5 - 2 PRE-FEASIBILITY STUDY ON COAL TRANSPORTATION BETWEEN QASIM AND LAKHRA BY RAILWAY

PREPARATORY SURVEY
ON
LAKHRA COAL FIRED THERMAL POWER PLANT CONSTRUCTION PROJECT
IN
PAKISTAN

PRE-FEASIBLITY STUDY
ON
COAL TRANSPORTATION BETWEEN QASIM AND LAKHRA BY RAILWAY

FINAL REPORT

October 2016

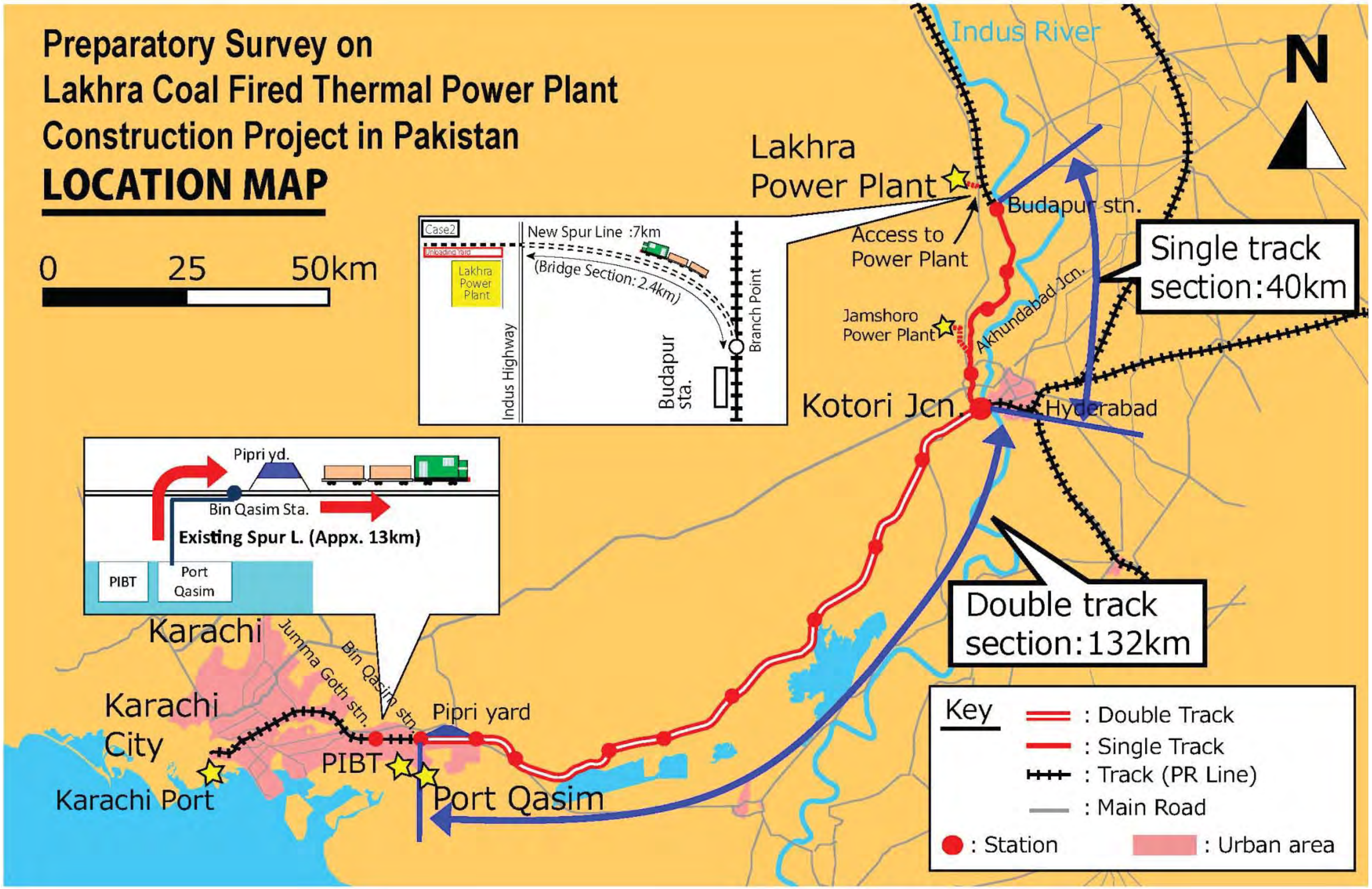
Japan International Cooperation Agency (JICA)

NIPPON KOEI CO., LTD.

Exchange Rate (July 2016)

1 US Dollar (USD) = 105.5 Yen (JPY)
1 US Dollar (USD) = 104.8 Pakistan Rupee (PKR)
1 Pakistan Rupee (PKR) = 1.01 Yen (JPY)

PROJECT LOCATION MAP



Preparatory Survey
on
Lakhra Coal-Fired Thermal Power Plant Construction Project in Pakistan
Pre-feasibility Study on Coal Transportation between Qasim and Lakhra by Railway

FINAL REPORT

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ABBREBIATIONS

Abbreviation	Official Term
AC	Alternating Current
ADB	Asian Development Bank
AEN	Assistant Executive Engineer
AWI	Assistant Way Inspector
CTC	Centralized Traffic Control
DCF	Discounted Cash Flow
DE	Diesel Electric
DEN	Divisional Engineer
DN	Down
EP	End Point
FIRR	Financial Internal Rate of Return
FOTCO	Fauji Oil Terminal & Distribution Co., Ltd.
FS	Feasibility Study
GENCO	Generation Company
GM	General Manager
GNI	Gross National Income
GTKM	Gross Tonne-Km
HP	Horse Power
HQ	Headquarters
Hz	Hertz
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
JPGP	Jamshoro Power Generation Project
KCR	Karachi Circular Railway
LCPP	Lakhra Coal Fired Thermal Power Plant
M&S	Manufacturing and Service
MHz	Mega Hertz
Mtpa	Million ton per annum
MTT	Multiple Tie Tamper
Mw	Megawatt
NLC	National Logistic Cell
NPV	Net Present Value
O&M	Operation and Maintenance
ODA	Official Development Assistance
PC-1	Planning Commission-1
PIBT	Pakistan International Bulk Terminal Limited
PIL	Pakistan Intermodal Limited
PLC	Paper Line Clear
PR	Pakistan Railways
PSC	Pre Stressed Concrete
PWG	Permanent Way Gangmate
PWI	Permanent Way Inspector
RBOD	Right Bank Outfall Drain
RC	Reinforced Concrete

Abbreviation	Official Term
RCC	Reinforced Cement Concrete
RCD	Rotary Car Dumper
ROE	Return on Equity
ROW	Right of Way
Rs.	Pakistan Rupee
RSJ	Rolled Steel Joint
SEPCO	SEPCO Electric Power Consultation Cooperation
UHF	Ultra High Frequency
UIC	Union International Chimin de Fer
UP	Up
USD	United States Dollar
VHF	Very High Frequency

Executive Summary

Executive Summary

1. Introduction

Due to the rapid growth of the economy of Pakistan, demand for electricity is increasing sharply in the past ten years, and there is a big gap between demands and supply of electricity due to shortage of fuel supply. In order to ease such situation, the Japan International Cooperation Agency (JICA) has carried out the Preparatory Survey on Lakhra Coal-Fired Thermal Power Plant Construction Project in Pakistan in September 2013. As part of the study results, another coal-fired thermal power plants, such as along the Indus River and near Karachi Bay, were studied. Lakhra Coal-Fired Thermal Power Plant is one of those plants.

The scope of this project is to study the feasibility of coal transportation by railway between Port Qasim or the Pakistan International Bulk Terminal Limited (PIBT) and the planned power plant in Lakhra. The study consists of the following components:

- Collection of basic data;
- Demand forecast of coal, other freight, and passenger transportation at the project area;
- Transportation plan;
- Operation plan;
- Stations, structures, and track;
- Signal and telecommunication facilities;
- Rolling stock;
- Organization of the project implementation;
- Organization of the coal train operation; and
- Recommendation.

2. Existing Railway Facilities

It was found that the track structure of the section between Karachi City Station and Kotri Junction is a double track with design axle load of 23.3 tons; and that of the section between Kotri Junction and Budapur Station is a single track with design axle load of 17.27 tons.

The condition of the existing track structure between Karachi City and Budapur stations is generally good and no special rehabilitation work will be required. The line capacity of the same section has enough room for planned coal trains.

3. Demand Forecast

Five coal-fired power plant projects for which coal is planned to be transported by rail are ongoing. Two projects are in Sindh Province, namely, Jamshoro and Lakhra power plants, and three projects are in Punjab Province, namely, Rahimyar Khan, Muzaffargarh, and Sahiwal power plants.

Annual requirement of coal for Lakhra Power Plant and that of other four power plants are 2 million and 4 million tons, respectively.

According to statistic data, freight transportation by Pakistan Railways (PR) has been decreased sharply since 2010 in tonnage and tons-kilometers. The peak of passenger transportation by PR is recorded between 2000 and 2005. Although the number of passengers is decreasing, passenger-kilometers are increasing.

4. Coal Transportation and Train Operation Plan

Considering the topographic condition of Lakhra Power Plant, existing track condition, and future construction plan, four alternative cases have been studied in this report.

Case 1: The coal train (axle load of 17.27 tons) carrying coal containers to Budapur Station using existing track. Coal containers are transferred to dump trucks to Lakhra Power Plant. The carrying capacity of coal per train is 1,520 tons; thus, four trains are required per day.

Case 2A: The coal train (axle load of 23.3 tons) carrying coal hopper wagons using new track from Kotri Junction to Budapur Station and to Lakhra Power Plant directly through spur line is to be constructed. The carrying capacity of coal per train is 2,400 tons; thus, three trains are required per day.

Case 2AR: The coal train (axle load of 23.3 tons) carrying coal hopper wagons using 23.3 tons by axle load upgraded track from Kotri Junction to Budapur Station and to Lakhra Power Plant directly through spur line is to be constructed. The carrying capacity of coal per train is 2,400 tons; thus, three trains are required per day.

Case 2B: The coal train (axle load of 17.27 tons) carrying coal hopper wagons using existing track from Kotri Junction to Budapur Station and to Lakhra Power Plant directly through spur line to be constructed. The carrying capacity of coal per train is 1,520 tons. Thus, four trains are required per day.

Case 3: The coal train (axle load of 23.3 tons) carrying coal hopper wagons to New Budapur Station which will be constructed 3.4 km north of the existing Budapur Station. Coal will be transported from New Budapur Station to Lakhra Power Plant by conveyor belt system. The carrying capacity of coal per train is 2,400 tons; thus, three trains are required per day.

Although one private sector is intending to transport coal by providing their own coal trains, there is a technical problem to connect railway line to their coal terminal. Since no other private sector is showing interest for coal transportation, PR shall operate the coal trains.

5. Rolling Stock Fleet and Maintenance Plan

When lightweight locomotives (Group III: locomotive axle load of 17.27 tons) are used for coal transportation, the existing track structure can be used up to Budapur Station. In order to acquire enough traction effort, two units of locomotives shall be used for a train.

If a new track is constructed between Kotri Junction and New Budapur Station (or Lakhra Power Plant Station), heavy weight locomotive (Group I) can be used for coal transportation. When the gradient to Lakhra Power Plant is less than 0.5%, one unit of locomotive is enough to pull a coal train set. In either case, i.e. direct access to power plant or transport by conveyor belts from New Budapur Station, hopper wagons are recommended for coal transportation.

Since the existing locomotive fleet cannot cover the requirements for the planned coal transportation, new locomotives shall be procured. The existing diesel shed for the maintenance work does not have enough capacity for new locomotives, therefore, it is recommended to build a new diesel shed.

There are limited number of hopper wagons at present in PR, therefore, suitable type of wagons for coal transportation shall be procured.

6. Coal Terminals, Coal Loading Facilities, Spur Line to the PR Main Line

Fauji Oil Terminal and Distribution Co., Ltd. (FOTCO) is one of the potential private sectors for coal transportation and is conducting a feasibility study of coal terminal at Port Qasim. The company is planning to unload 12 million tons of imported coal in 2020. Since the planned stockyard is close to the existing PR line, loading operation to coal trains will not be difficult.

PIBT is another potential private sector for coal transportation and is now constructing a bulk terminal at the west end of Port Qasim. PIBT is planning to import 18-20 million tons of coal and export four million tons of cement and clinker per annum in 2015. However, due to the problem in railway access from PR main line to PIBT, the coal transportation plan is uncertain at present.

The following case study is based on the assumption that coal loading system to train at Port

Qasim (either PIBT or FOTCO) will be available when Lakhra Power Plant starts its operation:

In Case 1, coal containers will be transferred from train to dump trucks at Budapur Station yard. Damp trucks carry the containers to Lakhra Power Plant and dump the coal at the stockyard.

In Case 2A, Case 2AR and 2B, the coal train will carry coal in hopper wagons directly to Lakhra Power Plant and unload the coal at the discharge pit near the stockyard.

In Case 3, the coal train will carry coal in hopper wagons to New Budapur Station. The coal will be unloaded at the discharge pit then transferred to the stockyard at Lakhra Power Plant by conveyor belt system.

7. Railway System Improvement Plan

PR has prepared the following railway improvement plans which are related to coal transportation by railway:

- Revised PC-I Proforma: Rehabilitation of Railway Assets Damaged during the Riots of 27 and 28 December 2007 (May 2009);
- PC-I Proforma: Coal Transportation by Rail to Jamshoro Power Plant (May 2014, Revised October 2014);
- Revised PC-I Proforma-2005: Upgrading of Signaling and Telecommunication by Providing Computer Based Interlocking with Centralized Traffic Control System (CTC) and Auto Block Signaling on Lodhran–Kotri Section;

  and
- Providing Traffic Control System (CTC) at Multan (Lodhran-Sahiwal) and Lahor (Sahiwal-Shahdra Bagh) Main Line Section of Pakistan Railways (June 2014).

When these plans are implemented, the line capacity will be increased to allow increasing number of coal trains to three power plants in Punjab Province and Jamshoro Power Plant in Sindh Province.

If the Lakhra Power Plant Project is assured by the government, PC-I Proforma for Coal Transportation by Rail to Lakhra Power Plant shall be prepared by PR.

The improvement plan shall include new track construction, station/yard construction, signal improvement, and procurement of locomotives and wagons.

8. Project Cost Estimate

There are big differences in the construction costs and operation and maintenance (O&M) costs (for 30 years) among Cases 1, 2A, 2AR, 2B and 3 as shown below.

- Case 1: Construction PKR 18.26 billion + O&M PKR 52.20 billion = PKR 70.47 billion

The existing track will be used for Case-1 from Port Qasim to Budapur Station. The axle load of coal train will be 17.27 tons. Open top containers and dump trucks will be used for coal transportation between Budapur Station and Lakhra Power Plant. The payload of a 20-feet container is 20 tons.

- Case 2A: Construction PKR 42.66 billion + O&M PKR 37.59 billion = PKR 80.25 billion

The existing track will be used for Case 2A from Port Qasim to Kotri Junction and then a new track will be used from Kotri Junction to Lakhra Power Plant Station. The axle load of coal trains will be 23.3 tons. Bottom or slide release-type hopper wagons will be used. The payload of a wagon is 60 tons.

- Case 2AR: Construction PKR 37.41 billion + O&M PKR 37.08 billion = PKR 74.49 billion

The existing track will be used for Case 2A from Port Qasim to Kotri Junction and then, the upgraded track will be used from Kotri Junction to Budapur Station. Furthermore, the new spur line will be used to Lakhra Power Plant Station from Budhapur Station. The axle load of coal trains will be 23.3 tons. Bottom or slide release type hopper wagons will be used. The payload of a wagon is 60 tons.

- Case 2B: Construction PKR 35.63 billion + O&M PKR 47.11 billion = PKR 82.73 billion

The existing track will be used for Case 2B from Port Qasim to Budapur Station and the new spur line will be used to Lakhra Power Plant Station. The axle load of coal trains will be 17.27 tons. Bottom or slide release type hopper wagons will be used. The payload of a wagon is 40 tons.

- Case 3: Construction PKR 25.73 billion + O&M PKR 37.05 billion = PKR 62.78 billion

In Case 3, the existing track from Port Qasim to Kotri Junction and the new track from Kotri Junction to Budapur Station will be used. The coal will be transported from Budapur Station to Lakhra Power Plant by conveyor belt system. The axle load of coal trains will be 23.3 tons. The payload of hopper type coal wagon is 60 tons.

The life cycle costs including unloading O&M costs for 30 years are summarized as follows:

- Case 1: Dump Truck System; PKR 78.13 billion
  (18.26 for Construction, 52.20 for Railway O&M and 7.67 for unloading O&M Cost)
- Case 2A: Spur Line; PKR 80.80 billion
  (42.66 for Construction, 37.59 for Railway O&M and 0.55 for unloading O&M Cost)
- Case 2AR: Spur Line; PKR 75.03 billion
  (37,41 for Construction, 37.08 for Railway O&M and 0.55 for unloading O&M Cost)
- Case 2B: Spur Line; PKR 83.56 billion
  (35.63 for Construction, 47.11 for Railway O&M and 0.82 for unloading O&M Cost)
- Case 3: Conveyor Belt System; PKR 65.86 billion
  (25.73 for Construction, 37.05 for Railway O&M and 3.08 for unloading O&M Cost)

The case study on access to PIBT cost being included as one-third of the Lakhra project cost was also studied.

9. Project Schedule

It is assumed that the railway-related construction projects can commence one year after the commencement of Lakhra Power Plant construction project. Construction of the power plant is assumed to take 40 months. Then, trial operation is scheduled after 9 months. Coal for the trial operation shall be transported to the stockyard for a 55-day operation.

On the other hand, because of the budgetary arrangement, the construction of railway-related projects, including the construction of a 2.4 km long approach bridge to the power plant, are scheduled to commence one year after the power plant construction project. It is assumed that the railway-related projects will take 37 months. This means that coal trains can be operated eight months after the completion of the power plant. Therefore, coal for trial operation shall be transported by other transportation mode for 10 months.

In order to avoid the abovementioned situation, the construction of railway-concerned projects shall also commence at the same time with the power plant construction.

10. Financial Viability and Financing Options

The railway project financial internal rate of return (FIRR) shall be included in the Lakhra

Power Plant Project FIRR, not only the railway portion. In addition to that, the economic evaluation and the economic internal rate of return (EIRR) will be calculated on the main report of Lakhra Coal-Fired Thermal Power Plant Construction Project since the benefit of the railway could not be elevated without the involvement of the power plant project.

11. Environmental and Social Impacts

Environment and social consideration focus on the assessment of potential impacts from the construction of a spur line between Budapur Station and Lakhra Power Plant for transportation of imported coal.

A study area of 5 km around the proposed Lakhra Power Plant was surveyed. The spur line alignment falls in the urban area in Manjhand Taluka of Jamshoro District in Sindh Province. The land east of the Indus Highway is mainly used for cultivation and residential purposes. The land west of the Indus Highway is a barren stony land with little natural vegetation cover with a few houses. About 51 % surveyed population is engaged in agriculture and 30% of the population is involved in Lakhra Coal Mining Companies.

During the construction phase, soil dust would be generated by civil works of land clearance and exhaust gases from trucks with construction materials. Water and soil contamination due to oil and fuel leak from heavy machineries could occur. Noise and vibration due to the civil works and vehicles are also predicted. Lakhra Power Generation Company Limited (LPGCL) has to make sure that the engineering procurement construction (EPC) contractors will implement appropriate mitigation measures on these impacts.

On the other hand, during operation, noise and vibration due to railway traffic which cause nuisance to neighboring communities along the spur line is predicted. Appropriate measures such as installation of insulation walls along the rail and restricted transportation period (only day time) shall be made.

The construction of the spur line requires acquisition of land. The potential impacts due to land acquisition include loss of cultivated land, un-cultivated land, residential land, crops, trees, public utilities, and income and livelihood. Some of the households have to be physically displaced.

The project proponent shall undertake consultation of stakeholders including the affected people and full assessment of impacts. A land acquisition and resettlement action plan (LARAP) has to be prepared to compensate the loss and rehabilitate the livelihood of affected people.

12. Case Study: Power Plant Construction at Port Qasim

The candidate site for the power plant is located at the east end of the Port Qasim. If coal train departs from FOTCO's coal loading site, the train needs to run on the elevated structure to clear roads, pipelines, and canals. In order to climb to the elevated structure, the train will require switch-back operation. Then, the total length of the new track structure will be 8.6 km.

Assuming that a coal train can carry 1,200 tons, five cycle of train operation can cover the requirements (6,000 tons per day). Since one cycle of train operation is estimated to take four hours, total train operation time will be 20 hours per day.

The construction cost of the railway transportation system will be PKR 42,547 million. If a conveyor belt system having similar transporting capacity is installed, the construction cost will be PKR 12,420 million. If calculating O&M costs, the difference in life cycle costs will be much more than that of initial costs.

Therefore, if a new power plant is constructed at Port Qasim area, a conveyor belt system is recommended for coal transportation.

13. Conclusion and Recommendation

(1) Existing Railway Facilities

Based on the hearing with PR and site visits, the existing railway facilities have enough capacity to transport coal to the planned five coal-fired thermal power plants including Lakhra Power Plant.

(2) Demand Forecast

The volume of coal transportation by railway officially recognized is 16 million tons per annum, including the three power plants in Punjab Province and Jamshoro Power Plant. However, since new construction at Lakhra Power Plant is not officially confirmed yet, transportation of 2 million tons per annum is not planned by PR. When Lakhra Power Plant Project is officially confirmed, PC-I Proforma for Coal Transportation by Rail to Lakhra Power Plant shall be prepared by PR.

(3) Railway System Improvement

Since the construction schedule of Jamshoro Power Plant is uncertain, the coal transportation to Lakhra Power Plant shall be based on the use of existing track (axle load of 17.27 tons). In this case, the length of crossing loop track at Sindh University, Cadet College Petaro, Unapur, and Budapur stations shall be extended to 650 m to suit the planned coal trains.

In order to transport coal efficiently by using heavy locomotives in the future, it is recommended to upgrade or construct a new track between Kotri Junction and Budapur Station with design axle load of 23.3 tons.

(4) Rolling Stock Plan

When the existing track between Kotri Junction and Budapur Station is used for coal transportation, light weight locomotives (Group III: axle load of 17.27 tons) shall be used. In order to acquire enough traction effort, two units of locomotives shall be used for a coal train. Since the traction capacity is 1,520 tons, four coal trains shall be operated to achieve transportation of 2 million tons of coal. For easy unloading of coal, bottom opening type hopper wagons are recommended

When the existing track is upgraded or new track is constructed in the future, heavy locomotives (Group I: 4,000 – 4,500 HP, axle load of 23.3 tons) can be used. In that case, three trains per day can transport enough volume of coal to Lakhra Power Plant.

(5) Spur Line Construction

There are three alternative methods of coal transportation between Budapur Station and Lakhra Power Plant, namely, 1) by dump trucks, 2) spur line, and 3) conveyor belt. Although the initial cost is high, spur line connection is recommended because of lower O&M costs and less possibility of coal theft.

(6) Project Schedule

It is assumed that the construction of Lakhra Power Plant will commence in March 2019 and be completed at the end of June 2022 (40 months). Then, trial operation period is scheduled for one year.

Railway-related projects are scheduled to be completed within 37 months. Since approximately three-month coal stock is required when trial operation starts, the railway-related projects shall commence the same time as the power plant construction. If railway projects are delayed, coal for trial operation shall be transported by other transportation mode until railway projects are completed.

(7) Financial and Economical Considerations

The assumed railway operator is PR and all railway-concerned project cost including O&M cost will be funded by the General company GENCO through railway tariff. Initial cost and railway O&M cost will be collected as railway tariff and internal rate of return (IRR) is variable accordingly. In this regard, FIRR is not calculated unless the railway tariff is set properly.

(8) Environmental Impacts

Environmental impacts, such as soil dust, noise, and vibration, are anticipated during the construction phase. The project owner should make sure that the contractor takes appropriate measures to mitigate those impacts. After the completion of construction, the railway operator shall provide countermeasures for noise and vibration from the railway operation

The project proponent shall undertake consultation of stakeholders, including affected people, and full assessment of impacts. LARAP shall be prepared to compensate the loss and rehabilitate the livelihood of the affected people.

(9) Case Study: Power Plant Construction at Port Qasim

If a new power plant is constructed within Port Qasim, coal transportation by rail is not recommended because of high initial and O&M costs. In that case, coal transportation by conveyor belt system is recommended.

(10) Management of Operation and Maintenance

Prior to the commencement of mass coal transportation to several power plants by railway, it is recommended to set up a new section dedicated to handle coal train operation within the PR organization. It is also recommended to construct a new workshop for the maintenance of locomotives and wagons for coal transportation.

(11) Participation of Private Sector for the Operation

Marine group of companies (PIBT and PIL) are planning to participate in coal transportation business. PIBT is constructing a bulk terminal at the west end of Port Qasim and Pakistan Intermodal Limited (PIL) is planning to procure locomotives and wagons. However, since there is a problem in railway connection to their bulk terminal and PR main line, it will take time for them to be a coal transportation operator.

FOTCO is now conducting a feasibility study (F/S) of coal terminal at Port Qasim. Their design of coal handling facilities is well planned and there is no problem in rail connection to

PR main line. However, FOTCO has no plan to participate in the coal transportation business at present.

The National Logistic Cell (NLC), another potential private sector having their own locomotive fleet, has shown no interest in the coal transportation business so far.

Chapter 1 Introduction

1.1 Background of the Project

Due to the rapid growth of economy in Pakistan, demand for electricity has increased by 6% annually in the past ten years. Although the power supply capacity in 2011 was at 23,538 MW, the actual effective power supply was at 16,104 MW due to shortage in fuel supply. The maximum gap between demand and supply of electricity at peak hours in 2011 summer season was 6,000 MW. In order to avoid black out, planned outage of ten hours on average was implemented throughout the country. In order to improve such situation, investment in the electric power sector in Pakistan is urgently requited.

In order to ease such situation, the Japan International Cooperation Agency (JICA) has carried out the Preparatory Survey on Lakhra Coal Fired Thermal Power Plant Construction Project in Pakistan in September 2013. As part of the study results, another coal-fired thermal power plant along the Indus River and near Karachi Bay was studied.

Investment in the development of Lakhra Power Station, one of the candidate power plants, is expected to be an economic multiplier through the establishment of new industries and manufacturing plants in the immediate vicinity of the power station and indeed throughout the area served by the national electricity grid. Such industrial development will be made possible by the availability of uninterrupted power supplies throughout the national grid and by the construction of roads and utilities in the vicinity of the new power station.

Measurement of additional industrial output and freight demand induced by expanded electricity supply at the national level requires a comprehensive and complicated input-output analysis and is, therefore, beyond the scope of this study.

However, measurement of the output and freight demand impacts in the vicinity of the new power plant will be possible in reference to the economic benefits assessed in the feasibility studies of this and other comparable power development projects. Depending upon the type of industrial products to be manufactured, transportation can be satisfied by road or rail, especially if the haulage distance is less than 300 km. Therefore, it will be necessary to supplement estimates of potential transport volume with modal split analysis based on the relative operating costs of road and rail transport.

This pre-feasibility study is aimed to confirm the transporting capacity of railway to the Lakhra Coal Fired Thermal Power Plant (hereinafter called LCPP) near the Indus River. After the transporting capacity is confirmed, the cost for the rehabilitation of the railway system, procurement of rolling stock, and construction of new spur line will be estimated to confirm the feasibility of the project.

1.2 Project Scope

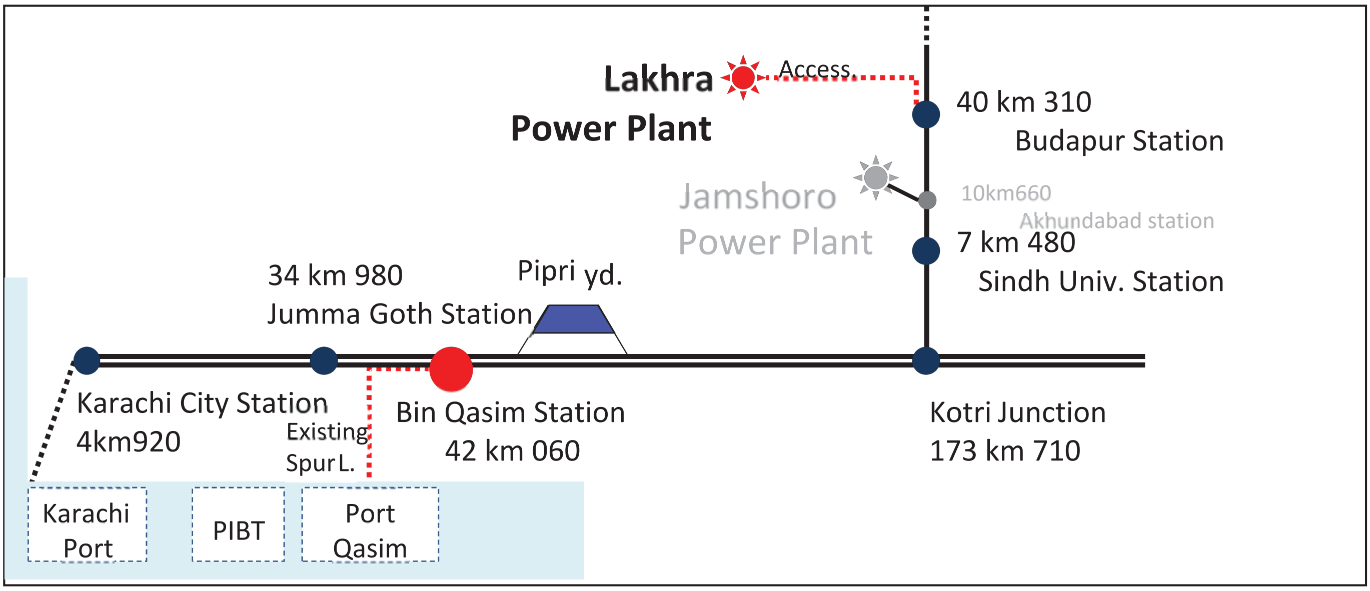
The scope of this project is to study the feasibility of coal transportation by railway between Port Qasim or PIBT[1] and the planned power plant in Lakhra. When the railway transportation is confirmed feasible, enhancement plan of transportation capacity shall also be studied.

The study consists of the following components:

- Collection of the basic data;
- Demand forecast on coal, other freight, and passenger transportation at the project area;
- Transportation plan;
- Operation plan;
- Stations, structures, and track;
- Signal and telecommunication facilities;
- Rolling stock;
- Organization of the project implementation;
- Organization of the coal train operation; and
- Recommendation.

The simplified location map is shown in Figure 1-1.

[1] The company is constructing bulk terminal inside of Port Qasim (refer to Clause 6.2).



Source: JICA Study Team

Figure 1-1 Schematic Location Map of the Project

1.3 Study Purpose

The purposes of this study are as follows:

- Confirmation of the feasibility of coal transportation from Port Qasim or PIBT to Lakhra Power Plant by railway, and
- Preparing recommendations for the following:
  1) Enhancement plan for railway transportation,
  2) Cost estimate,
  3) Project implementation schedule,
  4) Organization of project implementation, and
  5) Operating organization.

Chapter 2 Existing Railway Facilities

2.1 Key Feature of Pakistan Railways

The construction work of the first railway line, a 173 km-long line between Karachi and Kotri Junction, was started in 1858 and opened on 13 May 1861.

Pakistan Railways (PR) is a two-gauge system, i.e., broad-gauge and meter-gauge. The gauge-wise length and track length as of 30 June 2013 is shown in Table 2-1.

Table 2-1 Length of Track of Pakistan Railways

	Route (km)	Track (km)
Broad-gauge	7,479	11,366
Meter-gauge	312	389
Total	7,791	11,755

Source: PR Yearbook 2014

The key features of PR are as follows:

Track Gauge:

- Broad gauge: 1,676 mm
- Meter gauge: 1,000 mm

Axle Load:

- Group I: 23.3 tons, 22.86 tons, 19.3 tons
- Group II: 17.78 tons
- Group III: 17.27 tons
- Group IV: 16.76 tons
- Group V: 13.21 tons

Minimum Curve Radius:

10 degree (=175 m)

Maximum Gradient:

5‰ (0.5%)

Maximum Speed:

120 km/h (planned and designed, in operation, depending on the condition of the line)

Electrification:

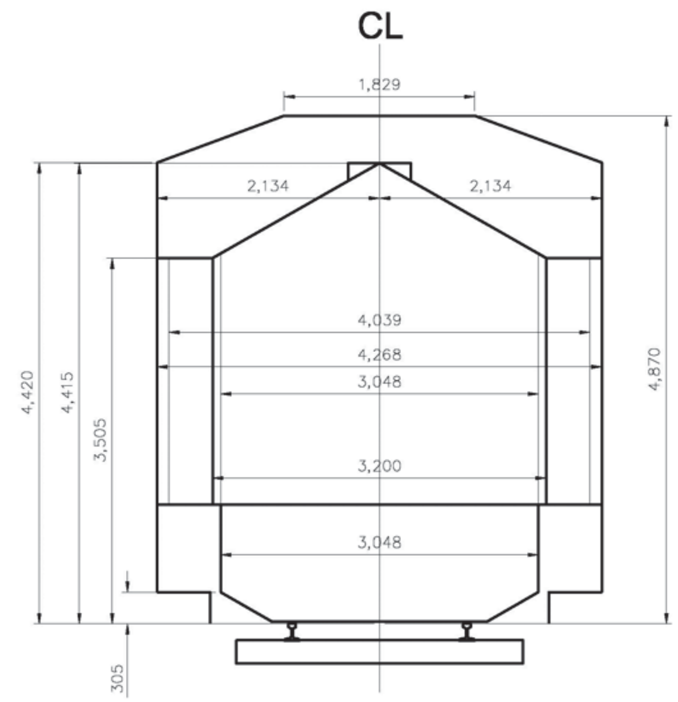
25 kV, 50 Hz, AC

Construction Gauge and Rolling Stock Clearance:

As shown in Figure 2-1.

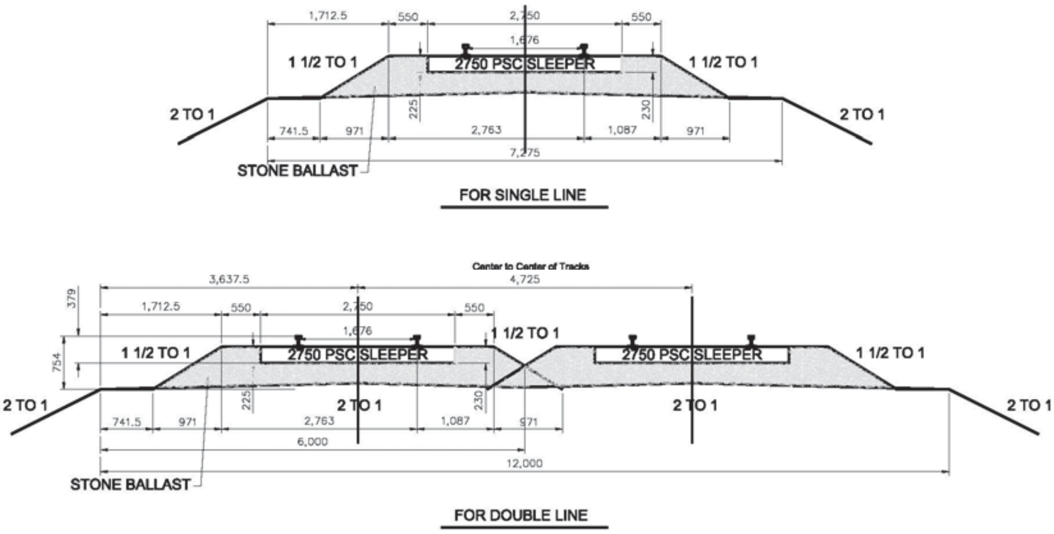
Standard Cross Section of Track:

As shown in Figure 2-2.



Source: Pakistan Railways

Figure 2-1 Construction Gauge and Car Clearance



Source: Pakistan Railways

Figure 2-2 Standard Cross Section of Track

2.2 Existing Line Condition

The line condition from Jumma Goth to Budapur Station via Kotri Junction at present is shown the Table 2-2.

Table 2-2 Station Name, Line Condition, and Signal System

Station Name	From Kiamari	Interval of Stations	Line Condition	Signal System	Axle Load
	km	**km**			**ton**
Jumma Goth	34.98	7.08	Double track	Automatic	23.3
Bin Qasim	42.06	2.94	Double track	Automatic	23.3
Badal Nala	45.00	2.94	Double track	Automatic	23.3
Marshalling yard		3.00	Double track	Automatic	23.3
Gaddar	50.94	9.25	Double track	Automatic	23.3
Dabehji	60.19	18.41	Double track	Automatic	23.3
Ran Pethani	78.60	11.92	Double track	Automatic	23.3
Jungshahi	90.52	16.61	Double track	Automatic	23.3
Braudabad	107.13	16.20	Double track	Automatic	23.3
Jhimpir	123.33	19.63	Double track	Automatic	23.3
Meting	142.96	20.87	Double track	Automatic	23.3
Bholari	163.83	9.88	Double track	Automatic	23.3
Kotri Junction	173.71	7.68	Double track	Mechanical	23.3
Sindh University	181.39	12.67	Single track	Mechanical	17.27
Cadet College Petaro	194.06	11.78	Single track	Mechanical	17.27
Unarpur	205.84	8.18	Single track	Mechanical	17.27
Budapur	214.02	9.10	Single track	Mechanical	17.27

Source: PR Timetable 2014

PR has a plan to construct a new track from Kotri Junction to Sindh University Station alongside the existing track, including the additional loop line.

The length of passing loops of Cadet College Petaro and Unapur stations are in need to be extended up to 650 m, same as the stations from Jumma Goth to Kotri Junction for efficient coal train operation. More details will be shown in Chapter 7 Railway System Improvement Plan.

The axle load from Kotri Junction to Budapur Station is 17.27 tons, it is lower compare to the axle load of 23.3 tons from Jumma Goth to Kotri Junction. The cost of improvement of the bridges to axle load of 23.3 tons will be expensive since there are 23 major bridges from Sindh University Station to Budapur Station. A more detailed explanation will be shown in Chapter 7.3 Bridge and Culvert Improvement.

The conditions of coal transportation plan are as follows:

- Minimum length of passing loop: 640 m

- Axle load for rolling stock: 17.27 tons

The railway assets of Karachi Division and Sukkur Division were damaged during the riots on 27 and 28 December 2007. There were 65 stations that were set ablaze or damaged, 23 diesel locomotives were burned, and 139 passenger coaches were set ablaze. The telecommunication system, including control telephone, VHF radio system, and coaxial cables on the main line between Hyderabad-Karachi and the branch line between Kotri Junction-Dadu were totally burnt. The train operation is being managed by extending the block sections and reception/dispatch of trains being worked on paper line clear (PLC) in the absence of normal signaling, which holds back each express train by almost four hours.

The rehabilitation of damaged assets is planned as 'Rehabilitation of Railway Assets Damaged During the Riots of 27 and 28 December 2007' Revised Planning Commission-1 (PC-1) Proforma, May 2009. The budget for the rehabilitation has been allocated and the rehabilitation works were already started, this was informed by the PR headquarters in end of November 2014.

These damages because of the riots badly affected the train operation of PR. The number of train operation and the transport volume of cargo drastically dropped after the riots.

2.3 Station Structure

The stations from Jumma Goth to Bholari Station are composed of two main lines and two passing loops. Kotori Junction has two main lines and five loop lines as a junction station, and the stations from Sindh University to Budapur Station are composed of one main line and one passing loop line. The details of the station are shown in Table 2-3.

Table 2-3 Station Name, Distance, and Number and Length of Loop Lines

Name of Station	From Kiamari or Kotri	Interval	Code	No. of Loop	Length of Loop Line in Meter
	km	km			m
Kiamari	0		KMR		
Karachi City	4.92	4.92	KYC	1	617.22
Karachi Cant.	8.62	3.7	KC	3	716.28
Departure Yard	14.24	5.62	DPY	2	663.25
Drigh Road	18.62	4.38	DID	3	609.75
Drigh Colony	20.53	1.91	DCL		
Malir Colony	23.54	3.01	MLCL	2	638.71
Malir	25.29	1.75	MXB		
Landhi	28.96	3.67	LND	4	685.80
Jumma Goth	34.98	6.02	JKTH	2	640.08
Bin Qasim	42.06	7.08	BQM	2	685.80
Bada Nala	45.00	2.94	BDNL		
Pipri Marshalling Yard			MYP		
Gaddar	50.94	5.94	GDR		
Dabheji	60.19	9.25	DBJ	2	655.32
Ran Pethani	78.60	18.41	RPN	2	655.32
Jungshahi	90.52	11.92	JGS	2	642.19
Braudabad	107.13	16.61	BKB	2	655.32
Jhimpir	123.33	16.2	JHP	2	655.32
Meting	142.96	19.63	MTG	2	655.32
Bholari	163.83	20.87	BOL	2	655.32
Kotri Junction	173.71	9.88	KOT	5	758.95
Kotri Junction	0		KOT		
Sindh University	7.68	7.68	SDUT	1	487.68
Cadet College Petro	20.35	12.67	CCQ	1	530.65
Unapur	32.13	11.78	UNR	1	606.72
Budapur	40.31	8.18	BDP	1	608.25

Source: PR Timetable 2014

The shortest length of passing loop line between Jumma Goth and Kotri Junction is 640.08 m in Jumma Goth, and the next shorter station is Jungshahi Station at 642.19 m, and between Kotri Junction and Budapur Station. The shortest is 487.68 m at Sindh University Station and the longest is 608.25 m at Budapur Station

The station structure has enough capacity to operate more trains compared with the present train operation.

2.4 Current Train Operation

2.4.1 Operation Organization

The train operation is controlled by the dispatch center of each division of PR. The central train operation control center of Karachi Division is located at the head office of Karachi

Division, and is divided into four sections: main line section, KCR section, Kotri Junction-Dadu section, and port area section. The train dispatcher in each section supervises and logs the train operation records compared with the standard train operation diagram. The turnouts and signals of each station are controlled by centralized traffic control (CTC).

Source: JICA Study Team

Figure 2-3 Dispatch Center of Karachi Division

One CTC located at Bin Qasim Station, which holds control between Karachi Cantt Station and Landhi Station, is still not working. The CTC office was attacked and burned during the riots of 2007; but the rehabilitation and improvement works were started at the beginning of December 2014.

After the turmoil in 2007, many infrastructure and rolling stocks were damaged and the number of train operation was decreased. And in 2014, it started to recover with new investment on improvement work and procurement of diesel locomotives. PR kept the employees of the engineering department during these years. Table 2-4 shows the number of employees of PR per department.

Table 2-4 Persons Employed by Pakistan Railways

Year	Civil Engineering	Mechanical Engineering	Transportation	Headquaters Office	All Other Departments	Total Cost of Employees
Average	No	No.	No.	No.	No.	(1000) PKR
1950-55	30,356	33,686	11,660	588	24,443	117,686
1955-60	31,748	36,054	13,013	622	29,805	131,984
1960-65	33,511	42,828	13,662	786	34,700	178,431
1965-70	33,288	46,164	15,475	944	38,936	231,885
1970-75	33,251	46,761	16,074	986	35,475	403,943
1975-80	33,147	46,772	18,384	1,072	38,544	640,887
1980-85	30,862	41,052	17,848	1,198	36,832	1,126,395
1985-90	34,020	41,612	18,500	1,158	36,495	1,990,039
1990-95	30,678	37,849	17,493	1,016	33,789	3,414,981
1995-2000	27,289	29,261	14,154	995	26,218	4,452,961
May-00	25,036	26,153	11,813	2,059	22,927	5,238,070
Oct-05	23,520	24,805	11,109	2,991	23,230	9,716,742
Nov-10	23,513	23,948	9,986	2,820	22,157	15,285,861
Dec-11	23,621	23,949	10,471	1,904	22,231	18,133,451
2012-13	23,109	23,729	10,123	2,515	22,404	20,557,285

Source: PR Yearbook 2012-2013

2.4.2 Train Diagram

The number of trains in the timetable at present is shown in Table 2.5, according to the timetable published by PR.

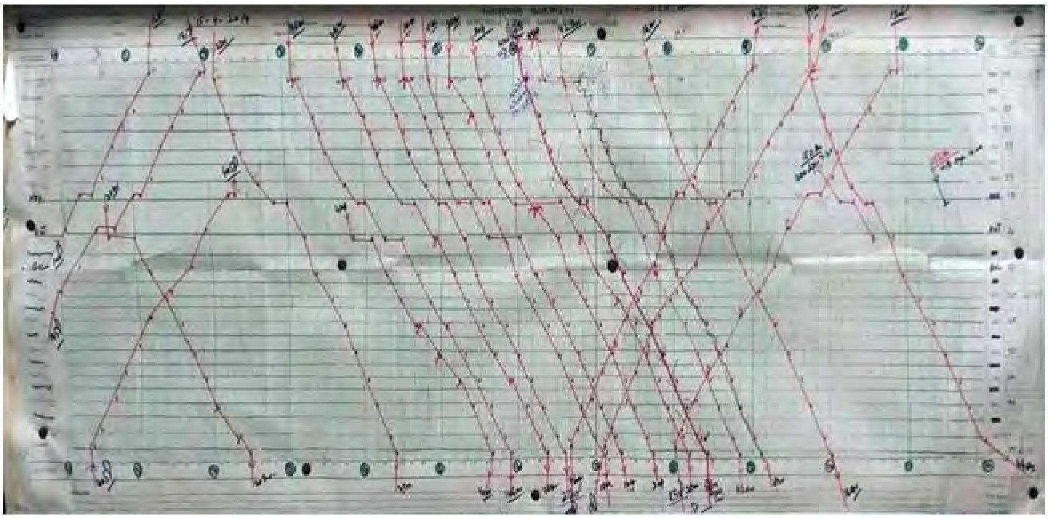
Table 2-5 Number of Trains according to PR Timetable 2014

Section	Passenger Train		Freight Train	
	Up Train	**Down Train**	**Up Train**	**Down Train**
Timetable April 2014				
Karachi City-Kotri	18	18	12	12
Kotri-Budapur	2	2	0	0
Timetable October 2014				
Karachi City-Kotri	19	19	7	7
Kotri-Budapur	2	2	0	0

Source: PR Timetable 2014

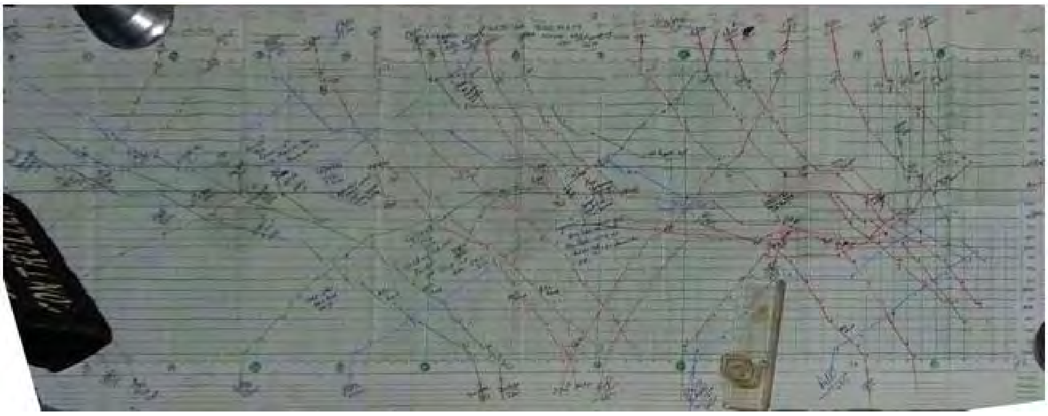
The trains on the timetable are planned train operation. Actual train operation is planned weekly or daily and the train operation diagram is prepared for the day. Then, the dispatcher controls the train operation depending on the daily planned diagram and records the actual operation diagram.

Figure 2-4 to Figure 2-7 show the daily planned train diagram and recorded diagram on 4 September 2014:



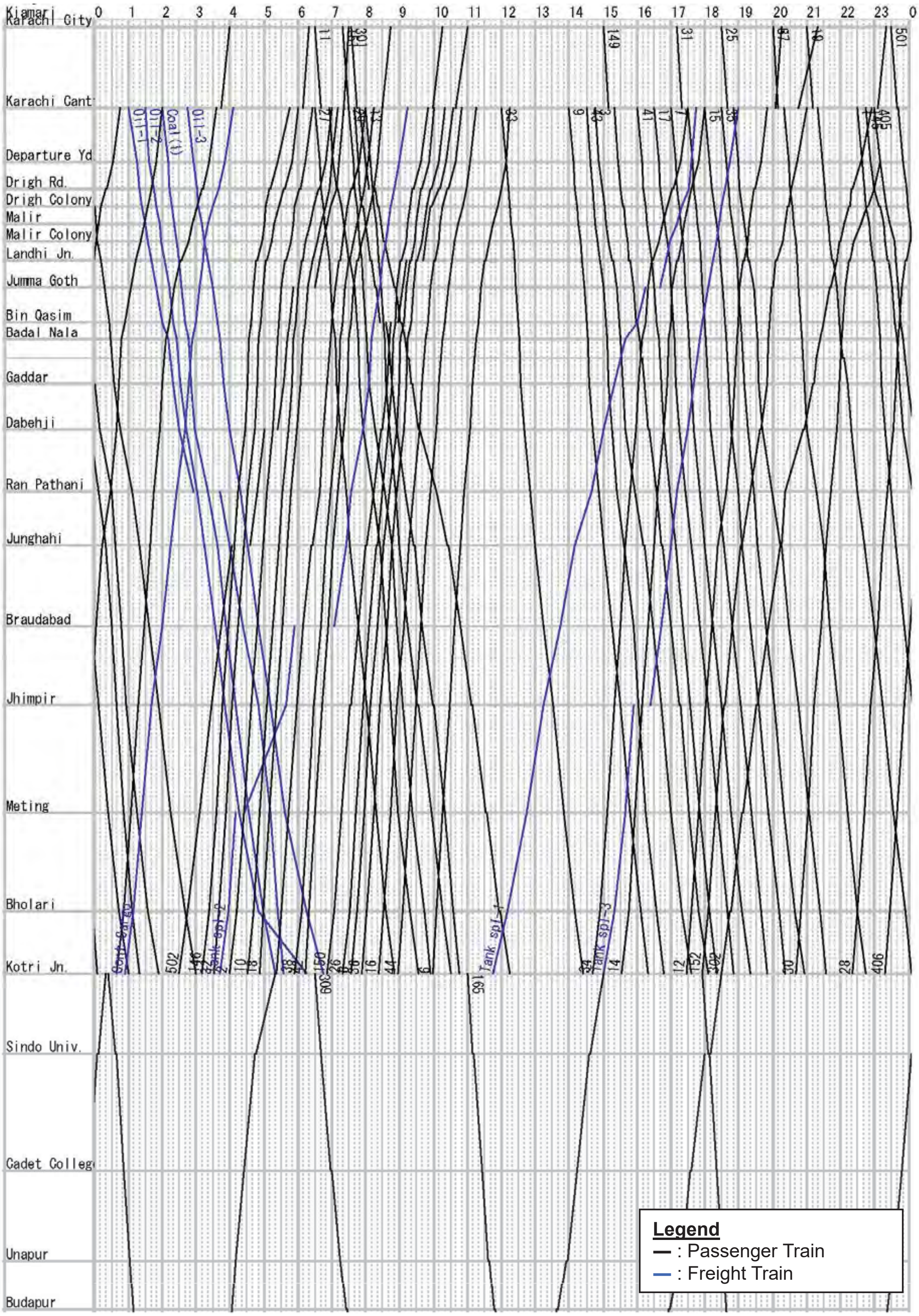
Source: JICA Study Team

Figure 2-4 Daily Plan Operation Diagram of Main Line (Gaddar–Kotri Junction-Hyderabad-Tando Adam) on 4 September 2014



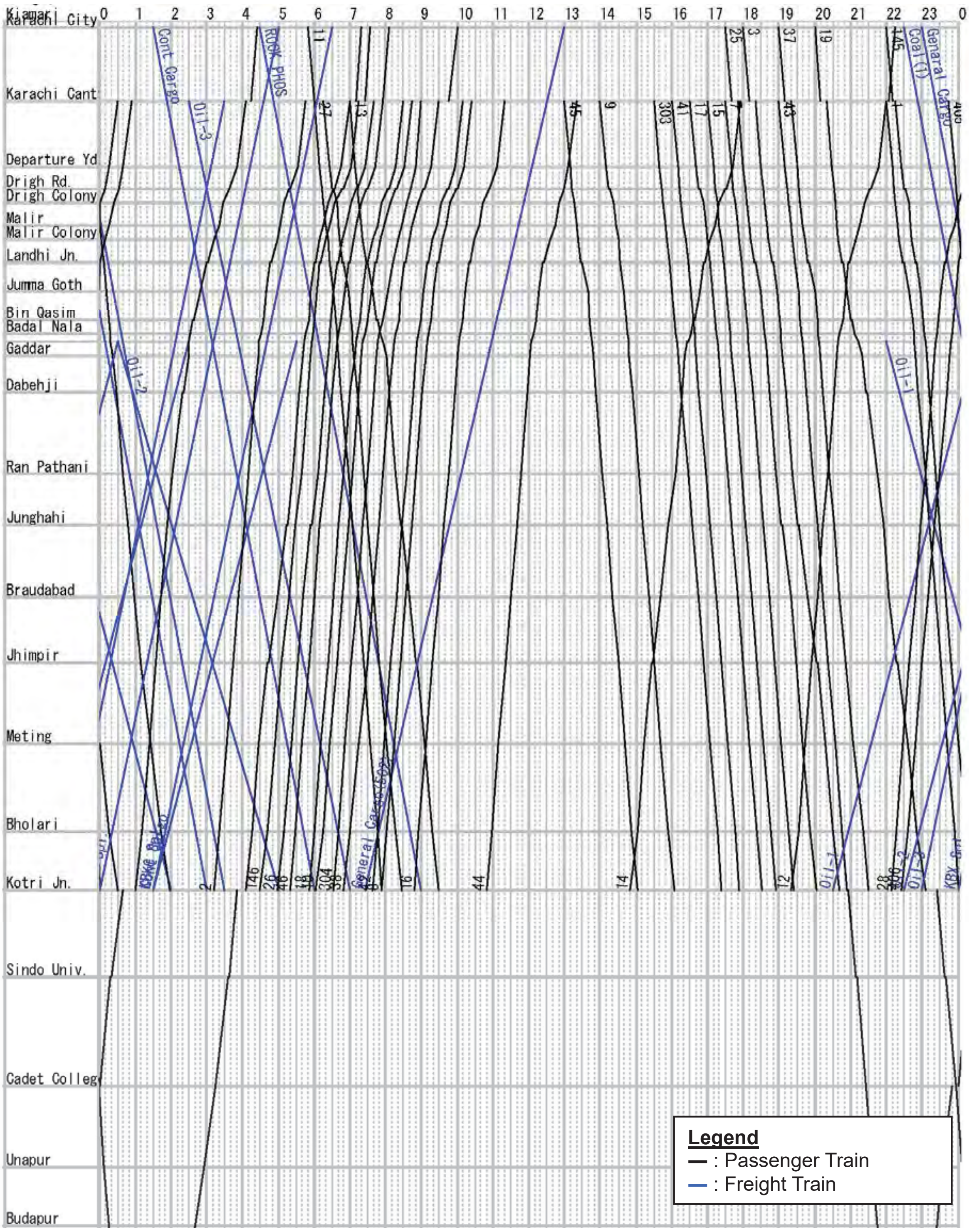
Source: JICA Study Team

Figure 2-5 Recorded Daily Operation Diagram of Main Line (Gaddar-Kotri Junction-Hyderabad-Tando Adam) on 4 September 2014



Source: PR Timetable 2006

Figure 2-6 PR Diagram in October 2006



Source: PR Timetable 2014

Figure 2-7 PR Diagram in October 2014

As shown in the freight train timetable below, the train only specified major stations such as Kotri Junction and Karachi City Station. Passing ahead of the train is figured in the diagram above, accordingly. It is expected that freight trains wait for the passing of the following train in the station loop. The detailed freight train operation time is prepared everyday depending on the requirement of the operation of the freight train. These works are additional load for the dispatcher. When coal transportation trains is operated in the future, it is recommended to plan the fixed coal train operation timetable same as the passenger trains since this will increase the capability of the train control center.

Table 2-6 includes one coal freight train; however, those capacity is quite small and not enough to cover the demand. In addition to that, PR only operates freight train main line between Karachi City and Kotri Junction, the branch section between Kotri Junction and Budapur Station is not included.

Table 2-6 PR Timetable for Freight Trains, April 2014

Hyderabad Direction

Station	Train Name	Oil -1	Coal -1	General Cargo	Oil-2	Cont. Cargo	Oil-3	Rock Phros.
Karachi City	Arr.							
	Dept.		22:30	23:00		1:30		4:30
Karachi Cantt	Arr.		‖	‖		‖		‖
	Dept.		‖	‖		‖	2:30	‖
(Marshalling yard)	Arr.		‖	‖	0:30	0:30	‖	‖
	Dept.	22:00	‖	‖	‖	‖	‖	‖
Kotri Junction	Arr.	2:00	3:00	3:30	5:00	6:00	7:00	9:00
(To Hyderabad)	Dept.	3:00	4:00	4:30	6:00	7:00	9:00	10:00

Karachi Direction

Station	Train Name	Oil-3	KBX Spl.	KBKC Spl.	Cont. Cargo	General Cargo	Oil-1	Oil-2
Kotri Junction	Arr.	22:00	23:00	0:30	1:00	6:10	19:30	21:30
	Dept.	23:00	0:00	1:30	1:30	7:25	20:30	22:30
(Marshalling Yard)	Arr.	‖	‖	5:30	‖	‖	0:30	2:30
	Dept.	‖	‖	=	‖	‖	=	=
Karachi Cantonment	Arr.	3:30	‖		‖	‖		
	Dept.	=	‖		‖	‖		
Karachi City	Arr.		5:00		13:00	13:00		

Source: PR Timetable October 2014

2.4.3 Line Capacity

Line capacity N shows the capability of number of trains can be operated in a day calculated by time requirement between blocks. In PR lines, a block is a section between stations and N is given by using the following formula:

$$N = \frac{f \cdot T}{t + c}$$

Where f: A daily service hour ratio and T[min]: minutes in a day (=1,440 min), t[min]: A travel time between stations and c[min]: A buffer time in a block. According to the interviews with

PR HQ, the daily working time is 24 hours and *f* is assumed at *f*=1.0.

- A margin time c= 0.0 min. up to Kotri Junction, automatic signal section, and c= 5.0 min. after Kotri Junction, mechanical signal section.
- A sectional travel time t is calculated by the distance divided by the average sectional speed.

According to the PR Timetable 2014, operation speed of passenger train between Karachi City Station and Kotri Junction ranged from 51.9 to 86.9 km/h and the average in all passenger trains including both directions was 68.3 km/h. The minimum bare running time which is used by PR to make the timetable and to calculate the line capacity is shown in PR Timetable with speed from 65 to 120 km/h between Karachi City Station and Kotri Junction and from 65 to 80 km/h between Kotri Junction. Consequently, the line capacity between Karachi City Station to Kotri Junction and Budapur Station is calculated based on the data of PR Timetable in October 2014.

The speed between Kotri Junction and Budapur Station has an average speed of 42.9 km/h. Speeds lower than 65 km/h is not mentioned in PR. Based on this reason, 42 km/h is used for line capacity calculation in the single line section up to Budapur Station after Kotri Junction for Dadu.

Table 2-7 PR Timetable for Passenger Train and Average Speed

UP Direction (Karachi City~Kotri~Dadu)

Train Number		27	11	13	45	9	149	303	41	17	15	7	25	3	43	37	19	1	145	405
Karachi City	Arriv.																			
	Dept.		5:50				14:50			16:00			17:30	18:00		19:00	20:00		22:00	
Karachi Cantt.	Arriv.		6:00				15:00			16:10			17:40	18:10		19:10	20:10		22:10	
	Dept.	6:00	6:15	7:00	13:00	14:00	15:10	15:30	16:00	16:30	17:00	17:30	17:50	18:20	19:00	19:20	20:20	22:00	22:15	23:45
Kotri Jn.	Arriv.		8:27	9:28		16:04	18:20						20:02	20:40		21:31	23:05		0:35	
	Dept.	7:54	8:29	9:30	15:02	16:06	18:22	17:24	17:54	18:32	18:54	19:24	20:04	20:55	20:54	21:33	23:25	0:02	0:50	1:56
Sindh University	Arriv.												35km/h	21:08		35km/h	23:38			
	Dept.													21:10			23:40			
Cadet College Petaro	Arriv.												48km/h			51km/h				
	Dept.													21:26			23:55			
Unapur	Arriv.												64km/h			59km/h				
	Dept.													21:37			0:07			
Budapur	Arriv.	-	-	-	-	-	-	-	-	-	-	-	61km/h	-	-	49km/h		-	-	-
	Dept.	-	-	-	-	-	-	-	-	-	-	-	-	21:45	-	-	0:17	-	-	-
Dadu	Arriv.													0:50			3:10			
	Dept.													1:00			3:20			
Average Speed in Branch Line Section	**50km/h**													52km/h			49km/h			

DN Direction (Dadu~Kotri~Karachi City)

Train Number		20	2	4	146	26	10	46	18	304	38	150	8	42	16	44	14	12	28	406
Dadu	Arriv.	20:40		23:50																
	Dept.	20:50		0:00																
Budapur	Arriv.																			
	Dept.	23:19		2:30																
Unapur	Arriv.		35km/h		33km/h															
	Dept.	23:33		2:45																
Cadet College Petaro	Arriv.	23:50	42km/h		39km/h															
	Dept.	0:00		3:03																
Sindh University	Arriv.	0:24	32km/h	3:25	35km/h															
	Dept.	0:26		3:27																
Kotri Jn.	Arriv.	0:45	24km/h	3:40	35km/h															
	Dept.	1:05	3:13	3:55	4:40	5:00	5:18	5:45	6:07	6:37	6:48	7:04	7:24	8:00	9:13	11:30	15:25	19:50	22:43	23:01
Karachi Cantt.	Arriv.	3:55	5:45	6:50	7:05	7:35	7:50	8:15	8:30	9:00	9:25	9:40	10:00	10:25	11:40	13:50	18:30	22:20	1:00	1:15
	Dept.	4:05	=	7:00	7:15	7:50	=	=	8:40	=	9:35	9:50	=	=	=	=	=	22:25	=	=
Karachi City	Arriv.	4:15		7:10	7:30	8:05			8:50		9:45	10:00						22:35		
	Dept.	=		=	=	=			=		=	=						=		
Average Speed in Branch Line Section	**34km/h**	33km/h		35km/h																

Average speed on UP and DN Direction

Kotri ~ Budapur	**42km/h**

Source: PR Timetable October 2014

According to assumptions discussed above, the number of line capacities by section is summarized as shown in Table 2-8.

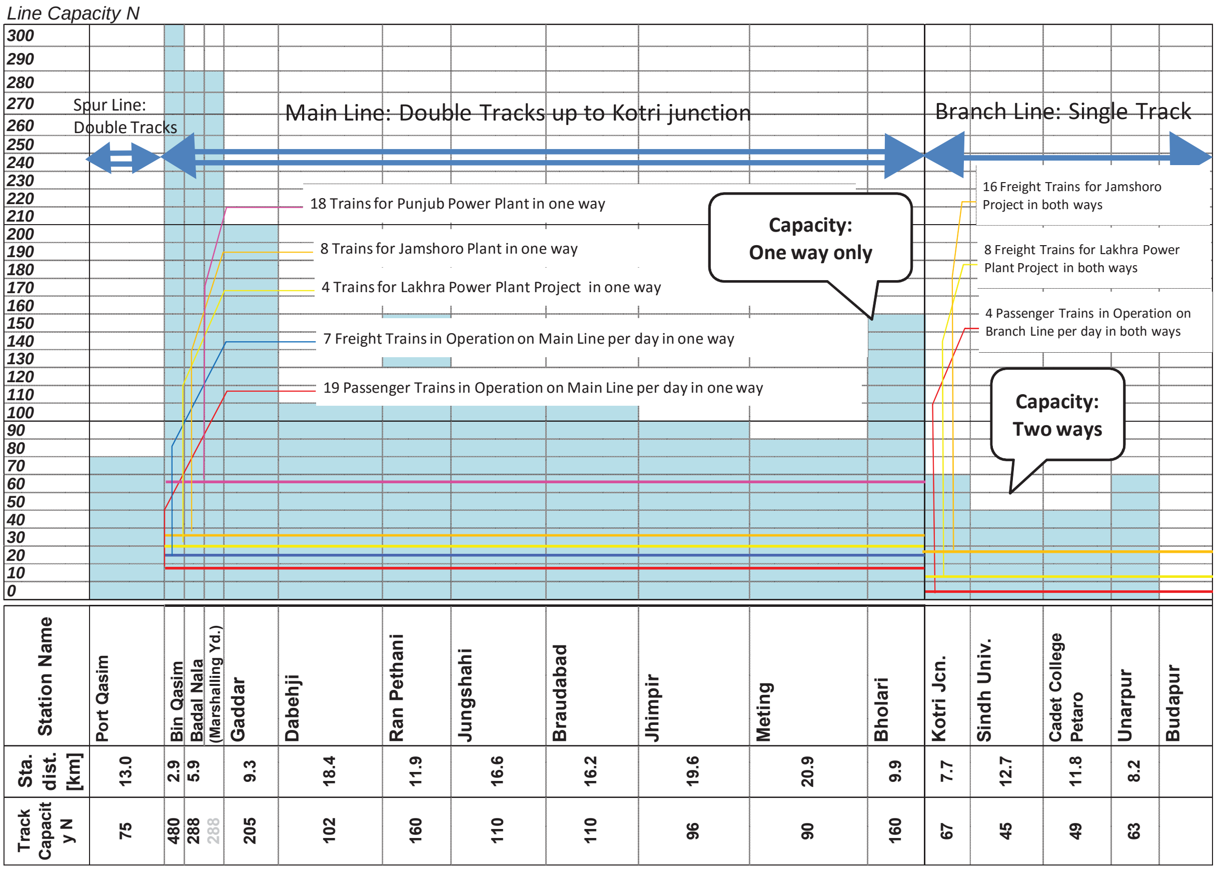
Table 2-8 Condition of Calculation of Line Capacity

Station Name	Interval of Stations [km]	Travel Time:t [minute]	Line Condition	Signal System	Train Speed (Average)	Line Capacity [Number]
Port Qasim						
	13.00	19	Single Track	Automatic	42 km/h	75
Bin Qasim						
	2.94	3	Double Track	Automatic	80 km/h	480
Badal Nala						
	5.94	5	Double track	Automatic	80 km/h	288
(Marshalling yard)						
			Double track	Automatic	80 km/h	
Gaddar						
	9.25	7	Double track	Automatic	80 km/h	205
Dabehji						
	18.41	14	Double track	Automatic	80 km/h	102
Ran Pethani						
	11.92	9	Double track	Automatic	80 km/h	160
Jungshahi						
	16.61	13	Double track	Automatic	80 km/h	110
Braudabad						
	16.20	13	Double track	Automatic	80 km/h	110
Jhimpir						
	19.63	15	Double track	Automatic	80 km/h	96
Meting						
	20.87	16	Double track	Automatic	80 km/h	90
Bholari						
	9.88	9	Double track	Automatic	80 km/h	160
Kotri junction						
	7.68	11	Single Track	Mechanical	42 km/h	67
Sindh University						
	12.67	19	Single Track	Mechanical	42 km/h	45
Cadet College Petaro						
	11.78	17	Single Track	Mechanical	42 km/h	49
Unarpur						
	8.18	12	Single Track	Mechanical	42 km/h	63
BudapurBudapur						

Note:
1. A section between Karachi City and Kotri Junction stations is one way; the other stations are two ways.
2. Travel time and average speed in double line on Bin Qasim-Kotri Section is based on the timetable of PR October 2014, Bin Qasim-Bada, Nala-Gaddar, and Braudabad-Jhimpir are recalculated and adjusted by the JICA Study Team.
3. For the average speed of single line section calculated by the JICA Study Team, refer to Clause 2.4.3.
4. Line capacity N is given by N= (f x T)/ (t +c): N is rounded down to decimal 0.
5. f=1.00 in double line section, f=0.75 in single line section
c-0.0 min. in automatic signal section, c=5.0 in mechanical signal
T=1,440 min/day
t= (interval of stations)/(average train speed) min.: t is rounded up to decimal 0.
Source: JICA Study Team based on timetable 2014

The maximum line capacity N=90 according to PR HQ. Karachi Division shows the calculation basis of operation speed at 80 km/h. The PR trains actually operates at least 80 km/h in main line, and the line capacity is appropriate.

As shown in the Figure 2-8, the section between Meting and Bholari stations is the most severe line capacity. *N*=90 in all sections where coal is transported against 26 trains in operation a day at present. However, even if Jamshoro and Lakhra plants start operation, 12 trains (four for Lakhra and eight for Jamshoro) will occupy the section and line capacity. Furthermore, 52 trains are still available.



Source: JICA Study Team

Figure 2-8 Line Capacity in Sections and Number of Trains in Operation

The most critical line capacity from Jumma Goth to Kotri Junction is between Meting Station and Bholari Station with 90 trains per one direction and only 26 operating trains, 19 passenger trains and 7 freight trains in October 2014. There is space for another 64 trains.

The numbers of coal trains for Lakhra, Jamshoro, and Punjab re as follows:

- Lakhra Power Plant (2 million tons per year): 4 trains in Case 2B
- Jamshoro Power Plant (4 million tons per year): 8 trains under same condition of Case 2B of Lakhra Power Plant
- Punjab Power Plants (4 million tons per year for 1 power plant and 3 power plants): 6 trains x 3 power plants = 18 trains

- Total number of coal trains for power plants: 4 + 8 + 6 x 3 =30 trains < 64 trains

As shown, the predicted number of coal trains is 30 trains and the line capacity is 64 trains, the line capacity between Jumma Goth and Kotri Junction is enough for coal transportation to the planned power plants: Lakhra, Jamshoro, and Punjab.

The line capacity from Kotri Junction to BudapurBudapur Station, with most critical between Kotri Junction and Sindh University Station, is 45 trains. The operating train number at present is only 4 passenger trains: two up trains and two down trains. No freight train is operating. There is still space for another 41 trains. The predicted number of coal trains is 12 x 2 = 24 trains to Lakhra Power Plant (4 trains/direction in Case 2B) and to Jamshoro (8 trains/direction under the same condition of Case 2B of Lakhra Power Plant) for both directions. The total number is 24 trains which is less than the capacity of 41 trains; however, the line capacity between Kotri Junction and BudapurBudapur Station is enough.

The number of passenger and freight trains drastically decreased compared with the past most active era.

The number of passenger coaches for broad gauge in 2012-2013, which maximum number was in 1985-1990, was 63% of the maximum. The number of passengers carried in 2012-2013, which maximum was at the year 1975-1980, was 29% of the maximum. The number of freight wagons for broad gauge, which maximum number was in 1970-1975, and the number of the freight wagons loaded, which maximum was at the year 1965-1970, was only 4% of the maximum in 2012-2013. The carried commodity of ton-km at in 2012-2013 was 7% of that in 2008-2009.

These results of transport operations of Pakistan Railways show that the infrastructure has enough capability to operate more trains.

2.4.4 Number of Trains and Transported Volume of Freight and Passengers

The number of passengers and transported volume of freight drastically decreased compared with the past most active era, but the number of trains on the timetable has not decreased.

The number of trains on the timetable from Karachi to Kotri Junction and BudapurBudapur Station is shown in

Table 2-9.

Table 2-9 Number of Trains (Karachi City-Kotri and Kotri-BudapurBudapur)

Year (Timetable)	Karachi City-Kotri		Kotri- BudapurBudapur	
	Passenger Train	Freight Train	Passenger Train	Freight Train
1999 October	19	N.A.	4	N.A.
2006 October	25	4	4	0
2013 May	17	12	2	0
2014 April	18	12	2	0
2014 October	19	7	2	0

Source: Timetable issued by PR

Table 2-10 Freight Carried (tons)

Year	Public Goods	Departmental	Total	% to 2007
1950-55 Average	7,782	1,462	9,244	142%
1955-60 Average	9,380	2,323	11,703	180%
1960-65 Average	11,577	2,579	14,156	218%
1965-70 Average	11,824	2,795	14,619	225%
1970-75 Average	10,858	1,857	12,715	196%
1975-80 Average	9,374	3,993	13,367	206%
1980-85 Average	8,100	3,085	11,185	172%
1985-90 Average	9,079	1,880	10,959	169%
1990-95 Average	6,738	949	7,687	118%
1995-2000 Average	5,169	716	5,885	91%
2000-2005 Average	5,017	1,081	6,098	94%
2005-2010 Average	5,183	1,308	6,491	100%
2010-2011	1,663	953	2,616	40%
2011-2012	833	490	1,323	20%
2012-2013	489	527	1,016	16%
*2013-2014	843	767	1,610	25%

*Provisional.
Source: PR Yearbook 2012-2013/2013-2014

The freight carried in tons decreased since 1978/79. The National Logistic Cell (NLC) started the freight transportation service using heavy lorries to settle the massive congestion at Karachi Port which occurred because of insufficient transport capability of PR caused by lack of locomotives, deterioration of freight wagons, and insufficient train control. After the commencement of freight transportation by NLC, the share of PR for freight transportation started to drop.

In the 1990s, PR put the priority on the passenger transportation. The condition of freight transportation was not improved and the freight transportation decreased.

The reasons of the shift of freight transportation to road transportation from railway transportation considered are as follows:

- Chronic substantial delay of train operation,
- Frequent cancelation of freight train operation
- Theft of cargo from train, and
- Long and unstable transportation time.

After the riot in 2007, the transportation of freight drastically decreased caused by the lack of locomotives. It was increased slightly in 2013-2014, but the number of scheduled freight trains decreased from 12 trains in May 2013 and April 2014 to seven trains on the main line and two trains on the branch line in October 2014.

Table 2-11 Passenger Carried

Year.	No. of Passengers Carried in Thousands	Total Passenger Kilometers in Thousands	Average No. of Kilometers Travelled by a Passenger	Average Revenue per Passenger (PKR)	Average Rate Charged per Passenger per Kilometer
1950-55 Average	78,942	6,778,538	85.9	1.5	1.75
1955-60 Average	102,657	8,064,025	78.5	1.56	1.99
1960-65 Average	126,284	9,533,593	75.5	1.55	2.05
1965-70 Average	130,475	10,025,201	76.9	1.83	2.28
1970-75 Average	134,076	10,792,170	80.5	2.36	2.93
1975-80 Average	145,710	15,111,969	103.71	4.47	4.31
1980-85 Average	113,474	17,402,638	153.4	11.32	7.21
1985-90 Average	82,319	18,483,168	224.5	21.15	9.42
1990-95 Average	69,084	17,828,907	258.1	40.76	15.55
1995-2000 Average	67,964	18,853,609	277.4	65.22	23.35
2000-2005 Average	72,828	21,992,225	301.9	101.87	33.7
2005-2010 Average	80,557	20,970,516	312.9	139.24	44.51
2010-2011	64,903	20,618,829	317.68	184.36	58.03
2011-2012	41,097	16,093,350	391.59	271.07	69.27
2012-2013	41,957	17,388,413	414.43	322.62	77.85
2013-2014	47,690	19,778,557	414.74	331.51	79.93

Source: PR Yearbook 2012-2013/2013-2014

The number of passengers decreased at present compared to before 2007; but the revenue from passengers carried was not decreased because of the extension of travel distance and fare rise.

The number of passengers and passenger kilometers slightly increased since 2011-2012.

2.5 Existing Track

The rail list is summarized as shown in Tables 2-12.

Table 2-12 Section-wise Type of Rail List

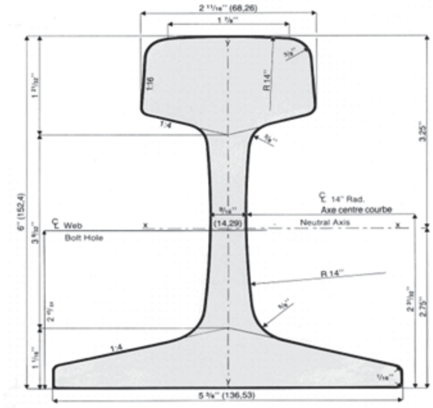
Section / Rail Type	Rail Weight	Remarks	Karachi City~ Jumma Goth	Jumma Goth~ Kotri	Kotri~ Akhundabad	Akhundabad~ Budapur	Total	
			Double Tracks, 23.3 tons Axle Load		**Single Track, 17.27 tons Axle Load**			
	(kg/m)		**UP & DN Total (km)**		**UP & DN Total (km)**		**(km)**	
100RE	49.61	100lbs/yd	22.2	57.3	0	0	79.5	(21%)
90R	44.65	90lbs/yd	7.3	0.8	10.7	29.7	48.4	(13%)
UIC-54	54.77		24.8	219.3	0	0	244.1	(66%)
Total			54.1	282.5	10.7	29.7	372.1	(100%)

Source: JICA Study Team

There are three types of rails installed in PR, but 90R rail is the minority in the scope area. In the main line after Jumma Goth Station, 78% of rail is shared by UIC-50. In the single track section, 90R is installed in the rail only. The dimensions of 100RE, 90R, and UIC-54 are shown in Table 2-13.

Table 2-13 Dimensions of 100RE Rail

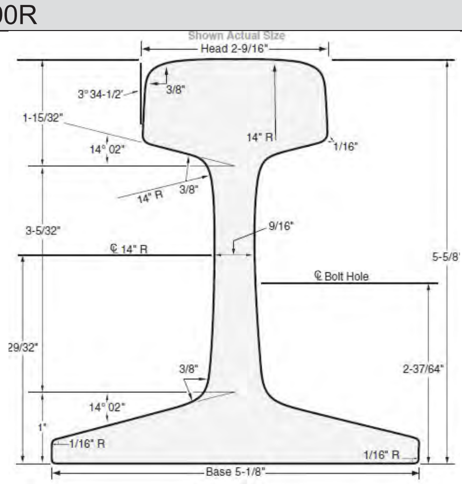
RAIL	RAIL TYPE 100 RE
Area	72, 58 cm^2 11.25 in^2
Kg/m lbs/yd	56, 90 kg/m 114.7 lbs/yd



Source: http://www.crownrail.com/raildetail2.htm

Table 2-14 Dimensions of 90R Rail

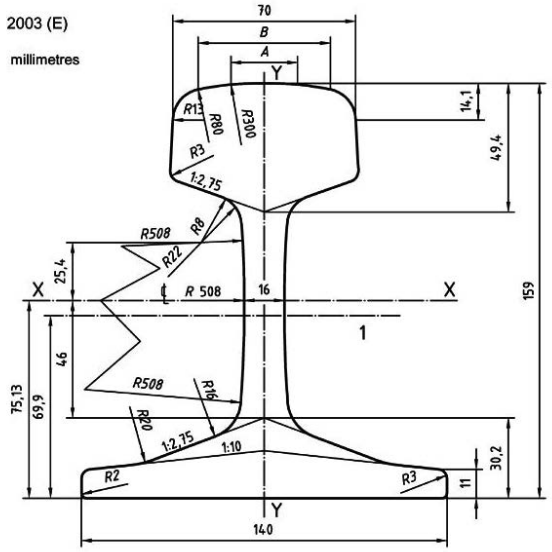
RAIL	RAIL TYPE 90R
Area	56.9 cm^2 8.82 In^2
Kg/m lbs/yd	90 lbs/ yd



Source: http://harmersteel.com/hs/wp-content/catalog/cache/harmer-steel-catalog-2014/18.pdf

Table 2-15 Dimensions of UIC-54 Rail

RAIL	RAIL TYPE UIC-54
Area	69.77cm^2
Kg/m lbs/yd	54.77 kg/m



Source: http://www.railwayrail.com/upload/images/en_13674-1_e_uic54_(54e1)_steel_rail.jpg

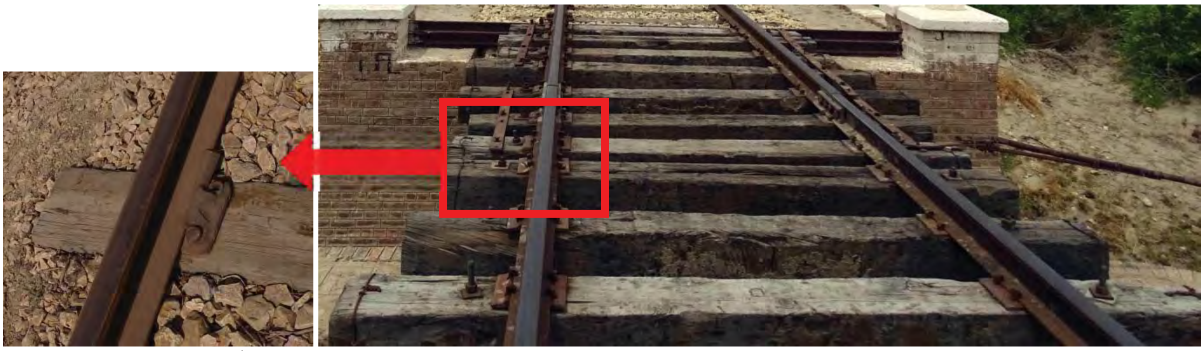
The section-wise sleeper-type list is shown in Table 2-16. About 83% of sleepers in the main line are pre-stressed concrete (PSC). On the other hand, no PSC sleepers are installed in the single track section.

Table 2-16 Section-wise Sleeper Type List

Section / Sleeper Type	Karachi City~ Jumma Goth	Jumma Goth~ Kotri	Kotri~ Akhundabad	Akhundabad~ Budapur	Total	
	Double Tracks, 23.3 tons Axle Load		**Single Track, 17.27 tons Axle Load**			
	UP and DN Total (km)		**UP and DN Total (km)**		**(km)**	
Wooden	13.3	2.4	1.6	0	17.3	(5.0%)
Wooden/PSC	1.4	0	0	0	1.4	(0.4%)
PSC	38.7	274.7	0	0	313.4	(91.5%)
Reinforced Cement Concrete (RCC) Twin Block	0	0	0.3	12.5	0.3	(0.1%)
Steel	0	0	8.8	13.6	8.8	(2.6%)
Points and crossing	0.86	0	0	0	0.9	(0.3%)
Others	0	0.4	0	4	0.4	(0.1%)
Total	54.3	277.5	10.7	29.7	342.4	(100%)

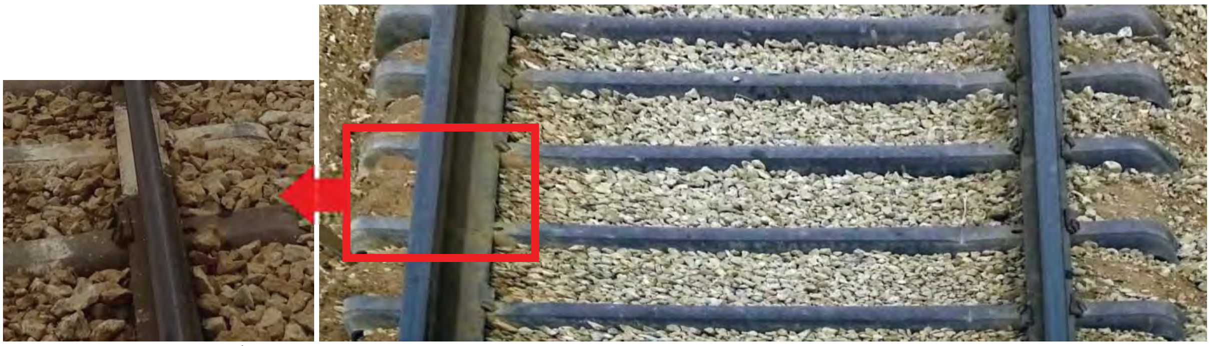
Source: JICA Study Team

Typical sleeper types listed in Table 2-16 is shown in Figure 2-9 to Figure 2-12.



Source: JICA Study Team

Figure 2-9 Typical Wooden Sleeper

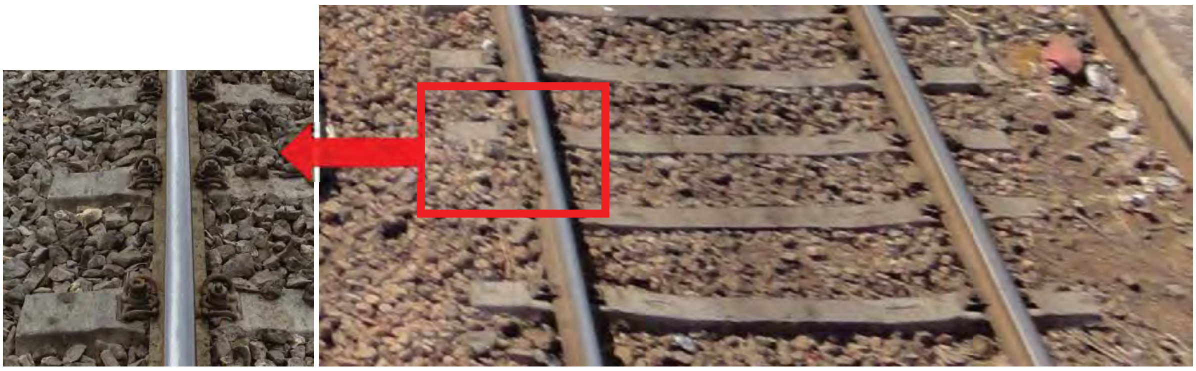


Source: JICA Study Team

Figure 2-10 Typical Steel Sleeper

Source: JICA Study Team

Figure 2-11 Typical RC Twin Block Sleeper



Source: JICA Study Team

Figure 2-12 Typical Pre-Stressed Concrete (PSC) Sleeper

2.5.1 Section Between Bin Qasim Station and Kotri Junction

The section between Karachi City and Kotri Junction is part of PR's trunk line, classified as Primary-A track structure. The maximum speed is 105 km/h and axle load of 23.3 tons. The track condition of this section is relatively good, and therefore, the maximum speed of over 100 km/h can be achieved by passenger trains.

Source: JICA Study Team

Figure 2-13 Bin Qasim Station

Source: JICA Study Team

Figure 2-14 Landhi Station

2.5.2 Section Between Kotri Junction and Budapur Station

The track structure of the section between Kotri Junction and Budapur Station, the nearest station to LCPP, is classified as secondary grade. The maximum speed is 80 km/h and the axle load is 17.27 tons.

The track condition near Kotri Junction is poor as shown in Figure 2-15 and Figure 2-16. The ballast is hardly cemented by soil, and shoulder embankment is eroded severely.

Source: JICA Study Team

Figure 2-15 Near Kotri Junction

Source: JICA Study Team

Figure 2-16 Embankment Section near Kotri Junction

An additional track is planned up to Jamshoro Power Plant in the section shown in Figure 2-15 and Figure 2-16. It seems difficult to acquire the land for additional track because the existing right of way (ROW) is very narrow.

2.5.3 Bridges and Culverts

In the survey area between Karachi City Station and Budapur Station, PR has 286 bridges according to the its record as shown in Table 2-17.

Table 2-17 Existing Bridges List by Structure Type

	Section				Total
Track	**23.3 tons, Double tracks**		**17.27 tons, Single track**		
Section Bridge Type	**Karachi City-Jumma Goth**	**Jumma Goth-Kotri**	**Kotri-Jamshoro Junction**	**Jamshoro Junction-Budapur**	
Girder	6	37	2	16	61
Reinforced cement concrete (RCC) slab	7	7	18	8	40
Rolled steel joint (RSJ)				8	8
Steel trough		72			72
Stone	1	7	2		10
Trough	8	6	1		15
Culvert			1		1
RCC pipe		5			5
Rail decking		16			16
Rail opening			3	4	7
Rail cluster			2	3	5
Arch	1	5	10	13	29
Brick masonry		5			5
Hume pipe	3	1	1	4	9
Others		3			3
All Types Total	26	164	40	56	286

Source: Pakistan Railways

2.5.4 Level Crossing Between Landhi Station to Kotri Junction and Budapur Station

The collision of trains with large-size cars, such as lorry and/or bus, at the level crossing is a serious accident for railway and road transportation. The accidents at the level crossing account for 75% of all railway accidents of PR in 2012.

Table 2-18 Number of Accidents

Description of Accidents	Number of Accidents	
	2011	**2012**
Derailments of passenger trains	31	9
Derailments of mixed trains	1	-
Derailments of goods trains	9	4
Collisions at manned level crossings	11	9
Collisions at unmanned level crossings	59	64
Fire in trains	6	3
Averted collision	1	-
Others	7	7
Total	125	96

Source: PR Yearbook 2012-2013

The accident at the level crossing has an important influence on train operation especially in busy line such as the main line from Karachi to Kotri Junction.

Most of the level crossings are manned in the main line between Karachi and Kotri Junction, while only one level crossing near Jhampir Station is unmanned. Four of the eight level crossings from Kotri Junction to Budapur Station are manned since these level crossings are adjacent to the station and busy with pedestrian and small cars. The other four level crossings are unmanned since the traffic volume of these unmanned level crossings are small; and moreover, the number of trains of this section is only four trains per day.

Table 2-19 Level Crossing

Location	Width	Man/Unmanned	Class
km	**m**		
Landhi-Jhampir			
33.950	9.5	manned	I
91.150	10	manned	II
105.460	3.7	manned	II
123.900	3.7	manned	II
Jhampir-Kotri Junction			
143.650	3.7	unmanned	III
158.900	3.7	manned	II
164.030	3.7	manned	II
172.080	7.3	manned	I
174.150	7.3	manned	II
Kotri Junction-Budapur			
1.200		manned	II
2.400		unmanned	III
8.400		manned	I
13.900		unmanned	III
21.150		manned	II
22.850		unmanned	III
37.600		unmanned	III
40.600		manned	II

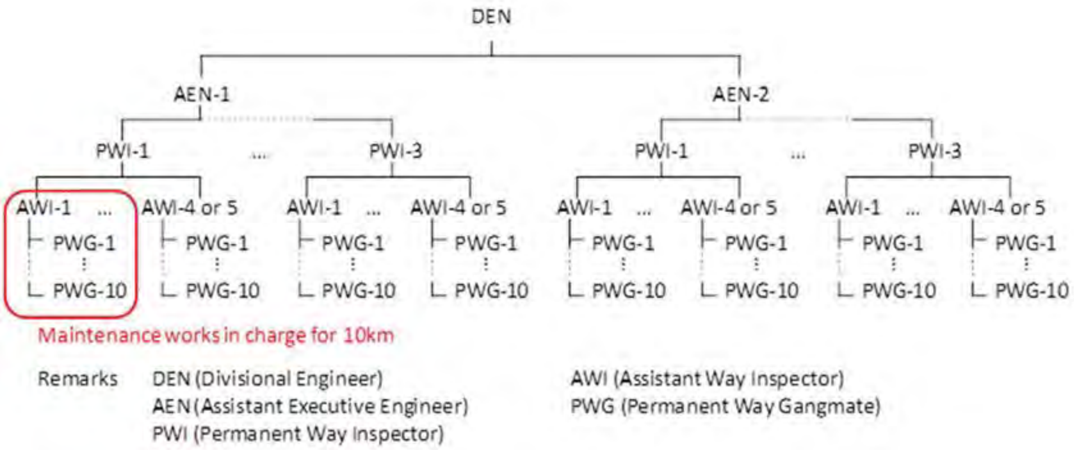
Source: JICA Study Team

2.5.5 Track Maintenance Work and Maintenance Organization

Although multiple tie tamper (MTT) is equipped in each district, regular track maintenance work is done manually (maintenance gang) in a manner which was adopted in many countries before mechanized maintenance was introduced. MTT is used only when and where new ballast is added or new track is constructed to provide deep tamping of ballast. The frequency of MTT operation at PR Karachi Division seems reasonable.

The organization of the track maintenance work is shown in Figure 2-17. Under the divisional engineer (DEN), there are two assistant executive engineers (AEN). Each AEN has three permanent way inspectors (PWI) and each PWI has four to five assistant way inspectors (AWI). There are ten permanent way gang mates (PWG) under AWI forming a track maintenance team. One team covers 10 km of track for regular maintenance work.

The abovementioned track maintenance system has been working well. No major accident was reported in the project area due to poor maintenance of track. However, when mass volume of coal transportation starts, the frequency of track maintenance work shall be increased depending on the increased number of trains.



Source: JICA Study Team

Figure 2-17 PR Track Maintenance Organization

2.6 Signal and Telecommunication

2.6.1 Train Control Center

The railway section of the Karachi Division is divided into three parts, namely, (i) main line section, (ii) Kotri Junction-Dadu Section, and (iii) port area section. Each dispatcher is in-charge of service management of the train group for one section exclusively. The dispatchers communicate with station masters by the telephone with the railway dedicated line. Actual running results of trains have been recorded as paper works by dispatchers for each day. This train control system has enough capability at present, with flexible freight train operation. In case of increase in coal trains, the capability of train control by the existing train control center is enough when the train operation time schedule will be fixed same as with passenger trains.

Source: JICA Study Team

Figure 2-18 Dispatcher of Main Line Section

Source: JICA Study Team

Figure 2-19 Dispatcher of Kotri Junction – Dadu Section

2.6.2 Main Line (Bin Qasim Station – Kotri Junction)

(1) Signaling System

The double track of main line is equipped with automatic signaling system and relayed interlocking in the section between Karachi and Kotri Junction (except Pipri Marshalling Yard and Kotri Junction).

Trains often delay due to the after-effects of the large-scale riot that occurred in 2007. The signaling system on various stations in Karachi and Sukkur Division of PR were badly damaged during the riots which resulted in approximately 100 places of signal cabin, including Bin Qasim Station, destroyed by fire. Therefore, automatic signaling system for the section near Bin Qasim Station has not been available since the riots. Then, train operation is controlled with absolute block system, which means, there is only one train on the section between two adjoining stations at this moment.

For the improvement of current situation, PR is planning the electronic interlocking installation on both Kotri Junction and Bin Qasim Station; and PC-1 has been submitted entitled as “Rehabilitation of Railway Assets Damaged during the Riots of 27 and 28 December 2007”. If these plans are implemented within several years, it is supposed that the mass transit of coal (2 mtpa) on the main line will be carried out without critical delay for the new power plant operation in Lakhra from the standpoint of the signaling system.

The budget for the rehabilitation has been allocated and the rehabilitation works were started at the end of November 2014. (refer to Clause 2.2)

Table 2-20 Main Line Instruments Related to Signaling System

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Station Name</th><th colspan="2">Distance</th><th rowspan="2">Block System</th><th rowspan="2">CTC</th><th rowspan="2">Interlocking System</th></tr>
<tr><th>Between Stations (km)</th><th>Accumulative (km)</th></tr>
<tr><td>1</td><td>Kiamari</td><td>----</td><td>0</td><td></td><td rowspan="3"></td><td></td></tr>
<tr><td>2</td><td>Karachi City</td><td>4.92</td><td>4.92</td><td rowspan="11">Automatic (Double Line)</td><td rowspan="11">Relay</td></tr>
<tr><td>3</td><td>Karachi Cantt</td><td>3.70</td><td>8.62</td></tr>
<tr><td>4</td><td>Departure Yard</td><td>5.62</td><td>14.24</td><td>o</td></tr>
<tr><td>5</td><td>Drigh Road</td><td>4.38</td><td>18.62</td><td>o</td></tr>
<tr><td>6</td><td>Drigh Colony</td><td>1.91</td><td>20.53</td><td>o</td></tr>
<tr><td>7</td><td>Malir Colony</td><td>3.01</td><td>23.54</td><td>o</td></tr>
<tr><td>8</td><td>Malir Cantt</td><td>1.75</td><td>25.29</td><td>o</td></tr>
<tr><td>9</td><td>Landhi Junction</td><td>3.67</td><td>28.96</td><td>o</td></tr>
<tr><td>10</td><td>Jumma Goth</td><td>6.02</td><td>34.98</td><td rowspan="12"></td></tr>
<tr><td>11</td><td>Bin Qasim</td><td>7.08</td><td>42.06</td></tr>
<tr><td>12</td><td>Badal Nara</td><td>2.94</td><td>45.00</td></tr>
<tr><td>----</td><td>Pipri Marshalling Yard</td><td>----</td><td>----</td><td>----</td><td>----</td></tr>
<tr><td>13</td><td>Gaddar</td><td>5.94</td><td>50.94</td><td rowspan="9">Automatic (Double Line)</td><td rowspan="8">Relay</td></tr>
<tr><td>14</td><td>Dabehji</td><td>9.25</td><td>60.19</td></tr>
<tr><td>15</td><td>Ran Pethani</td><td>18.41</td><td>78.60</td></tr>
<tr><td>16</td><td>Jungshahi</td><td>11.92</td><td>90.52</td></tr>
<tr><td>17</td><td>Braudabad</td><td>16.61</td><td>107.13</td></tr>
<tr><td>18</td><td>Jhimpir</td><td>16.2</td><td>123.33</td></tr>
<tr><td>19</td><td>Meting</td><td>19.63</td><td>142.96</td></tr>
<tr><td>20</td><td>Bholari</td><td>20.87</td><td>163.83</td></tr>
<tr><td>21</td><td>Kotri Junction</td><td>9.88</td><td>173.71</td><td>Mechanical STD-III</td></tr>
</table>

Source: JICA Study Team

The existing signaling system is shown in Table 2-20. The standard-III mechanical interlocking was installed at Kotri Junction as shown in Figure 2-20 and Figure 2-21. Relay type CTC was replaced with an electric one in 1984. CTC center (Figure 2-22) located at Karachi Cantt Station controls six stations (approximately 24 km) between the departure yard and Landhi Junction (Figure 2-23).

Source: JICA Study Team

Figure 2-20 Operation of Mechanical Interlocking

Source: JICA Study Team

Figure 2-21 View towards Budapur with Mechanical Interlocking System

Source: JICA Study Team

Figure 2-22 Operation at CTC Control Room at Karachi Cantt. Station

Source: JICA Study Team

Figure 2-23 Operation at Landhi Station

(2) Telecommunication System

The PR telecommunication system comprises of microwave, ultra-high frequency (UHF), and very high frequency (VHF) radios, telephone exchanges networks, train control system, overhead wires along the railway track, and underground cable.

Radio systems were installed in 1981-82 on the main line from Rawalpindi to Karachi and on important branch lines covering 2,700 route km nationwide. Microwave, UHF, and VHF radio systems are working in Pakistan. For the stations between Karachi and Kotri Junction, a simplex train radio system with VHF (172 MHz) is used for communication between crews, train dispatchers, and station staff at the main line and yards.

2.6.3 Branch Line (Kotri Junction – Budapur Station)

(1) Signaling System

The single track section of branch line between Kotri Junction and Budapur Station adopted the blocking system of outdated Neal's Ball Token Instrument (Figure 2-24 and Figure 2-25) and interlocking of second class mechanical interlocking type. The single line section towards Dadu is equipped with the same as shown in Table 2-21. The instruments connected with telegram lines are cooperative type, as such, line clear cannot be granted by the station without active cooperation of the station receiving the line clear.

Source: JICA Study Team

Figure 2-24 Neal's Ball Token Instrument

Source: JICA Study Team

Figure 2-25 Manufacturing Label on Neal's Ball Token Instrument

Table 2-21 Branch Line Instruments Related to Signaling System

No.	Station Name	Distance: Between Stations (km)	Distance: Accumulative (km)	Block System	Interlocking System
1	Kotri	----	0	----	Mechanical STD - III
2	Sindh University	7.68	7.68	Neal's Ball Token Instrument (Single Line)	Mechanical STC - I
3	Cadet College Petaro	12.67	20.35		
4	Unarpur	11.78	32.13		
5	Budapur	8.18	40.13		
6	Khanot	9.10	49.41		
7	Gopang	6.02	55.43		
8	Manjihand	12.39	67.82		
9	Sann	18.02	85.84		
10	Amri	20.32	106.16		
11	Laki Shah Sadar	15.32	121.51		
12	Sehwan Sharif	18.05	139.56		
13	Bubak Road	12.01	151.57		
14	Bhan Sayadabad	9.57	161.14		
15	Khudabad	9.67	170.81		
16	Dadu	9.74	180.55		

Note: Neal is the name of token system for railway signal and block system manufactured by Westinghouse Brake and Signal Co.
Source: JICA Study Team

The facilities are obsolete and depend on manual operation by signaling operators. Nevertheless, PR has not planned to modernize the signaling facilities for the single section due to only two passenger trains for each direction passing per day (a total of four trains for both directions per day scheduled on the latest timetable enforced from 15 April 2014).

Source: JICA Study Team

Figure 2-26 Mechanical Home Signal at Budapur Station

Source: JICA Study Team

Figure 2-27 Mechanical Point at Budapur Station

(2) Telecommunication System

The UHF radio system was installed on branch line of Kotri Junction-Dadu same as the main line in 1981-82. For the stations between Kotri Junction and Budapur Station, a train radio with VHF (172 MHz) is mainly used among dispatchers, train drivers, station staff, and maintenance staff, same as the main line at present.

2.7 Rolling Stock

2.7.1 Locomotives

According to PR Yearbook 2011-2012, the number of diesel-electric locomotives is 466. However, an average daily number of 214 locomotives are serviceable and the remaining locomotives are waiting spare parts. This means that, if supply of spare parts is assured, PR will be able to provide enough number of locomotives for coal transportation to Lakhra. However, because of aged models (made in USA) and short life models (made in China), supply of spare parts is not easy.

The number of rolling stocks of PR has decreased in recent years especially the operable rolling stock due to the deterioration and difficulty of acquisition of spare parts.

Table 2-22 shows the number of locomotives for broad gauge owned by PR. Since coal trains will be operated in shuttle service between the port and the power plant for a long period, it is preferable to fix the train composition. Therefore, it is recommended to procure new locomotives suitable for the service. Long term availability of spare parts shall be assured at the time of selection of those locomotives.

Details of PR owned locomotives are shown in Appendix No. 6.

Table 2-22 Locomotives Owned by Pakistan Railways (Broad Gauge)

Year.	Steam [No.]	Diesel [No.]	Electric [No.]
1950-55 Average	751	37	..
1955-60 Average	634	126	..
1960-65 Average	620	255	..
1965-70 Average	622	333	29
1970-75 Average	517	401	29
1975-80 Average	416	470	29
1980-85 Average	367	488	29
1985-90 Average	172	550	29
1990-95 Average	94	547	29
1995-2000 Average	16	545	29
2000-2005 Average	5	542	26
2005-2010 Average	6	513	18
2010-2011	5	500	16
2011-2012	5	494	16
2012-2013	5	465	16

Source: PR Yearbook 2014

An average of 180 locomotives out of 465 are available for daily operation service ,and the remaining locomotives are stabled for the supply of imported spare parts.

2.7.2 Coal Wagons

According to the Coal Handling Infrastructure Design Report for Jamshoro Power Generation Project (JPGP), (November 2013, ADB Contract No. 108815-580770), PR has 470 open top coal wagons at present. However, those wagons are hopper-type and not suitable for coal transportation to JPGP where rotary tippler (rotary car dumper) type unloading facility is planned.

Since this hopper-type of wagon has sloped floor for self-sliding of coal, the capacity is less than that of other wagon types. The advantage of this type is that there is no special facility or equipment required for discharging from wagon in the unloading site. However, due to having longer time for discharging, this type of wagon is not suitable for large scale coal transportation.

Source: JICA Study Team

Figure 2-28 PR Hopper Wagon

Table 2-23 Number of Freight Wagons Owned by Pakistan Railways (Broad Gauge)

Year	Number of Freight Wagon	
1950-55 Average	22,835	(64%)
1955-60 Average	24,310	(68%)
1960-65 Average	30,033	(84%)
1965-70 Average	34,999	(98%)
1970-75 Average	35,767	(100%)
1975-80 Average	34,966	(98%)
1980-85 Average	34,643	(97%)
1985-90 Average	34,774	(97%)
1990-95 Average	29,712	(83%)
1995-2000 Average	24,369	(68%)
2000-2005 Average	22,676	(63%)
2005-2010 Average	18,499	(52%)
2010-2011	18,402	(51%)
2011-2012	17,545	(49%)
2012-2013	16,635	(47%)

Source: PR Yearbook 2014

2.7.3 Passenger Carriage

Table 2-24 Number of Passenger Carriage (Broad Gauge only)

Year.	Passenger Carriage (No.)		Other Coaching Vehicles (No.)
1950-55 Average	1,429	58%	839
1955-60 Average	1,540	63%	935
1960-65 Average	1,643	67%	1,091
1965-70 Average	1,899	78%	1,128
1970-75 Average	1,846	75%	1,035
1975-80 Average	1,917	78%	764
1980-85 Average	2,166	89%	607
1985-90 Average	2,447	100%	458
1990-95 Average	2,190	89%	371
1995-2000 Average	1,705	70%	376
2000-2005 Average	1,549	63%	270
2005-2010 Average	1,601	65%	238
2010-2011	1,540	63%	234
2011-2012	1,584	65%	239
2012-2013	1,540	63%	245

Source: PR Yearbook 2014

2.8 Pipri Marshalling Yard

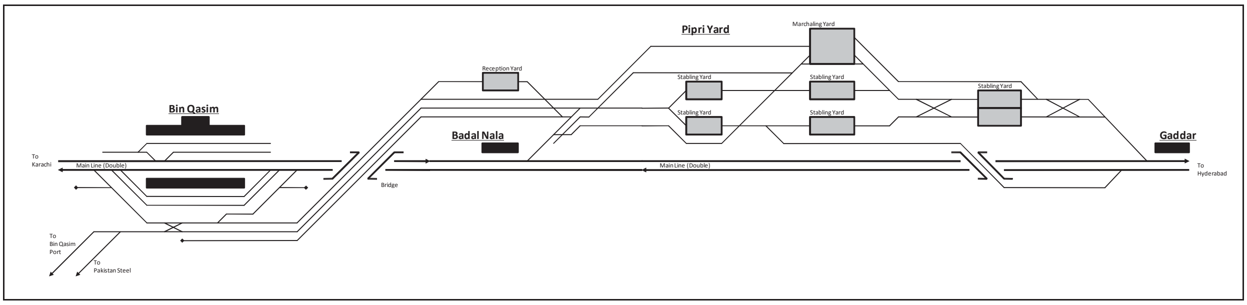
Pipri Marshalling Yard is a typical hump yard with car-retarder and is composed mainly of three parts: arriving yard, shunting yard, and departure yard (train making yard).

The arriving yard has 12 lines, shunting yard has 32 lines, and departure yard has 14 lines. This yard operated since 1982 and almost all car-retarders and automatic-turnouts are damaged and do not work at present. Some parts of this marshalling yard is used for shunting manually. Almost all lines of arriving yard and shunting yard are being used as stabling line for unused freight wagons.

The freight trains from Port Qasim arrive before the arriving yard and pass through the arriving yard and shunting yard and directly arrive at the departure yard.

Pipri Marshalling Yard has big potential for increasing freight transportation when all infrastructure, such as control system, automatic turnouts, and car-retarders, is rehabilitated.

For coal transport from Port Qasim and PIBT Port, the coal train shall be a unit train that does not needed shunting at the marshalling yard and is required only at the departure yard for the main line operation of unit coal train. The removal of the stored wagons and rehabilitation of automatic turnouts and control system for this part will be necessary for efficient use of the departure yard for coal transport unit train.

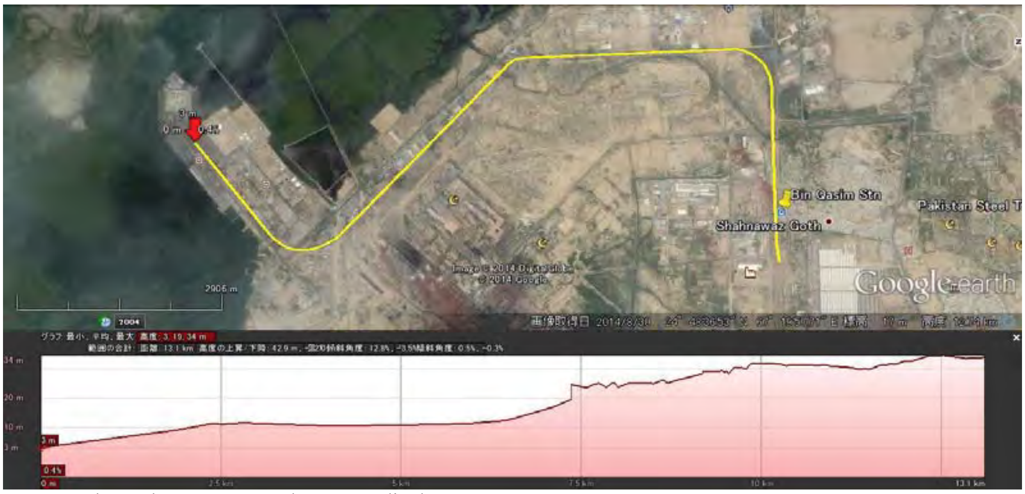


Source: JICA Study Team. Photo at the control center of PR Karachi Division

Figure 2-29 Track Layout of Pipri Marshalling Yard

2.9 Spur Line to Port Qasim

The construction of additional lines between Port Qasim to Bin Qasim Station (13 km), and rehabilitation of existing track of the same location (13 km) are included in the PC-1 for Coal Transportation by Rail to Jamshoro Power Plant (May 2014).



Source: Google Earth Pro. JICA Study Team. Edited.

Figure 2-30 Existing Spur Line to Port Qasim from Bin Qasim Station

There are siding tracks near the container yard at Port Qasim. Those siding tracks are designed mainly for container transportation. Considering the volume of coal transportation in the future, there should be a station having siding tracks for coal trains near the coal stockyard.

On the other hand, it is planned to operate three roundtrips by two train sets between PIBT and Jamshoro in the Coal Handling Infrastructure Design Report of Jamshoro Power Generation Project (November 2013).

However, it is unclear which site will be used for coal transportation at this moment. Considering the difficulty of railway access to PIBT, the idea to reinforce the existing railway facilities in Port Qasim seems practical.

2.10 Budapur Station

Budapur Station has one passing loop with two sidings for relief and track maintenance, and the effective length of the passing loop is 608.25 m.

The rail level is about 5 m embankment and the outside of the station area is being used as cultivated fields and water pool during rainy weather/season.

The track layout of Budapur Station is shown in Figure 2-35 and the farthest station signal is located at about 500 m in the Dadu side from Budapur Station.

Source: JICA Study Team

Figure 2-31 Main Line and Siding of Budapur Station

Source: JICA Study Team

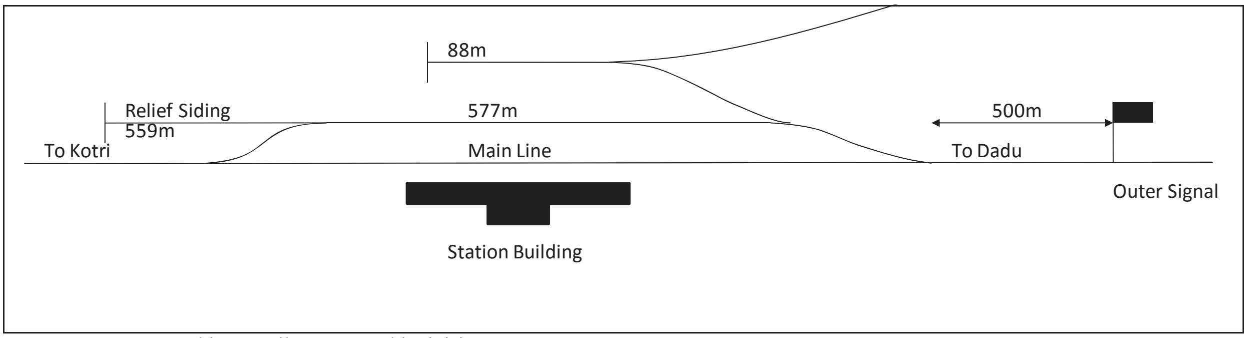
Figure 2-32 Train Dispatcher of Budapur Station

Source: JICA Study Team

Figure 2-33 Dadu Side of Budapur Station

Source: JICA Study Team

Figure 2-34 Kotri Junction Station Side of Budapur Station



Source: Pakistan Railways Karachi Division

Figure 2-35 Track Layout of Budapur Station

Chapter 3 Demand Forecast

3.1 Coal Transportation

There are five ongoing coal-fired power plant projects for which coal are planned to be transported from Pakistan International Bulk Terminal Limited (PIBT) and Port Qasim. Two projects are in Sindh Province and three projects are in Punjab State as shown below.

3.1.1 Coal Transportation to Jamshoro and Lakhra Power Plants

According to the Asian Development Bank (ADB) report, the annual requirements of coal for Jamshoro Power Plant will be 4.2 million tons while Lakhra Power Plant will require 2 million tons annually. Therefore, the total annual requirements of Jamshoro and Lakhra will be 6.2 million tons.

Source: Google Earth Pro. JICA Study Team. Edited.

Figure 3-1 Railway Line from Port Qasim to Jamshoro and Lakhra

3.1.2 Coal Transportation to Three Power Plants in Punjab State

According to PR, there are three coal-fired power plant projects in Punjab State, namely, Rahim Yar Khan, Muzaffargarh, and Sahiwal (or Qadirabad) power plants. Each power plant requires 4 million tons of coal annually. No further detailed information was available from PR.

The distance (track length) from Port Qasim to those plants are as follows:

- Port Qasim – Rahimyar Khan: 620 km approximately
- Port Qasim – Muzzaffargarh: 810 km approximately

- Port Qasim – Sahiwal: 1,020 km approximately

According to the the information from Port Qasim Authority, Sahiwal Power Plant Project has started the construction among the projects mentioned above. It is also informed that the location of one of the remaining projects may be shifted to Port Qasim site.

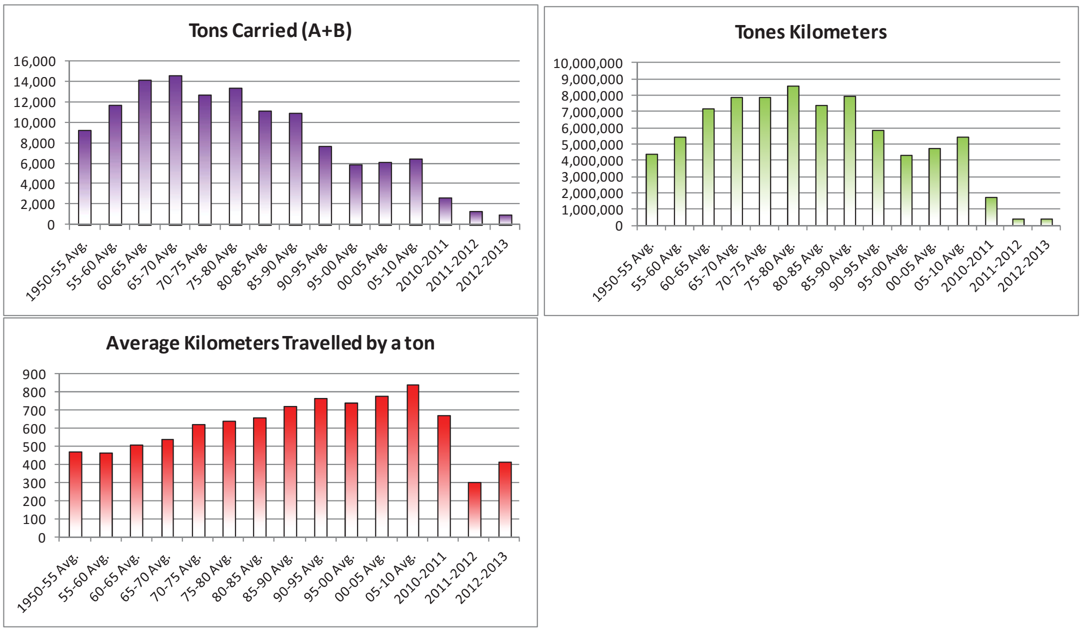
PR has provided coal transportation plan to power plants in Punjab State as described in Clause 4.3.

Source: Google Earth Pro. JICA Study Team. Edited.

Figure 3-2 Railway Line from Port Qasim/PIBT to Three Power Plants in Punjab State

3.2 Other Freight Transportation

As clearly shown in Figure 3-3, PR's freight transportation has been decreased drastically in terms of tonnage and tons-kilometers since 2010. Before 2010, the freight tonnage and tons-kilometers were decreased in parallel with the number of locomotives.



Source: JICA Study Team

Figure 3-3 PR Freight Transportation by Year

Major commodities transported by PR before and after 2010 are elaborated below.

3.2.1 Major Commodities in 2008-09

Major commodities in 2008-09 are as follows:

- Diesel and furnace oils: 1,302.2 million tons-km (22.1% of total freight)
- Container traffic: 1,007.7 million tons-km (17.1%)
- Cement: 420.4 million tons-km (7.1%)
- Railway materials and stones: 312.5 million tons-km (5.3%)
- Coal and coke for public: 257.1 million tons-km (4.4%)

3.2.2 Major Commodities after 2010

Major commodities in 2012-13 are as follows:

- Railway materials and stones: 155.8 million tons-km (37.2% of total freight)
- Diesel and furnace oils: 102.9 million tons-km (24.5%)
- Container traffic: 64.2 million tons-km (15.3%)
- Coal and coke for public: 50.6 million tons-km (12.1%)
- Cement: 25.8 million tons-km (6.2%)

3.2.3 Future Demand of Freight Transportation

It is difficult to forecast the future demand of PR's freight transportation except coal, because of the recent shrinkage of the demand. If this demand shrinkage was caused by the shortage of locomotives, future demand may increase in accordance with the increase of locomotives.

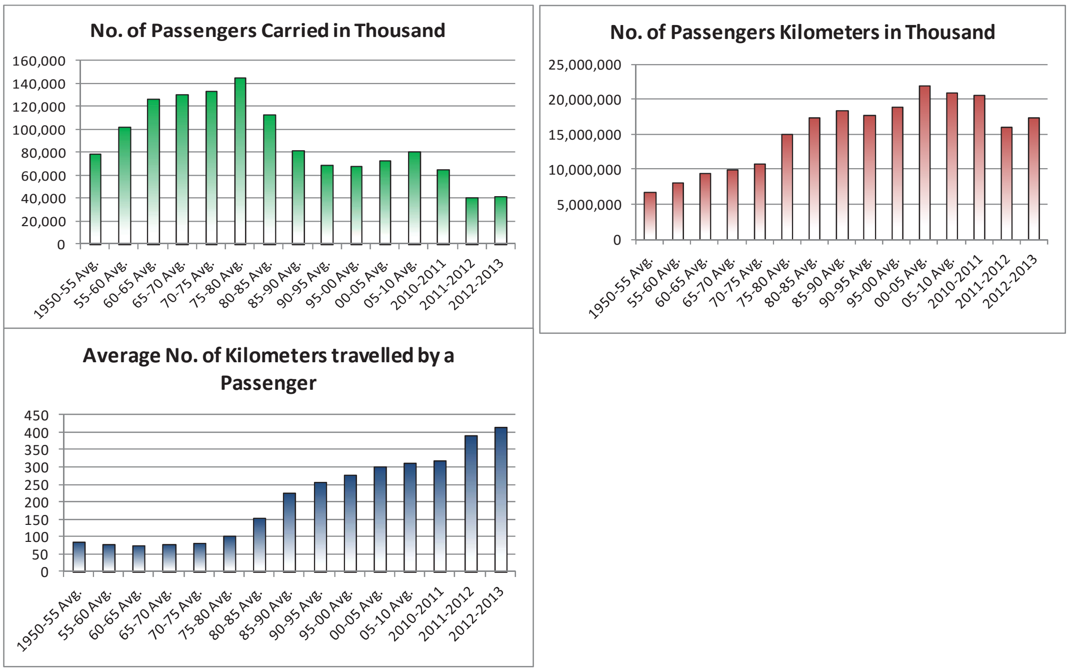
As described in Clause 2.6.2(1), the riots in December 2007 damaged not only the signaling system but also the reliability of transportation by PR. Since then, the share of freight transportation by PR decreased as shown in Figure 3.3.

When PR's transportation capacity recovers in the future, those commodities which have had higher share, such as diesel and furnace oils, containers, and cement, will be increased accordingly.

The line capacity between Bin Qasim Station and Kotri Junction is enough for increase in number of trains to transport coal for Lakhra, Jamshoro, and three Punjab power plants as explained in Clause 4.3. And if necessary, the line capacity will be doubled by improvement of the signal system. PR has another idea to construct a new railway line between Pipri Marshalling Yard and Kotri Junction for future increase in freight transportation (refer to Clause 4.3).

3.3 Passenger Transportation

As shown in Figure 3-4, the peak of passengers' number was recorded between 1975 and 1980. However, the peak of passenger-kilometers was recorded between 2000 and 2005; although the number of passengers was just half of what was recorded in 1975-1980. However, travelling distance has quadrupled within 25 years.



Source: JICA Study Team

Figure 3-4 PR Passenger Transportation by Year

The number of passengers is decreasing after the peak period especially after 2010. One of the reasons of the decrease in passengers' number is the decrease of locomotives. In the period of 1975-1980, the total number of locomotives was 992, including 416 steam locomotives. The number of steam locomotives kept on decreasing to 5 in 2000. Replacement of those steam locomotives by diesel locomotives were limited; thus, the total number of locomotives was decreased to 493 in 2013 (refer to Clause 2.4.4).

Chapter 4 Coal Transportation and Train OperationPlan

4.1 Preparation for Coal Train Operation Plan

The Japan International Cooperation Agency (JICA) Study Team studied five cases of coal transportation systems by means of type of wagon and axle load.

- **Case 1: Dump Truck System**

The lowest initial investment is by using the existing track from Kotri Junction to Budapur Station and locomotives and wagons with axle load lower than 17.27 tons. A coal-handling yard will be constructed at Budapur Station and the coal will be transported in an open top coal container. The coal containers will be transported by dump trucks on dedicated road to the coal stockyard of the Lakhra Power Plant. The allowable axle load of rolling stocks is 17.27 tons.

- **Case 2A: Spur Line with Additional Track Between Kotri Junction and Budapur Station**

Additional track beside the existing track from Akhundabad Junction to Budapur Station may be constructed to enable the use of heavy and high-power locomotives, and side or bottom hopper wagons, which are of the same type as the wagons that are planned to be used for coal transport to Jamshoro Power Plant and other power plants in Punjab State. The coal terminal station is constructed beside the coal stockyard of Lakhra Power Plant. The allowable axle load of rolling stocks is 23.3 tons.

- **Case 2AR: Spur Line with Rehabilitation of Track Between Kotri Junction and Budapur Station**

The track and bridges of the existing line from Kotri Junction to Budapur Station may be rehabilitated to enable the use of heavy and high-power locomotives, and the side or bottom hopper wagons which are of the same type as the wagons that are planned to be used for coal transport to Jamshoro Power Plant and other power plants in Punjab State. The coal terminal station is constructed beside of the coal stockyard of Lakhra Power Plant. The allowable axle load of rolling stocks is 23.3 tons.

- **Case 2B: Spur Line without Additional Track between Kotri Junction and Budapur Station**

Without the construction of additional track nor the rehabilitation of existing track from Kotri

Junction to Budapur Station, then the locomotives and wagons with axle load lower than 17.27 tons will be operated. The wagons are the side or bottom hopper wagons which are of the same type cited in Case 2A but only 40 tons of coal will be loaded. The coal terminal station is constructed beside the coal stockyard of Lakhra Power Plant. Allowable axle load of rolling stocks is 17.27 tons.

This case is applied in case of the railway improvement of Jamashoro Power Plant project will not be implemented.

- **Case 3: Conveyor Belt System**

Case 3 is similar to Case 2A and/or Case 2AR but the coal terminal station is located alongside the main track of Kotri Junction-Dadu line and the coal is transported by belt conveyor from the coal terminal station to the coal sockyard of Lakhra Power Plant. The purpose of this case is to reduce the construction cost of railway. The allowable axle load of rolling stocks is 23.3 tons.

4.1.1 Condition of Coal Transportation

(1) Volume of Coal to be Transported

The required volume of coal for Lakhra Power Plant is 2 million tons per year.

The Pakistan Railway (PR) plans to transport 4 million tons of coal to Jamshoro Power Plant. It is preparing the improvement of track from Port Qasim to Bin Qasim Station, and from Kotri Junction to Jamashoro Power Plant via Akhundabad Station, as well as the procurement of locomotives and coal wagons.

(2) Condition of Track

The axle load from Port Qasim Station and Bin Qasim Station to Kotri Junction is 23.3 tons, and from Kotri Junction to Budapur Station is 17.27 tons. PR plans to rehabilitate the track and bridges for the axle load of 23.3 tons, same as the main line between Karachi to Kotri Junction, and from Kotri Junction to Akhundabad Station for coal transportation to Jamshoro Power Plant.

The location of Lakhra Power Plant is about 7 km from the existing Budapur Station and the height of the power plant is about 20 m higher (about 40 m from sea level) from the ground level around Budapur Station (about 20 m).

The limit of the gradient of the main line of PR is 1/200 (0.5%), and the steepest gradient from

Bin Qasim Station to Kotri Junction and from Kotri Junction to Budapur Station is 1/200.

The minimum length of passing loop between Bin Qasim Station and Kotri Junction is 642 m at Jungshahi Station.

The length of the passing loop of stations between Kotri Junction and Budapur Station is less than 650 m (e.g., 487 m at Sindh University Station and 608 m at Budapur Station). The passing loops of this section will be extended to 650 m so that a 637 meter-train can stop with enough clearance to let other trains pass.

(3) Working Days per Year

PR intends to work 360 days per year for the coal transportation plan to Jamshoro Power Plant. The JICA Study Team plans to work 330 days per year considering track maintenance by machine in the future.

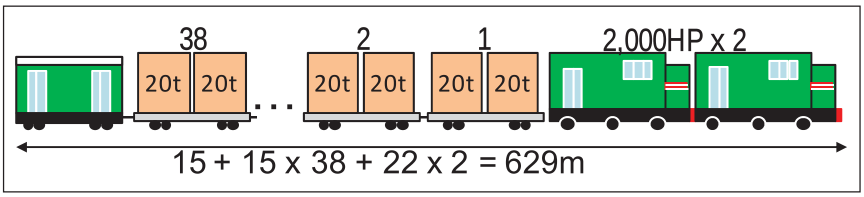
4.1.2 Transportation System

The JICA Study Team studied five cases of coal transportation systems based on type of locomotives and wagon and axle load.

(1) Case 1: Dump Truck System: Coal Container + Container Wagon and Truck

This system is for the purpose of lowest initial investment cost, easy transfer and easy unloading of coal. There will be no need for the upgrading of track, or construction of additional track, from Kotri Junction to Budapur Station.

The design axle load of the section between Kotri Junction and Budapur Station is 17.27 tons. The weight of loaded coal per wagon is limited to 40 tons, and the number of coal wagon is limited to 38 due to the length of the passing loop at the intermediate stations. Because of this, the required number of coal trains to Lakhra Power Plant will be four trains daily. Figure 4-1 shows the train composition of Case 1.



Source: JICA Study Team

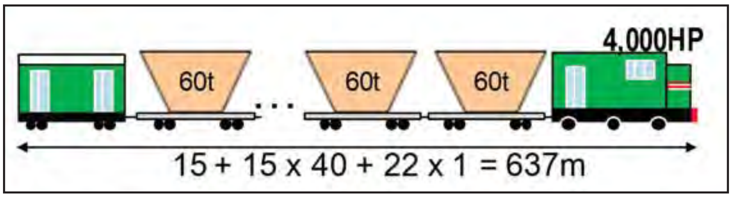
Figure 4-1 Train Composition of Case 1

Coal will be loaded in a 20-feet open top container which will be transported by common container wagons. The container will be transported to Budapur yard and transferred to truck by leach stacker and then transported to the deck beside the coal terminal of the power plant. The coal will then be dumped directly from the container to the coal terminal

The locomotives and container wagons are for axle load of 17.27 tons. There will be no need for track improvement from Kotri Junction to Budapur Station. However, the extension of passing loops to 640 m is necessary at the following stations: Sindh University Station, Cadet College Petaro Station, Unapur Station, and Budapur Station.

(2) Case 2A: Spur Line and High Grade Coal Wagon with Axle Load of 23.3 Tons

In this case, the section between Kotri Junction and Budapur Station is upgraded (by an additional track) to accommodate an axle load of 23.3 tons, the weight of loaded coal will be 60 tons, and the number of wagons will be 40 because of the use of single heavier locomotive. In this case, the required number of coal trains will be three trains per day. Figure 4-2 shows the train composition of Case 2A.



Source: JICA Study Team

Figure 4-2 Train Composition of Case 2A

The same system of coal transportation planned by PR to Jamshoro Power Plant, using high-power locomotive and high-grade coal wagons with side or bottom hopper will be applied for the coal transportation to Lakhra Power Plant. The axle load of locomotives and wagons is 23.3 tons. The track from Kotri Junction to Budapur Station is needed to upgrade its capacity to 23.3 ton-axle load by constructing additional track beside the existing track. When the Planning Commission-1 (PC-1) project of PR for Jamshoro Power Plant is implemented, the construction of additional track will be from Akhndabad Junction to Budapur Station

The spur line branched at Budapur Station to Lakhra Power Plant will be constructed and new terminal station, Lakhra Power Plant Station, will be constructed including the unloading facilities beside the coal stockyard of the power plant. The unloading facility is two sets of coal pits for bottom or side hopper wagons and belt conveyor system to transfer the coal to the stockyard.

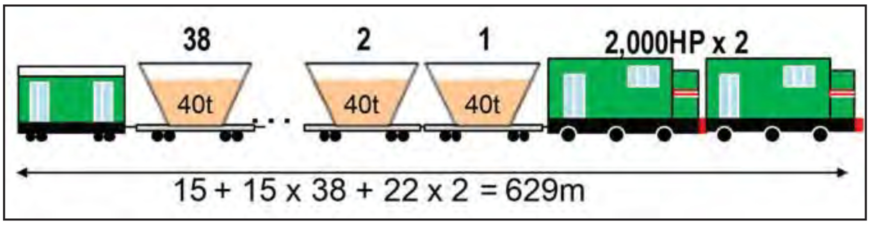
(3) Case 2AR: Spur Line and High Grade Coal Wagon with Axle Load of 23.3 tons

In this case, the section between Kotri Junction and Budapur Station is upgraded by the rehabilitation of track and bridges to accommodate an axle load of 23.3 tons, the weight of loaded coal will be 60 tons, and the number of wagons will be 40 because of the use of a single heavier locomotive. In this case, the required number of coal trains will be 3 trains per day. This is a similar concept as Case 2A.

(4) Case 2B: Spur Line and High Grade Coal Wagon with Axle Load of 17.27 ton

In this case, the section between Kotri Junction and Budapur Station is not upgraded and the track with the allowable axle load of 17.27 tons is kept, and the length of crossing/passing loop of intermediate four stations are short, as shown on Table 2-3, then the crossin/passing loops of these four stations will be extended to 650 m. At present, the weight of loaded coal per wagon is limited to 40 tons, and the number of coal wagons is limited to 38 due to the length of crossing/passing loop at the intermediate stations. Thus, the required number of the coal trains to Lakhra Power Plant will be four trains per day.

Figure 4-3 shows the train composition of Case 2B.



Source: JICA Study Team

Figure 4-3 Train Composition of Case 2B

This case is without additional track between Kotri Junction and Budapur Station, so that there will be lower initial investment cost. However, the crossing loops will be extended to 650 m at the following stations: Sind University (487.68 m), Cadet College Petaro (530.65 m), Unapur (606.72 m) and Budapur (608.25 m). The axle load of locomotives and wagons is limited to 17.27 ton. The track condition will be kept at present condition. The length of crossing loops of the four stations will be extended to 650 m to enable the trains crossing or passing at the station.

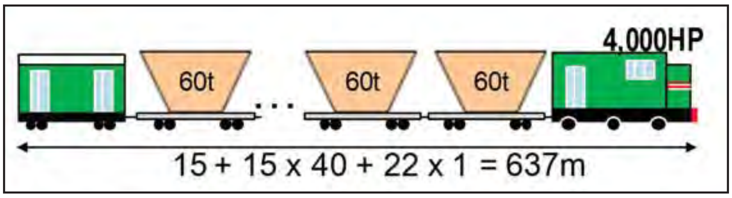
The wagons to be used in Case 2B are of the same type as of Case 2A with a payload of 60 tons. The coal that will be loaded can only weigh 40 tons into the same type of coal wagons as in Case 2A to keep the axle load less than 17.27 tons. The locomotives to be used are light weight with axle load less than 17.27 tons, which is the same as in Case 1.

The spur line to Lakhra Power Plant is same as Case 2A, and the structure of the spur line will be constructed for the axle load 23.3 ton same as Case 2A for the future improvement of the track from Kotri Junction to Budapur Station. The number of the stabling lines at Lakhra

Power Plant Station will be four and the unloading facility is two sets of coal pits for bottom or side hopper wagons, as in Case 2A.

(5) Case 3: Conveyor Belt System; Coal Terminal Station Alongside the Main Line

In this case, the section between Kotri Junction and Budapur Station is upgraded (by an additional track) to an axle load of 23.3 tons; the weight of loaded coal will be 60 tons, and number of wagons will be 40 because of the use of a single heavier locomotive. In this case, the required number of coal trains will be three trains per day. Figure 4-4 shows the train composition of Case 3.



Source: JICA Study Team

Figure 4-4 Train Composition of Case 3

As in the system of Case 2A, this case will use high power locomotive and high grade coal wagons with side or bottom hopper. The axle load of locomotives and wagons allowed is 23.3 tons. Additional track for axle load of 23.3 tons will be constructed from Kotri Junction or Akhundabad Junction to New Budapur Station.

A new coal terminal station will be constructed alongside the main track between Budapur Station and Khanot Station, near Lakhra Power Plant. Two sets of unloading facilities of coal pits for bottom or side hopper wagons and belt conveyor system to transfer the coal to the stockyard of Lakhra Power Plant will be constructed.

(6) Required Number of Coal Trains to Lakhra Power Plant

The required number of coal train per day to a specific coal-fired power plant can be calculated from the required volume of coal per day divided by the volume of coal transported by a train.

The assumptions in the calculation of the required number of trains are as follows:

- the required volume of coal for Lakhra Power Plant is 2 million tons per year,
- train operation days per year is 330 days,
- axle load is 17.27 tons for Case 1 and Case 2B, and 23.3 tons for Case 2A, Case 2AR, and Case 3,
- length of passing loop of stations is longer than 640 m (650 m),

- weight of container is 3 tons for 20 feet open-top container, two containers for one container wagon and weight of container wagon is 20 tons,
- weight of high-grade side/bottom hopper wagon is 25 tons,
- length of wagons: 15 m for container wagon, high grade side/bottom hopper wagon,
- length of locomotives: 22 m,
- capacity of container and wagon: container: 20 tons and high grade side/bottom hopper wagon: 60 tons,
- axle load of loaded wagon: container wagon is 16.5 tons, hopper wagon with 60 tons of coal is 21.25 tons, and hopper wagon with 40 tons of coal is 16.25 ton,
- train formation: in Case 1, two locomotives + 38 container wagons + one brake van,
- train formation: in Case 2A, Case 2AR and Case 3, one locomotive + 40 hopper wagons + one brake van
- train formation: in Case 2B, two locomotives + 38 hopper wagons + one brake van

The results of the calculation are shown in Table 4-2.

Table 4-1 Number of Trains to Transport 2 Million Tons of Coal per Year

Case	Axle Load	Length of Locomotive	No. of Locomotive/s	Length of Wagon	No. of Wagon/s	Length of Brake Van/s	Length of Train	Weight of Wagon	Weight of Coal / Wagon	Weight of Coal/ Train	No. of Trains/Day	Weight of Coal/Year
	ton	**m**	**No.**	**m**	**No.**	**m**	**m**	**ton**	**ton**	**ton**	**ton/ year**	**ton/year**
Case 1	17.27	22	2	15	38	15	629	26	40	1,520	4	2,006,400
Case 2A Case 2AR and Case 3	23.3	22	1	15	40	15	637	25	60	2,400	3	2,376,000
Case 2B	17.27	22	2	15	38	15	629	25	40	1520	4	2,006,400

Note: Transport volume: 2,000,000 tons/year
Operation days: 330 days/year
Source: JICA Study Team

4.1.3 The Traction Capability of Locomotives

(1) Traction Effort of Locomotives

The traction effort of locomotives owned by PR is shown on the following table.

Table 4-2 Traction Effort of Locomotives for Main Line Owned by PR

Loco Type	Unit	PHA20	AGE30	DPU30
Axle load	ton	17.7	22.1	23
Horse power	HP	2,200	3,300	3,500
Traction effort	kN	241	367	391
	Tonf	24.6	37.4	39.8

Note: PHA20: Diesel-Electric Locomotive made by Hitachi/Japan
AGE: Diesel-Electric Locomotive made by GE/USA and ADTRANZ/Germany
DPU30: Diesel-Electric Locomotive made by DLRW/China
Source: JICA Study Team: Data from Brochure of Pakistan Locomotive Factory Risalpur

(2) Running Resistance of Wagons

The running resistance of train is mainly the rolling friction, air resistance, and gradient resistance. The air resistance of a train is very small compared to the other resistance when the running speed is not fast, in this study, the air resistance is neglected.

The following table shows the calculation results and the data and factors used to determine the resistance/friction caused by 40 wagons in one train formation..

Table 4-3 Resistance/Friction of Wagons of a Train Set

Item	Unit	Hopper wagon Case 2A		Wagon Case 2B	Container Wagon
No. of wagon	No.	40		38	38
Weight of wagon	ton	25		25	26
Weight of brake van	ton	45		45	45
Weight of coal	ton	60		40	40
Total load	ton	3445		2515	2553
Rolling friction factor	kg/ton	0.005		0.005	0.005
Rolling friction	ton	17.2	17.2	12.6	12.8
Gradient of track		1/200	1/100	1/200	1/200
Gradient factor	kg/ton	0.005	0.01	0.005	0.005
Gradient resistance	ton	17.2	34.5	12.6	12.8
Total resistance/friction	ton	34.5	51.7	25.2	25.6

Source: JICA Study Team

(3) Case 1: Dump Truck System

The total running resistance within the gradient of 1/200 (0.5%) is 25.6 tons and this is slightly over the traction effort of the locomotive for axle load of 17.27 tons (PHA20), and one train set with 38 container wagons and one brake van **that** require two locomotives.

(4) Case 2A, Case 2AR: Spur Line and Case 3: Conveyor Belt System with Axle Load 23.3 Tons

The total running resistance within the gradient 1/200 is 34.5 tons and the traction effort of the high-power locomotives for main line more than 37.4 tons (AGE30). The existing locomotives for the main line have the capability to pull one train set with 40 hopper wagons plus one brake van, and the new locomotives under purchasing by PR are more high-powered than the existing fleet.

In the case of a steeper gradient of 1/100 (1%), the running resistance is 51.7 tons and the traction effort of the high-power locomotive is 39.8 tons (DPU30), which is lower than the running resistance. Two locomotives will be necessary to run the track with a 1/100 gradient.

(5) Case 2B: Spur Line with Axle Load 17.27 Tons

The total running resistance within the gradient of 1/200 (0.5%) is 25.2 tons and this is slightly over the traction effort of the locomotive for axle load 17.27 tons (PHA20) with traction effort of 24.6 tons, and one train set with 38 hopper wagons, and one brake van that require two locomotives of PHA20.

4.1.4 Cycle Time of Train Operation

Coal trains are generally operated in a form of shuttle service with fixed composition.

The cycle time of the shuttle train of coal transportation from Port Qasim to Lakhra Power Plant is discussed in this section.

(1) Case 1: Dump Truck System

The coal will be loaded in the containers on the container wagons at the coal loading line beside Port Qasim Station. The coal train will run from Port Qasim Station to Budapur Station via Bin Qasim Station, Kotri Junction, and then from Kotri Junction to the branch line at Budapur Station. The branch line only has enough capacity to allow four operating trains, each requiring a one-hour stand-by interval at the Kotri junction.. At the opposite direction, when a train from the branch line has to get to the main line but the main line is busy with a train operation, the train at the opposite direction has to wait for one to two hours before proceeding. Usually, the train operator of PR Karachi Division, allocates two hours for this interval.

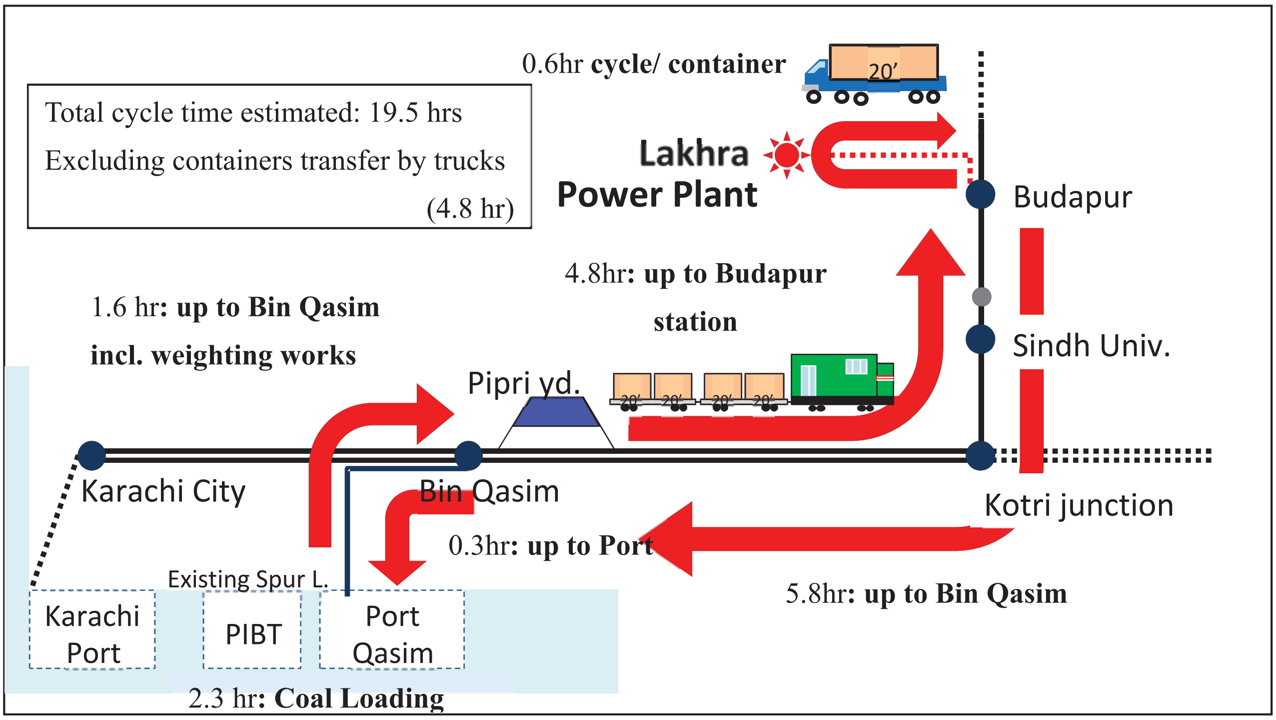
The cycle time for Case 1 was calculated with reference to the train operation concept and information on the coal transportation plan to Jamashoro from PR Karachi Division.

Table 4-4 Summary of Operation Cycle Time (Case 1)

	Item	Time	Quantity	No. of Containers	Total Time	Remarks
		Min.	No.		Min.	
1	Loading coal at Port Qasim	1	38 Nos.	2	76	2 containers/wagon
2	Shunting wagons for loading	30			60	To/from loading and station
3	Train running from Port Qasim to Bin Qasim station		13 km	2	19	42 km/h
4	Wagon weighing at Bin Qasim Station	2	38 Nos.		76	2 min./wagon
5	Train running from Bin Qasim Station to Kotri Junction		131.65 km		146	65 km/h
6	Waiting at Kotri Junction	60			60	
7	Train running from Kotri Junction to Budapur Yard		40.31 km		79	42 km/h
8	Unloading and loading coal container at Budapur Yard	3	38 Nos.	2	228	2 containers/wagon
9	Loading empty container	3	10 Nos.	2	60	loading after 10 wagons unloading
10	Train running from Budapur Station to Kotri Junction		40.31 km		79	42 km/h
11	Waiting at Kotri Junction	120			120	
12	Train running from Kotri Junction to Bin Qasim Station		131.65 km		146	65 km/h
13	Train running from Bin Qasim Station to Port Qasim		13 km		19	42 km/h
	Total Cycle Time (minutes)				1,168	
	Total Cycle Time (hours)				19.5	0.81 days

Source: JICA Study Team

According to the above calculation results, it is possible to consider one cycle per day for a stable train operation plan considering some margin in case of small accidents or some other operational troubles.



Source: JICA Study Team

Figure 4-5 Estimated Cycle Time

(2) Case 2A and Case 2AR: Spur Line with Axle Load of 23.3 tons

The empty coal train will arrive from Lakhra Power Plant Station and stay on the stable line of Port Qasim Station. The empty wagons will be transferred to the coal loading hopper by shunting locomotive. The coal will be loaded in the hopper wagons from the loading hopper on the coal loading line beside Port Qasim Station. The loaded coal wagons will be trasnfered to the departure line of Port Qasim Station by shunting locomotive and the coal train will run from Port Qasim Station to Budapur Station via Bin Qasim Station, Kotri Junction. It will go from Kotri Junction to the branch line at Budapur Station. The branch line only has enough capacity for four operating trains, each requiring a one-hour interval of waiting at the Kotri Junction. At the opposite direction, the train from the branch line going to the main line, train operation on main line is busy, the train needs to wait for enough interval of train operation of the main line, usually one ~ two-hour waiting is considered by the train operator of PR Karachi Division,. The train operation between Budapur Station and Lakhra Power Plant Station is through a branch line from Budapur Station and the train is required to wait there for some minutes before proceeding.

The coal-loaded train will arrive at Lakhra Power Plant Station and stay at a stabling line. Then, the coal-loaded wagons will be shunted to the unloading line by a shunting locomotive to unload the coal. After completing discharge of all the coal, the wagons will go back to the stabling line and wait for departure to Port Qasim Station. The track arrangement of Lakhra

Power Plant Station is shown on Figure 7-2 Track alignment of Lakhra Power Plant Station, including coal unloading facility.

The cycle time shown on the table below is calculated with reference to the train operation concept and information on the coal transportation plan to Jamashoro from PR Karachi Division.

Table 4-5 Summary of Operation Cycle Time (Case 2A and Case 2AR)

	Item	Unit time	Quantity	Total time	Remarks
		Min.	No.	Min.	
1	Loading coal at Port Qasim	2	40 No.	80	60 tons per wagon
2	Shunting wagons for loading	30	2	60	Between loading line and stable line of station
3	Train running from Port Qasim to Bin Qasim Station		13 km	19	42km/h
4	Wagon weighing at Bin Qasim Station	2	40 No.	80	2 min./wagon
5	Train running from Bin Qasim Station to Kotri Junction		131.65 km	146	65 km/h
6	Waiting at Kotri Junction	60		60	
7	Train running from Kotri Junction to Budapur Yard		40.31 km	79	42 km/h
8	Train running from Budapur Station to Lakhra Power Plant Station			20	6 km by 20 km/h, plus wait time 2 minutes at Budapur Station
9	Unloading at Lakhra Power Plant Station	3	40 No.	120	6 min. per wagon and 2 wagons unload in one time
10	Shunting of wagons for unloading	30		60	Between unloading line and stable line of station
11	Train running from Lakhra Power Plant Station to Budapur Station			20	6 km by20 km/h, wait time at Budapur Station
12	Train running from Budapur Station to Kotri Junction		40.31 km	79	42 km/h
13	Waiting at Kotri Junction	120		120	
14	Train running from Kotri Junction to Bin Qasim Station		131.65 km	146	65 km/h
15	Train running from Bin Qasim Station to Port Qasim		13 km	19	42 km/h
	Total Cycle Time (minutes)			1,108	
	Total Cycle Time (hours)			18.5	0.77 day

Source: JICA Study Team

According to the calculation results shown above, it is possible to consider one cycle per day for a stable train operation plan considering some margin in case of small accidents or some other operational troubles.

The weight of the loaded coal in the coal wagon is controlled by the coal loading hopper. The purpose of weighing the wagon at Bin Qasim Station is to confirm the weight of coal in the wagon to avoid overloading. The weighing machine at Bin Qasim Station did not work when the JICA Study Team visited the site and it was not used long time. PR intends to improve the weighing machine and shorten the weighing time from 5 minutes to 1 minute, according to the engineer of the Karachi division of PR (although the concrete improvement plan for the weighing machine was not confirmed by the authority of PR). The train must stop at the weighing machine to weigh the wagon and this takes a long time. PR plans to adopt a new type of machine to weigh the wagon without stopping it and/or shorten it to 1 minute per wagon. The JICA Study Team estimated 2 minutes per wagon for weighing. If the improvement of the weighing machine is not implemented, the time required to weigh a train with 40 wagons is going to be 3 hours and 20 minutes. Also, 2 hours shall be added to the cycle time. In total, the cycle time will be 20.5 hours, or still less than one day. There is no need to change the required number of train set. However, all the coal trains including Jamshoro Power Plant, and the power plants in Punjab State and Lakhra Power Plant will not be able to weigh in one day.

The shunting of wagons at Lakhra Power Plant Station for unloading is necessary.

(3) Case 2B: Spur Line with Axle Load 17.27 ton

The coal will be loaded in the hopper wagons from the loading hopper on the coal loading line beside Port Qasim Station. The coal train will then run from Port Qasim Station to Budapur Station via Bin Qasim Station, Kotri Junction. From Kotri Junction, it will go to the branch line to Budapur Station which has enough capacity only to allow four operating trains. Each train will have a one hour interval waiting at Kotri Junction before proceeding. From the opposite direction, the train from the branch line from Budapur Station to main line, train operation on main line is busy, the train needs to wait for enough interval of train operation of main line, usually one ~ two-hour waiting is considered by the train operator of PR Karachi Division,. The train operation between Budapur Station and Lakhra Power Plant Station is through a branch line from Budapur Station and the train is required to wait there for some minutes at Budapur Station before proceeding.

The cycle time, presented in the next table, is calculated using the same concept as with Case 2A and Case 2AR.

Table 4-6 Summary of Operation Cycle Time (Case 2B)

	Item	Unit time	Quantity	Total time	Remarks
		Min.	No.	Min.	
1	Loading coal at Port Qasim	2	38 No.	76	60 tons per wagon
2	Shunting wagons for loading	30	2	60	Between loading line and stabling line of station
3	Train running from Port Qasim to Bin Qasim Station		13km	19	42 km/h
4	Wagon weighing at Bin Qasim Station	2	38 No.	76	2 min./wagon
5	Train running from Bin Qasim Station to Kotri Junction		131.65km	146	65 km/h
6	Waiting at Kotri Junction	60		60	
7	Train running from Kotri Junction to Budapur Yard		40.31km	79	42 km/h
8	Train running from Budapur Station to Lakhra Power Plant Station			20	6 km by 20 km/h, plus wait time 2 minutes at Budapur Station
9	Unloading at Lakhra Power Plant Station	3	38 No.	114	6 min. per wagon and 2 wagons unload in one time
10	Shunting of wagons for unloading	30		60	Between unloading line and stabling line of station
11	Train running from Lakhra Power Plant Station to Budapur Station			20	6 km by20 km/h, wait time at Budapur Station
12	Train running from Budapur Station to Kotri Junction		40.31km	79	42 km/h
13	Waiting at Kotri Junction	120		120	
14	Train running from Kotri Junction to Bin Qasim Station		131.65km	146	65 km/h
15	Train running from Bin Qasim Station to Port Qasim		13km	19	42 km/h
	Total Cycle time (minutes)			1,094	
	Total Cycle time (hours)			18.2	0.76 day

Source: JICA Study Team

According to the results of the calculation, it is possible to consider one cycle per day for a stable train operation plan considering some margin in case of small accidents or some other operational troubles. The shunting of wagons at Lakhra Power Plant Station for unloading is necessary.

(4) Case 3: Conveyor Belt System

The coal will be loaded in the hopper wagons from the loading hopper on the coal loading line beside Port Qasim Station and the coal train will run from Port Qasim Station to Budapur Station via Bin Qasim Station, Kotri Junction. From Kotri Junction to the branch line at Budapur Station, only four trains are allowed to operate due to its capacity. Each train will go through one hour interval waiting at Kotri Junction. From the opposite direction, the train from the branch line to main line, train operation on main line is busy, the train needs to wait for enough interval of train operation of main line, usually one ~ two-hour waiting is considered by the train operator of PR Karachi Division,.

The cycle time, presented in the table below, is calculated using the same concept as with Case 2A and Case 2AR.

Table 4-7 Summary of Operation Cycle Time (Case 3)

	Item	Unit time or distance	Quantity	Total time	Remarks
		Min.	No.	Min.	
1	Loading coal at Port Qasim	2	40	80	60 tons per wagon
2	Shunting wagons for loading	30	2 No.	60	Between loading line and stable line of station
3	Train running from Port Qasim to Bin Qasim Station		13 km	19	42 km/h
4	Wagon weighing at Bin Qasim Station	2	40 No.	80	2 min./wagon
5	Train running from Bin Qasim Station to Kotri Junction		131.65 km	146	65 km/h
6	Waiting at Kotri Junction	60		60	
7	Train running from Kotri Junction to New Budapur Yard		44.5 km	90	42 km/h
9	Unloading at New Budapur Station	3	40 No.	120	6 min. per wagon and 2 wagons unload in one time
10	Shunting of wagons for unloading	30		60	Between unloading line and stable line of station
11	Train running from New Budapur Station to Kotri Junction		44.5 km	90	42 km/h
12	Waiting at Kotri Junction	120		120	
13	Train running from Kotri Junction to Bin Qasim Station		131.65 km	146	65 km/h
14	Train running from Bin Qasim Station to Port Qasim		13 km	19	42 km/h
	Total Cycle time (minutes)			1,090	
	Total Cycle time (hours)			18.2	0.76 day

Source: JICA Study Team

According to the results of the calculation, it is possible to consider one cycle per day for a stable train operation plan considering some margin in case of small accident or some other operational troubles.

The shunting of wagons at New Budapur Station for unloading is necessary.

Required Number of Coal Train Sets

Based on the results presented in Table 4-1 which is the number of trains required to transport 2 million tons of coal, and Table 4-4 to 4.6 which summarize the operation cycle time, four train sets for Case 1 and Case 2B, and three train sets for Case 2A, Case 2AR and Case 3 are required to transport 2 million tons of coal. Additional locomotives and wagons are necessary to be procured for the maintenance of the rolling stock and ensuring stable train operation.

Details of rolling stock will be explained in Chapter 5 Rolling Stock Fleet and Train Operation Plan.

4.1.5 Coal Transportation Plan to Jamshoro Power Plant Planned by PR (As a Reference)

The coal transportation to Jamshoro Power Plant is planned by the Ministry of Railways and Pakistan Railways (PR).

The outline of the transportation plan of coal of PR for Jamashoro Power Plant (PC-1 for Coal Transportation by Rail to Jamshoro Power Plant: May 2014) is as follows;

- Transport route is from Port Qasim to Jamshoro Power Plant via Bin Qasim Station, Pipri Marshalling Yard, Kotri Junction, Sindh University Station and Akhundabad Station
- Transport plan:
  - Coal to be transported per annum : 6.60 million tons
  - Lead : 160 km
  - Turn round : 1.4 days
  - No. of working days : 360
  - Coal to be transported per day : 18,333.4 ton
  - Axle load of hopper wagon : 21 tons
  - Pay load per wagon : 60 tons
  - Requirement of wagons per day : 427
  - In effective allowance @ 15% : 64
  - Hopper wagons requirement : 491
  - Total brake vans : 9
  - **Total requirement : 500**
  - Nos. of wagons per day : 305 wagons
  - No. of trains per day : 7.6 Nos. (=305/40)
  - Locomotive required per day : 7.6 Nos.
  - **Total requirement of locomotives : 10 Nos.** (=7.6 x 1.4)
- Cycle time of transportation (according to train operation engineer of PR Karachi division):

- Loading at port: 6 hours
- Running time, Port Qasim-Bin Qasim Station-Pipri Marshalling Yard: 1 hour
- Checking and weighing the train: 2 to 3 hours
- Running, Pipri Marshalling Yard- Kotri Junction: 3 hours
- Waiting time at Kotri Junction: 1 to 2 hours
- Running, Kotri Junction-Jamashoro: 2 hours
- Unloading at Jamshoro Power Plant: 6 hours
- Running, Jamshoro-Kotri Junction: 2 hours
- Waiting time at Kotri Junction: 1 to 2 hours
- Running, Kotri Junction-Pipri Marshalling Yard: 3 hours
- Running time, Port Qasim-Bin Qasim Station-Pipri Marshalling Yard: 1 hour
  - Total: 28 to 31 hours, 1.2-1.3 days. (nearly 1.4 days of turn round)

- For this operation PR will improve the infrastructure from Port Qasim Station to Bin Qasim Station, and from Kotri Junction to Jamshoro Power Plant, and procure the locomotives and high speed hopper wagons.

The plan of PR is to improve and track doubling between Port Qasim Station and Bin Qasim Station and to construct a new line from Kotri Junction to Jamshoro alongside the existing line.

The outline of the plan is as follows:

- Additional line from Kotri Junction to Jamshoro Power Plant (14.82 km),
- Additional loop line at Sindh University and Jamshoro (2.2 km),
- Rehabilitation of existing track between Akhundabad Station and Jamshoro including loop lines (3 Nos.) (6.12 km),
- Additional lines between Bin Qasim Station and Port Muhamad Bin Qasim Station (13 km),
- Rehabilitation of existing track between Bin Qasim Station to Port Muhamad BinQasim Station (13 km),
- Remodeling of signaling system from Bin Qasim Station to Port Muhammad Bin Qasim Station, Kotri Junction-Akhundabad Station and Sindh University Station yards,
- Extension of bridges and level crossing between Bin Qasim Station and Port Muhammad, Bin Qasim Station and Kotri Junction to Akhundabad Station,
- Procurement of 10 Nos. new DE locomotives,
- Procurement of 500 high-capacity hopper wagons including 9 Nos. brake van,

- Procurement of track machinery, vehicles and equipment,
- Renovation/ Construction of offices, office equipment and general expenses.

The total investment cost for the above-mentioned plan is estimated at PKR 15,495.6 million, which includes 3% contingency and 6.5% annual escalation from 2015 to 2016.

This plan does not include the coal treatment at Port Qasim, such as unloading system from ship, coal transfer system from unloader to coal stockyard and loading system to train from stockyard. These unloading, coal stock and loading facilities are not the responsibility of PR. These facilities will be prepared by port side, such as Port Qasim and/or PIBT.

4.2 Transportation Between Port Qasim and Bin Qasim Stations

4.2.1 Coal Loading Method and Location

The coal loading to coal train will be done using a hopper to shorten the loading time and ensure continuous loading to the train. The coal will be supplied by belt conveyor system from the coal stockyard. These facilities and works are under the port operators, such as Port Qasim, Fauji Oil Terminal & Distribution Co., Ltd. (FOTCO)[2] and Pakistan International Bulk Terminal Limited (PIBT).

The loading capacity by hopper is about 2 minutes for 60 tons of coal to open-top wagon, and an estimated 1 minute for the open-top coal container with a capacity of 20 tons.

The coal loading line with hopper will be constructed from the existing Port Qasim Station lines. This system is planned by PR as PC-1 for Coal Transportation by Rail to Jamshoro Power Plant. The construction of access track to the coal loading system is not clear whether it will be undertaken by PR or port operator. The track is important and it is better to be constructed by PR to ensure a technical standard for all tracks within the same station. This will be more advantageous from the viewpoint of train operation and track maintenance. In this plan the coal loading system shall be constructed by port.

4.2.2 Line Condition

The spur line to Port Qasim starts from Buda Nala Station, a part of Pipri Marshalling Yard, and over-crossing the main line then connecting to Bin Qasim Station. From Bin Qasim Station, one line is connected to Port Qasim and another line to Pakistan Steel. Both lines are single

[2] Fauji Oil Terminal & Distribution Co., Ltd. (FOTCO). The company is now constructing a Coal Handling Terminal at Port Qasim (refer to Clause 6.1).

line and ballast track with mainly wooden sleeper.

There are two line groups at Bin Qastim Station, one is main line group and another is spur line group connected to Pipri Marshalling Yard. The main line group is composed of two main lines and two passing loop lines. This main line group is connected to the spur line group at Bin Qasim Station

The distance from Bin Qasim Station to Port Qasim Station is 13 km, and from Bin Qasim Station to Bada Nala Station is 2.94 km, while Bada Nala Station to Gaddar Station is 5.94 km.

Bada Nala Station is at the Karachi City side Station of Pipri Marshalling Yard, and Gaddar Station is at the Kotri side Station. Pipri Marshalling Yard is connected to the main line through Bada Nala Station and Gaddar Station

The line capacity of the spur line to Port Qasim is 36 trains per day (total of up and down both ways) at present using a single track. The transportation capacity of coal by 18 trains (40 wagons with 60 tons of coal per wagon) is 43,200 tons per day. Given 330 working days per year, a total of 14 million tons per annum can possibly be transported if PR only transports coal from Port Qasim.

The transportation demand for containers and other freight from Port Qasim is not negligible. PR plans to rehabilitate the existing track and signal and construct an additional line between Bin Qasim Station and Port Qasim Station as PC-1 for coal transportation by rail to Jamshoro Power Plant, 2007.

A weighing machine for wagons is installed at the side line of the spur line group of Bin Qasim Station This machine did not work when the JICA Study Team visited the site. PR has plans to improve this weighing machine but it was not clear under what project it will be undertaken. Almost 5 minutes is necessary to weigh one wagon. The train has to stop so that each wagon can be weighed. It takes about about 3 hours and 20 minutes to weigh a train of 40 coal wagons. PR plans to improve the weighing machine so that the process can be done in about a minute without having to stop the train.

With the existing weighing machine, 288 wagons of seven trains with 40 wagons can be weighed per day. This number of trains is not sufficient for Lakhra and Jamshoro Power Plants. The weighing time for one train with 40 wagons is 3 hours and 20 minutes (about 3.4 hours). The cycle times with this longer weighing time in Case 1, Case 2A, Case 2B and Case 3 are 19.5 + 3.4 = 22.9 hours, 18.5 + 3.4 = 21.9 hours, 18.2 + 3.4 = 21.6 hours and 18.2 + 3.4 = 21.6 hours, respectively as shown Clause 4.1.4. In all the cases, the cycle time is within one day.

The required number of rolling stocks already calculated is enough in case the weighing time is 5 minutes, when considering the case of Lakhra Power Plant project.

4.2.3 Coal Transportation

The wagons are loaded with coal using the coal-loading system at the spur line. The coal train with 40 wagons and one brake van are formed as a train and the coal train will start from Port Qasim Station. All the wagons of the train will be weighed at Bin Qasim Station, The train will go to the main line at Bin Qasim Station or Gaddar Station via Bada Nala Station.

4.3 Transportation between Bin Qasim Station and Kotri Junction

This section has a double track with automatic signal system. It has enough line capacity to operate additional coal trains, at present. The passenger trains are given the highest priority while the long-run line haul trains such as oil train and coal train to Punjab are given the second priority. The short-run line haul coal trains to Lakhra and Jamshoro are given the third priority.

PR plans to operate eight trains per day for the transportation of 6.6 million tons per year from Karachi to Jamshoro. The required coal to be transported to three power plants in Punjab is estimated at 12 million tons per year (4 million tons x 3 power plants). This coal transportation may need 16 trains per day under the same condition as the coal transport to Jamshoro. In total, 28 coal trains (4 + 8 + 16 = 28) are predicted for the coal transportation to the power plants of Lakhra, Jamshoro and three in Punjab. The minimum line capacity between Bin Qasim and Kotri is 90, as calculated by PR. The total number of trains between Karachi City and Kotri will be 52 trains (19 passenger trains + 7 freight trains + 26 coal trains), the other 38 trains space can be used for additional trains, in the future, under the line capacity of 90.

PR has the idea to construct a new freight line from Pipri yard to Kotri Junction, if necessary. The JICA Study Team advised PR to improve the block system (signal system) from Karachi City Station to Kotri Junction by dividing one block section to two or more block sections between the two stations. The block system of PR at present is one block section between two adjacent stations, and the interval of stations are rather long, such as 20.9 km between Meting and Bholari (the longest interval bwteen Karachi City station and Kotri Junction with a line capacity of 90). The line capacity will double when one block section is divided to two block sections, because the train run time of one block section will be halved. This improvement in the signal system is easier and cheaper compared to constructing a new railway line to increase the line capacity.

The coal trains from Bin Qasim Station or Gaddar Station can run on the main line as line haul trains without stopping at intermediate stations until Kotri Junction. This is the same as an express passenger train. This type of train operation will increase the line capacity. When the train operation speed is the same as the other trains, the interval of trains can be constant and the line capacity will be at maximum, similar to commuter train operation.

All the three or four coal trains to Kotri Junction can be set to arrive between 10 to 14 hours as seen on the October 2014 train diagram..

4.4 Transportation Between Kotri Junction and Budapur Station

This section is a single line with a mechanical signal system. Only four trains are set on this line at present (end of year 2014) and there is enough line capacity for additional trains.

The line capacity between Kotri Junction and Budapur Station was calculated to be 43 (refer to Clause 2.4.3, Figure 2.8 Line Capacity in Sections and Number of Trains in Operation). The number of trains in October 2014 was four trains. The planned number of coal trains to Jamshoro is eight, and to Lakhra, four (Case 1 and Case 2B) or three (Case 2A, Case 2AR and Case 3). This gives a total of 12 or 11. There is enough space for the coal transport trains compared to the line capacity of this section.

The train diagram of 3 or 4 coal trains from Kotri Junction to Budapur Station is easily set depending on the condition of the train diagram between Bin Qasim Station and Kotri Junction. These trains can run without stopping at the intermediate station and go directly to Lakhra Power Plant Station.

The trains from Lakhra Power Plant Station to Kotri Junction, and from Kotri Junction to Bin Qasim Station, the interval of the higher priority trains is limited, then the empty coal trains to Bin Qasim Station are required to wait until the possible line of train diagram at Kotri Junction or other Station on the branch line such as Sindh University Station or other stations.

4.5 Transportation Between Budapur Station and Lakhra Power Plant Station

There are five cases for coal transportation between Budapur Station and Lakhra Power Plant, namely, Case 1: Dump Truck System, Case 2A, Case 2AR and Case 2B: Spur Line, and Case 3: Conveyor Belt System. Outline of these cases are as follows:

4.5.1 Case 1: Dump Truck System

The concept of this plan is to construct a new yard at the existing Budapur Station, and the coal containers on the container wagons are transferred to the trucks by reach stacker or forklift. The containers will then be transported by trucks through segregated or common road to

Lakhra Power Plant and unloaded by dumping to the coal stockyard directly.

This plan is aimed to minimize cost of construction and operation. The existing track from Kotri Junction to Budapur Station is constructed and designed for an axle load of 17.27 tons. Heavy and powerful locomotives cannot operate on this line. The coal transportation is planned under this condition of low axle load, easy unloading of coal at power plant, and use of the common container wagons. This plan is sufficient for the transportation of 2 million tons of coal per year.

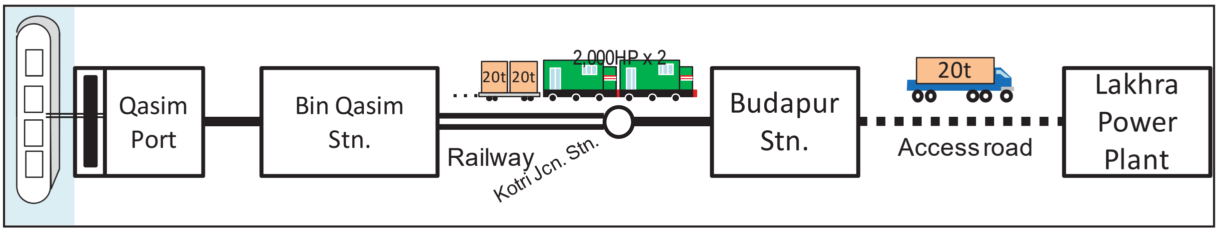
Table 4-8 Condition of Coal Transportation

Item	Quantity
Wagon Length	15 m
Number of Containers per Train Set	76
Yearly Coal Transport	2,000,000 tons
Yearly Working Days	330 days
Daily Coal Transported	6,060 tons
Coal Transportation Capacity per One Train Set	1,520 tons

Source: JICA Study Team

The coal containers are transferred from container wagon to truck by reach stacker or folk lift.

The trucks transport the coal container from Budapur Yard to Lakhra Power Plant and dump the coal at beside the coal stockyard, as shown the Figure below.

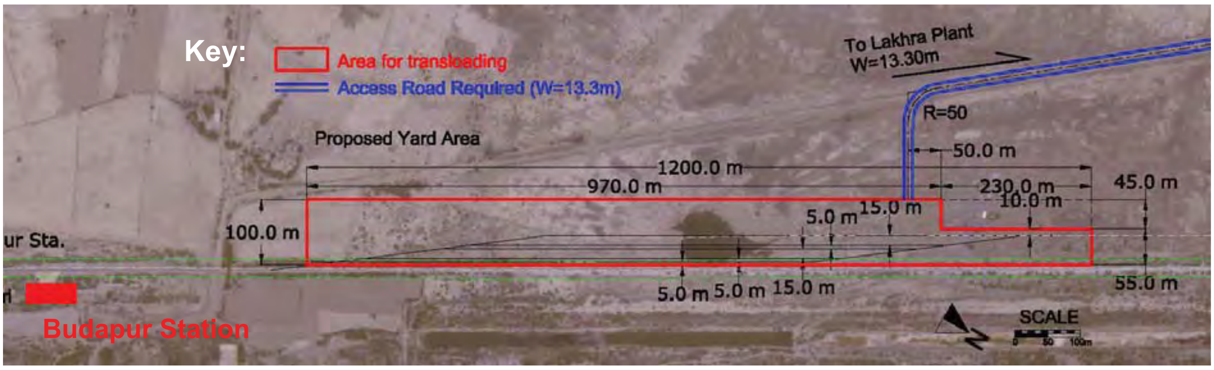


Source: JICA Study Team

Figure 4-6 Coal Transportation Concept of Case 1

(1) Budapur Yard

In the handling yard, coal-loaded containers will be transferred from trains to trucks by reach stackers. The yard is planned at Budapur Station and the layout and key features are shown in the succeeding figure and table.



Source: JICA Study Team

Figure 4-7 Budapur Yard Layout

The effective loop length planned is 650 m and PR track branches at 40 km 800[3], after passing Bridge No.311, with a turnout (type1 in 8[4]), the center of yard is 41.50 km from Kotri Junction. The level of the yard will be of the same height as the main track by soil fill, and the surface will be paved for dump truck and reach stacker operations. Station control room, container stockyard, trucks and reach stackers maintenance sheds, and parking facilities will be constructed in this yard.

Table 4-9 Key Features of Budapur Yard

Item	Quantity	Remarks
Number of stabling tracks	5	Excluding locomotive deadhead track with PR standard cross section of track is assumed.
Area	1,000 sqm	5 m high embankment and pavement are considered.
Minimum distance center to center	5 m	
Maximum distance center to center	15 m	Including reach stacker working area
Station control room	100 sqm	

Source: JICA Study Team

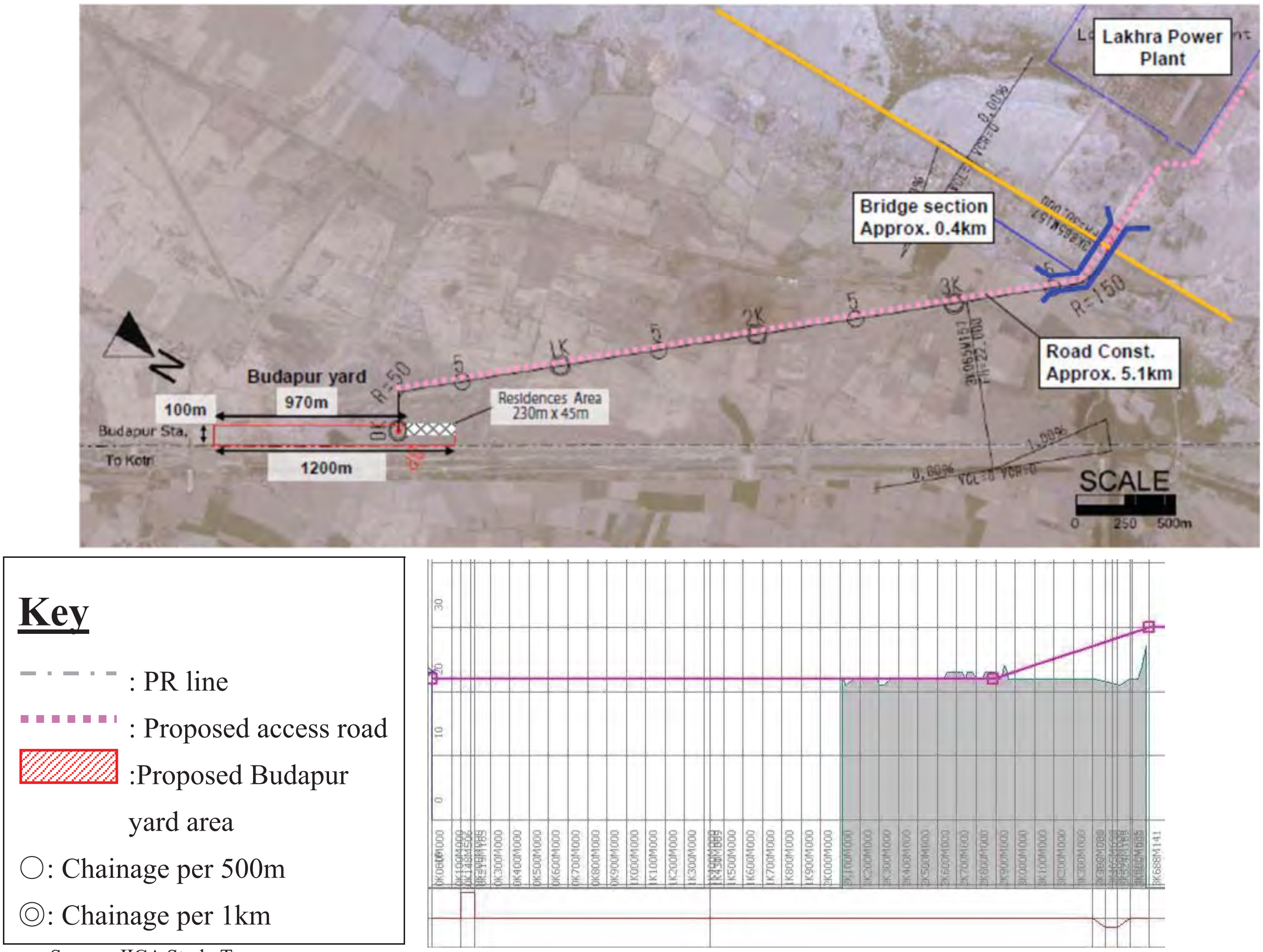
(2) Access Road

In terms of connectivity between Budapur yard and Lakhra Power Plant, an exclusive road for coal transportation is necessary for a continuous coal transport by trucks. The proposed 3.7 km long access road alignment is shown in the succeeding figure.

The construction of a flyover above the Indus Highway is required by the Authority of Indus Highway. Case 1 will construct a new segregated road beside the existing road with high embankment and flyover above the Indus Highway section to avoid the risk of coal theft by dump truck drivers, as anticipated by Generation Company (GENCO).

[3] Distance from Kimari St. (Karachi). 40 km 800 means 40.800 km

[4] The figure 1:8 indicates the opening angle of turnout (switch).



Source: JICA Study Team

Figure 4-8 Proposed Access Road Plan and Profile between Budapur Station and Lakhra Power Plant

(3) Sequence of Container Transfer

The sequence of container transfer works from train to truck, and from truck to wagon is as follows:

1) two reach stackers will work for one train at the same time,

2) the loading and unloading work of container from/to wagon to/from truck is assumed to be 3 minutes,

3) one reach stacker will transfer a coal-loaded container from wagon to truck,

4) one reach stacker will transfer an empty container from truck to wagon,

5) the distance of work 3) and work 4) is ten wagons away to maintain sufficient space for the truck waiting for the next loading work.

One pair of reach stackers will transfer the containers from/to wagon to/from truck of one train set with 38 x 2 = 76 containers; the necessary working time is 76x3 min. = 228 min. for container transfer, 10x2x3=60 min. for container transfer of 10 wagons with 20 containers, 228 + 60=288 min.=4.8 hours/train for whole container transfer works of one train. Say, one group of 2 reach stackers will transfer all the containers of 4 trains in 19.2 hours.

The cycle time of the dump truck between Budapur Yard and Lakhra Power Plant is shown in Table 4-10.

Table 4-10 Cycle Time of Dump Truck

Item	Distance [km]	Speed of truck [km/h]	Min.	
Transfer from train to truck			3.0	
Running time from Budapur Station to Lakhra Power Plant	3.7	30	8.0	
Waiting time			3.0	
Unloading time (dumping)			2.0	
Turning time			2.0	
Running time from Lakhra Power Plant to Budapur Station	3.7	30	8.0	
Waiting time			3.0	
Transfer from truck to train			3.0	
Waiting time			3.0	
Total cycle time			35.0	
Container				
Number of containers in one train	2	38	76	
Number of train			4	
Total number of containers			304	
Total time			10,640	Min.
			178	Hour

Source: JICA Study Team

(4) Advantage and Disadvantage of Case 1: Dump Truck System

The difference of the ground elevation between rail level near Budapur Station and Lakhra Power Plant is 16 m, and the daily volume of coal transportation is 6,000 tons. Considering such condition, coal transportation using dump trucks and coal containers can be an option between Budapur Station and Lakhra Power Plant.

The advantages of Case 1 are:

- no coal unloading facility is required at Lakhra Power Plant,
- it entails the lowest initial cost.

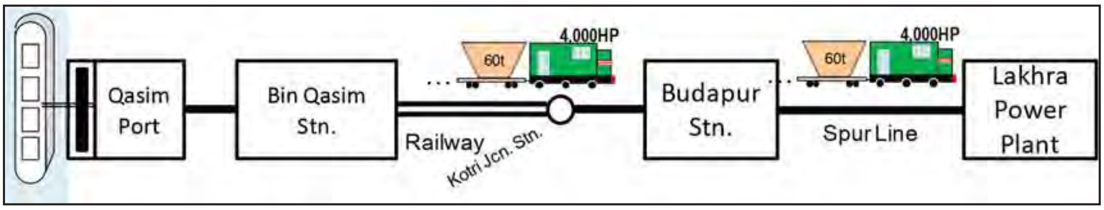
The disadvantages are as follows:

- risk of coal theft along the road,

- it entails higher operation and maintenance cost.

4.5.2 Case 2A and Case 2AR: Spur Line with Axle Load 23.3 Tons

This case was requested by GENCO. The concept is to unload the coal from train directly to the coal stockyard of Lakhra Power Plant. Figure 4-9 shows the concept of coal transportation.



Source: JICA Study Team

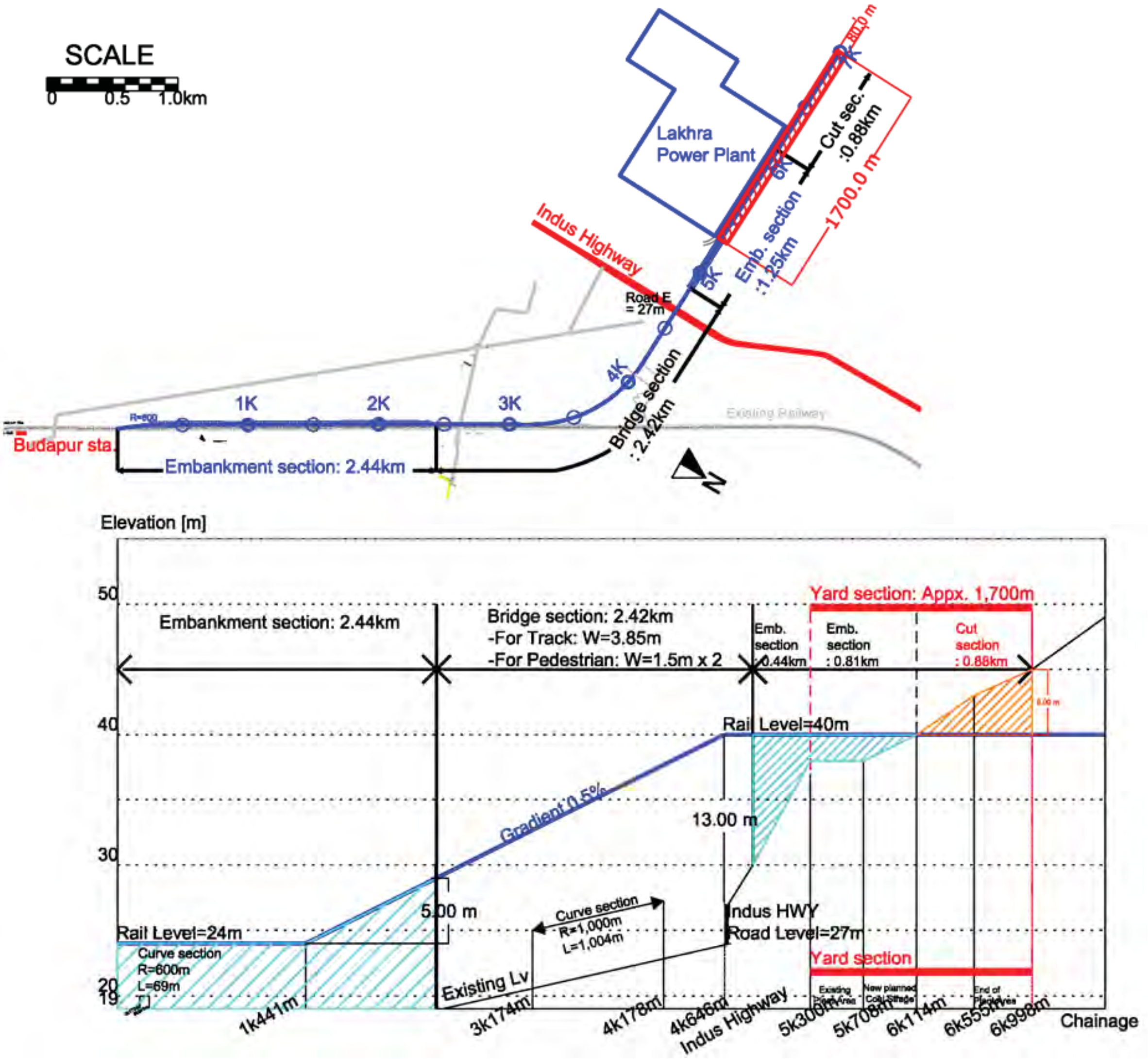
Figure 4-9 Coal Transportation Concept of Case 2A and Case 2AR

(1) Design of Spur Line

The spur line to Lakhra Power Plant Station will be branched at 41 km 040 point, pass Bridge No.311, at the Dadu side of Budapur Station. It will then go up to the height of the same level of Lakhra Power Plant, which is 40 m, over pass the Indus High Way and will arrive at Lakhra Power Plant Station, beside of the coal stockyard of the power plant. The location of Budapur Station center is 40km310, the branch point is 730m (41km 040 from Kotri Junction) away from the station center.

The ground level of Lakhra Power Plant is about 40 m, and the ground level near Budapur Station is about 20 m. The rail level of Budapur Station is 24 m, the difference in height between the rail level of Budapur Station and Lakhra Power Plant is 16 m.

The distance from the branch point of Budapur Station to Indus High Way is about 5 km. The average gradient is about 0.32%. This gradient is acceptable based on the regulation of PR where the maximum gradient should be less than 1/200 (0.5%). It is possible to shorten the bridge or higher embankment section using the gradient of 0.5%, where the track length is 3.2 km to resolve the 16 m difference in height.



Source: JICA Study Team

Figure 4-10 Lakhra Power Plant Station and Spur Line from Main Track

The road level of Indus Highway is 27 m, the difference between the planned rail level at Lakhra Power Plant Station (with a height of 40 m) is 13 m. The overhead clearance on Indus High Way can be more than 10 m, with a 2 m-thick girder of bridge over the Indus High Way, and 1 m track structure of ballast track, including some margin for future maintenance.

The train having a formation of 40 wagons and the same locomotive can run this spur line in case the gradient is less than 0.5%. The maximum gradient between Bin Qasim Station and Kotri Junction and Budapur Station is 0.5%. The train for coal transportation shall run on this line condition.

The average speed of the coal train is planned at 20 km/h, the distance of the Lakhra Power Plant Station is 6 km from the branched point. The train operation time of this section is 18 minutes. And the line capacity is 80 trains per day (up and down direction total) with a 100%

efficiency, the planned trains is only 6 trains, up and down directions total.

(2) Lakhra Power Plant Station

The Lakhra Power Plant Station is located at 47 km 140 from Kotri Junction, beside of the coal stockyard of the power plant. It has a railway station and a coal unloading system.

The railway station is composed of five lines, one shunting line and two coal discharge lines (refer to Figure 7-2 Track alignment of Lakhra Power Plant Station Including Unloading Facility). The following is a list of the facilities in the railway station:

- one arriving/departure line with 650 m effective length,
- three stabling lines,
- one engine run line,
- one shunting line, and
- two lines for coal discharge pits.

The length of each line is more than 650 m to keep the effective length of other stations to ensure stable train operations with 40 coal wagons, one brake van and one locomotive.

The coal unloading system is composed of two lines with coal discharge pits and two lead tracks.

Arriving/Departure Line

This line is used for the arrival and departure of trains and shunting of coal wagons for unloading and train formation. The arriving/departure line and a shunting line are possibly depend on the method of coal unloading works. A more detailed study of station work, including shunting of wagons for coal unloading is necessary.

Three Stabling Lines:

The coal unloading work will be done continuously but the arrival of the coal trains will not be on a constant and regular interval. When the trains are operated at regular interval of arrival and departure, matching the coal unloading work, only one line will be usable. The train operation of the main line between Bin Qasim Station and Kotri Junction is busy with high priority passenger trains and long distance line haul trains, and the trains to Lakhra Power Plant will be operated on irregular interval. Thus, the coal trains to Lakhra Power Plant will require waiting at the station for the coal unloading work and departure using the main line. Three lines of the stabling track are considered necessary for a smooth and stable train operation and coal unloading operation.

The Coal Unloading Works:

One train with 40 coal wagons will be divided into two- or three-fleet formation for the coal unloading operation. One formation of wagons will be hauled by shunting locomotive to the coal discharge pit via leading track. It will stop on the pit location and the coal contained in two wagons will be discharged in six minutes. Afterwards, this wagon formation will move by a distance equivalent to two wagons to discharge the coal of the next two wagons. This will be repeated until the discharge of coal from all the wagons is finished. The same wagon formation will be hauled to the shunting line and stabled temporarily. The locomotive will then haul another formation of wagons to the discharge pit line and discharge all the coal. It will then haul this formation to the shunting line and connect with the first wagon formation. It will comprise one train with 40 empty wagons. This 40-wagon formation will be hauled to the stabling line to wait for departure to Port Qasim.

The frequent stopping and starting of a train composed of a locomotive and wagons is hard work for a locomotive. The starting resistance of a train is larger than running resistance. The locomotive AGE30 with 3300 HP can pull a 40-wagon train on the main line, but for the starting resistance, this locomotive can pull only 14 wagons. The unloading work needs to decrease from a 40-wagon train to a 10-wagon train in case a small shunting locomotive is used. The JICA Study Team estimated the necessary shunting time to be 60 minutes for one train of 40 coal wagons.

Coal Unloading System:

Two sets of coal unloading system are prepared for this project. The capacity of one set of coal unloading system is enough to implement the unloading of 7,200 tons of coal per day or a total of 2 million tons per annum. The coal unloading system is required for a stable operation. Also, to ensure that the unloading work will not be halted for a long time, this system needs periodic maintenance to avoid the possibility of problems in the coal discharge pit and belt conveyer system. Maintenance work and troubleshooting require considerable time. Sometimes, it takes one week to more than one month to fix the trouble or change parts of the system. To ensure the unloading works, at least two sets of unloading system is necessary to maintain stable unloading, train operation and coal transportation.

Shunting Line:

The fleet of coal wagons is pulled by shunting locomotive to the shunting line and pushed back to the coal discharge pit line for the unloading of coal. After the completion of unloading of coal of one fleet of coal wagons, the fleet of empty coal wagons will be returned to the arriving/departure line and temporarily stabled there. The shunting locomotive will then pull another fleet of coal wagons to the shunting line and push it to the coal discharge pit line for unloading. Afterwards, it will also be transferred to arriving/departure line and will be connected to the first stabled fleet of wagons. These fleets will form into a single train with 40 wagons. It will start at the main line to be transferred to the stabling line and wait for departure. For the shunting works, the shunting line will be occupied to move the other line.

4.5.3 Case 2B: Without Additional Track from Kotri Junction to Budapur Station

This case is a scenario wherein the additional track from Kotri Junction to Akhundabad Junction is not constructed by PR as part of the Jamshoro Power Plant project, because there is a need to reduce the initial investment cost. If the additional track from Kotri Junction to Budapur Station is not constructed, only the extension work of passing/crossing loops of four stations between Kotri Junction and Budapur Station are implemented, the construction cost will be reduced but the procurement of rolling stocks and train operation cost will be increased.

The axle load between Kotri Junction and Budapur Station is not upgraded, the same as in Case 1: Dump Truck System. Therefore, the axle load of locomotives and wagons shall be limited to 17.27 tons. The usable locomotives are light weight and the payload of wagons is limited to 40 tons per wagon.

The spur line to Lakhra Power Plant Station is the same as in Case 2A and Case 2AR. The design axle load is 23.3 tons same as Case 2A and Case 2AR, considering the future coal transportation operation by heavy locomotive.

The train is composed of two light locomotives, 38 coal wagons with a payload of 40 tons of coal and one brake van. This can run in the spur line with less than 0.5% gradient.

The average speed of the coal train on this spur line is planned at 20 km/h. The distance from branch point to Lakhra Power Plant Station is 6 km. The train operation time of this spur line is 18 minutes, the same as in Case 2A and Case 2AR.

Lakhra Power Plant Station has six lines, one shunting line and two coal discharge lines (refer to Figure 7-3 Track Alignment of Lakhra Power Plant Station Including Unloading Facility). The facilities in the station are listed below:

- one arriving/ departure line with a 650 m effective length,
- four stabling lines for one day train operation with a 650 m effective length,
- one engine run line,
- one shunting line, and

- two lines for coal discharge pits.

One stabling line is added, compared to Case 2A and Case 2AR. The reason is the increase in the number of coal trains, from three in Case 2A and 2AR, to four trains in Case 2B, because the capacity of coal for one coal wagon is restricted due to the limitation in axle load.

The construction cost of the additional track between Kotri Junction and Budapur Station, and the cost of rolling stocks is PKR 4,473 million and PKR 4,096 million, respectively. This gives a total of PKR 8,569 million.

The number of trains to be operated is the same as in Case 1, which is four trains per day, each train with two locomotives and 38 coal wagons.

The number and cost of rolling stocks to be procured are the same as in Case 1, which are ten locomotives and 190 wagons, with a total procurement cost of PKR 5,924 million (PKR 3,668 million + PKR 2,256 million = PKR 5,924 million).

The difference in the investment cost between Case 2A (original) and Case 2B is PKR 2,645 million (PKR 8,569 million – PKR 5,924 million = PKR 2,645 million).

The train operation cost for 2 million tons of coal per year in Case 2A is around PKR 1,200 million. For Case 2B and Case 1, this is around PKR 1,500 million per year (Case 2B and Case1 have the same train formation and number of operation of trains).

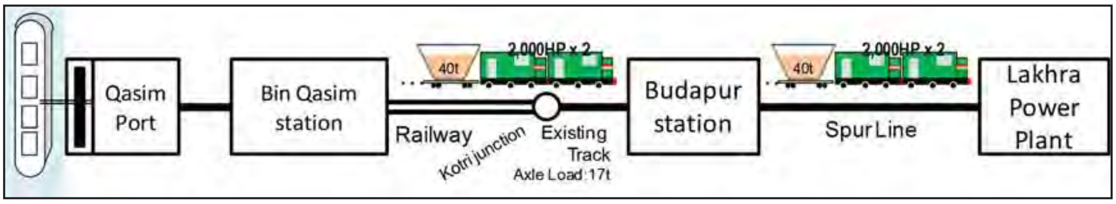
The difference in train operation cost between Case 2A (Case 2AR) and Case 2B (Case 1) is PKR 300 million per year or PKR 2,700 million in nine years.

The difference in investment cost (PKR 2,645 million) will be covered in nine years' train operation by the difference in train operation cost.

The initial investment cost of Case 2A is much higher than Case 2B, but Case 2B is not economical, in the long run, compared to Case 2A.

4.5.4 Case 3: Conveyor Belt System

The plan in Case 3 is to construct the New Budapur Station near Lakhra Power Plant and extend the belt conveyor system of the coal stockyard of the power plant to the new station. The purpose of this plan is to minimize the railway construction cost. Figure 4-11 shows the coal transportation concept in this case.

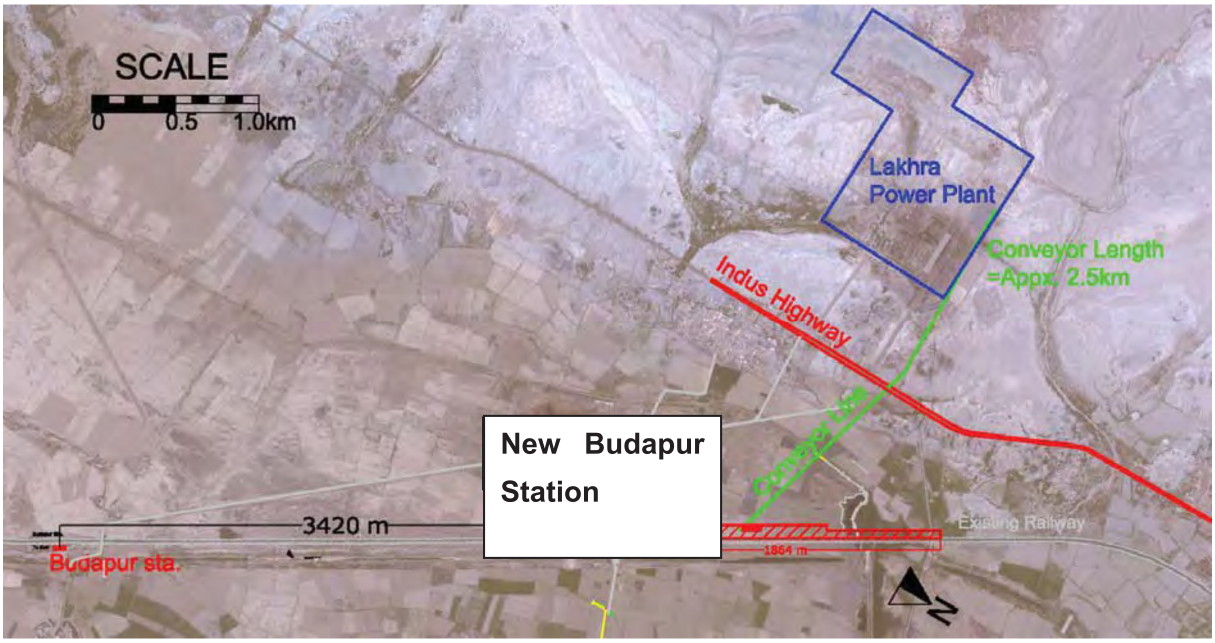


Source: JICA Study Team

Figure 4-11 Coal Transportation Concept of Case 3

(1) New Budapur Station

The New Budapur Station is branched at 43 km 700 from Kotri Junction, and the center of the station is 44 km 500 from Kotri Junction of the branch line between Kotri Junction and Dadu station.



Source: JICA Study Team

Figure 4-12 New Budapur Station

The track alignment and the arrangement of the unloading system are the same as in Case 2: Spur Line, Lakhra Power Plant Station, with six lines for station and two pits and track for unloading. The temporary coal stockyard will be constructed beside the unloading pits.

The speed of coal unloading from coal wagons is 120 tons per six minutes, equal to 20 tons per minute. The capacity of unloading pit is about 150 tons, a little bit larger than the coal volume of two wagons. Two wagons of coal will be discharged within six minutes in this plan. The capacity of belt conveyor from unloading pit should be more than this capacity, which is 20 tons per minute. This coal transportation capacity is too much for the belt conveyor system to the coal stockyard of the power plant. This system will be operated for 16 hours per day.

It is better to prepare a buffer of coal at the station, considering the possible troubles in the conveyor system. The volume of coal transported by train in one day, 7,200 tons or 2,400 tons per train x 3 trains per day. The temporary coal stockyard at the station is estimated to be 7,200 tons (about 9,000 m^3). The area of this buffer yard is 90 m x 50 m with 2 m height of coal stack.

(2) Conveyor Belt System

The discharged coal will be transferred by conveyor belt system directly from the coal discharge pits of the New Budapur Station to the coal stockyard of Lakhra Power Plant.

The planned conveyor belt line is estimated to be approximately 2.5 km long. The side or bottom hopper coal wagons are used for coal transportation, which is as the same as mentioned in Clause 4.5.2 Case 2A and Case 2AR: Spur Line. The unloading facility for side/bottom hopper wagons needs a coal receiving hopper beneath the railway track and belt conveyer lines at the coal handling yard. The conveyor belts will be installed as flyovers through all sections and will passed through as a flyover at the intersection with Indus Highway.

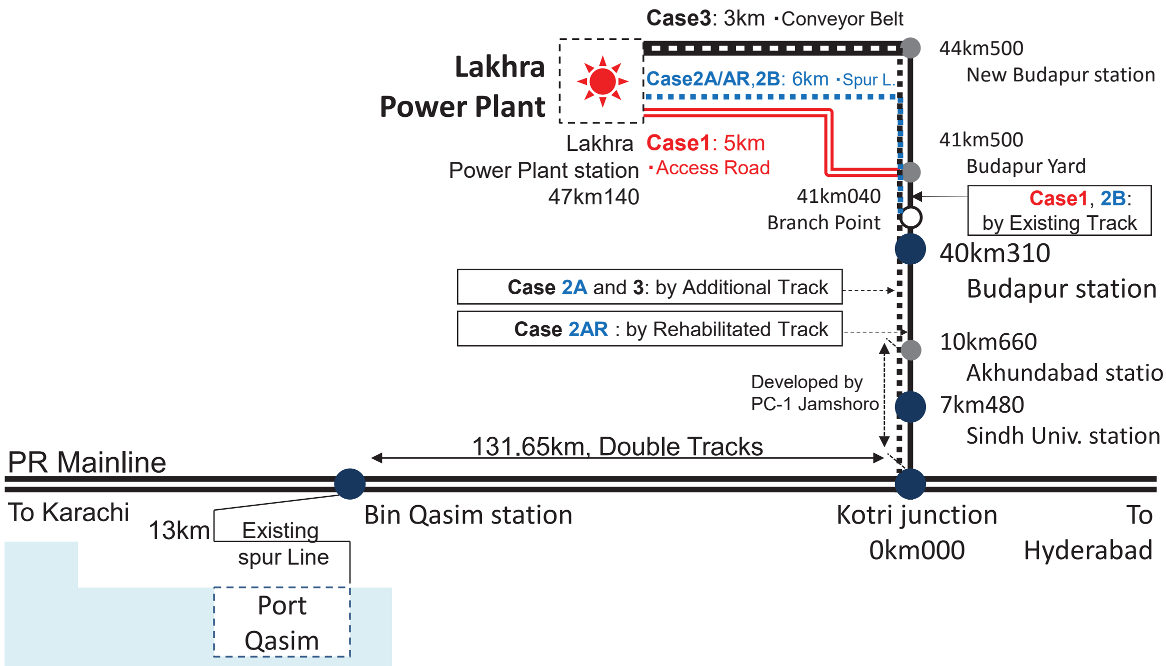
The capacity of the belt conveyor from the unloading pit shall be more than the unloading speed from side/bottom hopper wagon, which is 20 tons per minute. The planned capacity of the conveyor belt is 1,500 ton/hour, the calculated necessary capacity is as follows:

- 20 tons x 60 min = 1,200 ton/hour
- 1,200 tons x 1.2 = 1,440 tons, rounded this to 1,500 ton/hour
- The coefficient 1.2 is the margin of machine.

And two lines of conveyor belt will be constructed. One pit has one conveyor belt line considering the stable coal transfer operation, the same idea explained regarding the coal unloading system on Clause 4.5.2(2) Lakhra Power Plant Station.

The unloading hours of one coal train is estimated to be two hours as shown on Table 4-7 Summary of Operation Cycle Time Case 3: Conveyor Belt System. Another hour is estimated for shunting the coal train to the unloading pits from the train stabling line. Therefore, three hours is necessary for one coal train and nine hours for three coal trains. The coal trains operation is not independent. There are many other high priority trains on the main line. Hence, the interval of the arrival of coal trains to New Budapur Station is not constant in this case. The JICA Study Team assumed a 2 hour-interval. The total unloading and coal transfer works duration is 15 hours: 9 hours for three coal trains unloading and shunting works+ (2 hours interval x 3 trains) = 15 hours, the conveyor belt system will be operated 16 hours per day including 1 hour margin.

In case the buffer yard for coal between the unloading pits and the conveyor belt system will be used, the design capacity of the conveyor belt system will be reduced to 600 tons/hour when the conveyor belt system works 12 hours a day. The conveyor belt system in this case consists of the conveyor system from the coal unloading pits to the buffer coal stockyard, the coal spreader and the coal hopper pit to transfer the coal on the conveyor belt connected to the coal stockyard of the power plant.



Source: JICA Study Team

Figure 4-13 Case-Wise Route and Related Stations

The JICA Study Team recommends to apply the direct conveyor belt system to the coal stockyard of power plant from the New Budapur Station because this simple is simple and will entail lesser initial investment cost. However some space for future buffer must be kept.

4.5.5 Demarcation of Construction, Operation and Cost

The demarcation of the construction works, operation works and investment cost for PR, coal handling organization and Lakhra Power Plant are presented below.

(1) Construction Works

- Coal loading facilities at the port including transportation facilities of coal from ship and coal stockyard to coal loading hopper: coal handling organizations such as FOTCO, PIBT and port authority
- Railway infrastructure such as track, signal and station facilities including the track to coal loading hopper, and the track to coal unloading facilities: PR or GENCO
- Access road to coal stockyard of power plant for Case 1: Power plant (GENCO) or coal handling organization
- Coal unloading pits and conveyor belt system for Case 2A, Case 2AR, Case 2B and Case 3: Power Plant (GENCO)
- Conveyor belt system of Case 3: Power plant (GENCO)
- Procurement of railway rolling stocks such as locomotives and coal wagons: PR
- Procurement of coal handling facilities including reach stacker and dump truck in Case 1: Power plant (GENCO) or coal handling organization

(2) Operation Works

- Coal loading facilities at port including coal transportation facilities from ship and coal stockyard to coal loading hopper: Coal handling organization such as FOTCO, PIBT, and port authority
- Train operation of main line: PR
- Train operation between station and loading/unloading facilities: PR or coal handling organization or power plant
- Transfer of coal container between wagon and dump truck, and operation of dump truck between Budapur Station yard and power plant for Case 1: Power plant (GENCO) or coal handling organization
- Coal unloading works at Lakhra Power Plant Station for Case 2A, Case 2B and at New Budapur Station for Case 3: Power plant (GENCO) or coal handling organization.
- Operation of conveyor belt system of Case 3: Power plant (GENCO) or coal handling organization

(3) Investment Cost

- Construction cost of coal loading facilities at port, including coal transportation facilities from ship, and coal stockyard to coal loading hopper: Coal handling organization such as FOTCO, PIBT, and port authority; This cost will be added to the cost of coal.

- Construction cost of railway infrastructure such as track, signal and station facilities, including the track to coal loading hopper, and the track to coal unloading facilities: PR; This cost will be added to the coal transportation cost
- Construction and operation cost of coal unloading facilities including conveyor system for Case 3: Power plant (GENCO) or coal handling organization

The above-mentioned distribution of responsibility and costs is the idea of the JICA Study Team and the actual distribution shall be discussed and decided by all the organizations involved in this project.

4.6 Train Operation Plan

4.6.1 Basic Concept of Coal Transportation by Railway

Because of the huge volume of coal being transported, it is typical to operate coal trains in shuttle service with a fixed formation of wagons that are suitable with the loading and unloading facilities for coal.

4.6.2 Case 1: Dump Truck System; Coal Transportation by Container Train (Without Additional Track)

Since the timing of Jamshoro Power Plant construction is uncertain, the train operation plan without additional track section between Kotri Junction and Budapur Station is provided. The train operation plan is prepared based on the following conditions:

- design axle load between Kotri Junction and Budapur Station: 17.27 tons.
- required volume of coal for Lakhra Power Plant: 2 million tons/year
- maximum train length: 640 m (640 m plus clearance shall be more than 650 m effective length of passing loop)

Assuming yearly working day of PR as 330 days, then coal to be transported will be 6,061 tons per day or 2 million tons/330 days = 6,061 tons/day.

In order to clear the design axle load of structures, the train composition, tonnage and length shall be as follows:

- two units of lightweight locomotives (2,200 HP); Length is 44 m (22 m x 2),
- thirty-eight units of flat bed wagons for 2 units of 20 ft containers; Length is 570 m

(15 m x 38). Payload per wagon is 40 tons. The hauling capacity of a train is 1,520 tons (38 x 2 x 20)

- one unit of brake van (15 m); Total length of a train is 629 m (44 + 570 + 15 = 629)

In order to carry 6,061 tons of coal, four trains should reach Budapur Station in a day. (6,061/1,520 = 3.99)

The required number of train sets to operate and meet the above-mentioned requirements can be calculated based on the operation cycle time of a train.

The operation cycle and necessary time is shown on Table 4-4 Summary of Operation Cycle Time (Case 1) in Clause 4.1.4.

Because one train requires nearly 19.5 hours (0.81 day) per cycle, at least four train sets will be required for coal transportation to Lakhra Power Plant. Considering regular maintenance of rolling stock, one spare set will be required. Thus, a total of 5 sets of coal train will be needed.

As shown on the above table,Table 4-10 one train is staying at Budapur Station for at least 288 min (228 + 60 = 288 minutes or 4 hours and 48 minutes.)

In order to calculate the required number of dump trucks for coal transportation, the cycle time of a dump truck between Budapur Station and Lakhra Power Plant is 35 minutes as examined in Table 4-10 Cycle Time of Dump Truck in Clause 4.5.1.

As shown on the above-mentioned table Table 4-10, one dump truck can transport eight containers (288 /35 = 8.3) within 288 minutes, which is less than the time of coal train stabling at the Budapur yard.

Since one train carries 76 containers, the total number of dump trucks required will be ten (76 containers / 8 = 9.5). Considering regular maintenance work of dump trucks, five trucks shall be added for the standby of operation and maintenance. Thus the required number of dump trucks will be 15.

The required number of drivers will be 30 because they work in three shifts. One driver will be responsible for 11 containers. The calculation is: 2 containers x 38 wagons = 76 containers, and then 76 containers x 4 trains = 304 containers, hence, 304 containers / 30 drivers = 11 containers per driver.

4.6.3 Case 2A and Case 2AR: Spur Line; Coal Transportation by Hopper Wagon Train

to Power Plant

In case the construction of additional track from Kotri Junction to Budapur Station will be implemented, the direct train operation with heavy axle load trains to the Lakhra Power Plant will be available. Also, Case 2AR assumes that the existing track between Kotri and Budapur Station will be upgrated to operate 23.3 tons axle load.

For the effective train operation, it is recommended to use the same train formation as for Jamshoro Power Plant and other power plants in Punjab.

The following train composition can be used:

- one unit of heavy weight locomotive (4,000 HP) with length of 22.0 m,
- forty units of hopper wagons, with length of 600 m (15 m x 40 wagons = 600 m),
- payload per wagon is 60 tons. The hauling capacity of a train is 2,400 tons. (60 tons x 40 wagons = 2,400 tons),
- one unit of brake van (15.0 m),
- total length of a train is 637 m (22 m-locomotive + 600 m-hopper wagons + 15 m-brake van = 637 m).

In the same manner as in other cases, the required number of train sets can be calculated from the operation cycle time of a train. The operation details and required time is shown in Table 4-5 Summary of Operation Cycle Time (Case 2A and Case 2AR).

Because one train requires 18.5 hours (0.77 day) for one cycle, at least three train sets will be required for coal transportation to Lakhra Power Plant. Considering regular maintenance of rolling stock, one spare set will be required. Thus, a total of four sets of coal train will be required.

4.6.4 Case 2B: Spur Line; Coal Transportation by Hopper Wagon Train by Light Locomotives to Power Plant

In case the construction of additional track from Kotri Junction to Akhundabad Junction will not be implemented by PR, the passing/crossing loops of four stations, Sindh University, Cadet College Petaro, Unapur and Budapur Stations, are necessary to be extended to 650 m, and the train operation will be for light locomotives of 17.27-ton axle load until Lakhra Power Plant Station.

For an effective train operation, it is recommended to use the same type of coal wagons used for Jamshoro Power Plant and other power plants in Punjab. The coal capacity of one wagon is 60 tons, but the payload of each wagon will be limited to 40 tons to keep the axle load of coal wagons under 17.27 tons.

The following train composition can be used:

- two unit of light weight locomotive (2,200HP), with length of 44.0 m (22 m x 2),
- thirty-eight units of hopper wagons, with length of 570 m (15 m x 38 = 570 m),
- payload per wagon is 40 tons. The hauling capacity of a train is 1,520 tons. (40 tons x 38 wagons = 1,520 tons),
- one unit of brake van (15.0 m),
- total length of a train is 629 m (44 m-locomotive + 570 m-hopper wagons + 15 m-brake van = 629 m).

In the same manner as in other cases, the required number of train sets can be calculated from the operation cycle time of a train. The operation details and required time is shown in Table 4-6 Summary of Operation Cycle Time (Case 2B).

Because one train requires 18.2 hours (0.76 day) for one cycle, at least four train sets will be required for coal transportation to Lakhra Power Plant. Considering regular maintenance of rolling stock, one spare set will be required. Thus, a total of five sets of coal train will be required.

4.6.5 Case 3: Conveyor Belt System; Coal Transportation by Hopper Wagon Train and Conveyor Belt System

This is the case where the construction of a new railway is minimized, and the belt conveyors system of the coal stockyard is extended to the New Budapur station beside the main line of Kotri junction-Dadu branch line.Budapur

The concept of this case is the same as that of Case 2A and Case 2AR, which is a direct train operation from Kotri Junction with heavy axle load train by additional track. The track to the new station will branch at 43 km 700 m from the main line and the center of the new station is 44 km 500 m.

Because of the upgraded track and structures, the following train composition can be used:

- one unit of heavy weight locomotive (4,000HP), with length of 22.0 m,
- forty units of hopper wagons, with length of 600 m (15 m x 40 wagons= 600 m). Payload per wagon is 60 tons,
- the hauling capacity of a train is 2,400 tons (60 tons x 40 wagons = 2,400 tons),
- one unit of brake van (15.0 m),
- total length of a train is 637 m (22 m-locomotive + 600 m-hopper wagons + 15 m-brake van = 637 m).

In the same manner as in other cases, the required number of train sets can be calculated from the operation cycle time of a train. The operation details and required time is as shown in Table 4-7 Summary of Operation Cycle Time (Case 3) of Clause 4.1.4.

4.7 Operating Organization

According to the information obtained through interviews with PR and private companies, the coal transportation to the planned three-coal fired power plants in Punjab State will be undertaken by Pakistan Intermodal Limited (PIL), one of the Marine Group[5] companies same as PIBT, which is constructing a bulk terminal inside of Port Qasim.

PIL is now planning to procure locomotives and coal wagons for the abovementioned purpose. There is also information that all the imported coal will be unloaded at PIBT, exclusively. However, as detailed in Clause 6.2.2, the design of PIBT is insufficient to handle large volume of coal, and railway connection to PR main line is very difficult.

Considering the challenges for PIBT, it is recommended to use the existing wharf and railway track structure in the Port Qasim for coal transportation to Lakhra and Jamshoro. Train operation can be made either by PR or a private company. However, it is recommended that the coal trains to be operated by PR because it has sufficient staff, operation and maintenance (O&M) facilities and experiences.

4.7.1 Pakistan Railways

PR is a federal government department under the Ministry of Railways. It comprises of three functional units, namely, the Operations Unit, the Manufacturing and Service Unit, and the Development Unit. Each unit is headed by a General Manager who reports to the Secretary/Chairman of Railways for the performance of his unit.

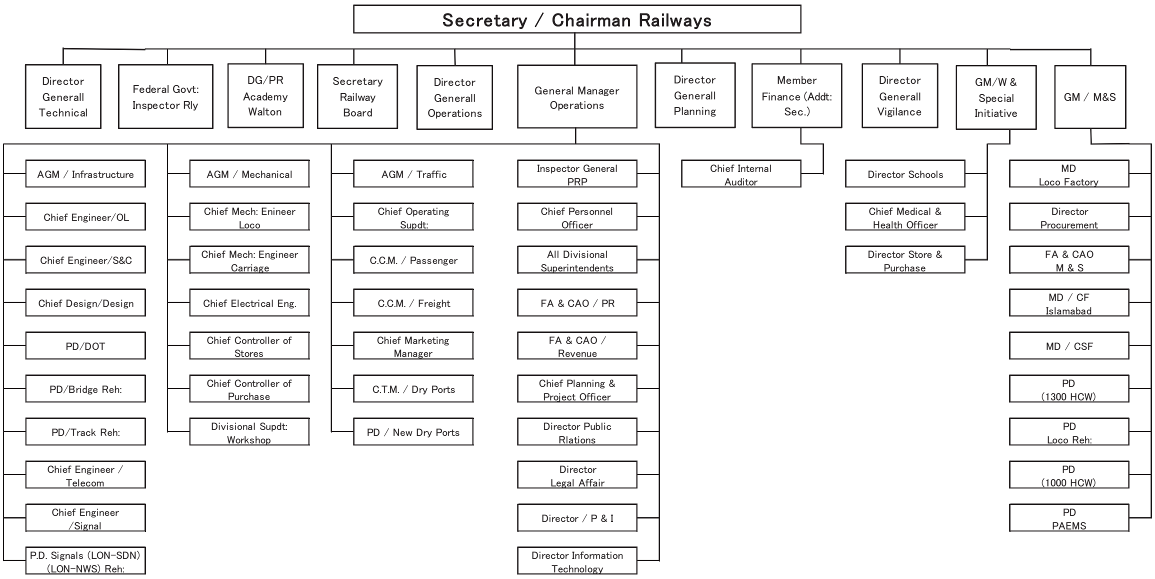
The Operations Unit is located in the North Western Railway headquarters. It oversees train operations and all related functions. There are three additional General Managers, each heading a business unit, namely, Infrastructure, Traffic, and Mechanical.

The Manufacturing and Service (M&S) Unit oversees the management of the concrete sleeper factories, locomotive and carriage factories,

The Development Unit manages all railway-owned schools, hospitals and Railway Academy.

PR comprises of seven territorial operating divisions, i.e., Peshawar, Rawalpindi, Lahore, Multan, Sukkur, Karachi and Quetta. Apart from these, there are workshop divisiona at Moghalpura and an administrative division at headquarters. Each of the territorial and workshops divisions are headed by a Divisional Superintendent directly under the supervision of the General Manager for Operations. The Divisional Superintendents are assisted by the Divisional and Assistant Officers of their respective departments, e.g., engineering departments, civil, mechanical, electrical, signal and telecommunications, medical, transportation and commercial, accounts and railway police.

The organization chart of PR is shown below.



Source: PR Yearbook 2013

Figure 4-14 Organization of Pakistan Railways

4.7.2 Private Sector Participation

There are three private sectors which have a potential for big volume coal transportation to power plants by railway, namely, PIBT and PIL of the Marine Group, National Logistic Cell (NLC), and FOTCO.

The Marine Group has shown interest to transport coal to the planned power plants in the Punjab state. PIBT is constructing a bulk terminal at the west end of Port Qasim, and PIL is planning to procure locomotives and coal wagons for the purpose of coal transportation.

The construction of bulk terminal is on-going. However, because the difficulty of railway access from PR main line to the bulk terminal remains unsolved, as detailed in the section 6.2, the commencement of coal transportation by rail from PIBT is unknown.

NLC, the other potential operator, has started railway freight train operation since 2009. NLC has purchased ten refurbished GMU-30 locomotives from Korean Rail in 2014. However, they have not shown any interest for coal transportation at this moment.

FOTCO is also planning to construct a bulk terminal near the marginal wharf. Since there is a spur line from Bin Qasim Station, they have no difficulty to access PR main line. However, FOTCO's interest is the construction of a bulk terminal only. And although FOTCO is planning to construct a coal stockyard, conveyor belt system to the spur line and coal loading facility to the train, they have not shown interest to operate coal trains by themselves.

According to the latest information, FOTCO's activity on the bulk terminal project is suspended, at present.

As described above, there is a small possibility of the private sector's participation for coal transportation, at present. If constant and large volume coal transportation demands are assured in the future, the private sector may participate in the business.

Source: JICA Study Team

Figure 4-15 Refurbished Locomotives of NLC

Chapter 5 Rolling Stock Fleet and Train Operation Plan

5.1 Rolling Stock Fleet

5.1.1 Light Weight Locomotive (Case 1: Dump Truck System and Case 2B: Spur Line)

The track structure including bridges and culverts between Kotri Junction and Budapur Station will not be upgraded, i.e., the design axle load of 17.27 tons will be maintained, and only light weight locomotives, such as ARPW-20, HAU-20, HBU-20, PHA-20, GRU-20, GEU-20, RGE-20, RGE-20 and HGS can be used.

Typical composition of a train is:

- 2 locomotives + 38 flat bed wagons with 76 coal containers + 1 brake van (Case 1),
- 2 locomotives + 38 hopper wagons with 40-ton coal + 1 brake van (Case 2B),

The length of train is 629 m as shown in Table 4-1 Number of Trains to Transport 2 Million tons of Coal Per Year, the length of locomotive is 22 m.

The total weight of wagons of the train is 2,553 tons for Case 1 and 2,525 tons for Case 2B as shown in Table 4.3 Resistance/friction of wagons of a train set.

The key feature of existing locomotives for Group-III (17.27 tons engine axle load) is as shown below:

Table 5-1 Typical Feature of Existing Locomotives for Group-III

Locomotive Type	Axle Load (ton)	Type of Bogie	Horsepower (HP)	Traction Effort	Maximum Speed
PHA 20	17.5	Co-Co	2,268	241 kN	125 km/h
HAU 20	17.26	Co-Co	2,200	NA	NA
GRU 20	17.5	Co-Co	2,268	NA	NA

Source: Data from PR and Brochure of Pakistan Locomotive Factory Risalpur

These types of locomotives will be used as the shunting locomotives at Port Qasim Station and Lakhra Power Plant Station or New Budapur Station.

The coal loading system is located beside the stabling track of Port Qasim Station and the coal wagons will be moved to/from the coal loading system by the shunting locomotive.

The coal unloading system of Lakhra Power Plant Station or New Budapur Station is located beside the stabling tracks and the wagons will be moved to the unloading pit by the shunting locomotive.

5.1.2 Heavy Weight Locomotive (Case 2A and Case 2AR: Spur Line, and Case 3: Conveyor Belt System)

The additional track including bridges and culverts between Kotri Junction and Budapur Station will be constructed to accept an axle load of 23.30 tons, and heavy and powerful locomotive can be used.

Typical composition of a coal train is:

- 1 locomotive + 40 hopper wagons + 1 brake van (Case 2A and Case 3),

The length of train is 637 m as shown Table 4-1 Number of Trains to Transport 2 Million tons of Coal Per Year, the length of locomotive is 22 m.

The total weight of wagons of the train is 3,445 tons as shown in Table 4-3 Resistance/Friction of Wagons of a Train Set.

The key feature of existing locomotives for Group-I (23.3, 22.86 and 19.3 tons engine axle load) is as shown below:

Table 5-2 Typical Feature of Existing Locomotives for Group-I

Type	Axle Load (ton)	Type of Bogie	Horsepower (HP)	Traction Effort	Maximum Speed
AGE 30	22.76	Co-Co	3,300	367kN	150 km/h
HGMU 30	20.00	Co-Co	3,300	NA	NA
DPU 30	23.30	Co-Co	3,550	391.5kN	125km/h

Source: Data from PR and Brochure of Pakistan Locomotive Factory Risalpur

The Japan International Cooperation Agency (JICA) Study Team recommends to apply the same type of locomotives for Jamshoro Power Plant project, planned in PC-1 for Coal Transportation by Rail to Jamshoro Power Plant (May 2014).

5.2 Wagons

5.2.1 Flat Bed Wagon for Container Transportation

The JICA Study Team proposes to use the open-top container for coal transport. In this case, the containers will be transferred to the dump truck from flat bed container wagon at Budapur Yard and the coal container will be transported from Budapur Yard to Lakhra Power Plant. The flat bed wagons will be used to carry 20 ft open-top coal containers.

The following table shows the key dimension of existing wagons for the container of PR.

Table 5-3 Key Dimension of Container Wagon

Type	Tare Weight (ton)	Maximum capacity (ton)	Load Per Axle (ton)	Length (m)	Width (m)	Height (m)
ZBFC-S	19.2	61	21	13.847	2.75	1.310
(ZBFC-S	19.2	46*	17.05	13.847	2.75	1.310)
BFC	19.05	43.5	15.75	14.986	2.835	NA

Note: * including two containers with a total of 40 tons of coal
Source: Data from PR

The dimension of the flat bed wagon applied for this project is as follows:

- Length between couplers: 15 m,
- Weight of wagon: 20 tons.

In order to assure constant and stable coal transportation from Port Qasim (or PIBT) to Lakhra, fixed train sets dedicated for Lakhra Power Plant are required.

Source: JICA Study Team

Figure 5-1 Flat Bed Wagons

5.2.2 Open-Top Container for Coal Transportation

(1) Container Type

The standard for train transportation are 20 and 40 ft-sized containers, but the former is easier to handle by trucks. In addition, bigger sized containers need high performance handling facilities from a wagon to track. In this report, containers of 20 ft, in a wagon, are planned for coal transportation by truck between Budapur Yard and Lakhra Power Plant site. An example of the proposed coal container is shown in Figure 5-2.

Source: JICA Study Team

Figure 5-2 An Example of 20 ft Containers Transported by a Coal Wagon

(2) Payload and Coal Volume per Container

Pakistan Railways (PR) defined the tracks into five categories, according to the specification. The limit set for the section between Karachi City and Kotri Junction is 23.3 tons (Group-I) axle load. and the rest of the section in the route, Between Kotri Junction and Budapur Station, the limit is set to 17.27 tons (Group-III). Assuming that there will be no axle load upgrading, the 17.27-ton axle load limit shall be kept, and 69.1 tons will be allowed per wagon. According to the condition given, a payload of 40 tons of coal per train is acceptable, as shown in the table below.

Table 5-4 Payload Breakdown per a Train Set

Item	Weight	Remarks
Total Weight	66 t	
Wagon Tare Weight	20 t	
Container Tare Weight	6 t	3 tons x 2 containers
Coal Payload	40 t	20 tons x 2 containers
Allowable Load	69.08 t	Axle Load x 4
(Axle Load	17.27 t	Group-III PR regulation)

Source: JICA Study Team

The succeeding table gives the International Organization for Standardization (ISO) standardized dimensions and the capacity 32.5 cubic meters enough to carry 20 tons coal bycontainers.

Table 5-5 Typical ISO Standardized Dimensions of 20 ft Container

	Length	Width	Height	
Dimensions	20 ft	8 ft	8 ft and 6 in	9 ft and 6 in”
	(6,058 mm)	(2,438 mm)	(2,591 mm)	(2,896 mm)
Minimum Internal Dimensions	5,867 mm	2,330 mm	2,330 mm	2,655 mm
Minimum Door Opening Dimensions		2,286 mm	2,261 mm	2,566 mm

Inside Dimensions				Weights			Capacity
Length	**Width**	**Height**		**Max. Gross**	**Tare**	**Max. Payload**	
		Middle	**Side**				
mm	mm	mm	mm	ton	ton	ton	Cu.m
5,895	2,350	2,380	2,340	32.500	2.250	30.250	32.5

Note: All units are in mm.
Source: ©Hapag-Lloyd

Source: JICA Study Team

Figure 5-3 Open-Top Coal Container (Indonesia)

Source: JICA Study Team

Figure 5-4 Unloading of Coal Container by Reach Stacker (Indonesia)

5.2.3 Hopper Wagon for Coal Transportation

Case 2A: Spur Line, and Case 3: Conveyor Belt System: The additional track, including bridges, will be constructed alongside the existing track to operate the train with axle load of 23.3 tons, same as those on the main line from Kotri Junction to Budapur Station. The hopper wagons, which are of the same type as those going to Jamshoro power plant and other power plants in Punjab, will already be used for the coal transportation to Lakhra Power Plant.

Case 2AR: Spur Line: The existing track will be rehabilitated between Kotri and Budapur Stations to operate the train with axle load of 23.3 tons. The other condition is same as in Case 2A and Case 3, in terms of hopper wagons.

Case 2B: Spur Line: In case the existing track between Kotri Junction and Budapur Station will not be improved, and the axle load is kept at 17.27 tons, the hopper wagons which are of the same type as in Case 2A and Case 3 can be used with a 40 ton-payload instead of 60 tons.

There are two types of hopper wagons, these are the side opening type and the bottom opening type.

The side opening type wagon has a sloped floor “so that the materials can slide by itself to discharge.. Therefore, the capacity of this type of wagon is less than that of the other wagon type. The advantage of this type is that there is no special facility or equipment required for discharging at the unloading site, except for workers to help in the discharging operation.

Both types of hopper wagons can be applicable for Case 2A, Case 2AR, Case 2B and Case 3. They are recommended to be used at the Jamshoro Power Plant and other power plants, for flexible operation and maintenance. The coal unloading facility at Lakhra Power Plant Station is suitable for both types, as well.

The following table shows the key dimensions of existing high side open wagons similar to the side hopper wagon of PR:

Table 5-6 Key Dimension of High Sided Open-Top Wagon

Type of Wagon (Code)	Tare Weight (ton)	Maximum Capacity (ton)	Load per Axle (ton)	Length (m)	Width (m)
ZBKC	22.6	60	21	14.438	3.08
BKC	20.6	44.7	16.33	13.462	2.845

Source: Data from PR

The dimension of the hopper wagon applied for this project is as follows;

- length between couplers:15 m
- weight of wagon:25 tons.

Source: JICA Study Team

Figure 5-5 Coal Hopper Wagon (Indonesia)

Source: JICA Study Team

Figure 5-6 Bottom Hopper Wagon

5.3 Required Number of Rolling Stock and Other Transportation Equipment

The quantity of the rolling stock is calculated based on the train operation cycle time. The cycle time of coal transportation train to Lakhra Power Plant is shown on Chapter 4.1.4 Cycle Time of Train Operation. The cycle times are:

- Case 1: 19.5 h or 0.81 days,
- Case 2A and Case 2AR: 18.5 h or 0.77 days,
- Case 2B: 18.2 h or 0.76 days, and
- Case 3: 18.2h or 0.76 days.

The number of trains to Lakhra Power Plant is only four or three trains (one way) per day, and these trains will be operated as part of the regular traffic of various trains on the main line between Bin Qasim Station and Kotri Junction. The train diagram shall be fixed for all the trains on a busy line. The four or three trains to Lakhra Power Plant have no possibility of flexible operation; these trains will be operated based on a fixed train operation diagram.

The cycle times in the five cases are 0.81 days, 0.77 days, 0.77 days and 0.76 days and 0.76 days. The planned cycle is assumed to be one day for all five cases in this study.

Therefore, the train sets for the coal transportation to Lakhra Power Plant will be operated one cycle per day, in all 5 cases, for easy and stable train operation.

To implement the necessary coal transportation, four or three train sets are enough. However, spare rolling stocks are necessary during periodic maintenance for all the rolling stocks, and to be used also in case of accidents during train operation.

Therefore, an additional train set is planned to be procured for this project.

5.3.1 Locomotives and Wagons

The following table shows the required number of rolling stocks.

Table 5-7 Quantity of Rolling Stocks

Item	Case 1	Case 2A, Case 2AR	Case 2B	Case 3
Calculated Cycle Time	19.5 hours	18.5 hours	18.2 hours	18.2 hours
(Reference Table)	(Table 4-4)	(Table 4-5)	(Table 4.6)	(Table 4-7)
Cycle Time for Train Operation	1 day	1 day	1 day	1day
Calculated Number of Train Sets (Refer to Table 4-1)	4	3	4	3
Additional Number of Spare Train Sets	1	1	1	1
Total Number of Required Train Sets	5	4	5	4
Train Formation (Refer to Table 4-4)	2 loco.+ 38 wagons+ 1 brake van and 76 containers	1 loco.+ 40 wagons+ 1 brake van	2 loco. + 38 wagons + 1 brake van	1 loco.+ 40 wagon+ 1 brake van
Required Number of Locomotives	10	4	10	4
Required Number of Wagons	190	160	190	160
Required Number of Containers	456	-		-
Required Number of Brake Van	5	4	5	4
Calculated Number of Shunting Locomotives	1 (Port Qasim)	2 (Port Qasim and Lakhra)	2 (Port Qasim and Lakhra)	2 (Port Qasim and New Budapur Station)
Additional Number of Shunting Locomotives (in case of maintenance and trouble of locomotive)	-	1	1	1
Required Number of Shunting Locomotives	1	3	3	3

Note: Number of containers for operation is 38 x 2 x 4 = 304, 50% of additional containers considering the maintenance and spare. 304 x 1.5 = 456 nos..
Source: JICA Study Team

5.3.2 Dump Trucks and Reach Stackers: Case 1

(1) Dump Trucks

One cycle time between Budapur yard and Lakhra Power Plant is estimated at 35 minutes, as mentioned in Chapter 4 Table 4-10 Cycle Time of Dump Truck. In this regard, 304 (38 x 2 x 4) containers shall be transported in a day, and 178 hours (=304 x 35=10,640 minutes) are required. If working hour is set at 20 hours a day, at least ten units of trucks are required (refer to Clause 4.6.2). These trucks must be procured, as well as an additional 50%, to serve as standby or back-up trucks. The total number of trucks required for procurement is 15, which is the 10 required trucks x 1.5, to include the 50% additional units.: 10x1.5=15

Thus, total 15 units of dump trucks will be required.

(2) Reach Stackers

In Budapur yard, 3 min each for the unloading and loading of containers from the wagons to the trucks are assumed. For transloading 304 containers a day, 15.2 hours (304 containers x 3 minutes = 912 minutes or 15.2 hours) and two reach stackers are required for loading and unloading works in a 20 hour-work a day. In this study, two reach stackers plus one, as backup or standby for maintenance, are assumed.

Thus, three units of reach stackers will be required.

5.4 Maintenance of Rolling Stock for Coal Transportation

Maintenance of locomotives and wagons is carried out under the Mechanical Unit of the Operation Unit of PR.

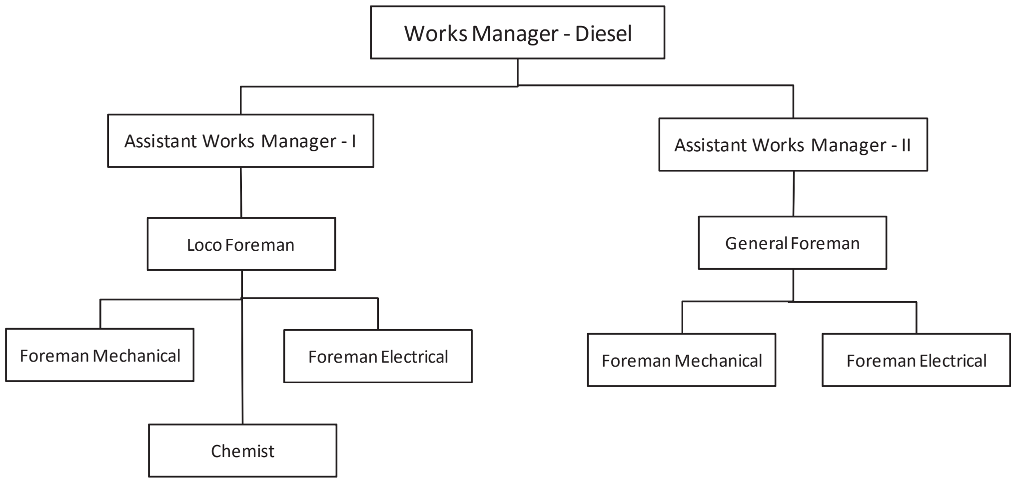
When the coal train operation to Lakhra power plant starts, maintenance of locomotives will be carried out in the diesel shed and shop adjacent to the Karachi Cantt. Station.

Source: JICA Study Team

Figure 5-7 Inside the Diesel Shed at Karachi Cantt Station

The Karachi Cantt diesel shed and shop was established in 1951. At present, it has 1,136 total number of staff (excluding managers). These are composed of 125 Class III staff (foreman) and 1,011 Class IV (labour). According to the Works Manager, the shortage in staff is 54 in Class III and 135 in Class IV 135, based on the approved number of staff.

The organization structure is shown in Figure 5-8 below.;



Source: JICA Study Team

Figure 5-8 Organization of Karach Cantt Diesel Shed and Shop

There is a training center in Karachi Cantt. diesel shed for new employees. The training center is open for Class IV staff every July to teach basic knowledge and skills on electrical and mechanical works.

Although the diesel shed has an area of 76,000 sq. yards (or 63,500 m^2, approx.), there is not enough room for the maintenance of additional locomotives which will be used for coal transportation. Therefore, it is recommended to build a new diesel shed for these locomotives in another location. Pipri Marshalling Yard is the best location for the new diesel shed because Pipri is located very close to Port Qasim and it is on the way to Jamshoro and Lakhra Power Plants. Due to the recent tendency of freight train operation, requirements for marshalling operations are reduced. The construction of diesel sheds will revitalize the Pipri yard.

The capacity of Karach Cantt. diesel shed is nearly full. A limited number of locomotives for Lakhra Power Plant may be maintained at the existing shed. However, when another power plant starts to operate, there is no space for these locomotives. Since the construction of a new diesel shed will take a few years, the construction will be planned in advance for the power plant projects.

At present, there is room for maintenance of diesel locomotives in Lahore workshop. Therefore, until a new diesel shed is constructed, regular maintenance can be done at Lahore if Karach Cantt shed can no longer accommodate the works, although taking time for transportation.

Workers for the new shed can be transferred from Lahore workshop because there is a surplus of foremen and technicians there, according to PR.

The maintenance schedule of diesel-electric locomotives is categorized from A to F, depending on time intervals and running distance of each locomotive. Schedule A means daily maintenance and F means overhaul. Checking point will be increased from schedule B to E. Karachi Cantt diesel shed can cover all maintenance work except overhaul. Overhaul of diesel-electric locomotive can be done only at Lahore workshop.

Source: JICA Study Team

Figure 5-9 Overhaul of Diesel-Electric Locomotive at Lahore Workshop

5.5 Operation of Rolling Stock

5.5.1 Locomotives

Shortage in locomotives is constant in the PR freight train operations. Since there is no surplus of locomotive in PR which can be utilized for massive and regular coal transportation to the planned power plants, new locomotives should be procured for the coal transportation.

A block train (unit train) service is widely used in the world for the transportation of coal. A block train is a train wherein all wagons carry the same commodity to and from the same origin and destination, without being split up or stored, en route. Therefore, it is recommended to use the same model of locomotives for the coal train if the volume of coal and wagon type is the same.

For the coal transportation to Lakhra Power Plant, if the section between Kotri Junction and Budapur Station is not upgraded, or a new track to accommodate axle load of 23.3 tons is not constructed, the locomotives shall be light-weight type to suit the axle load of 17.27 tons, such as 2,200 HP-type. Assuming the case of container train, the total payload will be 1,560 tons and gross trailing load of 2,700 tons, two locomotives will be required for sufficient hauling capacity.

In case where the section between Kotri Junction and Budapur Station is upgraded or a new track having a design axle load of 23.3 tons is constructed, heavy locomotive, such as 4,000 HP-type, can be introduced. In this case, hauling capacity of one locomotive will be enough.

5.5.2 Coal Wagons

Coal wagons for the planned power plants should be new because the number of PR-owned coal wagons are limited. When procuring coal wagons, the type of coal wagon should be selected considering the loading/unloading and transportation methods between port and power plant.

For Lakhra Power Plant, there are three alternative methods of coal transportation between Budapur Station and power plant, namely, coal container with dump truck, spur line, and conveyor belt.

If the container with dump truck method is selected, flat bed wagon for the container should be selected. In order to fit with the bed of the dump truck, 20 ft-containers will be used. Flat bed wagon will be loaded 2 units of 20 ft containers.

When the spur line is constructed between PR main line and the Power Plant, the hopper wagon will be selected. As described in Clause 6.5.2, the wagon types suitable for rotary car dumper (RCD) are not recommended because of the volume to be transported.

Hopper wagon is also recommended for the case where conveyor belt system is selected. Coal shall be unloaded at the drop pit which will be constructed at Budapur Station coal train handling yard.

Chapter 6 Coal Terminals, Coal Loading Facilities, Spur Line to the PR Main Line

6.1 Coal Terminal Construction at Port Qasim

Fauji Oil Terminal & Distribution Co., Ltd. (FOTCO) is now planning to construct a coal handling terminal at Port Qasim.

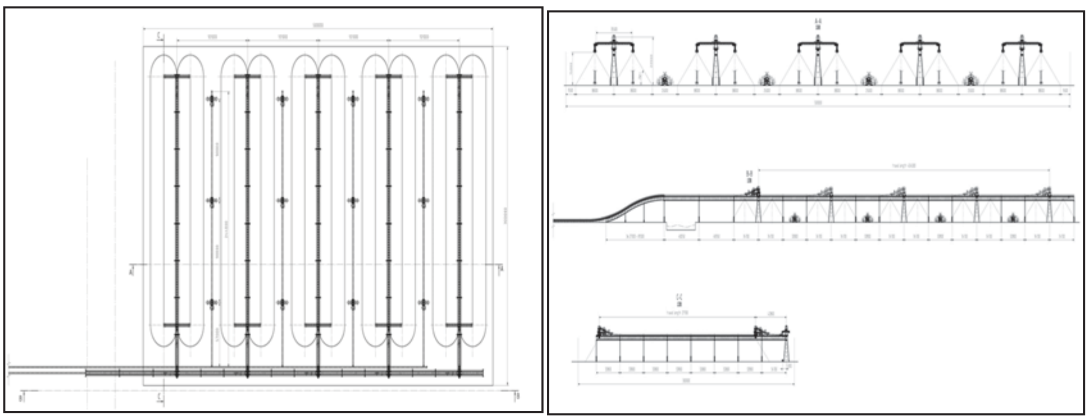
6.1.1 Design of Coal Terminal and Stockyard

FOTCO is planning to construct a Coal Terminal at the edge of the marginal wharf along the navigation channel as shown on the photos below.

Source: FOTCO

Figure 6-1 Coal Jetty, Conveyor Belt System and Storage Yard at Port Qasim

The planned stockyard will be reclaimed at the north-west side of the marginal wharf. The layout of the stockyard is shown in Figure 6-2.



Source: FOTCO

Figure 6-2 Layout of FOTCO's Coal Storage Yard

FOTCO is planning to unload 4 million tons of coal on the first phase (2017), 8 million tons on the second phase (2018), and 12 million tons on the final phase (2019).

According to recent information, FOTCO's planned project is suspended at present. Thus, it is difficult to expect the use of FOTCO's facility for coal transportation to Lakhra Power Plant in early stage.

6.1.2 Connection to PR Main Line

Coal unloaded at the coal jetty will be transported by conveyor belts to the storage yard. From the stockyard, coal will be transported by conveyor belts to three directions. The first 4 million tons/year will be delivered to the planned new power plant of K-Energy located near the port. Another 4 million tons/year will be delivered to the planned SEPCO Power Plant which is also located adjacent to the port. The last 4 million tons will be delivered to the railway yard and loaded on coal trains to Jamshoro Power Plant.

There are allowances in FOTCO's planned facilities and stockyard for additional demands. It was informed by FOTCO that, if Lakhra Power Plant project is officially recognized and there is a plan to utilize FOTCO's facility, FOTCO will modify its plan accordingly.

PR is planning to construct additional line between Port Qasim and Muhammad Bin Qasim Station. Therefore, there will be no waiting time required between PR main line and Port Qasim.

Source: JICA Study Team

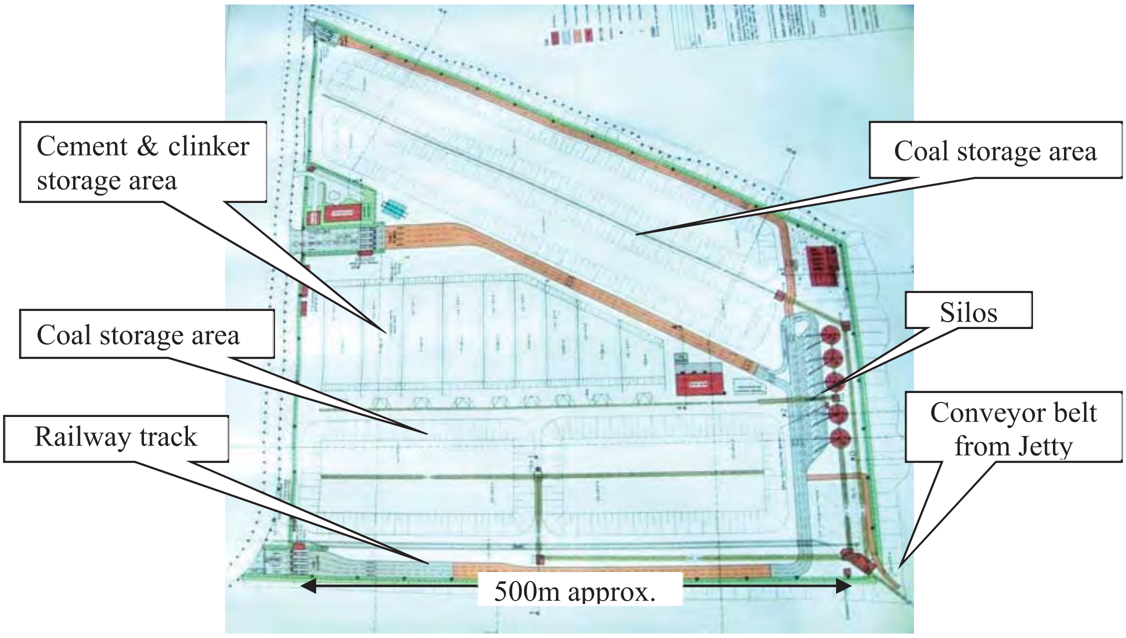
Figure 6-3 Connection Alignment between PR Main Line and Port Qasim

6.2 Pakistan International Bulk Terminal (PIBT)

6.2.1 Design of PIBT Yard

The construction of PIBT yard started from March 2012 and is scheduled to be completed within three years. PIBT yard is designed for the exclusive use of bulk materials, such as coal, cement and clinker.

The trapezoidal-shaped yard (62 acres or 251,000m^2 approximately) has storage capacity of 1 million tons of coal, 200,000 tons of clinker, and 50,000 tons of cement in silos. The design capacity of coal import per annum is 8 million tons of coal, and also exports per annum of 4 million tons of cement and clinker. Total capacity is planned to increase up to 20 million tons per annum.



Source: PIBT

Figure 6-4 Layout of PIBT Yard

Imported coal will be unloaded at the offshore jetty and transported by a 2.5 km-long conveyor belt to the storage yard. Coal handling capacity is 12 million tons per annum in Phase 1, and 20 million tons per annum in Phase 2.

Two railway tracks will be placed at the west edge for loading of coal, as shown in Fig. 6-4, above. Fully automated coal loading facility will be provided. However, track length within the yard is less than 500 m long. Therefore, the coal trains should be less than the effective length of the track, or should be separated into two blocks before entering the yard. If the breaking of train is required, such operation will be carried out at Pipri yard, which is 15 km away from PIBT because there is no space nearby PIBT.

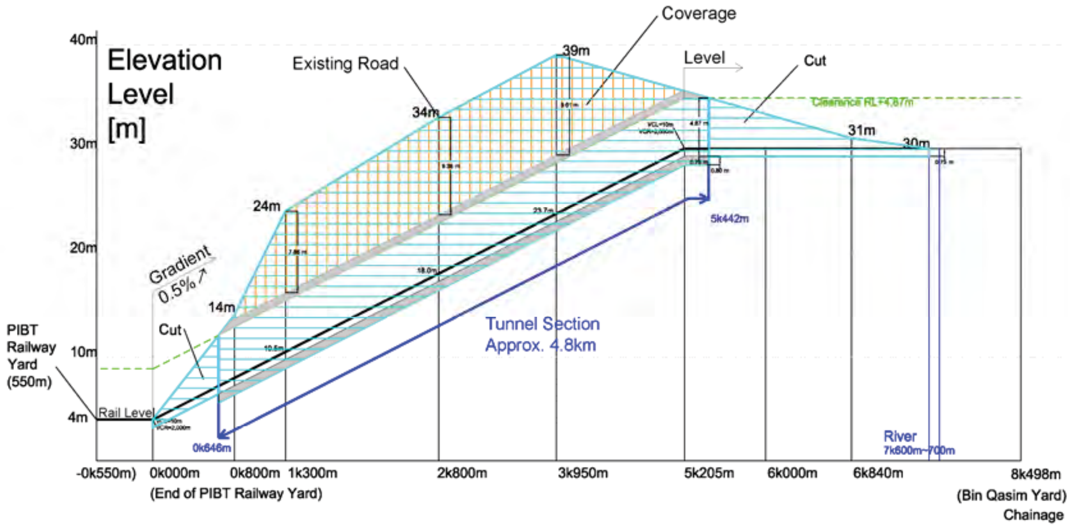
6.2.2 Spur Line from PIBT to PR Main Line

PR Karachi Division and PIBT jointly planned to connect the spur line from the PR main line to PIBT yard along the planned road. When the JICA Study Team visited the site, it was found that the difference of the ground height between PIBT and the PR main line was 30 m, approximately. Since the distance between PIBT and the mail line is 3 km, approximately, the gradient of the spur line will be more than 1%, or twice bigger than PR standard.

As shown on Figure 6-5, the vertical alignment from PIBT to PR main line is very steep for freight trains, especially near PIBT section. If applying PR's design standard, the new line requires to pass a tunnel section as shown on Figure 6-6. The rail level will be 20 m, approximately, below the existing road level.

Source: JICA Study Team

Figure 6-5 Planned Rail Connection from PR Main Line to PIBT



Source: JICA Study Team

Figure 6-6 Profile of Spur Line between PIBT Yard and Bin Qasim Station

Based on the inquiry from the JICA Study Team, PR staff surveyed the ground level at PIBT yard and Mehran Highway near the PR main line, and reported the height difference of 30.099 m. This means the slope from the highway to PIBT yard is 1.06%, and an additional locomotive will be required between the main line and PIBT yard operation.

Crossing of Mehran Highway is another problem. Since the traffic volume on the highway is not small, construction of a flyover should be considered.

In order to solve the problem, extension of the access track should be considered. If 0.5% gradient is given from PIBT, the rail level will be 15 m below the surface of Mehran Highway. After passing under the highway, the spur track should be turned right towards Pipri direction, parallel with the PR main line with 0.5% gradient.

Source: JICA Study Team

Figure 6-7 Revised Rail Access from PIBT to PR Main Line

Unless otherwise extending railway track within the PIBT yard, transportation capacity of PIBT yard will be much less than the planned volume because of breaking and coupling operation of coal train at Pipri yard. The required time of coal train was estimated and shown on Table 6-1.

Table 6-1 Coal Loading Time at PIBT Using One Set of Locomotives

No.	Item	Time (min.)	Remarks
1	Breaking of a coal train in 2 parts	30	
2	Running of one part of the train from Pipri to PIBT	48	16 km by 20 km/h
3	Coal loading at PIBT	120	6 min./wagon x 20 wagons
4	Running of one part of the train from PIBT to Pipri	48	16 km by 20 km/h
5	Decoupling/coupling of locomotive	30	
6	Running of another part of the train from Pipri to PIBT	48	16 km by 20 km/h
7	Coal loading at PIBT	120	6 min./wagon x 20 wagons
8	Running of another part of the train from PIBT to Pipri	48	16 km by 20 km/h
9	Coupling of separated wagons	40	
	Total time required	532	9 hours approx.

Source: JICA Study Team

Table 6-2 Coal Loading Time at PIBT Using Two Sets of Locomotives

No.	Item	Time (min.)	Remarks
1	Breaking of a coal train in 2 parts	30	
2	Running of two parts of the train from Pipri to PIBT	48	16 km by 20 km/h
3	Coal loading of the first part of train at PIBT	120	6 min./wagon x 20 wagons
4	Shunting operation at PIBT	30	
5	Coal loading of the second part of train at PIBT	120	6 min./wagon x 20 wagons
6	Running of another part of the train from PIBT to Pipri	48	16 km by 20 km/h
7	Coupling of separated wagons	40	
	Total time required	436	7 hours approx.

Source: JICA Study Team

As shown on the above table, PIBT yard is able to load only two trains in a day if train breaking operation is required at Pipri Marshalling Yard. Even adding additional locomotive sets, three trains in a day will be the maximum capacity. This means the coal transportation capacity of PIBT yard will be as follows:

- 2 trains/day: 2,400 tons x 2 = 4,800 tons/day (1.7 million tons/year)
- 3 trains/day: 2,400 tons x 3 = 7,200 tons/day (2.5 million tons/year)

6.2.3 Conveyor Belt System to PR Main Line

As described above, railway connection to PIBT will be ineffective and insufficient. Considering the topographic condition and distance from PR main line, selection of the conveyor belt system will be more realistic.

There is a big open space near Jumma Goth Station which is the nearest station from PIBT. Since the distance between PIBT and Jumma Goth Station is 3 km only, construction of the conveyor belt system will not be very difficult.

Conveyor belt system has other advantages, in this case, as follows:

- There is Mehran Highway between PIBT yard and PR main line. It is easy for the conveyor belt system to cross over the highway compared to a railway.
- It is preferable to construct a coal loading yard at the northern side of PR main line because of the running direction of loaded coal trains. Similar to the crossing over Mehran Highway, it is not difficult for a conveyor belt system to cross the PR main line.

Source: JICA Study Team

Figure 6-8 Sample Photo of Conveyor Belt System

6.3 Coal Loading Facility to Train

The loading of coal from coal stockyard to train will be done by the port operator.

The coal loading to coal train will be done using a hopper to shorten the loading time and ensure the continuous loading to the train. The coal will be supplied by belt conveyor system from coal stockyard. The facilities and works will be under the port operator, such as Port Qasim and PIBT yard.

If understod properly, can this be re-written as: For 40 tons to 60 tons of coal, the loading can be done in 2 min by a hopper to an open-top wagon. It can also take an estimated time of 1 min to load to a 20 ton-capacity open-wagon.

Since the position of coal hopper is fixed, the coal train will move forward to receive coal from each wagon. The loaded coal shall be measured by weighbridge located near the hopper. Measurement can be processed automatically without halting the train.

Photos of coal-loading hopper are as shown in Figure 6-9.

Source: JICA Study Team

Figure 6-9 Coal-Loading Hopper

6.4 Budapur Yard for Transfer of Coal

The design of Budapur Yard for coal transfer will depend on the selected transportation method of coal between Budapur Station and Lakhra Power Plant, namely, 1) Case 1: dump truck system by open top container and dump truck, 2) Case 2A, Case 2AR and Case 2B: spur line is direct railway access to the coal stockyard of power plant, and 3) Case 3: conveyor belt system will transfer of coal by conveyor belt from coal unloading pit to the coal stockyard of power plant.

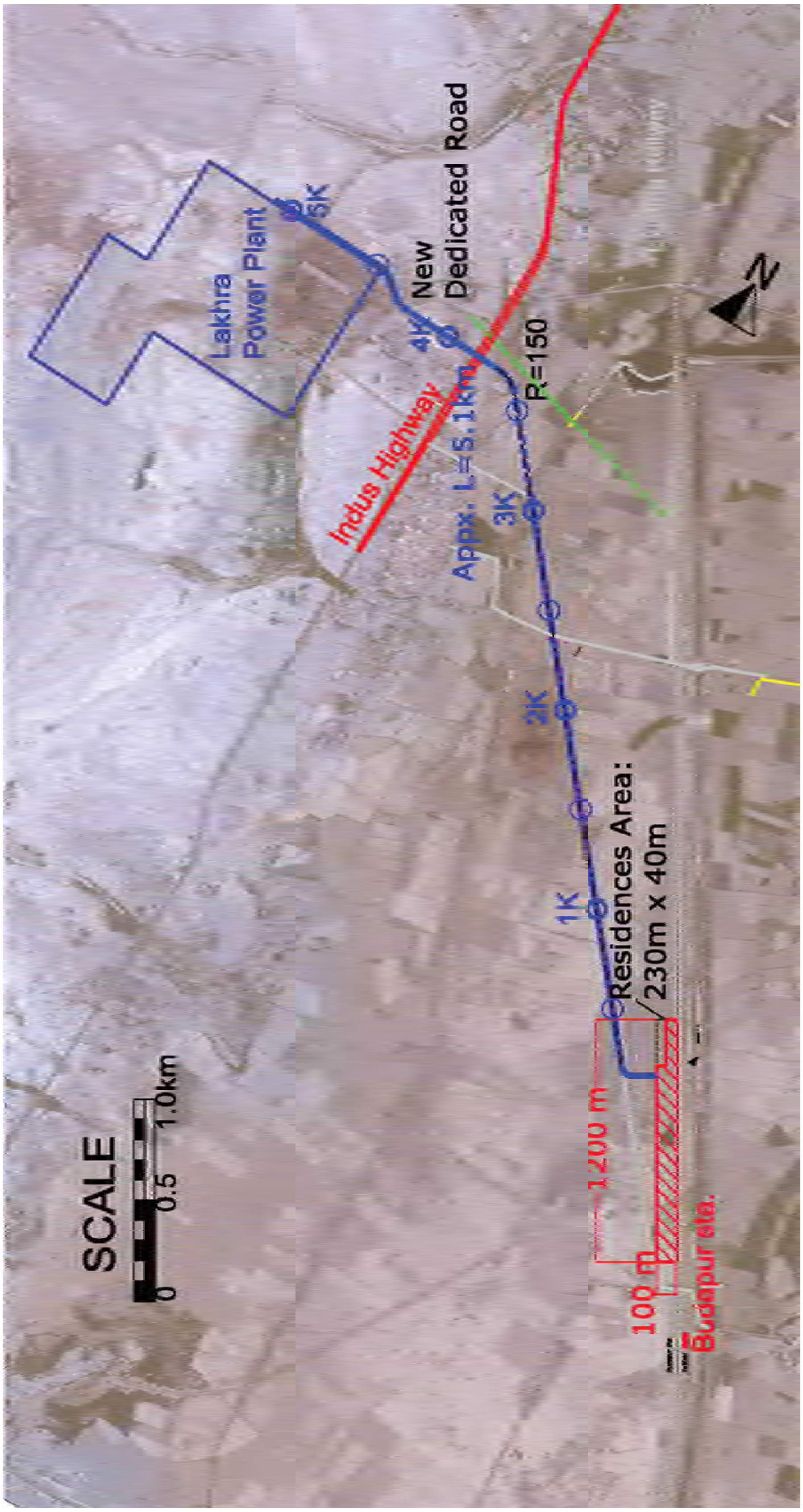
6.4.1 Case 1: Dump Truck System; Coal Transportation by Dump Truck

The trains with coal containers from port will arrive at Budapur Station and stop at the station yard to transfer the coal container from the wagon to the dump truck.

The spur line to station yard will be branched from main line at the outer turnout of Khanot side of Budapur Station.

The station yard will have four stabling lines with 650 m effective length, one locomotive run-round line, and two lead tracks. The station yard will be on the embankment beside the main track next to Budapur Station. The area of the station yard is about 100 m wide and 1,000 m long. This station yard is connected to the access road to the power plant. The existing road is not wide enough for frequent truck traffic, hence, this road will be widened by two lanes. The ground of the station yard will be paved for truck running and for the operation of reach stackers in transfering the container from railway wagon to dump truck.

The track alignment is shown on Figure 6-10.



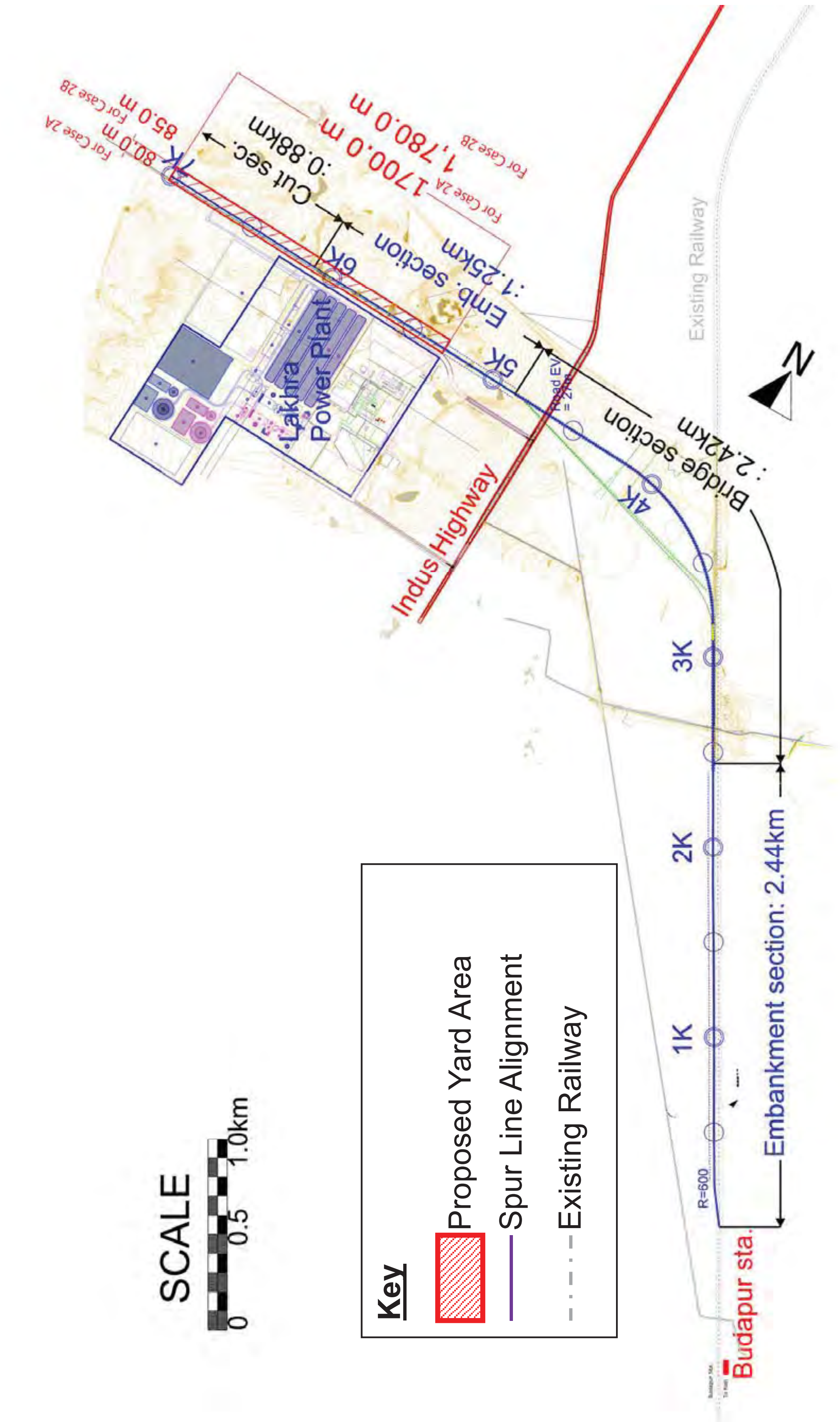
Source: JICA Study Team

Figure 6-10 Route Alignment of Case 1: Dump Truck System

6.4.2 Case 2A and Case 2AR: Spur Line; Spur Line to the Power Plant

No station yard will be constructed at the Budapur Station when a spur line is constructed at the Power Plant. The shunting yard shall be located after passing the coal unloading site at the Power Plant.

When a steeper slope is adopted to shorten the bridge section, additional locomotives will be required to push or pull the coal train. In this case, refuge track shall be provided for those locomotives at Budapur Station (see Figure 4-10, Clause 4.5.2, and the Figure 6-11).



Source: JICA Study Team

Figure 6-11 Route Alignment of Case 2A/AR and Case 2B: Spur Line

6.4.3 Case 2B: Spur Line to the Power Plant with Light Locomotives

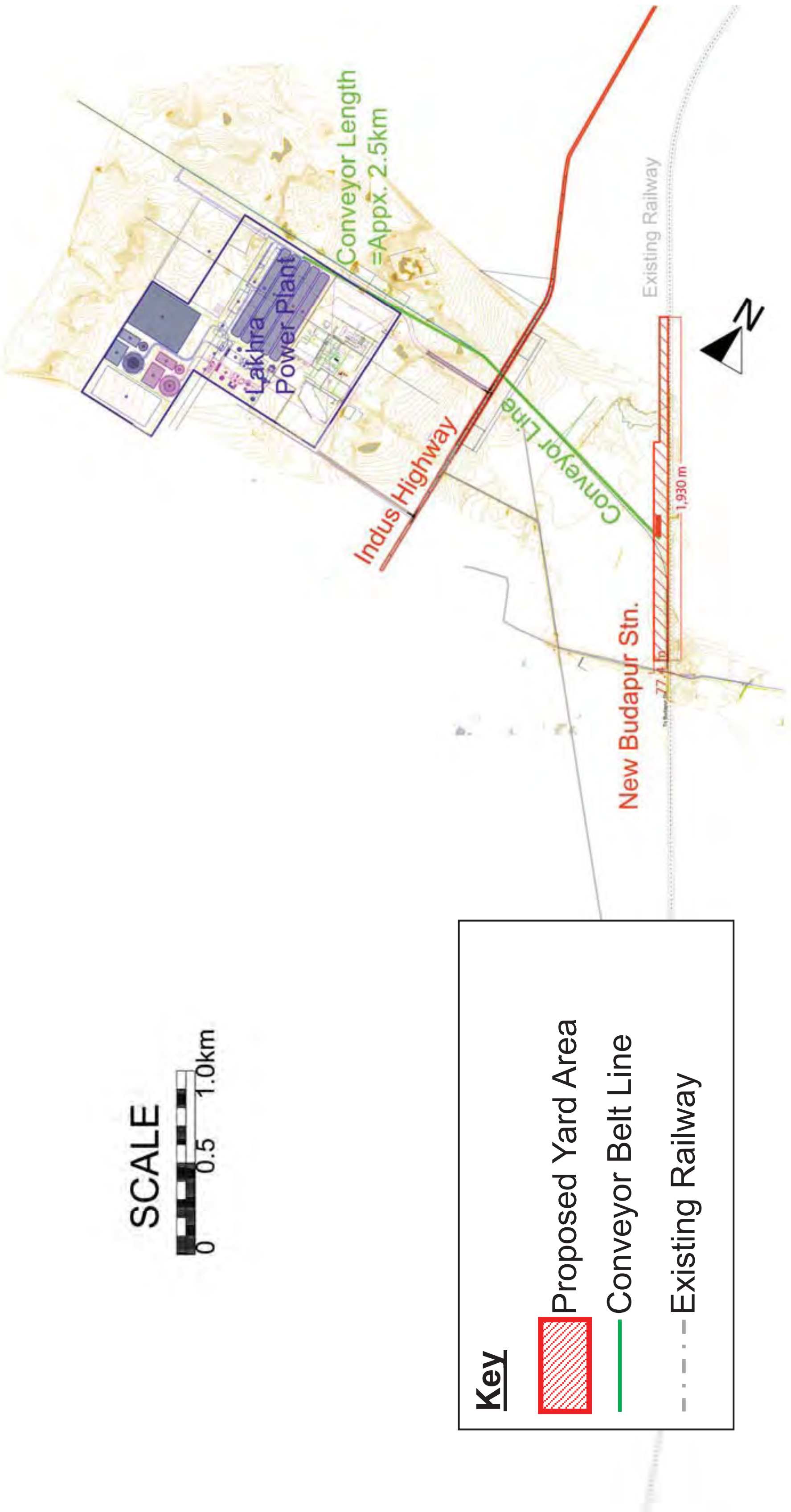
The same as in Case 2A and Case 2AR, no station yard will be constructed at Budapur Station when a spur line is constructed at the power lant. A shunting yard shall be located after passing the coal unloading site at the power plant.

Hopper wagons with reduced payload of 40 tons per wagon will be used, and the number of the wagons is increased compared to Case 2B. The number of stabling lines and the unloading works at the Lakhra Station will be increased.

6.4.4 Case 3: Conveyor Belt System; Transportation by Conveyor Belt

The hopper wagons will be used for coal transportation from Port Qasim to Budapur yard. The coal transfer facility will be equipped at the yard where the coal from wagon to conveyor belt will be transferred.

Coal will be dropped from hopper wagon into a pit, then moved to temporary stockyard or directly to the conveyor belt going to the power plant. Capacity of the temporary stockyard will be 20,000 tons approximately.



Source: JICA Study Team

Figure 6-12 Route Alignment of Case 3: Conveyor Belt System

6.5 Coal Unloading Facility at Lakhra Power Plant

6.5.1 Case 1: Dump Truck System; Coal Transportation by Coal Container and Dump Truck

Considering the topographic condition at the Lakhra Power Plant site and the required volume of coal, the transportation method using 20 feet open-top containers and dump trucks is considered. The coal containers will be transferred from the container wagon of the coal train to the dump truck by reach stackers. Dump trucks will transport coal containers from Budapur yard to Lakhra Power Plant through a 4.1 km dedicated road. Coal will be unloaded at the designated pit or stockyard by lifting up of loading platform. The coal dumped from the container will be moved and smoothed by bulldozer or loader at the stockyard.

Thus, no special unloading facility will be required when coal is transported by dump trucks.

6.5.2 Case 2A, Case 2AR and Case 2B: Spur Line; Coal Transportation by Spur Line

The alternative method of unloading at the power plant is by installing a railway track from Budapur Station to the side of the coal stockyard and unload the coal using tippler, rotary car dumper (RCD), or side/bottom hopper of the special wagons for coal transport. The stabling lines and shunting lines will be constructed beside the unloading facility and the length of this yard will be more than 1.5 km. The number of stabling tracks and shunting tracks is at least five for Case 2A/ AR and six tracks for Case 2B. The site where the yard will be constructed is up and down and the surface is rough. The construction of a railway station with unloading facilities will be costly due to the volume of cut and fill on this hilly area.

The unloading facility for coal wagon, such as tippler or RCD, is a large mechanical facility and the installation, operation and maintenance costs are expensive. Therefore, these facilities are reasonable for large scale unloading of coal, and not for small scale operations such as unloading of 2 million tons per year. The mechanical unloading system needs periodical maintenance and it is necessary to consider possible machine breakdowns. Thus, two set with two lines must be installed in this mechanical loading system.

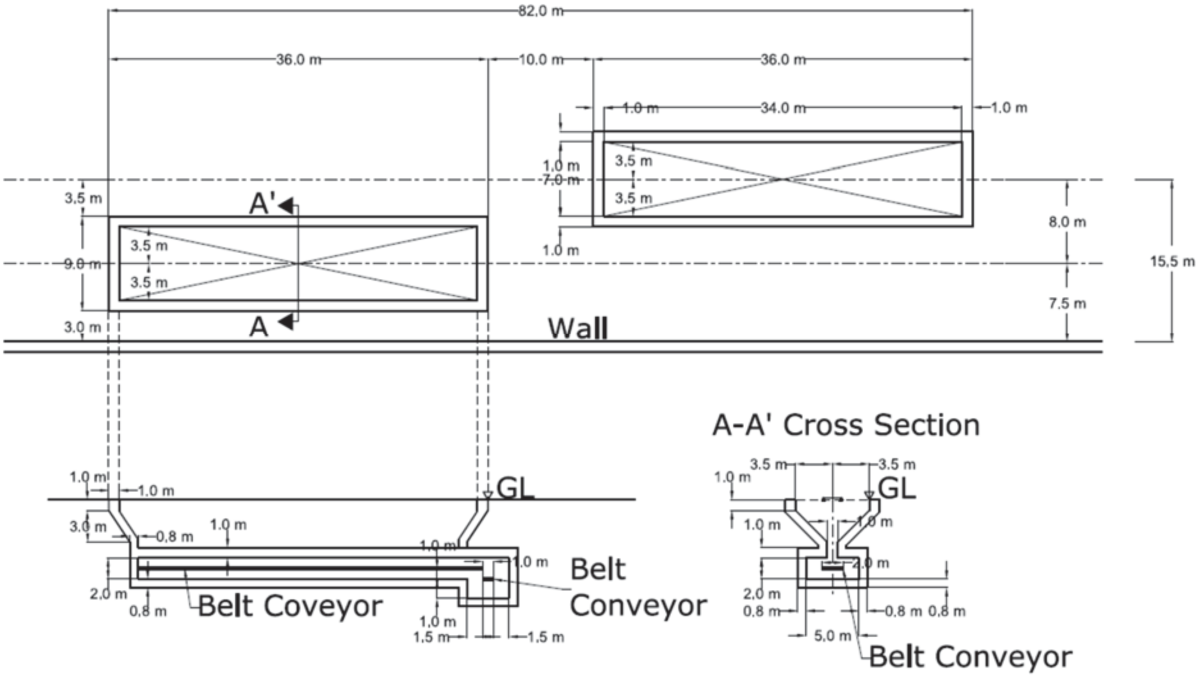
The side or bottom hopper coal wagons are used commonly for coal transport. The unloading facility for side/bottom hopper wagons needs a coal-receiving hopper beneath the railway track and other coal transfer facilities such as a belt conveyor.

Figure 6-13 is a photo showing the RCD, open top wagon for coal container.

Source: JICA Study Team

Figure 6-13 Coal Wagon Inside Rotary Car Dumper

The following drawing shows the proposed coal pit system for discharged coal from the side/bottom hopper wagons. This coal pit system same will be the case for Case 2A, Case 2AR and Case 2B: Spur Line and Case 3: Conveyor Belt System.



Source: JICA Study Team

Figure 6-14 Coal Unloading Facilities

Source: JICA Study Team

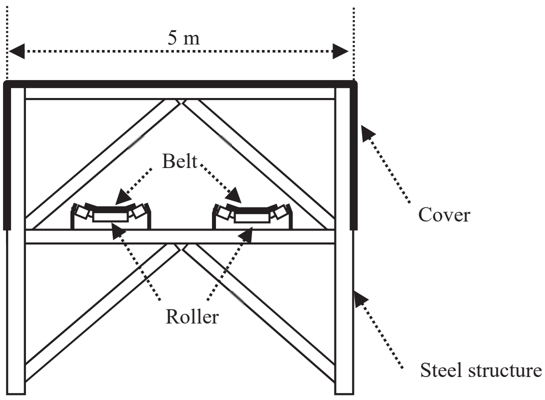
Figure 6-15 Coal Pit for Side/Bottom Hopper Wagon

6.5.3 Case 3: Conveyor Belt System; Coal Transportation by Conveyor Belt System

In the case where coal is transported by conveyor belt system from Budapur yard to Lakhra Power Plant, the coal unloading facility will be constructed at Budapur yard.

Coal wagons for this case will be bottom hopper type. In order to expedite the unloading, the coal unloading pit must be wide enough to receive two wagons at a time. The coal pits are the same as in Case 2A, Case 2AR and Case 2B: Spur Line, as shown Figure 6-14.

The schematic diagram of the cross section of the conveyor line is shown in Figure 6-16.



Source: JICA Study Team

Figure 6-16 Schematic Diagram of the Cross Section of the Conveyor Belt System

Chapter 7 Railway System Improvement Plan

7.1 Premise

The Ministry of Railways and Pakistan Railways (PR) had the railway improvement plan from Port Qasim to Jamshoro Power Plant via Bin Qasim Station, Pipri yard, Kotri Junction, Sindh University, and Akhundabad Station to transport coal. The budget has been prepared under PC-1 for Coal Transportation by Rail (May 2014: Jamshoro PC-1).

7.1.1 PC-1 for Coal Transportation by Rail to Jamshoro Power Plant (May 2014)

This study is under the condition the completion of the railway improvement from Port Qasim to Akhundabad Station. Case 1, Case 2A, Case 2B, and Case 3 are based on this Jamshoro PC-1 study.

The main items of PC-1 for Coal Transportation by Rail to Jamshoro Power Plant are as follows:

Track Works

- Additional line from Kotri Junction to Jamshoro Power Plant (14.82 km): Providing and laying new track with UIC 54 / 60 rails. Pre-stressed concrete (PSC) sleepers (1,640 pieces per km), 30 cm ballast cushion and W-14 fastenings,
- Additional loop line at Sindh University and Jamshoro (2.20 km): Providing and laying new track with UIC 54 / 60 rails. PSC sleepers (1,640 pieces per km), 30 cm ballast cushion and W-14 fastenings,
- Additional lines between Bin Qasim Station to Port Muhammad Bin Qasim Station (13 km): Providing and laying new track with UIC 54 / 60 rails. PSC sleepers (1,640 pieces per km), 30 cm ballast cushion and W-14 fastenings,
- Rehabilitation of existing track between Bin Qasim Station to Port Muhammad Bin Qasim Station (13 km): Providing and laying new track with UIC 54 / 60 rails. PSC sleepers (1,640 pieces per km), 30 cm ballast cushion and W-14 fastenings,
- Rehabilitation of existing track between Akhundabad Station to Jamshoro including loop lines (3) (6.12 km): Sleeper replacement with PSC sleeper and W-14 fastenings.

Structural Works

- Extension of bridges and level crossing between Bin Qasim Station-Port Muhammad Bin Qasim Station:

- Extension of Bridge No. 4 and 5 (4-span (4 x 60))
- One girder bridge (2 x 60), 3 reinforced cement concrete (RCC) box culvert (3 x 3), 02 nos. RCC box culvert (4 x 3).
- Construction of protection wall for railway embankment
- Earthwork for embankment (cutting and filling)
- Extension of 1 level crossing
- Bridge (single span) between Bin Qasim Station to Port Muhammad Bin Qasim Station

- Extension of bridges and level crossing between Kotri Junction to Akhundabad Station:
  - Bridge (single span) between Kotri Junction-Akhundabad Station
  - Bridge (hume pipe) 4 x 18"
  - Steel girder for bridge (1 x 67-3")
  - Extension of bridge built on RBOD project between Kotri Junction-Sindh University (1 x 40, 2 x 60)

Mechanical Works

- Procurement of ten new DE locomotives: Procurement of DE locomotives (4,000-4,500 HP)
- Procurement of high-capacity hopper wagons and brake van: Procurement of 500 high capacity hopper wagons (gross load 84 tons, pay load 60 tons) and 9 brake vans
- Procurement of track machinery, vehicles, and equipment:
  - Self propelled material lorry (heavy duty)
  - Rail cutting machine with 200 disks
  - Rail drilling machine with 100 bits
  - Universal power wrench
  - Motor cycles
  - Tractor with blades and trolley
  - Motorized dip lorries
  - Miscellaneous track tools and equipment

- Motor trolleys with T&P
- Push trolleys
- Suzuki jeep 1,000 CC
- Mini truck
- Suzuki cultus 1,000 CC

Signal Works

- Remodeling of signaling system from Bin Qasim Station-Port Muhammad Bin Qasim Station, Kotri Junction-Akhundabad Station and Sindh University Station yards.

7.1.2 PC-1 for Coal Transportation by Rail to Jamshoro Power Plant (October 2014)

Jamshoro PC-1 has been revised since October 2014 (hereinafter Revised Jamshoro PC-1) and it will upgrade the existing track between Kotri and Akhundabad from axle load of 17.27 tons to 23.3 tons. Case 2AR is based on the Revised Jamshoro PC-1.

Track Works

- New loop lines at Sindh University Station and at Jamshoro Power Plant (2 km)
- Rehabilitation of existing track between Kotri to Jamshoro Power Plant and loops lines (5 nos.) (17.99 km)
- Turnouts 54/60 kg (13 sets)

Signaling

- Remodeling of signaling system from Kotri to Akhundabad and at Sindh University Station yards
- Main equipment
- Block equipment
- Signaling equipment
- Fiber Optic
- Installation and commisioning

Structural Works:

- Rehabilitation of bridges, provision of turn table, earthworks, etc.
- Estimate cost of rehabilitation of existing bridges between Kotri-Akhundabad
- Construction of signal cabin

- Construction of turn table at Jamshoro Power Plant (lump sum)
- Earthworks

Mechanical Works

- Procurement of 5 new DE locomotives
- Procurement of 351 high-capacity hopper wagons including 6 brake vans

Others

- Procurement of track machinery, vehicles, and equipment
- Renovation/construction of offices, office equipment, and general expenses

7.2 Station Improvement

In order to operate the railway efficiently, provision of passing and crossing loops at stations are essential. Since running speed of passenger trains is faster than that of freight trains, freight trains are obliged to wait for passenger trains passing by at the double track section. The length of these passing loops should be long enough so that the freight train can pass safely. On the other hand, the function of crossing loop at the single track section is to give a way for trains coming from the opposite direction.

As shown in Table 2-3, station name, distance, number, and length of loop lines and stations between Bin Qasim Station and Kotri Junction Station (double track section) have two passing loops except Bada Nala and Gaddar stations (passing loop will not be required at Bada Nala and Gaddar stations because those stations are adjacent to Pipri Marshalling Yard). Length of those passing loops are longer than the planned coal trains. Therefore, improvement of station layout between Bin Qasim Station and Kotri Junction will not be required.

The crossing loops between Kotri Junction and Budapur Station; Sindh University, Cadet College Petro, Unapur and Budapur stations, will be improved to have enough length for the planned coal trains. The length of crossing loop shall be 650 m, same as the section between Bin Qasim Station and Kotri Junction. When the track improvement project of Jamshoro Power Plant project will be implemented, the loop line extension work of Sindh University Station is not necessary in this project.

Table 7-1 Length of Loop Line

Station Name	From Kotri Junction	Loop Length (Now)	Loop line Extension	Remarks
	km	m	m	
Sindh University	7.68	487.68	650	Covered by Jamshoro project
(Akhundabad Station)	10.66			
Cadet College Petaro	20.35	530.65	650	Track siding considered on the project
Unapur	32.13	606.72	650	Track siding considered on the project
Budapur	40.31	608.25	650	Covered by the newly constructed Budapur Yard or New Budapur Station, Case 1 and Case 3

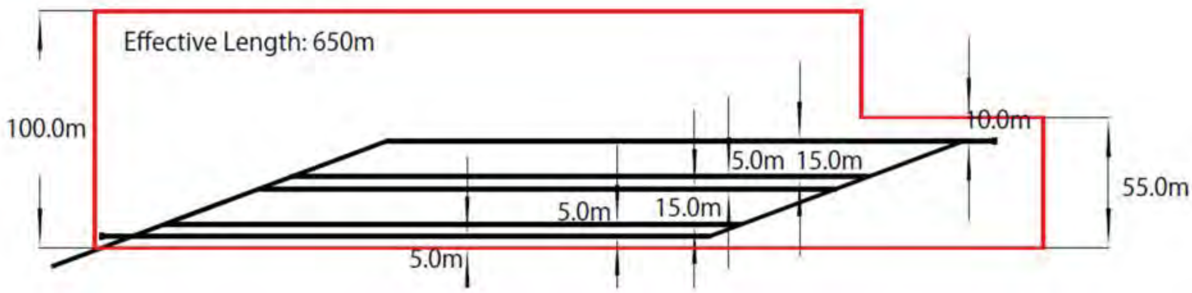
Note: Sindh University Station is being planned to extend loop line in PC-1 for Coal Transportation by Rail to Jamshoro Power Plant
Loop line extension of Budapur Station is necessary in Case 2A, Case 2AR, and Case 2B.
Source: JICA Study Team

(1) Case 1: Dump Truck System; Budapur Yard

This station yard will be constructed for the transshipment of coal container from train to dump truck.

The track to this yard will be branched at 40 km 800 of the Budapur Station with a crossing of 1/8, this location is adjacent to Bridge No. 311 to avoid the construction of a new bridge. The center of Budapur yard is located at 41 km 500 from Kotri Junction.

The alignment of the yard is with five tracks, one arriving/departure and engine run track, and four stabling tracks. The transshipment of the containers will be done on the stabling track. All the area of this yard shall be paved with asphalt or concrete to enable the mobility of the dump truck and reach stacker. The alignment of the tracks is shown on the following figure:



Source: JICA Study Team

Figure 7-1 Track Alignment at Budapur Yard

Table 7-2 Key Features of Budapur Yard

Item	Quantity	Remarks
Number of stabling tracks	5	Excluding locomotive deadhead track with PR standard cross section of track is assumed.
Area	1,000 sqm	5 m high embankment and pavement are considered.
Min. distance center to center	5 m	
Max. distance center to center	15 m	Including reach stacker working area.
Station control room	100 sqm	

Source: JICA Study Team

The area of yard includes the yard control center, temporary container stockyard and truck parking area and truck maintenance facilities.

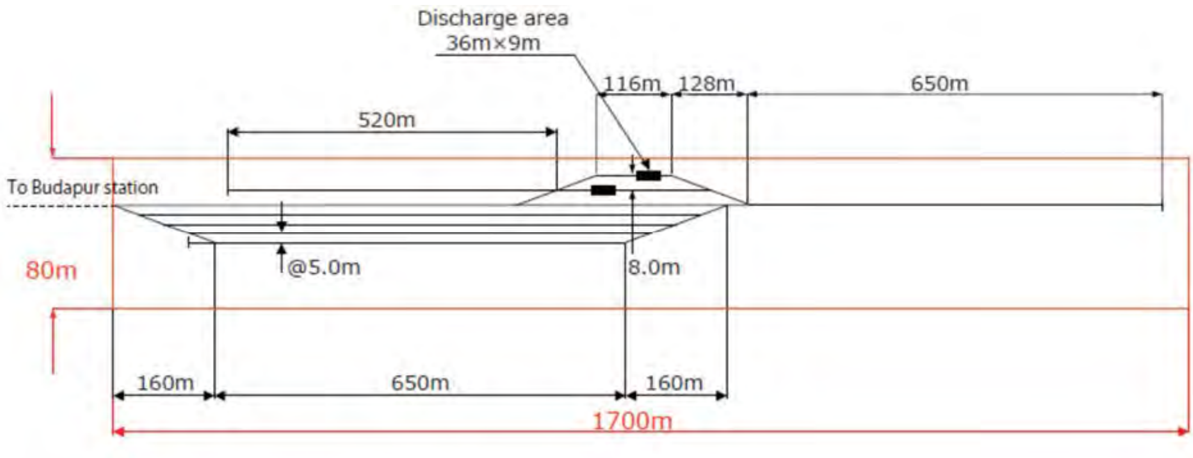
(2) Case 2A and Case 2AR: Lakhra Power Plant Station

The Lakhra Power Plant Station will be constructed beside the coal stockyard of the power plant. This station is adjacent to the coal unloading facilities as an integrated station with coal unloading pit and track. This station is connected with the spur line from Budapur Station and this spur line is branched at 41 km 040 inside Budapur Station.

This station is located at 47 km 140 from Kotri Junction and is composed of one arriving/departure track, three stabling tracks, and one engine run track. These tracks station are connected to the coal unloading facilities via shunting tracks.

The coal unloading facility is composed of two tracks which are laid on the coal pits to receive the coal discharged from hopper wagons.

The track alignment of the station is shown in Figure 7-2. Each dimension is calculated from the planned train length, size of locomotive and wagon, type of turnout, and PR design standards.



Source: JICA Study Team

Figure 7-2 Track Alignment of Lakhra Power Plant Station Including Coal Unloading Facility (Case 2A and Case 2AR)

(3) Case 2B: Track Alignment of Lakhra Power Plant Station

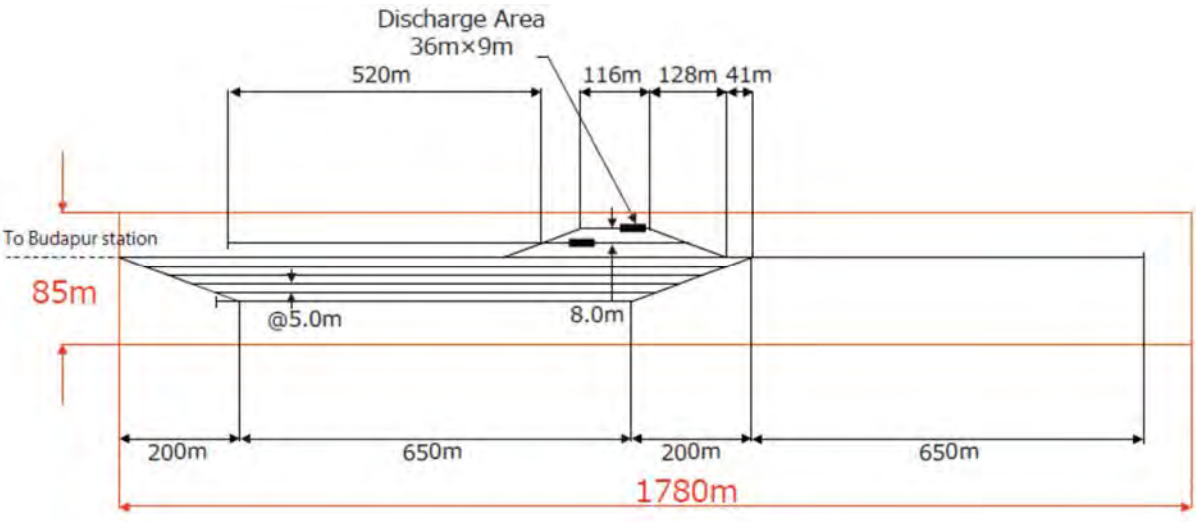
The same concept of Case 2A and Case 2AR is adapted to this station.

The spur line and Lakhra Power Plant station will be constructed beside the coal stockyard of the power plant with an axle load of 23.3 tons considering the future improvement of the track between Kotri Junction and Budapur Station. This station is integrated with the railway station facilities including stabling tracks and the coal unloading pit and track. The spur line branched at 41 km 040 inside the Budapur Station is the same as Case 2A and Case 2AR.

This station is located at 47 km 140 from Kotri Junction and is composed of one arriving/departure track, four stabling tracks, and one engine run track and these tracks of station is connected to the coal unloading facilities via shunting tracks.

The coal unloading facility is composed with two tracks which are laid on the coal pits to receive the coal discharged from hopper wagons.

The track alignment of the station is shown in Figure 7-3.



Source: JICA Study Team

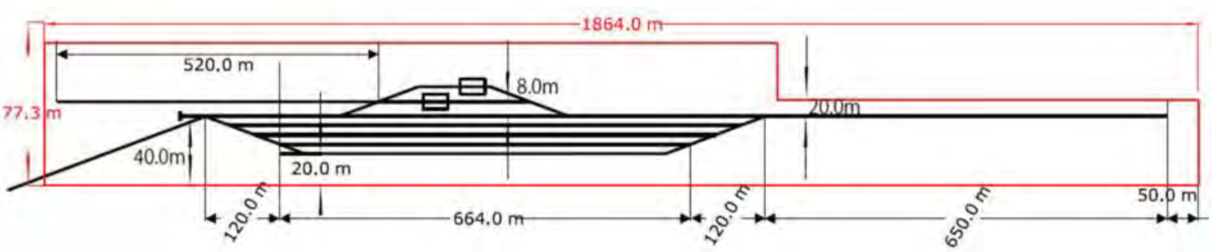
Figure 7-3 Track Alignment of Lakhra Power Plant Station Including Coal Unloading Facility (Case 2B)

(4) Case 3: Conveyor Belt System; New Budapur Station

The new Budapur Station is branched at 43 km 700 and the center of the new station is located at 44 km 500 from Kotri Junction. The station yard will be constructed beside the main line.

The station alignment is same as the Lakhra Power Plant Station, but the coal stockyard of 90 m x 50 m will be constructed near the connecting point of the belt conveyor.

The station alignment of the New Budapur Station is shown in Figure 7-4.



Source: JICA Study Team

Figure 7-4 Station Alignment of New Budapur Station

7.3 Track Improvement

7.3.1 Track Section between Bin Qasim Station and Kotri Junction

Because of the difficulty of access to the existing track between Karachi and Kotri Junction, the condition of the existing track was inspected in major stations accessible from the roads such as Karachi Cantt, Landhi, Bin Qasim Station, Pipri, Dabheji, and Kotri junctions.

Based on the site investigation in these stations, the track condition was judged generally fair to good and therefore, urgent rehabilitation of the track seems not required.

Source: JICA Study Team

Figure 7-5 Karachi Cantt. Station

Source: JICA Study Team

Figure 7-6 Motor-driven Point Machine

Source: JICA Study Team

Figure 7-7 Landhi Station

Source: JICA Study Team

Figure 7-8 Track Condition at Landhi Station

Source: JICA Study Team

Figure 7-9 Track of Main Line near Bin Qasim Station

7.3.2 Track Section between Kotri Junction and Akhundabad Junction

Track condition between Sindh University Station and Akhundabad Junction, branching point to Jamshoro Power Plant, was inspected using a small motor car. Track condition is generally good except in the section near Sindh University Station where the urban area is located and the inhabitants along the tracks pass through anywhere in the railway track.

Source: JICA Study Team

Figure 7-10 Track near Sindh University Station

Source: JICA Study Team

Figure 7-11 Embankment Section

The track condition near Sindh University Station is poor. The shoulder of the embankment is eroded at the section where additional track construction is planned to Jamshoro Power Plant. Since the right of way (ROW) is 45 feet (13.7 m, approx.) from the track center both side, it seems difficult to construct an additional track without shifting the existing track at this high embankment section.

Track condition outside of the urban area is well maintained.

Source: JICA Study Team

Figure 7-12 Branching Point to Jamshoro Power Plant

Source: JICA Study Team

Figure 7-13 Inspection Vehicle at Budapur Station

Track condition will be improved at the urban area and the high embankment section near Sindh University Station

The improvement of track and construction of additional track in this section will be implemented under the project of PC-1 for Coal Transportation by Rail to Jamshoro Power Plant.

7.3.3 Track Section between Akhundabad Junction and Budapur Station

The track length from Akhundabad Junction to Budapur Station is 29.61 km and designed and constructed under the condition of axle load of 17.27 tons for light weight trains. Case 1: Dump Truck System and Case 2B are plans to minimize the track improvement cost, and Case 2A and Case 2AR: Spur Line and Case 3: Conveyor Belt System are plans to use the common heavy locomotives and coal wagons same as in the Jamshoro project.

(1) Case 1: Dump Truck System and Case 2B: Spur Line with Light Locomotives

The improvement of existing track and bridges are not implemented for the purpose of minimizing the cost of long section track improvement because there are 96 bridges and culverts between Kotri Junction and Budapur Station to be reconstructed to meet the requirement of design axle load of 23.3 tons. The crossing loops of the station of Sindh University, Cadet College Petaro, Unapur and Budapur stations will be extended to 640 m to enable to stop the coal train for passing/crossing the opposite trains. And in Case 1, a new station yard will be constructed at Budapur Station for transfer of containers as described in Clause 7.2.

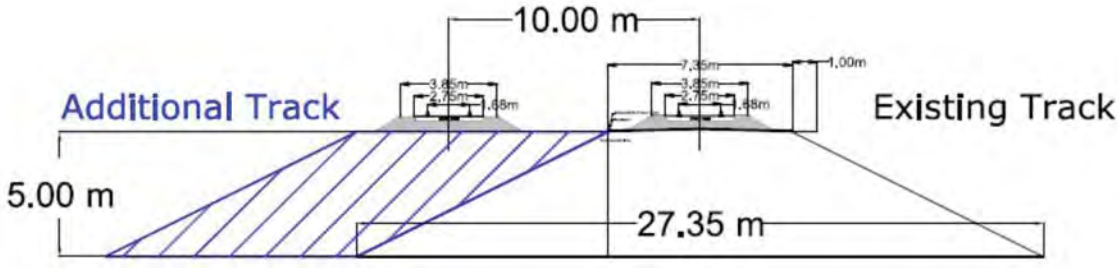
In Case 2B, the construction schedule of Jamshoro Power Plant is unkown. Therefore, coal transportation plan cannot be prepared based on the assumed completion of Jamshoro PC-I construction. Therefore, the coal transportation plan for Lakhra Power Plant is based on the use of existing track structure.

(2) Case 2A: Spur Line and Case 3: Conveyor Belt System

The new additional track from Akhundabad Station to the branch points of spur line to Lakhra Power Plant Station (Case 2A) or New Budapur Station (Case 3) shall be constructed beside the existing track with bridges and culverts of axle load of 23.3 tons to enable to run the coal trains with 60 tons of wagon and heavy locomotives of 4,000 HP.

The distance between the existing track and new track is 10 m considering the security of train operation during the construction of new bridges adjacent to the existing ones. The distance between the two tracks is 4.725 m according to the construction gauge of PR, and it is economical to reduce the distance of two tracks between the bridges and to widen the distance to 10 m at the bridges. There are 56 bridges and culverts in 30.01 km between Akhundabad Junction and Budapur Station, and the average interval is about 0.54 km. Therefore, in the case of the 10 m distance at bridges and 4.725 m between bridges, the track alignment of this section will be the continuity of curves. On a track with one curve after another, the possibility of derailment of trains, especially trains with empty wagons, is high. The JICA Study Team proposes to construct new track with 10 m distance from the existing track between Akhundabad Junction and Budapur Station. It is recommended to review the distance between tracks particularly at the stage of feasibility study and design to reduce the construction cost and safety of the train operation.

The typical cross section of track is shown in Figure 7-14.



Source: JICA Study Team

Figure 7-14 Typical Cross Section of Embankment at Spur Line

The turnouts between the new track and existing track will be constructed at Cadet College Petaro and Unapur and Budapur stations, and the interval of two turnouts of each station is 650 m of effective length. The purposes of the connection of two tracks with turnouts is for flexible train operation and for smooth operation of track maintenance machines.

It is possible to run the coal trains with 60 tons of wagon and heavy locomotives when all the bridges and culverts are reinforced or reconstructed for the axle load of 23.3 tons. The superstructure (girders) and substructure (abutment and piers) of bridges are designed and constructed with the axle load of 17.27 tons, and the reinforcement or reconstruction of the substructures are very difficult and would require higher cost especially in keeping the security of train operation and this would take a long time to be finished. Therefore, the JICA Study Team proposes to construct a new track beside the existing track in this report.

7.3.4 Case 2AR: Spur Line

The rehabilitation of track and bridges from Kotri Junction to the branch points of spur line to Lakhra Power Plant Station will be done to enable to run coal trains with 60 ton-wagon and heavy locomotives of 4,000 HP with axle load of 23.3 tons.

The rehabilitation work of the track is composed of the replancement or addition of ballast, and replacement of sleepers and rails, and these works are same as track maintenance.

The turnouts of the existing track will be rehabilitated with track rehabilitation, and length of loop line will be extended to 650 m effective length.

7.4 Bridges and Culverts Improvement

It was confirmed by the hearing from PR Karachi Division that the bridges and culverts at the section between Bin Qasim Station and Kotri Junction are constructed following the design axle load of 23.3 tons. Since no requirement for repair or rehabilitation is reported, those structures can be considered in sound condition.

It was also confirmed that the bridges and culverts at the section between Kotri Junction and Budapur Station are constructed following the design axle load of 17.27 tons, and those structures are in sound condition.

Therefore, if the coal trains to Lakhra Power Plant are formed in the axle load of 17.27 tons or less, there is no requirement of structure improvement or reinforcement. However, if the coal trains are formed to suit the axle load of 23.3 tons, those bridges and structures at the section between Kotri Junction and Budapur Station will be reinforced or replaced to suit the axle load of 23.3 tons.

The reinforcement or replacement of bridges and culverts of the track under operation is difficult because the time available for track closure required for construction is very limited. Since there are 96 structures between Kotri Junction and Budapur Station, it will require a long time to reinforce or replace those structures.

According to PC-1 for Coal Transportation by Rail to Jamshoro Power Plant, PR is planning to construct a new track from Kotri junction to Jamshoro Power Plant in the design axle load of 23.3 tons. If this new track construction is completed prior to the construction of Lakhra Power Plant, it is recommended to extend the new track from Akhundabad Station (branching point to Jamshoro Power Plant) to Budapur Station because it does not affect the existing train operation and the new track provides efficient transportation of coal.

In the case of Case 2A: Spur Line, and Case 3: Conveyor Belt System, the axle load of rolling stock will increase to 23.3 tons, and the following bridges and culverts will be extended with a design axle load of 23.3 tons at the new track section.

In the case of Case 2AR: Spur Line, the axle load of rolling stock will increased to 23.3 tons, and the bridges with girder will be reinforced with additional girders at minimum cost. In this case, more detailed investigation of the condition of bridges is recommended before reinforcement works and train operation. The detailed investigation includes geological survey by boring near the substructure of bridges, condition of substructures, main girders, condition of structural, and material of culverts and arch bridges. The bridges to be reinforced are not yet determined but the bridges between Kotri Junction and Budapur Station are simple structures, such as culvert, arch, and simple beam girder bridge. It is not difficult to work technically to reinforce these bridges since the method of reinforcement is the same as what is usually being done to existing old and deteriorated bridges, such as reinforcement of substructure with additional concreting and support by putting additional steel works and for super structures, replacement of beames and/or reinforcement by adding beams. All of these works will be done inside the right of way but beneath the operating track, and it is necessary to implement at the interval of train operation.

Table 7-3 List of Bridges and Culverts to be Improved Between Akhundabad Station and Budapur Station

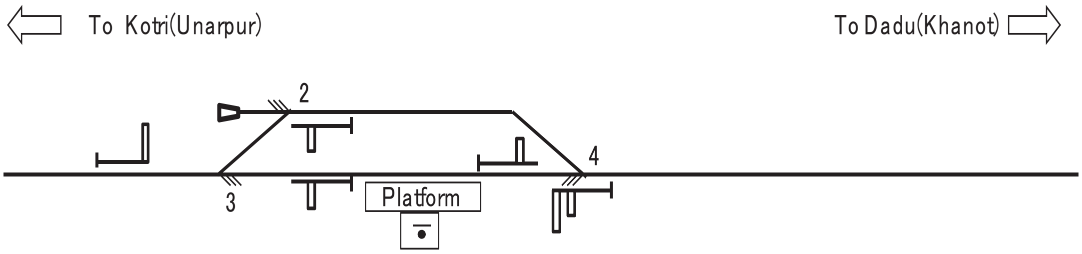
S/No.	Bridge No.	Kilometer from Kotri Junction	Span Length	Type
1	254	11.53	1x5'-0"	Arch
2	255	11.87	5x20'-4"	Plate Girder
3	256	12.73	15x10'-0"	Arch
4	257	13.47	3x5'-0"	Reinforced Cement Concrete (RCC) Slab
5	258	13.67	1x7'-0"	Plate Girder
6	259	14.33	5x10'-0"	Girder
7	260	14.87	1x5'-0"	Arch
8	261	14.93	1x5'-6"	Girder RSJ
9	263	16.13	1x10'-0"	RCC Slab
10	264	16.27	4x20'-0"	RSJ
11	265	16.33	1x10'-0"	RCC Slab
12	266	17.47	12x19'-6"	RSJ
13	267	18.07	2x9'-9"	RSJ
14	268	18.93	2x6'-6"	RSJ
15	269	19.07	1x6'-6"	RCC Slab
16	270	19.13	1x20'-0"	Girder
17	271	20.73	5x1'-6"	Hume Pipe
18	272	21.00	1x10'-0"	RCC Slab
19	273	21.20	2x4'-6"	Hume Pipe
20	274	21.33	1x4'-6"	Hume Pipe
21	275	22.00	2x20'-0"	Arch
22	276	21.87	1x2'-0"	Rail Opening
23	277	23.07	1x2'-0"	Rail Opening
24	278	23.47	1x2'-0"	Rail Opening
25	279	23.73	1x2'-0"	Rail Opening
26	280	24.27	1x20'-0"	Arch
27	281	24.93	1x3'-3"	Rail Cluster
28	282	25.27	1x3'-3"	Rail Cluster
29	283	25.93	1x3'-3"	Rail Cluster
30	284	27.07	1x20'-0"	Arch
31	285	27.40	2x20'-0"	Arch
32	286	27.67	1x5'-0"	Arch
33	287	27.80	2x5'-0"	Arch
34	288	27.93	1x3'-3"	RCC Slab
35	289	28.00	1x9'-9"	Girder
36	290	28.13	1x4'-6"	Hume Pipe
37	291	28.33	2x9'-9"	RSJ
38	292	28.73	1x10'-0"	RSJ
39	293	29.20	1x10'-0"	RSJ
40	293/A	29.67	3x20'-0"	RSJ
41	294	29.93	1x19'-10"	Plate Girder
42	295	30.27	12x19'-9"	Plate Girder
43	296	30.87	16x19'-6"	Girder RSJ
44	297	31.27	10x40'-0"	Girder
45	298	31.60	14x19'-6"	Girder
46	299	32.87	2x19'-6	Girder
47	300	33.33	1x10'-6"	Arch
48	301	33.67	1x5'-0"	Arch
49	302	34.33	14x19'-6"	Girder
50	302/A	34.67	5x19'-6"	Girder
51	302/B	35.40	3x20'-0"	Girder
52	305	37.27	2x20'-0"	Arch
53	306	37.40	2x7'-0"	Arch
54	307	38.20	1x3'-3"	RCC Slab
55	308	38.53	1x2'-10"	RCC Slab
56	311	40.67	2x9'-9"	Girder

Source: PR

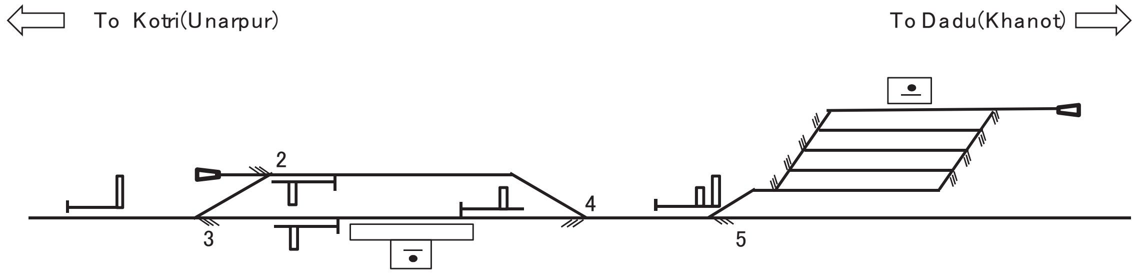
7.5 Signal and Telecommunication Improvements

7.5.1 New Coal Handling Yard Near Budapur Station

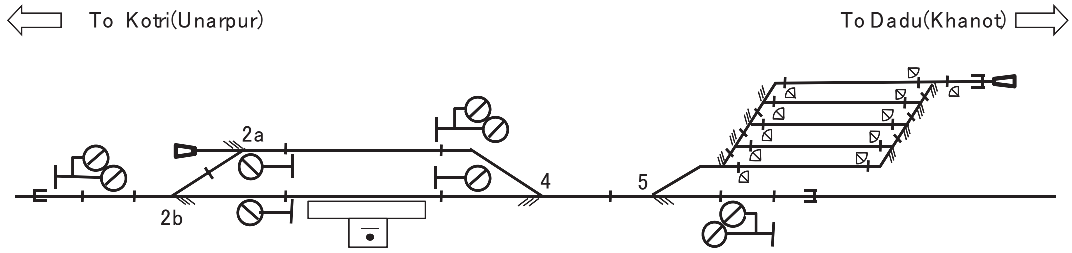
The station diagram of Budapur Station and new coal handling yard is planned in Clause 7.2. The yard is planned as an independent yard which detains up to five trains near Budapur Station and will be used to take down coals transported from Port Qasim toward Lakhra Power Plant. Figure 7-15 (a) shows the diagram of the existing Budapur Station, and (b) shows the planned station diagram with mechanical signal and interlocking system (Plan A). Plan B is shown in Figure 7-15 (c) as an alternative option in the future.



(a) Station Diagram of Existing Budapur Station

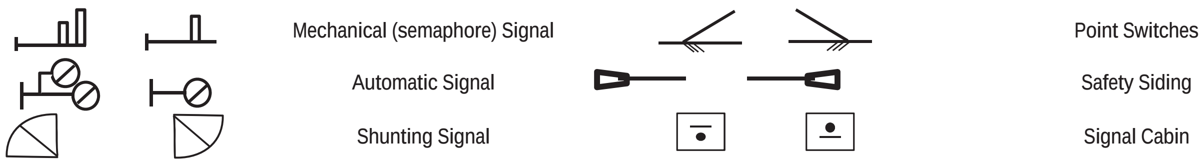


(b) Station Diagram of Planned Budapur Station: Plan A



(c) Station Diagram of Planned Budapur station: Plan B

LEGEND



Source: JICA Study Team

Figure 7-15 Station Diagram of Budapur Station and New Planed Coal Handling Yard with Mechanical Signal System

Plan A assumes unstable power supply; therefore, the operation of point switches is manual and the locking depends only upon the heaviness of the steering wheel. Plan A is suitable for the general condition of power supply in Pakistan at this moment.

Plan B is a substitute plan where power supply is backed up by engine generator facilities in case the commercial power supply is cut off. The relay interlocking system, electric point switches, automatic signal, and shunting signal device can be installed for Plan B. Plan B is an alternative option for future development at this moment.

7.5.2 Upgrading on Existing Line

(1) Main Line Section

Rehabilitation work for electrical interlocking and automatic signaling system is being planned by PR to be submitted to PC-1 for Rehabilitation of Railway Assets Damaged during the riots on the 27th and 28th December 2007, hence, the Project assumes that any rehabilitation work on the main line is not necessary in terms of signaling system and telecommunication.

(2) Branch Line Section Between Kotri Junction and Budapur Station

Extension of loop lengths at Cadet College Petaro Station and Unapur Station is needed for coal transportation between Kotri Junction and Budapur Station Therefore, it will be carried out to relocate the existing mechanical signaling systems as per the extension plan described in Clause 7.2. Through the relocation works, mechanical signaling system will be replaced due to obsolete condition. For the telecommunication system, upgrading/rehabilitation works are not necessary.

Chapter 8 Project Cost Estimate

8.1 Track Rehabilitation/Construction Cost

8.1.1 Section between Port Qasim and Bin Qasim Station

Construction of an additional line between Port Qasim and Bin Qasim Station, and rehabilitation of the existing track in the same section are scheduled to be implemented during the construction of the Jamshoro Power Plant as scheduled in the PC-1 for Coal Transportation by Rail to Jamshoro Power Plant (May 2014) prepared by the Ministry of Railways (Jamshoro PC-1).

Since it is assumed that the coal trains for Lakhra Power Plant will use the same track as that for the Jamshoro Power Plant, no additional cost for the rehabilitation/construction of track at this section is considered.

8.1.2 Section between Bin Qasim Station and Kotri Junction

As described in Clause 2.5, the existing track condition between Bin Qasim Station and Kotri Junction is relatively good. If the existing track will be properly maintained in the same manner as the current situation, no special provision for rehabilitation cost will be required. There is also no provision for track rehabilitation/construction cost under the PC-1 for Rehabilitation of Railway Assets Damaged during the Riots of 27th and 28th December, 2007 stated in Clause 8.1.1.

8.1.3 Section between Kotri Junction and Budapur Station

It is assumed that the construction of the new track between Kotri Junction and Akhundabad Station has been completed prior to the construction of the new track between Akhundabad Station and Budapur Station for Case 2A and Case 3 as a basis of PC-1 since the planned axle load exceeds 17.27 tons.

According to the Revised Jamshoro PC-1 dated 23 November 2015, the track will be upgraded between Kotri Station and Akhundabad Junction instead of new construction. In Case 2AR, it is assumed that the axle load of the existing track between Kotri Station and Akhundabad Station will be upgraded to 23.3 tons to be funded by the project.

The route length from Akhundabad Station to Budapur Station is 29.65 km, and the length from from Budapur Station to Lakhra Power Plant Station is 6.83 km. Since the track construction or upgrading between Akhundabad Station and Budapur Station may not be completed prior to the commencement of the trial operation of Lakhra Power Plant, the construction of the section between Budapur Station and Lakhra Power Plant Station shall be constructed separately. This section shall be completed at least six months before the trial operation of the power plant.

The construction cost of the new track is estimated based on the cost estimate shown in the Jamshoro PC-1. The upgrading cost is based on the cost estimate in the Revised Jamshoro PC-1. The base cost shown in PC-1 is based on April 2014 prices. The estimated cost of the civil and track works for the Lakhra Power Plant is calculated by multiplying the escalation factor with the base costs.

8.2 Station Improvement Cost

8.2.1 Section betweem Bin Qasim Station and Kotri Junction

As summarized in Table 2-3, all the stations between Bin Qasim Station and Kotri Junction have loop lines longer than 640 m. Therefore, similar to the track rehabilitation work, the station improvement between Bin Qasim Station and Kotri Junction is not required. It is also not mentioned in PC-1 for Coal Transportation by Rail to Jamshoro Power Plant.

8.2.2 Section between Kotri Junction and Budapur Station

The lengths of the existing loop lines between Kotri Junction and Budapur Station are ranging from 483.68 m to 608.25 m as listed in Table 2-3. When the existing track will be used for coal transportation, i.e., operating trains having axle load of 17.27 tons, the length of the crossing loop tracks shall be extended to allow the crossing of coal trains. The planned length of the coal train is 629 m; the length of the crossing loop track shall be extended up to 650 m giving some allowances.

Considering the train operation plan, it is found that the loop lines at Sindh University, Cadet College Petaro, and Unapur and Budapur stations are required to be extended for the purpose. It is planned to extend the loop length in Cadet College Petaro and Sindh University stations under PC-1 for Coal Transportation by Rail to Jamshoro Power Plant (May 2014, Jamshoro PC-1) and PC-1 for Coal Transportation by Rail to Jamshoro Power Plant (October 2014, Revised Jamshoro PC-1). Thus, Case 1 is not included in the cost of the project. In terms of conservative consideration, all the required loop line extension works are included in Case 2B.

Case 2A and Case 3 will construct additional line on the existing line between Akhundabad Junction and Budapur Station in parallel. The line is used by the Jamshoro project exclusively; thus, loop extension works are not required.

Case 2AR will upgrade the existing track between Akhundabad Junction and Budapur Station and will include the loop extension quantity estimate based on the Revised PC-1. Sindh University Station is planned to extend the crossing loop under Revised Jamshoro PC-1; thus, this case will include the Unapur, Cadet College Petaro, and Budapur Station loop extension cost.

8.3 Signal and Telecommunication Improvement Cost

The station-wise cost estimate of signal and telecommunication improvement is shown in Table 8-1 below.

Table 8-1 Station-wise Cost Estimate of Signal and Telecommunication Improvement

No.	Name	Unit Cost	Sindh Univ. Station		College Station		Unarpur Station		Budapur Station		Budapur Yard		Total (in Thousand PKR)	
			Q'ty	**Cost**	**Q'ty**	**Cost**	**Q'ty**	**Cost**	**Q'ty**	**Cost**	**Q'ty**	**Cost**	**Q'ty**	**Cost**
	Signal Room													
1	Interlocking Units		0	0	0	0	0	0	0	0	0	0	0	0
2	Maintenance Terminal		0	0	0	0	0	0	0	0	0	0	0	0
3	Power Supply Unit	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000
4	Relay Shelf	168	1	168	1	168	1	168	1	168	1	168	1	168
5	Signal Relay	20	80	1,600	50	1,000	50	1,000	50	1,000	60	1,200	290	5,800
6	Terminal Shelf	800	1	800	1	800	1	800	1	800	1	800	1	800
7	Track Circuit Resistor	176	15	2,643	13	2,291	10	1,762	10	1,762	16	2,819	64	11,277
8	Apparatus Stand	40	1	40	1	40	1	40	1	40	1	40	1	40
9	Indoor Cables	10	450	4,680	315	3,276	270	2,808	270	2,808	405	4,212	1,710	17,784
		Sub-total		11,931		9,575		8,578		8,578		11,239		37,869
	Station Room													
10	Signal Panel	800	1	800	1	800	1	800	1	800	1	800	5	4,000
		Sub-total		800		800		800		800		800		4,000
	Field Apparatus													
11	Electric Switch Machine	1,200	7	8,400	6	7,200	4	4,800	4	4,800	8	9,600	29	34,800
12	Electric Signal Indicator	240	16	3,840	10	2,400	10	2,400	10	2,400	12	2,880	58	13,920
13	Track Circuit (including Safety Devices and Bonds)	280	15	4,200	13	3,640	10	2,800	10	2,800	16	4,480	64	17,920
15	Insulated Rail Joint	40	20	800	14	560	12	480	12	480	18	720	76	3,040
16	Connecting Box	160	4	640	4	640	4	640	4	640	2	320	18	2,880
17	Signal Cables	5	1,800	9,000	1,260	6,300	1,080	5,400	1,080	5,400	1,620	8,100	6,840	34,200
		Sub-total		26,880		20,740		16,520		16,520		26,100		106,760
	Removal and Delivery													
18	Mechanical Switch Machine	160	5	800	6	960	2	320	3	480			5	800
19	Pipe, Carrier, Joint	40	50	2,000	60	2,400	20	800	30	1,200			50	2,000
20	Mechanical Signal Indicator	3	7	21	6	18	6	18	6	18			7	21
21	Lever, Wheel, Wire	1	700	700	600	600	600	600	600	600			700	700
	Sub-total			3,521		3,978		1,738		2,298				3,521
	Grand Total			**43,132**		**35,093**		**27,636**		**28,196**		**38,139**		**152,150**

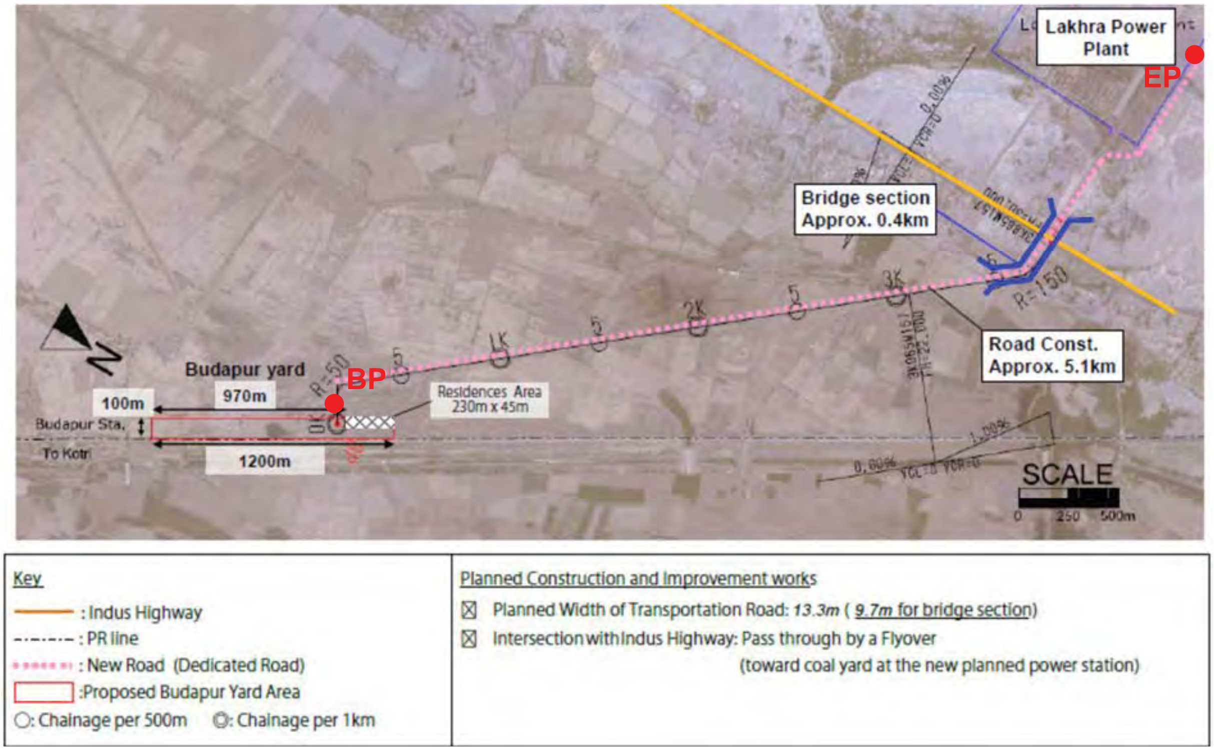
Source: JICA Study Team

8.4 Case 1: Budapur Yard/Lakhra Coal Handling Yard Construction

8.4.1 Yard Construction

Embankment volume is calculated with height of 5 m on the required area for the proposed yard with pavement. The details of Budapur Yard are explained in Clause 4.5.1.

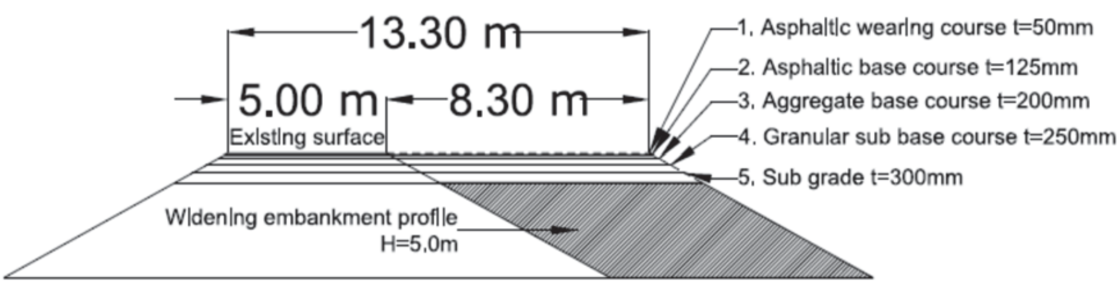
8.4.2 Access Road Construction



Source: JICA Study Team

Figure 8-1 Proposed Access Road Plan and Existing Road between Budapur Station and Lakhra Power Plant

The existing road from the yard to Chainage = 3.0 km is 5 m wide. Furthermore, a connection road has been constructed between the End Point (EP) shown in the figure above and the Lakhra plant site. In this project, approximately 5.1 km access road with 400 m long bridge section will be constructed from Budapur Yard which will be widened to 13.3 m as shown in Figure 8-2 below. In this regard, it is planned that the Budapur Yard pavement will be the same as the access road with 5 m high embankment.



Source: JICA Study Team

Figure 8-2 Typical Cross Section of the Access Road

8.5 Rolling Stock and Other Coal Transportation Equipment

As discussed in Clause 5.3, the quantities of the locomotive, wagons, and trucks are set as follows:

- Locomotives: 10 sets of 2,268 HP locomotives for Case 1 and Case 2B and 4 sets of 4,000 HP for Case 2A, Case 2AR, and Case 3
- Shunting locomotives: 1 set for Case 1 and 3 sets for Case 2A, Case 2AR, Case 2B, and Case 3
- Wagons and containers: 190 flat wagons and 456 coal containers for Case 1, 160 hopper wagons for Case 2A, Case 2AR, and Case 3, and 190 hopper wagons for Case 2B.
- Dump trucks and reach stackers: 15 sets of dump trucks and 3 sets of reach stackers for Case 1.

8.6 Conveyor Belt System

The conveyor belt system will adopt two lines to assure the redundancy of the system. The widths of the belts are 1.2 m. For the mitigation of the risk of theft, the conveyor system will be raised to at least 2 m above the ground level. The structure and belt conveyor systems will be covered on the top and side. The cover will also prevent scattering of the coal dust from the viewpoint of environmental aspect. At the coal yard of the new power plant, the coal will be unloaded into hoppers by gravity. Transportation speed of the coal will be set to 680 t/hour taking into account the transportation link with railway at the new coal handling yard beside the existing railway.

8.7 Tax

The following taxes are applicable to the project works and contracts:

Table 8-2 Rates of Main Taxes

Tax	Foreign Procured Goods	Locally Purchased Goods
GST on Imported Goods (GOP):	17%	Not Applicable
GST on Locally Purchased Goods (GOP):	Not Applicable	17%
Custom Duty on Import of Goods (GOP):	5%	Not Applicable
Applicable Rate in the Report	**22%**	**17%**

Source: JICA Study Team

The estimated initial cost only considers the direct cost; thus, corporate tax is not included in the cost. Tax rate for foreign procured cost is assumed at 22% and for locally purchased, it is assumed at 17%. The applicable tax items for the project shall be examined in the further study.

8.8 Summary of Construction Cost Estimates

8.8.1 Case 1: Dump Truck System; Coal Transportation by Container Train

This estimate excludes the costs of port facilities (such as coal jetty, storage yard, coal loading facility), new track construction between Port Qasim and Bin Qasim Station, and track improvement between Bin Qasim Station and Kotri Junction.

Table 8-3 Summary of Initial Cost Estimate of Case 1

Case 1: Coal Transportation by Container Train (without Track Upgrading)

								Base cost FY 2016basis			
No.	**Work Item**	**Quantity**	**Unit**	**Unit Cost (in 1000 Rs.)**	**Total Cost (Rs. In Million)**	**LC**	**FC**	**Unit Cost (in 1000 Rs.)**	**Total Cost (Rs. In Million)**	**LC**	**FC**
1	Construction of coal Jetty, stock yard. Coal loading facility to train at Port Qasim	(Item to be covered by PIBT and PQA)									
2	New track construction between Port Qasim and Bin Qasim	(Item to be covered by PR)									
3	Track improvement between Bin Qasim and Kotri junction	(ditto)									
4	Consulting Service Fee	1	L.S.	634,401	634	0	634	654,864	655	0	655
5	Extension of Loop line at Cadet College Petaro and Unapur stations	2	station	10,920	22	19	3	12,114	24	22	3
6	Signal and telecommunication improvement	1	L.S.	160,650	161	161	0	179,826	180	180	0
7	Construction of Budapur Coal Handling yard	1	L.S.	906,000	913	788	124	1,010,736	1,011	882	128
8	Construction of Access road to Power Plant	5.1	km	339	1,730	1,730	0	379,706	1,936	1,936	0
9	Procurement of 2268 HP locomotives	10	unit	366,800	3,668	0	3,668	378,632	3,786	0	3,786
10	Shunting Locomotive	1	unit	366,800	367	0	367	378,632	379	0	379
11	Procurement of flat bed wagons	190	unit	13,534	2,571	0	2,571	13,971	2,654	0	2,654
12	Procurement of brake vans	5	unit	11,872	59	0	59	12,255	61	0	61
13	Procurement of 20ft open top containers	456	unit	2,229	1,016	0	1,016	2,301	1,049	0	1,049
14	Procurement of dump trucks	15	unit	5,042	76	0	76	5,205	78	0	78
15	Procurement of reach stackers	3	unit	85,446	256	0	256	88,202	265	0	265
	Sub-total				11,474	2,698	8,775		**12,079**	3,020	9,058
16	Land acquisition	195,770	m^2	3.6	705	705	0	4	789	789	0
17	Price Escalation*1	1	L.S.	1,583,664	1,584	-	-	1,583,664	1,584	915	669
18	Contingency*2	1	L.S.	722,561	723	-	-	722,561	723	236	486
19	Tax	1	L.S.	2,958,918	2,959	-	-	3,090,243	3,090	843	2,247
	Initial Cost Total				17,444	-	-		**18,264**	5,803	12,461

Major Components	Quantity: Case 1
Loop Extension Works	
Embankment [m^3]	4,600
Track [km]	0.18
Yard Construction Works	
Embankment [m^3]	548,250
Cut [m^3]	0
Track [km]	4
Pavement [m^2]	109,650
Turnout [Nos.]	9
Access Road Construction	
Pavement, Embankment and Cut for Road Construction Works [m^2]	62,510
Road Bridge Construction [m^2]	3,880
Culvert [Nos.]	9
Wall works	400

Note:
Consulting service fee is 8% of civil works project cost and 5% of rolling stock procurement cost.
Contingency is assumed at 5% of project cost.
Price escalation rates for local component and foreign component are assumed at 5.9% per annum and 1.8% per annum, respectively.
Source: JICA Study Team

8.8.2 Case 2A: Spur Line; Coal Transportation by Hopper Wagon Train Direct to the Power Plant with Additional Track

This estimate also excludes the same items excluded in Case 1 above.

Table 8-4 Summary of Initial Cost Estimate of Case 2A

Breakdown cost of Case2A

No.	Work Item	Quantity	Unit	Unit Cost (in 1000 Rs.)	Total Cost (Rs. In Million)	LC	FC	Unit Cost (in 1000 Rs.)	Total Cost (Rs. In Million)	LC	FC
								Base cost FY 2016basis			
1	Construction of coal Jetty, stock yard. Coal loading facility to train at Port Qasim	(Item to be covered by PIBT and PQA)									
2	New track construction between Port Qasim and Bin Qasim	(Item to be covered by PR)									
3	Track improvement between Bin Qasim and Kotri junction	(ditto)									
4	New track construction between Kotri Junction and Akhundabad	(ditto)									
5	Consulting Service Fee	1	L.S.	1,605,067	1,605	0	1,605	1,656,861	1,657	0	1,657
6	New track construction between Akhundabad and Budapur station, including embankment, bridges, culverts and level crossings	30.38	km	147,238	4,473	4,058	415	163,624	4,971	4,543	428
7	New siding track between Budapur station and Lakhra Power Plant	6.99	km	11,501,500	11,502	11,429	72	1,840,924	12,868	12,793	75
8	Yard Construction Works of Lakhra Power Plant station	1	L.S.	495,013	495	311	184	538,056	538	348	190
9	Installation of coal unloading facilities at Power Plant	1	L.S.	156,000	156	0	156	161,032	161	0	161
10	Signal and telecommunication improvement	1	L.S.	160,650	161	161	0	179,826	180	180	0
11	Procurement of 4000 HP locomotives	4	unit	549,080	2,196	0	2,196	566,791	2,267	0	2,267
12	Shunting Locomotive	3	unit	366,800	1,100	0	1,100	378,632	1,136	0	1,136
13	Procurement of hopper wagons	160	unit	11,872	1,900	0	1,900	12,255	1,961	0	1,961
14	Procurement of brake van	4	unit	11,872	47	0	47	12,255	49	0	49
	Sub-total				23,635	15,959	7,676		**25,788**	17,864	7,924
15	Land acquisition	571,300	m^2	3.6	2,057	2,057	0	4	2,302	2,302	0
16	Price Escalation*1	1	L.S.	6,275,386	6,275	-	-	6,275,386	6,275	5,722	553
17	Contingency*2	1	L.S.	1,718,257	1,718	-	-	1,718,257	1,718	1,294	424
18	Tax	1	L.S.	6,159,194	6,159	-	-	6,579,235	6,579	4,621	1,958
	Initial cost Total				39,844	-	-		**42,663**	31,803	10,859

Major Components	Quantity: Case 2A
Additional Track Construction/ Track Improvement Works	
Embankment [m^3]	1,519,000
Railway Bridge Construction [m]	3,334
New Track [km]	30
Level Crossing [Nos.]	5
Yard Construction Works	
Embankment [m^3]	92,872
Cut [m^3]	176,000
Track [km]	6
Turnout [Nos.]	14
Additional Track Construction	
Embankment [m^3]	392,808
Track [km]	5.30
Railway Bridge Construction [m^2]	12,947

Note:
Consulting service fee is 8% of civil works project cost and 5% of rolling stock procurement cost.
Contingency is assumed at 5% of project cost.
Price escalation rates for local component and foreign component are assumed at 5.9% per annum and 1.8% per annum, respectively.
Source: JICA Study Team

8.8.3 Case 2AR: Spur Line; Coal Transportation by Hopper Wagon Train Direct to the Power Plant with Upgraded Track

This estimate also excludes the same items excluded in Case 1 above.

Table 8-5 Summary of Initial Cost Estimate of Case 2AR

Breakdown cost of Case2AR

No.	Work Item	Quantity	Unit	Unit Cost (in 1000 Rs.)	Total Cost (Rs. In Million)	LC	FC	Base cost FY 2016basis Unit Cost (in 1000 Rs.)	Total Cost (Rs. In Million)	LC	FC
1	Construction of coal Jetty, stock yard. Coal loading facility to train at Port Qasim	(Item to be covered by PIBT and PQA)									
2	New track construction between Port Qasim and Bin Qasim	(Item to be covered by PR)									
3	Track improvement between Bin Qasim and Kotri junction	(ditto)									
4	Track and structure, signaling improvement with loop between Kotri Junction and Akhundabad (Covered by Revised PC-I)	10.66	km	65,438	698	501	196	71,647	764	561	202
5	Consulting Service Fee	1	L.S.	6,975,202	6,975	0	1,464	1,510,916	1,511	0	1,511
6	Extension of Loop line at 3 stations between Akhundabad to Budapur Station (Revised PC-1 basis)	3	station	49,316	148	107	41	54,013	162	120	42
7	Track improvement between Akhundabad and Budapur station, including embankment, bridges, culverts and level crossings (Revised PC-1 Basis)	30.38	km	61,234	1,860	1,419	441	67,278	2,044	1,589	455
8	New siding track between Budapur station and Lakhra Power Plant	6.99	km	11,501,500	80,395	11,429	72	1,840,924	12,868	12,793	75
9	Yard Construction Works of Lakhra Power Plant station	1	L.S.	495,013	495	311	184	538,056	538	348	190
10	Installation of coal unloading facilities at Power Plant	1	L.S.	156,000	156	0	156	161,032	161	0	161
11	Signal and telecommunication improvement	1	L.S.	160,650	161	161	0	179,826	180	180	0
12	Procurement of 4000 HP locomotives	4	unit	549,080	2,196	0	2,196	566,791	2,267	0	2,267
13	Shunting Locomotive	3	unit	366,800	1,100	0	1,100	378,632	1,136	0	1,136
14	Procurement of hopper wagons	160	unit	11,872	1,900	0	1,900	12,255	1,961	0	1,961
15	Procurement of brake van	4	unit	11,872	47	0	47	12,255	49	0	49
	Sub-total				**96,131**	13,928	7,798		**23,640**	15,591	8,050
16	Land acquisition	269,500	m^2	3.6	970	970	0	4.0	1,086	1,086	0
17	Price Escalation*1	1	L.S.	5,357,955	5,358	-	-	5,357,955	5,358	4,798	560
18	Contingency*2	1	L.S.	1,504,221	1,504	-	-	1,504,221	1,504	1,074	430
19	Tax	1	L.S.	5,464,432	5,464	-	-	5,822,088	5,822	3,833	1,989
	Initial cost Total				109,428	-	-		**37,411**	26,381	11,029

Major Components	Quantity: Case 2AR
Loop Extension Works	
Embankment [m^3]	75,000
Track [km]	3.00
Additional Track Construction/ Track Improvement Works	
Embankment [m^3]	1,519,000
Bridge Rehabilitation [m]	866
Track Improvement [km]	30
Level Crossing [Nos.]	5
Jamshoro Revised PC-I Project Cost	
Loop Line Extension [km]	2
Rehabilitation of Existing Track between Kotri and Jamshoro [km]	10.66
Turnouts [Nos.]	19
Rehabilitation of Bridges, Earthworks, etc. [L.S.]	1
Yard Construction Works	
Embankment [m^3]	92,872
Cut [m^3]	176,000
Track [km]	6
Turnout [Nos.]	14
Additional Track Construction/ Track Improvement Works	
Embankment [m^3]	392,808
Track [km]	5.30
Railway Bridge Construction [m^2]	12,947

Note:
Consulting service fee is 8% of civil works project cost and 5% of rolling stock procurement cost.
Contingency is assumed at 5% of project cost.
Price escalation rates for local component and foreign component are assumed at 5.9% per annum and 1.8% per annum, respectively.
Source: JICA Study Team

8.8.4 Case 2B: Spur Line; Coal Transportation by Hopper Wagon Train Direct to the Power Plant Using Existing Track

This estimate also excludes the same items excluded in Case 1 above.

Table 8-6 Summary of Initial Cost Estimate of Case 2B

Breakdown cost of Case2B

No.	Work Item	Quantity	Unit	Unit Cost (in 1000 Rs.)	Total Cost (Rs. In Million)	LC	FC	Base cost FY 2016basis: Unit Cost (in 1000 Rs.)	Total Cost (Rs. In Million)	LC	FC
1	Construction of coal Jetty, stock yard. Coal loading facility to train at Port Qasim	(Item to be covered by PIBT and PQA)									
2	New track construction between Port Qasim and Bin Qasim	(Item to be covered by PR)									
3	Track improvement between Bin Qasim and Kotri junction	(ditto)									
4	Consulting Service Fee	1	L.S.	1,348,650	1,348	0	1,349	1,392,123	1,392	0	1,392
5	Extension of Loop line at 4 stations between Kotri Junction to Budapur Station.	4	station	11,142	45	39	5	12,357	49	44	5
6	Signal and telecommunication improvement	1	L.S.	161,000	161	161	0	179,826	180	180	0
7	Procurement of 2268 HP locomotives	10	unit	366,800	3,668	0	3,668	378,632	3,786	0	3,786
8	Shunting Locomotive	3	unit	366,800	1,100	0	1,100	378,632	1,136	0	1,136
9	Procurement of hopper wagons	190	unit	11,872	2,256	0	2,256	12,255	2,328	0	2,328
10	Procurement of brake van	5	unit	11,872	59	0	59	12,255	61	0	61
11	New siding track between Budapur station and Lakhra Power Plant	6.99	km	11,501,500	11,502	11,429	72	1,840,924	12,868	12,793	75
12	Yard Construction Works of Lakhra Power Plant station	1	L.S.	567,909	568	355	213	617,179	617	398	219
13	Installation of coal unloading facilities at Power Plant	1	L.S.	156,000	156	0	156	161,032	161	0	161
	Sub-total				**20,863**	11,984	8,878		**22,580**	13,415	9,165
14	Land acquisition	284,800	m^2	3.6	1,025	1,025	0	4	1,148	1,148	0
15	Price Escalation*1	1	L.S.	4,854,273	4,854	-	-	4,854,273	4,854	4,210	645
16	Contingency*2	1	L.S.	1,429,075	1,429	-	-	1,429,075	1,429	939	490
17	Tax	1	L.S.	5,289,801	5,290	-	-	5,616,794	5,617	3,351	2,266
	Initial cost Total				33,461	-	-		**35,627**	23,061	12,566

Major Components	Quantity: Case 2B
Loop Extension Works	
Embankment [m^3]	9,725
Track [km]	0.39
Jamshoro Revised PC-I Project Cost	
Loop Line Extension [km]	2
Rehabilitation of Existing Track between Kotri and Jamshoro [km]	10.66
Turnouts [Nos.]	19
Rehabilitation of Bridges, Earthworks, etc. [L.S.]	1
Yard Construction Works	
Embankment [m^3]	98,982
Cut [m^3]	204,000
Track [km]	7
Turnout [Nos.]	16
Spur Line Construction Budapur Station and Lakhra Power Station	
Embankment [m^3]	392,808
Track [km]	5.30
Railway Bridge Construction [m^2]	12,947

Note:
Consulting service fee is 8% of civil works project cost and 5% of rolling stock procurement cost.
Contingency is assumed at 5% of project cost.
Price escalation rates for local component and foreign component are assumed at 5.9% per annum and 1.8% per annum, respectively.
Source: JICA Study Team

8.8.5 Case 3: Conveyor Belt System; New Station and Conveyor System

This estimate also excludes the same items excluded in Case 1 above.

Table 8-7 Summary of Initial Cost Estimate of Case 3

Case 3: Coal Transportation by Hopper Wagon Train and Conveyor Belt System
Breakdown cost of Case3

								Base cost FY 2016basis			
No.	Work Item	Quantity	Unit	Unit Cost (in 1000 Rs.)	Total Cost (Rs. In Million)	LC	FC	Unit Cost (in 1000 Rs.)	Total Cost (Rs. In Million)	LC	FC
1	Construction of coal Jetty, stock yard. Coal loading facility to train at Port Qasim	(Item to be covered by PIBT and PQA)									
2	New track construction between Port Qasim and Bin Qasim	(Item to be covered by PR)									
3	Track improvement between Bin Qasim and Kotri junction	(ditto)									
4	New track construction between Kotri Junction and Akhundabad	(ditto)									
5	Consulting Service Fee	1	L.S.	969,692	970	0	970	1,000,975	1,001	0	1,001
6	New track construction between Akhundabad and Budapur station, including embankment, bridges, culverts and level crossings	31.4	km	144,160	4,527	4,098	429	160,171	5,029	4,587	443
7	Construction of conveyor belt system between Budapur coal yard and Lakhra Power Plant	2.5	km	1,336,000	3,340	0	3,340	1,379,094	3,448	0	3,448
8	Construction of Budapur coal unloading yard	1	L.S.	660,793	661	466	195	722,675	723	521	201
9	Installation of coal unloading facilities at Power Plant	1	L.S.	156,000	156	0	156	161,032	161	0	161
10	Signal and telecommunication improvement	1	L.S.	160,650	161	161	0	179,826	180	180	0
11	Procurement of 4000 HP locomotives	4	unit	549,080	2,196	0	2,196	566,791	2,267	0	2,267
12	Shunting Locomotive	3	unit	366,800	1,100	0	1,100	378,632	1,136	0	1,136
13	Procurement of hopper wagons	160	unit	11,872	1,900	0	1,900	12,255	1,961	0	1,961
14	Procurement of brake vans	4	unit	11,872	47	0	47	12,255	49	0	49
	Sub-total				15,057	4,724	10,333		**15,954**	5,288	10,667
15	Land acquisition	442,300	m^2	3.6	1,592	1,592	0	4	1,782	1,782	0
16	Price Escalation*1	1	L.S.	2,715,621	2,716	-	-	2,715,621	2,716	1,892	823
17	Contingency*2	1	L.S.	1,022,622	1,023	-	-	1,022,622	1,023	448	575
18	Tax	1	L.S.	4,052,491	4,052	-	-	4,253,988	4,254	1,600	2,654
	Initial Cost Total				24,440	-	-		**25,729**	11,010	14,719

Major Components	**Quantity: Case 3**
Additional Track Construction/ Track Improvement Works	
Embankment [m^3]	1,570,000
Railway Bridge Construction [m]	3,334
New Track [km]	31
Level Crossing [Nos.]	5
Yard construction works	
Embankment [m^3]	580,000
Track [km]	7
Turnout [Nos.]	15
Belt Conveyor Construction [km]	2.50

Note:
Consulting service fee is 8% of civil works project cost and 5% of rolling stock procurement cost.
Contingency is assumed at 5% of project cost.
Price escalation rates for local component and foreign component are assumed at 5.9% per annum and 1.8% per annum, respectively.
Source: JICA Study Team

8.8.6 Scope Demarcation of the Project

It is necessary to transport the coal along the Jamshoro Project's scope area. Table 8-8 shows the demarcation of each project. The coal transportation of the project is not affected by the gray shadowed items (1-6, 5-5, and 5-6). In Case 1, trains transport coal on the existing line since axle load is 17.27 tons. Thus, in addition to the gray shadowed items, the blue highlighted items (1-2 and 1-4) have no impacts on the project.

Case 2B covers the loop line extension cost up to 650 m and uses the existing line only. Therefore, there are no cost demarcations between the Lakhra Project and Jamshoro Project in terms of item 2-1. However, items 1-1, 1-3, and 3-1 cover the rehabilitation costs between Port Qasim and Bin Qasim Station. Consequently, these items will be required to transport coal from Port Qasim and Lakhra Power Plant via Bin Qasim Station in all cases that use Port Qasim.

Case 2AR is not listed in Table 8-8 because this case is based on the Revised Jamshoro PC-1 and all the required costs between Kotri Junction and Akhundabad are included in this case. That is, there is no demarcation between the Jamshoro Project and Lakhra Project in terms of the project cost.

Table 8-8 Scope Demarcation between Jamshoro Project and Lakhra Project

S.No	DESCRIPTION OF WORKS	COST (Rs. In Million)				
		Jamshoro Project	Lakhra Power Plant Proj.			
		TOTAL	Case-1	Case-2A	Case-2B	Case-3
1	**Additional Track Construction Works and Rehabilitation of Existing Track**					
1-1	[J] Extension of Bridges and level crossing between Bin Qasim- Port Qasim station	479				
1-2	[J] Extension of Bridges and level crossing between Kotri-Akhundabad junction	663				
1-3	[J] Additional and Rehabilitation of existing track between Bin Qasim to Port Qasim.	839				
1-4	[J] Additional line from Kotri to Jamshoro Power Plant (14.82Km)	478				
1-5	[L] Additional Track Construction Works between Akhundabad to Budapur station		0.0	4,473.1	0.0	4,526.4
1-6	[J] Rehabilitation of existing track between Akhundabad to Jamshoro including loop lines (3 Nos.) (6.12 Km)	68				
2	**Loop Extension Works**					
2-1	[J] Additional loop Line at Sindh University and Jamshoro (2.20 Km)	71			44.6*	
2-2	[L] Loop Extension Works at Cadet Collage Petaro station and Unapur station.		21.8	0		0
3	**Signal and Telecommunication improvement**					
3-1	[J] Remodeling of Signaling system from Bin Qasim-Port Qasim, Kotri-Akhundabad & Sindh University station yards	24				
3-2	[L] Signaling works between Akhundabad junction and Budapur station		160.6	160.6	160.6	160.6
4	**Yard and the Access to Lakhra Plant Construction Works**					
4-1	[L] Yard Construction works		912.6	495.0	567.9	660.8
4-2	[L] Access Road, Spur Line or Belt Conveyor Construction		1,730.0	11,501.5	11,501.5	3,340.0
5	**Procurement of Locomotives, Wagons and Unloading Equipments**					
5-1	[L] Procurement of Locomotives incl. shunting one for Lakhra Proj.		4,034.8	3,296.7	4,768.4	3,296.7
5-2	[L] Procurement of wagons for Lakhra Project		2,630.8	1,947.0	2,315.0	1,947.0
5-3	[L] Procurement of Containers and Dump Tracks		1,092.1	0.0	0.0	0.0
5-4	[L] Transloading equipment (Reach Stacker)		256.3	156.0	156.0	156.0
5-5	[J] Procurement of 10 Nos. New DE Locomotives	5,491				
5-6	[J] Procurement of 500 High capacity Hopper wagons including 09 Nos. brake van	5,936				
6	[J] Procurement of Track Machinery, Vehicles and Equipments	622				
7	[J] Renovation/Construction of Offices, Office Equipments and General Expenses on Jamshoro Project	35				
8	[J] Temporary Establishment charges on Jamshoro Project	60				
9	[L] Land Acquisition between Budapur and Lakhra Power Plant		704.8	2,056.7	1,025.3	1,592.3
10	[L] Consulting Service Fee for Lakhra		634.4	1,605.1	1,348.6	969.7
	[J] PC-1 for Jamshoro Project Total without contingencies and price escalation added.	14,767				
	[L] Lakhra Power Plant Railway Initial Cost Total		12,178.3	25,691.8	21,888.0	16,649.6
	[J] Add 3% contingencies	443				
	[J] PC-1 for Jamshoro Project with contingencies Total	15,210				
	[J] Escalation @6.5% from July 2015 to June 2016(2nd Financial Year)	286				
	[J] PC-1 for Jamshoro Project Grand Total	**15,496**				

Note: [J] and [L] named items are included in PC-1 of the Jamshoro Project and this project, respectively.
*Includes loop extension works in Budapur, Cadet College Petaro, Unapur, and Sindh University stations.
Source: Jamshoro PC-1: PC-1 for Coal Transportation by rail to Jamshorp Power Plant (May 2014), JICA Study Team.

Chapter 9 Project Schedule

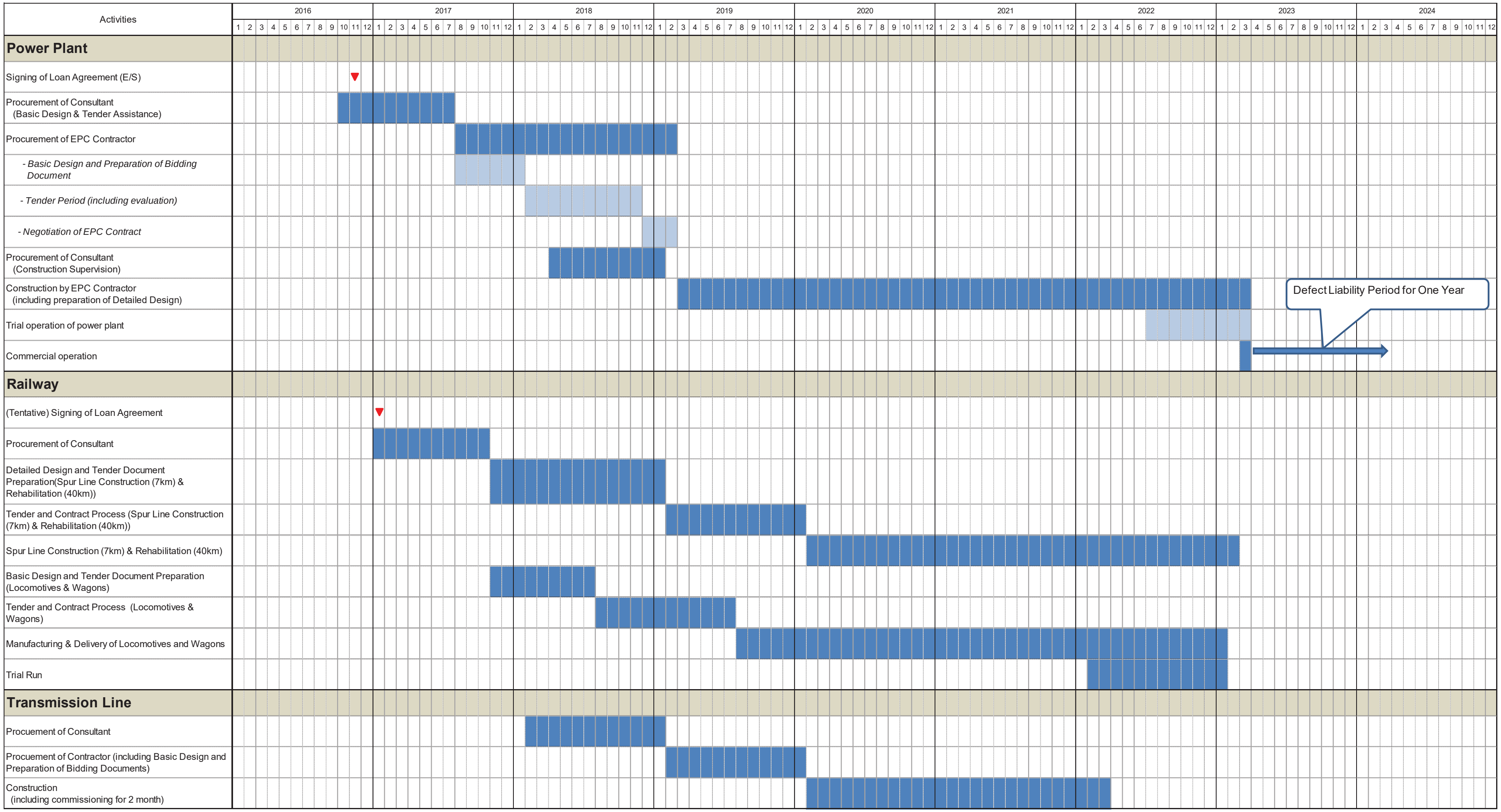
9.1 Assumptions

The schedule of the coal transportation to Lakhra Power Plant project (Case 2AR) is prepared based on the following assumptions:

- The construction of the Lakhra Power Plant project will be commenced in March 2019 and completed at the end of June 2022. Trial operation of the power plant will take 9 months.
- Coal shall be stocked for 55 days prior to the trial operation.
- In Case 2AR, since civil works including track works will be completed eight months after the completion of the power plant construction, coal for trial operation shall be transported by other transportation mode until coal transportation by rail can be started.
- Tender for procurement of locomotives and wagons can be commenced nine months after the commencement of the consulting services.
- Coal will be loaded at the coal loading site at Port Qasim area. Coal loading will be done by hopper system. Weigh bridge will be provided near the coal loading site. Weighing will be done automatically without the stopping of train.
- Enough number of locomotives and coal wagons will be provided.
- Spur line to the Lakhra Power Plant will be constructed. Shunting yard will be constructed within the power plant yard.

9.2 Schedule

The project schedule of Case 2AR is shown in the following Figure 9-1:



Source: JICA Study Team

Figure 9-1 Project Schedule

The completion of the railway facilities to the power plant is just before the start of the commercial operation of the power plant. It is necessary to transport the coal during the trial operation of the power plant (9 months) by other transportation method. The transportation of coal by trucks from Port Qasim to the power plant is suitable during this period. The required coal for the trial operation of the power plant is about 2,200 tons/day (about 40% of commercial operation) and it is necessary to operate 44 trucks per day (the payload of one truck is 50 ton). Moreover, 22 trucks are necessary for the coal transportation under the following conditions:

- Distance: 190 km from Port Qasim to Lakhra Power Plant
- Average speed of truck: 60 km/h
- Working hours per day: 20 hours
- Payload of one truck: 50 ton
- Cycle time of truck operation: 10 hours including loading coal, running and unloading; 2 operations per day.
- Interval of truck operation on national highway: One truck per 27 minutes.

As another method, transporting the coal from Port Qasim to Budapur Station by train and from Budapur Station to the power plant by trucks is another option. The condition of this case is as follows:

- The coal wagon is bottom dump same as for the other power plants,
- Temporary coal unloading facilities is constructed beside the existing loop lines of Budapur Station for the transfer of coal from train wagon to truck,
- The access road from Budapur Station to the power plant is improved for the passing of trucks with a 50 ton-coal payload,
- Truck operation is 1 truck per 27 minutes same as the previous coal transportation by trucks,
- The cost of the right of way and construction of temporary coal unloading facilities is roughly estimated to be about 20% to 30% of the new station construction of Case 3.

This alternative coal transportation method by the combination of railway and truck is not recommendable because of high investment cost of temporary facilities for only nine months; there is no possibility of reusing these temporaly facilities after the coal transportation for the trial operation of the power plant.

A coal trading company in Pakistan has experience of coal transportation to Islamabad and Lahore, and the company informed the possibility of transporting the coal to the Lakhra Power Plant. It is necessary to confirm the possibility and condition of coal transportation by truck to the Lakhra Power Plant in the beginning of the consulting work for this project and when it is difficult to transport the coal by truck, it is recommended to reconsider the timing of the start of the trial operation of the Lakhra Power Plant.

9.3 Role and Responsibility of Coal Transportation

Coal transportation from Bin Qasim Station to the Lakhra Power Plant requires the involvement of MoPS, GHCL/LPGCL, MoR and Pakistan Railways (PR). Roles and responsibilities of these authorities concerned are estimated as shown in Table 9-1. The final demarcation of roles and responsibilities will be described in the Inland Coal Transportation Agreement.

Table 9-1 Roles and Responsibilities for Coal Transportation between Bin Qasim Station and Lakhra Power Plant

Work Item / Activity	Finance Source	Sponsering Agency	Executing Agency (= Project owner)	Construction	Operation and Maintenance	Ownership of Property
Rehabilitation of Track and Signaling between Bin Qasim and Kotri Junction	GoP	MoR	PR	PR	PR	PR
Upgrading of Track and Bridges between Kotri and Budapur	IsDB	MoWP	GHCL/LPGCL	PR	PR	PR
Construction of Spur Line between Budapur and Lakhra Power Plant Station	IsDB	MoWP	GHCL/LPGCL	PR	GHCL/LPGCL subletting to PR	GHCL/LPGCL
Procurement of Locomotives and Wagons for Coal Transportation	IsDB	MoWP	GHCL/LPGCL		GHCL/LPGCL subletting to PR	*2 GHCL/LPGCL
Train Operation between Bin Qasim Station and Budapur Station			PR		PR	PR
Train Operation between Budapur Station and Lakhra Power Plant Station			GHCL/LPGCL subletting to PR		GHCL/LPGCL subletting to PR	GHCL/LPGCL

Source: JICA Study Team

It was identified during the environmental impact assessment (EIA) preparation that the construction of spur line from Budapur Station to Lakhra Power Plant requires resettlement of some households. Although the preparation of land acquisition and resettlement action plan (LARAP) is not obliged in Pakistan when the resettlement of inhabitants is required, LARAP shall be prepared in accordance with the JICA Guidelines.

The EIA shall be submitted to SEPA by GHCL/LPGCL, and the LARAP shall be approved by GHCL/LPGCL who are responsible for the resettlement.

Chapter 10 Financial Viability and Financing Options

This section describes the methodology which would apply to the financial appraisal of the railway portion of the project which has been assumed to be financed through an official development assistance (ODA) loan to the railway operating authority, in this case, the Pakistan Railways (PR).

10.1 Project Initial Cost Estimates

The railway alternatives initially appraised are as follows:

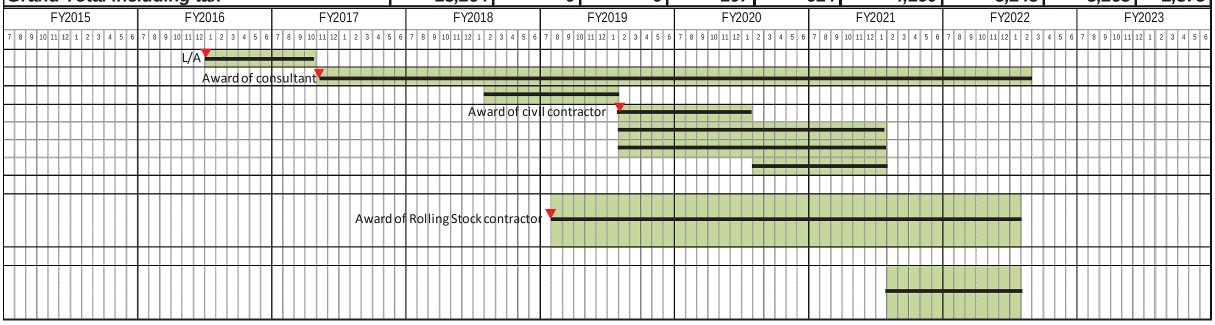
- Case 1:
  Rail haulage of imported coal from Port Qasim to Budapur Station involving transfer to the power station by dump trucks conveying bulk containers;
- Case 2A:
  Rail haulage of imported coal from Port Qasim direct to the Lakhra power station via an access line connecting the power station with Budapur Station on the Kotri Junction-Dadu branch line. In this case, 4,000 HP heavy locomotive uses additional line constructed between Kotri Junction and Budapur Station with 23.3-ton axle load.
- Case 2AR
  This case uses the rehabilitated existing line from Kotri to Budapur Station with 4,000 HP heavy locomotive with 23.3-ton axle load. The other conditions are the same as in Case 2A above.
- Case 2B:
  Rail haulage of imported coal from Port Qasim direct to the Lakhra power station similar to Case 2A. 2,000 HP light locomotive uses the existing PR branch line with existing loop extension up to 650 m.
- Case 3:
  Rail haulage of imported coal from Port Qasim to the new Budapur Station involving transfer to the power station by conveyor belt system.

Capital cost estimates for Case 1, Case 2A, Case 2AR, Case 2B, and Case 3 were considered as the basis for the financial appraisal of the railway component of the project. It was assumed that construction would be scheduled over a period of three years for all cases. The capital expenditure profiles for all cases are given in Table 10-1, Table 10-2, Table 10-3, Table 10-4, and Table 10-5.

Table 10-1 Capital Expenditure Profile for Railway Component of Case 1

Case 1 **Initial Cost**

Item	**Initial capital cost (Rs.mill)**								
	Total	2015	2016	2017	2018	2019	2020	2021	2022
Consulting Service	***655***	**0**	**0**	**82**	**123**	**123**	**123**	**123**	**82**
Land Acquisition	***789***	***0***	***0***	***0***	***329***	***460***	***0***	***0***	***0***
Siding track extension	24	0	0	0	0	10	14	0	0
Construction of Budapur Station Yard	1,011	0	0	0	0	211	505	295	0
Constructioon of dedicated access road	1,936	0	0	0	0	403	968	565	0
Signalling and weighbridge Bib Qasim	180	0	0	0	0	0	75	105	0
Sub-total - civil works	***3,151***	***0***	***0***	***0***	***0***	***624***	***1,563***	***965***	***0***
Procurement of new 2,400 HP locomotives	3,786	0	0	0	0	992	1,082	1,082	631
Procurement of new shunting locomotives	379	0	0	0	0	99	108	108	63
Procurement of flatbed wagons and brake vans	2,716	0	0	0	0	711	776	776	453
Sub-total - rolling stock	***6,881***	***0***	***0***	***0***	***0***	***1,802***	***1,966***	***1,966***	***1,147***
Procurement of Open Top Containers	1,049	*0*	*0*	*0*	*0*	*0*	0	437	*612*
Procurement of Dump Trucks	78	*0*	*0*	*0*	*0*	*0*	*0*	33	*46*
Procurement of Reach Stacker	265	*0*	*0*	*0*	*0*	*0*	*0*	110	*154*
Sub-total - handling equipment	***1,392***	***0***	***0***	***0***	***0***	***0***	***0***	***580***	***812***
Sub-total	***12,868***	***0***	***0***	***82***	***451***	***3,009***	***3,651***	***3,633***	***2,041***
Price Escalation	***1,584***	***0***	***0***	***1***	***43***	***290***	***520***	***525***	***204***
Contingency	***723***	***0***	***0***	***4***	***25***	***165***	***209***	***208***	***112***
Tax	***3,090***	***0***	**0**	**19**	**95**	**696**	**865**	**896**	**518**
Grand Total including tax	***18,264***	***0***	***0***	***107***	***614***	***4,160***	***5,245***	***5,263***	***2,875***

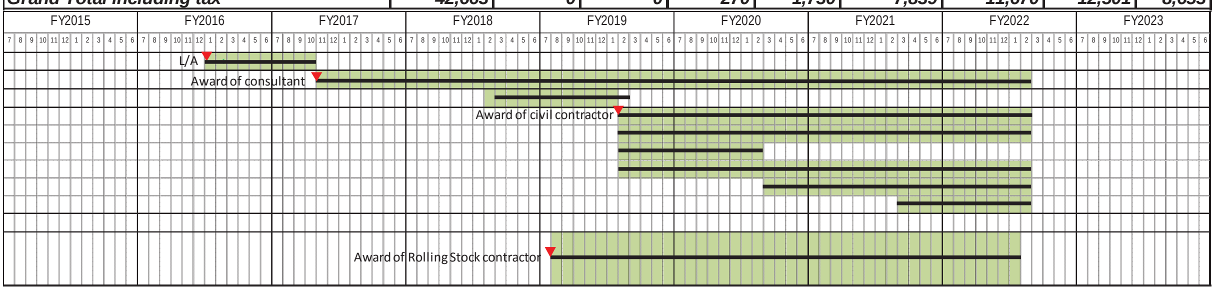


Source: JICA Study Team

Table 10-2 Capital Expenditure Profile for Railway Component of Case 2A

Case 2A **Initial Cost**

Item	**Initial capital cost (Rs.mill)**								
	Total	2015	2016	2017	2018	2019	2020	2021	2022
Consulting Service	***1,657***	**0**	**0**	**207**	**311**	**311**	**311**	**311**	**207**
Land Acquisition	***2,302***	***0***	***0***	***0***	***959***	***1,343***	***0***	***0***	***0***
New line Akhundabad-Budapur	4,971	0	0	0	0	672	1,612	1,612	1,075
Siding track Budapur-Lakhra P.S.	185	0	0	0	0	25	60	60	40
Earthwork for siding track	176	0	0	0	0	68	108	0	0
Bridge construction	12,507	0	0	0	0	1,690	4,056	4,056	2,704
Track and signalling work in yard	718	0	0	0	0	0	120	359	239
Coal unloading facilities	161	0	0	0	0	0	0	54	107
Sub-total - civil works	***18,718***	***0***	***0***	***0***	***0***	***2,455***	***5,956***	***6,141***	***4,166***
Procurement of new 4,000 HP locomotives	2,267	0	0	0	0	594	648	648	378
Procurement of new shunting locomotives	1,136	0	0	0	0	297	325	325	189
Procurement of hopper wagons and brake vans	2,010	0	0	0	0	526	574	574	335
Sub-total - rolling stock	***5,413***	***0***	***0***	***0***	***0***	***1,418***	***1,547***	***1,547***	***902***
Sub-total	***28,090***	***0***	***0***	***207***	***1,270***	***5,526***	***7,814***	***7,998***	***5,275***
Price Escalation	***6,275***	***0***	***0***	***3***	***125***	***775***	***1,592***	***2,077***	***1,703***
Contingency	***1,718***	***0***	***0***	***11***	***70***	***315***	***470***	***504***	***349***
Tax	***6,579***	***0***	**0**	**49**	**266**	**1,224**	**1,794**	**1,922**	**1,326**
Grand Total including tax	***42,663***	***0***	***0***	***270***	***1,730***	***7,839***	***11,670***	***12,501***	***8,653***

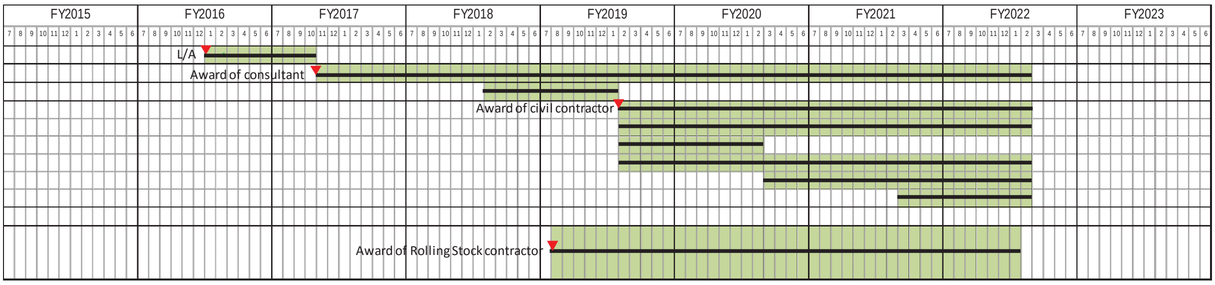


Source: JICA Study Team

Table 10-3 Capital Expenditure Profile for Railway Component of Case 2AR

Case 2AR — Initial Cost

Item	Initial capital cost (Rs.mill)								
	Total	2015	2016	2017	2018	2019	2020	2021	2022
Consulting Service	***1,511***	**0**	**0**	**189**	**283**	**283**	**283**	**283**	**189**
Land Acquisition	***1,086***	***0***	***0***	***0***	***453***	***634***	***0***	***0***	***0***
Track improvement Akhundabad-Budapur	2,206	0	0	0	0	298	715	715	477
Siding track Budapur-Lakhra P.S.	185	0	0	0	0	25	60	60	40
Earthwork for siding track	176	0	0	0	0	68	108	0	0
Bridge construction	12,507	0	0	0	0	1,690	4,056	4,056	2,704
Track and signalling work in yard	718	0	0	0	0	0	120	359	239
Coal unloading facilities	161	0	0	0	0	0	0	54	107
Sub-total - civil works	***15,953***	***0***	***0***	***0***	***0***	***2,081***	***5,060***	***5,244***	***3,568***
Procurement of new 4,000 HP locomotives	2,267	0	0	0	0	594	648	648	378
Procurement of new shunting locomotives	1,136	0	0	0	0	297	325	325	189
Procurement of hopper wagons and brake vans	2,010	0	0	0	0	526	574	574	335
Sub-total - rolling stock	***5,413***	***0***	***0***	***0***	***0***	***1,418***	***1,547***	***1,547***	***902***
Lakhra Required Revised PC-I Portion	***764***	***0***	***0***	***0***	***0***	***578***	***185***	***0***	***0***
Sub-total	***24,726***	***0***	***0***	***189***	***736***	***4,994***	***7,075***	***7,074***	***4,659***
Price Escalation	***5,358***	***0***	***0***	***3***	***63***	***652***	***1,406***	***1,778***	***1,456***
Contingency	***1,504***	***0***	***0***	***10***	***40***	***282***	***424***	***443***	***306***
Tax	***5,822***	***0***	**0**	**44**	**158**	**1,117**	**1,628**	**1,703**	**1,172**
Grand Total including tax	***37,411***	***0***	***0***	***246***	***997***	***7,045***	***10,533***	***10,998***	***7,592***

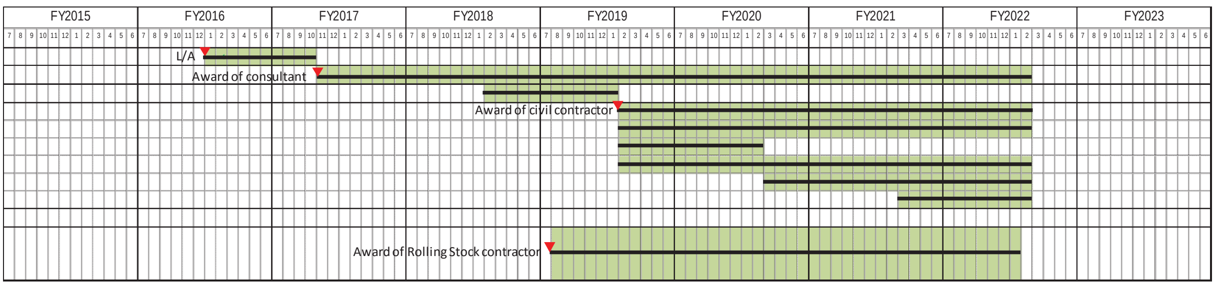


Source: JICA Study Team

Table 10-4 Capital Expenditure Profile for Railway Component of Case 2B

Case 2B — Initial Cost

Item	Initial capital cost (Rs.mill)								
	Total	2015	2016	2017	2018	2019	2020	2021	2022
Consulting Service	***1,392***	**0**	**0**	**174**	**261**	**261**	**261**	**261**	**174**
Land Acquisition	***1,148***	***0***	***0***	***0***	***478***	***669***	***0***	***0***	***0***
Loop Extension works	49	0	0	0	0	7	16	16	11
Siding track Budapur-Lakhra P.S.	185	0	0	0	0	25	60	60	40
Earthwork for siding track	176	0	0	0	0	68	108	0	0
Bridge construction	12,507	0	0	0	0	1,690	4,056	4,056	2,704
Track and signalling work in yard	797	0	0	0	0	0	133	399	266
Coal unloading facilities	161	0	0	0	0	0	0	54	107
Sub-total - civil works	***13,876***	***0***	***0***	***0***	***0***	***1,789***	***4,373***	***4,585***	***3,128***
Procurement of new 2,400 HP locomotives	3,786	0	0	0	0	992	1,082	1,082	631
Procurement of new shunting locomotives	1,136	0	0	0	0	297	325	325	189
Procurement of hopper wagons and brake vans	2,390	0	0	0	0	626	683	683	398
Sub-total - rolling stock	***7,312***	***0***	***0***	***0***	***0***	***1,915***	***2,089***	***2,089***	***1,219***
Sub-total	***23,727***	***0***	***0***	***174***	***739***	***4,635***	***6,724***	***6,935***	***4,521***
Price Escalation	***4,854***	***0***	***0***	***3***	***65***	***558***	***1,249***	***1,641***	***1,338***
Contingency	***1,429***	***0***	***0***	***9***	***40***	***260***	***399***	***429***	***293***
Tax	***5,617***	***0***	**0**	**41**	**158**	**1,047**	**1,558**	**1,675**	**1,138**
Grand Total including tax	***35,627***	***0***	***0***	***226***	***1,003***	***6,500***	***9,929***	***10,680***	***7,290***

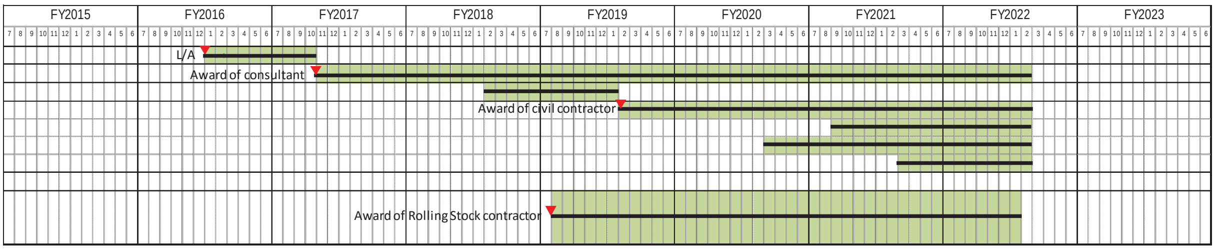


Source: JICA Study Team

Table 10-5 Capital Expenditure Profile for Railway Component of Case 3

Case 3 — Initial Cost

Item	Initial capital cost (Rs.mill)								
	Total	2015	2016	2017	2018	2019	2020	2021	2022
Consulting Service	***1,001***	**0**	**0**	**125**	**188**	**188**	**188**	**188**	**125**
Land Acquisition	***1,782***	***0***	***0***	***0***	***743***	***1,040***	***0***	***0***	***0***
New line Akhundabad-Budapur	5,029	0	0	0	0	680	1,631	1,631	1,087
Conveyor Belt construction	3,448	0	0	0	0	0	0	1,915	1,532
Track and signalling work in yard	903	0	0	0	0	0	150	451	301
Coal unloading facilities	161	0	0	0	0	0	0	54	107
Sub-total - civil works	***9,541***	***0***	***0***	***0***	***0***	***680***	***1,782***	***4,051***	***3,028***
Procurement of new 4,000 HP locomotives	2,267	0	0	0	0	594	648	648	378
Procurement of new shunting locomotives	1,136	0	0	0	0	297	325	325	189
Procurement of hopper wagons and brake vans	2,010	0	0	0	0	526	574	574	335
Sub-total - rolling stock	***5,413***	***0***	***0***	***0***	***0***	***1,418***	***1,547***	***1,547***	***902***
Sub-total	***17,737***	***0***	***0***	***125***	***930***	***3,325***	***3,516***	***5,786***	***4,055***
Price Escalation	***2,716***	***0***	***0***	***2***	***95***	***387***	***531***	***925***	***776***
Contingency	***1,023***	***0***	***0***	***6***	***51***	***186***	***202***	***336***	***242***
Tax	***4,254***	***0***	**0**	**29**	**193**	**754**	**829**	**1,422**	**1,026**
Grand Total including tax	***25,729***	***0***	***0***	***163***	***1,269***	***4,652***	***5,079***	***8,468***	***6,099***



Source: JICA Study Team

10.2 Railway Operation and Maintenance Costs

Together with the project capital costs (outlined above) and the financing cost, the cost of operating and maintaining the railway asset provided by the project will be offset against the coal haulage revenue it generates, in order to establish if the project will provide an acceptable financial return.

The railway operation and maintenance (O&M) costs of hauling coal by rail between Port Qasim and the Lakhra power station were estimated with the assistance of a railway point-to-point traffic costing model. This model combines inputs of train operating parameters and unit costs derived from railway accounting data, to generate estimates of railway O&M costs per train, per ton, and per net ton-km.

10.2.1 Derivation of Unit Costs

The principal items of O&M cost are indicated in Table 10-6, which details the unit costs for each item as derived for services operated by Pakistan Railways (PR) and alternatively by a private company. The principal difference between the two is that the labour costs of the privately operated railway will be set at rates which are competitive with those of road transport and consequently will exclude the high fixed costs of pension and health contributions which constitute two thirds of the state railway labour costs. As may be seen in

Table 10-6, the private operator crew cost is estimated at PKR 764 per train hour, or about PKR 255 per crew member hour. This is comparable to an estimated truck driver cost of PKR 200 per hour.[6] Although PR operates coal freight train, the private operator for the coal transportation has not been fixed yet. Thus, the O&M unit cost operated by PR was applied for the railway O&M cost calculation.

Table 10-6 Estimated O&M Unit Costs under PR and Private Operation

S/N	UNIT COST ITEM	PR operation	Private operation
1	Train crew cost per train hour (1)	1,238	764
2	Fuel consumption, Litres per '000 GTK (2)	3.0	3.0
3	Unit cost of diesel fuel, litre (3)	101.00	101.00
4	Unit cost of loco maintenance, per loco-km (diesel) (4)	167.15	125.42
5	Unit cost of wagon maintenance, per wagon km (5)	23.48	14.78
6	Variable cost of track maintenance, per GTK (6)	0.1934	0.1934
7	Fixed cost of route inf. maintenance, per track-km per year (7)	549,667	549,667
8	Station staffing cost per route-km per year (8)	882,957	882,957
9	Overheads as % of fixed and variable costs (9)	25%	10%

Sources:
1. Ministry of Railways, Government of Pakistan, *Year Book 2011-12.*
2. Financial Review for month of June (Final) 2012, 2013, 2014.

Notes:
(1) Train crew comprises a Driver, Assistant Driver and Train Guard
(2) Fuel consumption for a 4,000 HP diesel-electric locomotive, with a hauling capacity of 2,400 tonnes on near level grade.
(3) Based on retail price of diesel fuel near Karachi in early December 2014
(4) Inclusive of the cost of scheduled overhauls, unscheduled repairs and running maintenance (lubrication, brake-block replacement, sanding, and fuelling)
(5) Inclusive of the cost of scheduled overhauls, unscheduled repairs and running maintenance (eg lubrication, brake-block replacement)
(6) Track maintenance cost which varies with the level of gross passing tonnage - principal cost components: rail replacement; ballast replacement
(7) Inclusive of the fixed cost of track maintenance cost (principally daily inspection cost), as well as signalling and communications system maintenance
(8) Inclusive of the salary and wages cost of: station staff, train control staff, and level crossing protection staff, all of which are regarded as fixed costs
(9) Primcipal item is administrative overhead cost

Source: JICA Study Team

The basis for the estimation of unit costs is given below.

(1) Train Crew Cost

The average wage cost for train crew staff was estimated at the average wage rate for Traffic Department staff, as indicated in Table 10-7. This rate was derived from the PR financial review for the 2011-12 financial year. In the case of service operation by PR, the direct wage cost was expanded to include pension and medical contributions and was updated to 2014 values using the national inflation rates for 2012-13 and 2013-14. In the case of operation by a private company, train crew cost was assumed to exclude pension and medical contributions. In both cases, the derived annual expense per employee was divided by the total working time per employee of 2,400 hours per year (8 hours per day x 6 days per week x 50 weeks per year) to arrive at a cost per employee per train hour. For PR-operated services, the cost per employee per train hour is PKR 301, or PKR 903 per crew of 3 persons per train hour. The latter figure

[6] Estimated on the basis of the lease agreement for the Karachi Circular Railway Project of 2012.

was expanded to allow for holiday and other leave coverage and then inflated to 2013/14 values, resulting in a train crew cost per train hour of PKR 1,238.

Table 10-7 Crew Cost per Train Hour

Item	Value	USD	Sources
Traffic Dept Staff No. 2011/12	10471		PR Yearbook 2011-12, pages 134-135
TD Employee expenses (Rs.mill.)	4536.331		PR, Financial Review for month of June 2012
Average annual expense per TD employee	433,228.06	4,308.58	
Plus pension and other staff overheads	289,192.96	2,876.11	
Total annual expense per employee, 2011/12, Rs.	722,421.02	7,184.69	
Annual hours worked/employee: 8 hrs x 6 days x 50 weeks	2400		
Av. cost per employee hour: Rs.722421/2400 hours, Rs.	301		
Cost of freight train crew per hour worked (3 crew x 301)	903		
No of hours worked per year (3 shifts)	7200		
No.of working hours to be covered per year (350days x 24 hrs)	8400		
Expansion factor (8640/7200)	1.1667		
Adjusted crew cost per train hour (1.1667 x 903), 2011-12, Rs.	1054	10.43	
Inflation factor 2011-12 to 2013-14	1.1751		World Bank Pakistan Country Snapshot March 2014
Crew cost per train hour 2013-14	***1238***	***12.26***	

Source: JICA Study Team

(2) Fuel Consumption Estimate and Cost

In Case 1 and Case 2B, it was assumed that new 2,400 HP locomotives would be purchased to haul lighter trains (axle load of 17.27 tons) only as far as Budapur Station where coal would be off-loaded for transfer to the power station by road. In Case 2A, Case 2AR, Case 2B, and Case 3, it was assumed that new 4,000 HP diesel electric locomotives would be purchased to haul coal trains direct to the power station on heavier (23.3-ton axle load) track.

Fuel consumption was estimated at a rate per thousand gross ton-km (GTK), a measure of work done, since this allows a lower level of fuel consumption for train haulage in the empty direction. Fuel consumption rates were estimated at 3.0 litres per thousand GTK for 4,000 HP locomotives. These rates were derived from rates given for locomotives of comparable power rating in Australia. In the cases using two 2,000 HP locomotives, it was assumed that the fuel consumption rate is 3.0 litres similar to the 4,000 HP locomotives.

The unit price of high speed diesel was assumed to be equivalent to the retail price of automotive diesel fuel at the time of the JICA Study Team’s second visit to Pakistan in early December 2014, i.e., PKR 101 per litre. Since then, world oil prices have collapsed by about 30%, but owing to the dynamic state of the world oil market, it was not possible to determine the level at which domestic diesel prices would settle during early 2015.

(3) Locomotive Maintenance Cost

The cost of maintaining locomotives includes the cost of overhauls which are scheduled to occur every six years and every four years, respectively, as well as the cost of running repairs and maintenance (comprising recurrent costs of brake block replacement, fuelling, sanding, lubrication, etc).

These costs were estimated from cash expenses (covering the cost of wages and salaries plus consumables) and the cost of stores, which is mainly the cost of spare parts. Both cost components were obtained from the PR Financial Review for the month of June 2012. The resulting annual cost estimate was assumed to be spread over the estimated total locomotive running km for the PR network, giving a cost per locomotive-km as shown in Table 10-8 below.

Table 10-8 Locomotive Running Maintenance and Overhaul

Item	Value			Sources
Engine km per day per engine in use	403			PR Yearbook 2011-12, page 116
Operating days per year	350			
Average running km per engine in use per year	141,050			
No. of diesel locomotives registered on PR	442			Rolling stock data supplied by PR HO Sept 2014
Percentage of locomotives utilized	50%			Rolling stock data supplied by PR HO Sept 2014
Number utilized	221			
Total Loco Running Km in 2011-12 (estimated)	31,172,050			
Locomotive Repair and Maintenance Expenses	Direct	With On-costs		
Cash expenses 2011-12, Rs.mill.	1,658.72	2,765.97		PR, Financial Review for month of June 2012
Stores 2011-12, Rs. mill.	1,668.35	1,668.35		PR, Financial Review for month of June 2012
Total, Rs. mill.		4,434.32		
			USD	
Loco R&M per loco-km (2011-12), Rs.		*142.25*	*1.41*	
Inflation factor 2011-12 to 2013-14		1.1751		
Loco R&M per loco-km (2013-14 prices), Rs.		***167.15***	***1.66***	

Source: JICA Study Team

(4) Wagon Maintenance Cost

The cost of maintaining wagons was estimated in the same way as for locomotives. The resulting cost estimate per wagon-km is shown in Table 10-9 below.

Table 10-9 Wagon Running Maintenance and Overhaul

Item	Value			Sources
Wagon-km/year	44,120,000			PR Yearbook 2011-12, page 115
Wagon Repair and Maintenance Expenses	Direct	With On-costs		
Cash expenses 2011-12, Rs.mill.	489.35	816.00		PR, Financial Review for month of June 2012
Stores 2011-12, Rs. mill.	65.72	65.72		PR, Financial Review for month of June 2012
Total, Rs. mill.		881.72		
			USD	
Wagon R&M per wagon-km (2011-12)		*19.9846194*	*0.19787*	
Inflation factor 2011-12 to 2013-14		1.175052		
Wagon R&M per wagon-km (2013-14 prices)		***23.483***	***0.2325***	

Source: JICA Study Team

(5) Variable Cost of Track Maintenance

This is the portion of track maintenance cost which varies directly with the gross tonnage passing over the track.

The split between fixed and variable track maintenance is often a matter of judgement by cost analysts. However, there are track maintenance inputs which are uniquely determined by the level of passing traffic. For example, ballast renewal or cleaning because the ballast bed has broken down under the load from passing trains. Similarly, it can be argued that the condition of sleepers and rails will be more affected by traffic volume than by the mere passage of time. On the other hand, the costs of track inspection, vegetation control, and fence repairs are more likely to be time related and therefore will be fixed in nature.

Initially, it is necessary to estimate the proportions of fixed and variable track maintenance costs. For railways which have a very high level of traffic (e.g., India and China), variable track maintenance can be expected to account for a dominant share of track maintenance costs, typically of the order of 65-70%. For railways with relatively low levels of traffic, the reverse is true, with fixed costs typically accounting for 80% or more of the total track maintenance costs. In this instance, PR has been considered as an intermediate case, with fixed costs assumed to be around 65-70% of the overall cost of track maintenance.

As shown in Table 10-10, the overall cost of track maintenance was assessed to be PKR 7.0 billion in 2011-12 based on the Pakistan Railways Financial Review of June 2012. This amount includes wage costs expanded to include on-costs such as pension and medical contributions and store costs which are mainly the costs of spare parts. It was divided into fixed costs of PKR 4.5 billion (65%) and variable costs of PKR 2.5 billion (35%).

When inflated to 2013-14 values and related to an estimate of GTK on the PR network, the variable cost was estimated at PKR 0.23 per GTK. The train costing model applies this variable unit cost to the level of GTK generated by the costed traffic to derive an annual variable cost.

(6) Fixed Cost of Infrastructure Maintenance

The fixed cost of infrastructure maintenance includes the fixed cost of track maintenance, which represents 65% of the total track maintenance costs as well as the costs of signal and telecommunications system maintenance, 100% of which are assumed to be fixed in nature. The calculation of fixed infrastructure maintenance cost is also shown in Table 10-10.

The overall fixed cost estimate at 2013-14 values (PKR 5.14 billion) was divided by the total track-km on the PR network, to derive a unit cost for application to the train costing model. The model apportions this unit cost (PKR 514,675 per track-km) to the costed traffic in proportion to its share of the number of trains transiting the route annually.

(7) Station and Train Control Operation Costs

These are essentially the salary and wage costs of the station and train control staff deployed along the costed route. Wage overheads, primarily pension and medical contributions, were added to the base labour rates to derive the overall cost of station and train control staffing – see Table 10-11 below.

Costs in this category are regarded as fixed because their level will not vary with the tonnage of passing traffic. The model apportions them to the costed traffic in the same way as for fixed infrastructure maintenance costs.

Table 10-10 Fixed and Variable Infrastructure Maintenance Costs

A. Calculation of gross tonne-km

Item	Value	Sources
Pax train-km 2011-12, '000	21,459	PR Yearbook 2011-12, page 113
Coaching vehicle km, '000	157,944	PR Yearbook 2011-12, Principal statistics
Av. Vehicles per train	7.36	say 9 with van
Av. Gross tonnes per pax train (9 cars x 50t + 117.6 t loco weight)	568	
GTKM pax, mill.	12,180	
Freight train km 2011-12	699	PR Yearbook 2011-12, page 113
Av. Net load per freight train	557	PR Yearbook 2011-12, page 113
Assumed G:N ratio	1.50	
GTKM freight, mill.	584	
Total GTKM on PR 2011-12, mill.	**12,764**	

B. Estimation of fixed and variable infrastructure maintenance costs

	Direct	With On-costs	Fixed	Variable
Total Permanent Way Engineering and Structure Works				
Cash expenses (wages etc), 2011-12, Rs. mill	3,485.03	5,811.39		
Stores, 2011-12, Rs. mill.	1,189.67	1,189.67		
% split fixed vs. variable			65%	35%
Total Expenditure 2011/12, Rs.mill.	4,674.70	7,001.07	4,550.69	2,450.37
Total Signalling				
Cash expenses (wages etc), Rs. mill	235.82	393.23		
Stores, Rs. mill.	62.35	62.35		
% split fixed vs. variable			100%	-
Expenditure 2011/12, Rs.mill.	298.16	455.58	455.58	-
Total Communications				
Cash expenses (wages etc), Rs. mill	74.83	124.78		
Stores, Rs. mill.	17.67	17.67		
% split fixed vs. variable			100%	-
Expenditure 2011/12, Rs.mill.	92.50	142.44	142.44	-
TOTAL INFRASTRUCTURE				
Cash expenses (wages etc), Rs. mill	**3,795.67**	**6,329.40**		
Stores, Rs. mill.	**1,269.69**	**1,269.69**		
Expenditure 2011/12, Rs.mill.	**5,065.36**	**7,599.09**	5,148.72	2,450.37
Fixed infra costs per track-km (2011-12 prices), Rs.			438,002.18	
Inflation factor 2011-12 to 2013-14			1.18	
Fixed infra costs per track-km (2013-14 prices), Rs.			***514,675.33***	
Variable infra costs per GTKM (2011-12 prices), Rs.				*0.19*
Inflation factor 2011-12 to 2013-14				1.18
Variable infra costs per GTKM (2013-14 prices), Rs.				***0.23***

Source: JICA Study Team

Table 10-11 Station Staffing and Train Control Operating Cost

Number of manned stations on PR network	558	PR Yearbook 2011-12, page 29
Total operating staff (Transport Department)	10,471	
Less train crew staff (estimated)	2,367	
Equals no. station and train control staff	8,104	
Number per station	14.5	
Route km	7,791	PR Yearbook 2011-12, page 2
Number per route km	1.04	
Unit cost per employee (incl. wage overheads)	722,421.02	See "Train crew cost"
Staffing cost per route-km (2011-12 prices), Rs.	*751,419.58*	
Inflation factor 2011-12 to 2013-14	1.1751	
Staffing cost per route-km (2013-14 prices), Rs.	***882,957***	

Source: JICA Study Team

(8) Administrative Overheads

The administrative overhead rate was determined on the basis of the relationship between the administration costs of the PR organization and the fixed and variable O&M costs as identified above. This was calculated at 25.6% as shown in Table 10-12.

Table 10-12 PR Expense Breakdown (PKR million)

R&M	11,977.79	
Operation Fuel	8,511.33	
Operation Staff	4,536.33	
Operation Other	935.42	As % of direct
Admin	5,412.99	25.6%
Misc	69.48	
TOTAL	31,443.34	

Source: JICA Study Team

10.2.2 Estimation of Railway O&M Costs for Coal Haulage from Port Qasim – Lakhra: Train Costing Model

A train costing model was used to estimate the O&M costs which would be incurred under the following five alternatives:

- Case 1: Rail movement as far as Budapur Station with transfer by dump truck to the power station, using 2,400 HP locomotives, flat bed container wagons, and 20 ft bulk containers;
- Case 2A: Direct rail movement to the power station site using 4,000 HP locomotives and bottom discharging wagons with additional dedicated line from Akhundabad and Budapur Station;

- Case 2AR: Direct rail movement to the power station site using 4,000 HP locomotives and bottom discharging wagons with track upgrading from Kotri and Budapur Station;
- Case 2B: Direct rail movement similar to Case 2A and Case 2AR but using 2,400 HP locomotives and existing track between Kotri and Budapur Station; and
- Case 3: Rail movement as far as the New Budapur Station, newly constructed at 3.39 km from the Budapur Station, with transfer to the Lakhra Power Plant by conveyor belt.

(1) Train Operating Parameters and Assumptions

The operating parameters and assumptions used for the calculation of the O&M costs using the train costing model are given in Table 10-13 below.

Table 10-13 Railway Operating Parameters and Assumptions Underlying the O&M Cost Estimates

Parameter	Railway Alternatives				
	Case 1: Port Qasim to Budapur Station (Road Transfer to Power Station)	Case 2A: Direct from Port Qasim-Lakhra Power Station with Additional Track	Case 2AR: Direct from Port Qasim to Lakhra Power Station with Existing Track Upgrading	Case 2B: Direct from Port Qasim to Lakhra Power Station Using Existing Track	Case 3: Conveyor Belt Transfer at New Budapur Station
Train Composition					
Locomotives (Diesel Electric) - Horsepower - Number per train	 2,400 2	 4,000 1	 4,000 1	 2,400 2	 4,000 1
Wagons - Type - Number per train - Tare weight (tons) - Payload (tons)	Flatbed with 2 x 20 ft containers 38 26 40	Side or Bottom discharge 40 25 60	Side or Bottom discharge 40 25 60	Side or Bottom discharge 38 25 40	Side or Bottom discharge 40 25 60
Train Payload (tons) - Forward - Return	 1,520 0	 2,400 0	 2,400 0	 1,520 0	 2,400 0
Train Gross Load (tons) - Forward - Return	 2,744 1,224	 3,551 1,151	 3,551 1,151	 2,705 1,185	 3,551 1,151
Section between Akhundabad and Budapur Station	Freight and passenger train use	Dedicated line for freight	Freight and passenger train use	Freight and passenger train use	Dedicated line for freight
Length of Haul (km)	186.2	191.8	191.8	191.8	189.2
Transit Time per Trip (hours)	19.5	18.5	18.5	18.2	18.2
Cycle Time (days)	0.81	0.77	0.77	0.76	0.76
Number of Trains per year (330 days)	4 trains a day; 1,320 rounds/ year	3 trains a day; 990 rounds/ year	3 trains a day; 990 rounds/ year	4 trains a day; 1,320 rounds/ year	3 trains a day; 990 rounds/ year

Source: JICA Study Team

(2) Results of O&M Cost Estimation

The application of the train costing model yielded the results shown in Table 10-14, Table 10-15, and Table 10-18, for rail services terminating at Budapur Station (Case 1), for direct rail services (Case 2A, Case 2AR and Case 2B), and for conveyor transportation at the New Budapur Station (Case 3), respectively. These results show that Case 2A/2AR and Case 3 would incur an O&M cost which is more than one fifth lower than the cost of the other alternatives since the number of train per day is four thirds bigger than the other alternatives.

Table 10-14 Railway O&M Costs for Case 1

Case1									
O&M Cost Results Regarding Railway							For Route	Per net	Per net
	(Financial)						per year	ton (Rs.)	t-km (Rs.)
O&M COSTS (Variable)							in mil. Rs.	2mil.	186.2
	Train Crews unit cost	hrs/day(one way)	No.Trains/yr *1						
Train crews	1238 x	9.7 x	2,640			=	31.8	16	0.085
	Diesel unit cost	Haul km*2	Gross ton/train incl. Loco. *3		Fuel comsumption rate				
Fuel/energy consumption	101 x	186.2 x0.5x(	2,744 +	1,224)x0.001x	3.0 x	2,640 =	295.5	148	0.794
	Locomotive OM unit cost	Haul km	Nos. Loco/train	No.Trains/yr					
Locomotive maintenance	167 x	186.2 x	2 x	2,640		=	164.3	82	0.441
	Wagon OM unit cost	Haul km	No.Trains/yr *1	No. wagon/train					
Wagon maintenance	23 x	186.2 x	2,640 x	38		=	438.7	219	1.178
	Variable track Maintenance unit cost		Gross ton/train incl. Loco. *2		No.Trains/yr *1				
Variable track maintenance	0.23 x	186.2 x0.5(	2,744 +	1,224)x	2,640	=	220.0	110	0.591
*1 No. of trip per day (one way)		Annual coal vol.	Payload/ wagon	No. of wagon/train	both way=2 x one way			both way=2 x one way	
(Min. requirement)	2,632 =	2mil.t /(	40 x	38)x	2 <	2,640 =	4 trains a day	x 330days	x 2
*2 Haul km (P.Qasim~BinQasim~Kotri~Lakhra Plant sta.):		13.0km +	131.7km +	41.5km		=	186.2		
*3 Gross tonnage per train	haul ton/train	Gross ton of Loco.	Nos. Loco/train	No. of wagon/train	Gross ton of: wagon	,Brake Van			
(forward)	2,744 =	105 x	2 +	38 x	66 +	26 =			
(back)	1,224 =	105 x	2 +	38 x	26 +	26 =			
SUB-TOTAL, O&M COST (variable)							1,150.3	575.1527	3.089
O&M COSTS (Fixed)									
	Fixed cost of infrastructure								
	Unit cost	Track-km, new	Track-km, exsting*4	Share of Traffic*3					
Fixed cost of infra. Maint.	514,675 x(	4.5 +	371 x	15%)		=	31.0	15	0.083
	Station Ope. unit cost	Haul km	Share of Traffic						
Station operating cost	882,957 x(	186.2 x	15%	)		=	24.7	12	0.066
*3	Share of Traffic	No. of Trains dispatched/ yr *1		Existing No. of trains/ yr					
	15% =	2,640 /(	2,640 +	14,954)		=	15%		
*4 Between P.Qasim-Budapur sta.(40km310) existing track-km:		370.58km +	0.49km (	40.80km : Branch pt.)		=	371km		
SUB-TOTAL, O&M COST (fixed)							55.6	28	0.149
OVERHEADS									
	1,205,937,411 x	25.6% of O&M Cost				=	309.3	155	0.830
GRAND TOTAL - FULLY ALLOCATED COST							**1,515.2**	757.6	**4.069**

Source: Railway Bulk Freight Traffic Costing Model, January 2015

Table 10-15 Railway O&M Costs for Case 2A

Case2A									
O&M Cost Results Regarding Railway	**(Financial)**						For Route per year in mil. Rs.	Per net ton (Rs.) 2mil.	Per net t-km (Rs.) 191.8
O&M COSTS (Variable)									
	Train Crews unit cost	hrs/day(one way)	No.Trains/yr *1						
Train crews	1238 x	9.2 x	1,980			=	22.6	11	0.059
	Diesel unit cost	Haul km*2	Gross ton/train incl. Loco. *3		Fuel comsumption rate				
Fuel/energy consumption	101 x	191.8 x0.5x(	3,551 +	1,151)x0.001x	3.0 x	1,980 =	270.5	135	0.705
	Locomotive OM unit cost	Haul km	Nos. Loco/train	No.Trains/yr					
Locomotive maintenance	167 x	191.8 x	1 x	1,980		=	63.5	32	0.165
	Wagon OM unit cost	Haul km	No.Trains/yr *1	No. wagon/train					
Wagon maintenance	23 x	191.8 x	1,980 x	40		=	356.7	178	0.930
	Variable track Maintenance unit cost		Gross ton/train incl. Loco. *2		No.Trains/yr *1				
Variable track maintenance	0.23 x	191.8 x0.5(	3,551 +	1,151)x	1,980	=	201.4	101	0.525
*1 No. of trip per day (one way)		Annual coal vol.	Payload/ wagon	No. of wagon/train	both way=2 x one way				both way=2 x one way
(Min. requirement)	1,668 =	2mil.t /(	60 x	40)x	2 <	1,980 =	3 trains a day	x 330days	x 2
*2 Haul km (P.Qasim~BinQasim~Kotri~Lakhra Plant sta.):		13.0km +	131.7km +	47.1km		=	191.8		
*3 Gross tonnage per train	haul ton/train	Gross ton of Loco.	Nos. Loco/train	No. of wagon/train	Gross ton of: wagon	,Brake Van			
(forward)	3,551 =	126 x	1 +	40 x	85 +	25 =			
(back)	1,151 =	126 x	1 +	40 x	25 +	25 =			
SUB-TOTAL, O&M COST (variable)							914.8	457.4	2.385
O&M COSTS (Fixed)									
	Fixed cost of infrastructure								
	Unit cost	Track-km, new	Track-km, exsting*4	Share of Traffic*3					
Fixed cost of infra. Maint.	514,675 x(	42.0 +	371 x	12%)		=	43.9	22	0.115
	Station Ope. unit cost	Haul km	Share of Traffic						
Station operating cost	882,957 x(	191.8 x	12%	)		=	19.8	10	0.053
*3	Share of Traffic	No. of Trains dispatched/ yr *1		Existing No. of trains/ yr					
	12% =	1,980 /(	1,980 +	14,954)		=	12%		
*4 Between P.Qasim-Budapur sta.(40km310) existing track-km:		370.58km +	0.73km (	41.04km : Branch pt.)		=	371km		
SUB-TOTAL, O&M COST (fixed)							63.7	32	0.166
OVERHEADS									
	978,500,462 x	25.6% of O&M Cost				=	250.9	125	0.654
GRAND TOTAL - FULLY ALLOCATED COST							**1,229.4**	614.7	**3.205**

Source: Railway Bulk Freight Traffic Costing Model, January 2015

Table 10-16 Railway O&M Costs for Case 2AR

Case2AR									
O&M Cost Results Regarding Railway	**(Financial)**						For Route per year in mil. Rs.	Per net ton (Rs.) 2mil.	Per net t-km (Rs.) 191.8
O&M COSTS (Variable)									
	Train Crews unit cost	hrs/day(one way)	No.Trains/yr *1						
Train crews	1238 x	9.2 x	1,980			=	22.6	11	0.059
	Diesel unit cost	Haul km*2	Gross ton/train incl. Loco. *3		Fuel comsumption rate				
Fuel/energy consumption	101 x	191.8 x0.5x(	3,551 +	1,151)x0.001x	3.0 x	1,980 =	270.5	135	0.705
	Locomotive OM unit cost	Haul km	Nos. Loco/train	No.Trains/yr					
Locomotive maintenance	167 x	191.8 x	1 x	1,980		=	63.5	32	0.165
	Wagon OM unit cost	Haul km	No.Trains/yr *1	No. wagon/train					
Wagon maintenance	23 x	191.8 x	1,980 x	40		=	356.7	178	0.930
	Variable track Maintenance unit cost		Gross ton/train incl. Loco. *2		No.Trains/yr *1				
Variable track maintenance	0.23 x	191.8 x0.5(	3,551 +	1,151)x	1,980	=	201.4	101	0.525
*1 No. of trip per day (one way)		Annual coal vol.	Payload/ wagon	No. of wagon/train	both way=2 x one way				both way=2 x one way
(Min. requirement)	1,668 =	2mil.t /(	60 x	40)x	2 <	1,980 =	3 trains a day	x 330days	x 2
*2 Haul km (P.Qasim~BinQasim~Kotri~Lakhra Plant sta.):		13.0km +	131.7km +	47.1km		=	191.8		
*3 Gross tonnage per train	haul ton/train	Gross ton of Loco.	Nos. Loco/train	No. of wagon/train	Gross ton of: wagon	,Brake Van			
(forward)	3,551 =	126 x	1 +	40 x	85 +	25 =			
(back)	1,151 =	126 x	1 +	40 x	25 +	25 =			
SUB-TOTAL, O&M COST (variable)							914.8	457.4	2.385
O&M COSTS (Fixed)									
	Fixed cost of infrastructure								
	Unit cost	Track-km, new	Track-km, exsting	Share of Traffic					
Fixed cost of infra. Maint.	514,675 x(	26.1 +	263 x	8%		=	34.4	17	0.090
		+	11 x	27% +	30 x	57.6%)			
	Station Ope. unit cost	Haul km	Weighted share						
Station operating cost	882,957 x(	191.8 x	20%	)		=	34.4	17	0.092
SUB-TOTAL, O&M COST (fixed)							68.8	34	0.179
OVERHEADS									
	983,574,389 x	25.6% of O&M Cost				=	252.2	126	0.658
GRAND TOTAL - FULLY ALLOCATED COST							**1,235.8**	617.9	**3.222**

Source: Railway Bulk Freight Traffic Costing Model, January 2015

Table 10-17 Railway Operation Costs for Case 2B

Case2B									
O&M Cost Results Regarding Railway							For Route per year	Per net ton (Rs.)	Per net ton-km
	(Financial)								
O&M COSTS (Variable)							in mil. Rs.	2mil.	191.8
	Train Crews unit cost	hrs/day(one way)	No.Trains/yr *1						
Train crews	1238 x	9.1 x	2,640			=	29.8	15	0.080
	Diesel unit cost	Haul km*2	Gross ton/train incl. Loco. *3		Fuel comsumption rate				
Fuel/energy consumption	101 x	191.8 x0.5x(	2,705 +	1,185)x0.001x	3.0 x	2,640 =	298.4	149	0.801
	Locomotive OM unit cost	Haul km	Nos. Loco/train	No.Trains/yr					
Locomotive maintenance	167.15 x	191.8 x	2 x	2,640		=	169.3	85	0.455
	Wagon OM unit cost	Haul km	No.Trains/yr *1	No. wagon/train					
Wagon maintenance	23.483 x	191.8 x	2,640 x	38		=	451.8	226	1.213
	Variable track Maintenance unit cost		Gross ton/train incl. Loco. *2		No.Trains/yr *1				
Variable track maintenance	0.2256 x	191.8 x0.5(	2,705 +	1,185)x	2,640	=	222.2	111	0.597
*1 No. of trip per day (one way)		Annual coal vol.	Payload/ wagon	No. of wagon/train	both way=2 x one way				both way=2 x one way
(Min. requirement)	2,632 =	2mil.t /(	40 x	38)x	2 <	2,640 =	4 trains a day	x 330days	x 2
*2 Haul km (P.Qasim~BinQasim~Kotri~Lakhra Plant sta.):		13.0km +	131.7km +	47.1km		=	191.8		
*3 Gross tonnage per train	haul ton/train	Gross ton of Loco.	Nos. Loco/train	No. of wagon/train	Gross ton of: wagon	,Brake Van			
(forward)	2,705 =	105 x	2 +	38 x	65 +	25 =			
(back)	1,185 =	105 x	2 +	38 x	25 +	25 =			
SUB-TOTAL, O&M COST (variable)							1,171.5	585.7	3.146
O&M COSTS (Fixed)									
	Fixed cost of infrastructure								
	Unit cost	Track-km, new	Track-km, exsting*4	Share of Traffic*3					
Fixed cost of infra. Maint.	514,675 x(	12.6 +	371 x	15%)		=	35.2	18	0.094
	Station Ope. unit cost	Haul km	Share of Traffic						
Station operating cost	882,957 x(	191.8 x	15%	)		=	25.4	13	0.068
*3	Share of Traffic	No. of Trains dispatched/ yr *1		Existing No. of trains/ yr					
	15% =	2,640 /(	2,640 +	14,954)		=	15%		
*4 Between P.Qasim-Budapur sta.(40km310) existing track-km:		370.58km +	0.73km (	41.04km : Branch pt.)		=	371km		
SUB-TOTAL, O&M COST (fixed)							60.6	30	0.163
OVERHEADS									
	1,232,077,820 x	25.6% of O&M Cost				=	316.0	158	0.848
GRAND TOTAL - FULLY ALLOCATED COST							**1,548.1**	774.0	**4.036**

Source: Railway Bulk Freight Traffic Costing Model, January 2015

Table 10-18 Railway O&M Costs for Case 3

Case3										
O&M Cost Results Regarding Railway								For Route per year	Per net ton (Rs.)	Per net t-km (Rs.)
	(Financial)									
O&M COSTS (Variable)								in mil. Rs.	2mil.	189.2
	Train Crews unit cost	hrs/day(one way)	No.Trains/yr *1							
Train crews	1238 x	9.1 x	1,980				=	22.3	11	0.059
	Diesel unit cost	Haul km*2	Gross ton/train incl. Loco. *3		Fuel comsumption rate					
Fuel/energy consumption	101 x	189.2 x0.5x(	3,551 +	1,151)x0.001x	3.0 x	1,980	=	266.9	133	0.705
	Locomotive OM unit cost	Haul km	Nos. Loco/train	No.Trains/yr						
Locomotive maintenance	167 x	189.2 x	1 x	1,980			=	62.6	31	0.165
	Wagon OM unit cost	Haul km	No.Trains/yr *1	No. wagon/train						
Wagon maintenance	23 x	189.2 x	1,980 x	40			=	351.9	176	0.930
	Variable track Maintenance unit cost		Gross ton/train incl. Loco. *2		No.Trains/yr *1					
Variable track maintenance	0.23 x	189.2 x0.5(	3,551 +	1,151)x	1,980		=	198.7	99	0.525
*1 No. of trip per day (one way)		Annual coal vol.	Payload/ wagon	No. of wagon/train	both way=2 x one way				both way=2 x one way	
(Min. requirement)	1,668 =	2mil.t /(	60 x	40)x	2 <	1,980	=	3 trains a day	x 330days	x 2
*2 Haul km (P.Qasim~BinQasim~Kotri~Lakhra Plant sta.):		13.0km +	131.7km +	44.5km			=	189.2		
*3 Gross tonnage per train	haul ton/train	Gross ton of Loco.	Nos. Loco/train	No. of wagon/train	Gross ton of: wagon	,Brake Van				
(forward)	3,551 =	126 x	1 +	40 x	85 +	25	=			
(back)	1,151 =	126 x	1 +	40 x	25 +	25	=			
SUB-TOTAL, O&M COST (variable)								902.3	451.1	2.385
O&M COSTS (Fixed)										
	Fixed cost of infrastructure									
	Unit cost	Track-km, new	Track-km, exsting*4	Share of Traffic*3						
Fixed cost of infra. Maint.	514,675 x(	38.0 +	374 x	12%)			=	42.0	21	0.111
	Station Ope. unit cost	Haul km	Share of Traffic							
Station operating cost	882,957 x(	189.2 x	12%	)			=	19.5	10	0.052
*3	Share of Traffic	No. of Trains dispatched/ yr *1		Existing No. of trains/ yr						
	12% =	1,980 /(	1,980 +	14,954)			=	12%		
*4 Between P.Qasim-Budapur sta.(40km310) existing track-km:		370.58km +	3.39km (	43.70km : Branch pt.)			=	374km		
SUB-TOTAL, O&M COST (fixed)								61.6	31	0.163
OVERHEADS										
	963,874,317 x	25.6% of O&M Cost					=	247.2	124	0.653
GRAND TOTAL - FULLY ALLOCATED COST								**1,211.1**	605.5	**3.200**

Source: Railway Bulk Freight Traffic Costing Model, January 2015

10.3 Revenue Estimates

10.3.1 Regression Analysis

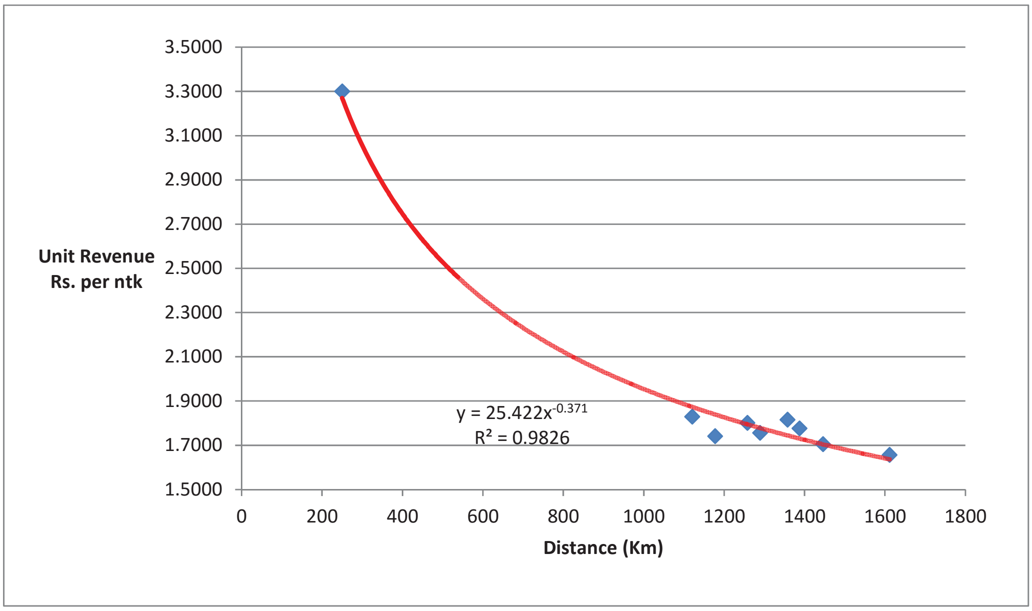
The revenue unit price will be discussed between contractors in the further stage and in this study, the unit price is assumed to be the actual unit price in use.

The unit revenue rates likely to be applied by PR to the Port Qasim to Lakhra coal traffic were calculated by regressing the unit rates (i.e., rate in PKR per net ton-km) applicable to nine existing coal routes against haul distance. The distances and unit revenue for all nine routes are given in Table 10-19 while the regression analysis is given in Figure 10-1.

Table 10-19 Unit Revenues and Haul Distances for Nine Existing Rail Routes

From	To	Rs.per tonne	Km	Rs per ntk*
Karachi Pt	Khonot	825	250	3.3000
Karachi Pt	Chak Jumrha	2050	1121	1.8287
Karachi Pt	Ghribwal (1)	2465	1358	1.8152
Karachi Pt	Ghribwal (2)	2265	1258	1.8005
Karachi Pt	Ghribwal (3)	2465	1388	1.7759
Karachi Pt	Lala Musa Jn	2265	1290	1.7558
Karachi Pt	Eaiwind	2050	1178	1.7402
Karachi Pt	Ghribwal (4)	2465	1446	1.7047
Karachi Pt	Kohat Cantt	2670	1612	1.6563
			* net tonne-km	

Source: PR Head Office, Cost of Goods Trains 2013-14



Source: PR Head Office, Cost of Goods Trains 2013-14

Figure 10-1 Regression of Unit Revenue Against Distance

As shown in Figure 10-1, a regression coefficient (R^2) of more than 0.98 was obtained, indicating a very close correlation between the unit revenue and distance for existing coal hauls. When the distances (x) relating to the cases of direct rail haul and haul terminating at Budapur Station are inserted in the function $y = 25.422x^{-0.371}$, the respective unit revenues of PKR 3.67, PKR 3.62, and PKR 3.64 per net ton-km are derived.

10.3.2 Comparison of Revenues and O&M Costs

The comparison of revenues and costs for all operating cases is shown in Table 10-20. The revenue less O&M cost per ton is negative for Case 1 and Case 2B. Similarly, for Case 2A, Case 2AR, and Case 3, the amount of revenue is less for covering the railway O&M cost.

Table 10-20 Revenues vs. O&M Costs for Five Railway Operating Cases

Item	Case 1	Case 2A	Case2AR	Case 2B	Case 3
Rail haul distance (Km): *x*	186.20	191.80	191.80	191.80	189.20
Unit Revenue (Rs./ton-km): *y**	3.66	3.62	3.62	3.62	3.63
Revenue per ton (Rs.)	**680.81**	**693.62**	**693.62**	**693.62**	**687.69**
Unit O&M cost (Rs./ton-km)	4.12	3.27	3.22	4.09	3.26
O&M Financial cost per ton (Rs.)	**766.72**	**626.49**	**617.91**	**785.10**	**617.55**
Revenue less O&M cost per ton (Rs.)	**-85.91**	**67.13**	**75.71**	**-91.48**	**70.14**
Annual revenue for 2 million tpa - Rs mill.	**1361.62**	**1387.24**	**1387.24**	**1387.24**	**1375.38**
Annual O&M financial cost for 2 mil. tpa - Rs mill.	**1533.44**	**1252.98**	**1235.82**	**1570.20**	**1235.11**

Note: Unit revenue is calculated using the estimated formula in the report: $^{*}y=25.422\,x^{-0.371}$
Source: JICA Study Team

10.3.3 Renewal of Open-top Container

Although locomotives and wagons can be used for 30 years, open-top containers cannot be used for long period. Here, the container life is assumed at five years and it was considered in the railway O&M cost in Case 1.

10.4 Unloading O&M Cost Summary

The O&M costs of railway personnel, equipment, and facilities within Budapur Yard or Lakhra Power Plant Station are not included in the following tables. These O&M costs are included in the transportation cost of each case.

The O&M costs for 30 years for the unloading works are estimated to calculate the life cycle costs.

10.4.1 Case 1: Dump Truck System

Table 10-21 Summary of Unloading O&M Cost Estimate of Case 1 for 30 Years

No.	Work Item	Quantity	Unit	No. of Renewal/ MM	Unit Cost (in Rs.)	Total Cost (Rs. In Million)
	Personnel Expenses					
1	Chief Drivers (Dump truck)	3	psn	360	91,000	98.3
2	Drivers (Dump truck)	90	psn	360	77,000	2,494.8
3	Operators for Reach Stacker	6	psn	360	100,000	216.0
4	Security for Budapur yard	36	psn	360	39,000	505.4
	Operation and Maintenance					
5	Renewal of dump trucks	15	no.	5	6,732,000	504.9
6	Renewal of reach stackers	3	no.	2	102,600,000	615.6
	Fuel and electricity					
7	Diesel oil	57,497	ltr	360	100	2,069.9
8	Tax (LC=17%)	30	year	17%		915.4
	Tax (FC=22%)	30	year	22%		246.5
	Total					7,666.8

*Diesel Oil	5,714	Requirement of coal/ day (2mtpa, 350days)
Quantities	286	No. of shuttles/ day (20t dump trucks)
detail	15	Distance of drive in km/ shuttle
	4,286	Total distance of driv/ day
	2.17	Fuel expenses in km/ Litter
	29.2	No.of days for a month
		(350days assumed for a year)

Source: JICA Study Team

10.4.2 Case 2A and Case 2AR: Spur Line with Additional Line

Table 10-22 Summary of Unloading O&M Cost Estimate of Case 2A and Case 2AR for 30 Years

No.	Work Item	Quantity	Unit	No. of Renewal/ MM	Unit Cost (in Rs.)	Total Cost (Rs. In Million)
	Personnel Expenses					
1	Engineer	2	psn	360	104,000	74.9
2	Unloading operator	20	psn	360	39,000	280.8
3	Railway Operator for train shunting	2	psn	360	117,000	84.2
4	Assistant for railway operator	2	psn	360	39,000	28.1
5	Tax (LC=17%)	30	year	17%		79.6
	Total					547.6

Source: JICA Study Team

10.4.3 Case 2B: Spur Line Using Existing Line

Table 10-23 Summary of Unloading O&M Cost Estimate of Case 2B for 30 Years

No.	Work Item	Quantity	Unit	No. of Renewal/ MM	Unit Cost (in Rs.)	Total Cost (Rs. In Million)
	Personnel Expenses					
1	Engineer	3	psn	360	104,000	112.3
2	Unloading operator	30	psn	360	39,000	421.2
3	Railway Operator for train shunting	3	psn	360	117,000	126.4
4	Assistant for railway operator	3	psn	360	39,000	42.1
5	Tax (LC=17%)	30	year	17%		119.3
	Total					821.3

Source: JICA Study Team

10.4.4 Case 3: Conveyor Belt System

Table 10-24 Summary of Unloading O&M Cost Estimate of Case 3 for 30 Years

No.	Work Item	Quantity	Unit	No. of Renewal/ MM	Unit Cost (in Rs.)	Total Cost (Rs. In Million)
	Personnel Expenses					
1	Security for conveyor belt system	22	psn	360	39,000	308.9
2	Engineer	2	psn	360	104,000	74.9
3	Unloading operator	20	psn	360	39,000	280.8
4	Renewal of belt and roller	5000	no.	6	50,000	1,500.0
5	Renewal of motors for conveyor	2	no.	2	10,000,000	40.0
	Fuel and electricity					
6	Electric power consumption		kW			360.0
	Tax (LC=17%)	30	year	17%		174.2
	Tax (FC=22%)	30	year	22%		338.8
	Total					3,077.5

Source: JICA Study Team

For the personnel expenses, 1) engineer, 2) unloading operators, and 3) security are considered.

It is assumed that the three trains per day operation needs three shifts and lower works are necessary for three trains per day operation. Here, three shifts and two shifts are considered for the unloading works. One shift is composed of one engineer and ten operators. In order to reduce the risk of coal theft, it is recommended to allocate security guards at every 200 m along the belt conveyor lines for 24 hours operation (8 hours × 3 shifts) with 11 persons in a shift.

For the maintenance expense, it is assumed that belts and rollers are replaced every five years and motor for belt is replaced every ten years. For the electric power supply, power factor of 0.8 and 350 day-operation are assumed.

It should be noted that the O&M cost for unloading is not included in the financial analysis for the railway portion since the responsibility of railway transportation is between yards.

10.5 Summary of Life Cycle Costs

The entire life cycle cost is summarized in Table 10-25 below.

Table 10-25 Summary of Life Cycle Costs

Case	Case 1	Case 2A	Case 2AR	Case 2B	Case 3
Cost Item	Container Train + Dump trucks	Hopper Wagon Train Direct Access With Additional Track	Hopper Wagon Train Direct Access With Track Upgrading	Hopper Wagon Train Direct Access Without Additional Track	Hopper Wagon Train + Conveyor Belt System
Initial Cost	18,264	42,663	37,411	35,627	25,729
Railway O&M Cost (30 years)	52,203	37,589	37,075	47,106	37,053
Life Cycle Cost of Railway Portion	70,467	80,252	74,485	82,733	62,782
Unloading O&M Cost (30 years)	7,667	548	548	821	3,078
Life Cycle Cost of Railway and Unloading Portion	78,134	80,800	75,033	83,555	65,860

Source: JICA Study Team

10.6 Case Study: Construction Cost Estimate of Railway Access to PIBT

Since the Pakistan International Bulk Terminal Limited (PIBT) had planned the direct connection of the railway from the PR main line to PIBT for coal transportation, the following analysis was prepared based on the idea to fulfill the direct railway connetion. However, because of the difficulty of direct connection due to the topographic condition as detailed in Clause 6.2.2, another study of coal transportation from PIBT to the PR main line is underway. Thus, the coal transportation method and cost estimate shall be referred to the relevant study result.

10.6.1 Precondition of the Cost Estimate

The construction cost estimate of the railway access to PIBT is prepared based on the following preconditions:

- Direct access of railway from Bin Qasim Station to PIBT. The spur line shall be double track equipped with appropriate signaling system.
- Coal loading operation at PIBT will be 330 days per year, and working hour shall be as required.
- Based on the future plan of PIBT, 20 million tons of coal to be delivered (assuming 14 million tons to Punjab Province and 6 million tons to Jamshoro and Lakhra) annually.
- Payload of 60 ton wagons (axle load of 23.3 tons) to be used for Punjab Province (60 tons x 40 wagons = 2,400 tons/train, hereinafter referred to as Heavy Train). Payload of 40 ton wagons (axle load of 17.27 tons) to be used for Jamshoro and Lakhra power plants (40 tons x 38 wagons = 1,520 tons/train, hereinafter referred to as Light Train).
- Coal train will not be broken for coal loading operation.
- Land acquisition cost is excluded. (Because of the lack of detailed topographic data, the required space for the construction could not be assumed.)

10.6.2 Coal Loading Operation at PIBT

(1) Coal Train to Punjab Province

In order to transport 14 million tons of coal to Punjab Province, daily output from PIBT shall be;

- 14,000,000 tons / 330 days = 42,500 tons/day

The required number of coal train is:

- 42,500 tons/day / 2400 tons/train = 17.7 = 18 trains/day

(2) Coal Train to Jamshoro and Lakhra

In order to transport 6 million tons of coal to Jamshoro and Lakhra power plants, the daily output from PIBT shall be:

- 6,000,000 tons / 330 days = 18,200 tons/day

The required number of coal train/day is:

- 18,200 tons/day / 1,520 tons/train = 12 trains/day

10.6.3 Time Required for Coal Loading

Coal trains shall be waiting at the stabling yard nearby PIBT. Therefore, the time required for coal loading is counted from the time when the train is leaving from the stabling yard until the time it is leaving the PIBT yard. The time required for the 60 ton wagon case is shown in Table 10-26.

Table 10-26 Coal Loading Time of Heavy Train

No.	Item	Time (min.)	Remarks
1	Running from stabling yard to coal loading track	10	
2	Coal loading	80	2 min./wagon x 40 wagons
3	Running from coal loading track	10	
	Total	100	

Note: Coal loading time may vary depending on the coal loading system.
Source: JICA Study Team

The time required for the Light Train case is shown in Table 10-27.

Table 10-27 Coal Loading Time of Light Train

No.	Item	Time (min.)	Remarks
1	Running from stabling yard to coal loading track	10	
2	Coal loading	76	2 min./wagon x 38 wagons
3	Running from coal loading track	10	
	Total	96	

Note: The difference of loading time between 60 ton and 40 ton-wagons is few seconds only.
Source: JICA Study Team

The total time required for Heavy Train per day is:

- 18 trains/day x 100 min/train = 1,800 min = 30 hrs

The total time required for Light Train per day is:

- 12 trains/day x 96 min/train = 1,152 min = 19 hrs, 12 min
  - Total: 1,800 min + 1,152 min = 2,952 min = 49 hrs, 12 min

Thus, a total of 49 hrs and 12 min will be required by one unit of coal loading system. This means that even two units of coal loading system operating at 24 hrs cannot clear the requirements. When providing three sets of coal loading system, each system needs to operate for 16 hrs and 24 min per day.

- 2,952 min / 3 = 984 min = 16 hrs, 24 min

10.6.4 Construction Cost Estimate

In order to achieve the abovementioned operation, the following facilities and equipment will be required:

(1) Port Facilities and Equipment

- Coal Loading Facilities and Equipment: Additional 2 sets (Total of 3 sets)
- Corridor to Marshalling Yard: L 820 m x W 40 m
- Marshalling Yard adjacent to PIBT: L 1,516 m x W 110 m

(2) Railway Facilities

- Double track spur line from Bin Qasim Station to PIBT Marshalling Yard including cut and cover tunnel, deep cut section, and flyover of local road.
- Track work on the corridor to the marshalling yard: Double track
- Track work in the marshalling yard adjacent to PIBT: 14 tracks including 2 arriving and departure tracks and 2 engine turning tracks. 10 tracks are for stabling.
- Signaling system for coal train operation between Bin Qasim and PIBT

10.6.5 Cost Estimate for Additional Facilities to PIBT and Rail Access

The estimated construction cost based on the preconditions is summarized in Table 10-28.

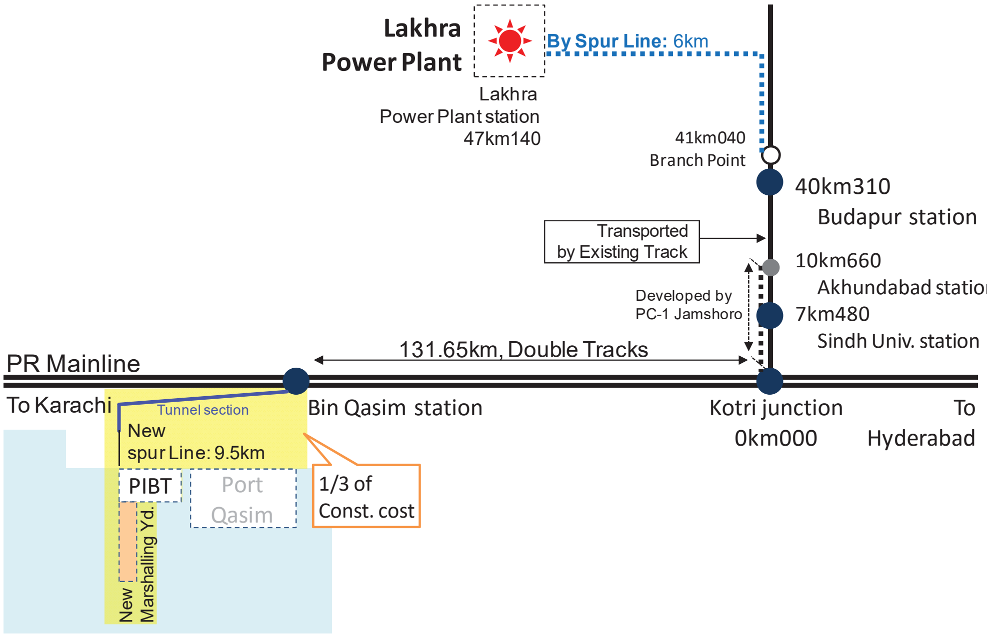
Table 10-28 Construction Cost Estimate

No.	Item	Unit	Unit Cost (x 1,000 PKR) In FY 2016 basis	Qty	Total Cost (x 1,000 PKR)	Remarks
1	PIBT Facilities and Equipment					
1.1	Additional coal loading facilities	unit	447,746	2	895,491	Additional facilities
1.2	Corridor to marshalling yard	m^2	9	32,800	293,721	Reclamation for new structure
1.3	Marshalling yard	m^2	9	166,760	1,493,321	ditto
Sub-total of 1					2,682,533	
2	Railway Structures and Facilities					
2.1	Double track between Bin Qasim Station and PIBT Marshalling Yard	km	71,446	10	678,738	FC 42.3%
2.2	Cut and cover tunnel	m^2	3,358	4,796	16,105,409	
2.3	Deep cut approach section	m^2	1,119	2,044	2,287,980	
2.4	Track work in marshalling yard	m^2	36	13,356	477,117	FC 42.3%
2.5	Track work on the corridor	m^2	36	1,644	58,729	FC 42.3%
2.6	Additional track for coal loading	m^2	54	1,800	97,427	FC 42.3%
2.7	Turnout #8	unit	7,257	29	210,446	FC 100%
2.8	Scissors crossing	unit	45,889	1	45,889	FC 100%
2.9	Weigh bridge	unit	55,968	1	55,968	
2.10	Signaling work	unit	335,809	1	335,809	
2.11	Flyover of local road	unit	895,491	1	895,491	
2.12	Utility relocation	Unit	111,936	1	111,936	
Sub-total of 2					21,360,941	
3					1,923,478	
3.1	Consulting fee			8%	7,521,596	Assumed 8% of 1+2
3.2	Price escalation				1,674,427	5.9%(LC) and 1.8%(FC) per annum
3.3	Contingencies			5%		Assumed 5% of 1+2+3.1+3.2
3.4	Tax				5,814,825	
3.4.1	Tax (Local component: 17%)			17%	210,787	
3.4.2	Tax (Foreign component: 22%)			22%	1,923,478	
Sub-total of 3					17,145,113	
Total of 1 + 2 + 3					41,188,587	

Source: JICA Study Team

10.6.6 Estimated Cost for Lakhra Power Plant Project

Although it is possible that PIBT will be used by the Lakhra Power Plant, Jamshoro, and Sahiwal K-Electric, in this case study, it is assumed that cost demarcation for Lakhra Power Plant is one third for conservative consideration. This is equivalent to 2 million tons of coal per year for the Lakhra Power Plant divided by 6 million tons per year of required coal for both Lakhra and Jamshoro. The transportation system in this case study is shown in Figure 10-2. The system between Bin Qasim Station and Lakhra Power Plant is similar to that of Case 2AR in this report.



Source: JICA Study Team

Figure 10-2 Transportation System in the Case Study

The construction cost estimate and railway O&M cost are shown in Table 10-29 and Table 10-30, respectively. As mentioned above, the railway O&M cost between PIBT and PR main line is one third of the total O&M cost.

Table 10-29 Major Component of Construction Cost Estimate of Additional Facilities to PIBT and Rail Access

No.	Item	LC	FC	Total
1	PIBT Facilities and Equipment	2,683	0	2,683
2	Railway Structures and Facilities	20,575	786	21,361
3	Consulting Fee	1,861	63	1,923
4	Price Escalation	7,457	64	7,522
5	Contingencies	1,629	46	1,674
6	Tax	5,815	211	6,026
7	Total of 1 to 6	40,020	1,169	41,189
8	Cost for Lakhra Power Plant: (7) x 3/1	13,340	390	13,730
9	Total Initial Cost of Case 2AR	26,381	11,029	37,411
	Grand Total (8)+(9)	39,721	11,419	51,140

Note: All units in million PKR. The required land should be determined in the further study; however, it has small impact on the overall cost thus land acquisition cost is not included in the table.
Source: JICA Study Team

Table 10-30 Railway O&M Cost Estimate in the Case Study

Case2AR-alt									
O&M Cost Results Regarding Railway							For Route	Per net	Per net
	(Financial)						per year	ton (Rs.)	ton-km
O&M COSTS (Variable)							in mil. Rs.	2mil.	9.5
	Train Crews unit cost	hrs/day(one way)	No.Trains/yr *1						
Train crews	1238 x	9.2 x	1,980			=	22.6	11	1.191
	Diesel unit cost	Haul km	Gross ton/train incl. Loco. *2		Fuel comsumption rate				
Fuel/energy consumption	101	x(178.8 + 9.5 /3) x0.5x (	3,551 +	1,151)x0.001x	3.0 x	1,980 =	256.7	128	13.508
	Locomotive OM unit cost	Haul km	Nos. Loco/train	No.Trains/yr					
Locomotive maintenance	167.15	x(178.8 + 9.5 /3) x	1 x	1,980		=	60.2	30	3.170
	Wagon OM unit cost	Haul km	No.Trains/yr *1	No. wagon/train					
Wagon maintenance	23.483	x(178.8 + 9.5 /3) x	1,980 x	40		=	338.4	169	17.812
	Variable track Maintenance unit cost		Gross ton/train incl. Loco. *2		No.Trains/yr *1				
Variable track maintenance	0.2256	x(178.8 + 9.5 /3) x0.5(	3,551 +	1,151)x	1,980	=	191.1	96	10.057
*1 No. of trip per day (one way)		Annual coal vol.	Payload/ wagon	No. of wagon/train	both way=2 x one way			both way=2 x one way	
(Min. requirement)	1,668 =	2mil.t /(	60 x	40)x	2 <	1,980 =	3 trains a day	x 330days	x 2
*2 Haul km (P.Qasim~BinQasim~Kotri~Lakhra Plant sta.):		9.5km +	131.7km +	47.1km		=	9.5	+178.8=	188.3
*2 Gross tonnage per train	haul ton/train	Gross ton of Loco.	Nos. Loco/train	No. of wagon/train	Gross ton of: wagon	,Brake Van			
(forward)	3,551 =	126 x	1 +	40 x	85 +	25 =			
(back)	1,151 =	126 x	1 +	40 x	25 +	25 =			
SUB-TOTAL, O&M COST (variable)							869.0	435	46
O&M COSTS (Fixed)									
	Fixed cost of infrastructure								
	Unit cost	Track-km, new	Track-km, exsting	Share of Traffic					
Fixed cost of infra. Maint.	514,675	x ((13.08 + 35.8 /3) +	263 x	7.9%)		=	33.9	17	1.784
		+	10.66 x	26.8% +	30 x	57.6%)			
	Station Ope. unit cost	Haul km	Weighted share						
Station operating cost	882,957	x(178.8 + 9.5 /3) x	25%	)		=	40.9	20	2.152
SUB-TOTAL, O&M COST (fixed)							74.8	37	3.936
OVERHEADS									
	944 x	25.6% of O&M Cost				=	242.0	121	12.739
GRAND TOTAL - FULLY ALLOCATED COST							**1,185.9**	592.9	**62.413**

Source: JICA Study Team

10.6.7 Map and Drawings

(1) Railway Access to PIBT and Additional Facilities

The railway access to PIBT and the additional facilities of PIBT are shown in Figure 10-3 below.

Source: Google Earth

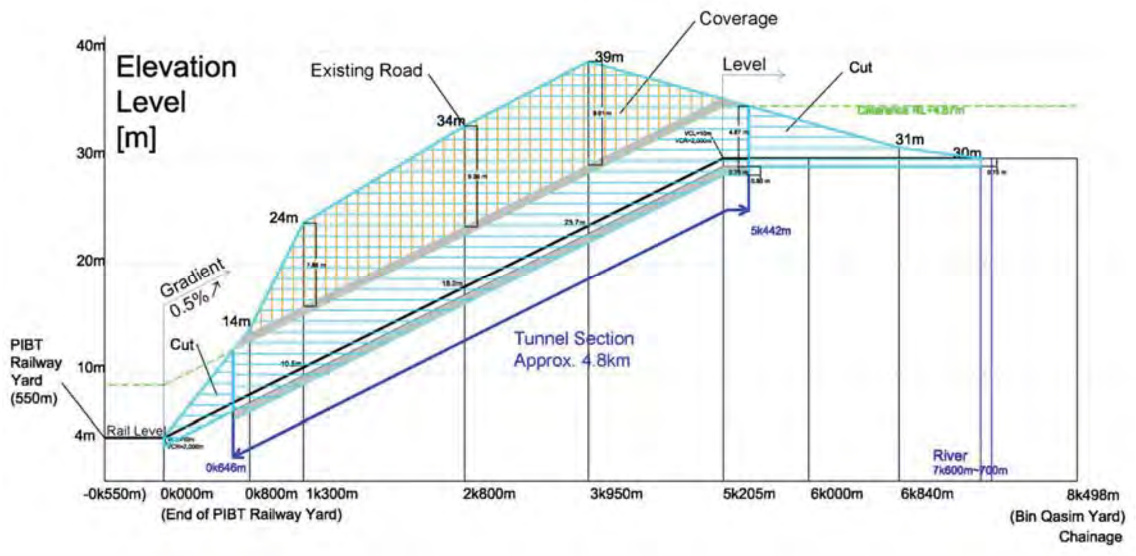
Figure 10-3 Additional Facilities to PIBT and Rail Access

The planned PIBT Marshalling (Stabling) Yard has 14 tracks including 2 engine turning tracks as detailed in Figure 10-3. The outline of the marshalling yard is shown in Figure 10-4.

Source: Google Earth

Figure 10-4 Planned Marshalling Yard

The existing ground level between PIBT and Bin Qasim Station and the planned tunnel section are shown in Figure 10-5.

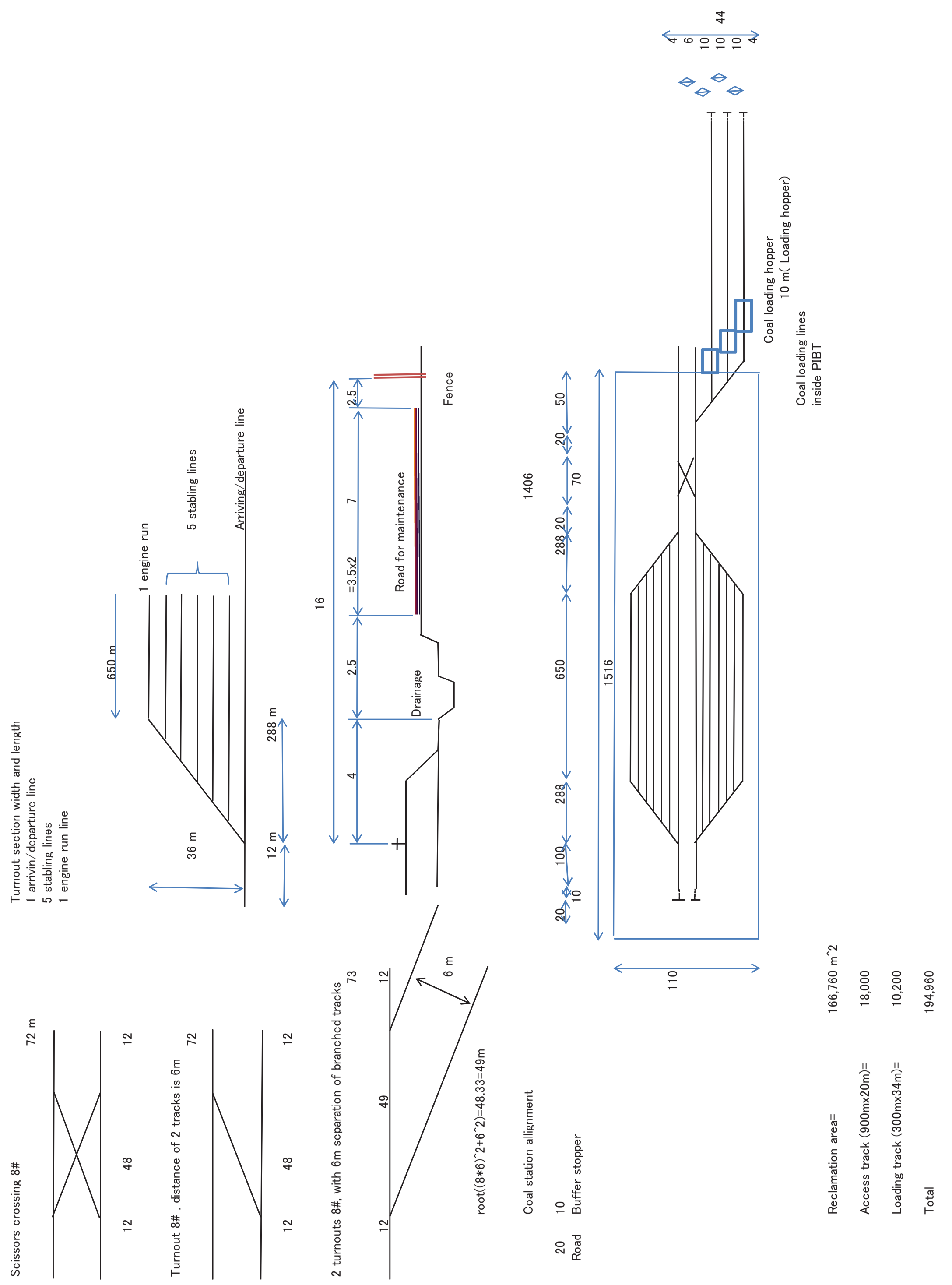


Source: JICA Study Team

Figure 10-5 Schematic Drawing of Tunnel Section

(2) Track Layout in PIBT Marshalling Yard

The track layout in the PIBT Marshalling Yard and the coal loading tracks are shown in Figure 10-6 below.



Source: JICA Study Team

Figure 10-6 Track Layout in PIBT Marshalling Yard

10.7 Financial Viability of the Preferred Project Case

The railway project's financial internal rate of return (FIRR) shall be included in the FIRR of the Lakhra Power Plant Project and not only for the railway portion. In addition, in the economic evaluation, the economic internal rate of return (EIRR) will be calculated for the Lakhra Coal Fired Thermal Power Plant Construction Project since the benefit from the railway could not be considered without involving the power plant project.

For reference, Appendix 8 estimates the railway tariff under several scenarios of FIRR hurdle rates

Chapter 11 Environmental and Social Impact

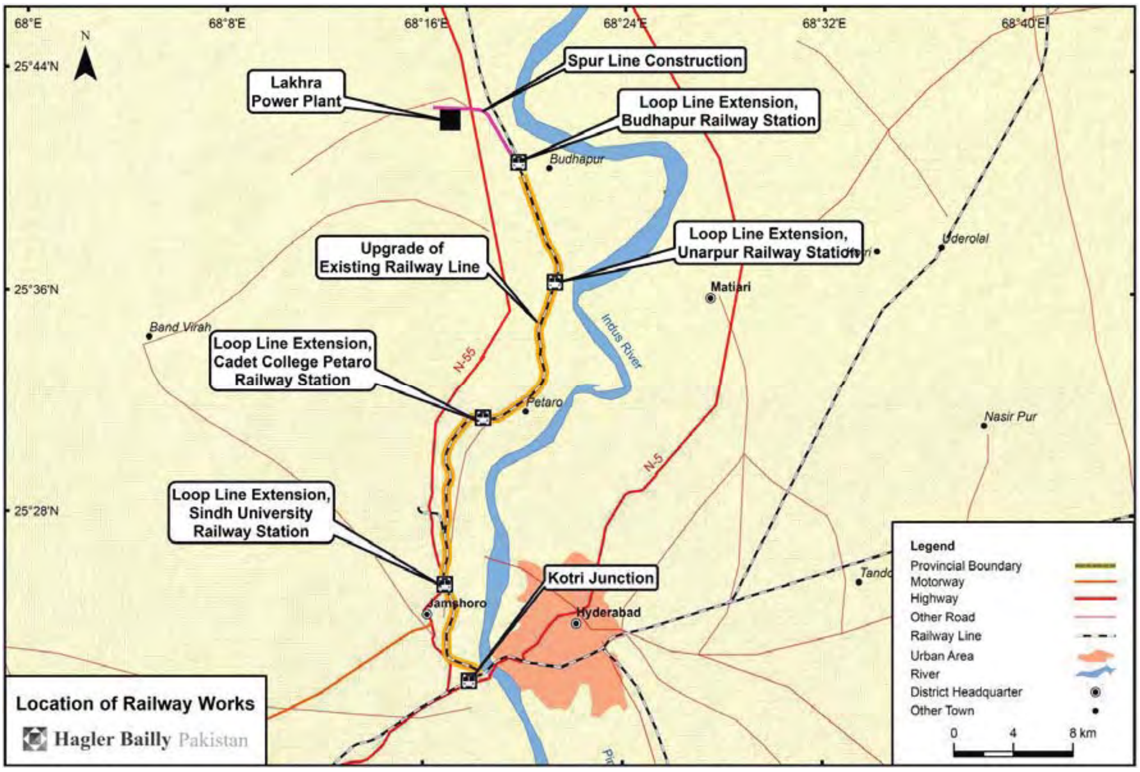
11.1 Outline of the Project Components

The sub-bituminous coal will be imported via Port Qasim and will then be transported to the proposed Lakhra Power Plant site through rail, and this includes several components. The main components of this project are the following:

- Extension of existing loop lines at Budapur, Unarpur, Cadet College Petaro, and Sindh University stations;
- Construction of the spur line from Budapur Railway Station to the power plant;
- Upgrade of existing railway track between Kotri Junction and Budapur Station; and
- Operation of coal trains from Bin Qasim Station, on the main PR line, to the proposed power plant via Kotri Junction.

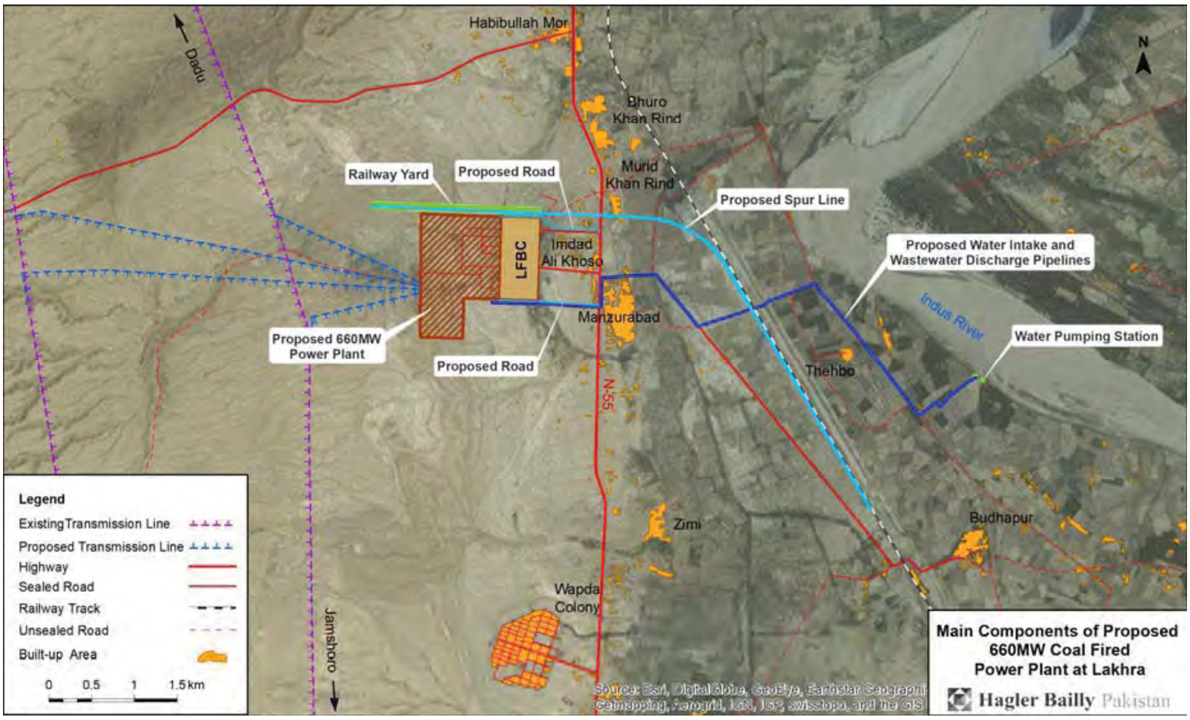
11.1.1 Project Location

The locations of the proposed project are shown in Figure 11-1 and Figure 11-2.



Source: Hagler Bailly Pakistan

Figure 11-1 Location of Project Components



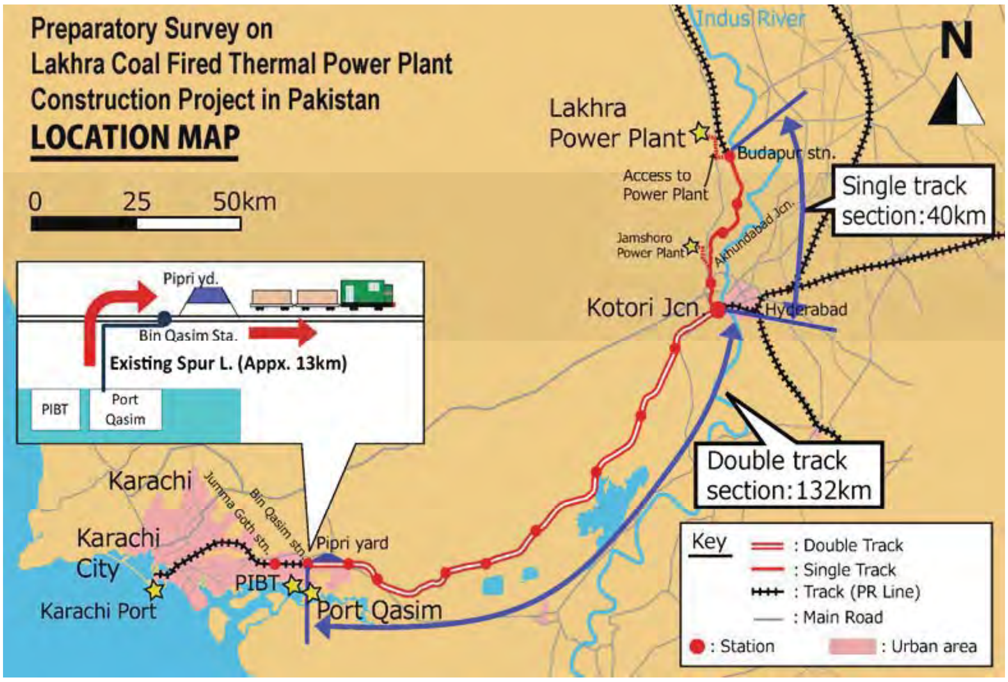
Source: Hagler Bailly Pakistan

Figure 11-2 Location Map of the Proposed Spur Line

11.1.2 The Description of Coal Transportation Route

The proposed route for coal transportation is shown in Figure 11-3. The coal from Port Qasim will arrive at the Bin Qasim Station on the main Karachi to Peshawar Railway Line. It will be transported to Kotri Junction on this line. From Kotri it will take the Kotri to Dadu line to Budapur Railway Station.

Between Bin Qasim Station and Budapur Station there are 13 stations, hence, 14 segments. The total distance between Bin Qasim and Budapur is 171.96 km.



Source: JICA Study Team

Figure 11-3 Coal Transportation Route

11.1.3 Scope of Impacts to be Assessed in this Chapter

The scope of environmental and social impact assessment includes: 1) construction of the additional loop lines, 2) upgrade of railway track, 3) construction of the spur line, and 4) transportation of coal from Bin Qasim to the proposed power plant.

11.2 Basic Situation of Environment and Society

11.2.1 Environmental Status

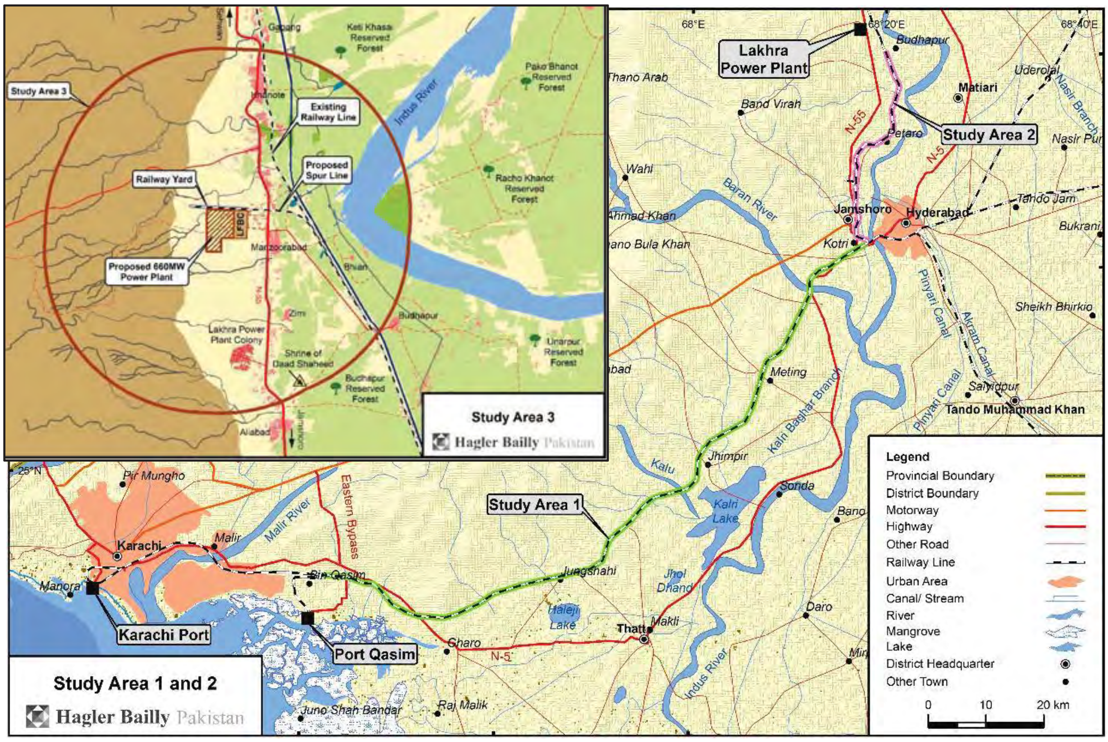
(1) Area of Influence

The potential impacts of the Project on its surrounding physical and biological environments depend on the sensitive receptors present in the area. For the purpose of the baseline, the following areas have been considered:

Segment 1: The train route from Bin Qasim Station to Kotri. The only activity on this route will be transportation of coal to the power plant. (**Study Area 1**)

Segment 2: The train route from Kotri to Budapur. The route will be upgraded to a 23.3-ton axle weight by rehabilitating the existing 17.27-ton track. The extension of the loop lines at four stations will take place on this route and coal for the power plant will be transported. (**Study Area 2**)

Segment 3: The proposed plant site and its surroundings. This is where the construction activity on the spur line will take place and where the coal will be unloaded. (**Study Area 3**)



Source: Hagler Bailly Pakistan

Figure 11-4 Study Areas

(2) Water Resources

Major water bodies in the study area include the Indus River, the Kalri–Bhaghiar Feeder Canal from Kotri Barrage on the Indus River, and the under construction right bank outfall drain (RBOD). Groundwater is not a major source of drinking water in the study area due to its high salinity. Two lakes, the Kalri Lake and the Haleji Lake, are located in Thatta District. These bodies of water are important bird staging areas.

(3) Air Quality

Other than the existing Lakhra Fluidized Bed Combustion Power Station (LFPS), there are no major stationary sources of gaseous emission in the study area. The main non–stationary source is the N–55 (Indus Highway) that passes close to the plant. Beyond the study area, the main sources of emission are the following:

- Jamshoro Thermal Power Station (JTPS) which is 25 km south of the existing LFPS; and
- Lakhra Coalfield which is 10-25 km to the west and northwest of the plant site.

Emissions from these sources consist of oxides of nitrogen (NOx), sulfur dioxide (SO_2), carbon monoxide (CO), and particulate matters.

According to the ambient air quality study conducted in Study Area 3 from 14 February 2014 to 8 March 2014, the following results were confirmed:

- The observed values of all gaseous pollutants (SO_2, NO, and NO_2) are well within the corresponding maximum value set by the Sindh Environmental Quality Standards (SEQS) for ambient air quality and ambient air quality guidelines of the International Finance Corporation (IFC).
- Particulate matter, both PM_{10} and $PM_{2.5}$, at most of the locations generally exceed SEQS and IFC guidelines values.

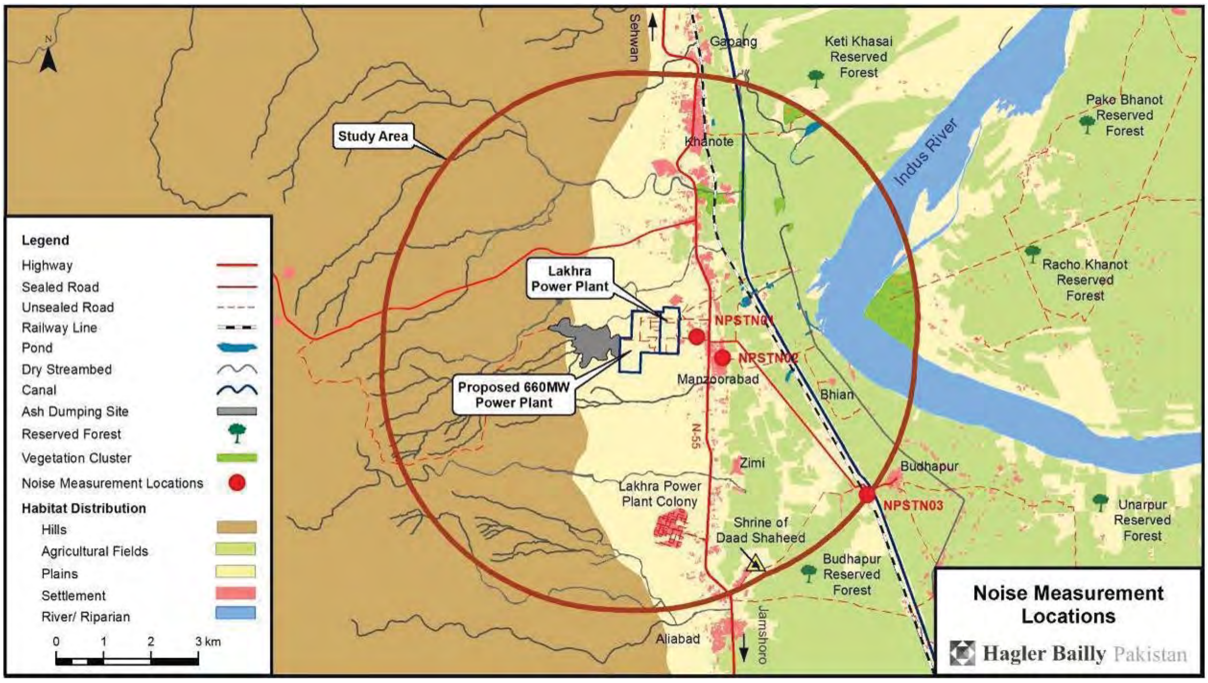
(4) Noise

There is no industrial source of noise within the railway works project vicinity other than the plant in Study Area 3. The locations were selected considering the nearest community to the project. Total of three representative locations were selected in Study Area 3. Measurements were taken at three locations in February 2014 as shown Table 11-1 in and Figure 11-5 .

Table 11-1 Noise Measurement Locations in Study Area 3

Measurement Location ID	Coordinates	Site Description	Rationale
NPSTN01	25° 42’ 17.1"E 68° 17’ 35.5"N	350 m east of the plant, residential huts, primary school	Noise (nearest settlement in east)
NPSTN02	25° 42’ 03.0"E 68° 17’ 55.1"N	950 m east of the plant, Manzorabad settlement	Noise (nearest settlement to road route)
NPSTN03	25° 40’ 29.8"E 68° 19’ 44.8"N	5 km south of the plant, rail station, residential houses	Noise (nearest settlement to rail route near plant)

Source: Hagler Bailly Pakistan



Source: Hagler Bailly Pakistan

Figure 11-5 Noise Measurement Locations

General Noise Level

A summary of results is provided in Table 11-2. The minimum and maximum noise levels are reported as L_{10} and L_{90}, respectively. L_{10} and L_{90} refer to percentile noise levels that are exceeded 10% and 90% of the time, respectively. Furthermore, L_{eq}, which is the average sound level, is calculated excluding the 10% upper and lower extreme ranges of the noise data.

The noise levels during daytime are within guideline values. However, nighttime values are exceeding guideline values for point N01 and N02. This may be attributed due to the location of the measurement points near the highway (N–55) and existing plant.

Table 11-2 Summary of Noise Levels During the Survey

Measurement Point	Noise Levels (dB(A))			
	Time	L_{10}	L_{eq}	L_{90}
NPSTN01	Daytime	46.9	51.7	56.1
	Nighttime	48.3	53.8	56.1
NPSTN02	Daytime	48.3	55.4	61.4
	Nighttime	48.3	53.0	61.4
NPSTN03	Daytime	31.7	45.5	51.3
	Nighttime	31.6	38.3	51.3
NEQS Ambient Quality Limits				
Daytime (06:00 – 22:00 hours)	–		55	–
Nighttime 22:00 – 06:00 hours	–		45	–

Source: Hagler Bailly Pakistan

Rail Route Noise

The existing rail track is located about 1.5 km east of the plant. Noise levels on the rail route were recorded at Budapur Railway Station (Record Point ID: NPSTN03), located 5 km southeast of the plant. The noise meter for NPSTN03 was placed on the roof of a single story building, about 30 m from the rail track. This data was recorded in February 2014.

In June 2016, rail route noise levels were recorded at another point (NPSTN04). This time, the meter was placed on the roof of a single story school building located 80 m east of the rail track in Jamshoro City. The train track was measured to be 1.75 m above the natural grade whereas the noise meter was located 4.45 m above the ground. Thus, the noise meter was 2.7 m above the train track. The rail route noise levels record locations and sensitive receptors nearby the route between Jamshoro and the plant are shown in Figure 11-6 and Figure 11-7 , respectively.

The station master of the Budapur Railway Station reported that four trains pass through this station daily. All four trains pass through the night and all of them are passenger trains. However, currently, none of the trains stop at this station. During the noise survey in February 2014, two trains passed through the Budapur Station. Analysis of the train noise is presented in Table 11–3.

A summary of noise levels data recorded in Jamshoro at point NPSTN04 and near the plant (NPSTN03) is provided in Table 11–4. L_{eq}, which is the average sound level, is calculated excluding the 10% upper and lower extreme ranges of the noise data. The values exceed the guideline values for daytime and nighttime at point NPSTN04 located in Jamshoro City. This may be attributed due to the location of the measurement point within Jamshoro City.

Table 11–3 Train Noise Analysis at Budapur Station (NPSTN03)

Train	Time of Day (hours)	Time Taken to Pass the Station (minutes)	Peak Noise Level (dB(A))	L_{eq} During the Passage (dBA)	L_{eq} Five Minutes before Passage (dB(A))	L_{eq} Five Minutes after Passage (dB(A))
1	22:09	4	80.9	67.8	37.7	36.4
2	23:54	5	83.3	68.1	33.1	36.3

Table 11–4 Rail Route Background Noise

Measurement Point	Noise Levels (dB(A))			
	Time	L_{10}	L_{eq}	L_{90}
Near Budapur (NPSTN03)	Daytime	31.7	45.5	51.3
	Nighttime	31.6	38.3	51.3
In Jamshoro City (NPSTN04)	Daytime	54.5	61.3	64.7
	Nighttime	46.8	55.8	59.7
NEQS Ambient Quality Limits				
Daytime: 06:00 – 22:00 hours	–		55	–
Nighttime: 22:00 – 06:00 hours	–		45	–

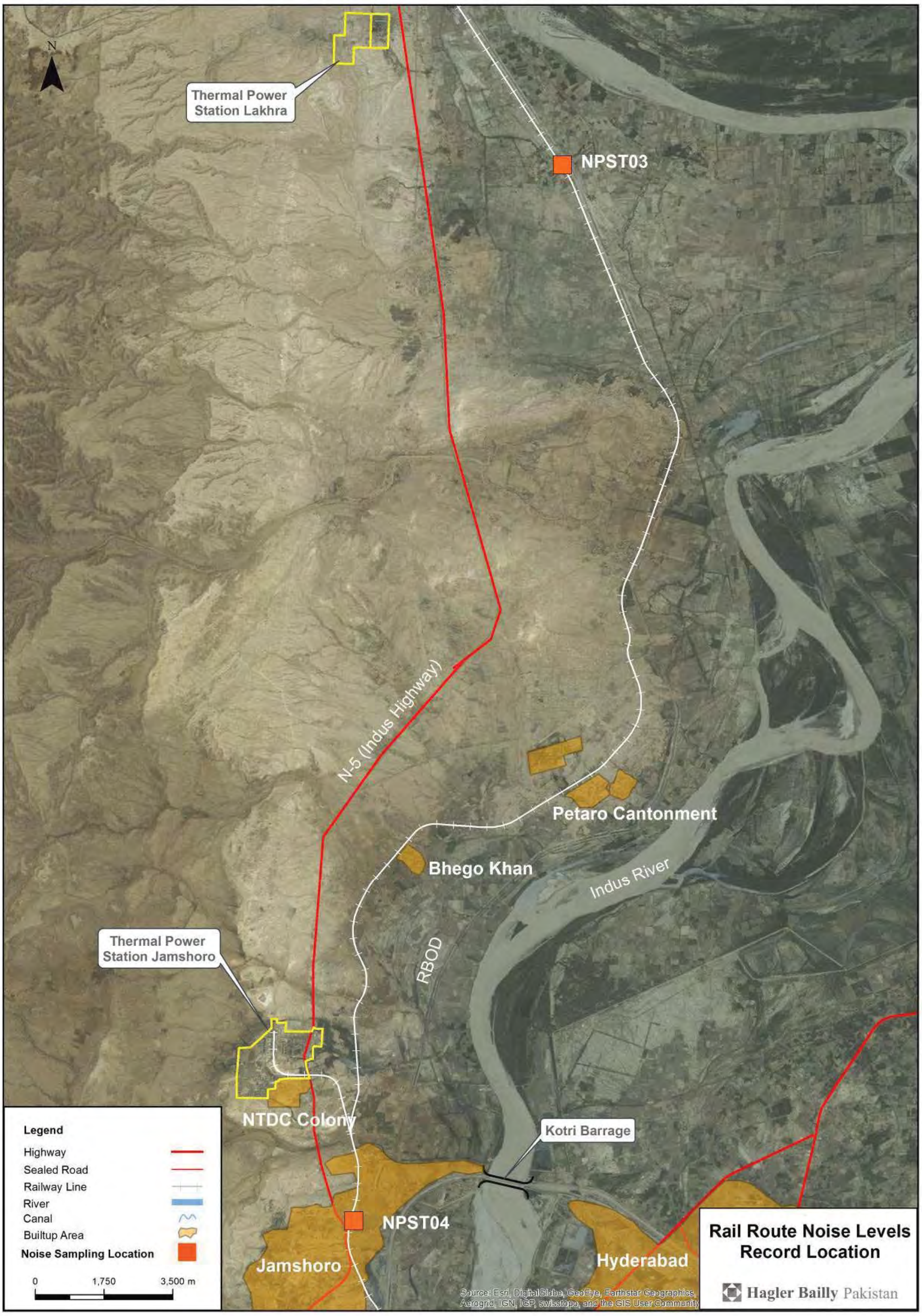
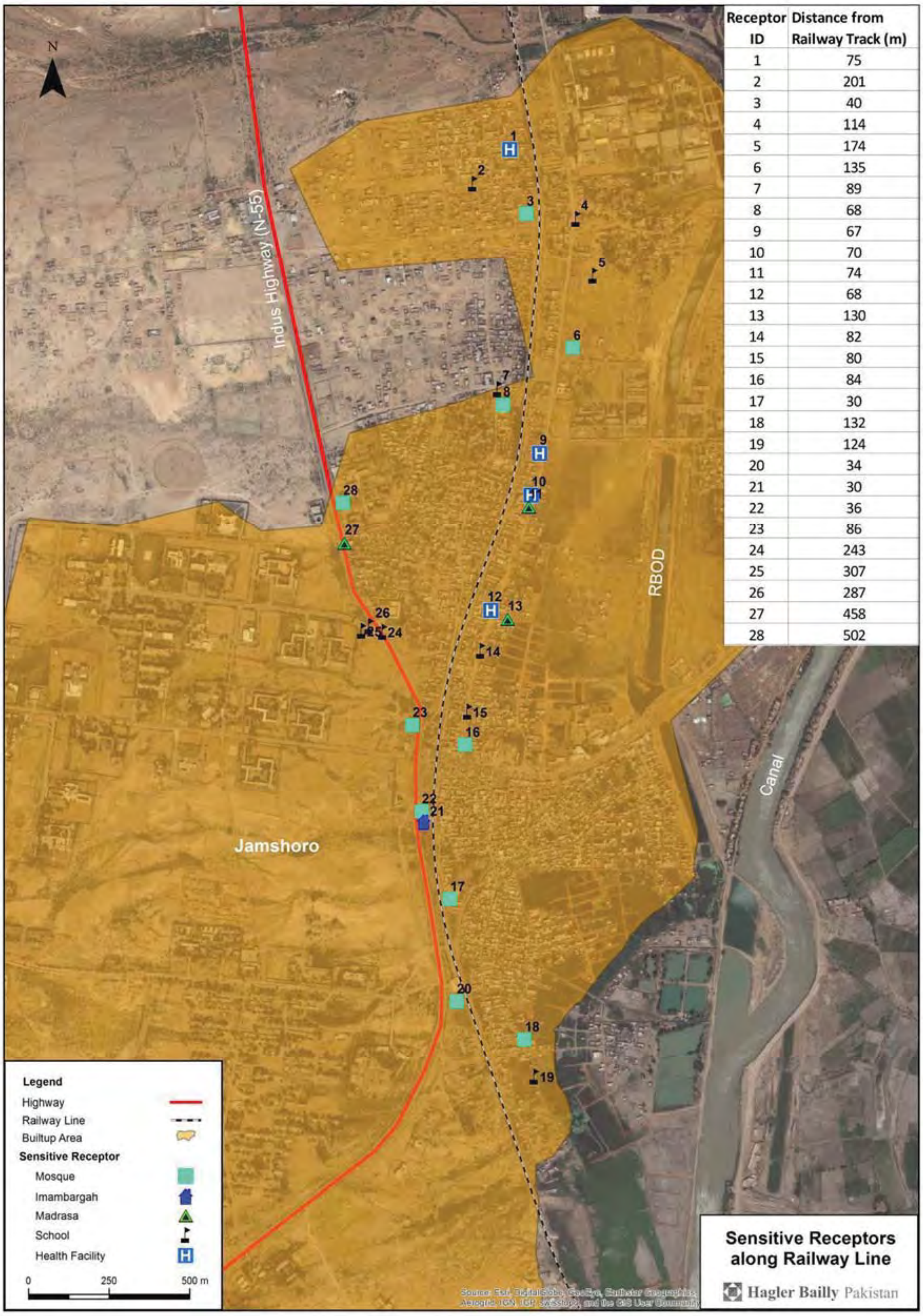


Figure 11-6 Rail Route Noise Level Record Locations



Receptor ID	Distance from Railway Track (m)
1	75
2	201
3	40
4	114
5	174
6	135
7	89
8	68
9	67
10	70
11	74
12	68
13	130
14	82
15	80
16	84
17	30
18	132
19	124
20	34
21	30
22	36
23	86
24	243
25	307
26	287
27	458
28	502

Figure 11-7 Sensitive Receptors along the Railway Line

Train Noise Profile

A survey was conducted on train noise profile on the main rail route connecting Karachi with Hyderabad and the rest of the northern part of Pakistan (Figure 11-8). A dedicated surveyor was deployed for eight hours each in 27 June 2016 and 28 June 2016. Total of 20 trains passed during the presence of the surveyor in forth (to Karachi) and back (to Hyderabad) directions. Among these, 16 were passenger trains and four were cargo bound trains. During the survey, noise levels were recorded for each train at a distance of 50 m and 100 m from the track along with background noise levels during no train traffic condition. The train length, passing time from the identified line on the track, and the speed of the train were also recorded. All these information is provided in Table 11–5.

The data shows attenuation of 2.5 dB(A) in average and 2.8 dB(A) in peak noise levels between 50 m and 100 m distance for passenger trains passing at record point with average speed of 100 km/hr. The average and peak attenuation noise levels for the cargo trains at the same point, is 9.29 dB(A) and 8.74 dB(A), respectively, with an average speed of 54 km/hr.

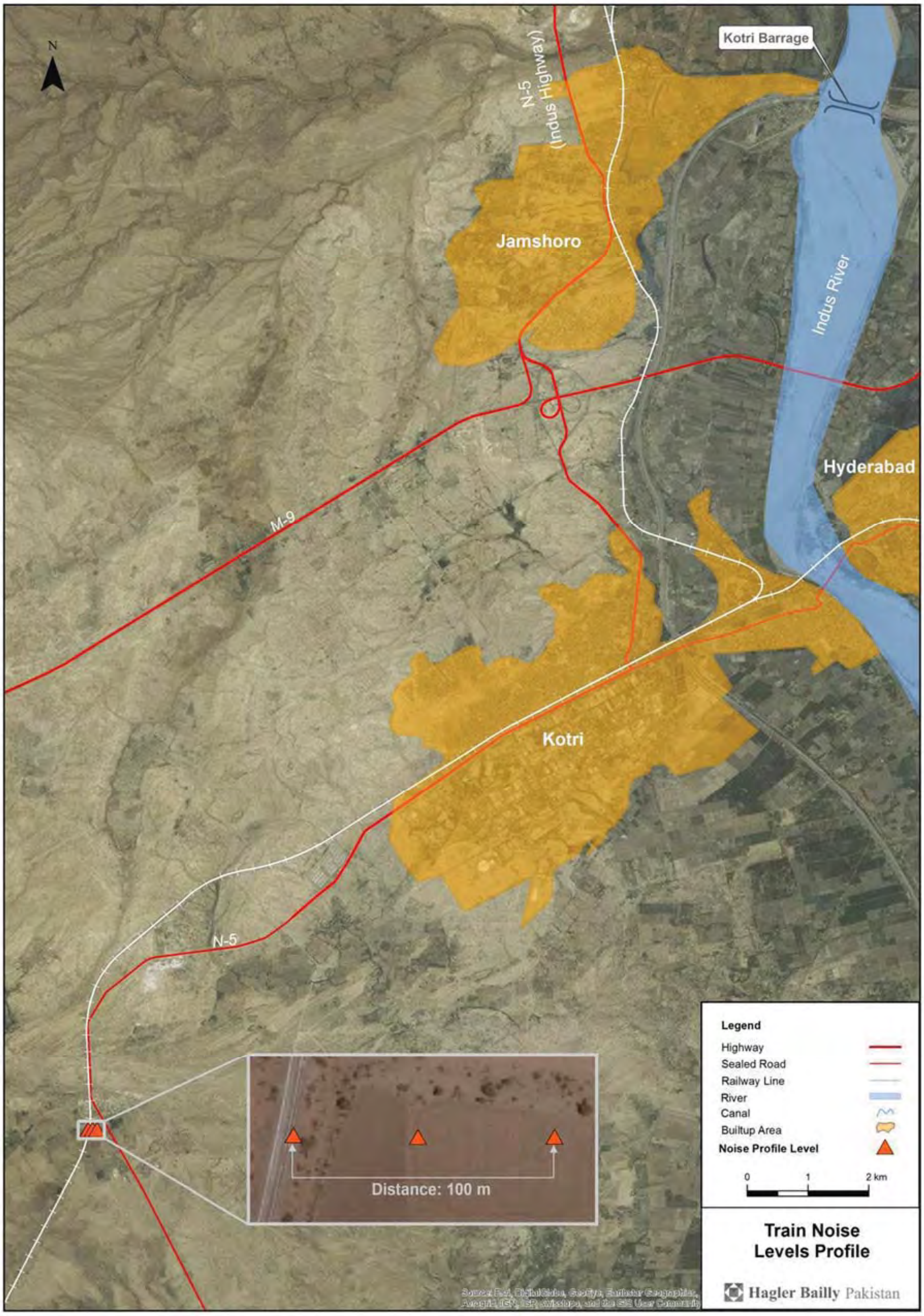


Figure 11-8 Train Noise Levels Profile Record Locations

Table 11–5 Train Noise Profile at Main Rail Route Near Kotri Station

Train ID	Time	Train Type	Train Whistle	No of Engines	No of Coaches	Length (m)	Time of Pass the meter (sec)	Speed (km/s)	Direction	Background Noise	Distance of Meter from Track (m)	Noise Duration	Leq	Peak
1	3:21 PM	P	N	1	19	457	15.16	109	U	40.72	50	1:14	74.2	82.9
											100	1:26	70.3	80.0
2	4:03 PM	P	N	1	17	411	13.44	110	U	43.88	50	1:05	76.0	84.3
											100	1:22	74.4	84.2
3	5:34 PM	P	Y	1	16	388	12.25	114	U	40.00	50	1:11	73.2	83.1
											100	1:02	75.4	82.5
4	6:12 PM	P	Y	1	18	434	20.86	75	U	44.45	50	1:14	71.7	81.2
											100	1:38	71.5	81.1
5	6:23 PM	P	N	1	18	434	19.56	80	D	44.04	50	1:13	76.6	84.1
											100	1:19	76.4	84.0
6	6:38 PM	P	Y	1	18	434	16.89	92	U	46.55	50	1:04	76.4	84.7
											100	1:27	75.9	85.4
7	6:45 PM	P	Y	1	16	388	13.24	105	U	44.12	50	0:44	72.1	80.0
											100	1:22	72.4	78.7
8	7:32 AM	P	N	1	18	434	13.12	119	D	42.33	50	0:57	81.8	88.5
											100	1:04	76.8	84.0
9	7:55 AM	P	Y	1	16	388	13.13	106	D	43.21	50	1:24	78.3	91.1
											100	1:09	76.3	88.5
10	8:13 AM	P	N	1	14	342	12.16	101	U	41.83	50	1:56	79.7	95.0
											100	0:52	76.1	87.5
11	8:22 AM	P	Y	1	18	434	14.50	108	U	43.73	50	1:14	78.9	89.1
											100	1:13	74.1	83.9
12	8:43 AM	P	Y	1	15	365	13.42	98	U	43.56	50	1:32	74.9	86.2
											100	1:27	71.1	83.7
13	8:57 AM	G(C)	N	2	31	456	29.46	56	U	41.94	50	1:38	77.1	84.3
											100	1:44	71.1	76.9
14	8:59 AM	G(T)	N	2	20	305	15.54	71	U	46.55	50	1:14	73.8	82.2
											100	1:41	68.7	78.0
15	9:25 AM	P	Y	1	16	388	16.96	82	D	41.51	50	1:38	78.1	88.2
											100	1:31	72.8	81.6
16	9:37 AM	P	Y	1	18	434	14.89	105	U	41.93	50	1:19	78.7	91.8
											100	1:44	75.5	89.6
17	9:53 AM	P	Y	1	16	388	13.34	105	D	41.38	50	1:25	78.8	89.2
											100	1:25	72.3	82.6
18	10:18 AM	G(O)	N	2	25	374	22.05	61	D	43.66	50	1:45	76.8	84.9
											100	1:23	68.1	74.8
19	10:36 AM	G(C)	N	2	22	333	40.04	30	U	41.73	50	0:42	82.9	96.0
											100	1:03	65.4	82.8

Notes:
1. **P**: Passenger; **G(O)**: Goods (Oil), **G(C)**: Goods (Coal); **G(T)**: Goods (Containers)
2. Engine Length: Passenger trains 20 m; Goods train 15 m
3. Coach length: Passenger trains 23 m; Goods train 13.75 m
4. Direction: **U** Up-country (Karachi to Kotri); **D**: Down-country (Kotri to Karachi)

(5) Ecology

A summary of Study Area 3 with relevant information on Study Area 1 and 2 is provided below.

1) Vegetation

There are no protected or reserve forests in the study area. There are some reserve forests outside the study area but are not likely to be impacted by project activities.

A total of 25 plant species was observed in Study Area 3. Similar vegetation is also found in Study Area 1 and 2. Most of the observed plant species were common and found in more than one habitat. These include *Acacia senegal, Prosopis cineraria, Aerva javanica, Leptadenia pyrotechnica, Salvadora oleoides, Ziziphus nummularia,* and *Calotropis procera*. The vegetation of the Indus River bank is mostly composed of perennial shrubs of *Tamarix dioica* and *Alhagi camelorum*.

With regard to conservation and protection status, no threatened or endemic plant species were observed in Study Area 3 during the survey nor reported from the literature survey.

2) Mammals

A total of 21 mammal species was reported to exist in the Study Area 3 and its vicinity.[7] These include members from Family *Canidae, Erinaceidae, Felidae, Herpestidae, Hystricidae, and Leporidae*. Among the river mammals, a dolphin specie from family *Platanistidae*[8] and an otter from family *Mustellidae*[9] were reported to exist in the Indus River, mostly at the upstream of Kotri barrage. Small mammals reported from the study area include species from *Muridae, Vespertilionidae, Sciuridae, Viverridae, and Soricidae* families.[10]

Among the terrestrial mammals, two species belonging to *Vulpes* genus, family *Canidae* are known to exist in the study area: the bengal fox *Vulpes bengalensis* and the common red fox *Vulpes vulpes*. They are both listed as near threatened in the Pakistan's Mammals National Red List 2006 and also included in the Convention on International Trade in Endangered Species (CITES) Species List.[11] Another member of the family *Canidae*, Asiatic jackal *Canis aureus,* is listed as near threatened in the Pakistan's Mammals National Red List 2006 and also included in the CITES Species List. One member of the family *Felidae*, jungle cat *Felis*

[7] Ghalib, S.A., Hasnain, SA., and Khan, A.R. 2004. Current status of the Mammals of Sindh. J. Nat. Hist. Wildl. 3(1):16.
[8] Gachal, G. S. and Slater, F. M. 2004. Barrages, Biodiversity and the Indus River Dolphin. *Pakistan J.Biol. Sci*., **7**(5):797–801.
[9] Khan, W. A., Akhtar, M., Ahmad, M. S., Abid M., Ali H. and Yaqub A. Historical and Current Distribution of Smooth–coated otter (*Lutrogale perspicillatasindica*) in Sindh, Pakistan. Pakistan J. Wildl., vol. 1(1): 5–15, 2010
[10] Roberts, T. J. 1997. The Mammals of Pakistan. Revised Edition, Oxford University Press, 5–Bangalore Town, Sharae Faisal, Karachi.525 pp.
[11] UNEP–WCMC. 04 March 2014. UNEP–WCMC Species Database: CITES–Listed Species

chaus, is reported to exist in the study area. Other small and medium sized mammals of conservation importance were reported to exist in the study area including Indian crested porcupine *Hystrix indica,* grey mongoose *Herpestes edwardsii,* small Indian mongoose *Herpestes javanicus,* and small Indian civet *Viverricula indica*.

3) Reptiles and Amphibians

An ecological survey was conducted in June 2012 in Jamshoro District about 25 km from the project site.[12] Signs of four reptile species were observed. These species include the Indian fringe–toed sand lizard *Acanthodactylus cantoris,* Cholistan desert lacerta *Eremias cholistanica,* brilliant ground agama *Trapelus agilis,* and the Indian spiny–tailed ground lizard *Saara hardwickii.*

A survey was conducted in Study Area 3 in February 2014 to study herpeto–faunal abundance and diversity during spring season. This was a good time for sampling reptiles and amphibians that come out of winter hibernation. A total of 39 individuals belonging to 13 species were seen during the February 2014 survey.

The most abundant herpeto–faunal specie seen was the Indian roofed turtle *Pangshura tecta.* It was seen exclusively in the river/riparian habitat. This is a quiet–water turtle, living in streams, canals, oxbows, ponds, and man–made water tanks. It can also be seen in brackish coastal waters.[13] Reptiles and amphibians are highly habitat specific, and therefore, occupy small niches spread all over the study area. Unlike birds and mammals that have very wide foraging ranges, reptiles and amphibians have a restricted home range. Except monitor lizards and large snakes, other species usually stay within an area of 1 km^2 for feeding and breeding.[14] Geckos or skinks may occupy microhabitats spread over even smaller areas. The breeding ground for reptile or amphibian species cannot be marked at one or two places; these are spread all over the area within suitable habitats at several scattered places, provided that other climatic factors remain conducive.

Six of the reptiles reported to exist in Study Area 3 are included in the International Union for Conservation of Nature (IUCN) Red List.[15] The narrow–headed softshell turtle *Chitra indica* is listed as endangered, while the spotted pond turtle *Geoclemys hamiltonii*, Indian softshell turtle *Nilssonia gangetica*, peacock softshell turtle *Nilssonia hurum,* and common river turtle *Hardella thurji* are listed as vulnerable. The brown roofed turtle *Pangshura smithii* is listed as near threatened. Only one specie, Cholistan desert lacerta *Eremias cholistanica,* is endemic.

[12] Asian Development Bank (ADB), July 2012, Environmental Impact Assessment of Rehabilitation of Thermal Power Station Jamshoro. Report prepared for Engconsult Ltd.
[13] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 10 March 2014.
[14] Mertens, R. 1969. Die Amphibiens und Reptiliens West Pakistan. Stutt. Beit. *Naturkunde*, 197:1–96.
[15] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 10 March 2014.

The species included in the CITES Species List[16] are spotted pond turtle *Geoclemys hamiltonii,* Indian roofed turtle *Pangshura tecta*, narrow–headed softshell turtle *Chitra indica,* peacock softshell turtle *Nilssonia hurum,* Indian softshell turtle *Nilssonia gangetica,* Indian monitor lizard *Varanus bengalensis,* and Indo–Pak desert monitor *Varanus griseus koniecznyi.*

Also included in the CITES Species List[17] are common sand boa *Eryx johnii,* dhaman *Ptyas mucosus,* Indian cobra *Naja naja,* Indian flap shell turtle *Lissemys punctata,* bull frog *Hoplobatrachus tigerinus,* common river turtle *Hardella thurji,* brown-roofed turtle *Pangshura smithii,* Russell's sand boa *Gongylophis conicus,* and Indian spiny–tailed ground lizard *Saara hardwickii.*

4) Birds

A total of 65 bird species have been reported to exist in Study Area 3. Most of the reported species are endemic in the study area, while some winter migrant and passage migrant species were also reported**.**

The important bird areas (IBAs)[18] are designated by Birdlife International in different countries of the world and are key sites for conservation. There is no IBA in the vicinity of the study area. The closest IBA is the Kirthar National Park that is located at least 40 km away from the study area.

The Study Area 3 is not declared as a protected wetland Ramsaar site.[19] Even though some migratory birds were reported in the vicinity, investigations reveal that most of the migratory birds do not use the study area and its vicinity as a breeding and nesting area, but merely as a resting ground on their way to coastal areas where there is greater food and habitat available.

Two bird species reported from the study area are included in the IUCN Red List.[20] The River tern *Sterna aurantia* is listed as near threatened, while Indian skimmer *Rynchops albicollis* is listed as vulnerable in the IUCN Red List. Species included in CITES Species List are White wagtail *Motacilla alba,* common crane *Grus grus*, black–shouldered kite *Elanus caeruleus,* black kite *Milvus migrans,* and steppe eagle *Aquila rapax nipalensis.*

5) Fish

The fish fauna of the study area has not been intensively studied, but there are few reports on

[16] UNEP–WCMC. 27 February 2014. UNEP–WCMC Species Database: CITES–Listed Species.
[17] Ibid
[18] Birdlife International official website. http://www.birdlife.org/action/science/sites/index.html. Downloaded on 5 March 2014.
[19] The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
[20] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 10 March 2014.

the fish fauna of adjacent sections of the Indus River. At least 49 fish species have been recorded from the reaches of the Indus River near Study Area 3 and its environs.[21] Out of these, ten species have very high commercial value.[22] The project is not likely to have any impact on the fish fauna.

6) Critical Habitat

A critical habitat is designated by the IFC Performance Standard 6[23]. The critical habitat is described as an area having a high biodiversity value, as defined by the following:

- Areas protected by the IUCN (Categories I–VI),[24]
- Wetlands of international importance (according to the Ramsar Convention),[25]
- Important bird areas (defined by Birdlife International),[26] and
- Biosphere reserves (under the United Nations Educational, Scientific and Cultural Organization (UNESCO) Man and the Biosphere Programme.[27]

The study area does not meet any of the above criteria. The following additional characteristics were used in determining whether the study area lies in a critical habitat.

(6) Protected Area

Though the candidate site is not included in any protected area (i.e., wildlife sanctuary, national park, and game reserves), Keti Khasai, Budapur, and Racho Khanot Reserved Forests exist in about 6 to 8.5 km from the site. According to the Forest Department, Hyderabad, those reserved forests are forests where the species are protected in their natural habitat and no human interference is allowed or any kind of human activity is strictly prohibited without any special permission. Those forests are managed by Forest Department, Hyderabad. Since those forests are situated in more than 5 km from the candidate site, no significant impact on them would be expected.

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21 Hussain, Z., (1973) Fish and fisheries of the lower Indus basin (1966–67), Agric. Pakistan, (**24**): 170–188
22 Rafique, M. 2009. Fish Fauna of Haleji Lake, Sindh, Pakistan. Rec. Zool. Surv. Pak. (19):61–65.
23 Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.
24 IUCN. 1994. Guidelines for *Protected Areas* Management *Categories*. *IUCN*, Cambridge, UK.
25 Ramsar Convention, or Convention on the Wetlands of International Importance, Administered by the Ramsar Secretariat, Geneva, Switzerland
26 Birdlife International, UK
27 Administered by International Coordinating Council of the Man and the Biosphere (MAB), UNESCO.

11.2.2 Socioeconomic Environment

Baseline investigations were undertaken to document existing socioeconomic conditions of the population that can be affected by project activities. The results of the socioeconomic baseline investigations are documented in this section of the report.

Since the primary impact will be in Study Area 3, this section discusses this area in detail. A brief discussion of Study Area 1 and 2 is provided in the end.

(1) Delineation of Study Area

The population likely to be affected by project activities was identified based on an understanding of the potential impacts of the project. The potential socioeconomic impacts of the project fall into two categories: the direct socioeconomic impacts, such as, employment generation and skill and technology transfers; and indirect socioeconomic impacts due to physical environmental impacts of the project, such as, land transformation resulting in physical and economic displacement. Project induced changes to the physical environment are expected to reduce with the increased distance from the project facilities, affecting settlements located up to 5 km, to the proposed project facilities.

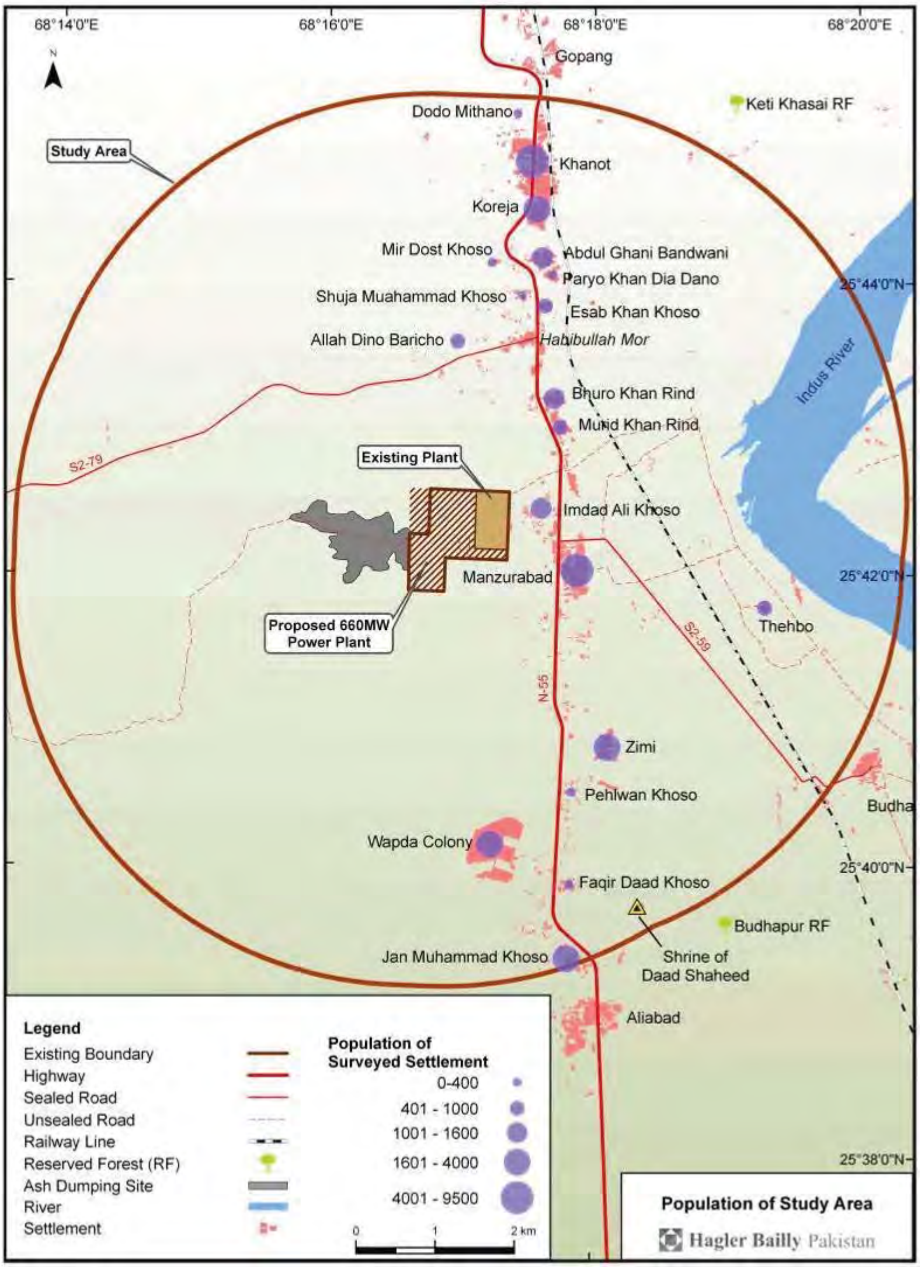
For this, a study area of 5 km around the proposed project site was delineated, to assess the baseline conditions in the areas likely to be affected by the spur line construction and operation. This is referred to as the socioeconomic study area in this report which is the same as with the Study Area 3 introduced earlier.

Direct socioeconomic impacts of the project will not only affect the immediate socioeconomic environment of the project but also diffuse to other parts of Jamshoro District and possibly Sindh Province. The baseline conditions in these areas will be studied through the district, and where taluka level published data is available.

(2) Demography

The locations of settlements in Study Area 3 are shown in Figure 11-9 In addition to the 18 rural settlements and one colony, there is one commercial area, Habibullah Mor. There is no resident population in the commercial area, therefore, it is not included in the settlement survey.

Table 11-6 gives a list of the settlements in study area. The total population of the study area was 38,685, which is approximately 25% of the total population of Manjhand Taluka in 2014. Rural population is 37,020 persons and colony population is 1,665 persons. Population in the colonies constitutes 4% (1,665 persons) of the total population of the study area and the remaining 96% (37,020 persons) is rural.[28]



Source: Hagler Bailly Pakistan

Figure 11-9 Location of Settlements in the Study Area

28 Socioeconomic settlement survey held in the study area from 8 to 15 April 2014 by the HBP team.

Table 11-6 Population of Settlements in the Study Area

Name of Settlement	Union Council	Taluka	District	Total HH	Estimated Population of Settlement	HH Size
Rural Settlements						
Manzurabad	Manzurabad	Manjhand	Jamshoro	1,150	8,500	7.4
Zimi	Manzurabad	Manjhand	Jamshoro	300	2,400	8.0
Imdad Ali Khoso	Manzurabad	Manjhand	Jamshoro	138	1,300	9.4
Shuja Muhammad Khoso	Manzurabad	Manjhand	Jamshoro	50	400	8.0
Bhuro Khan Rind	Manzurabad	Manjhand	Jamshoro	300	1,500	5.0
Jan Muhammad Khoso	Manzurabad	Manjhand	Jamshoro	500	4,000	8.0
Khanot	Manzurabad	Manjhand	Jamshoro	1,200	9,500	7.9
Thehbo	Manjhand	Manjhand	Jamshoro	200	1,000	5.0
Paryo Khan Dia Dano	Manzurabad	Manjhand	Jamshoro	40	320	8.0
Koreja	Manzurabad	Manjhand	Jamshoro	250	2,500	10.0
Allah Dino Baricho	Manzurabad	Manjhand	Jamshoro	100	800	8.0
Esab Khan Khoso	Manzurabad	Manjhand	Jamshoro	100	900	9.0
Murid Khan Rind	Manzurabad	Manjhand	Jamshoro	90	900	10.0
Abdul Ghani Bandwani	Manzurabad	Manjhand	Jamshoro	200	1,600	8.0
Dodo Mithano	Manzurabad	Manjhand	Jamshoro	50	400	8.0
Mir Dost Khoso	Manzurabad	Manjhand	Jamshoro	30	240	8.0
Faqir Dad Khoso	Manzurabad	Manjhand	Jamshoro	50	360	7.2
Pehlwan Khoso	Manzurabad	Manjhand	Jamshoro	50	400	8.0
Colony						
Wapda Colony	Manzurabad	Manjhand	Jamshoro	333	1,665	5.0
Total:				**5,131**	**38,685**	**7.5**

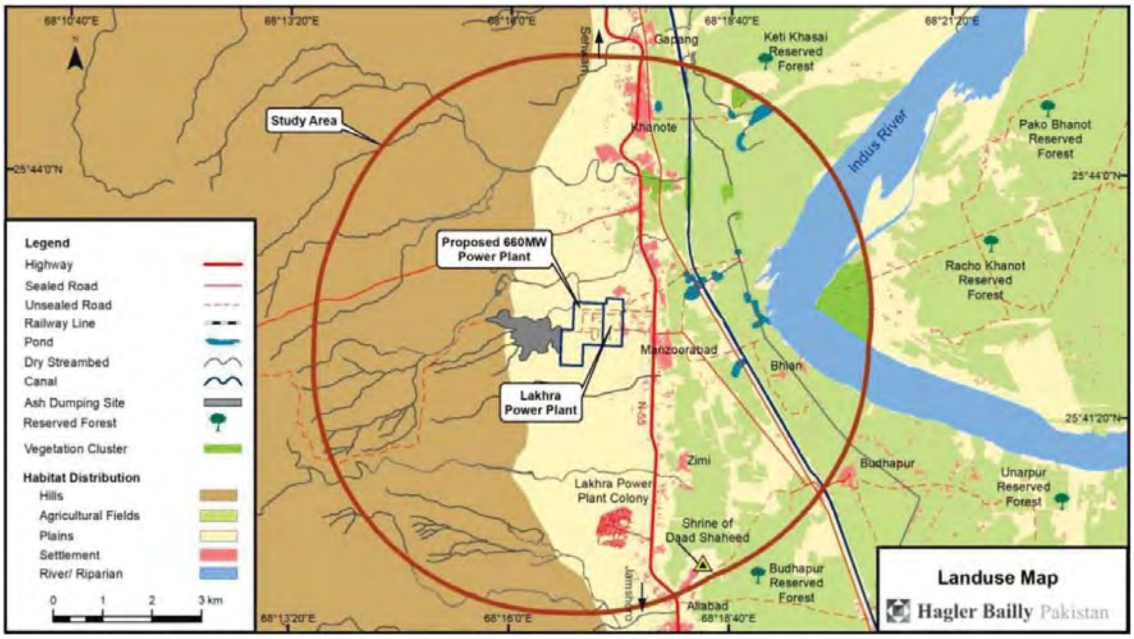
Note: HH abbreviates for Household.

Source: Hagler Bailly Pakistan

(3) Land Use

Based on the analysis using Google Earth satellite image, the total area of Study Area 3 is approximately 102.5 km^2. Within Study Area 3, about 38% of the area constitutes hills, 32% is barren land, 20% is cultivated, 1% is covered by the settlements/colony, and the remaining 7% area includes the Indus River, flood plain, and Lakhra Power Plant.

As a result of field survey, the barren land has little natural vegetation cover (small trees, shrubs, and grasses). The settlements are mainly colonized along the Indus Highway. The agricultural field is spread in the flood plain of the Indus River. In the agricultural field, livestock grazing (e.g., goats and cattle) were observed. In the Indus River, fishing activities were observed.



Source: Hagler Bailly Pakistan

Figure 11-10 Land Use in the Study Area

(4) Occupation and Income Level

Agriculture and coal labor are the two major sources of income in the Study Area. About 51% of the total surveyed population is engaged in farm labor either on their own land or as a laborer on others' land. About 30% of the population is involved in coal labor with coal mining companies working in the area. About 14% of the population earns income through other labor works including daily wage labor, masonry, wood cutting and selling, shop ownership, and shop keeping. Only 1% of the population in the area is employed in government services including teaching and driving.[29] The percentage of occupations observed in surveyed settlements of the study area is given in.

The average monthly household income is PKR 5,667 in rural area of Sindh Province. Of the Sindh working population, 37.61% of total monthly income is sourced by agriculture, 27.04% by wages and salaries, 14.99% by self-employment, such as grazing and other business, and 7.14% by property management (land owning).

29 Socioeconomic settlement survey held in the study area from 8 to 15 April 2014 by the HBP team.

(5) Industry

Industries include Jamshoro, Lakhra, and Kotori Power Stations; Lakhra Coal Mine; and other mining that involves manpower and sustain a part of the Jamshoro regional economy. According to the hearing during the socioeconomic survey, 58 locals of the eight settlements[30] are employed in the existing Lakhra Power Plant. These employees are usually laborers, drivers, or security guards at the Lakhra Power Plant. Two government-owned companies and 20-25 private companies are engaged in mining in the Lakhra Coal Field, which is located approximately 16 km west of the candidate site. In the settlements in the study area, 32% of the total workforce is involved in coal mining labor.

(6) Fishery

The Department of Livestock and Fisheries controls the fisheries departments of all the districts in Sindh. The district office of concerned department issues an annual license for fishing in a specific area for PKR 12,000 per person per boat. Fishing is only permitted in the allotted area which is normally within the stretch of the river or a water body within the registered district. The project site is located in the river stretch under jurisdiction of Nwabsha, Hyderabad, Jamshoro, and Matiari districts office. The number of registered fishermen and boats, and annual fish production are as shown in Table 11-7. In general, the livelihood of fishermen strongly depends on the income from fish sales. The fishermen sell their catch in local market. Jamshoro is the main market for fish, and other small markets exist in Sehwan and Bhan areas[31].

Table 11-7 Inland Fish Production by Districts

Province/District	Fish Production (Million Tons)	Total Numbers of Registered Fishermen	Total Numbers of Registered Boats
Nawabshah/ Shaheed Benazirabad	5,175	1,100	363
Hyderabad	5,408	1,032	152
Jamshoro	11,180	2,130	597
Matiari	3,378	501	152
Total	25,141	4,763	1,264

Source: Department of Livestock and Fisheries of Sindh

30 Eight settlements including Manzurabad, Zimi, Imdad Ali Khoso, Bhuro Khan Rind, Khanot, Paryo Khan Dia Dano, Koreja, and Murid Khan Rind. Information for Faqir Dad Khoso and Pehlwan Khoso is not available since surveys could not be conducted in these settlements.

31 Information was shared with HBP by Mr. Abdul Latif, Deputy Director of Department of Livestock and Fisheries, Hyderabad.

(7) Agriculture

Sindh's diversified economy comprises of a well–developed agricultural base supported by an effective irrigation network on the Indus. Around 14% wheat, 30% rice, 30% sugar cane, 25% cotton, and 30% vegetable crops grown in Pakistan are from Sindh.[32]

In the study area, agriculture forms the major income generating activity with 51% surveyed population pursuing farm labor either on their own lands or on other agricultural land.[33] Major crops produced in study area and their estimated production is given in Table 11-8

Table 11-8 Major Crops and Their Production in the Study Area[34]

Average Production (kg/ha)						
Summer		Winter				
Cotton	Sesame Seeds	Wheat	Chickpeas	Lentil	Sorghum	Cluster bean
2,700	1,000	2,300	2,100	1,500	1,900	1,900

Note: Information for Faqir Dad Khoso and Pehlwan Khoso is not available since surveys could not be conducted in these settlements.
Source: Hagler Bailly Pakistan

Nine of the 17 surveyed settlements reported that agriculture is dependent on rain and flood events. However, settlement of Thehbo reported that land is cultivated every year since the settlement is located less than 1 km from the Indus River. In this settlement, irrigation channels bringing water from the river, were dug to irrigate the land using the river water. Such irrigation channels were observed in few other rural settlements. In some agricultural lands, underground water wells have been dug to irrigate the land. Some village locals reported that storm water runoff carrying coal ash deposited near their settlements causing damage to agricultural lands.

(8) Housing

According to the 1998 District Census Report of Dadu, there were 25% masonry dwellings and 75% adobe households in Manjhand Taluka.

(9) Water Supply and Sanitation

According to the Pakistan Social and Living Standards Measurements Survey in 2011–2012, 73% of rural population of Sindh province used hand pumps for drinking purposes, while the rest used sources including tap water, motor pump, dug wells, and water tankers. The average

32 Sindh Board of Investment. http://www.sbi.gos.pk/sindh–economy.php (accessed 27 March 2014).

33 Socioeconomic Settlement Survey held in the study area from 8 April 2014 to 15 April 2014 by the HBP team.

34 Ibid.

monthly water bill in rural Sindh is PKR 120, paid by approximately 62% of the population.[35]

The main source of drinking water in the Jamshoro District is tap water, which is used by 30% of the households. Almost 22% of the households have access to hand pumps and 12% through motor pumps. About 21% uses groundwater wells and 15% are dependent on other sources.[36]

Only 22% of rural Sindh has flush toilet facility compared to 58% overall rural average in Pakistan. About 83% of rural Sindh has no sanitation system. Open drains are provided in only 15% of the rural areas of the province. There is no garbage collection system in the rural areas of the province.[37]

(10) Health

Health services in Jamshoro District are mainly provided through basic health units (BHUs), rural health centers (RHCs), and district headquarter hospital (DHQ) in Jamshoro. These facilities are equipped for primary health care services and to some extent comprehensive emergency obstetric care services.[38] There are four hospitals in the district (one located in each taluka), five RHCs, 16 BHUs, and six government dispensaries.[39]

(11) Education

The provincial education department runs primary, middle, and secondary schools in Jamshoro District. However, there are very few middle, secondary, and higher secondary school facilities for both boys and girls. Jamshoro District has 926 educational institutions including primary, middle, secondary, and higher secondary institutions. Out of these, 753 are located in urban areas and the remaining 173 are in rural areas. About 74% of the total enrolment in Jamshoro District is in primary schools.[40] This shows a high drop–out rate of students in the entire district.

(12) Heritage

There is no cultural heritage (protected archeological/cultural site[41]) or landscape within the

35 Pakistan Bureau of Statistics, Government of Pakistan. *Pakistan Social and Living Standards Measurements (PSLM).* Government Report, Islamabad: Pakistan Bureau of Statistics, 2013.
36 Ibid.
37 Ibid.
38 Emergency obstetric care (EmOC) refers to the care of women and newborns during pregnancy, delivery, and the time after delivery
39 District Government Jamshoro. http://www.jamshoro.com.pk/. http://www.jamshoro.com.pk/Glance.htm (accessed 27 March 2014).
40 National Education Management Information System (NEMIS) Academy of Educational Planning and Management (AEPAM). (2012). *District Education Profile 2011–12.* Islamabad: Ministry of Education, Trainings and Standards in Higher Education, Government of Pakistan.
41 Protected sites are notified under the Antiquity Act 1975 and Sindh Cultural Heritage (Preservation) Act 1994.

study area.

(13) Culture and Traditions

The main languages spoken in Jamshoro District are Sindhi and Balochi. In addition, other languages spoken are Urdu, Pubjabi, Saraiki, Pashoto, Hindko, Saraiki, Marvari, and Jabli.

Sindh is known all over the world for its handicrafts and artifacts such as the *ajrak,* and *topi* is famous as a gift at Eid, weddings or on other special occasions like homecoming.

(14) Gender Role

A household usually contains two gender-based positions of authority; first is the position of the head, the oldest, the able-bodied male member of a household. The society in rural Sindh is male-dominated. The second is the position of the senior woman, ideally the wife of the eldest resident male, who is subordinate of the household head. The male members govern household decision making process and are responsible to represent the household in the neighborhood and larger society.

(15) Child

There are about 50 million children aged between 5 and 19 years old in Pakistan[42.] While, almost 25 million children and adolescents are out of school, out of which 7 million children aged between 3 and 5 years are yet to receive primary schooling. It is reported that there were 12 million child laborers in Pakistan in 2012. Another report revealed that 5,659 cases of violence against children were reported from January to October 2012[43].

[42] Pakistan Bureau of Statistics, Government of Pakistan, Population Census 1998

[43] Daily Times, Pakistan (29 May 2013) Report on State of Pakistan's Children 2012, United Nations Educational, Scientific and Cultural Organization (UNESCO) (2013) Financing for Global Education

11.3 Land Use Conditions in Study Area 1 and 2

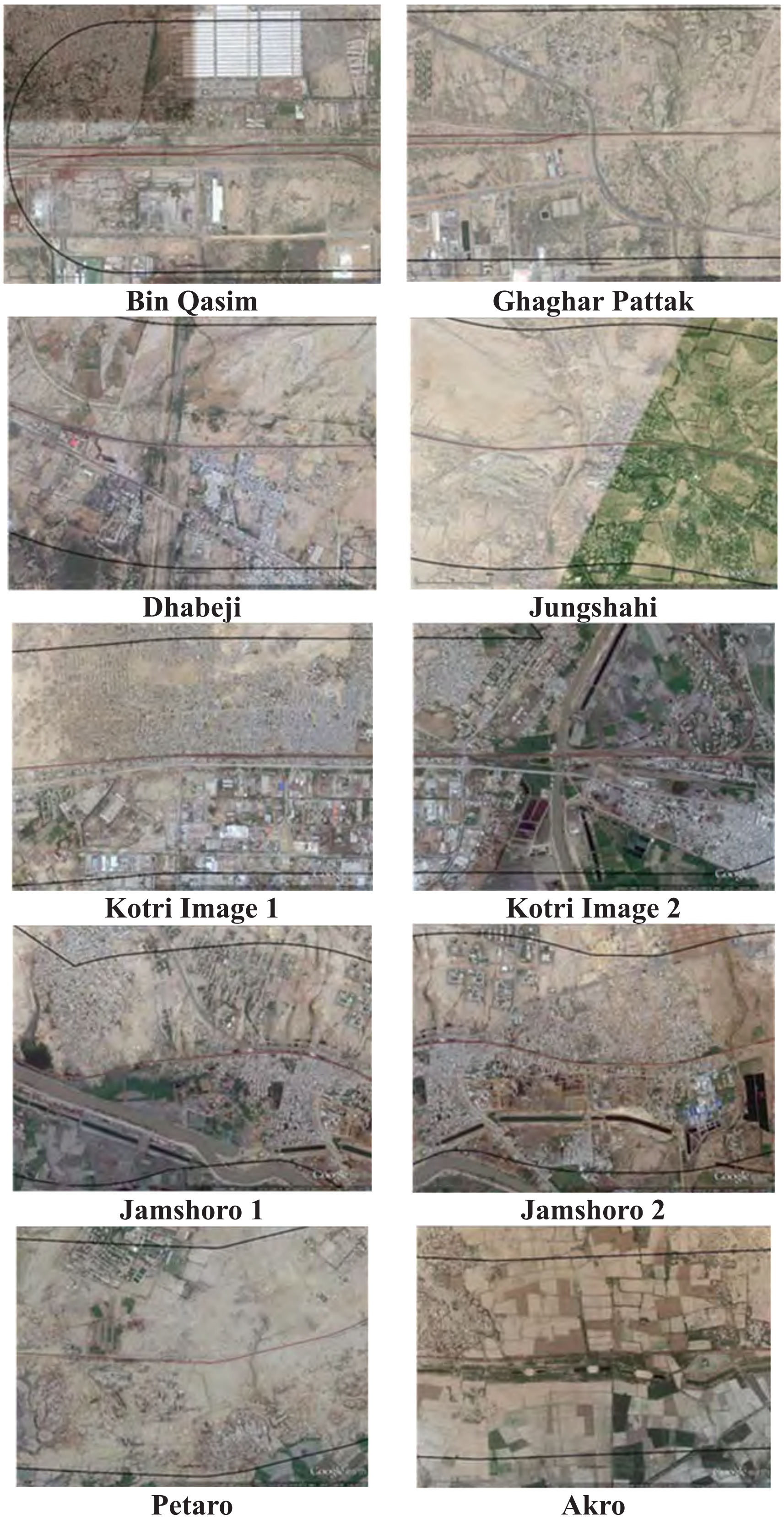
The main settlements along the transport route are provided in Table 11-9. As per this analysis, of the total area, the land used for settlements (residential and commercial), agricultural, industrial, and educational purposes in Study Area 1 are 5.8%, 1.2%, 2.4%, and 0.2%, respectively. The total area is a corridor of width 2 km centered on the existing railway track from Bin Qasim to Kotri. The area is approximately 262 km^2. Similarly, of the total area between Kotri and Budapur, the land used for settlements (residential and commercial), agricultural, industrial, and educational purposes in Study Area 2 are 11.5%, 39.5%, 0.0%, and 9.3%, respectively. The area is approximately 84 km^2.

Of the total 346 km^2, the combined land used for settlements (residential and commercial), agricultural, industrial, and educational purposes in both study areas are 7.2%, 10.5%, 1.8%, and 2.4%, respectively. Nearly 90% of Study Area 1 and 40% of Study Area 2 do not have any formal land use. Of the combined area, 78% does not have a formal land use. In Figure 11-11, selected satellite imagery of areas with intense land uses are shown.

Table 11-9 Main Settlements and Land Use in Study Area 2 and 3

No	Distance from Bin Qasim (km)	Main Settlements	Composition of Major Land Use (% of the length of segment)				
			Residential and Commercial	Agricultural	Industrial	Educational	Length of Segment (km)
Study Area 1							
1	0 –1	Bin Qasim, Pipri	10		50		1
2	6–9	Ghagar Phatak, Haji Ibrahim, Natho Tando Khoso, Haji Jhangi Khan and Railway Colony, Textile Institute	30		10	10	3
3	16–21	Dhabeji Area	30				5
4	47–50	Jungshahi, Sabz Ali Khan Brohi	30				3
5	50–52	–		40			2
6	79–82	Jhimpir	20				3
7	117–118	Small village	10				1
8	120–122	Outskirts of Kotri	15				2
9	123–131	Kotri	40	10	30		8
Study Area 2							
1	131–133	Kotri					2
2	133–136	Area between Kotri and Jamshoro					3
3	136–142	Jamshoro					6
4	145–146	Village					1
5	148–154	Petaro and other small villages					6
6	154–159	Cadet College Petaro					5
7	160–173	Akro, Manjhu, Takri, Unarpur					13

Source: Hagler Bailly Pakistan



Source: Hagler Bailly Pakistan

Figure 11-11 Satellite Imagery of Areas with Intense Land Uses

11.4 Legal and Institutional Framework

11.4.1 Procedure of IEE and EIA

(1) Law on IEE and EIA Procedure

The "Sindh Environmental Protection Agency (EPA) Regulations, 2014" (Sindh IEE-EIA Regulations 2014) provides the necessary details on the preparation, submission, and review of the initial environmental examination (IEE) and environmental impact assessment (EIA). The following guidelines and standards should be referred to:

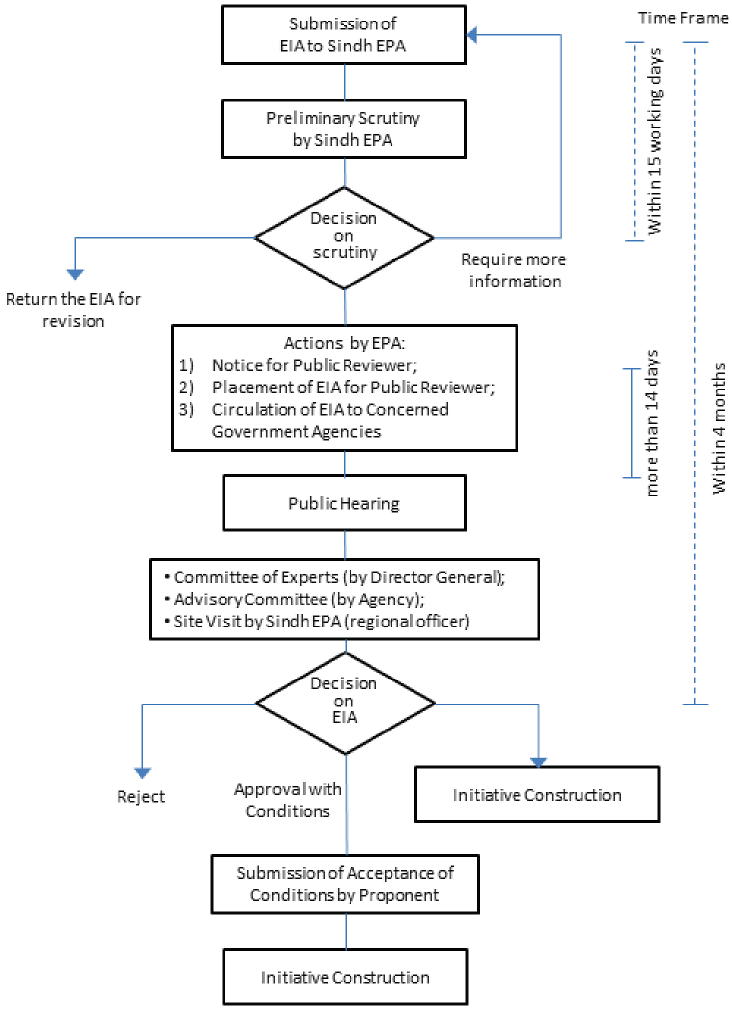
- Guidelines for the preparation and review of environmental reports,
- Guidelines for public consultation,
- Guideline for sensitive and critical areas,
- National Environmental Quality Standards (NEQS) 1993, and
- Sindh Environmental Quality Standards (SEQS) 2014.

(2) Categorization

Categorization of projects for IEE and EIA is one of the main components of the Sindh IEE-EIA Regulations 2014. Projects have been classified on the basis of expected degree of adverse environmental impact. Project types listed in Schedule II (List of Projects Requiring an EIA) of the regulations are designated as potential seriously damaging to the environment and require EIA. The railway works fall under the category of Schedule II; EIAs should be prepared for each component.

(3) Environmental Impact Assessment Procedure

Generally, decision on the EIA will be made within four months from submission of EIA to Sindh EPA. The procedure of EIA approval is as follows (Figure 11-12) and the detailed procedure is provided in the separately prepared EIA report.



Source: JICA Study Team

Figure 11-12 Review and Approval Procedure of Environmental Impact Assessment

(4) Information Disclosure

Public participation required for the preparation of EIA is designated in the first clause of Section 11 of Sindh EIA-IEE Regulations 2014. The procedure of information disclosure is conducted through the following media:

- English or Urdu national newspaper and a local newspaper of general circulation in the area affected by the project, and
- Notice on which the type of project, its exact location, proponent's information (i.e., name and address) and facility where the EIA is available for inspection are described.

11.4.2 Environmental Regulations

The Sindh Environmental Protection Act 2014 (hereinafter referred to as 'Sindh Act 2014') is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, industrial liquid effluent, marine, and noise pollution, as well as handling of hazardous wastes. The articles of Sindh Act 2014 that have a direct bearing on the proposed project are listed below. The details are discussed in the following sections.

- Article 11 that deals with the Sindh environmental quality standards (SEQS) and its application,
- Article 13 that deals with hazardous substances,
- Article 14 that prohibits various acts detrimental to the environment,
- Article 15 that relates to vehicular pollution, and
- Article 17 that establishes the requirement for environmental impact assessment.

Following the promulgation of Sindh Act 2014, Sindh has notified its own ambient air quality standard. It is understood that the NEQS issued prior to Sindh Act 2014 remain in force in Sindh unless they are expressly amended, as is the case with the ambient air quality standards. Since the Sindh Act 2014 does not have the provision for a national standard and Pakistan Environmental Protection Act (PEPA) 1997 is no longer applicable in Sindh, the term 'Sindh Environmental Quality Standards' is understood to include the NEQS (except ambient air quality standards) issued under PEPA 1997. However, the term NEQS is still used in this document where reference is made to older standards.

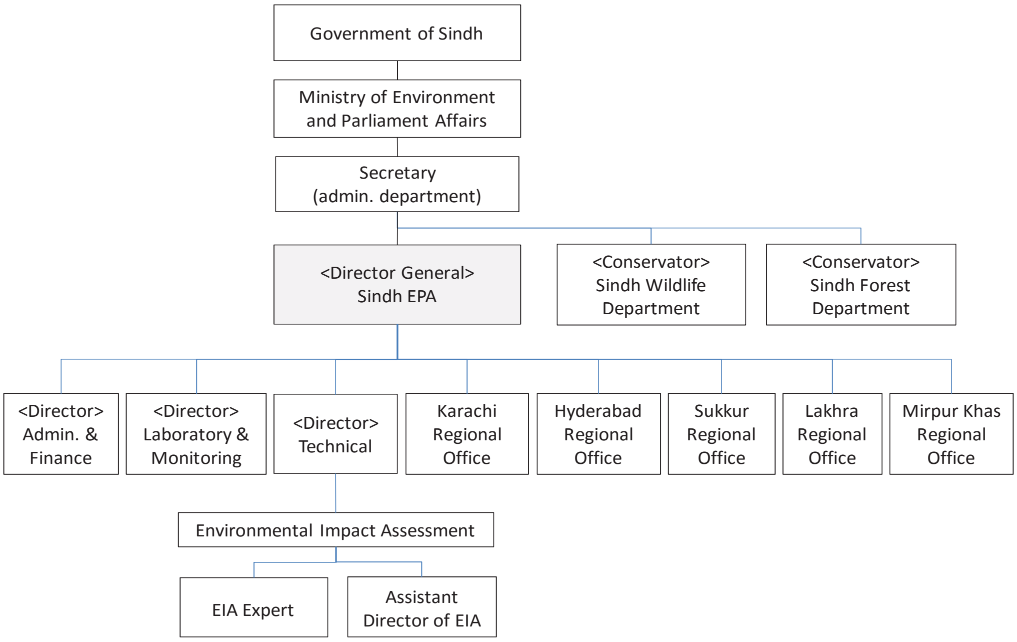
All industrial standards (ambient air quality, gaseous emission, ambient noise, and industrial effluent) are applicable to the proposed plant.

The proposed project is legally required to comply with the SEQS for gaseous emission, ambient air quality[44], and liquid effluent. The only exception is the ambient air quality standards which Sindh EPA has notified separately. In addition, in case of co-financing project, IFC environmental guidelines should also be followed.

11.4.3 Relevant Organization

In Sindh Province, Sindh EPA has been responsible for provincial matters. All environmental technical issues such as EIA, monitoring, and enforcement of law/environmental quality standards are headed by the director general of Sindh EPA. The structures of Sindh Province and Sindh EPA are shown in Figure 11-13.

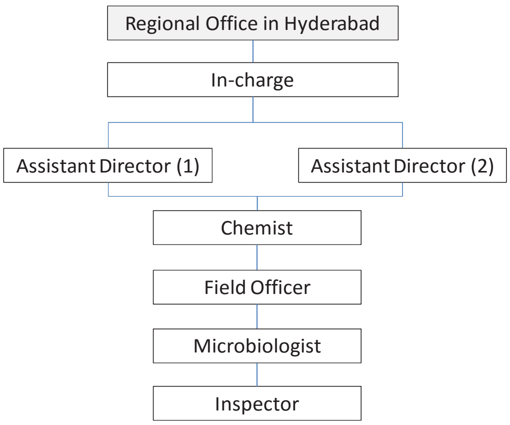
[44] Ambient air quality means the maximum concentration of air pollution substances at ground level.



Source : Sindh EPA

Figure 11-13 Structure of Sindh Province and Sindh EPA

As to project(s) in Jamshoro District, the regional office in Hyderabad is responsible for the monitoring at operation stage. They sometimes conduct speculations. Its structure is shown in Figure 11-14.



Source : Sindh EPA

Figure 11-14 Structure of Regional Office in Hyderabad

11.4.4 Approval of the EIA

The preparation and approval of the EIA is a legal requirement. Approval of the EIA does not absolve the project proponent from requirements under other laws. The following are some of the related permits:

11.5 Environmental and Social Considerations on Railway Works

11.5.1 Scoping for Railway Works

According to the Japan International Cooperation Agency (JICA) Guidelines (April 2010), the predicted environmental impacts are assessed by referring to the results of first and second site works and analysis of Google Earth Pro satellite image dated 16 May 2014 as shown in Table 11-10.

Table 11-10 Result of Scoping (Railway Works)

No.	Item	Assessment		Assessment Reason
		Pre/During Construction	Operation	
Pollution Control				
1	Air quality	B-	B-	**[Construction Phase]** Exhaust and soil dust might emit from construction vehicles. **[Operation Phase]** Coal dust might diffuse through coal transportation. Air pollution derived from spontaneous ignition during coal transportation is predicted.
2	Water quality	B-	B-	**[Construction Phase]** Leakage of heavy oil from construction vehicles might pollute underground water. **[Operation Phase]** Oil and coal dust might be spilled or leaked from coal wagons along the railway and pollute surface water and groundwater.
3	Soil quality	B-	B-	**[Construction Phase]** Oil might spill or leak and contaminate soil. **[Operation Phase]** Oil and coal dust from coal wagons might leak along the railway and pollute soil.
4	Wastes	B-	D	**[Construction Phase]** Solid waste will be generated.
5	Noise and vibration	B-	A-	**[Construction Phase]** Noise and vibration will be generated from the traffic of construction vehicles and heavy machines. **[Operation Phase]** Noise and vibration will be generated from the transportation and unloading of coal.
6	Subsidence	D	D	**[Construction and Operation**] No subsidence will occur.
7	Odor	B-	B-	**[Construction Phase]** Odor might be generated from domestic wastes and latrines at base camps. **[Operation Phase]** Odor derived from spontaneous ignition during coal transportation is predicted.
8	Sediment quality	B-	D	**[Construction]** Adverse impact on sediment is predicted in upgrading works of bridges.
Natural Environment				
9	Protected Areas	D	D	**[Construction/Operation Phase]** The sites for spur line as well as extended loop lines are not located within the protected area.
10	Ecosystem	B-	D	**[Construction]** Adverse impact on ecosystem is predicted during upgrading works of bridges. Although vegetation might be cut down for spur line construction works to some extent, no significant impact on the ecosystem is expected because of being mainly agricultural land.
11	Hydrology	D	D	No impact on hydrology is predicted.
12	Topography and	B-	D	**[Construction Phase]** Small-size topographical change can be

No.	Item	Assessment		Assessment Reason
		Pre/During Construction	Operation	
	geology			predicted due to the route of spur line and location of conveyor.
Social Environment				
13	Resettlement	C-	C-	**[Pre-construction Phase]** Economical and physical relocation will be required as a result of land acquisition.
14	People below the poverty Line	C-/C+	C-/C+	**[Pre-construction Phase]** Affected people may include group of people below the poverty line. **[Construction and Operation Phase]** Job creation and provision of job training would impact positively. **[Operation Phase]** Loss of income source would be expected without appropriate mitigation measures and may cause adverse impact on people's living.
15	Living and livelihood	B-/C+	C-/C+	**[Pre-construction Phase]** Affected people may lose their income source without appropriate mitigation measures due to land acquisition. **[Construction Phase]** Temporary traffic increase may disturb the existing traffic and may lead to adverse impact on regional economic activities. **[Construction and Operation Phase]** Job creation and provision of job training would impact positively.
16	Use of land and resources	C-	C-	**[Construction Phase]** The general mobility of locals and their livestock in and around the spur line route will be affected in specific locations. **[Construction and Operation Phase]** Use of land under the towers and lines will be changed.
17	Water use	C-	B-	**[Construction]** Temporary contamination of surface water and groundwater due to construction activities (clearing and grabbing, excavation, filling, laying down concrete foundation for towers and camps, and use of fuel and lubricants) may affect water use (for the purpose of drinking, agriculture, and fishing). **[Operation Phase]** Oil and coal dust might spill or leak from coal wagons along the railway and pollute surface water and groundwater.
18	Infrastructure and social services	B-	D	**[Construction Phase]** Construction works across the existing roads may temporary disturb traffic.
19	Social capita, institutions, and conflicts	C-	C-	**[Pre-construction Phase]** Differences in acceptance of the project and loss of income source among stakeholders may create changes in social relation and conflicts.
20	Landscape	C-	C-	**[Construction and Operation Phase]** Changes in landscape will be expected in some extent.
21	Gender	C-	C-	**[Construction and Operation Phase]** Gender issues such as any unethical activities, disturbance in routine movement, and increase in work load may be expected.
22	Child rights	C-	C-	**[Construction and Operation Phase]** Degradation of income and livelihood standard of the affected people may worsen the situation of child labor and school drop-out.
23	Infectious diseases	B-	D	**[Construction Phase]** Influx of workers may increase risks in respiratory and infectious disease.
24	Working condition and accident	B-	B-	**[Construction Phase]** Risks of accident and spread of infectious diseases may increase. **[Operation Phase]** Accident could occur in the work environment.

No.	Item	Assessment		Assessment Reason
		Pre/During Construction	Operation	
				The project will result in increase in train traffic, and hence, increase the risk of train accidents
Others				
25	Transboundary of waste treatment and climate change	B-	B-	**[Construction Phase]** Temporal emission of CO_2 from trucks and heavy machines is predicted. **[Operation Phase]** CO_2 will be emitted from transportation of imported coal with locomotives.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown (further examination is needed, and the impact could be clarified as the study progresses).
D: No impact is expected.

Source: JICA Study Team

11.5.2 TOR for Environmental and Social Consideration Survey for Railway Works

Terms of reference for the spur line is shown in Table 11-11.

Table 11-11 Terms of Reference (Railway Works)

Environmental Item	Survey Item	Survey Method
Air quality	(1) Confirmation of environmental standards (NEQS, IFC, etc.) (2) Current condition of air quality (3) Confirmation of location of residential area, school, hospital, etc. around the project site (4) Impact during construction	(1) Collection of air quality standards (2) Collection of meteorological data (temperature, humidity, wind direction and wind speed, etc.) Measurement of ambient air quality (baseline) (3) Site investigation (4) Confirmation of construction method
Water quality	(1) Confirmation of environmental standards (NEQS, IFC, etc.) (2) Current condition of surface water (the Indus River, pond) and groundwater quality	(1) Collection of drinking water quality standards and effluent quality standards (2) Measurement of groundwater quality
Soil quality	(1) Oil leakage prevention measures during construction and operation (2) Current condition of surface soil quality	(1) Confirmation of construction method (2) Measurement of soil quality
Wastes	(1) Domestic waste during construction	(1) Hearing with project component
Noise and vibration	(1) Confirmation of environmental standards (NEQS, IFC, etc.) (2) Distance between the site and residential area, school, hospital, etc. (3) Current condition of noise and vibration	(1) Collection of standards for noise and vibration (2) Site investigation (3) Measurement of current noise (baseline)

Environmental Item	Survey Item	Survey Method
Resettlement	- Land and assets to be relocated - Residence (affected people) to be economically or physically relocated - Renters, businesses, workers, employees, and people without allocation (squatters and encroachers) - Replacement cost for land and assets (farm land, urban land, houses, and other structures) - Supplementary measure for loss of assets	- Analysis of legal frameworks - Collection of reference material - Analysis on satellite image - Population census survey - Collection of land record and assets inventory - Socioeconomic survey (interviews, public meeting, group discussion, and site investigation)
People below poverty line	- Presence and state of affected people below poverty line	- Collection of reference material - Collection of land record - Socioeconomic survey - Population census survey - Income and livelihood survey - Interviews, public meeting, group discussion, and site investigation
Living and livelihood/regional economy	- Baseline information on livelihoods and standards of living of affected people	- Collection of reference material - Socioeconomic survey - Income and livelihood survey - Site investigation and interview to affected people, labor's association, local government, and NGO
Land and resources	- Baseline information on land use - Baseline information on local resources	- Collection of reference material - Analysis on satellite image - Analysis of land use map - Site investigation and interview
Water use	- Baseline information on use of river water and groundwater for different purposes i.e. drinking and irrigation	- Collection of reference material - Analysis of water management record - Interviews to local government - Site investigation
Infrastructure and social services	- Transporting route of construction materials and equipment - Transporting route of coal - Location of social infrastructures (school, hospital, and other services)	- Analysis on satellite image - Analysis of land use map - Site investigation to understand geographic relations of roads and infrastructures - Interviews to local government
Social capita, institutions, and conflicts	- Baseline information of social capita and relation of institutions.	- Interviews to local government
Gender and child	- Baseline information of women's role and work state (especially in families of fishermen) - Baseline information of child labor and school drop-out (especially in families of fishermen)	- Socioeconomic survey - Income and livelihood survey - Site investigation and interview to affected people, fishermen, labor's association, local government, and NGO
Infectious diseases (HIV/AIDS)	- Infection rate of diseases such as respiratory diseases and HIV/AIDS in the local community - Local NGOs conduct activities regarding infectious disease	- Collection of reference materials - Interviews to local government, medical facilities, and NGOs

Environmental Item	Survey Item	Survey Method
Working Conditions	- Potential hazards to workers during construction and operation phase - Potential health risk to workers - Baseline information of labor forces	- Requirements and guideline of occupational health and safety in Pakistan - Environmental, Health, and Safety Guidelines (EHS Guidelines) - Collection of reference material (similar projects' EIA) - Interview with local government, NGOs, labors association
Accident	- Potential hazards to workers during construction and operation phase - Time, route, and area of public movement	- Analysis of satellite image - Analysis of land use map - Collection of reference material (similar projects' EIA) - Interviews
Stakeholder consultation	- Stakeholder's states and the relations - Concerns and comments on project - Baseline information	- Stakeholder meetings - Public consultations - Focus group interviews - Individual interviews
Climate change	- Emissions of CO_2 from trucks and heavy machines	- Confirmation of construction method

Source: JICA Study Team

11.5.3 Environmental Impact Asseccement for Railway Works

(1) Impacts at Construction Site

Some of the environmental and social impacts of construction activities are related to activities at the spur line and loop line construction site; whereas, others are related to the setting up and operation of the construction crew camp (only for the spur line). Typical issues include the following:

- Site clearance leading to dust emission,
- Removal of vegetation leading to loss of vegetative cover,
- Erosion and sedimentation due to large scale earthwork,
- Air quality impact from operation of construction machinery and earthwork,
- Noise and vibration from machinery and construction work,
- Generation of waste and its disposal,
- Off–site impacts such as those related to borrow pits,
- Disposal of effluent from construction camp,
- Impact of storm water on the surrounding areas, and
- Cultural impact related to presence of non–local workers.

Many of the construction impacts are temporary and end with the completion of the construction activity. However, poor management can result in long–term residual impacts.

(2) Disposal of Waste from Construction Works

Solid Waste

The spur line and loop line construction and installation activity can generate considerable amount of solid waste. It will include metals, concrete, wood, cotton, plastic, paper, packing materials, and insulation material. Different types of hazards are associated with some of the waste material. Some hazards are the following:

- Sharp edges in metals,
- Tripping hazards if material is left in the pathways,
- Soil contamination from leaking oil from equipment,
- Slipping hazard from oil on floors,
- Potentially toxic content,
- Dust and soot, and
- Respiratory disorders.

Wastewater

The wastewater will be generated during construction work; the associated hazards are as follows:

- Camp sanitary waste—biological hazard leading to potential spread of disease.
- Camp washing waste—corrosion and contamination of land and soil.
- Wash water from workshop—oil and grease.
- Storm water runoff—oil and grease and other contamination.

(3) Construction Noise

Noise is defined as a loud, undesired sound that interferes with normal human activities. If it affects the well–being of the surrounding community (environmental noise), it is considered a nuisance. Exposure to very high noise levels (exceeding 85 dB(A)), particularly for prolonged period can cause hearing loss.

The noise during the construction phase greatly depends on the stage of construction work and equipment used at the site. The construction activities can be divided into the following phases:

- Site clearing and preparation,
- Excavation and pile driving,
- Foundations and concrete placement, and
- Delivery of equipment and materials to the site.

The NEQS for ambient noise and IFC Guidelines[45] require that noise impacts should not exceed daytime[46] levels of 55 dB(A) and nighttime levels of 45 dB(A), or result in a maximum increase in background levels of 3 dB at the nearest receptor located off–site.

(4) Occupational Health and Safety Risks

During the construction phase, other than environmental impact, the proposed project can also increase the risk of exposing the workers and employees of the construction team and their contractors to occupational and safety hazards.

(5) Socioeconomic Impacts

Project activities can potentially have both positive and negative impacts on the existing socioeconomic environment of the study area as well as of the broader region. The positive impacts mainly include increased job opportunities and secondary business opportunities during construction.

The potential adverse impacts include the following:

- Physical or economic displacement as a result of land acquisition,
- Changes in income source patterns as a result of economic displacement, and
- Changes in values and norms of the local culture as a result of social interaction between the local communities and incoming labors.

Each of these is discussed below.

Changes in Employment and Local Economy

The project will create new job opportunities both during construction. During construction period, during peak time, approximately 300–400 people may be hired and local people will be ***given*** priority. Job experience during construction periods and/or the skill training and

[45] IFC General EHS Guidelines: Environmental Noise Management

[46] Defined as 07:00–22:00 by IFC and 06:00–22:00 by NEQS

capacity building activities provided in this project as a part of the social augmentation will open up new job fields and opportunities for the local residents.

The project will increase job opportunities though, child labor should be avoided.

Physical or Economic Displacement

Additional land will be required for the project. Both physical and economic displacement will be involved. Without livelihood restoration measures and appropriate support, those who will be displaced will be adversely affected.

Other Changes in Social Environment

Social Conflicts: With the influx of labor force and other staff related to the construction activities, conflicts with the local people on cultural issues may arise and the local custom and norm may be affected.

Disturbance to Society: During the construction phase, the general mobility of locals and their livestock around the project area will be affected. The movement of the heavy equipment may increase traffic congestion and accident, and affect mobility of the locals.

Gender: Influx of migratory labor during construction works may increase impact on women's daily activities, privacy of women, and/or increase possibility of abuse to local women.

Infectious Diseases: Influx of migratory labor during construction works may increase the risk of infection.

Working Condition and Accident: Projects are exposed to the risks of accident and spread of infectious diseases especially during construction period.

(6) Operations Impact

Impact of Coal Dust

Coal is transported using open wagons. This is the standard practice worldwide. Although, there are some recent studies to assess the possibilities of covered wagons, but due to low risk and technological and operational hindrances, this is not practicable so far.

Coal dust can be from sources in the coal train. These include coal surface of the loaded wagons, leakage from doors of loaded wagons, spill from wagon doors and wind erosion of spilled coal in corridor, and leakage and emission of residual coal in unloaded wagons.[47] The factors that affect the emission of coal dust from coal wagons are the following:[48]

- Car and load geometry (rail car dimension, coal load profile, and total exposed surface area of coal),
- Coal physical properties (coal moisture content and coal size distribution),
- Trip specifics (train speeds throughout the route, load jostling in the route, total journey length, and weather—wind, precipitation, and temperature), and
- Dust controls (control measure effectiveness).

Various attempts have been made to estimate the rate of fugitive coal dust emissions from coal trains. However, there is still lack of clear information about how much coal is lost through fugitive dust in transit.[49] The estimates range from 0.5% to 3% of total coal transported.[50]

It has been reported that fugitive coal dust from in–transit coal cars does not appear to violate ambient air quality.[51] The estimate of coal dust from the proposed coal train is calculated as shown in Table 11-12.

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47 Connell Hatch. Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains Goonyella, Blackwater and Moura Coal Rail Systems Queensland Rail Limited. 31 March 2008. http://thegenerator.com.au/wordpress/wp–content/uploads/2013/05/Coal_DustLoss_Management_Project_Environmental_Evaluation.pdf. Accessed August 2015.

48 Robert Kotchenruther. Fugitive Dust from Coal Trains: Factors Effecting Emissions & Estimating PM2.5, USEPA, 2013. http://lar.wsu.edu/nw–airquest/docs/201306_meeting/20130606_Kotchenruther_coal_trains.pdf. Accessed August 2015.

49 Robert Kotchenruther. Fugitive Dust from Coal Trains: Factors Effecting Emissions & Estimating PM2.5, USEPA, 2013 (http://lar.wsu.edu/nw–airquest/docs/201306_meeting/20130606_Kotchenruther_coal_trains.pdf)

50 Ibid.

51 Calvin, EM and Williams, JE. A Rail Emission Study: Fugitive Coal Dust Emission and Mitigation (http://www.powerpastcoal.org/wp–content/uploads/2011/08/a–rail–emission–study–fugitive–coal–dust–assessment–and–mitigation.pdf)

Table 11-12 Quantification of Coal Dust Emission from Coal Trains

Parameter	Quantity
Total Coal	2,000,000 tons
Distance Covered	
Bin Qasim to Kotri	131 km
Kotri to Lakhra	40.3 km
Emission Factor[52]	
Bin Qasim to Kotri	0.1516 g/km/ton of coal
Kotri to Lakhra	0.0526 g/km/ton of coal
Total Emission	
Bin Qasim to Kotri	39.72 tons
Kotri to Lakhra	4.23 tons
Total Emissions	43.95 tons

Source: Hagler Bailly Pakistan

The estimated amount contains particles of all sizes. Generally, large dust particles (greater than about 30 µm) will largely deposit within 100 m of sources. It is only the smaller particles that are likely to travel to larger distances. In terms of health impact, the greatest concern is particles less than 2.5 microns, followed by particles less than 10 microns. It has been reported that coal dust particles associated with rail transport are most likely to be present as larger dust particles that settle from the air, but some will exist as PM_{10} particles.[53] Complete estimate of particle size distribution of coal dust is not available. Studies[54] have reported that minimal amount of coal dust found through sampling and analysis and only a limited portion of the sampled material is of the particle size PM_{10}. Furthermore, $PM_{2.5}$ is unlikely to be present in the coal dust since this pollutant is generally generated in the combustion process. This observation is corroborated by monitoring of coal dust in studies such as in Australia; monitoring results showed that ambient particle concentrations complied with ambient air quality standards for both PM_{10} and $PM_{2.5}$ concentrations.[55]

Noise Impacts

The impact assessment for noise on settlements within the proximity of the railway line required the determination of the level of noise, in decibels (dB), which will reach the receptor

52 Based on train speed.

53 Western – Metropolitan Rail Systems Coal Dust Monitoring Program. State of Queensland (Department of Science, Information Technology, Innovation and the Arts), 2013

54 Air Quality Evaluation Report Dust from Rail Transportation of Coal. Treasure State Resource Industry Association. 2014.

55 Western – Metropolitan Rail Systems Coal Dust Monitoring Program. State of Queensland (Department of Science, Information Technology, Innovation and the Arts), 2013

populations within that proximity.

To determine this, the approach to the methodology was to carry out noise modelling. This was done for a single train and its noise impacts on a single receptor. The parameters measured include the noise level of the train and the duration of passage of the train. This approach was chosen because the train chosen to be used for modelling was an old train, hence, its noise levels relative to the trains currently being used will be higher. This means that the noise impacts of current trains will be lower compared to this train. Furthermore, the train used in the modelling is slower compared to current trains, hence, the duration of exposure of a single receptor to the current trains will be relatively shorter. However, the current trains are expected to be larger than the train used in modelling, therefore, duration of exposure could be longer than that for the train used in modelling. But considering that the current trains are faster (as state earlier), their size being greater could be compensated by their increased speed.

Noise Measurements at a Site Along the Railway Line Under the Study

Noise measurements were carried out by HBP staff during April 2014 for an EIA for a preparatory survey for the construction of the Lakhra Coal-fired Thermal Power Plant at the Lakhra Site. Additional data was then collected in June 2016 for 19 trains of different categories on the main line near Kotri. The results are presented in 11.2.1, (4).

Determination of Variation of Noise levels (in dB) with Distance

The determination of the variation of noise level (in dB) with distance was carried out using the following relationship between noise and distance:

$L_p = L_m – 20[\log(r/rm)]$

Where,

L_p = sound pressure level at desired location (dB)

L_m = sound pressure level at location of measurement (dB)

r = distance from source to desired location (m)

r_m = distance from source to location measured (m)

This relationship was obtained from an academic paper reference Prof. Hansen. H. C., Fundamentals of Acoustics, Department of Mechanical Engineering, University of Adelaide, South Australia 5005, Australia.

Train Traffic

The train traffic (in number of trains) along the railway line for the two baseline conditions “Present Traffic” and “Peak Traffic” of the three track segments (Karachi to Kotri, Kotri to Jamshoro, and Jamshoro to Budapur) are presented in Table 11-13. “Present Traffic” refers to the present level of train traffic on the tracks, whereas “Peak Traffic” refers to the peak level of train traffic based on past train activity. Note that the present train traffic is less than the historical peak recorded on the segments.

Table 11-13 also provides the expected traffic for coal transportation for four different conditions. In this, “Addition of Lakhra” refers to the train traffic if the proposed Lakhra Plant is developed, “Addition of Jamshoro” refers to the train traffic if the proposed Jamshoro Plant is developed, “Addition of Sahiwal” refers to the train traffic if the proposed Sahiwal Plant is developed, and “Addition of Other” refers to the train traffic due to other planned power plants in Punjab.

Table 11-13 Number of Trains per Day for Various Conditions

Development Options	Traffic Activity	Karachi to Kotri			Kotri to Jamshoro			Jamshoro to Budapur		
		P	F	T	P	F	T	P	F	T
Baseline										
A	Peak	50	24	74	8	2	10	8	2	10
B	Present	38	14	52	4	0	4	4	0	4
Coal Trains										
C	Addition of Lakhra	–	6	6	–	6	6	–	6	6
D	Addition of Jamshoro	–	10	10	–	10	10	–	–	
E	Addition of Sahiwal	–	10	10	–	–		–	–	
F	Addition of Other*	–	36	36	–	–		–	–	

P = Passenger; F = Freight; T = Total

Source: Hagler Bailly Pakistan

Table 11-14 shows the possible traffic activity for possible future scenarios (combination of four development options against two possible baseline conditions). It shows that for each development option, there is a specific number of trains. Those numbers will vary based on additional projects undertaken at Lakhra, Jamshoro, Sahiwal, and any others which may cause an incremental increase.

Four scenarios were developed for both peak activity (worst case from an EIA perspective) and an expected case (present case). This is considered the expected case because the present policies and plans of PR do not indicate any significant possible increase in train traffic over the next few years.

Table 11-14 Modeling Scenarios

Scenarios	Karachi to Kotri	Kotri to Jamshoro	Jamshoro to Budapur
Case 1: Peak activity (Worst Case)			
P1 (historic peak of passenger and freight trains—A)	74	10	10
P2 (Baseline: historic maximum, Jamshoro and Sahiwal—P1 + D + E)	94 (74+10+10)	20 (10+10)	10
P3 (Project impact: baseline and Lakhra—P2 + C)	100 (94 + 6)	26 (20+6)	16 (10+6)
P4 (Cumulative: project impact and other Punjab plants—P3 + F)	136 (100+36)	26	16
Case 2: Current Activity (Expected Case)			
R1 (Current passenger and freight train—B)	52	4	4
R2 (Baseline: current trains, Jamshoro and Sahiwal—R1 + D + E)	72 (52+10+10)	14 (4+10)	4
R3 (Project impact: baseline and Lakhra—R2 + C)	78 (72+6)	20 (14+6)	10 (4+6)
R4 (Cumulative project impact and other Punjab plants—R3 + F)	114 (78+36)	20	10

Source: Hagler Bailly Pakistan

Assumptions About Calculations for Noise Levels Due to Passage of Train Traffic

A number of assumptions were made about train traffic and activity before calculating noise impacts under different scenarios. These include the following:

- All trains have the same speed and will be passing past the receptor for the same period as train 2 (5 minutes),
- Passenger and freight trains will be considered identical in terms of their noise impacts, and
- All trains are identical, hence, have the same noise levels.

Limitations of the Calculations

The calculation method does not take into account variations in the following:

- Speed of trains,

- Noise levels of trains,
- Duration of passage of trains past a receptor, and
- Time of day passage of train.

Noise Impacts

For the purpose of assessment, the noise level at Current Activity Level (Case 2) and the impact at a standard distance of 100 m is considered.

The variations in noise levels within the distance were calculated using the relationship identified earlier. The current noise levels on the three segments, separated by urban and rural areas and by day and night, is presented in Table 11-15- The observations based on the calculations are as follows:

1. The current noise levels at 100 m from the mainline (Karachi to Kotri Segment) is above the NEQS. It is also above the NEQS in the urban areas (Jamshoro) of the Kotri to Jamshoro segment. Whereas in the rural areas from Kotri to Budapur, the noise level is within NEQS.
2. The predicted noise levels for pre-project (before commissioning of the Lakhra Plant) and post-project (after commissioning of the Lakhra Plant) show that typical increase on the mainline will be less than 1 dB(A) on the mainline and the Kotri to Jamshoro segment. On the Jamshoro to Budapur segment, the increment will be between 3 to 4 dB(A).

Table 11-15 Predicted Noise Levels

Segment and Scenario	***Rural Area***		***Urban Area***	
	Day	***Night***	***Day***	***Night***
Karachi to Kotri Segment				
Current	55.0	53.2	–[a]	–
Current + Jamshoro + Sahiwal	56.3	54.5	–	–
Current + Jamshoro + Sahiwal + Lakhra	56.6	54.9	–	–
Kotri to Jamshoro				
Current	48.4	44.9	61.4	56.1
Current + Jamshoro	52.7	50.6	61.8	56.9
Current + Jamshoro + Lakhra	53.7	51.8	61.9	57.2
Jamshoro to Budapur				
Current	48.4	44.9	–[a]	–
Current + Lakhra	50.8	48.2	–	–

a. There are no urban areas on this segment.

Source: Hagler Bailly Pakistan

3. Typically, any change in noise level less than 3 dB(A) is not noticeable to human ears. In this respect, the increase of noise on the Karachi to Kotri and Kotri to Jamshoro segments due to the trains carrying coal for the Lakhra Plant will not be significant.
4. On the Jamshoro to Budapur segment, the increase in noise level during the day will be less than 3 dB(A), and the post-Lakhra noise level is predicted to be less than the NEQS. The increase in noise level during the night is likely to be higher than 3 dB(A) as well as above the NEQS.

The distances at which the noise levels were equal to or in excess of 45 dB(A) were identified as cutoff points. These cutoff points are summarized in Table 11-16. The cutoff was determined as 45 dB(A)—or 48 dB(A), if the noise level is close to 45 dB(A) in the vicinity—based on the nighttime NEQS for ambient noise. Any settlements falling within these distances were considered at risk from the adverse impacts of noise pollution caused by train traffic.

Table 11-16 "Cutoff Points"—Distance to 45 dB(A)

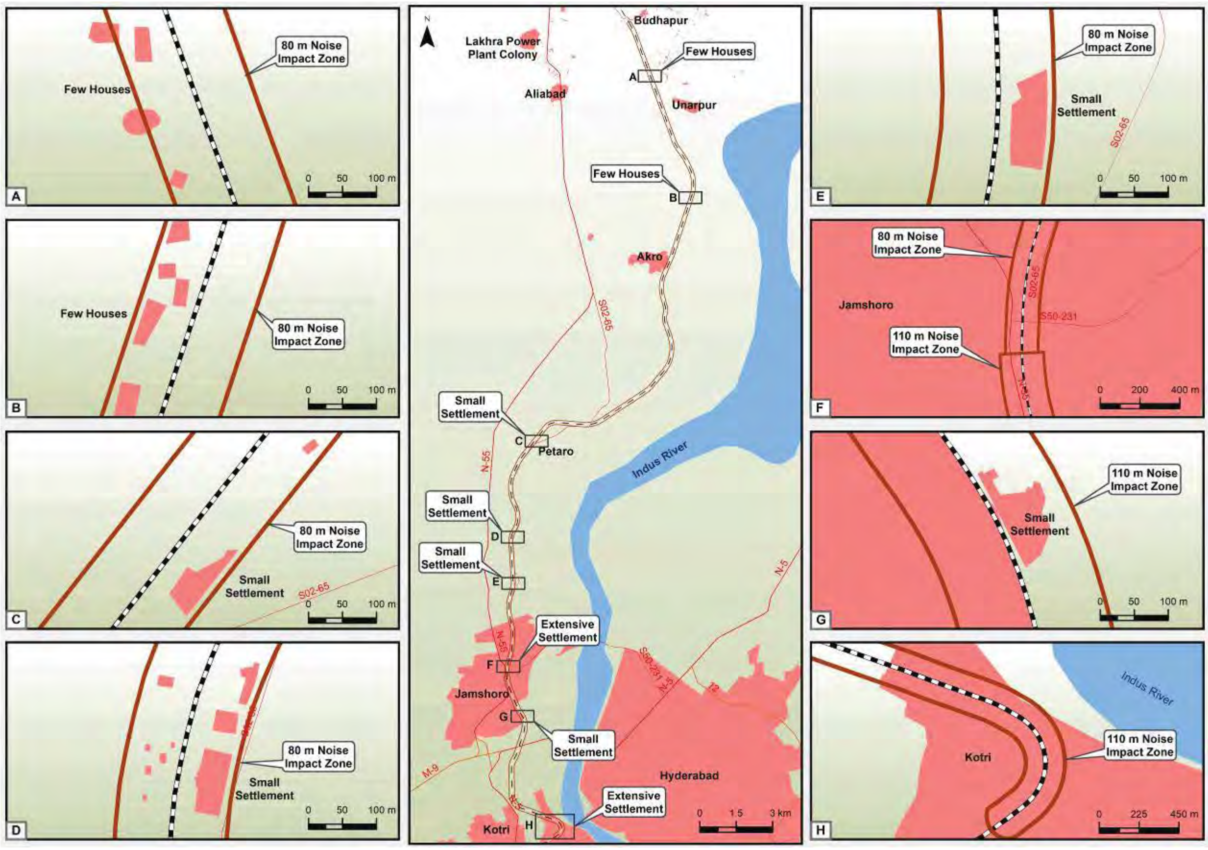
Segment	*Karachi to Kotri*	*Kotri to Jamshoro*	*Jamshoro to Budapur*
Worst Case (P3)	300 m	130 m	100 m
Realistic Case (R3)	270 m	110 m	80 m

Note: Values are rounded to the nearest 10 m.

Source: Hagler Bailly Pakistan

It is unlikely that the passenger and freight trains traffic will reach their historic peak in the near future. Therefore, the most likely condition is that there will be train traffic in the Karachi to Kotri segment under present activity including train traffic associated with Lakhra, Jamshoro, and Sahiwal.

With respect to the Kotri to Jamshoro segment, a zone on either side of the railway track at distances given for the most likely occurrences were marked. In the case of Kotri to Jamshoro, this was 110 m. In the case of Jamshoro to Budapur, this was 80 m. Within these respective ranges, all receptors are at risk of receiving noise levels of 45 dB(A) or more. These markings can be observed in the map shown in Figure 11-15, marked as noise impact zones with their respective distances (110 m or 80 m). Figure 11-15 shows the noise impact zones. The central map shows the railway line extending from Kotri to Budapur. It also shows the station of Jamshoro, where an extensive settlement is evident. Along the railway track, eight settlements were identified which were falling within the noise impact zones (110 m or 80 m). These settlements are shown in detail together with the railway track and their respective noise impact zones in images A through H on either side of the central map.



Source: Hagler Bailly Pakistan

Figure 11-15 Noise Impact Zones (Realistic Case)

In images A and B, it can be seen that only a few houses fall within the 80 m noise impact zone. In images C, D, and E, small settlements fall within the 80 m noise impact zone. Image F shows the railway line passing through the relatively extensive settlement of Jamshoro where a much larger absolute amount of settlement falls within both noise impact zones as compared to the other points on the track, comprising only small settlements and a few houses. In image G, the point is located at the start of the settlement at Jamshoro; therefore, only a small settlement is located within the noise impact zone. At Kotri, like in Jamshoro, a relatively larger portion of the settlement is located in the noise impact zone since there is greater population density relative to the other points.

Figure 11-15 clearly shows at risk populations within the noise impact zones for both Kotri to Jamshoro and Jamshoro to Budapur segments. Along the two settlements at Kotri and Jamshoro, the greatest concern, in terms of numbers, lies with the railway line passing through the relatively larger settlements in the segments. Other settlements in the segments are small or composed of only few houses.

Similar mapping for Bin Qasim to Kotri segment is considered unnecessary because the volume of Lakhra traffic is just a small fraction of the total train traffic.

Given the low and marginal risk due to the project and uncertainties in prediction, no mitigation measure is proposed at this time. A general guidance is provided that to the extent possible, the coal trains will be operated during the day and the use of horns will be minimized.

To avoid any future risk, a noise monitoring program will be initiated to identify areas of noise impact so that mitigation measures can be planned.

Ecological Impacts

Any activity associated with the proposed project is not going to encroach upon any wildlife habitat or affect any habitat of any ecologically sensitive areas. However, the upgrading works of bridges might have some impacts on ecosystems in the river. To avoid such impact, less impact method should be considered by contractors.

Community Safety

Train accidents at level crossings accounted for 75% of train accidents of PR in 2012, with seven times more accidents occurring at unmanned crossings as compared to manned crossings. Between Kotri Junction and Budapur Station there are four manned and four unmanned crossings. In addition to crossings for vehicles, communities along the railway track noted the need for pedestrian and animal crossings, and the high rate of accidents that took place due to the absence of such crossings during consultations. It is expected that with the increase in rail traffic will lead to the increase in accidents along this route. A community safety monitoring plan will be initiated.

Cumulative Impacts

The cumulative impacts of the proposed project are related to the followings activities:

1. Noise impacts of other trains in the noise corridor, and
2. Coal dust impacts of other coal trains.

The noise impact assessment done above sections includes the cumulative impact of other trains. The coal dust impact in the train corridor will increase because of additional coal trains. In general, the impact may be five to six times of that of the coal for Lakhra.

(7) Impact Assessment for Railway Project

The result of the environmental and social impact assessment due to the railway project after applying above mitigation measures is presented in Table 11-17.

Table 11-17 Result of Environmental and Social Impact Assessment (Railway Works)

No.	Item	Assessment of Scoping		Assessment of Survey Result		Assessment Reason
		Pre/During Construction	Operation	Pre/During Construction	Operation	
Pollution Control						
1	Air quality	B-	B-	B-	B-	**[Construction Phase]** Exhaust and soil dust will be emitted from construction vehicles and machinery, earthwork, and site clearance. **[Operation Phase]** Coal dust might diffuse through coal transportation. Air pollution derived from spontaneous ignition during coal transportation is predicted.
2	Water quality	B-	B-	B-	B-	**[Construction Phase]** Effluent will be generated from construction activities (e.g. storm water run-off, oil and grease-contaminated water, and domestic wastewater from construction site and crew camp). **[Operation Phase]** Oil and coal dust might spill or leak from coal wagons along the railway and pollute surface water and groundwater.
3	Soil quality	B-	B-	B-	B-	**[Construction Phase]** Spill over or leaking of oil from construction vehicles and machines can impact soil quality. **[Operation Phase]** Oil and coal dust from coal wagons might leak along the railway and pollute the soil.
4	Wastes	B-	D	B-	D	**[Construction Phase]** Solid waste will be generated from construction activities (e.g. metals, concrete, wood, cotton, plastic, paper, packing materials, insulation material, and hazardous wastes)
5	Noise and vibration	B-	A-	B-	B-	**[Construction Phase]** Noise and vibration will be generated from construction activities such as site clearance and preparation, excavation and pile driving, foundations and concrete placement, and delivery of equipment and materials to the site. **[Operation Phase]** Noise and vibration will be increased along the railway track. However, the increase in the noise level after commissioning of the Lakhra Plant will be less than 1 dB(A) on the mainline of Karachi to Kotri and the Kotri to Jamshoro segment, and between 3 to 4 dB(A) on the Jamshoro to Budapur segment.
6	Subsidence	D	D	D	D	**[Construction and Operation]** No subsidence will occur.
7	Odor	B-	B-	B-	B-	**[Construction Phase]** Odor can be generated from domestic wastes and latrines at base camps of contractor. **[Operation Phase]** Odor derived from spontaneous ignition during coal transportation is predicted.

No.	Item	Assessment of Scoping		Assessment of Survey Result		Assessment Reason
		Pre/During Construction	Operation	Pre/During Construction	Operation	
8	Sediment quality	B-	D	B-	D	**[Construction]** Erosion and sedimentation will be expected due to large scale earthwork for the spur line.
Natural Environment						
9	Protected areas	D	D	D	D	**[Construction/Operation Phase]** There is no protected areas nor ecological sensitive areas along the project area.
10	Ecosystem	B-	D	B-	D	**[Construction]** Construction activities can have impact on ecosystem, especially on aquatic ecosystem in surface water bodies.
11	Hydrology	D	D	D	D	**[Pre-construction/Construction/Operation Phase]** No impact on hydrology is predicted.
12	Topography and geology	B-	D	B-	D	**[Construction Phase]** Small-size topographical change can be predicted due to the route of spur line and location of conveyor.
Social Environment						
13	Resettlement	C-	C-	B-	B-	**[Pre-construction Phase/Construction/Operation Phases]** The project will acquire 33.97 acres of land including governmental, residential, and cultivated and uncultivated land. Of these land, 33.04 acres are private land of 30 households (222 people). Of the 30 affected households, six households will be physically relocated and five households will lose a part of their livelihood from loss of cultivated land.
14	People below the poverty Line	C-/C+	C-/C+	B-	B+	**[Pre-construction/Construction/Operation Phases]** Out of the 30 affected households, four households were identified as poor with income below the poverty line. However, they will only lose uncultivated land and there is no loss of income source. **[Construction and Operation Phase]** Job creation and provision of job training would impact positively.
15	Living and livelihood	B-/C+	C-/C+	B-/B+	B-/B+	**[Pre-Construction Phase]** Five households will lose a part of their livelihood from loss of cultivated land. **[Construction Phase]** Temporary traffic increase can disturb the existing traffic and may lead to adverse impact on regional economic activities. **[Construction and Operation Phase]** Coal transportation increase can disturb the existing traffic. It will also increase the risk of accidents involving locals and their livestock. Job creation and provision of job training would impact positively.
16	Use of land and resources	C-	C-	B-	B-	**[Construction Phase]** Long construction activities can disturb use of land and mobility of locals and livestock along railway track and new spur line. **[Construction and Operation Phase]** Use of land under the overhead bridge of the spur line will be changed.

No.	Item	Assessment of Scoping		Assessment of Survey Result		Assessment Reason
		Pre/During Construction	Operation	Pre/During Construction	Operation	
17	Water use	C-	B-	B-	B-	**[Construction Phase]** Temporary contamination of surface water and groundwater due to construction activities can affect water use for drinking, agriculture, and fishing. **[Operation Phase]** Oil and coal dust might spill or leak from coal wagons along the railway and pollute surface water and groundwater.
18	Infrastructure and social services	B-	D	B-	B-	**[Construction Phase]** Construction works across the existing roads can temporary disturb traffic. **[Operation Phase]** Increase in coal transportation trains can disturb traffic at intersection of road and railway.
19	Social capita, institutions, and conflicts	C-	C-	B-	D	**[Pre-construction Phase]** Differences in acceptance of the project, and loss of land, residences, income source among local communities, and changes of cultural value and norms between the local communities and incoming labors can create changes in social relation and conflicts.
20	Landscape	C-	C-	C-	B-	**[Construction Phase]** No significant impact is expected. **[Operation Phase]** Changes in landscape will be expected because of existence of overhead bridge of the proposed spur line in agricultural and residential lands.
21	Gender	C-	C-	B-	D	**[Construction Phase]** Influx of migratory labor during construction works may increase impact on women's daily activities, privacy, and possibility of abuse of local women. **[Operation Phase]** Significant impacts specific on women are not expected.
22	Child right	C-	C-	D	D	**[Construction Phase]** It will be made sure that children will not be employed in the project. **[Operation Phase]** Significant impacts specific on children are not expected.
23	Infectious diseases	B-	D	B-	D	**[Construction Phase]** Influx of workers can increase risks in respiratory and infectious disease.
24	Working condition and accident	B-	B-	B-	B-	**[Construction Phase]** Risks of accident and spread of infectious diseases will possibly increase. **[Operation Phase]** Accident could occur in the work environment.
Others						
25	Transboundary of waste treatment and climate change	B-	B-	B-	B-	**[Construction Phase]** Temporal emission of CO_2 from trucks and heavy machines is predicted. **[Operation Phase]** CO_2 will be emitted from transportation of imported coal with locomotives.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown (further examination is needed, and the impact could be clarified as the study progresses).
D: No impact is expected.

Source: JICA Study Team

11.5.4 Mitigation Measures and Environmental Management Plan for Railway Works

(1) Mitigation Measures

a) Impact at Construction Site

Many of the construction impacts are temporary and end with the completion of the construction activity. However, poor management can result in long–term residual impacts. To avoid adverse impact of the construction activities on the environment, the following measures will be taken:

1. The camps of the construction contractor(s) will be located at least 250 m from any community.
2. The construction contractor will be required to develop a site–specific construction management plan (CMP) based on the CMP Framework included in the environmental management plan (EMP). Separate CMP will be developed for each loop line and for the spur line project. The CMP will be submitted to the PR or Lakhra Power Generation Company Limited (LPGCL) and the project implementation consultant (PIC) for approval.
3. Each CMP will contain a site plan of the construction site. The site plan will cover all areas that will be utilized during construction for various purposes. These will include, for example, the following:
    - Areas where construction will take place,
    - Areas where wearing personal protective equipment (PPE) is mandatory,
    - Areas used for camp and offices,
    - Storage areas for raw material and equipment,
    - Waste yard,
    - Location of any potentially hazardous material such as oil,
    - Parking area,
    - Area reserved for loading and unloading of material,
    - Septic tanks,
    - Storm water runoff direction and control measures, and
    - Bridges to be upgraded.

b) Waste Disposal from Construction Works

Solid Waste

A comprehensive waste management plan will be instituted by the project and reuse opportunities for waste generated during construction will be investigated. Hazardous waste identified, if any, will be stored in the proposed hazardous waste storage facility at the power plant site.

As a standard practice, all metal (mainly iron and copper) parts generated as waste will be recycled. Similarly, wood will also be recycled.

Wastewater

The wastewater that will be generated during construction work, will be handled as follows:

- Camp sanitary waste (biological hazard leading to potential spread of disease)—Septic tanks will be constructed to contain the waste. Wastewater from the septic tank will be emptied out before closure of camp or periodically and discharged to a municipal treatment plant. Alternatively, a packaged wastewater treatment unit will be installed

- Camp washing waste (corrosion and contamination of land and soil)—Wastewater will be screened, neutralized, and will be used for plantation.

- Wash water from workshop (oil and grease)—Wastewater will be screened; oil and grease will be separated using API separator, neutralized, and will be used for plantation

- Storm water runoff (oil and grease and other contamination)—Drainage from area containing potentially hazardous material will be separated from the rest. Runoff from these areas will be directed to a settling basin. It may be further treated if required before discharge. The runoff discharge point will be selected so that the contaminated water does not go to agricultural fields.

c) Construction Noise

The NEQS for ambient noise and IFC Guidelines[56] require that noise impacts should not exceed daytime[57] levels of 55 dB(A) and night–time levels of 45 dB(A), or result in a maximum increase in background levels of 3 dB at the nearest receptor location off–site.

[56] IFC General EHS Guidelines: Environmental Noise Management

[57] Defined as 07:00–22:00 by IFC and 06:00–22:00 by NEQS

Noise will be measured and monitored around the periphery of the construction site to assure that permissible limits are not exceeded. An alarm system will be employed to alert the main control room when any of the detectors indicate excessive noise levels. The detectors will be installed at critical receptor areas, such as hospital, school, and residential areas. These detectors will be checked and calibrated periodically by plant personnel.

d) Occupational Health and Safety Risks

An occupation health and safety management system could control and manage risks. There is no explicit occupational health and safety law in Pakistan. To certain extent, it is covered in the Factory Act 1934 and Sindh Factories Rules 1975. The following measures will be taken to minimize the impacts:

- A workplace health and safety policy will be developed and communicated to workers, visitors, and contractors.
- Hazards and potential risks to health and safety (including community in the vicinity of the construction work) will be identified.
- Measures will be implemented to eliminate or minimize the level of these risks (including the documentation of steps undertaken so that all people are given the highest level of health and safety protection from hazards arising from work, so far as is reasonably practicable).
- It will be ensured that employees, visitors, and contractors are provided with safety equipment and that the equipment area used when undertaking works or visiting the hazardous sites.
- Prior to commencing work, a job hazard analysis will be undertaken. The results of the analysis will be shared with all concerned persons.
- Responsibilities and accountabilities for health and safety management will be assigned to specific person within the construction team.
- The requirement for trainings will be assessed and workers will be trained accordingly.
- A reporting and recording system for workplace health and safety incidents implemented.
- Progress and achievements of the occupational health and safety system will be monitored on an ongoing basis.
- Appropriate emergency procedures associated with events such as fire, fall, and gas or chemical leaks will be developed and implemented.

e) Socioeconomic Impacts

Changes in Employment and Local Economy

During construction period, at the peak time, approximately 300–400 people may be hired and local people will be ***given*** priority. However, the project will prohibit labor contracts with children.

Physical or Economic Displacement

The land will be acquired through the principles and standards laid out under Pakistan Land Acquisition Act 1894, JICA ***Guideline*** (2010), and World Bank Safeguard Policy OP 4.12 Annex A. Based on the requirement, the affected people will be compensated adequately for their loss due to resettlement.

To minimize the impact of both physical and economic displacement, fair, prompt and negotiated compensation for their loss will be provided to the affected. Livelihood restoration measures and other support will be provided, and the progress will be monitored.

A separate land acquisition and resettlement action plan (LARAP) will be developed and it will provide a framework of compensation and other support in order to minimize potential impacts and restore livelihood.

Other Changes in Social Environment

Social Conflicts: In order to minimize the social impacts from influx of project labor and other staff related to the construction activities, the contractor will maintain close liaison with the local communities to ensure that any potential conflicts related to the use of common resource and if any, be resolved quickly.

Disturbance to Society: Specific timings for construction work will be planned so to avoid disturbance to the local communities and their mobility during business hours. If necessary, traffic signs, driving safety education, speed restriction, and facilities to check/maintain vehicle equipment will be installed. Also, mobility of the contractor's staff through the nearby residential areas will be prohibited to avoid any inconvenience or risk.

Gender: The contracted labors will be educated and local communities will be consulted and monitored in order to avoid/minimize the impact on women’s daily activities, privacy and/or increase possibility of abuse to local women, resulting from the influx of migratory labor during construction works.

Infectious Diseases: Influx of migratory labor during construction works may increase the risk of infection. To minimize the effects, the project will implement periodic medical check and conduct education programs on health of workers.

Working Condition and Accident:

To control the risks of accidents and spread of infectious disease during construction period, the following mitigation measures are proposed:

- Safety and sanitation management plan will be developed.,
- Regular health check of the labors will be implemented,
- Long–time exposure of workers to noise will be restricted,
- The workers will be directed to wear personal protective gears,
- Construction of temporary first aid station at the working site with nurse, and
- Establishment of cooperative relationship with the local medical facilities.

f) Operations Impact

Emission Controls from Coal Dust

Evidences suggest that coal dust from coal trains is not a significant issue. General precautionary measures may be required to mitigate any potential impact. Some precautionary measures that may be employed, if needed may include, use of suppressants to the surface of the coal profile in wagons, maintaining the freeboard around the edge of the wagon, loading the train to a consistent and even profile, removal of parasitic coal (coal stuck to various parts of the wagon which then leaks when the train moves), frequent checking of doors and underside of the wagons to contain leakage, and periodically cleaning and washing the wagons.

Noise Impacts

Given the low and marginal risk due to the project and uncertainties in prediction, no mitigation measure is proposed at this time. A general guidance is provided that to the extent possible, the coal trains will be operated during the day and the use of horns will be minimized. To avoid any future risk, a noise monitoring program will be initiated to identify areas of noise impact so that mitigation measures can be planned.

Community Safety

During consultations, communities along the railway track noted the need for pedestrian and animal crossings and the high rate of accidents that took place due to the absence of such crossings. It is expected that with the increase in rail traffic will lead to the increase in accidents along this route. A community safety monitoring plan will be initiated.

g) Cumulative Impacts

The cumulative impacts of the proposed project are related to the following activities:

1. Noise impacts of other trains in the noise corridor, and
2. Coal dust impacts of other coal trains.

The noise impact due to operation of other trains is likely to be 0.4 to 1.6 dB(A) higher than the predicted noise levels due to Scenarios P3 and R3. This impact is valid only on the main line. The details are included in the separate EIA for coal transportation between Bin Qasim Station and Lakhra site by railway.

The coal dust impact in the train corridor will increase because of additional coal trains. In general, the impact may be five to six times of that of the coal for Lakhra.

(2) Environmental Mitigation and Plan

The environmental mitigation plan was prepared and given in Table 11-18. The key components of the plan are discussed in the following sections. The environmental and social mitigation plan includes the following:

- Measures that are required to be implemented during the design, construction, and implementation phases of the project are identified;
- For each mitigation measure, the person responsible to implement and monitor the implementation is identified; and
- The timing to implement and the location to implement.

Table 11-18 Environmental Mitigation Plan

Aspect or Concern	Potential Environmental Impact	Environmental Mitigation Measures	When	Institutional Responsibilities	
				Implementation	Supervision
A. Design Phase					
Project disclosure	Stakeholder concerns	Submit EIA to Sindh EPA and obtain approval.	Before start of construction	LPGCL	PR/GHCL
Land acquisition	Effects of resettlement on livelihood	The LARAP will be implemented in accordance with international practices. In case of any changes in the area of the land, the LARAP will be updated before any acquisition of land. Coordination of activities with relevant regulatory government departments such as the DC and the Revenue Department.	Before start of construction	LPGCL/PR	PIC
B. Construction and Implementation Phase					
Construction management	Construction activities although temporary can potentially have adverse impact on the environment.	1. Ensure that a detailed CMP based on the skeleton plan is developed. A separate CMP will be developed for each loop line and for the spur line. Separate CMP will be developed for track upgrade works, if necessary. 2. Ensure that each CMP contains a site plan of the construction site, and the site plan covers all areas that will be utilized during construction for various purposes. 3. Ensure that the camps of the construction contractor(s) are located at least 250 m from any community or waterway. 4. Ensure that all CMPs are submitted to the PR/LFPS and PIC for approval.	Before construction	Contractor	PIC/PR/LPGCL
		Ensure that the CMP is implemented	During Construction	Contractor	PIC/PR/LPGCL
Disposal of replaced construction related spare parts and fluids (oil filters, engine oil, tires, *etc.*)	Generated wastes such as iron, copper, electronics, and oil	Ensure that the waste is disposed as per the waste management plan.	During construction	Contractor	PIC/PR/LPGCL

Aspect or Concern	Potential Environmental Impact	Environmental Mitigation Measures	When	Institutional Responsibilities	
				Implementation	Supervision
Construction noise	Disturbance to community	Ensure that all equipment is tuned and individually meet the NEQS for vehicle noise (85 dB(A) at 7.5 m from the source)	During construction	Contractor	PIC/PR/LP GCL
Socioeconomic					
Changes in social environment	Impacts of the influx of labor force and staff and social conflicts	Maintain liaison with the local community to ensure that conflicts related to the use of common resources, if any, are identified as early as possible, and are resolved in a timely and appropriate manner. Ensure grievance mechanisms and implement regular monitoring.	During construction	Contractor	PIC/PR/LC PGL
	Impacts of the influx of labor force and staff on women	Ensure grievance mechanisms are developed and implemented. Carry out regular review of the efficacy of mechanisms.	During construction	Contractor	PIC/PR/LC PGL
	Impacts of the influx of labor farce and staff on infectious diseases.	Regular health checks of labor and conduct education programs on health of workers.	During construction	Contractor	PIC/PR/LP GCL
	Effects of movement of construction equipment on traffic congestion and movement of people	Specific timings for construction work will be planned to avoid disturbance to the local communities and their mobility during business hours. If necessary, traffic signs, driving safety education, and speed restrictions will be implemented. Regular maintenance of vehicles and associated equipment will be carried out. Mobility of the contractor's staff through nearby residential areas will be controlled and prohibited, where possible, to avoid any inconvenience or risk.	During construction	Contractor	PIC/PR/LP GCL
Occupational health and safety	Exposure to the risks of accident	Ensure that the following measures are implemented: 1. A workplace health and safety policy will be developed and communicated to workers, visitors, and contractors. 2. Hazards and potential risks to health and safety (including community in the vicinity of the construction work) will be identified. 3. Measures will be implemented to eliminate or minimize the level of these	During construction	Contractor	PIC/PR/LP GCL

Aspect or Concern	Potential Environmental Impact	Environmental Mitigation Measures	When	Institutional Responsibilities	
				Implementation	Supervision
		risks (including the documentation of steps undertaken so that all people are given the highest level of health and safety protection from hazards arising from work, so far as is reasonably practicable). 4. It will be ensured that employees, visitors, and contractors are provided with safety equipment; and that the equipment area used when undertaking works or visiting the hazardous sites is safe. 5. Prior to commencing work, a job hazard analysis will be undertaken. The results of the analysis will be shared with all concerned persons. 6. Responsibilities and accountabilities for health and safety management will be assigned to specific person within the construction team. 7. The requirement for trainings will be assessed and the workers will be trained accordingly. 8. A reporting and recording system for workplace health and safety incidents implemented. 9. Progress and achievements of the occupational health and safety system will be monitored on an ongoing basis. 10. Appropriate emergency procedures associated with events such as fire, fall, and gas or chemical leaks will be developed and implemented.			
C. Operation and Maintenance Phase					
Coal dust	Pollution of air due to coal dust	Coal sprinkling system will be installed to the coal loading system at Bin Qasim.	During operation	PR	PR/GHCL /LPGCL
Train noise	Disturbance to the residents of communities near the track	Initiate a noise monitoring program to identify areas of severe noise impact so that possible long-term mitigation measures can be planned.	During operation	PR	PR/GHCL /LPGCL

Aspect or Concern	Potential Environmental Impact	Environmental Mitigation Measures	When	Institutional Responsibilities	
				Implementation	Supervision
Community safety	Increased accidents due to the increase in train traffic and poor crossing infrastructure	Initiate community safety monitoring program to identify severe traffic points and high risk of accidents.	During construction	PR	PR/GHCL /LPGCL

Source: Hagler Bailly Pakistan

(3) Environmental Management Plan

The main objective of the Environmental Management Plan (EMP) is to identify mechanisms to implement the environmental mitigation measures discussed in the above sections. It is the fundamental tool that does the following:

- Consolidates all mitigation measures, and
- Identifies and specifies responsibilities and resources required to implement the measures.

The EMP also includes monitoring measures, as a feedback mechanism, on implementation and effectiveness of the mitigation measures.

The EMP is prepared for all the identified environmental impacts during design, construction, and O&M stages associated with the project. The methodology followed for preparing the EMP consisted of the following steps:

- Deriving mitigation/protection measures for identified impacts;
- Recommending mitigation, compensation, and enhancement measures for each identified impact and risk;
- Developing a mechanism for monitoring the proposed mitigation measures;
- Estimating budget requirements for implementation mitigation and monitoring measures; and
- Identifying responsibilities of various agencies involved in the project for implementation and monitoring of mitigation measures.

In addition to the environment mitigation plan and environmental monitoring plan, specific management plans have been developed for areas of concern, including the following:

- Waste management plan,

- Construction management plan,
- Spill management plan,
- Fire emergency response plan, and
- Transportation management plan.

The EMP will be included in all the bid documents of the project and will become part of the civil works contract. The strict implementation of the EMP and project management's strict enforcement of the adequate construction practices and standards will greatly reduce the negative impacts of the Project.

a) Waste Management Plan

The waste inventory and disposal plan is presented in Table 11-19.

Table 11-19 EMP for Waste Management

	Material Waste	Final Disposal Method	Associated Risks	Recommended Procedure
1	Iron	• Materials returned to store as unserviceable • Scrap store • Recycling	• Equipment and parts may be contaminated with oil or other liquids. This may pose hazards during recycling and/or melting.	• Separate contaminated parts and ensure disposal contractor cleans and removes contaminations before recycling equipment.
2	Copper	• Recycling • Scrap store	• Copper wires and tubes may be covered with insulation and may pose hazard if melted.	• Separate insulated copper from rest and ensure disposal contractor removes it before recycling.
3	Other materials	• Materials returned to store as unserviceable • Scrap store • Recycling • Landfill	• Some waste materials may contain hazardous materials (such as mercury and lead) which may pose health risks if not handled or disposed of properly.	• All hazardous substances such as lead and mercury will be identified and separated. • Ensure waste contractor disposes hazardous materials in accordance with accepted methods.
4	Wood, cotton, plastic, waste and packing materials	• Recycling • Landfill	• Burning of wood, paper, plastic and other materials may cause air pollution • Littering due to improper disposal	• Ensure waste contractor disposes all non–recyclable plastic wastes and other non–recyclable materials at land disposal site.
5	Electronics	• Materials returned to store as unserviceable	• Some electronic equipment may contain toxic materials and pose health risk if opened or dismantled.	• Ensure contractor disposes equipment properly and equipment is opened only under guidance of qualified professional.
6	Insulation	• Materials reused • Landfill	• Burning may cause air pollution. • Littering due to improper disposal	• Ensure properly certified recycling contractors are used.
7	Oil	• Recycling contractors	• May cause contamination of soil or waterways	• Ensure properly certified recycling contractors are used.
8	Concrete	• Landfill or reuse for filling	• None	• Ensure safe storage until disposal

b) Construction Management Plan

The construction contractor will develop a specific CMP based on the CMP included in Table 11-20. The CMP will be submitted to PR and JICA for approval.

The CMP will clearly identify all areas that will be utilized during construction for various purposes. For example, on a plot plan of the construction site, the following will be shown:

- Areas where construction will take place,
- Areas where wearing PPE is mandatory,
- Areas used for camp and offices,
- Storage areas for raw material and equipment,
- Waste yard,
- Location of any potentially hazardous material such as oil,
- Parking area,
- Area reserved for loading and unloading of material,
- Septic tanks, and
- Storm water runoff direction and control measures.

Table 11-20 Construction Management Plan

Aspect	Objective	Mitigation and Management Measure
Discharge from construction sites	Minimize surface water and groundwater contamination. Reduce contaminant and sediment load discharged into water bodies affecting humans and aquatic life.	• Install temporary drainage works (channels and bunds) in areas required for sediment and erosion control and around storage areas for construction materials. • Prevent all solid and liquid wastes entering waterways by collecting waste where possible and transport to approved waste disposal site or recycling depot. • Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This will be done in every exit of each construction vehicle to ensure the local roads are kept clean.

Aspect	Objective	Mitigation and Management Measure
Soil erosion and siltation	Avoid sediment and contaminant loading on surface water bodies and agricultural lands.	• Minimize the length of time an area is left disturbed or exposed. • Reduce length of slope of runoff. • Construct temporary cutoff drains across excavated area. • Setup check dams along catch drains in order to slow down flow and capture sediment. • Water the material stockpiles, access roads, and bare soils to minimize dust. • Increase the watering frequency during periods of high risk (e.g. high winds). • All the work sites (except permanently occupied by the plant and supporting facilities) will be restored to its initial conditions (relief, topsoil, and vegetation cover).
Excavation, earth works, and construction yards	Ensure proper drainage of rainwater and wastewater to avoid water and soil contamination.	• Prepare a program to prevent/avoid standing waters, which PIC will verify in advance and confirm during implementation. • Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connected to existing established drainage lines.
Ponding of water	Prevent mosquito breeding	• Establish local drainage to avoid ponding of water.
Storage of hazardous and toxic chemicals	Prevent spillage of hazardous and toxic chemicals	• Implement waste management plans. • Construct appropriate spill containment facilities for all fuel storage areas.
Land clearing	Preserve fertile top soils enriched with nutrients required for plant growth or agricultural development.	• Strip the top soil to a depth of 15 cm and store in stock piles of height not exceeding 2 m and with a slope of 1:2. • Spread the topsoil to maintain the physio–chemical and biological activity of the soil. • The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites.
	Avoid changes in local topography and disturbance to the natural rainwater/flood water drainage	• Ensure the topography of the final surface of all raised lands are conducive to enhance natural draining of rainwater/flood water. • Reinstate the natural landscape of the ancillary construction sites after completion of works.

Aspect	Objective	Mitigation and Management Measure
Construction vehicular traffic	Control vehicle exhaust emissions and combustion of fuels.	• Use vehicles with appropriate exhaust systems and emission control devices. • Establish and enforce vehicle speed limits to minimize dust generation. • Cover haul vehicles carrying dusty materials (cement, borrow, and quarry) moving outside the construction site • Level loads of haul trucks travelling to and from the site to avoid spillage. • Use of defined haulage routes and reduce vehicle speed where required. • Transport materials to site during off-peak hours. • Undertake regular maintenance of all vehicles. • All vehicle exit points from the construction site shall have a wash–down area where mud and earth can be removed from a vehicle before it enters the public road system.
	Minimize nuisance due to noise	• Maintain all vehicles in good working order. • Make sure all drivers comply with the traffic codes concerning maximum speed limit, driving hours, etc.
	Avoid impact on existing traffic conditions	• Prepare and submit a traffic management plan. • Restrict the transport of oversized loads. • Operate transport vehicles, if possible, during non–peak periods to minimize traffic disruptions.
	Prevent accidents and spillage of fuels and chemicals	• Restrict the transport of oversize loads. • Operate transport vehicles, if possible, during non–peak periods to minimize traffic disruptions. • Design and implement safety measures and an emergency response plan to contain damages from accidental spills. • Designate special routes for hazardous materials transport.

Aspect	Objective	Mitigation and Management Measure
Construction machinery	Prevent impact on air quality from emissions	• Use machinery with appropriate exhaust systems and emission control devices. • Provide regular maintenance of all construction machinery. • Provide filtering systems, duct collectors or humidification, or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all stages.
	Reduce impact of noise and vibration on the surrounding	• Appropriately site all noise generating activities to avoid noise pollution to local residents. • Ensure all equipment is in good condition and operated in correct manner. • Install high efficiency mufflers to construction equipment. • Operators of noisy equipment or any other workers in the vicinity of excessively noisy equipment are to be provided with ear protection equipment. • The project shall include reasonable actions to ensure that construction works do not result in vibration that could damage property adjacent to the works.
Construction activities	Minimize dust generation	N/A
	Reduce impact of noise and vibration on the surrounding Avoid driving hazard where construction interferes with pre–existing roads.	• Notify adjacent landholders or residents prior to noise events during night hours. • Install temporary noise control barriers where appropriate. • Avoid working during 21:00 to 06:00 within 500 m from residences.
	Minimizing impact on water quality	• Stockpiles of potential water pollutants (i.e. bitumen, oils, construction materials, fuel, etc.) shall be located so as to minimize the potential of contaminants to enter local watercourses or storm water drainage.

Aspect	Objective	Mitigation and Management Measure
		• Storm water runoff from all fuel and oil storage areas, workshop, and vehicle parking areas is to be directed into an oil and water separator before being discharged to any watercourse. • A spill management plan specifically for construction shall be prepared.
Siting and location of construction camps	Minimize impact from construction footprint	• Arrange accommodation in local towns for small workforce. • Locate the construction camps at areas which are acceptable from environmental, cultural, or social point of view.
Construction camp facilities	Minimize pressure on local services	• Provide adequate housing for all workers. • Provide a safe and reliable water supply. • Provide hygienic sanitary facilities and sewerage system. • Provide treatment facilities for sewerage of toilet and domestic wastes. • Provide adequate storm water drainage facilities. • Provide in–house community entertainment facilities.
Disposal of waste	Minimize impacts on the environment	• Ensure proper collection and disposal of solid wastes in the approved disposal sites. • Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector. • Establish waste collection, transportation, and disposal systems. • Ensure that materials with the potential to cause land and water contamination or odor problems are not disposed of on the site. • Ensure that all on–site wastes are suitably contained and prevented from escaping into neighboring fields, properties, and waterways; and the waste contained does not contaminate soil, surface water or groundwater or create unpleasant odors for neighbors and workers.
Fuel supplies for cooking purposes	Discourage illegal fuel wood consumption	• Provide fuel to the construction camps for domestic purpose. • Conduct awareness campaigns to educate workers on preserving the protecting the biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection.

Aspect	Objective	Mitigation and Management Measure
Site restoration	Restoration of the construction camps to original condition	• Restore the site to its condition prior to commencement of the works.
Construction activities near religious and cultural sites	Avoid disturbance to cultural and religious sites	• Stop work immediately and notify the site manager if, during construction, an archaeological or burial site is discovered. • It is an offence to recommence work in the vicinity of the site until approval to continue is given by the plant management. • Maintain appropriate behavior with all construction workers especially women and elderly people. • Resolve cultural issues in consultation with local leaders and supervision consultants.
Best practices	Minimize health and safety risks	• Implement suitable safety standards for all workers and site visitors which will not be less than those laid down on the international standards (e.g. International Labor Office guideline on 'Safety and Health in Construction; World Bank Group's 'Environmental Health and Safety Guidelines') and contractor's own national standards or statutory regulations. • Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas. • Provide personal protection equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full–face eye shields, and ear protection. • Maintain the PPE properly by cleaning dirty ones and replacing damaged ones.
Water and sanitation facilities at the construction sites	Improve workers' personal hygiene	• Provide portable toilets at the construction sites and drinking water facilities. • Portable toilets will be cleaned once a day. • All the sewerage will be pumped from the collection tank once a day into the common septic tank for further treatment.

c) Spill Management Plan

Liquid waste spills shall be appropriately managed not to have the potential to harm the environment. By taking certain actions, PR can ensure that the likelihood of spills to occur is reduced and that the effect of spills is minimized.

Avoiding Spills

By actively working to prevent spills, PR can save money and time by not letting resources go to waste. In addition, the environment is protected from contaminants that can potentially cause harm.

All liquids will be stored in sealed containers that are free from leakage. All containers will be on sealed ground and in an undercover area. Sharp parts and items will be kept away from containers containing liquid to avoid damage and leaks.

Bunding: To prevent spills from having an effect on plant site operations or the environment, bunding will be placed around contaminant storage areas. A bund can be a low wall, tray, speed bump, iron angle, sloping floor, drain or similar, and is used to capture spilt liquid for safe and proper disposal.

Spill Management

To avoid spills and help the cleanup process of any spills, both management and staff members should be aware of spill management procedures. By formalizing these procedures in writing, staff members can refer to them when required, thus, avoiding undertaking incorrect spill management procedures. As part of the overall EMP for the site, spill procedures will be practiced by holding drills. A detailed spill management plan will be prepared and will contain the following:

- Identification of potential sources of spill and characterization of spill material and associated hazards,
- Risk assessment (likely magnitude and consequences),
- Steps to be undertaken when a spill occurs (stop, contain, report, clean up, and record), and
- A map showing the locations of spill kits or other cleaning equipment.

Spill Kits

Spill kits are purpose designed units that contain several items useful for cleaning up spills that could occur. Typical items are as follows:

- Safety gloves and appropriate protective clothing (depending on the type of chemicals held onsite);

- Absorbent pads, granules, and/or pillows;
- Booms for larger spills;
- Mops, brooms, and dustpans.

Spill kits are used to contain and clean up spills in an efficient manner. PR will have enough spill kits or big enough spill kits to deal with any potential spills. Spill kits will be kept in designated areas that are easily accessible to all staff.

Staff members will be trained in using the spill kit correctly. The supplier may do this at the time of purchase or the management may organize it itself.

After cleaning up a spill, the materials used to clean up will be disposed of correctly. Depending on the spill material, the used material may be disposed in the hazardous waste facility or the landfill site.

Responding to Spills

- *Stop the source:* If it is safe to do so, the source of the spill should be stopped immediately. This may be a simple action like upturning a fallen container.
- *Contain and control the flow:* To stop the spill from expanding, absorbent materials and liquid barriers will be placed around the spill. Work from the outside to soak up the spill. It is vital that spilt liquid is not allowed to reach storm water drains, sewer drains, natural waterways, or soil. For large-scale spills that involve hazardous materials, authorities may have to be alerted.
- *Clean up:* Using information from material safety data sheets (MSDS) about the properties of the liquid spilled and the spill equipment available, spills will be cleaned up promptly.
- *Record the incident:* By keeping a simple log of all spills, precautionary measures can be put in place to avoid similar accidents from occurring in the future.

d) Fire Emergency Response Plan

A firefighting system will be installed in the Lakhra Power Plant Station with a standard operating procedure considering the potential fire from sparks during coal storage and handling.

e) Transportation Management Plan

A detailed transportation management plan will be prepared through the PIC. The outline of the plan is as follows:

- *Objective:* To protect the community and environment from potential hazards of coal unloading and bulk transportation, and to protect the workers of PR and its contractors from occupational hazards associated with bulk transportation of material.
- *Scope:* The plan will cover both rail and road transportation of all material including, but not limited to, equipment, staff, and construction material.
- *Timeline:* The plan for the construction phase of the project will be completed before the start of construction activity and arrival of the equipment on port. The plan for the operation phase will be completed at least one year before the commissioning of the project.
- *Executing Arrangement:* The PIC will be responsible to commission the study and implement its recommendations.

(4) Environmental Monitoring Plan

Monitoring of environmental components and mitigation measures during implementation and operation stages is a key component of the EMP to safeguard the protection of environment. The objectives of the monitoring are to (i) monitor changes in the environment during various stages of the project life cycle with respect to baseline conditions; and (ii) manage environmental issues arising from construction works through closely monitoring the environmental compliances. A monitoring mechanism is developed for each identified impact and it includes the following:

- Location of the monitoring (near the project activity, sensitive receptors, or within the project influence area);
- Means of monitoring, i.e. parameters of monitoring and methods of monitoring (visual inspection, consultations, interviews, surveys, field measurements, or sampling and analysis); and
- Frequency of monitoring (daily, weekly, monthly, seasonally, annually or during implementation of a particular activity).

The monitoring program will also include regular monitoring of construction and commissioning activities for their compliance with the environmental requirements as per relevant standards, specifications, and EMP. The purpose of such monitoring is to assess the performance of the undertaken mitigation measures and to immediately formulate additional mitigation measures and/or modify the existing ones aimed at meeting the environmental compliance appropriate during construction. The environmental monitoring program is presented in Table 11-21.

Table 11-21 Environmental Monitoring During Construction and Operation

Parameter	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implementing	Supervising
During Construction					
Handling and storage of equipment	Work sites	Visual inspection	Daily	Contractor	PIC, PR
Top soil	Construction areas	Top soil of 0.5 m depth will be excavated and stored properly.	Beginning of earth filling works	Contractor	PIC, PR
Erosion	Construction areas and material storage sites	Visual inspection of erosion prevention measures and occurrence of erosion.	Monthly	Contractor	PIC, PR
Hydrocarbon and chemical storage	Construction camps	Visual inspection of storage facilities.	Monthly	Contractor	PIC, PR
Local roads	Approach roads	Visual inspection to ensure local roads are not damaged.	Monthly	Contractor	PIC, PR
Traffic safety	Access roads	Visual inspection to see whether proper traffic signs are placed and flagmen for traffic management are engaged.	Monthly	Contractor	PIC, PR
Air quality (dust and smoke)	Construction sites	Visual inspection to ensure good standard equipment is in use and dust suppression measures (spraying of waters) are in place.	Daily	Contractor	PIC, PR
	Material storage sites	Visual inspection to ensure dust suppression work plan is being implemented.	Monthly	Contractor	PIC, PR

Parameter	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implementing	Supervising
Air quality (PM)	Suggested locations are the following: a) Locations where the impact of construction activity, power plant construction activity, road traffic, and other sources are minimal; b) Budapur, Unarpur, Cadet College Petaro and Akhudabad RS; and c) Village near the railway track.	Air–borne dust through dust–fall method (ASTM 1739–98: Standard Test Method for Collection and Measurement of Dustfall (Settleable Particulate Matter))	Equipment to be installed throughout the construction period. Sample is to be collected every 7 or 15 days, depending on the intensity of activity. Monitoring must start at least a month before commencement of construction activity at the site.	Contractor	PIC, PR
Noise	Construction sites	Visual inspection to ensure good standard equipment are in use.	Weekly	Contractor	PIC, PR
		Hourly, day and night time noise levels (dB) monitoring using noise meters.	Quarterly	Contractor through a nationally recognized laboratory	PIC, PR
Waste management	Construction camps and construction sites	Visual inspection that solid waste is disposed at designated site.	Monthly	Contractor	PIC, PR, External Monitor
Drinking water and sanitation	In construction sites and construction camps	Ensure the construction workers are provided with safe water and sanitation facilities in the site.	Monthly	Contractor	PIC, PR
Cultural and archeological sites	All work sties	Visual observation for chance finding	Daily	Contractor	PIC, PR
Reinstatement of work sites	All work sites	Visual Inspection	After completion of all works	Contractor	PIC, PR
Safety of workers	At work sites	Usage of PPE	Monthly	Contractor	PIC, PR

Parameter	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implementing	Supervising
During Operation and Maintenance					
Ambient air quality	Three to four locations on the Bin Qasim to Kotri Route, and same number on Kotri to Budapur Track Suggested locations: Dhabeji, Jungshahi, Jhimpir, Kotri, Jamshoro, Petaro, and Budapur	24-hour air quality monitoring of PM_{10}, $PM_{2.5}$, and TSP	24–hour sample to be collected every 12 months	PR	PR through third party
Noise	Three to four locations on the Bin Qasim to Kotri Route and same number on Kotri to Budapur Track Suggested locations: Dhabeji, Jungshahi, Jhimpir, Kotri, Jamshoro, Petaro, and Budapur	Hourly, day and night time noise levels (dB) monitoring using noise meters	24–hour sample to be collected every 12 months	PR	PR through third party
Soil erosion from the exposed earth berming underneath the installed rails	Entire route	Visual inspection	Annual	PR	GHCL
Adverse impacts on the residents' daily movement across railway corridors	Near settlements	Consultation with the community	Annual	PR	GHCL

Source: JICA Study Team

11.5.5 Institutional Framework and Budget

(1) Institutional Framework

The institutions responsible for executing and monitoring the environmental aspects of this project are as follows:

- Project management unit (PMU) at the PR Headquarters, and
- Project implementation unit (PIU) at the site.

The PMU and PIU will ensure that the mitigation and management measures proposed are properly implemented. For this purpose, PR will develop internal institutional capacity for environmental management.

The PIC will be primarily responsible for the monitoring of the EMP, and will report to the PMU. The PIC will be engaged at the start of the project and will remain engaged through the construction and commissioning of the project. The PIC will ensure that all activities of the engineering-procurement-construction (EPC) contractor(s) are carried out under the project and comply with the JICA guidelines and international standards; and will provide necessary guidance and supervision to PIU for this purpose. Since the EPC contractors will be working simultaneously for timely and speedy implementation of the project, it is important that the PIC ensures that the environmental activities are being implemented in the field. The PIC will also be responsible to update or make necessary changes to the EMP if required based on the revised designs and locations.

Each EPC contractor engaged for this project will be responsible for implementation of the EMP to the extent that it applies to the contractor’s area of work. Each contractor will be recommended to have an environmental management system compliant with ISO 14001:2004 environmental management system (EMS) certification. The major contractors will be required to have one environmental specialist and one occupational health and safety specialist, who will be working in close coordination with the environmental staff of PIC and PR.

(2) Institutional Strengthening

PR will develop internal capacity to manage health, safety, and environmental issues. This will require setting up of a health, safety, and environment department within the PMU.

(3) Reporting and Feedback Mechanism

The contractor will prepare a ‘Construction Environmental Action Plan’ (CEAP) demonstrating the manner in which they will comply with the requirements of mitigation measures proposed in the EMP. The CEAP will form the part of the contract documents and will be used as monitoring tool for compliance. Violation of the compliance requirements will be treated as non–compliance leading to the corrections or otherwise imposing penalty on the contractors.

The contractor, through the environmental specialist on the team, will prepare monthly status reports on the EMP implementation. Such reports must carry information on the main types of activities carried out within the reporting period, status of any clearances/permits/licenses which are required for carrying out such activities, mitigation measures applied, and any environmental issues that emerged in relations with suppliers, local authorities, affected communities, etc. Contractor's monthly status reports shall be submitted to the PIC and PR.

The PIC will prepare monthly reports on the status of EMP implementation and environmental performance of the contractor. These reports will be based on the contractor's reports and their supervision. The PIC will assess the accuracy of factual information provided in the contractor's reports, fill any gaps identified in them, and evaluate adequacy of mitigation measures applied by contractor. The PIC will highlight any cases of incompliance with EMPs, inform on any acute issues brought up by contractor or revealed by supervisor himself, and propose corrective actions.

The PR will prepare annual environmental reports during construction and operation. The construction period environmental report will contain information on status of EMP implementation and environmental performance of the contractor; any damage to the environment, and corrective measures taken. The report will also provide monitoring data and analysis. After commissioning of the railway works, the report will be based on the operation phase EMP. The environmental reports will be reviewed and submitted to Sindh EPA by Genco Holding Company Limited (GHCL)/LPGCL. It may contain information on status of EMP implementation, environmental performance of PR, and monitoring data and its analysis. The annual environmental reports will be shared with Sindh EPA, institutional stakeholders (e.g., educational institutions), and government departments, and will also be available to the community. Copies of summary of the report in Sindh will be made available to community elders and representatives.

After project completion, PR will be in charge of the coal trains and will thus be responsible for compliance with the monitoring plan during O&M.

Feedback and adjustment will be carried out in two tiers. Upon request for EMP modification by the contractor, PR will review the proposals in detail and consider their acceptance or rejection. Only those modifications which do not contradict to conditions of the environmental permit will be considered.

PR will be responsible for enforcing compliance of contractor with the terms of the contract, including adherence to the EMP. For minor infringements which causes temporary but reversible damage, the contractor will be given 48 hours to remedy the problem and to restore the environment. If restoration is done satisfactorily during this period, no further actions will be taken. If it is not done during this period, PR will arrange for another contractor to do the restoration, and deduct the cost from the offending contractor's next payment. For major infringements causing a long–term or irreversible damage, there will be a financial penalty up to 1% of the contract value in addition to the cost for restoration activities.

(4) Performance Indicators

The environmental parameters that may be qualitatively and quantitatively measured and compared are selected as 'performance indicators', and recommended for monitoring during project implementation and O&M stages. These monitoring indicators will be continuously monitored to ensure compliance with the national or other applicable standards and comparison with the baseline conditions established during design stage. The list of indicators and their applicable standards to ensure compliance are given below. The monitoring data will be reviewed on a regular basis (as and when collected and annually) to determine trends and issues. The performance indicators are given in Table 11-22.

Table 11-22 Performance Indicators

Aspect	*Indicator*
Ambient air quality (PM_{10}, $PM_{2.5}$, and TSP)	Requirement of IFC EHS Guidelines and the NEQS for ambient air.
Noise levels	Requirement of IFC EHS Guidelines and the NEQS for ambient noise.

(5) Training Program

The planned training program is shown in Table 11-23.

Table 11-23 Training Program

	Type of Training	*Training By*	*Personnel to be Trained*	*Training Description*	*Period*	*Duration*
1	Occupational health and safety	External sources	EHS manager Plant managers and supervisors	Training will be provided to aware staff to conform to safety codes. The plant manager will ensure the mandatory use of PPE by the senior administration during all plant visits. That will attract other junior and maintenance staffs to abide by the rules. Precautions to be taken for working in confined areas.	Before starting of project activities	Whole day (8-hour session)
2	Occupational health and safety	EHS manager	Workers Staff	Health, safety, and hygiene Proper usage of personnel protective gear Precautions to be taken for working in confined areas.	Before starting of project activities During project activities	Whole day (8-hour session)
3	Health, safety, and environmental auditing	External sources	Staff responsible for inspection/audits	Procedures to carry out Health, safety, and environmental audits Reporting requirements	Before starting of project activities	Whole day (8 hour session)
4	Waste disposal and handling	External sources	Relevant workers Relevant staff	Segregation, identification of hazardous waste, use of PPEs, and waste handling.	Before starting of project activities	Whole day (8-hour session)
5	Social and environmental laws and regulations, norms, procedures, and guidelines of government and JICA	External sources	EHS staff Plant managers and supervisors	Environmental standards and their compliance JICA and government regulations	Before starting the project activities	Whole day (8-hour session)
6	Pollution monitoring, pollutant analysis, and pollution control facilities	External sources	EHS staff Plant managers and supervisors	The understanding of basic theory and pollution abatement	Before starting the project activities	Whole day (8-hour session)
7	Implementation of environmental management and monitoring plan	External sources	EHS staff Responsible supervisory staff Management	Concepts of environmental management and monitoring plan	Once every three months during the entire construction period	Whole day (8-hour session)

(6) Total Budget Estimates for Environmental Mitigation and Monitoring

Cost estimates are prepared for all the environmental mitigation and monitoring measures proposed in the EMP. The details of the cost estimates and the budget during construction stage and first three years of operation stage for the mitigation and monitoring measures are given in Table 11-24. The cost estimates for control measures and some of the mitigation measures that were already part of the engineers estimate are not included in the EMP.

The cost estimates also include the budget for environmental monitoring, consultants for EMP implementation, institutional strengthening and capacity building of power plant staff, and environmental enhancement/compensation measures.

The total budget for EMP implementation is estimated to be about USD 187,000.

Table 11-24 Summary of Costs for Environmental Management and Monitoring

	Item	Unit	Unit Cost in USD	Quantity	Total Cost in USD
A	**Environmental Monitoring (Design, Construction, and Operation Periods) – 6 years**				
1	Air quality monitoring equipment (TSP, PM_{10}, and $PM_{2.5}$ samplers)	Units	30,000	1	30,000
2	Air quality monitoring recurring cost (6 years)	Years	10,000	6	60,000
3	Equipment for monitoring noise	Units	8,000	1	8,000
4	Noise monitoring recurring cost (6 years)	Years	1,000	6	6,000
5	Dust fall method equipment	Units	1000	8	8,000
	Sub Total (A)				**112,000**
B	**Training Cost**				**75,000**
	Grand Total (A+B)				**187,000**

11.6 Stakeholder Consultations and Disclosure

As part of the EIA process, consultations were undertaken with communities and institutions that may have interest in the proposed project or may be affected by it. This section documents the consultation process for the EIA of the proposed project.

In early stages of the project, the proposed power plant and the transportation of coal to the site using existing the railway track was considered as a single project and accordingly combined consultation were undertaken for both components. The details of these are provided in the EIA of the proposed power plant. Subsequently, it was decided to prepare a separate EIA for the railway components. Additional consultations were undertaken for the railway component to cover any gap.

In this chapter, reference is made to the power plant's EIA for the combined process and scopes. However, all results relevant to the railway components are reported here.

11.6.1 Framework for Consultations

The EIA of the proposed project was undertaken in compliance with relevant national legislation and in accordance with the environmental and social safeguards laid out under JICA Guidelines for Environmental and Social Considerations, April 2010 (JICA Guideline 2010) and World Bank Operational Policy 4.01 (OP 4.01) Annex B.

(1) JICA Guidelines for Environmental and Social Considerations (April 2010)

Public consultation is mandated under JICA Guideline 2010[58].

- Projects must be adequately coordinated so that they are accepted in a manner that is socially appropriate to the country and locality in which they are planned.
- In the case of Category A projects[59] with a potentially large environmental impact, project proponents must consult with local stakeholders such as residences at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans.
- Appropriate consideration must be given to vulnerable social groups, such as women, children, the elderly, the poor, and ethnic minorities, all members of which are susceptible to environmental and social impacts and may have little access to decision–making processes within the society.

(2) Sindh Environmental Protection Act 2014

Public consultation is mandated under Sindh's environmental law. Regulation 6 of the IEE–EIA Regulations 2000 provides the general requirements whereas the sectoral guidelines indicating specific assessment requirements are provided in the Guidelines for Public

58 "5. Social Acceptability", Appendix 1, Guidelines for Environmental and Social Considerations, April 2010, Japan International Cooperation Agency.
http://www.jica.go.jp/english/our_work/social_environmental/guideline/pdf/guideline100326.pdf

59 Guidelines for Environmental and Social Considerations, April 2010, Japan International Cooperation Agency.
http://www.jica.go.jp/english/our_work/social_environmental/guideline/pdf/guideline100326.pdf

Consultation 1997 (the 'Guidelines'). These are summarized below.

- Objectives of Public Involvement: 'To inform stakeholders about the proposed project, to provide an opportunity for those otherwise unrepresented to present their views and values, providing better transparency and accountability in decision making, and creating a sense of ownership with the stakeholders'.
- Stakeholders: 'People who may be directly or indirectly affected by a proposal will clearly be the focus of public involvement. Those who are directly affected may be project beneficiaries, those likely to be adversely affected, or other stakeholders. The identification of those indirectly affected is more difficult, and to some extent it will be a subjective judgment. For this reason, it is good practice to have a very wide definition of who should be involved and to include any person or group who thinks that they have an interest. Sometimes it may be necessary to consult with a representative from a particular interest group. In such cases, the choice of the representative should be left to the group itself. Consultation should include not only those likely to be affected positively or negatively by the outcome of a proposal, but should also include those who can affect the outcome of a proposal'.
- Mechanism of Consultations: 'Provide sufficient relevant information in a form that is easily understood by non–experts (without being simplistic or insulting); allow sufficient time for stakeholders to read, discuss, consider the information and its implications, and to present their views; responses should be provided to issues and problems raised or comments made by stakeholders; and selection of venues and timings of events should encourage maximum attendance'.
- Timing and Frequency: Planning for the public consultation program needs to begin at a very early stage; ideally it should commence at the screening stage of the proposal and continue throughout the EIA process.
- Consultation Tools: Some specific consultation tools that can be used for conducting consultations include focus group meetings, needs assessment, semi–structured interviews, village meetings, and workshops.
- Other Important Considerations: 'The development of a public involvement program would typically involve consideration of the following issues: objectives of the proposal and the study, identification of stakeholders, identification of appropriate techniques to consult with the stakeholders, identification of approaches to ensure feedback to involved stakeholders, and mechanisms to ensure stakeholders' consideration are taken into account'.

11.6.2 Consultation Methodology

(1) Stakeholder Identification and Analysis

Stakeholders were identified as groups and individuals that can be affected by the project activities or that can influence the outcome of the project.

All groups and individuals that fall within the study area were identified as stakeholders that can be affected by the project activities and were consulted through representatives during the scoping phase.

Groups and individuals that hold interest in the project and can influence the outcome of the project (latter part of the definition of stakeholders) include the following:

- Government and regulatory authorities directly or indirectly connected to or overseeing, the activities of the project;
- Non–governmental organizations working in areas that can be affected by the project; and
- Academia that can be interested in transfer of skill and knowledge aspect of the project.

The stakeholders were identified on the basis of the most recent information and understanding of the project and its surrounding environment. Given the varying roles and educational backgrounds, stakeholders were divided into the following target groups for consultations:

- Institutional stakeholders, and
- Communities.

A different consultation approach was adopted for each target group to suit their varying backgrounds, as described ahead.

11.6.3 Consultation with Institutional Stakeholders

Combined meetings for power plant and railway components were scheduled with the institutional stakeholders at a place and time of their convenience in February and March 2014. The stakeholders were informed via telephone or email of the objective of the consultation meetings. Where possible, a copy of the BID was shared in advance of the consultation meeting to encourage understanding of project information for discussion during meeting. The details of the consultation were provided in the EIA for the power plant.

Additional consultations for the railway components were held in July 2015, March 2016, and June 2016.

The list of institutional stakeholders consulted are shown in Table 11–25.

Table 11–25 List of Institutional Consulted in Scoping Phase

Institutions Invited	Date Consulted
World Wildlife Fund (WWF), Islamabad	19 February 2014
Pakistan Museum of Natural History (PMNH), Islamabad	19 February 2014
International Union for Conservation of Nature (IUCN), Islamabad	19 February 2014
Lakhra Coal Development Company (LCDC), Lakhra	24 February 2014
Sindh Wildlife Department (SWD), Hyderabad	25 February 2014
Deputy Commissioner (DC), Jamshoro	25 February 2014
Sindh Forest Department, Hyderabad	25 February 2014
Mehran University, Jamshoro	26 February 2014
Department of Livestock and Fisheries, Hyderabad	26 February 2014
Liaqat University of Health and Medical Sciences (LUMHS), Jamshoro	26 February 2014
Lakhra Coal Development Company Limited (LCDC), Karachi	28 February 2014
International Union for Conservation of Nature (IUCN), Karachi	04 March 2014
Station Master, Budapur Station	13 July 2015
Assistant Station Master, Unarpur Railway Station	13 July 2015
Points Man, Cadet College Petaro Railway Station	13 July 2015
Station Master, Sindh University Jamshoro Railway Station	13 July 2015
Deputy Commissioner (DC), Jamshoro	25 March 2016
Agriculture Department, Sindh	25 March 2016
Works and Services Department, Sindh	25 March 2016
President Sindh United Party	26 March 2016
University of Sindh	30 March 2016
Sindh Environmental Protection Agency	16 June 2016

11.6.4 Community Consultation

Total of 23 rural communities were consulted for the combined power plant and railway consultation. A visit was paid to each community a day in advance of the consultation meeting to establish a contact with the representatives, to inform them of the purpose and intent to consult, and to ascertain their availability and willingness for the meeting.

Separate consultation sessions were organized for the community women bearing in mind local customs. The consultation meetings were held at a place of convenience for the stakeholders (at residences of attendees) within the settlements and Lakhra Power Plant colony.

Stakeholders were introduced to the team and briefed about the consultation process and its objectives. The main points of the BID were read out to the stakeholders in Urdu and Sindh, depending on their language preference. Through the BID an overview of the project and the EIA process was provided. Stakeholders were given the opportunity to raise queries or concerns regarding the project. Queries were responded to and concerns were documented.

Of the 23 communities, seven were relevant to the EIA for railway components. The settlements that were consulted for the railway components are Manzoorabad, Imdad Ali Khoso, Bhoro Khan Rind, Dato Khoso, Goth Pereal, Murid Khan Rind/Goth Miandad, Thehbo, Akro, Chakar Khan Rajar Goth, Haji Imam Buksh Shanro, and Jamshoro.

The list of communities consulted along with the dates when the consultations took place are shown in Table 11–26 and mapped in Figure 11-16.

Consultation could not take place in Pehlwan Khoso and Faqir Dad Khoso since the residents of these settlements could not attend the meeting due to unrest as a result of an incident of crime in the villages.

The consultation team recorded all discussions during the meetings. Photographs were also recorded for both institutional and community consultations as shown in Figure 11-17. However, photographs of consultations with the women of the community are not presented in consideration of local customs and traditions.

Table 11–26 List of Communities Consulted during Scoping Stage

SR	*Location*	*Union Council*	*Taluka*	*Date Consulted*
1	Manzoorabad	Manzoorabad	Manjhand	9 April 2014 12 July 2015
2	Thehbo	Manjhand	Manjhand	12 April 2014
3	Murid Khan Rind/Goth Miandad	Manzoorabad	Manjhand	14 April 2014 11 July 2015 15 March 2016
4	Dato Khoso	Manzoorabad	Manjhand	11 July 2015
5	Goth Pereal	Manzoorabad	Manjhand	12 July 2015
6	Imdad Ali Khoso	Manzoorabad	Manjhand	10 April 2014
7	Bhuro Khan Rind	Manzoorabad	Manjhand	10April 2014
8	Akro	Unarpur (Petaro)	Kotri	22 March 2016
9	Chakar Khan Rajar Goth	Unarpur (Petaro)	Kotri	22 March 2016
10	Haji Imam Buksh Shanro	Unarpur (Petaro)	Kotri	22 March 2016
11	Jamshoro	Jamshoro	Kotri	22 March 2016

Figure 11-16 Locations of the Scoping Consultations for Communities

Consultation with Manzoorabad Community

Consultation with Thehbo Community

Consultation with Murid Khan Rind Community

Consultation with Dat Khoso Community

Consultation with Akro Community

Consultation with Chakar Khan Goth

Consultation with Haji Imam Buksh Shanro Community

Consultation with Jamshoro Community

Figure 11-17 Photographs of the Scoping Consultations for Communities

11.6.5 Opinions Expressed During Consultations

As a positive response from the stakeholders, the project was valued in terms of its contribution for the electricity shortage in the country. The local communities hoped that the duration of load shedding will be reduced. The women were generally content with the establishment of the power plant and were hopeful that the plant will bring economic and social development to their area.

Almost no concern regarding the upgrade of the existing railway track and extension of loop lines were expressed. The key concerns emerged from consultations were summarized in Table 11-27 and explained how each concern was addressed in the EIA.

Table 11-27 Summary of Concerns Expressed in Scoping Consultation and How They Were Addressed in the EIA

Items	*Issues Raised by Stakeholders*	*Addressed in the EIA*
Coal transportation	Coal transportation by trucks increase traffic and cause various environmental issues.	• Transportation of the imported coal by trucks has been replaced by transportation by rail. The imported coal will be unloaded at Port Qasim and transported to the plant station by rail in order to avoid congestion of traffic on roads. A new spur line from Budapur to plant site will be developed which is the subject of a separate EIA.
Track alignment	People were in support of the project in principle; however, they wanted to know whether the alignment of the railway track can be changed to avoid relocating houses	• For technical reason, the realignment of the railway line is not possible. However, by making it an elevated line over a bridge, the width of the required land has been minimized. The corresponding LARAP discusses land related issues in greater detail.
Risk due to passing trains	The absence of any railway crossing has resulted in many accidents involving people and animals near the villages. A permanent railway crossing is required immediately in villages to prevent the number of accidents that occur currently.	• These issues will be considered when planning railway works; and health and safety of locals will be given highest priority.

Items	*Issues Raised by Stakeholders*	*Addressed in the EIA*
Job opportunities and social uplift	The locals should be provided jobs at the project to promote livelihood opportunities. Social upliftment programs should be conducted by the company for locals. Since the coal cargo will be passing the village, the villagers should be given some relief in the form of employment opportunities as village will be suffering from the pollution and hazards that the coal cargo and the powerhouse will pose in the future.	• The locals will be prioritized for employment at the project wherever skills are needed. • Social uplift programs will be planned as part of corporate social responsibility (CSR) activities.

Source: JICA Study Team

11.6.6 Future Consultations

(1) Consultation During the EIA Approval Process

Further consultations to be undertaken as part of the project EIA approval process include the project public hearing. Sindh EPA will require that one or more public hearings are held to assess public opinion on the environmental impacts of the project. Within ten days upon receipt of the EIA report for the project and subject to acceptance of the EIA for review, Sindh EPA will notify the project proponents that one or more public hearings must be held. Sindh EPA will advertise the public hearings in a newspaper. The legal requirement is to be advertised in at least one English or Urdu national newspaper; but in practice, advertisements are usually placed in two national newspapers and in local newspapers. The public hearings will be held at least 30 days after the public notice. Copies of the EIA report and a non–technical summary have to be made accessible to the public during the notification period.

(2) Consultation Beyond the EIA Approval Process

The Project management will continue community engagement activities throughout the life of the plant. Visits will be undertaken in all the communities twice or more time in a year, depending on the number of concerns raised under each consultation. Ongoing community engagement activities relevant to the EIA include the following:

- Ongoing reporting of the implementation progress of the environmental and social management measures and recording of comments on the effectiveness of these measures,
- Updating communities about new project developments and recording comments on these, and
- Ongoing operation of the grievance mechanism.

11.7 Land Acquisition and Resettlement Action Plan

11.7.1 Necessity of the Land Acquisition and Resettlement

This project will require 72.30 acres of land in total and relocation of six residences.

Table 11-28 Land Acquisition Requirements by Project Component

No.	*Project Component*	*Required Land (Acres)*
1	Spur line	71.81
2	Loop line at Budapur Station	0.06
4	Loop line at Unarpur Station	0.06
5	Loop line at Cadet College Petaro Station	0.16
6	Loop line at Sindh University Jamshoro Station	0.21
Total		**72.30**

(1) Spur Line Construction

The spur line has four main components as shown in Figure 6-11.

- Section 1: 1st Embankment Section
- Section 2: Bridge Section
- Section 3: 2nd Embankment Section
- Section 4: Cut Section

The total land required for the spur line is 71.81 acres. Of which 25.22 acres of land will be acquired from private owners of which 3.66 acres is actively cultivated. The remaining land is already owned by either LPGCL, the Government of Sindh or other government agencies and will be provided to the project for free or at nominal rates. The privately acquired land includes six houses which will have to be relocated.

(2) Loop Line Extension

The total land required for the extension of loop lines is approximately 0.49 acres and is already owned by PR. At each railway station, the width of extended loop line is expected to be 5 m and extension length is different in each station as shown in Table 11-29.

Table 11-29 List of Stations and Corresponding Extension Lengths

Name of Stations	*Length of Existing Loop Lines*	*Length and Width of Extension**	*Total Length of Loop Lines after Extension*	*Direction of Extension*
Budapur	608 m	L: 50 m, W: 5 m	650 m	For Kotri
Unarpur	606 m	L: 50 m, W: 5 m	650 m	For Kotri
Cadet College Petaro	530 m	L: 130 m, W: 5 m	650 m	For both side (65 m each)
Sindh University	487 m	L: 170 m, W: 5m	650 m	For Kotri

*Note: Up to 10 m of additional land is added in the required length for contingency.

(3) Railway Track Upgrade

No land will be required for the upgrading of the existing railway line from Kotri Junction to Budapur Station.

(4) Consideration of Alternatives

After the rail was selected as the mean of coal transportation from Bin Qasim, it was identified that the construction of spur line between Budapur and Lakhra Power Plant will have impact on private land owners.

In June–July 2014 and July–August 2015, initial discussions were held with affected households (AHs). Those who will lose their residence raised concern about the adequacy of the amount of compensation that will be paid to them by the Revenue Department and suggested to revise the alignment of the railway to avoid their houses.

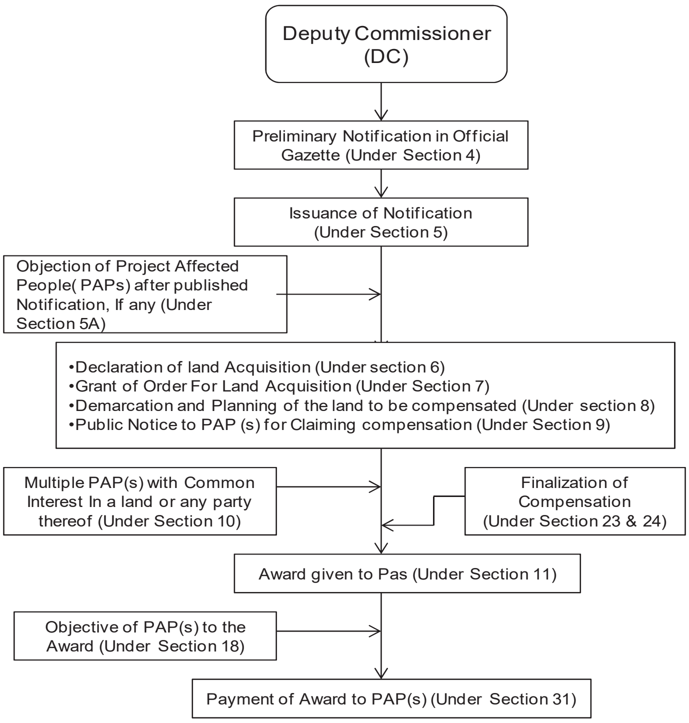
The alignments design and mean of coal transportation were further compared and considered to avoid or minimize the impacts of land acquisition and resettlement. After consideration of alignments and fair compensation, all AHs gave consent to sell their lands and those who will lose their residence agreed to relocate during the consultations in March and April 2016.

11.7.2 Analysis of Legal Framework and Concerning Land Acquisition

(1) Land Acquisition Act (LAA) 1894

The Pakistan law governing land acquisition is the LAA of 1894 and its successive amendments. The LAA regulates the land acquisition process and enables the provincial government to acquire private land for public purposes. Land acquisition is a provincial responsibility and provinces have also their own province specific implementation rules like Punjab and Sindh Land Acquisition Rules, 1983.

The flow of the land acquisition activities according to LAA are summarized in Figure 11-18.



Source: JICA Study Team

Figure 11-18 Procedure of LAA 1984

(2) Analysis of Gaps between Pakistan Laws and JICA Guideline (April 2010)

There are gaps between LAA and JICA Guidelines (April 2010) and World Bank (WB) Safeguard Policy. In Pakistan, there is no legal requirement for the project proponent to develop a land acquisition and resettlement action plan nor to conduct consultations with affected people. Land acquisition will be implemented according to LAA rules. The lost land and crops are to be compensated in cash at the current market rate to titled landowners following an impact identification and valuation exercise. The affected people, if not satisfied, can go to the court of law to contest the compensation award.

In order to fill the gaps between the Pakistani legal frameworks and JICA Guideline (April 2010), a separate LARAP was developed in this preparatory-study in accordance with 'World Bank Safeguard Policy OP 4.12' (Appendix 9).

11.7.3 Socioeconomic Profile and Social Impacts

The resettlement field survey (RFS) including population census, asset inventory survey, and household socio-economic survey was conducted from 22 June to 28 July 2014 and updated from 11 July to 10 August 2015.

During the RFS, population census and inventory survey was completed for all the AHs. The population census provides the basic information to identify the magnitude of direct impact and to determine eligibility for compensation. A cut-off-date was fixed on 22 June 2014 which was communicated to all AHs during consultation.

The socioeconomic profile of the AHs was developed by interviewing 24[60] out of 30 AHs (80% of all AHs). Given the similarity in socioeconomic characteristics of the AHs, the socioeconomic profile presented in this section can be considered to provide a reasonable representation of all the AHs.

(1) Distribution and Demography of Affected Households

RFS revealed that a total of 30 households will be affected by the project. On average, each household comprises of about eight members. As shown in Table 11-30, the 30AHs have a total of 222 persons, of whom about 47% are male and 53% are female. The female to male ratio of the AHs is 1.13.

Table 11-30 Settlement-wise Distribution of Affected Population and Sex Ratio

Location	*Direct Affected Households*	*Sex*				*Population*	
		Male	*%*	*Female*	*%*	*Total*	*%*
Dato Khoso	1	5	4.81	3	2.54	8	3.60
Goth M Pareal	5	13	12.50	12	10.17	25	11.26
Manzoorabad	11	40	38.46	44	37.29	84	37.84
Murid Khan Rind	13	46	44.23	59	50.00	105	47.30
Total	30	104	46.85	118	53.15	222	100.00

Source: Field Survey June–July 2014, July 2015

(2) Vulnerability

Certain groups of population, by virtue of their socioeconomic realities, are considered socially vulnerable, and thus in need of special consideration so that they can benefit from the development activities of the project. These groups include (a) hardcore poor households, (b)

[60] Out of the 24 surveyed households, one household was not available and information for this household was collected from a relative of the head of the household.

female–headed households (FHH), and (c) households headed by disabled persons.

The RFS revealed that out of the total affected households, four AHs are below the national poverty line and one AH is a female headed household, and will be considered as vulnerable AHs.

(3) Loss of Assets

The Project will have impacts on local communities including land acquisition, loss of residential structures, loss of public structures, loss of livelihoods, loss of trees and loss of crops (Table 11-31).

Table 11-31 Type of Losses Due to the Project

Type of Loss	*Unit*	*Quantity*	*No. of AHs*	*APs**
Loss of Houses				
Covered area of lost houses	(ft^2) acres	(6,411 ft^2) 0.15	6	42
Loss of Land				
Cultivated land	acres	3.66	5	33
Uncultivated land	acres	21.06	21	141
Residential land	acres	0.50	1	7
Government of Sindh land	acres	44.95	–	–
GENCO land	acres	1.02	–	–
Pakistan Railway owned land	acres	0.49	–	–
Land under different public structures (roads and canals)	Acres	0.62	–	–
Total Land	**acres**	**72.30**		
Loss of Structure and Other Assets				
Loss of cropped area	acres	3.66	5	33
Loss of trees	number	14	1	7
Loss of electric poles	number	27	–	–

Source: Resettlement Field Surveys June-July 2014, July-Aug 2015

Out of the 30 AHs, five AHs will also lose part of their livelihood in terms of cultivated land and will be compensated for their lands and crops.

Out of these five AHs, one AH will lose more than 10% of his monthly income as a result of land acquisition. Affected household losing more than 10% of his livelihood will also be eligible for severe impact allowance. One person from the household will be eligible for labor work or job according to its skills and education.

11.7.4 Entitlement, Assistance, and Benefits

(1) Compensation Eligibility

The households entitled to compensation and/or rehabilitation under the project are the following:

- All households affected by loss of any type of assets,
- All households affected by loss of residence,
- All households affected by loss of agriculture lands,
- All households affected by loss of barren or uncultivated lands,
- All households affected by loss of crops,
- All households affected by loss of trees, and
- All households affected by loss of any type of livelihood.

The entitlement matrix is included in Section 5 of the LARAP in **Appendix 9**.

(2) Cut-off Date

Compensation eligibility will be limited by a cut-off date fixed on the first day of the RFS as 22 June 2014 for this railway project. This date has been disclosed to each affected village and AHs during the RFS. The illegal encroachers that settle in the affected area and/or establish any asset after this cut-off date will not be eligible for compensation. They will, however, be given sufficient advance notice requesting them to vacate premises/corridor and dismantle affected structures and/or other establishments (if any) prior to project implementation. However, the project cannot force the owners of the land not to make any transactions unless Section 4 of LAA is announced. After the announcement of the Section 4 of LAA, a new RFS will be conducted and LARAP will be updated.

11.7.5 Information Disclosure, Consultation, and Participation

The RFS team (one resettlement expert, one sociologist, one male enumerator, and one female enumerator) started its field work and consultation process in the project area from 22 June to 28 July 2014, and another round from 11 July to 10 August 2015 to understand the concerns and grievances of the directly and indirectly affected households. For this purpose, the RFS team held meetings with men and women groups of Manzoorabad, DatoKhoso, Goth Pereal, and Murid Khan Rind/Goth Miandad villages.

(1) Discussion Points

In these consultative meetings, project details, construction related impacts, deduction in power outage and revival of the affected economies, increase in traffic due to project related transportation, change to existing social and cultural norms, land acquisition, relocation of houses, and resettlement issues were discussed.

(2) Concerns Raised by the Community

The concerns raised in the consultation meetings are summarized as follows. Some comments and concerns were related to the main project of Lakhra Coal Fired Power Plant, not on the railway spur line project.

- Majority of the APs expressed their concerns about compensation rates and payments for lost assets such as houses, land, and trees;
- Some APs mentioned issues related to income rehabilitation such as employment opportunities in the project;
- Some APs expressed that they did not trust local government in terms of dealing with land acquisition and resettlement;
- Two respondents mentioned their concerns regarding community assets like school and health clinic in post-project period;
- The contractor may damage the cultivated lands; and
- Some people raised their concerns regarding wastewater generated from the plant.

(3) Feedback from the Stakeholder Consultations

Feedback from the stakeholder consultations are as follows:

- Households of Murid Khan Rind/Goth Miandad to be affected by residence were willing to cooperate with the project authorities at the time of the final consultation in 2016;
- Locals should be given due share in the employment opportunities created by the project implementation;
- Fair and timely compensation;
- Vocational training for young men and needy people;
- Drinking water should be provided to local communities;
- Health facilities should be provided to local communities; and
- Culverts should be provided to all the affected water courses so that the community may

continue their agricultural activities.

(4) Mechanism of Addressing the Views Emerging from Consultation

All feedback and concerns from various consultation meetings and surveys were considered in the design of the LARAP. Internal, and if required external monitoring, will be conducted to ensure proper implementation of the plan. Following the feedback consultations, the following steps were taken:

- Market value of affected assets will be paid before taking physical possession of the affected assets and lands.
- All the households affected by the project will be served a prior notice by the district management on behalf of the district collector to vacate their lands and assets after providing the compensation and all the allowances to them. If any household refuses to do so, the project authorities will approach the household to convince it to do so. Forced evacuation will be the last resort using right of eminent domain.
- Priority will be given to locals for project related jobs and labor works during the construction and execution of the project. Drinking water will be provided to the affected communities.
- Culverts will be provided to all the watercourses affected by the railway line.

11.7.6 Grievance Redress Mechanism

The grievance redress mechanism was proposed for the project meet the compliance requirements laid out under the relevant national legislation and the environmental and social safeguards laid out under JICA Guideline 2010 and World Bank Safeguard Policy, OP 4.12, Annex E (Resettlement Plan). The mechanism is included in LARAP (**Appendix 9**).

11.7.7 Land Acquisition and Resettlement Budget

The compensation costs used herein are based on the unit rates derived through consultations with the affected communities in the subproject area, and the officials of the District Revenue Department during RFS in June–July 2014 and updated in July–August 2015.

The total estimated cost of this LARAP (Table 11-32), including compensations for the affected lands, houses, crops, trees, cost of replacement of affected public structures, relocation allowances and technical assistance, administration charge 15% of compensations, and 10% contingency was estimated at PKR 66.67 million (USD 0.66 million).

Table 11-32 Estimated Resettlement Cost of Lakhra Power Plant Project

No.	Resettlement Activity	No.	Unit	PKR/Unit	Total (PKR)
A.	**Asset Compensation**				
A.1	Houses			–	
A.1.1	Pucca houses	6,411	ft^2	959	6,148,149
A.2	Land				
A.2.1	Cultivated land	3.66	acres	1,500,000	5,490,000
A.2.2	Uncultivated land	21.06	acres	1,000,000	21,060,000
A.2.3	Residential land	0.50	acres	2,000,000	1,000,000
A.2.4	Public structures land	0.62	acres	–	–
A.2.5	Government of Sindh barren land	44.95	acres	500,000	22,475,000
A.2.6	GENCO land	1.02	acres	500,000	510,000
A.2.7	Pakistan Railways land	0.49	acres	500,000	245,000
A.2.8	25% compulsory land acquisition surcharge (on A.2.1, A.2.2 and A.2.3)	25%			6,887,500
A.3	Trees				
A.3.1	Kikar (*Acasia nilotica)*	3	number	5,500	16,500
A.3.2	Eucalyptus	11	number	5,500	60,500
A.4	Crops	3.66	acres	28,249	103,391
A.	Total Asset Compensation				63,996,040
B.	**Public Structures**				
B.1	Electric poles	27	number	100,000	2,700,000
B	Total Public Structures				**2,700,000**
C	**Resettlement Allowances**				
C.1	Vulnerable allowance	5	number	50,000	250,000
C.2	Relocation grant	6	number	20,000	120,000
C.3	Dislocation allowance	6	number	25,000	150,000
C.4	Self-managed relocation allowance	15%			922,222
C.5	Severe impact allowance	1	number	50,000	50,000
C	Total Resettlement Allowances				1,492,222
D.	**Technical Assistance**				
D.1	Resettlement specialist (implementation)	6	person/month	350,000	2,100,000
D.2	External monitoring (LARP activities)	3	person/month	350,000	1,050,000
D.3	Training of staff	–	Lump sum	500,000	500,000
D	Total Technical Assistance	–	–	–	3,650,000
E.	**Administration Costs**				
	(15% of A+B+C)				10,228,239
E	Total Administration Costs				**10,228,239**
F.	Subtotal (A+B+C+D+E)				82,066,502
G.	Contingency (10% of F)				8,206,650
Total Amount (PKR):		–	–	–	**90,273,152**
Total Amount (USD*):		–	–	–	**895,301**

* US$ 1.00 = PKR 100.83, 16 July 2015

11.7.8 Institutional Arrangements and Responsibilities for Implementation

GHCL will have the overall responsibility for land acquisition and resettlement as an executing agency under the Ministry of Water and Power (MoWP). General project execution will be functioned through PMU at the GHCL level headed by the general manager (D&D) Thermal.

Implementation of land acquisition and resettlement activities will be the responsibility of the LPGCL and Revenue Department.

11.7.9 Monitoring and Reporting

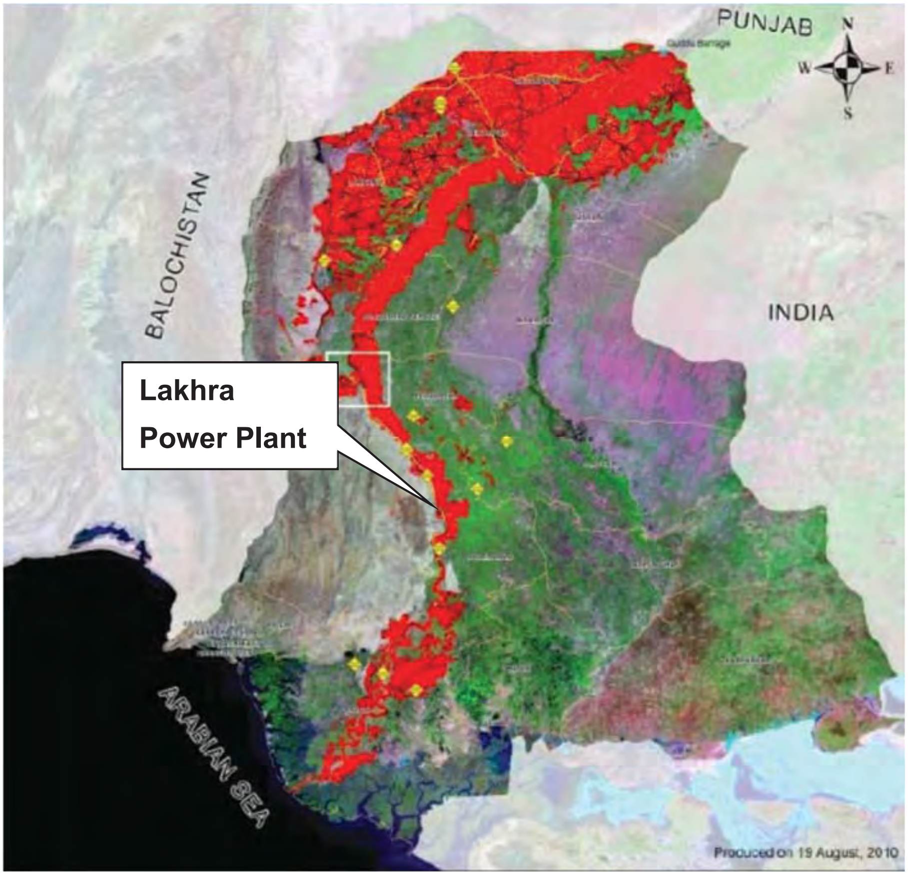
The monitoring of the implementation of resettlement was designed as an essential part of LARAP implementation and incorporates a systematic monitoring process. Land acquisition and resettlement activities will be monitored internally by PMU/PIU and externally by EMA/PIC as per following mechanisms.

The PIU's environment and social aspects section will prepare monthly progress reports on resettlement implementation activities. The EMA/PIC will submit progress monitoring and final monitoring reports to LPGCL/PIU, and PIU will submit to it GHCL for onward submission to JICA/funding agency. The reports will also include corrective action plans if required and recommendations for improvement. The monitoring documents will also be publicly available, including posting in project website.

11.8 Countermeasure for Flooding

The historical floods in Pakistan began in late July 2010 and lasted until September 2010. Approximately one-fifth of the Pakistan's land was underwater. Floods damaged approximately 25,000 km of roads (10% of the road network, and 3,91 8km of highways) and 1,225 km of railway (16% of railway network). Damage and losses were estimated at USD 1.2 billion and USD 60 million, respectively.

The following flood map indicating the flood area of Sindh Province during the heavy flood on August 2010.



Source: Pakistan Flood MAPS

Figure 11-19 Flood Map of Sindh Province in 19 August 2010

As shown on the flood map, the flood area near Lakhra Power Plant is not widely spread compared with the upstream side due to the hilly terrain at west side. However, due to the narrower stream, the speed of water flow increased and eroded the railway embankment as shown on the Figure 11-20.

The following photos are captured from a video taken near Cadet College Petaro Station near Budapur Station at August 2010.

Source: Youtube

Figure 11-20 Erosion of Railway Embankment near Cadet College Petaro Station

As seen from the photos, although the track structure was few meters above the water, the shoulder of the embankment was severely eroded.

Between Kotri Junction and Budapur Station, the Indus Highway runs the boundary between hilly area and the floodplain of the Indus River, and the railway line runs on the floodplain. Therefore, when the river water rises, the railway embankment is directly in contact with the water.

According the PR Karachi Division, it was the first time in history that the flood water inundated higher than the railway embankment, then overflowed and washed out the embankment near Budapur Station during the floods in 2010.

The idea to provide slope protection for the railway embankment between Kotri Junction and Budapur (40 km long) is not realistic considering the cost, performance, and frequency of similar scale of flood.

The 2010 floods affected majority of Pakistan and it was the most damaging floods as shown in Table 11-33 and Table 11-34.

Table 11-33 Flood Damage in the Indus Basin, 1950-2011

Year	Direct losses (USD in millions)	Affected Villages	Flooded Area (km^2)
1950	227	10,000	17,920
1955	176	6,945	20,480
1956	148	11,609	74,406
1957	140	4,498	16,003
1959	109	3,902	10,424
1973	2,388	9,719	41,472
1975	318	8,628	34,931
1976	1,621	18,390	81,920

Year	Direct losses (USD in millions)	Affected Villages	Flooded Area (km^2)
1977	157	2,185	4,657
1978	1,036	9,199	30,597
1981	139	2,071	4,191
1983	63	643	1,882
1984	35	251	1,093
1988	399	100	6,144
1992	1,400	13,208	38,758
1994	392	1,622	5,568
1995	175	6,852	16,686
1998	na	161	na
2001	na	na	na
2003	na	na	na
2010	10,056	na	38,600
2011	66	38,700	9,098

Source: ADB Report; Indus Basin Floods, Mechanisms, Impacts, and Management, 2013

Table 11-34 Flood Peaks Along the Indus River 1929-2010

			2010 Flood		Historical Flood Events	
Location	Design Discharge	100-Year Floods	Peak	Return Period (year)	Year	Peak
Sukkur	25,486	36,529	32,060	46	1976	32,890
Kotri	24,778	27,241	27,323	101	1956	27,779

Source: ADB Report; Indus Basin Floods, Mechanisms, Impacts, and Management, 2013

The remedial work took time because the damage to railway track was spread nationwide. Moreover, the remedial work of road needed more machine and manpower in wider area of Pakistan.

In order to keep the operation of Lakhra Power Plant when coal transportation by railway is suspended due to flooding, enough volume of coal shall be stocked at stockyard. The stockyard of Lakhra Power Plant is designed to store coal for 55 days of operation. If flooding is not so severe, 55 days will be enough to cover the time for restoration of railway structures. However, if the flooding took a long time similar to 2010, coal transportation by trucks shall be considered.

If railway transportation shall be kept, it is recommended to construct new track at west side of the existing track. The existing railway embankment will function as a protective structure for floods.

Chapter 12 Case Study: Power Plant Construction at Port Qasim

12.1 Candidate Site

The location of the candidate site and relation with the existing Pakistan Railway (PR) main line and spur line is indicated in Figure 12-1. The yellow line is the existing PR lines and the red line indicates the planned line to the candidate site.

Source: Google Earth Pro. JICA Study Team. Edited

Figure 12-1 Candidate Site and Relation with the Existing PR Main Line and Spur Line

12.2 Assumptions for Consideration

Construction costs of the railway structure and facilities for the candidate locations of Qasim Power Plant were estimated based on the following assumptions:

Length of the coal train is approximately 300 m, and makes shuttle services between the coal loading yard and power plant.

In order to avoid disturbance to the PR main line, the coal train to Qasim Power Plant shall move on the dedicated track and not pass the PR main line.

One coal train can carry 1,200 tons of coal (20 wagons x 60 tons = 1,200 tons).

Land acquisition and land reclamation costs are not included.

Construction cost of the elevated structure and cost of required rolling stock is indicated in Clause 13.4 together with the construction cost of the conveyor belt system for comparison purposes. Total costs including operation and maintenance (O&M) costs will be indicated separately.

12.3 Railway Alignment to the Candidate Site

Because availability of land for track at grade is unclear from coal loading site to the candidate site, track structure is planned to be constructed on the elevated structure along the planned road. Since the diameter of the pier is 2 m or less, it is not difficult to construct at the median or side of the road.

In order to climb to the level of the elevated structure, the coal train shall move towards the PR main line approximately 2.2 km; then, switch back at the location where ground level is 11 to 12 m towards the power plant direction as shown in Figure 12-2

The length of the new structure for the candidate site is 8.6 km. About 75% of the railway track is running on the elevated structure.

Source: Google Earth Pro. JICA Study Team. Edited

Figure 12-2 Alignment to the Candidate Site

12.4 Cycle Time of Shuttle Operation

Cycle time of train operation for the candidate case is examined in consideration of the following:

1) Coal loading for 20 wagons at the loading yard: 100 min. (5 x 20 = 100 min.)

2) Running to power plant (3.55+9.57) km: 40 min. (13.12 km / 20 km/h = 39.36 min.)

3) Coal unloading at stockyard: 60 min. (20 wagons x 3 min. = 60 min.)

4) Running to coal loading yard: 40 min.

5) Total time of one cycle: 240 min. = 4 hours

Since the required volume of coal per day is 6,000 tons, five cycles of train operation can cover the requirements (1,200 tons / train x 5 train = 6,000 tons).

12.5 Cost Comparison

The estimated construction costs are shown in Table 12-1.

Table 12-1 Construction Costs of Rail Access

Unit: Mil. Rs.

Railway Case

Item	Remarks	Unit Rate	PR Spur Line-Candidate Site Qt's	PR Spur Line-Candidate Site Cost
Track	Jamshoro Project Unit Cost	32,285,965 /km	8.8 km	284
Bridge	W=1.5m(sidewalk)+3.85m(Track)+1.5m(sidewalk)	863,000 /m2	47,080 m2	40,630
4000-4500HP Locomotives		549,080,000 /No.	2 No.	1,098
Hopper wagons		11,872,000 /No.	45 No.	534
			Total	42,547

Norw: Track length is measured from the switch-back point.
Source: JICA Study Team

The estimated construction cost of the conveyor belt system for both case is shown in Table 12-2.

Table 12-2 Construction Costs of Conveyor Belt System

Unit: Mil. Rs.

Conveyor Belt Case

Item	Remarks	Unit Rate	Coal Loading Site-Candidate Site Qt's	Coal Loading Site-Candidate Site Cost
Belt Conveyor	Japan Product case	1,411,350 /m	8,800 m	12419.88
			Total	12,420

Note: Length of conveyor belts is measured from the coal loading site.
Source: JICA Study Team

12.6 Conclusion of the Case Study

The above tables indicate the construction costs only. Even if there is no big difference in O&M costs between the railway case and the conveyor belt case, provision of conveyor belt system is recommended because of lower initial cost. The O&M costs of the railway case is much bigger than that of the conveyor belt system because of the required number of operating staff and maintenance cost of rolling stock.

Generally speaking, railway transportation has advantages in long distance and big volume haulage when compared with other transportation modes. There is no case to transport coal for such short distance.

Chapter 13 Conclusion and Recommendation

13.1 Existing Railway Facilities

Based on the results of hearing from Pakistan Railways (PR) and site visits, the existing railway facilities have enough capacity to transport coal to the planned five coal-fired thermal power plants including Lakhra Power Plant. However, because there is no requirement of coal transportation by railway to the power plant at present, locomotives and coal wagons shall be procured.

13.1.1 Track Structures between Bin Qasim and Budapur Stations

Coal trains are scheduled to be loaded at the Pakistan International Bulk Terminal Limited (PIBT) in Port Qasim, then move to Bin Qasim Station on the PR main line through the planned existing new spur line.

The section between Bin Qasim Station and Kotri Junction is a double track section and classified as Group I, with design axle load of 23.3 tons. The condition of track structure is relatively good and properly maintained. There are 12 stations (including both end stations) having passing loop track with minimum length of 640 m.

The section between Kotri Junction and Budapur Station is a single track section and classified as Group III, with design axle load of 17.27 tons. The track structure of this section is also relatively good and properly maintained. There are five stations (including both end stations) having crossing loop track with minimum length of 487 m.

13.1.2 Line Capacity of the Section between Bin Qasim and Budapur Stations

There are 19 passenger trains and seven freight trains running daily at the section between Bin Qasim Station and Kotri Junction at present. According to the calculation of line capacity, there is enough room for additional 64 trains per direction.

There are four passenger trains running daily at the section between Kotri Junction and Budapur Station at present. Since the line capacity of this section is 43, there is room for additional 39 trains. If Jamshoro Power Plant will use light weight locomotives on the existing track, the total number of coal trains will be 24 (8 x 2 for Jamshoro and 4 x 2 for Lakhra). This means there is room for another 15 trains per day at this section.

Assuming that the three power plants in Punjab Province require six coal trains per day, Jamshoro Power Plant requires eight trains, and Lakhra Power Plant requires four coal trains per day, the coal train running on the section between Bin Qasim Station and Kotri Junction will be 30 trains and 24 trains at the section between Kotri Junction and Budapur Station. Thus, the line capacity of the existing track is enough for the planned coal trains.

13.2 Demand Forecast

The volume of coal transportation officially recognized is 16 million tons per annum, including the three power plants in Punjab State and Jamshoro Power Plant. Since the requirement for coal transportation of 2 million tons per annum for Lakhra Power Plant is not officially recognized yet, and neither PIBT nor Fauji Oil Terminal & Distribution Co., Ltd. (FOTCO) (potential bulk terminal operators) is planning to increase their coal handling capacity at present.

Procurement of new locomotives and coal wagons are required for coal transportation to Lakhra Power Plant. PC-I Proforma for Coal Transportation by Rail to Lakhra Power Plant shall be prepared by PR when the final decision for the power plant is confirmed.

The recent decrease of other freight transportation is caused by uncertainty of railway transportation due to shortage of locomotives. Once customers shifted to road transportation, it will be difficult to recover the share to the level of 2005-2010 even when new locomotives are introduced.

13.3 Railway System Improvement

Since the existing railway facilities between Bin Qasim Station and Kotri Junction is properly maintained, the railway system improvement for Lakhra Power Plant project is limited to improving the section between Kotri Junction and Budapur Yard or Lakhra Power Plant Station.

If the existing line between Kotri Junction and Budapur Station will be used, the length of crossing loop lines at Sindh University, Cadet College Petaro, Unapur, and Budapur stations shall be extended to 640 m; the same level as those at the section between Bin Qasim Station and Kotri Junction.

If the new track between Kotri Junction and Akhundabad Station (to Jamshoro Power Plant) is extended to Budapur Station. New track and structures shall be constructed in the design axle load of 23.3 tons.

At Lakhra Power Plant Station, a new signaling system shall be installed to operate the coal trains efficiently, since track layout of the yard is complicated as shown in Figures 7.3. Trains cannot be operated safely without a signaling system.

13.4 Rolling Stock Plan

Considering operational efficiency, it is recommended to select the same type of locomotives and coal wagons to be used for Jamshoro Power Plant. However, if rotary car dumper (RCD) is adopted for unloading of coal at Jamshoro Power Plant, same type of coal wagons cannot be used at Lakhra Power Plant. In such case, hopper-type coal wagons are recommended for Lakhra Power Plant.

As detailed in the Clause 5.3.1, procurement of four diesel-electrical locomotives (4,000 – 4,500 HP) and 160 hopper wagons will be required for coal transportation to Lakhra Power Plant.

13.5 Connection Between Budapur Station and Lakhra Power Plant

Considering the topographic condition of the site between Budapur Station and the planned Lakhra Power Plant, the difference on ground level of 16 m as shown in Figure 4-10, the connection by railway is not the recommendable option because it requires the construction of a 2.4-km long bridge and the total length of 2.25 km high embankment sections at each side of the bridge. Construction of the bridge and embankment requires higher construction cost and longer construction period.

The JICA Study Team considers Case 3, connection by conveyor belt system, is the best option because of lower construction cost and faster construction period. The construction of the conveyor belt system can be completed prior to the trial operation of the Lakhra Power Plant. However, Case 2AR (spur line connection) is selected due to the strong request from Generation Company (GENCO). In that case, the coal shall be transported by dump truck for some period until the completion of the long bridge and railway structures.

If direct access to Lakhra Power Plant by rail is an essential requirement for GENCO, the rail level at the plant and gradient between PR main line to the plant shall be examined carefully in order to minimize the construction and operation and maintenance (O&M) costs.

Although PR's design standards limit the maximum gradient to 0.5%, steeper gradient may be adopted by using additional locomotive. The steeper gradient makes shorter bridge length and less construction cost. If the gradient becomes double, the bridge length becomes half. This subject shall be discussed between PR and GENCO.

13.6 Project Schedule

It is assumed that the construction of Lakhra Power Plant will commence in March 2019 and be completed at the end of June 2022 (40 months). Then, trial operation period is scheduled for 9 months. Coal for the trial operation shall be stocked at the plant yard for a 55-day operation at the time of commencement of trial operation.

On the other hand, because of the budgetary arrangement, the construction of railway-related projects are scheduled to commence 11 months after that of the power plant construction work. It is assumed that the railway-related projects will require 37 months to complete. This means that, the completion of the railway-concerned projects will be eight months after the completion of the power plant project. Therefore, coal for trial operation of the power plant shall be transported by other transportation mode for ten months.

If such situation should be avoided, the construction of railway-related projects shall commence at the same time with the power plant construction.

Major components of railway-related projects for Lakhra Power Plant are as follows:

- Extension of siding track at Sindh University, Cadet College Petaro, Unapur, and Budapur stations;
- Spur line construction from Budapur Station to Lakhra Power Plant, including earthwork, bridge work, track work, and Lakhra Power Plant Station;
- Signal improvement of Sindh University, Cadet College Petaro, Unapur, and Budapur stations, and new signal system construction at Lakhra Power Plant Station; and
- Procurement of diesel locomotives and hopper wagons.

The most time consuming activity of the railway projects will be the new line construction from Akhundabad Station to Budapur Station, and super line construction from Budapur Station to Lakhra Power Plant. Both constructions will require 37 months, approximately.

13.7 Financial and Economical Considerations

The railway project financial internal rate of return (FIRR) shall be included in the Lakhra Power Plant project FIRR, not only the railway portion. In addition to that, the economic evaluation and the economic internal rate of return (EIRR) will be calculated on the main report of Lakhra Coal Fired Thermal Power Plant Construction Project, since the benefit from the railway could not be elevated without the involvement of the power plant project.

13.8 Environmental Impacts

During the construction phase, soil dust would be generated because of civil works such as site clearing and earthwork. Water and soil contamination by oil could occur from trucks and heavy equipment. Noise and vibration are also predicted by the operation of heavy equipment and trucks. The project owner should make sure that the contractor takes appropriate measures to mitigate those impacts.

After the completion of the construction projects, noise and vibration from the railway operation is predicted. Appropriate countermeasures shall be provided by the railway operator.

Project proponent shall undertake consultation of stakeholders including affected people and full assessment of impacts. Land acquisition and resettlement action plan (LARAP) shall be prepared to compensate the loss and rehabilitate the livelihood of affected people.

13.9 Case Study: Power Plant Construction at Port Qasim

As detailed in Clause 12, coal transportation by rail within Port Qasim is not recommended because of high initial and O&M costs. If the power plant is constructed inside Port Qasim, it is recommended to adopt conveyor belt system for coal transportation.

13.10 Management of Operation and Maintenance

When mass coal transportation to several power plants is started, it is recommended to set up a new section handling coal train operation in the PR organization. It is also recommended to construct a new workshop for the maintenance of locomotives and wagons for coal train.

The maintenance of track and civil works are being done in compliance with “Way & Works Manual 1969” and other related regulations and circular notices. The maintenance works including inspection shall be done steadily and in time when repair works just is necessary. The JICA Survey Team recommends allocation of necessary manpower and budget to implement steady maintenance works to keep the constant and stable transportation of coal for power plants.

13.11 Participation of Private Sector for the Operation

PIBT is planning to participate in the coal transportation business by constructing coal terminal and procuring locomotives and wagons for the transportation from the terminal to the power plants in Punjab State. If the coal terminal works as they have planned, and technical problems of rail connection to PR main line are solved, PIBT can take part in coal transportation business in Pakistan. However, since the problem in railway connection to PR main line is still unsolved, it will take time for PIBT to be a coal transportation operator.

FOTCO is now planning to construct a coal terminal in Port Qasim. Their design of coal handling facilities is well planned and connection to PR main line has no problem. However, FOTCO's activity is suspended at present, and thus, coal transportation from FOTCO site cannot be expected. It has no plan to participate in coal transportation business at the moment.

The National Logistic Cell (NLC), another potential private sector, has also no interest in coal transportation business so far.

Considering the abovementioned situation, PR shall take full responsibility for coal transportation by rail in Pakistan until other private sectors obtain the capacity for the business.