.1 Objectives of EMP

The Environmental Management Plan is developed with following objectives:

- Defining the responsibilities of the Project proponent during the three phases of the project, that are design, construction and operation phase.
- Facilitation of the implementation of mitigation measures and to propose and implementation schedule for the measures.
- An important objective of EMP is to indentify monitoring criteria and to ensure that all mitigation measures that are proposed are implemented effectively and completely.

6.1.2 Key Environmental and Social Components

The key environmental and social issues related to this project are as follows:

1. Resettling commercial structures owned by squatters which fall in the project corridor.
2. “Locating temporary construction camps, asphalt plants and waste disposal sites appropriately and mitigating the environmental impacts of these facilities” (ADB).
3. Enhancing and maintaining tree plantation to compensate for loss of vegetation along the entire length of project.
4. Considerations for topsoil erosion during construction.
5. “Ensuring pedestrian and traffic safety during construction and operation phase” (ADB).
6. Minimizing the impact on cultural sites and community owned assets during construction and operation.

6.1.3 Role of Officials in Implementing Environmental Management Plan

a. Project Director

At NHA the Project Director is responsible for the timely completion and effective implementation of the project and for looking over the development and implementation of EMP.

b. Environmental Consultants

Environmental consultants are hired by project proponent for preparation of EMP in compliance with the guidelines of EPA and ADB.

c. Design Consultants

All the mitigations measure proposed and committed for the design phase should be incorporated in the design of the project by the design consultants.

d. Supervision Consultants

Supervision consultants in this project will be appointed by the GM of NHA and ADB. Their job is to supervise the project contractors to ensure quality of work and fulfillment of contractual obligations. "They have among them Environmental specialist/Monitoring Consultant (MC) who ensure that all the environmental and social parameters comply with applicable standards and effective implementation of EMP" (NHA).

e. Construction Contractors

EMP is made part of the contract agreement and the contractor has to execute the Project in compliance with the EMP.

Other than this there are other governmental agencies that have responsibility regarding implementation and supervision of implementing mitigation measures during different stages concerning their departments like EPA Punjab, National Highway & Motorway Police (NH&MP), Forest and Wildlife Department etc.

6.1.4 Design/Pre-construction Phase

Table 6.6.1 Environmental Management Plan for Design/Pre-construction Phase

Aspect	Project Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
1. Topography	- Change in topography due to construction related structures such as bridges, embankment etc. - Visual changes to topography	Provision for plantation in design.	Design Consultants (DC)	NHA

2. Soil Erosion	- Road stability, increased flood risk (by more rapid and higher levels of runoff), silting up of water bodies. - In worst cases reduction in economic productivity of land and biodiversity in the project area.	Plantation and stone pitching or rip-rap on embankments and around bridges etc.	DC	NHA
3. Land Acquisition and Resettlement	- Loss of 4794 acres of agriculture land. - Resettlement of Affected People (AF)	- Careful alignment and route selection by designer to minimize resettlement - Developing compensation packages for affectees. - Giving compensation amount before shifting.	DC	NHA
4. Flora	Cutting of 18000 trees of different species.	- Sapling of trees to be planted on both sides of the road along the length. - Regular monitoring of plantation. - Indigenous tree lost to be replanted. - Any rare species if present in RoW to be uprooted and transplanted elsewhere under suitable conditions. - Efforts to be made to save old and mature plants.	DC, NHA	NHA, Forest Departme nt
5. Change in Hydrologic Regime	Minor Impacts	- Provision of culverts to control flood damages and ensure safety of embankments.	DC	NHA

		- Construction of sufficient size of drains to take estimated flow even for future needs.		
6. Water logging and salinity	Minor Impact	Drainage culverts in water logged areas.	DC	NHA
7. Restricted access	Blockade of access across the motorway because of being fenced.	Construction of flyover and underpasses at the existing roads and passages.	DC	NHA
8. Public utilities	Inconvenience caused by disruption of public utilities.	- Relocation of existing utility infrastructure wherever required and ahead of time before construction start.		
9. Noise	Disturbance to neighboring communities	Excessive tree plantation.	DC	NHA

6.1.5 Construction Phase

Table 6.6.2 Environmental Management Plan for Construction Phase.

Aspect	**Project Impact**	**Mitigation Measure**	**Responsibility**	
			Implementation	**Supervision**
1. Topography	Cutting and Dismantling of existing landscape and infrastructure.	Proper landscaping.	Construction Contractors (CC)	Supervision Consultants (SC)
2. Air Quality	Air quality will be affected by fugitive dust emissions from	- Sprinkling of water to settle dust.	CC	SC. EPD Punjab

	construction machinery, asphalt plant, vehicular movement. Emissions may be carried long distances due to wind.	- Emission control by using filter or wet scrubbers to also reduce level of dust - Enforcing NEQS applicable to gaseous emissions.		
3. Construction waste disposal	Unhygienic conditions, health risk to workers.	- Waste water effluent to be passed gravel/ sand beds to remove oil/grease contaminants before discharging into natural streams. - Ensuring safe storage and handling of oils and chemicals by workers to avoid spillage. - Treat solid waste and dispose it properly at designated sites. - Ensure reuse and recycling of waste wherever possible.	CC	SC, EPA Punjab
4. Construction camps and other facilities.	Loss of plantation and social disturbance for the nearby communities.	- Construction camps and workshops not to be located in sensitive areas and should be atleast at a distance of 500 meters from existing settlements. - Try to minimize or compensate for the vegetation loss. - The crushing plants and asphalt plants should not be located in the sensitive areas or near existing settlements.	CC	NHA & SC

		- The construction material to be taken from the approved and existing quarries and no new quarries to be dug. - Proper storage of construction material to be ensured to avoid losses and damage to the environment.		
5. Soil Erosion and Contamination	Increase flood risk, silting up of water bodies, loss in productivity and biodiversity.	- Non-productive, barren land, publicly recognized waste lands to be used for borrowing materials. - The evacuation of earth fill should be limited to 50 to 100 cm. - Drainage ditches around the borrow pits to prevent run off. - Use of rip-raps to avoid soil erosion. - Soil contamination by bitumen, fuel etc minimize by disposing them in secure pit with impermeable base and embankment.	CC	SC
6. Noise	Physiological and psychological impacts.	- Employ equipments with in-built damping techniques and with muffling devices. - Confining excessive noisy work to regular working hours. - Providing workers with suitable hearing protection.	CC	SC, EPA Punjab

		- Noise quality monitoring to be carried out regularly.		
7. Suface and ground water	- Surface water can get contaminated by construction waste. - Unattented construction waster can form leachate and percolate in the soil.	- The surface and ground water to be adequately protected from any source of direct contamination. - Solid waste to be disposed off in properly designed landfills. - Regular waste quality monitoring. - No construction debris should reach irrigation canals or any water bodies. - Excessive construction activities to be avoided along water bodies and in rainy season.	CC	SC, EPA Punjab
8. Flora and Fauna	- Loss of 4794 acres of agriculture land. - Cutting of almost 18,000 trees. - Hunting and fishing.	- Flowering and fruiting shrubs to be planted along the road. - All old and mature trees should be preserved as it is. - Illegal animal hunting and fishing should not be allowed and penalties to be enforced in case of violation.	NHA	SC, Forest and Wildlife Departme nt

		- Reforestation and afforestation to be employed.		
9. Social and cultural problems	- Restricted access of motorway. - Livelihood problems due to loss of agriculture land. - Law and Order issues due to interaction of workers and locals.	- Providing alternate ways for locals to perform their routine tasks. - Formulation of clauses in construction contracts to avoid any law and order situation. - Local labour should be employed. - In time compensation for resettlement.	CC, NHA	SC
10. Traffic Management	Inconvenience in traffic and commuting routes due to construction.	Proposing and publicizing a proper alternative traffic management plan.	CC, NHA, Local Traffic Police Department	SC
11. Utilities	Relocation of various utilities that fall in RoW such as electrical pole, telephone lines etc.	- Relocation of utilities before constructions starts. - Strengthening the provision of utilities wherever requires.	NHA, Local Departments	SC

6.1.6 Operation Phase

Table 6.6.3 Environmental Management Plan for Operation Phase .

Aspect	**Project Impact**	**Mitigation Measure**	**Responsibility**	
			Implementation	**Supervision**

1. Noise	Physiological and psycological	Tree plantation and enforcing laws for noise pollution	NHA	NHA & NH&MP
2. Soil Erosion and Contamination	- Flood risk by rapid run-off undermining the building structures such as bridges, flyover etc. - Soil contamination due to waste water from service area etc.	- Excessive vegetation. - Continuous monitoring of building structures. - Service areas equipped with septic tanks and waste disposal at specific sites.3	NHA	NHA & NH&MP
3. Road safety	Road safety issues like accidents.	- Enforcing speed limits and imposing penalties on the violation of rules. - Rest and service areas to provide rest during the drive. - Traffic signs for awareness and education of the users. - Use of reflectors at medians, sharp turns to aid users at night. - Use of warning signs.	NH&MP	NHA
4. Landscaping	Solid waste along the motorway.	- Enforcement for making motorway no litter zone. - Safe disposal of waste from toll plazas, service and rest areas.	NHA	
5. Air quality	Change in air quality of the passage of time.	- Regular monitoring of air along the project area to meet and maintain international air quality standards. - Tree plantation to purify and circulate air.	NHA	EPA Punjab
6. Socioeconomic conditions.	- Inaccessibility except from interchanges.	- Providing interchanges at appropriate locations.	NHA	

	- Access to rural markets and changes in communication patterns.	- Keeping intact the old roads and passages along or across the motorway.		
7. Time Saving	Reduce travel time			
8. Deterioration of Vehicles	Less wear and tear due to improved road conditions.			

6.2 Environmental Monitoring

Environmental monitoring plan identifies and monitors the actual impacts the project is having on environment. Following are the objectives of environmental monitoring:

- Monitoring the actual impacts of the work on physical, biological and socio-economic parameters within the project corridor.
- Recommend mitigation measures for any unexpected impact or where the impact level exceeds the expected values.
- It should be ensured that the excess construction material is safely disposed.
- Evaluate the effectiveness of proposed mitigation measures.
- Evaluation of long term impacts on the environment due to the project.

6.2.1 Monitoring Parameters

6.2.1.1 Environmental Monitoring Parameters

Following are the environmental parameters that need to be monitored in accordance with NEQS and WHO standards:

- Ambient air quality (NO_X, SO_X, PM_{10}, Hydrocarbons, Smoke)
- Water Quality

Groundwater Quality (Total Coliforms, Fecal E. Coli., Total Colonial Count, Fecal Enterococci, pH, TDS, Total Hardness, Nitrate, Chloride, Sodium)

Wastewater Quality (pH, S, Alkalinity, BOD, COD, Turbidity)

- Noise Levels

6.2.1.2 Social Monitoring Parameters

Following baseline indicators and criteria should be considered while carrying out social monitoring (SIA by ADB):

- "Number of Project Affected People (PAPs) to be resettled, relocated, provided livelihood assistance and the availability and adequacy of alternative resettlement sites for PAPs.
- Inventory and valuation of PAPs assets. Number of vulnerable PAPs and their compensation. Verification of shifting assistance provided to displaced squatters. PAPs perspective on compensation procedures and proposed alternative resettlement sites.
- Number of public facilities and utilities to be relocated and the number of cultural and community owned assets to be relocated and verification of relocation".

7 CONCLUSION AND RECOMMENDATIONS

Faisalabad-Khanewal motorway can provide many social and economic opportunities if planned to meet the needs and desires of not only local and international trade but also the need of local inhabitants of the area. Having said that the environmental consequences of any project need

to be considered in the decision making process. Thus the aim of EIA is to influence decision-making by identifying environmental impacts of the developmental projects and determining the ways to prevent or reduce those impacts.

The major environmental impacts of the project can be concluded to be:

- Loss of a total 4,715 acres of agricultural land.
- About 18,300 trees to be removed from the RoW and additional 12,900 fruit trees to be uprooted.
- Total number of 207 houses (including kacha, semi-pacca and pacca) to be demolished.
- Displacement and resettlement of people.
- Different utilities such as transmission lines and poles, telephone lines and sui gas will be disrupted.
- Controlled access of motorway and problems in commuting.
- Loss of other infrastructure like tube wells, farm houses etc.

The mitigation proposed for the aforementioned impacts are:

- Judicious compensation packages for the affectees.
- Cash compensation for the people from whom the land has been acquired.
- All affected utilities to be relocated prior to their disruption.
- Reconstruction of public infrastructure like tube wells etc.
- Plantation along the road and preservation of old and indigenous plants.
- Existing roads and passages to be saved.

The following table gives an overview and basic comparison of the impacts the project will have on various aspects of environment during construction phase and operation phase.

Aspect	**Impacts**	
	During Construction	**During Operation**
Flora	- Strong negative - Removal of agricultural land and natural vegetation - Due to construction activities	- If EMP implemented effectively positive impact.
Borrow/Open Pits	- Strong negative - Soil and water contamination - Hygiene issues.	- Borrow pits are abandoned and filled after construction phase.
Air Quality	- Strong negative - Dust and hydrocarbon emissions due to construction activities and working of heavy machinery and asphalt plants.	- Neutral to no negative impact - Checks for vehicles that commute on the motorway. - Replantation and paved, carpeted roads.
Noise Pollution	- Strong negative impact - Due to construction activities and running of heavy machinery.	- Neutral impact - Checks for vehicles and smooth and fast transportation - Plants act as a sound barrier
Soil Erosion and Contamination	- Strong negative - Due to construction activities and loss of vegetation	- Moderately negative - Lesser infiltration and soil erosion due to run off. - Contamination due to waste from service areas.

Surface and Ground Water	- Strong negative impact. - Excessive soil and waste run off to the water bodies and their blockage due to construction activities - Percolation of unattended waste water	- Contamination and issue of management of waste water from service areas.
Public Utilities	- Damage or relocation of infrastructure for public utilities	- Positive impact - Better and improved infrastructure.
Social Concerns	- Land acquisition issues. - Loss of livelihood due to loss of agricultural land - Disruption in everyday activities and commuting	- Inaccessibility except from interchanges. - Access to rural markets and changes in communication patterns. - Time saving

7.1 Benefits and Objectives of the Project

At the end the benefits of the project are weighed with respect to the environmental implications and their mitigation should be incorporated during the design, construction and operation of the project. The primary objectives of the projects are as follows:

- Enhance and develop trade activities in the region.
- To provide future trade linkages with Central Asian countries and to promote trade with China.
- Provide safe, high speed and time saving corridor to the travelers.

7.2 Gaps in EIA Process

Although the legislation for EIA and its execution is there in our country for a long time but there are still a lot of flaws and gaps in it. EIA for this project is relatively very thorough because of guidelines implemented by ADB but it still has a lot of gaps. Following are some of the flaws observed in the official EIA process for this project and in general:

- Lack of sufficient and reliable baseline data.
- Lack of involvement of locals during public participation and along the project.
- Very few local people employed in the project.
- Misrecognition of the vulnerable group.
- Lack of awareness regarding the project impacts and environmental consequences.
- Compensation mainly only for land owners but tenants and the people who lost their jobs were neglected.
- Social issues like increase in crime and unemployment are not considered in EIA.
- The main focus is on direct and short-term issues.

7.3 Implementation of Proposed Mitigations

From field visits the effectiveness of implementation of mitigation measures was observed which is accounted in the following table:

Table 7.1 Implementation of Proposed Mitigation

Aspect	**Proposed Mitigation**	**Implementation (Findings)**
Flora	Compensatory plantation.	No
	Reserved avenue along the highway for plantation.	Yes

	Promote organic farming to minimize use of pesticides and fertilizers.	No
	Awareness among people regarding preservation of flora.	No
Borrow/Open Pits	At least a kilometer away from resettlements.	Yes
	Regular monitoring for soil erosion.	No
	Check on accumulation of water.	Yes
Air Quality	Regular sprinkling of water.	Yes
	Use of plastic covers while transportation of construction material.	No
	Scrubbers for asphalt plants.	No
	Asphalt plant, site camps and quarries located at least a kilometer away from resettlement.	Yes
	Use of dust masks by workers.	Occasionally
	Regular monitoring of air quality standards.	Yes
Noise Pollution	Use of advance and efficient machinery.	Yes
	Machinery with in-built muffling device.	No
	Use of machinery limited to day.	Yes
Soil Erosion and Contamination	Provision of riprap.	Yes
	Non productive, barren land used for borrowing and construction camps.	No
	Proper storage of oils and chemicals on an impermeable surface.	Yes
	Proper designated sites for waste disposal.	Yes
Surface and Ground Water	Bridges over canals for unobstructed flow of water.	Yes
	Drains and culverts to regulate flow of water.	Yes
	Water channels to be monitored for blockage.	Yes
	Proper storage of oils and chemicals on an impermeable surface.	Yes
	Construction work to be limited in monsoon.	Yes

	Proper designated sites for waste disposal.	Yes
Public Utilities	Improvement and relocation of infrastructure for public utilities before construction started.	No (It was relocated during construction)
Land Acquisition, Resettlement and Commuting Issues	Compensation plan according to ADB's guidelines.	Yes
	Full compensation provided before construction started.	No (It was provided in installments and during construction)
	Cattle creeps and underpasses for existing roads and passageways.	Yes
	Timely completion of project.	No
Social Concerns	Employment of locals in construction activities.	No
	Awareness among people regarding the impacts of the project and their participation in mitigation.	No
	Timely completion of project.	No
	Access to locals to share their issues and concerns regarding project.	No

7.4 Recommendations

Following are some recommendations for EIA of this project and in general:

- Setting up clear planning process.
- Developing and preserving the baseline data for future reference.
- Indentifying and proposing mitigation measures for long-term and indirect environmental issues.
- Applying a systematic assessment to clarify socioeconomic and environmental benefits, problems, risks, and tradeoffs,

- Involving locals and communicating them during developing and implementing an EIA.

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9 APPENDIX

Figure 9.1 Existing Inter-City Highways. Sargodha road (Above) Faisalabad-Jhang road (Below)

Figure 9.2 Agricultural Fields along the Project Area

Figure 9.3 Construction Camp near Gojra

Figure 9.4 Heavy Machinery used During Construction

Figure 9.5 Small Settlements along the Project Area

Figure 9.6 During Interaction with people.