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NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORTION LIMITED
(MINISTRY OF ROAD TRANSPORT & HIGHWAYS)
GOVT. OF INDIA

Consultancy Services for preparation of Feasibility Study and DPR for upgradation of Dergaon Town Section of NH-37 from Km 426.800 to Km. 437.800 in the state of Assam






Detailed Project Report

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Material Report

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VOYANTS
PARTNERING VISION

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CHAPTER 1 INTRODUCTION

1.1 Project Background

The General Manager (Tech), National Highways and Infrastructure Development Corporation Limited (NHIDCL) under MoRTH, Govt. of India has been entrusted with the assignment of preparation of Detailed Project Report for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-1).

In view of the above work General Manager (Tech), NHIDCL has appointed M/s Voyants Solutions Pvt. Ltd. for Package II of Lot-1 to carry out the preparation of Detailed Project Repot including field investigations, road inventory, structure inventory, Pavement Investigation, road crust sample (trial pits), material investigation, secondary data collection and traffic survey (classified traffic volume count, O-D, intersection counts, axle load survey, animal/pedestrian crossing counts and speed-delay survey). The Letter of Commencement has been issued vide Letter No. NHIDCL/Bharatmala/DPR/Phase-I/Lot-1/Package II/2017/80 dt. 13.04.2018.

In addition, a supplementary agreement was signed on 19th June 2019 between NHIDCL and M/s Voyants Solutions Pvt. Ltd. for preparation of Feasibility Study and DPR for Dergaon Town Section on NH-37 from Km 426.800 to Km. 437.800 in the state of Assam.

1.2 Project Road Description

The road segment of the project road stretch is mentioned below in **Table 1.1**.

Table 1.1: List of Road Segments

Segment	Description	Chainage (km)		Length (km)
		Start	End	
Dergaon Stretch				
1	From Km 426+800 to Km 437+800	426+800	437+800	11.000
Total Length =				**11.000**

Project location on state and district maps are presented on **Figure 1.1** and **1.2** respectively.

The project road follows NH-37. It starts at existing Km. 426+800 (26°41'36.76"N, 93°56'29.23"E) and ends at existing Km. 437+800 (26°43'29.62"N, 94° 2'27.11"E) on NH-37. It passes through Dergaon Village in Golaghat District.

The total project length as mentioned in the above table is, however, exclusive of any diversions/realignments that might have to be incorporated in the alignment for geometric improvements.

CHAPTER 2 SUB GRADE INVESTIGATION

2.1 Sub-grade Investigation Methodology (Test Pits)

The basic objective of the investigation was to form a database for characterization of existing pavement. The investigation was carried out by digging trial pits staggered left/right.

2.2 Large Pits (1.0m x 1.0m x 1.0m)

Large Trial pits of size 1m x 1m x 1m and small trial pit size 0.5m x 0.5m x 0.5m were dug at the pavement shoulder interface, extending through the pavement layers down to the subgrade level. Pits were at least 300 mm within the carriageway. Pits were made in such a way that half of the pit remains within the carriageway and the other half (in the shoulder), ensuring minimum damage to the original pavement and disruption to the traffic. Large test pits are done on both sides of the project road were dug at the pavement shoulder interface extending through the pavement layers down to the sub-grade level

The following sequence of operation was followed for each large test pit:

- Manual excavation of 1.0 m x 1.0 x 1.0 m and 0.5m x 0.5m x 0.5m pit down to subgrade level .The thickness of the different pavement layers were measured and type of material examined and logged from three sides.
- Field (in-situ) dry density using sand replacement method as per IS 2720: Part 28 was carried out at the subgrade level.
- Adequate sample in sealed polythene bag were collected for classification tests as per IS: 2720 (relevant parts)
  - Field moisture content
  - Grain size analysis
  - Atterberg limits

One sample of 40 kg was collected from the top 300 mm of subgrade for the following laboratory tests (as per IS:2720)

- Free swell index
- Moisture-Density test (heavy compaction)
- CBR (4 days soaked at three energy levels of 10, 35 and 65 blows)

After the completion of field tests and collection of samples, the pits were backfilled with the excavated materials and compacted suitably so as not to jeopardize the smooth movement of traffic of the existing road.

The existing pavement structure mostly comprises of three layers, namely bituminous layer, base course and sub-base course. During the present investigation the surfacing course is reported, on the whole, as bituminous course (BC). The base course comprises of stone, gravel, cobble mix with clay mix with sand only and few stretches present in WBM mix. The sub-base course consists mainly occasional presence of sand layer along the stretch.

The total thickness of the pavement varies from 470 mm to 555 mm. The thickness of the bituminous surfacing layer varies from 120 mm to 130 mm thick, base course varies from 340 mm to 430 mm.

2.3 Existing Pavement Composition

The existing pavement structure mostly comprises of two and three layers, namely bituminous layer varies from 120 mm to 130 mm thick, base course varies from 340 mm to 430 mm. Details of existing pavement composition (Large Pits) is provided in **Table 2.1**.

Table 2.1: Details of Existing Pavement Composition

S.NO	Side	Chainage (KM)	Crust Composition (mm)		Total Thickness (mm)	DCPT CBR 200mm	DCPT CBR 400mm
			Bituminous Coarse	Base Coarse			
1	LHS	427+000	125	430	555	5.32	6.18
2	RHS	428+000	124	420	544	5.14	5.23
3	LHS	429+000	125	413	538	5.28	5.99
4	RHS	430+000	125	408	533	5.77	6.11
5	LHS	431+000	121	415	536	5.46	5.98
6	RHS	432+600	120	400	520	5.57	6.13
7	LHS	433+500	125	405	530	5.66	5.92
8	RHS	434+500	125	394	519	5.74	5.25
9	LHS	435+400	130	340	470	4.94	5.72
10	RHS	436+500	128	375	503	5.44	5.79
11	LHS	437+500	130	393	523	4.80	5.78

2.4 Laboratory Properties of Sub-grade Soil

The laboratory test results consist of gradation, Atteberg limits, field moisture content, Field dry density (FDD), compaction characteristics (maximum dry density and optimum moisture content relationship as per heavy compaction), CBR (soaked) etc. for the subgrade soils underneath the existing pavement

2.4.1 Grain Size

The fraction of the materials of the sub-grade soils passing 75μ sieve is 12.0% to 16.06 % on an average,

The soil is CL and SC type soil.

2.4.2 Atterberg Limit

The liquid limits for existing pavement of the soil are NP to plastic. Plasticity index for existing pavement soils are 8.6 to 11.5.

2.4.3 Moisture Content vs. Dry Unit Weight Relationship (Heavy Compaction)

Soil samples obtained by test pits have been compacted in the laboratory at various moisture contents to derive moisture content vs. dry unit weight relationship. The method of heavy compaction in accordance with IS 2720 (Part 8) has been used. The results of heavy compaction test carried out on sub-grade samples of existing pavement to determine the maximum dry density (MDD) and optimum moisture content (OMC) relationship.

For existing sub-grade soil the maximum dry density (MDD) of ranges between 18.2 kN/ m^3 and 18.6 kN/m^3. The optimum moisture content varies between 8.6 % and 11.5 %. The result indicates that the maximum dry density of existing sub-grade soil is greater than 17.5 kN/ m^3 at all chainages which satisfies the unit weight requirement of sub-grade soil as specified by MORT&H.

2.4.4 CBR of Existing Sub Grade Soil

California Bearing Ratio (CBR) tests were carried out on the pit samples in the laboratory as per standard procedures. At optimum moisture content (OMC) soil samples were compacted at three different energy levels corresponding to 10 blows, 35 blows, 65 blows as per IS:2720 (Part 8). These compacted soils at different compaction levels were tested after immersion in water for four days. Soaked CBR at 97% maximum dry density (MDD) has been interpolated from CBR-dry density curve. The Stretch I soil, soaked CBR value at 97% MDU ranges from 6.0 % to 7.8 %.

2.4.5 Field Dry Density

Field dry density, as obtained from laboratory test results, is provided in **Table 2.2**.

Table 2.2: Field Dry Density

S.NO.	CHAINAGE (KM)	SIDE	MOISTURE CONTENT (%)	FIELD DRY DENSITY (gm/cc)
1	427+000	LHS	8.00	1.717
2	428+000	RHS	9.50	1.766
3	429+000	LHS	8.50	1.747
4	430+000	RHS	10.00	1.696
5	431+000	LHS	11.00	1.705
6	432+600	RHS	9.00	1.723
7	433+500	LHS	10.00	1.702
8	434+500	RHS	11.50	1.732
9	435+400	LHS	10.50	1.709
10	436+500	RHS	9.00	1.685

S.NO.	CHAINAGE (KM)	SIDE	MOISTURE CONTENT (%)	FIELD DRY DENSITY (gm/cc)
11	437+500	LHS	8.50	1.736

2.4.6 Laboratory Properties of Sub-Grade Soil

Laboratory test results of sub-grade soils are presented in **Table 2.3**.

Table 2.3: Test Results of Existing Subgrade Soil

Sl. No.	SIDE	Chainage (Km.)	Grain size analysis			Heavy Compaction		Atterberg Limits			FSI	AT 97 % CBR Soaked
			Gravel (%)	Sand (%)	Silt & Clay (%)	MDD (gm/cc)	OMC (%)	LL (%)	PL (%)	PI (%)		
1	LHS	427+000	2.90	41.90	55.20	1.852	11.80	30.30	20.80	9.50	10.00	6.0
2	RHS	428+000	3.90	47.90	48.20	1.860	11.60	28.90	20.30	8.60	7.50	6.5
3	LHS	429+000	0.00	22.60	77.40	1.820	12.60	35.10	23.60	11.50	30.00	7.0
4	RHS	430+000	2.50	35.30	62.20	1.839	12.10	32.40	22.30	10.10	17.50	6.3
5	LHS	431+000	0.00	23.90	76.10	1.825	12.50	34.60	23.50	11.10	25.00	7.2
6	RHS	432+600	2.20	32.70	65.10	1.834	12.20	32.90	22.40	10.50	20.00	7.5
7	LHS	433+500	3.60	44.80	51.60	1.858	11.70	29.80	20.40	9.40	7.50	6.3
8	RHS	434+500	3.20	39.10	57.70	1.847	12.00	31.20	21.40	9.80	12.50	7.8
9	LHS	435+400	1.20	25.30	73.50	1.832	12.20	33.90	23.00	10.90	22.50	6.9
10	RHS	436+500	3.30	40.10	56.60	1.851	11.90	30.70	21.00	9.70	10.00	6.4
11	LHS	437+500	2.70	37.00	60.30	1.842	12.10	31.90	21.90	10.00	15.00	7.5

DCPT CBR calculation and related graphs are provided in **Appendix 4.19** and **Appendix 4.20** in Volume-II.

2.5 Material Investigation

2.5.1 Borrow Area Material Survey

The Consultants has conducted necessary survey to find out the general characteristics of earth materials available in the area. The objective of this investigation is mainly to assess the general availability of soil required for construction of sub-grade and embankment as per design CBR recommended for design of new pavement.

Grain Size

The fraction of the materials of the Borrow area soils passing 75m sieve is 14.05 % on an average, indicating higher sand and clay content in the borrow area soil and that the soils are predominantly Gravely sandy Clay. (mix with moorum)

Atterberg Limit

The liquid limit for borrow soil are plastic to NP. Plasticity index for Borrow area soils are 08 to 11.4.

Moisture Content vs. Dry Unit Weight Relationship (Heavy Compaction)

For borrow area soil the maximum dry density (MDD) of ranges between 18.26 kN/ $m^3$and 18.52 kN/. The optimum moisture content varies between 10.4. % and 11.7 % . The result indicates that the maximum dry density of borrow area soil is greater than 17.5 kN/m^3 at all chainages which satisfies the unit weight requirement of sub-grade soil as specified by MORT&H.

CBR of Borrow Area Soil

The soil, soaked CBR value at 97% MDU ranges from 6.5 % to 7.6 %.

Table 2.4: Summary of the Laboratory Test Results

SL. No	SAMPLE NO.	Grain Size Analysis			Heavy Compaction		Atterberg's Limit			FSI (%)	AT 97 % SHOAKED CBR
		Gravel (%)	Sand (%)	Silt & Clay (%)	MDD (gm/cc)	OMC (%)	LL (%)	PL (%)	PI (%)		
1	BA-1	3.80	37.40	58.80	1.852	10.40	33.10	22.80	10.30	20.00	6.5
2	BA-2	0.00	25.80	74.20	1.826	11.70	35.10	24.10	11.00	27.50	7.6

2.5.2 Quarry Material Survey

The material investigation for road construction has been carried out to identify the potential sources of construction materials and to assess their general availability, engineering properties and quantities. This is one of the most important factors for stable, economic and successful implementation of the road program within the stipulated time. The material investigation is quite representative, but more exhaustive search may surely be explored by the contractors at the time of construction. For improvement work as well as for new construction the list of materials includes the following:

- *Granular materials for sub-base works*
- *Crushed stone aggregates for base, bituminous surfacing and cement concrete works*
- *Sand for bituminous and cement concrete works, sub-base, filter materials and filling materials etc.*
  Borrow earth materials for embankment, sub-grade and filling

Objective

The following are the basic objective to make material investigation:

- Source locations indicating places, kilometerage, availability and the status whether in operation or new source.
- Access to source, indicating the direction and nature of the access road i.e. left/ right of project road, approximate lead distance from the gravity center and type of access road.
- Ownership of land/ quarries, either government or private.
- Test results, indicating the quality of materials with respect to their suitability in construction.
- Probable use indicating the likely use of materials at various stages of construction work i.e. fill material, sub-grade, sub-base, base, bituminous surfacing and cross drainage structures.

The potential sources of construction materials were selected from consideration of the availability and suitability of the materials, easy access to the source and minimum hauling distance from the source in order to make the construction economical and feasible as far as possible. The samples from various identified sources have been collected for laboratory testing as per IRC/MORT&H/BIS standards.

A) <u>Coarse Aggregate</u>

Coarse aggregates such as trap rocks consisting of mainly basalt, black and grey in colour, are available in the vicinity of the project road. Stone quarries have been primarily identified as stone aggregate source for construction of various components of road, namely, Bituminous Concrete, Semi dense Bituminous concrete (SDBC), Dense Bituminous Macadam (DBM), Wet Mix Macadam (WMM), Granular sub-Base (GSB) as well as for the cement concrete works. The sources identified including their location details, lead distance and availability of the stones are tabulated in **Table 2.5.**

Table 2.5: Details of Coarse and fine Aggregates Quarry Sources

Sl. No.	Sample No	Crusher plant location/Village Name	Side	Lead (km)
1	Coarse Aggregate-1	Uriyamghat Quarry, Uriyamghat Biddapur	RHS	Lead 70 Km from Ext. Chainage 430+450 Km on Dergaon-Golaghat road

2.5.3 Laboratory Test Results of Coarse Aggregate Samples

Laboratory tests carried out for the above mentioned samples are presented in **Table 2.6** to **Table 2.7** respectively.

Table 2.6: Test results of Aggregate samples of size 20mm

Description	% of passing of Quarry Sample
Passing through 40MM	100
Passing through 20MM	93.60
Passing through 10MM	4.10
Passing through 4.75MM	2.30

Table 2.7: Test results of Aggregate samples of size 10 mm

Description	% of passing of Quarry Sample
Passing through 12.5MM	100
Passing through 10 MM	89.50
Passing through 4.75MM	8.40
Passing through 2.36MM	2.10

Laboratory test results summary of coarse aggregates has been presented in **Table 2.8**

Table 2.8: Summary of Laboratory Test Result of Aggregates

Sample No	Crusher plant location/Village Name	AIV (%)	LAV (%)	Specification	FI+EI (%)	Specific-ation	Specific Gravity	Water Absorption (%)	Specific-ation
CA-1(20 MM)	Uriyamghat Quarry, Uriyamghat Biddapur	18.8	24	Not more than 30% for non-bituminous work, 27% & 24% for DBM and BC work respectively	29	Not more than 35%	2.676	.98	Not more than 2%
CA-1(10 MM)	Uriyamghat Quarry, Uriyamghat Biddapur	20.5	26	Not more than 30% for non-bituminous work, 27% & 24% for DBM and BC work respectively	29.8	Not more than 35%	2.662	.96	Not more than 2%

The results from **Table 4.8** indicate that all the quarry samples are of approved standard and can be used for Road construction.

B) <u>Fine Aggregate</u>

Many sources have been identified are available in the vicinity of the project road. The quarry location and approximate lead distance from project is given in **Table 2.9**

Table 2.9: Details of Fine Aggregate Sources

S. No.	Sample No	Crusher plant location/Village Name Village Name	Side	Lead (km)
1	FA-1	KANAIGHAT	LHS	LEAD 35 KM FROM EXT. CHAINAGE 426+800 Km ON NH37

2.5.4 Laboratory Test Results of Fine Aggregate Samples

Laboratory tests were conducted on the sand samples collected from the River and are summarized below in **Table 2.10.**

Table 2.10: Gradation of Fine aggregate

Sl. No.	Sieve Size (mm)	% of passing	FA Zone I	FA Zone II	FA Zone III	FA ZONE IV
1	10	99.7	100	100	100	100
2	4.75	98.3	90 - 100	90 - 100	90 - 100	95-100
3	2.36	93.2	60 - 95	75 - 100	85 - 100	95-100
4	1.18	71.4	30 - 70	55 - 90	75 - 100	90-100
5	600 mic	45.3	15 - 34	35 - 59	60 - 79	80-100
6	300 mic	10.85	5-20	8-30	12-40	15-50
7	150 mic	1.82	0 - 10	0 - 10	0 - 10	0-15
8	Fineness Modulus (F.M) of FA	2.72				
9	Specific Gravity	2.44				
10	Water absorption	1.45				

Table 4.13 shows that fine medium coarse sand is available from the above river. The grading zone and fineness modulus of above stone chursher Zone II & Zone II(IS 383 2016) and 2.798 & 2.864 respectively, indicating that it is suitable for road pavement and structural concreting works.

2.5.5 Gradation of GSB/WMM Samples

Gradation of GSB and WMM sample are provided in **Appendix 4.21** and **4.22** respectively

2.5.6 Manufactured Materials

Cement, bitumen, steel are the manufactured materials. Cement and steel with I.S. certification are indigenously available in abundance from the manufacturers. Bitumen of VG-10,VG-20,VG-30 & VG-40 viscosity grade and emulsion are available from IOCL Haldia, within the vicinity of project road .The regular supply of bitumen and cement can be satisfactorily met by advance agreements with the

manufacturers. The grades of bitumen should be selected as per the guidelines of the MORT&H Specifications for Road and Bridge Works.

A) Cement

Cement to be used in the construction work shall be any of the following types with the prior approval of the Engineer:

- Ordinary Portland cement, 33 Grade, conforming to IS: 269
- Rapid Hardening Portland Cement, conforming to IS: 8041
- Ordinary Portland cement, 43 Grade, conforming to IS: 8112
- Ordinary Portland cement, 53 Grade, conforming to IS: 12269
- Sulphate Resistance Cement, Conforming tfo IS: 12330

The chloride content in cement shall in no case exceed 0.05 percent by mass of cement. Also, total sulphur content calculated as sulphuric anhydride (SO_3) shall in no case exceed 2.5 percent and 3.0 percent when tri-calcium aluminates present by mass is upto 5 or greater than 5 respectively. Good quality Cement is locally available.

B) Steel

For plain and reinforced concrete (PCC and RCC) or pre-stressed concrete (PSC) works, the reinforcement/un-tensioned steel as the case may be shall consists of the following grades of reinforcing bars as shown in **Table 2.11** are available with local stockists. Before incorporation into the work, steel shall be got approved by the engineer.

Table 2.11: Characteristic Strength of Reinforcement Steel

Grade Designation	Bar Type conforming to governing IS Specification	Characteristic Strength f_y(MP_a)	Elastic Modulus GP_a
S 240	IS:432 Part I, Mild Steel Bar	240	200
S 415	IS:1786 High Yield Strength Deformed Bars (HYSD)	415	200

C) Bitumen

Bitumen of viscosity grade VG-10 and VG-30 is available from IOCL, Haldia within the vicinity of project road, either in bulk tanker or in drums. It is advised that Polymer Modified Bitumen / Crumb Rubber Bitumen to be used for construction of bituminous layer.

Sl No.	Name of Company	Location
1	IOCL	Haldia

D) Water

Detailed survey for locating water sources for the use in concrete works and for construction of road works were carried out in the vicinity of the project road. The most suitable source of water was which are in close proximity to some points of the alignment of the rivers, along with numerous nallas and irrigation canals cross the alignment at suitable intervals. However to facilitate construction works it is always advisable to install wells with due permission from authority at suitable places for obtaining water for construction purposes.

2.6 Lead Charts

Lead chart for borrow are materials for NH 37 are provided in **Figure 2.1** respectively. The same quarry materials are presented in **Figure 2.2** for NH 37.

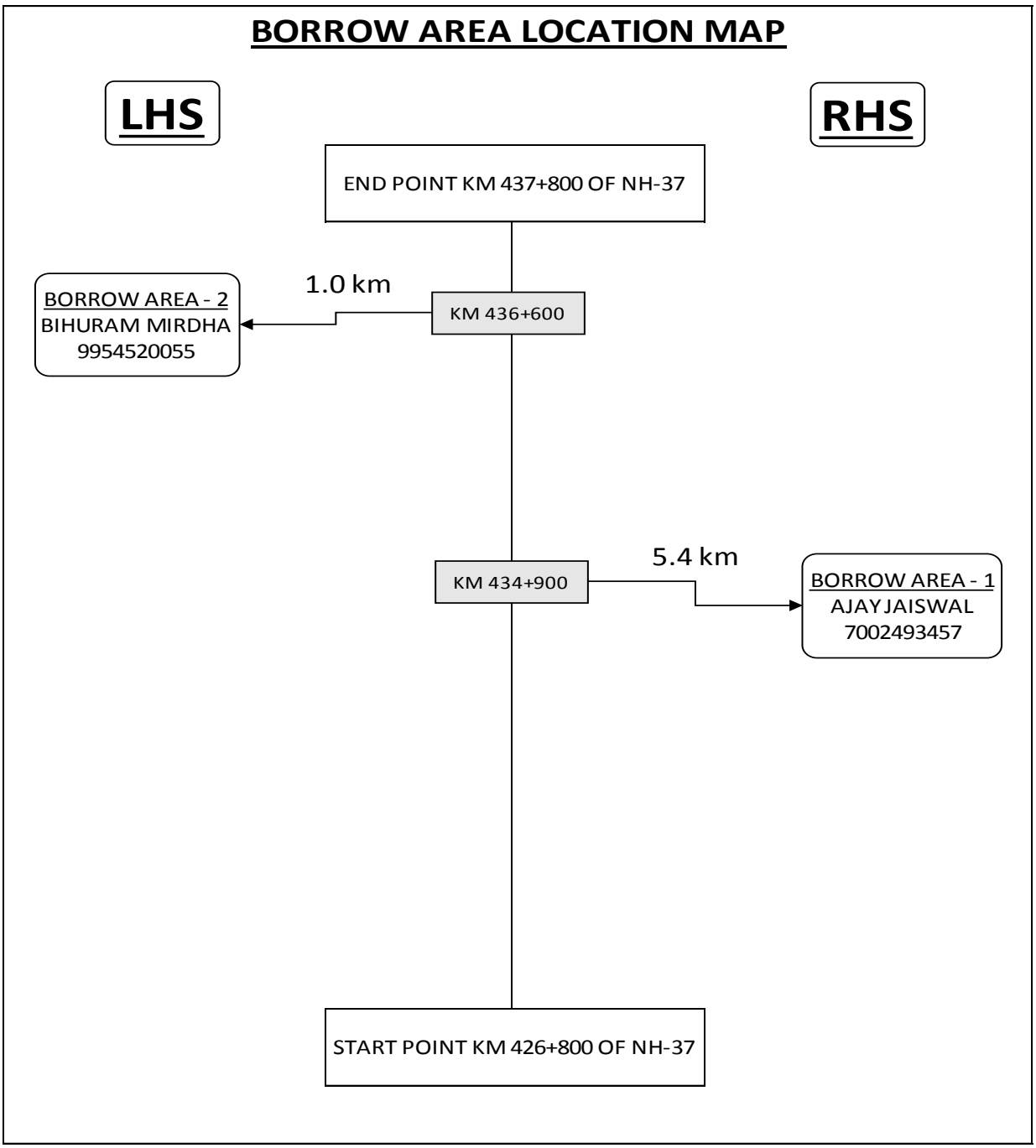

Figure 2.1: Lead Chart for Borrow Area Materials

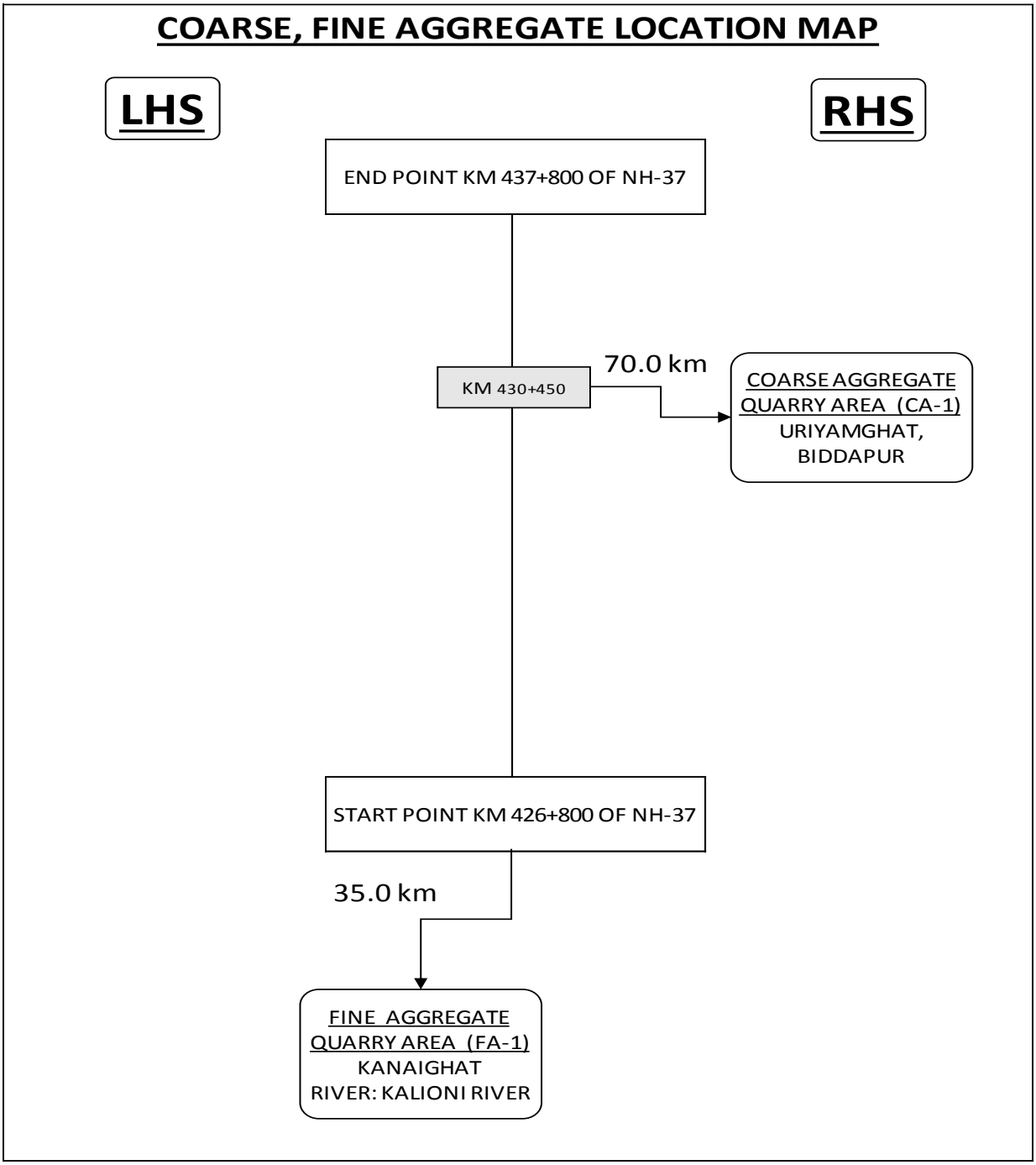

Figure 2.2: Lead Chart for Quarry Materials