APPENDIX R

RIVER CROSS SECTION AND LONGITUDINAL PROFILE SURVEY

R.1 Introduction

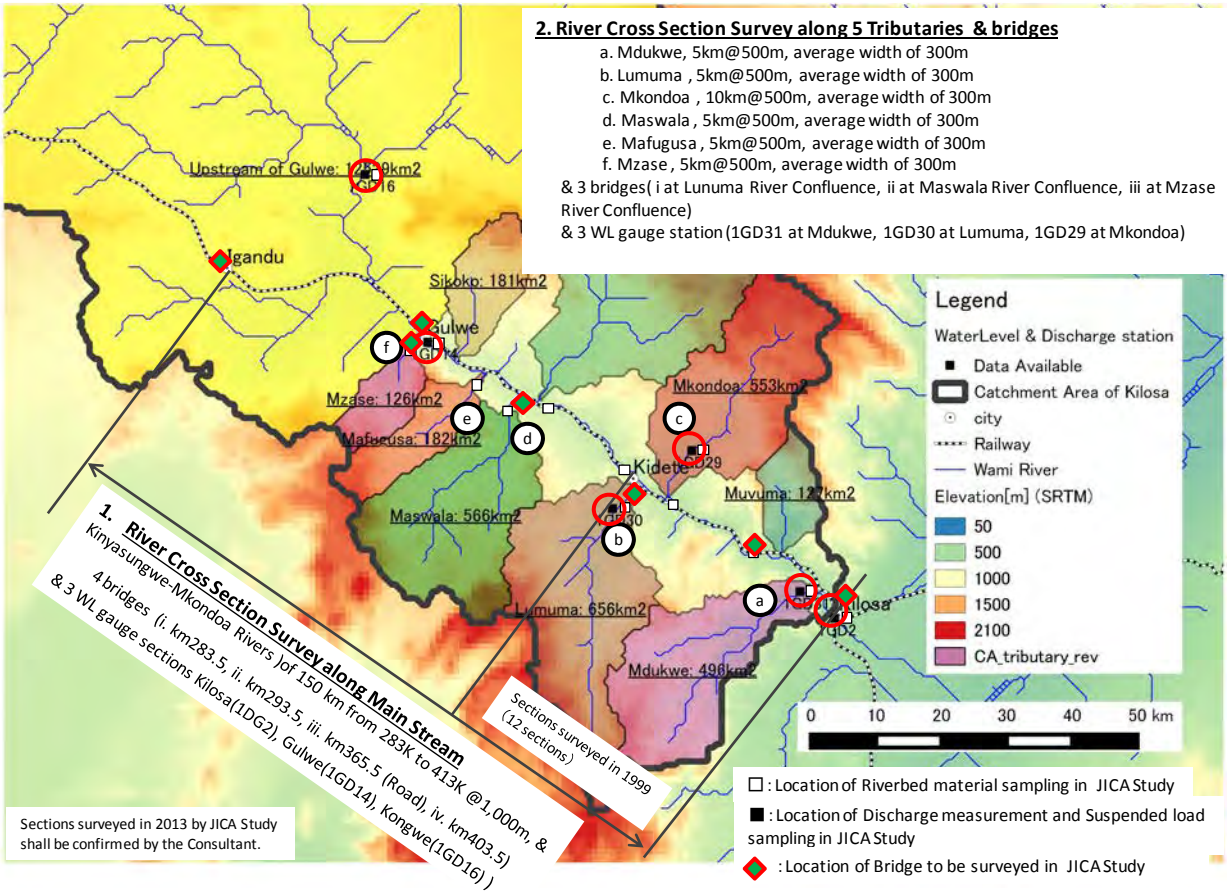
R.1.1 Main Objective

The purpose of the work is to measure the current conditions of river cross-sections and riverbed slopes that will be used for the hydraulic simulation of the Kinyasungwe/Mkondoa River and seven major tributaries.

R.1.2 Survey Contract

Through competitive bidding of least-cost proposals, the following subcontractor was selected of three who submitted their bids by the deadline. Key information on the subcontractor is summarized below:

- Date of contract signed: 23 December 2014
- Survey period: 23 December 2014 to 31 March 2015 (contract); 25 February to 25 July 2015 (actual)
- Contractor: Dunny Geoinformatics Consultancy & Services
- Address: P.O. Box 371, Plot No. 14 Boma Road, Morogoro, Tanzania
- Representative/Contact: Mr. Dunford Mateso; Tel: +252-21-754372851; e-mail: dunnygca@gmail.com

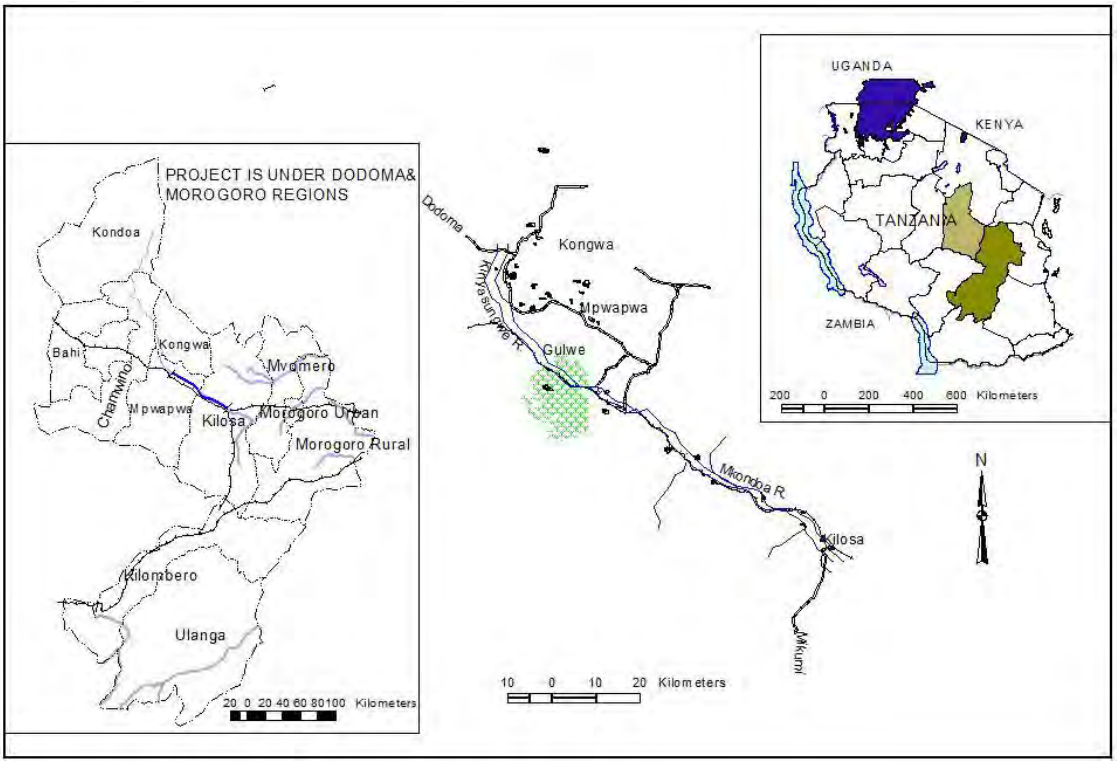


Source: JICA Study Team

Figure R.1: Map of River Cross-Section and Longitudinal Profile Survey

R.1.3 Survey Area

The survey area is a corridor of approximately 1.0 km width of the Kinyasungwe/Mkondoa River from Kilosa to Gulwe along the Central Railway line and is shown on the location map in Figure R.2.



Source: Danny Informatics

Figure R.2: Location Map of Surveyed Area

R.1.4 Work Schedule

Actual work schedule is shown in Figure R.3 in next page:

No.	Activity	2015																											
		Febr				March				April				May				June				July							
1.0	**Mobilization**																												
1.1	Work preparation:- Procurement of field materials, Purchase of signal corrections, Mobilization of field teams& Camp shift																												
2.0	**Ground Control Points extension**																												
2.1	Points identification (Team_1)																												
2.2	Points monument at every 5km (along railway) (Team_1)																												
	Point description (Team_1)																												
2.3	Spirit levelling& Search for National BM (Team_4)																												
2.4	Points monument at every 1km (along railway) (Team_1, 2& 3)																												
2.5	GPS-RTK Observations for 5km interval points (Team_1)																												
3.0	**River Cross Section readings**																												
3.1	Lines clearance																												
3.2	GPS-RTK Observations, along cross sections (Team_1,2&3)																												
3.3	Data processing (Team_1,2&3)																												
3.4	Report writing (Team_1,2&3)																												
	Omnistar observation																												
4.0	**Preparation of drawings and compile a draft report (Team_1,2&3) and Office team**																												
5.0	**Demobilization (Team_1,2&3)**																												
6.0	**Submission of final draft report (Team leader)**																												
7.0	**Submission of final report (Team leader)**																												
8.0	**Re-submission of final report (Team leader)**																												

Source: Dunny Geoinformatics

Figure R.3: Actual Work Schedule

R.2 Methodology

R.2.1 Installation of Bench Marks and Field Measurement

The bench marks and stake pins of the work were installed together along the railway line at interval of approximately 5 km and 1 km, respectively. These Bench marks and stake pins of the work used to control measurements of all cross sections along the Kinyasungwe/Mkondoa River together with selected tributaries and bridges.

All alignments for the Kinyasungwe/Mkondoa River and selected tributaries were identified and scanned. This helped to calculate the number of bench marks and stake pins to be installed and number of bench marks were placed on the ground at every 20 km (approx.) from Kilosa to Gulwe. The process of alignment identification was carried out in the office using GIS techniques with Arc View software.

Handheld GPS was used in the field to navigate the approximate positions of points along the railway line and to select positions where by residents not easier to damage the monuments. The coordinates of these points were digitized from the geo-referenced topographic maps Nos. 163/1, 3&4, 164/3 and 181/1–4.

Monuments of pillars were placed by using bucket of 10 litres of 25 cm diameter and height of 30 cm. The bucket placed in the trench for 20 cm down and remaining part of 10 cm is above the ground surface.

Later, bucket was filled up with mortar including remaining spaces on the trench to strengthen the pillar (See photo below). Centre of the bucket placed a small iron bar of 10 mm diameter and height of 23 cm to define a centering point of instrument. Monument of pillars (bench marks) at the top is marked with name as shown below:

(a) Plan view

(b) Side view

Source: Dunny Geoinformatics

Figure R.4: Monument of Bench Mark

Placement of the stake pins were followed by having 10–15 mm diameter and height of 1.0 meter. The iron pin was placed for 70–90 cm deep and just few10-30 cm above surface line and rounded with mortar on small trench to strengthen a pin.

Layout of all iron pins are indicated on map sheets of 1:50,000 at interval of 1 km along railway and other pins for the bridges with staff gauge and old cross sections, which were surveyed in 1999, placed the same.

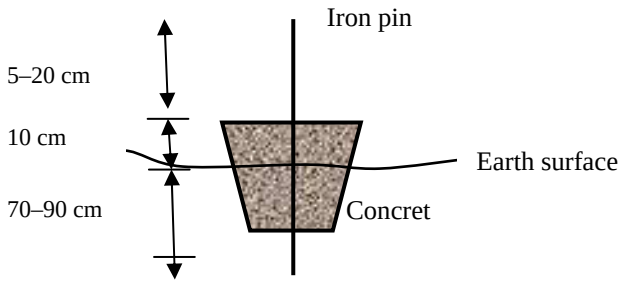


Figure R.5: Iron Pin in Concrete

R.2.2 Coordination of Bench Marks

(1) Ordinary (Spirit) Leveling

A horizontal line of sight is established by an observer with aid of a spirit bubble, plumb line or freely suspended compensator system. Enables line is to be sighted through a telescope in a horizontal direction.

Methods (differential leveling, rise & fall, height of collimation); (dH = BS - FS) the survey was conducted based on rise and fall method. Reasonable accuracies was achieved, but the requirement to close all leveling circuits remains to avoid gross errors and to control misclosure limits.

Leveling of all points along railway line was started from known National Bench Marks and traversing through newly established stake pins at every 1km along the railway line. Spirit levelling survey based to the Rise and Fall method, its traverse were started to a known National Bench Marks, which height values are known and closed to the another bench mark, which could be checked itself and confirmed to be in-situ.

The Instruments used for the survey were Automatic Levels, Tripod stands, leveling staffs, ranging rods, steel tape, Iron blade (*Panga*). The accuracy specified is per loop ±10 mm√D (D: leveled distance in km) were achieved (Ref: Appendix 4).

(2) Coordination of Horizontal Positions

The horizontal positions (N, E) with coordination of all the bench marks and the section stakes points were surveyed by using of the satellite positioning techniques instead of Total Station traversing. This process was carried out in two stages by the first being the coordination of the main bench marks at 20 km intervals basing on the National Bench Marks. This was secondly followed by the coordination of the Section Stake points with this coordination being based on the 20 km bench mark points as references.

The coordination of the bench marks was verified by using the Trimble ProXRT GNSS receiver (See figure below). All GNSS receivers are able to receive signals from the current available satellite positioning systems including the United States Global Positioning System (GPS), the Russian Global Navigation Satellite System (GLONASS), the European Galileo. Currently some systems can also receive signals from the Chinese BDS system. This lead to a rapid and relatively high accuracy positioning compared to using only one system.

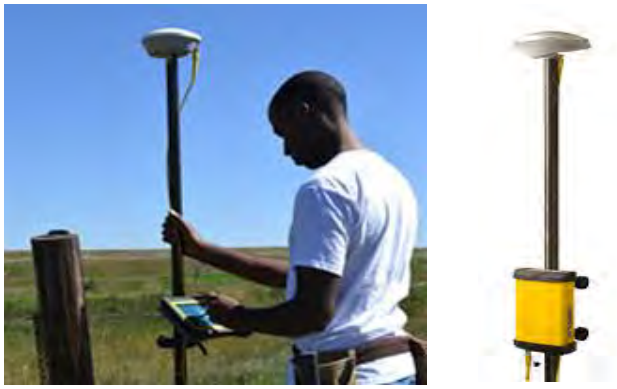


Figure R.6: Trimble Pro-XRT GNSS Receiver

In addition, using the signals from multiple satellite systems for improved positioning, the accuracy is further improved to centimeter level by applying differential corrections to the observed position. This involves getting corrections from a reference fixed station which is simultaneously making observations on a known location and computes differences to observed and the known coordinates on that reference points. The theory is that the differences are due to un-modelled errors from the satellite systems which reduce the accuracy of the observed positions. These differences are then sent to the observer as corrections to the observed

positions and results in the final observed position to have accuracy of ±3 cm or less. The differential corrections can be sent to the observer via orbiting satellites systems such as the OmniSTAR system or via direct radio link or cellular GSM systems in a mode known as Real Time Kinematic (RTK or GPS-RTK or GNSS-RTK).

Using the Trimble ProXRT GNSS receiver with corrections from OmniSTAR system six benchmarks namely CSS001, IP285 CSS002, CSS003, CSS004 and CSS005 were coordinated. In order to have all coordinates referred to the National Coordinate system, the OmniSTAR corrections were initialized by using a known point in Kilosa.

Based on the six bench marks as reference controls, the stake pins at one km interval were coordinates by using the GNSS-RTK technique. Two survey groups were involved. One group used the X900 GNSS-RTK instrument from the Chinese CHC company, while the other group used the V30Pro GNSS-RTK instrument from the Chinese Hi-Target company. GNSS-The RTK technique was also used for observing the cross sections once the stake pin has been coordinated. The observation of the cross section was based on the coordinates of the stake pin. As for cross section observations, the elevation value used was that obtained from spirit leveling.

Figure R.7: X900 GNSS- RTK Instrument Set

Figure R.8: V30 Pro GNSS- RTK Instrument Set

Using the GNSS-RTK methods Stake pins at every cross section in the main river of Kinyasungwe/ Mkondoa coordinated. Namely, these were IP282, IP283, IP284, IP285, IP286, IP287, IP288, IP289, IP290, IP291, IP292, IP293, IP294, IP295, IP296, IP297, IP298, IP299, IP300, IP301, IP302, IP303, IP304, IP305, IP306, IP307, IP308, IP309, IP310, IP311, IP312, IP313, IP314, IP315, IP316, IP317, IP318, IP319, IP320, IP321, IP322, IP323, IP324, IP325, IP326, IP327, IP328, IP329, IP330, IP331, IP332, IP333, IP334, IP335, IP336, IP337, IP338,

IP339, IP340, IP341, IP342, IP343, IP344, IP345, IP346, IP347, IP348, IP349A, IP349A1, IP249B, IP349C, IP349, IP350, IP351, IP352, IP353, IP354, IP355, IP356, IP357, IP358, IP359, IP360, IP361, IP362, IP363, IP364, IP365 and IP366.

In addition to the above, stake pins that were established on historical sections, which were previously measured in 1999, were re-surveyed. These are named as Sect_284.38, Sect_289.37, Sect_290.74, Sect_291.70, Sect_292.30, Sect_292.70, Sect_296.50, Sect_298.30, Sect_302.18, Sect_306.80 and Sect_314.60 respectively.

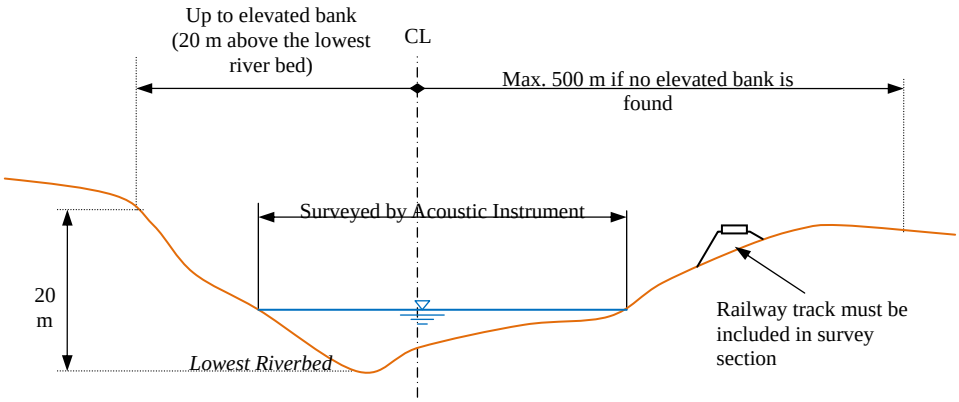
Additional sections were also measured on selected bridges and these include two bridges at Kilosa, near Km293.5 (New bridge) Kidete, Kidibo, Gulwe and at Kongwa.

R.2.3 River Cross Section Survey for the Kinyasungwe–Mkondoa Rivers and Seven Tributaries

Setting up of the cross sections for Kinyasungwe/Mkondoa River were conducted after all points were monumented along the railway. Two points more were fixed besides of the river along the same line using tracking alignment set up of GPS-RTK.

The Surveyors were responsible to make sure the cross section meet approximately at perpendicular to the direction of water flow. The width and interval of each cross section were maintained as requirements in the specification, unless there limitation which does not fit the intention, but another option was adapted to fulfill the specifications.

During the time of setting out of cross sections, observations by using Real Time Kinematic RTK method was continued to coordinates in terms of Northings, Eastings and height of all desirable points simultaneously (section width 1000 m and interval 1000 m). The accuracy of Differential GPS is 5–10 cm.



Source: JICA Study Team

Figure R.9: Cross Section Layout

Cross sections for tributaries were fixed of 500 m interval with 300 m width and reading of each section was started at rivers confluence to the direction to upstream for 5 km. The two marks of iron pins with concrete were placed at each safe side of the river. Thereafter, reading of points along the section was carried out by using RTK- GPS.

R.2.4 Certification of Existing Control Points (Datum Points)

The Director of Survey and Mapping in the Ministry of Lands, Housing and Human Settlements Development has approved the survey to adopt methodology of using Trimble ProXRT receiver that has capacity to operate in real time and without the need for local base stations or telemetry links and permit of using bench marks that are existing along or near the railway line. The used instruments of Trimble ProXRT No. 85360-10 with Activation code No. 14-0053568 of signal corrections as Omnister Id and are known worldwide that is operating in Tanzania.

R.2.5 Consultations Meeting

The survey contractor had meetings several times with JICA Study Team to modify, update and change the number of activities in order to make sure the work to accomplish under the specified standards.

R.2.6 Survey Personnel and Tasks Allocated

Team No.1

Tasks: (1) To install Bench marks of our work of 20 km interval and 5 km interval.
(2) Monumentation of bench marks and stake pins
(3) GPS- RTK observations in cross sections points
(4) Data compilation and computations

Sr. No.	Names	Position(s)	Education
1.	Samuel Mwanga	Geomatician	BSc. Geomatics
2.	Daniel Mnkeni	Survey Tech.	Diploma in Geomatics
3.	Andrew Lungo	Survey Tech (Experienced)	Std VII
4.	Daliki A. Dalikia	Survey Tech (Experienced)	Form IV
5.	Emmanuel Kanuti	Driver	Form IV

Team No. 2

Tasks: (1) To install Stake pins along railway line at every 1 km
(2) Monumentation of stake pins
(3) GPS- RTK observations along cross sections points
(4) Data compilation and computations

Sr. No.	Names	Position(s)	Education
1.	Katete Enock	Geomatician	BSc. Geomatics
2.	Saleh Khamis	Survey Tech	–
3.	Sabinus Tilia	Survey Tech	–
4.		Driver	–

Team No. 3

Tasks: (1) To install Stake pins along railway line at every 1 km
(2) Monumentation of stake pins
(3) GPS- RTK observations along cross sections points
(4) Data compilation and computations

Sr. No.	Names	Position(s)	Education
1.	Jaffari Lindonde	Geomatician	BSc. Geomatics
2.	Muhsin Ally	Survey Tech	–
3.	Hemedi Ally Buguza	Survey Tech	–
4.	Hamisi Namanka	Geomatician	BSc. Geomatics

Team No. 4

Tasks: (1) To install Stake pins along railway line at every 1km
(2) Monumentation of stake pins
(3) Levelling of all points along Railway line from Kilosa to Gulwe
(4) Data compilation and computations

Sr. No.	Names	Position(s)	Education
1.	Athumani Shehoza	Surveyor	BSc-Geomatics
2.	Kamtwanje Hussein	Surveyor	BSc-Geomatics
3.	Salum Mohamed	Surveyor	Diploma Land Surveying

Office team

Tasks: (1) Administration& Management
(2) Data compilation& computations
(3) Preparation of drawings

Sr. No.	Names	Position(s)	Education
1.	Dunford Mateso	Leader	MSc. LUP& BSc. Geomatics
2.	Hassan Mdimu	Land Surveyor	Diploma in Land Surveying
3.	Yassin Kabandika	Sen. Land Surveyor	Diploma in Land Surveying

R.3 Survey Results

R.3.1 Bench Marks and Stake Pins

A total of five stations were established along the railway line. These points were qualified as bench marks, thereafter 89 points were established in each kilometer from Kilosa to Gulwe and also qualified as stake pins nearby cross sections lined.

Purposely of determining deposition of materials on the riverbed also 12 points were approximately installed at the positions where another sections measured in 1999. The size, shape and name of all points listed on previous chapter 2.

Some of the dedicated points were prepared its description cards (Appendix 1) which will help other surveyors to approach the points easily.

R.3.2 Spirit Leveling

Leveling instruments occupied to the new installed bench marks along railway line from IP282 to IP366 (Traverse route indicated on Appendix 5) and make a total of 24 Bench marks of our work and 84 Stake pins. The fixations of these points were assured at a level of misclosure not greater than ±0.025 m, this fact you can get from Appendix 3. Table below illustrates Names of occupied Bench marks and Stake pins and the column for elevation values.

The National Bench marks used to fix the height of new points were as follows: A4/6, A4/10, A4/25, A4/25, A4/28 and A4/42. The points abstracted from the list of National Bench Marks on Appendix 3.

The lowest value along the route of new Bench marks and Stake pins is 487.680 m and highest is 782.457 m determined at IP282 and IP366 respectively, which make a difference in height of 294.777 m.

The approximately middle height can be found at IP319 and IP320 where its values are 629.884 m and 637.170 m respectively, the locality of the middle elevation along the railway can be found near Mwasa settlements.

Table R.1: Summary of Levels

SR	STN ID	ADJ RL	Remarks
1	**IP 282**	**487.680**	Stake pin
2	**CSS001**	**489.359**	BM of our work
3	**IP 283**	**489.277**	Stake pin
4	**IP 284**	**494.726**	Stake pin
5	**IP 285**	**497.900**	BM of our work
6	**IP 286**	**500.327**	Stake pin
7	**IP 287**	**503.124**	Stake pin
8	**IP 288**	**506.391**	Stake pin
9	**IP 289**	**505.947**	Stake pin
10	**IP 290**	**510.170**	BM of our work
11	**IP 291**	**512.469**	Stake pin
12	**IP 292**	**515.785**	Stake pin
13	**SECT 292.30**	**516.856**	Stake pin
14	**SECT 292.70**	**519.365**	Stake pin
15	**IP 293**	**520.143**	Stake pin
16	**IP 294**	**520.335**	Stake pin
17	**IP 295**	**523.218**	BM of our work
18	**IP 296**	**527.807**	Stake pin
19	**SECT 296.50**	**529.869**	Stake pin
20	**IP 297**	**530.786**	Stake pin
21	**IP 298**	**536.165**	Stake pin
22	**SECT 298.30**	**535.968**	Stake pin
23	**IP 299**	**538.470**	Stake pin
24	**IP 300**	**544.533**	Stake pin
25	**IP 301**	**549.155**	Stake pin
26	**IP 302**	**552.445**	Stake pin
27	**CSS002**	**554.755**	BM of our work
28	**IP 303**	**555.573**	Stake pin
29	**IP 304**	**561.459**	Stake pin
30	**IP 305**	**564.947**	BM of our work
31	**SECT 289.37**	**506.797**	Stake pin
32	**SECT 290.74**	**511.679**	Stake pin
33	**IP 306**	**567.324**	Stake pin
34	**SECT 306.80**	**570.503**	Stake pin
35	**IP 307**	**571.693**	Stake pin
36	**IP 308**	**576.286**	Stake pin
37	**SECT 308.84**	**578.664**	Stake pin
38	**IP 309**	**578.845**	Stake pin
39	**IP 310**	**585.058**	BM of our work
40	**IP 311**	**590.355**	Stake pin

Note: SR= Serial number, STN ID= Station name, ADJ RL= Adjusted Levels, BM= Bench marks.

SR	STN ID	ADJ RL	Remarks
41	**IP 312**	**595.714**	Stake pin
42	**IP 313**	**602.292**	Stake pin
43	**IP 314**	**606.241**	Stake pin
44	**SECT 314.60**	**607.480**	Stake pin
45	**IP 315**	**610.009**	BM of our work
46	**IP 316**	**616.318**	Stake pin
47	**IP 317**	**620.057**	Stake pin
48	**IP 318**	**623.918**	Stake pin
49	**IP 319**	**629.884**	Stake pin
50	**IP 320**	**637.170**	BM of our work
51	**IP 321**	**643.095**	Stake pin
52	**IP 322**	**651.969**	Stake pin
53	**IP 323**	**660.781**	Stake pin
54	**IP 324**	**670.249**	Stake pin
55	**IP 325**	**675.829**	BM of our work
56	**IP 326**	**674.722**	Stake pin
57	**IP 327**	**670.329**	Stake pin
58	**IP 328**	**670.192**	Stake pin
59	**IP 329**	**670.633**	Stake pin
60	**IP 330**	**671.056**	BM of our work
61	**IP 331**	**671.367**	Stake pin
62	**IP 332**	**676.265**	Stake pin
63	**IP 333**	**678.772**	Stake pin
64	**IP 334**	**685.490**	Stake pin
65	**IP 335**	**688.649**	BM of our work
66	**IP 336**	**690.007**	Stake pin
67	**IP 337**	**694.795**	Stake pin
68	**IP 338**	**700.725**	Stake pin
69	**IP 339**	**701.982**	Stake pin
70	**IP 340**	**704.060**	BM of our work
71	**IP 341**	**704.846**	Stake pin
72	**IP 342**	**708.872**	Stake pin
73	**CSS004**	**713.731**	BM of our work
74	**IP 343**	**714.695**	Stake pin
75	**IP 344**	**722.607**	Stake pin
76	**IP 345**	**729.157**	BM of our work
77	**IP 346**	**734.343**	Stake pin
78	**IP 347**	**736.304**	Stake pin
79	**IP 348**	**738.148**	Stake pin

Note: SR= Serial number, STN ID= Station name, ADJ RL= Adjusted Levels, BM= Bench marks.

SR	STN ID	ADJ RL	Remarks
80	**IP 349/1A**	**739.490**	Stake pin
81	**IP 349A**	**739.729**	Stake pin
82	**IP 349B**	**743.354**	Stake pin
83	**IP 349C**	**751.261**	Stake pin
84	**IP 350**	**752.142**	BM of our work
85	**IP 351**	**751.321**	Stake pin
86	**IP 352**	**754.388**	Stake pin
87	**IP 353**	**755.374**	Stake pin
88	**IP 354**	**757.692**	Stake pin
89	**IP 355**	**765.882**	BM of our work
90	**IP 356**	**768.310**	Stake pin
91	**IP 357**	**769.475**	Stake pin
92	**IP 358**	**770.314**	Stake pin
93	**IP 359**	**771.221**	Stake pin
94	**IP 360**	**772.385**	BM of our work
95	**IP 361**	**774.189**	Stake pin
96	**IP 362**	**774.292**	Stake pin
97	**CSS005**	**777.752**	BM of our work
98	**IP 363**	**777.203**	Stake pin
99	**IP 364**	**777.549**	Stake pin
100	**IP 365**	**781.691**	BM of our work
101	**IP 349**	**753.546**	Stake pin
102	**IP 366**	**783.277**	Stake pin
103	**IP 366/5**	**782.457**	Stake pin
104	**SECT 284.38**	**495.113**	Stake pin

Note: SR= Serial number, STN ID= Station name, ADJ RL= Adjusted Levels, BM= Bench marks
Source: Dunny Geoinformatics

R.3.3 Measurements of Cross sections

Cross sections in our project are the lines running approximately perpendicular to the Main River and selected tributaries.

To set these lines we used GPS- RTK to fix the position of each point at any change of gradient along specified line.

To make sure line is straight at any point, the GPS-RTK instruments setup was automatic not to read position in Northings, Eastings and Height till it reach within 3 cm allowable error.

Before carrying out measurements the GPS-RTK should have two receivers, one is set at known station in position wise and another is roaming along sections line to determine new positions. The two receivers they link to each other through radio waves.

Cross sections data sample (Table R.2) were listed in terms of Offset, Elevation and Descriptions, the data were abstracted from coordinates of Northings, Eastings, Elevations and Descriptions which processed direct from the software after downloading from GPS- RTK controller.

Cross sections details sketch for bridges is indicated on Appendix 6.

Table R.2: River Cross Section Data

IP322			IP323		
Offset	Eleva	Description	Offset	Eleva	Description
423.4052	657.1322	SH	565.7042	660.354	SH
418.3545	651.965	SH	638.0018	662.315	SH
415.7619	652.4128	CRL322	625.4196	660.44	SH
413.3934	651.97	IP322	602.6077	656.192	SH
402.764	657.6654	SH	584.6743	654.633	SH
361.9957	655.208	SH	572.4312	660.668	SH
309.0032	653.114	SH	569.2765	660.841	RL
257.3459	651.4415	SH	567.2066	660.575	IP323
226.0828	647.3995	SH	555.5353	654.532	SH
201.345	647.4754	SH	525.0898	654.794	SH
144.2205	647.3511	SH	492.5978	655.225	SH
89.0366	648.3255	XIP322/1	422.7103	655.218	SH
80.82334	648.0481	RB	369.2219	654.213	SH
61.39231	639.2339	RBO	363.5568	653.12	SH
0	640.135	Criver	326.6521	653.131	SH
-135.18	640.856	SH	296.9185	653.975	SH
-196.076	641.573	SH	257.2293	655.511	SH
-247.937	641.9078	LBO	209.0607	654.97	SH
-260.874	646.4381	LB	154.2609	654.566	SH
-277.858	647.1563	XIP322/2	124.881	654.797	SH
-333.036	646.4778	SH	113.5425	654.766	IP323/1 BANK
-525.774	645.6612	SH	104.5989	645.347	SH
-766.092	648.4664	SH	98.82636	642.775	WATER FLOOR
-785.227	654.3099	SH	88.47241	642.735	SH
-807.854	661.4751	SH	77.79019	642.709	SH

Source: Dunny Geoinformatics

Lack of reliable horizontal National bench marks the Ministry of Land allowed our project to base on Static GPS of Integrated Omnistar signal corrections.

The entire work its coordinates system were transformed from GPS-RTK to adopt the Static GPS system, it is not possible to have the same transformation parameters because our project is in linearity character which their distortion in scale, rotation and transition it starts to change in large values beyond 5 km. So in our particular project we break portions of 10–15 km and transform the coordinates with different parameters which were desired.

The transformation process produces ±0.5–1 meter accuracies in positioning horizontally and this vary depending on the distances. Shorter distance, error is small and longer distances having big error.

We have experienced the UTM coordinates system used in mapping in Tanzania is based on Arc 1960 Datum which is not fitting well on determined ellipsoid compared to WGS84 Datum.

Here we revised readings to improve the accuracy attained earlier by occupying more Bench Marks of our work and stake pins.

We used Trimble Pro XRT to revisit some points which control revised cross section readings, their readings listed down on Table R.3. In the table you can find accuracies attained by instrument.

Table R.3: Static GPS Observations

Pt_name	Location	Max_PDOP	Max_HDOP	Corr_Type	GPS_Date	Filt_Pos	Horz_Prec	Std_Dev	Northing	Easting
IP366	GULWE	2.2	1.3	Real-time Code	6/22/2015	30	9.2	0.037735	9286700.368	213542.189
IP364	GULWE	2.2	1.0	Real-time Code	6/22/2015	30	9.2	0.027707	9285808.606	215265.731
IP363	GULWE	3.1	1.1	Real-time Code	6/22/2015	30	9.3	0.012856	9285404.442	216168.572
css 005	GULWE	2.3	1.0	Real-time Code	6/22/2015	30	9.2	0.011541	9285361.960	216364.428
IP366/5	GULWE	2.3	0.9	Real-time Code	6/23/2015	30	9.2	0.029786	9287013.387	213150.932
IP362	GULWE	2.5	1.0	Real-time Code	6/23/2015	30	9.4	0.019881	9284766.341	216870.545
IP361	GULWE	2.1	1.2	Real-time Code	6/23/2015	30	9.4	0.018639	9284229.948	217691.177
IP360	GULWE	2.0	1.0	Real-time Code	6/23/2015	30	9.1	0.019949	9283449.770	218272.793
IP359	GULWE	2.2	1.0	Real-time Code	6/23/2015	30	9.3	0.040670	9282775.122	218997.271
IP358	GULWE	2.1	0.9	Real-time Code	6/23/2015	30	9.2	0.070559	9282441.107	219929.148
IP357	GULWE	2.4	1.1	Real-time Code	6/23/2015	30	5.6	0.023463	9282516.322	220923.309
IP356	GULWE	1.9	0.9	Real-time Code	6/23/2015	30	9.3	0.027361	9282374.113	221816.395
IP354	GULWE	1.6	0.8	Real-time Code	6/23/2015	30	9.6	0.012106	9281764.676	223715.912
IP350	GULWE	2.2	0.9	Real-time Code	6/24/2015	30	9.3	0.016413	9279459.162	226727.188
IP346	Godegode	2.2	1.3	Real-time Code	6/24/2015	30	9.3	0.018305	9276378.326	232656.904
IP343	GODEGODE	2.1	1.0	Real-time Code	6/24/2015	30	9.3	0.021454	9275928.541	235300.023
IP342	GODEGODE	4.6	1.3	Real-time Code	6/24/2015	30	9.3	0.061287	9275254.756	236043.378
IP338	GODEGODE	2.3	1.0	Real-time Code	6/24/2015	30	9.1	0.016947	9273014.274	239000.916
IP337	GODEGODE	2.3	1.0	Real-time Code	6/24/2015	30	9.2	0.033980	9272343.975	239686.436
IP333	GENGE5	2.1	1.0	Real-time Code	6/25/2015	30	9.1	0.045751	9269474.336	241508.689
IP329	GENGE5	2.1	1.0	Real-time Code	6/25/2015	30	9.8	0.018898	9267258.111	244325.068
IP324	KIDETE	2.0	1.0	Real-time Code	6/25/2015	30	9.2	0.041804	9263677.813	246862.013
IP317	MWASA	5.5	1.7	Real-time Code	6/25/2015	30	9.8	0.047106	9260746.408	252152.366
IP312	MZAGANZA	2.4	1.1	Real-time Code	6/25/2015	30	9.1	0.034054	9259028.534	256642.721
IP310	MZAGANZA	2.2	1.4	Real-time Code	6/26/2015	30	9.2	0.018342	9258661.521	258557.003
IP305	MZAGANZA	4.6	1.3	Real-time Code	6/26/2015	30	9.7	0.026327	9255441.102	261624.938
IP300	MUNISAGARA	2.4	1.0	Real-time Code	6/26/2015	30	9.3	0.038771	9254543.662	265931.764
IP295	MUNISAGARA	2.0	0.9	Real-time Code	6/26/2015	30	9.4	0.020893	9253037.211	269814.107
IP282	KILOSA	2.1	1.0	Real-time Code	6/27/2015	30	8.8	0.022695	9244803.072	277886.999
IP283	KILOSA	2.1	1.3	Real-time Code	6/27/2015	30	9.2	0.034049	9244708.916	276896.629
IP290	KILOSA	3.1	1.1	Real-time Code	6/27/2015	30	9.3	0.046017	9249912.226	273283.706
IP 285	KILOSA TOWN	1.9	0.8	Real-time Code	4/25/2015	30	9.4	0.053919	9245932.764	275568.439
IP 302	MUNISAGARA	2.3	0.9	Real-time Code	4/25/2015	30	9.7	0.014211	9254092.191	263993.433
CSS002	MUNISAGARA	2.1	0.8	Real-time Code	4/25/2015	30	9.5	0.084359	9254200.076	263189.625
IP 323	KIDETE	4.2	1.2	Real-time Code	4/25/2015	30	9.4	0.017076	9263515.416	247824.266
CSS004	GODEGODE	1.5	0.8	Real-time Code	4/26/2015	30	9.3	0.013520	9275816.128	235466.925
MORGA	GULWE	2.3	0.8	Real-time Code	4/26/2015	30	9.6	0.092836	9287107.542	212941.678
KN03A	KONGWA	2.7	1.1	Real-time Code	4/26/2015	30	9.8	7.058889	9312285.609	204104.404
BASE	KONGWA	2.2	1.0	Real-time Code	4/26/2015	30	8.9	0.025089	9312292.130	204107.821

Note: Pt_name= Point name, Max_PDOP= Maximum Precision Dilution of Positions, Max_HDOP= Maximum of Height Dilution of Positions, Corr_Type= Signal correction type, Rcvr_Type= Receiver type, GPS_date= Global Positioning System date, Vrt_Prec= Vertical precision, Hrz_Prec= Horizontal precision, Std_Dev= Standard deviation.
Source: Dunny Geoinformatics

R.3.4 Data Processing of GPS- RTK (Real Time Kinematic)

The raw data collected by a receiver were processed in order to determine the differential relationship between the points during data collection. The results of processing GPS raw data were vectors defining this relationship. Computation of these vectors was the role of the data processing module done within GNSS (Glonass Network Satellite System) Solutions software.

The purpose of data processing module was to analyze the quality of the raw data files and adjust processing parameters to produce the best vectors. In GNSS Solutions software, the actual processing of data is limited to a simple press of the process button.

In this stage of data processing, three steps were done as follows:

- **Pre-process data analysis**: Point and observation properties were verified and/or entered
- **Processing**: GNSS vectors were produced from raw data.
- **Post-process data analysis**: Produced GNSS vectors were analyzed using supplied analysis tool to determine the quality of processed data.

R.3.5 Coordinate System Summary

Coordinate system	
Name:	UTM/ARC1960/UTM zone 37S
Type:	Projected
Unit name:	Meters
Meters per unit:	1
Vertical datum:	EGM96
Vertical unit:	Meters
Meters per unit:	1
Datum	
Name :	ARC 1960
Ellipsoid Name:	CLARK1880
Semi-major Axis:	6378249.149 m
Inverse Flattening:	293.465
DX to WGS84:	−160.0000 m
DY to WGS84:	−6.0000 m
DY to WGS84:	−302.0000 m
RX to WGS84:	0.000000 "
RY to WGS84:	0.000000 "
RZ to WGS84:	0.000000 "
ppm to WGS84:	0.000000000000
Projection	
Projection Class:	Transverse_Mercator
Latitude of origin	0° 00' 00.00000"N
Central meridian	39° 00' 00.00000"E
Scale factor	0.999600000000
False easting	500000.000 m
False northing	10000000.000 m

R.3.6 Output

(1) Layout map of main river cross sections, tributary and bridge positions were plotted on physically on the ground. The surveyed cross sections were overlaid on the topographic maps in scale of 1:50000.
(2) Plan view drawn to scale of 1:50000 and two sheets of A1 size covered to all cross sections
(3) Longitudinal section was drawn in scale of 1: 50000 for horizontal and vertical to and covered with two sheets of A1.
(4) Cross sections were drawn in scale of 1:500 for horizontal and vertical to 1:100 view to all of main river and tributaries
(5) Bridges cross section were shown with large scale this made to explore more details especially bridge size and height between bridge level and river bed.

R.4 Recommendations

As for combined observation method using GPS based on Omnistar signal corrections and GPS-RTK, surveyors should take care of the distance limit for getting proper accuracy. If distance of fixing position is beyond 5 km, the accuracy starts decreasing due to distortions of scale and rotation. Therefore, it is advised that surveyors on using both instruments should take care of the distance limits not to fix points beyond radius of 5 km.

Appendices

Appendix 1: Drawings

List of Survey Drawings

Id	List of survey drawings	Copies	Scale
1.	General location map		
2.	Location map of bench mark and cross sections (1/2)	3	1:50000
3.	Location map of bench mark and cross sections (1/2)	3	1:50000
4.	Plan view (1/2)	3	1:50000
5.	Plan view (2/2)	3	1:50000
6.	Longitudinal profile of main stream	3	Vertical 1:1500 Horizontal 1:7500
7.	Longitudinal profile of Mzase tributary	3	Vertical 1:1500 Horizontal 1:7500
8.	Longitudinal profile of Sikoko tributary	3	Vertical 1:1400 Horizontal 1:7000
9.	Longitudinal profile of Kidibo tributary	3	Vertical 1:1400 Horizontal 1:7000
10.	Longitudinal profile of Maswala tributary	3	Vertical 1:1000 Horizontal 1:5000
11.	Longitudinal profile of Mangweta tributary	3	Vertical 1:1400 Horizontal 1:7000
12.	Longitudinal profile of Lumuma tributary	3	Vertical 1:7500 Horizontal 1:15000
13.	Longitudinal profile of Mkondoa tributary	3	Vertical 1:1600 Horizontal 1:8000
14.	Cross sections tributaries	21	Vertical1:100 Horizontal 1:500
15.	Cross sections of main river		Vertical1:200 Horizontal 1:1000 Horizontal 1:1500

Source: Dunny Geoinformatics

Appendix 2: Control Points Description Cards

TANGANYIKA

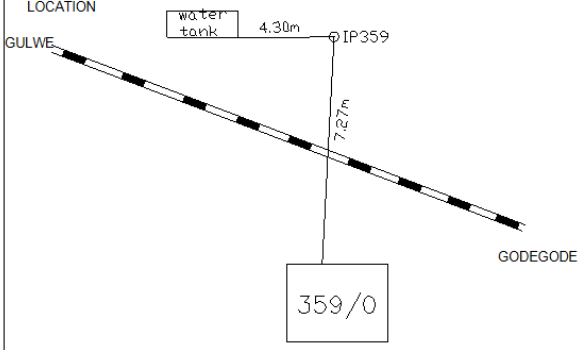
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP359
HEIGHT 772.385
DATE BUILT March 2015

REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/4

DISCRIPTION; Iron pin in concreate

LOCATION



APPROACH

TANGANYIKA

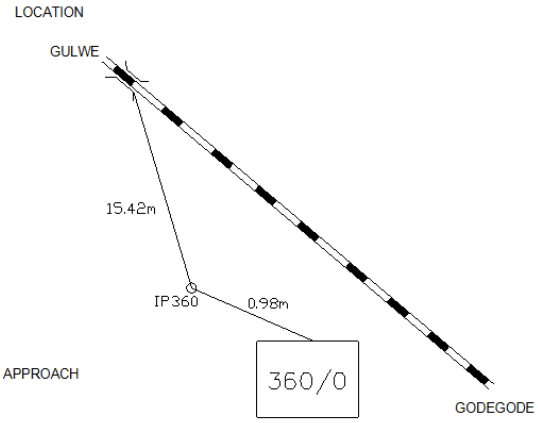
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP360
HEIGHT 772.385
DATE BUILT March 2015

REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/4

DISCRIPTION; Iron pin in concreate

LOCATION



APPROACH

TANGANYIKA

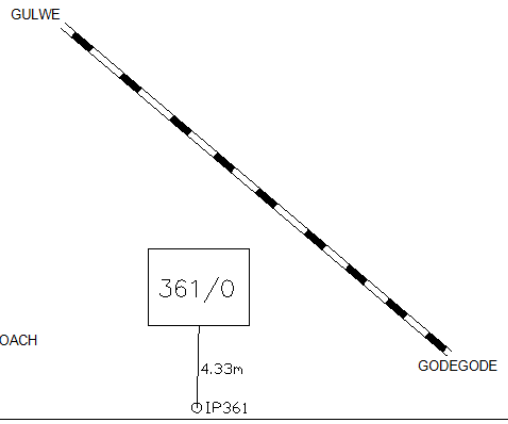
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP 361
HEIGHT 774 .189
DATE BUILT March 2015

REGION Dodoma
DISTRICT Mpwapwa
LOCALITY GULWE
MAP REF 164/4

DISCRIPTION; Iron pin in concreate

LOCATION



APPROACH

TANGANYIKA

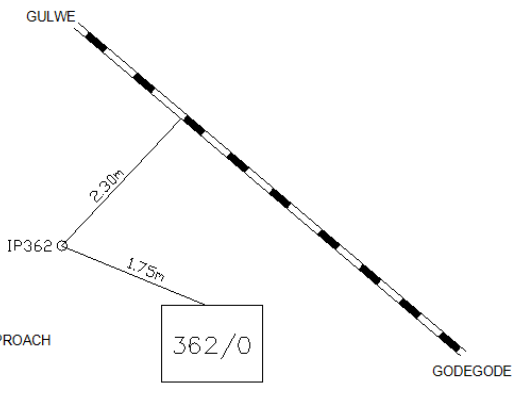
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP362
HEIGHT 774 .292
DATE BUILT March 2015

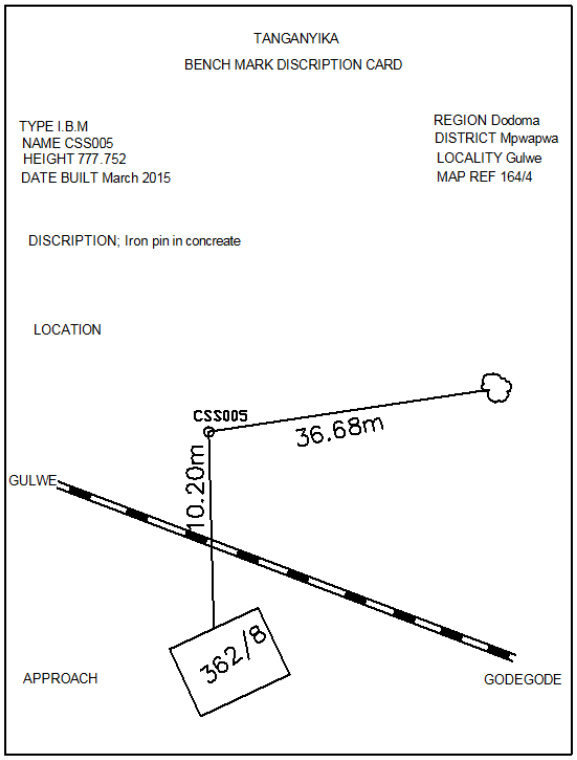
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY GULWE
MAP REF 164/4

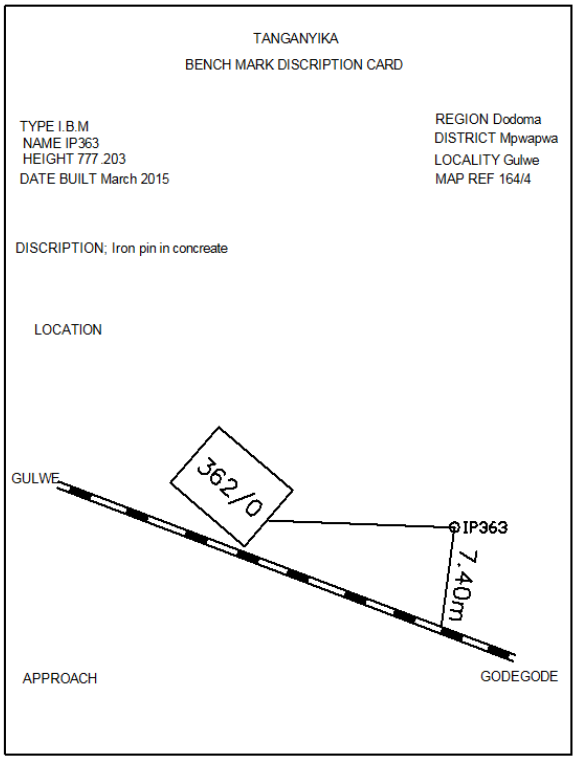
DISCRIPTION; Iron pin in concreate

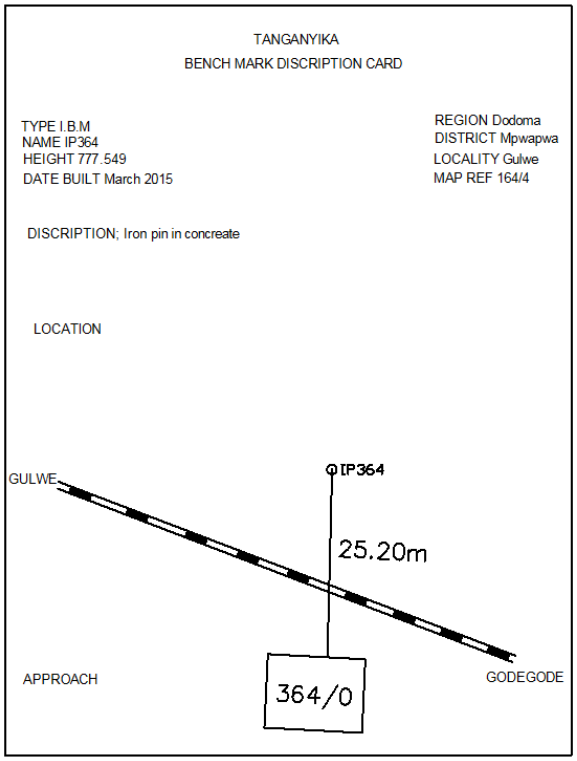
LOCATION

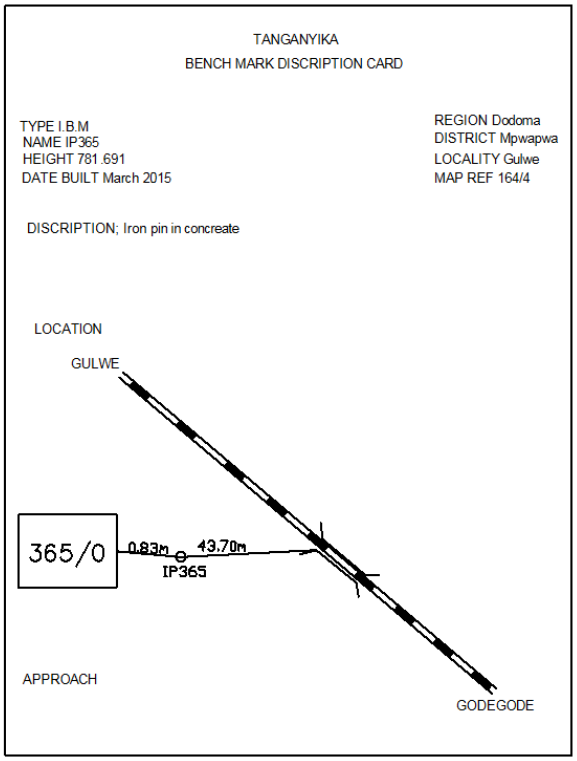


APPROACH


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME CSS005
HEIGHT 777.752
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Gulwe
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
CSS005
36.68m
10.20m
GULWE
362/8
APPROACH
GODEGODE


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP363
HEIGHT 777.203
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Gulwe
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
362/0
IP363
7.40m
APPROACH
GODEGODE


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP364
HEIGHT 777.549
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Gulwe
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
IP364
25.20m
APPROACH
364/0
GODEGODE


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP365
HEIGHT 781.691
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Gulwe
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
365/0
0.83m
43.70m
IP365
APPROACH
GODEGODE

TANGANYIKA

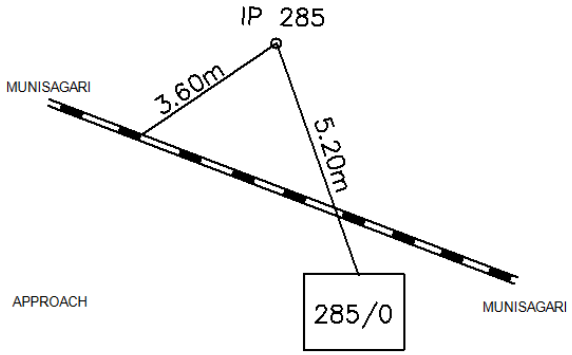
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP 285
HEIGHT 497.900
DATE BUILT March 2015

REGION Morogoro
DISTRICT Kilosa
LOCALITY Munisagara
MAP REF 181/4

DISCRIPTION; Iron pin in concreate

LOCATION



TANGANYIKA

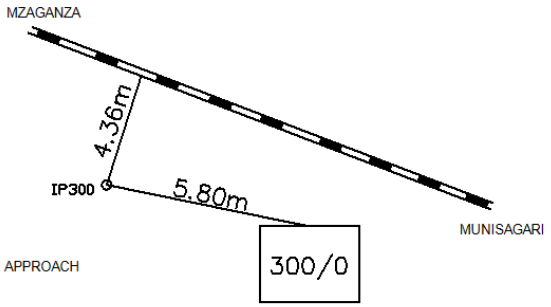
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP300
HEIGHT 544.533
DATE BUILT March 2015

REGION Morogoro
DISTRICT Kilosa
LOCALITY Munisagara
MAP REF 181/2

DISCRIPTION; Iron pin in concreate

LOCATION



TANGANYIKA

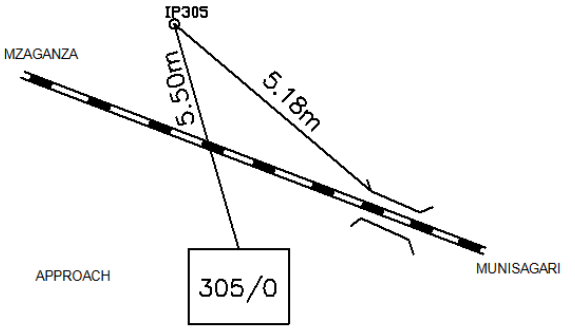
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP305
HEIGHT 564.947
DATE BUILT March 2015

REGION Morogoro
DISTRICT Kilosa
LOCALITY Munisagara
MAP REF 181/2

DISCRIPTION; Iron pin in concreate

LOCATION



TANGANYIKA

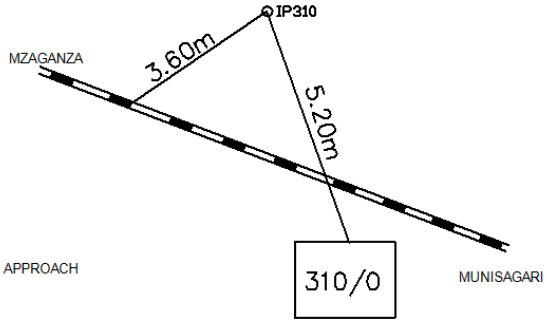
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP310
HEIGHT 585.058
DATE BUILT March 2015

REGION Morogoro
DISTRICT Kilosa
LOCALITY Munisagara
MAP REF 181/2

DISCRIPTION; Iron pin in concreate

LOCATION



TANGANYIKA

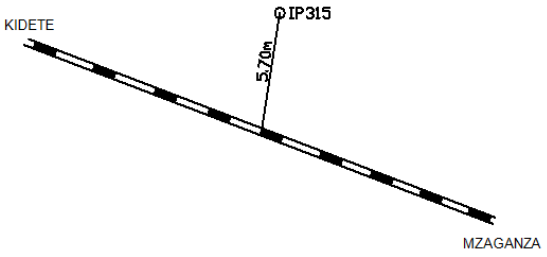
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP 315
HEIGHT 610.009
DATE BUILT March 2015

REGION Morogoro
DISTRICT Kilosa
LOCALITY Mwasa
MAP REF 181/1

DISCRIPTION; Iron pin in concreate

LOCATION



APPROACH

TANGANYIKA

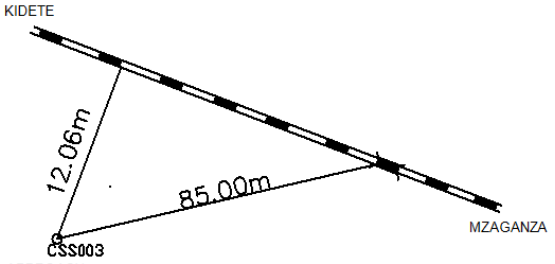
BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME css 003
HEIGHT 661.751
DATE BUILT March 2015

REGION Morogoro
DISTRICT Kilosa
LOCALITY Mzaganza
MAP REF 181/1

DISCRIPTION; Iron pin in concreate

LOCATION



APPROACH

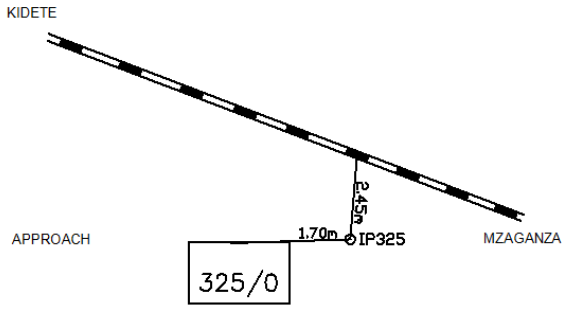
TANGANYIKA

BENCH MARK DISCRIPTION CARD

TYPE I.B.M
NAME IP325
HEIGHT 675.829
DATE BUILT March 2015
DISCRIPTION; Iron pin in concreate

REGION Morogoro
DISTRICT Kilosa
LOCALITY Kidete
MAP REF 181/1

LOCATION



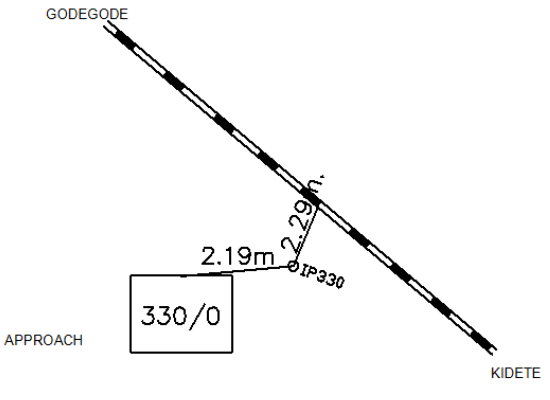
TANGANYIKA

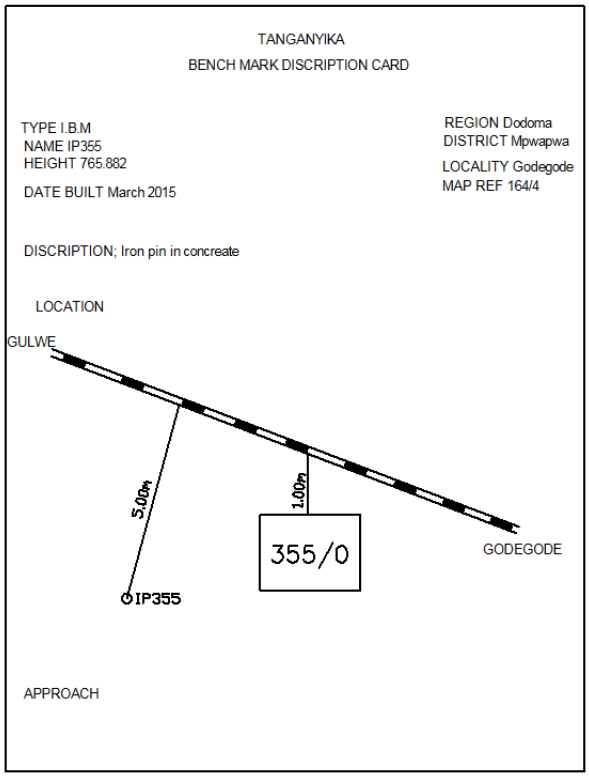
BENCH MARK DISCRIPTION CARD

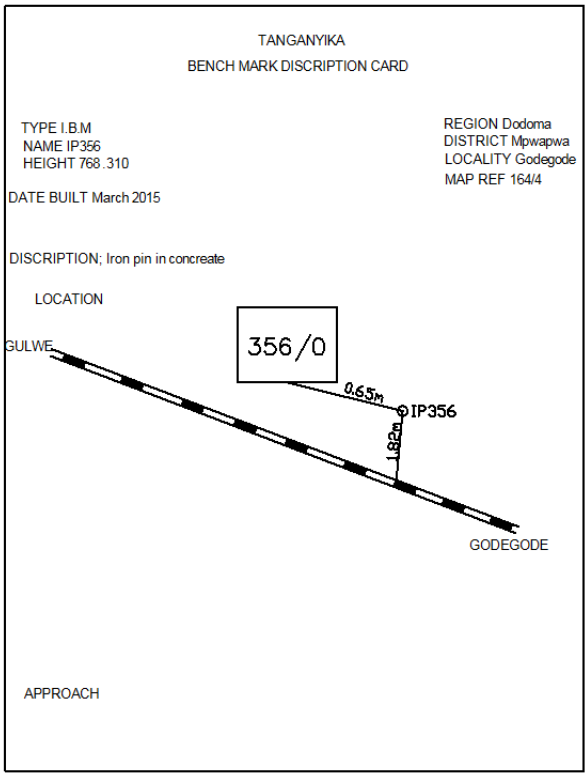
TYPE I.B.M
NAME 330
HEIGHT 671.056
DATE BUILT March 2015
DISCRIPTION; Iron pin in concreate

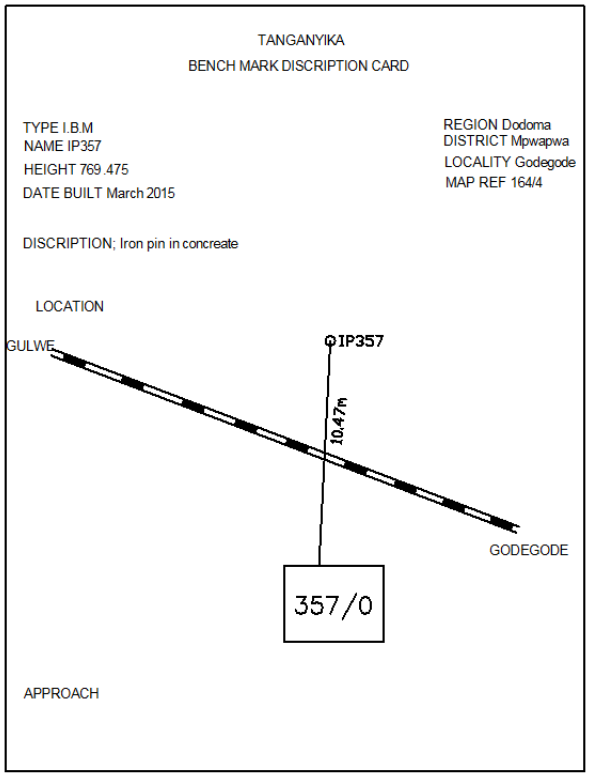
REGION Morogoro
DISTRICT Kilosa
LOCALITY Kidete
MAP REF 181/1

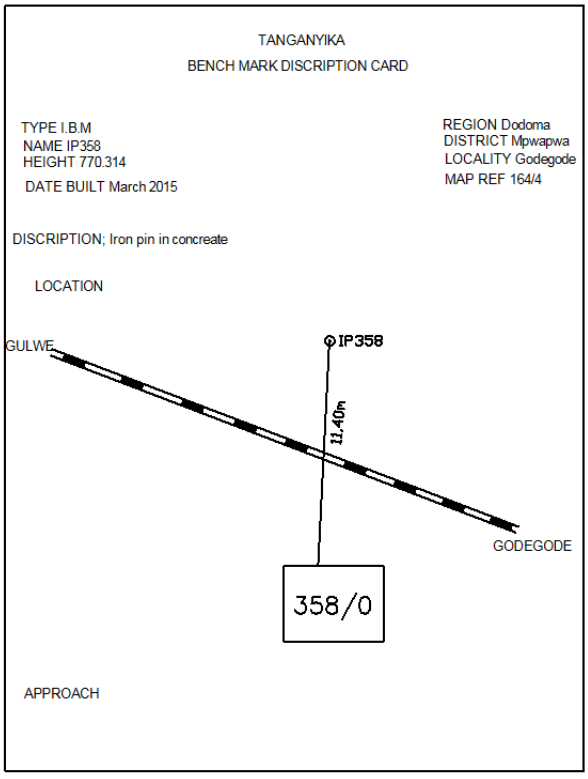
LOCATION




TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP355
HEIGHT 765.882
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
5.00m
1.00m
355/0
IP355
GODEGODE
APPROACH


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP356
HEIGHT 768.310
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
356/0
0.65m
IP356
1.82m
GODEGODE
APPROACH


TANGANYIKA
BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP357
HEIGHT 769.475
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
IP357
10.47m
GODEGODE
357/0
APPROACH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BENCH MARK DISCRIPTION CARD
TYPE I.B.M
NAME IP358
HEIGHT 770.314
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/4
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
IP358
11.40m
GODEGODE
358/0
APPROACH

TANGANYIKA

BENCH MARK DISCRIPTION CARD

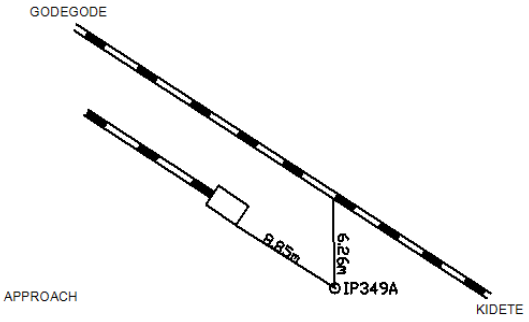
TYPE I.B.M
NAME 349 A
HEIGHT 739 .729

REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Kidete
MAP REF 181/1

DATE BUILT March 2015

DISCRIPTION; Iron pin in concreate

LOCATION



TANGANYIKA

BENCH MARK DISCRIPTION CARD

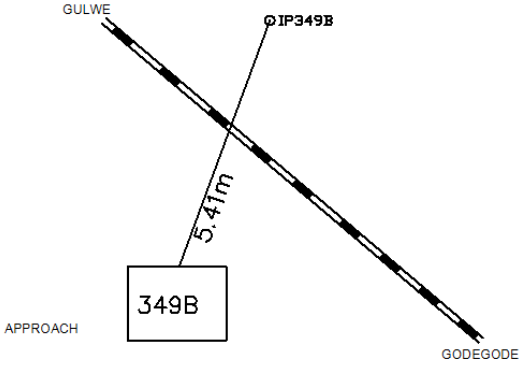
TYPE I.B.M
NAME 349 B
HEIGHT 743.354

REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 181/1

DATE BUILT March 2015

DISCRIPTION; Iron pin in concreate

LOCATION



TANGANYIKA

BENCH MARK DISCRIPTION CARD

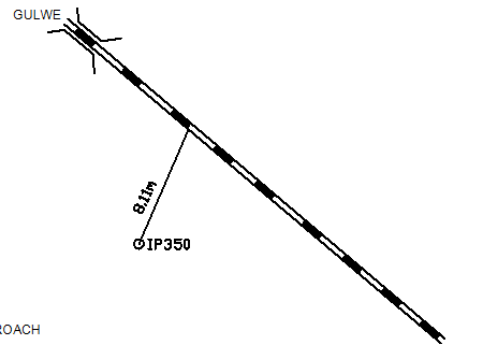
TYPE I.B.M
NAME 350
HEIGHT 752 .142

REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 181/1

DATE BUILT March 2015

DISCRIPTION; Iron pin in concreate

LOCATION



TANGANYIKA

BENCH MARK DISCRIPTION CARD

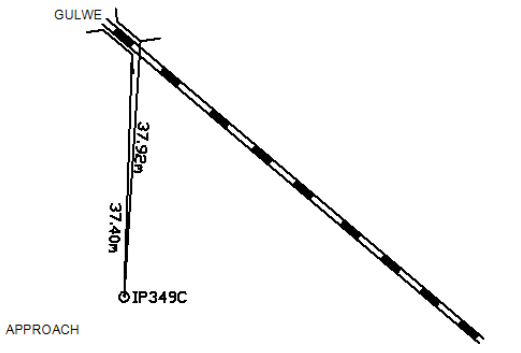
TYPE I.B.M
NAME 349 C
HEIGHT 751.261

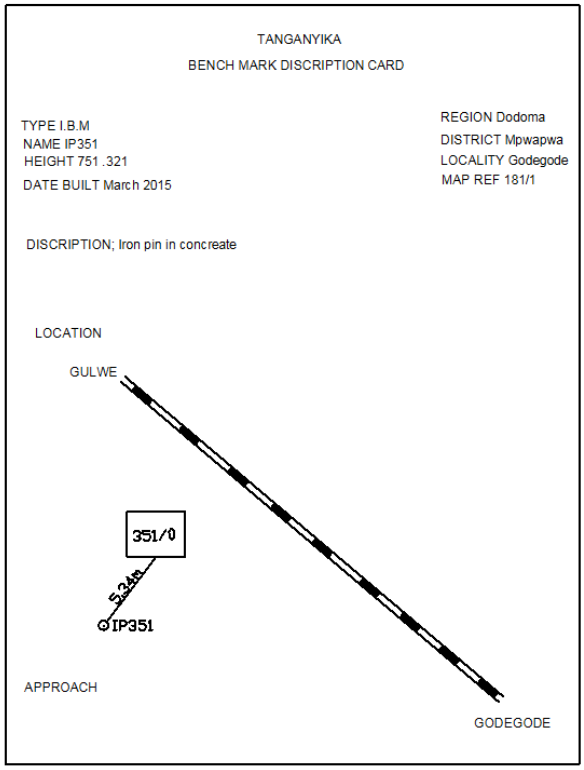
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 181/1

DATE BUILT March 2015

DISCRIPTION; Iron pin in concreate

LOCATION

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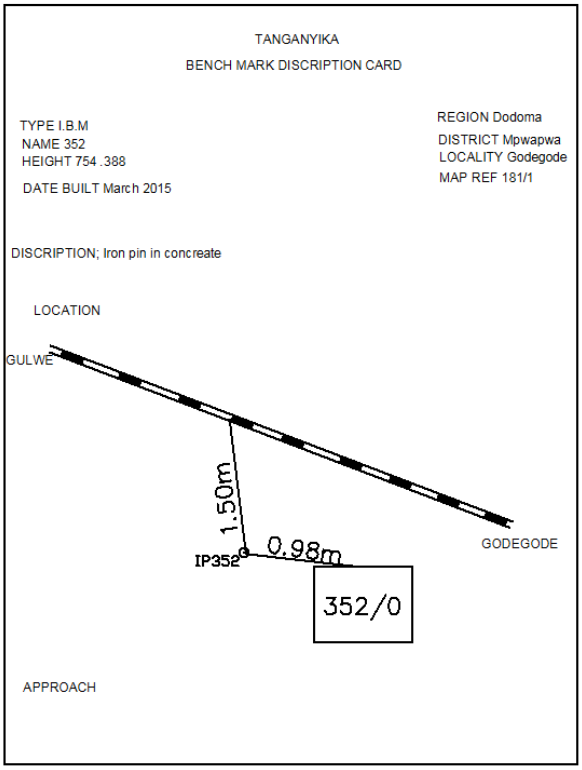
TYPE I.B.M
NAME IP351
HEIGHT 751 .321
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 181/1
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
351/0
5.24m
IP351
APPROACH
GODEGODE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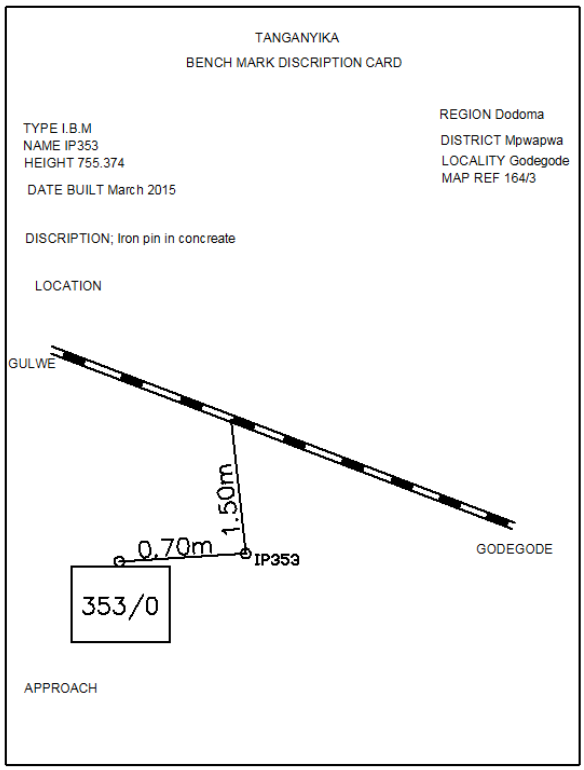
TYPE I.B.M
NAME 352
HEIGHT 754 .388
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 181/1
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
1.50m
0.98m
IP352
352/0
APPROACH
GODEGODE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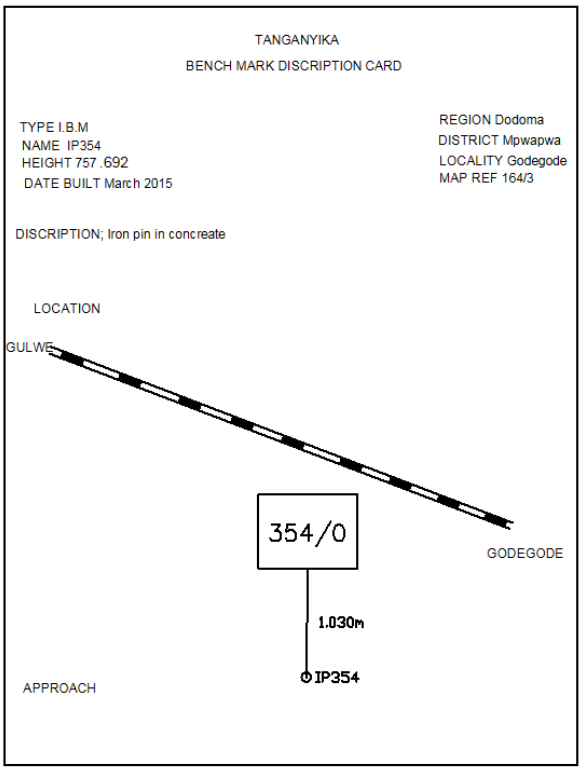
TYPE I.B.M
NAME IP353
HEIGHT 755.374
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/3
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
1.50m
0.70m
IP353
353/0
APPROACH
GODEGODE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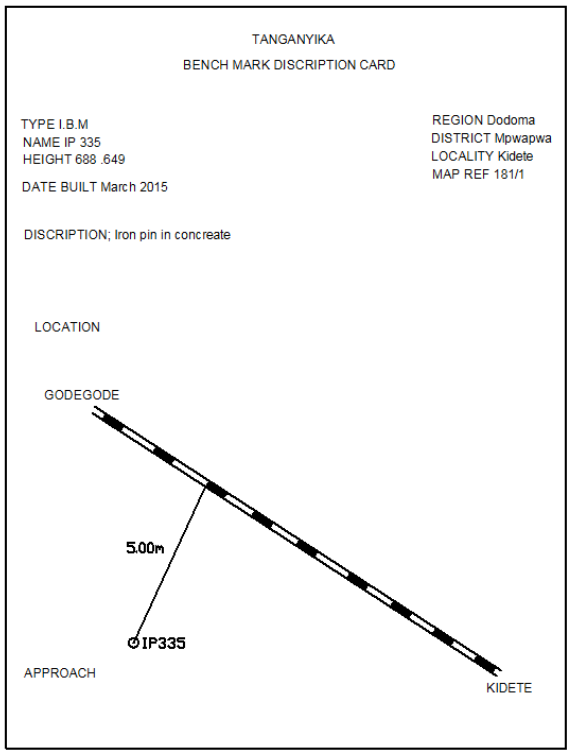
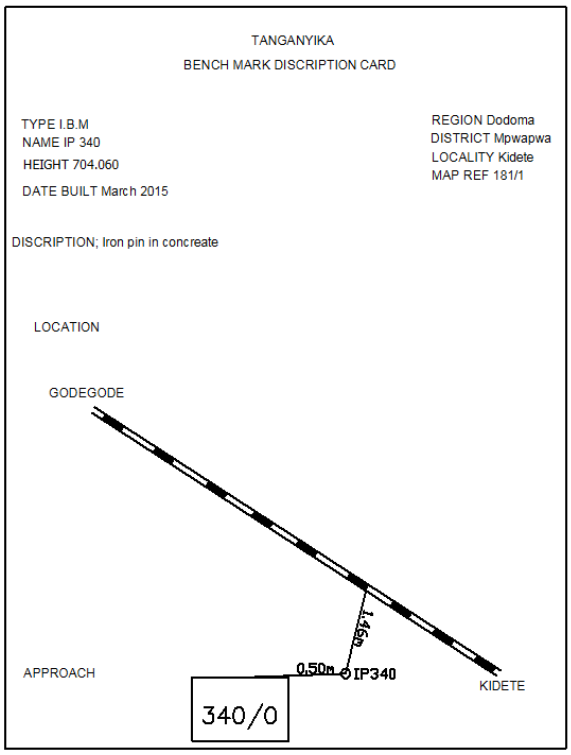
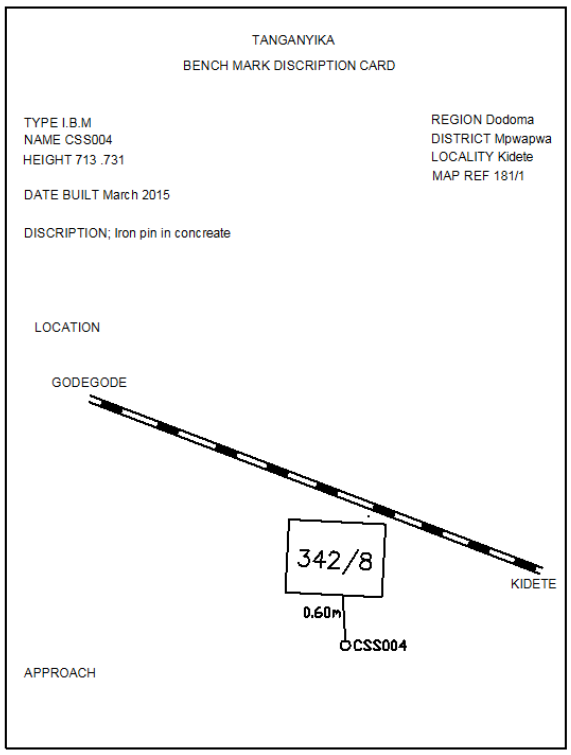
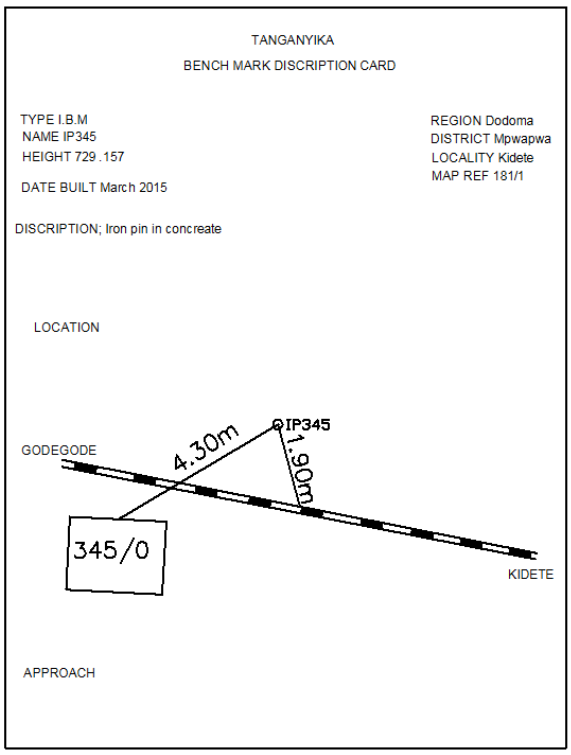
TYPE I.B.M
NAME IP354
HEIGHT 757 .692
DATE BUILT March 2015
REGION Dodoma
DISTRICT Mpwapwa
LOCALITY Godegode
MAP REF 164/3
DISCRIPTION; Iron pin in concreate
LOCATION
GULWE
354/0
1.030m
IP354
APPROACH
GODEGODE









Source: Dunny Geoinformatics

Appendix 3: List of National Bench Marks

FROM		F.B.M KILOSA	
TO		F.B.M GULWE	
		HEIGHT	
SR	POINT ID	IN feet	IN meters
1	F.B.M KILOSA	1640.48	500.018
2	SURFACE MARK	1645.76	501.628
3	A4/1	1630.37	496.937
4	A4/2	1639.65	499.765
5	A4/3	1662.44	506.712
6	A4/4	1663.37	506.995
7	A4/5	1685.17	513.640
8	A4/6	1702.51	518.925
9	A4/7	1706.95	520.278
10	A4/8	1731.21	527.673
11	A4/9	1742.76	531.193
12	A4/10	1759.44	536.277
13	A4/11	1789.80	545.531
14	A4/12	1813.40	552.724
15	A4/13	1827.47	557.013
16	A4/14	1852.82	564.740
17	A4/15	1872.34	570.689
18	A4/16	1893.48	577.133
19	A4/17	1918.78	584.844
20	A4/18	1939.21	591.071
21	A4/19	1975.87	602.245
22	A4/20	1988.17	605.994
23	A4/21	2015.34	614.276
24	A4/22	2029.32	618.537
25	A4/23	2047.21	623.990
26	A4/24	2075.51	632.615
27	A4/25	2108.62	642.707
28	A4/26	2139.24	652.040
29	A4/27	2196.57	669.515
30	A4/28	2219.72	676.571
31	A4/29	2195.70	669.249
32	A4/30	2201.95	671.154
33	A4/31	2202.96	671.462
34	A4/32	2231.46	680.149
35	A4/33	2255.37	687.437
36	A4/34	2268.83	691.539
37	A4/35	2300.37	701.153
38	A4/36	2302.85	701.909
39	A4/37	2310.63	704.280
40	A4/38	2340.39	713.351
41	A4/39	2383.17	726.390
42	A4/40	2400.00	731.520
43	A4/41	2412.27	735.260
44	A4/42	2427.81	739.996
45	A4/43	2449.24	746.528
46	A4/44	2470.61	753.042
47	A4/45	2471.31	753.255
48	A4/46	2474.36	754.185
49	A4/47	2478.91	755.572
50	A4/48	2514.18	766.322
51	A4/48.5	2521.11	768.434
52	A4/49	2519.76	768.023
53	A4/50	2520.77	768.331
54	A451	2540.51	774.347
55	A4/51.5	2541.09	774.524
56	A4/52	2538.98	773.881
57	A4/53	2548.02	776.636
58	F.BM. GULWE	2570.08	783.360
59	SURFACE MARK	2571.61	783.827

KEY
Bench Marks used

Source: Dunny Geoinformatics

APPENDIX U

BREAKDOWN OF COST ESTIMATE

U.1 Direct Unit Price and Construction Daily Productivity[1]

(1) Gabion Mattress

Construction Cost

					Local Currency (TZS.)		Foreign Currency (JPY)		Remarks
4	Unit Price 10m Gabion Mattress, W=1.2m, H=0.5m, V=6.0m3			Quantity					
	Description	Dimension	Unit		Unit Price	Amount	Unit Price	Amount	
1)	Forman		man	0.44	64,000	28,160	0	0	
2)	Skilled labor		man	1.28	34,000	43,520	0	0	
3)	Unskilled labor		man	2.40	25,000	60,000	0	0	
4)	Gabion mattress	1.2W, 0.5H	m	10	24,445	244,455	1,894	18,940	GS-3,4mm,13cm
	Stone filling		m3	5.70	142,329	811,273			05-10
	Filter mat	10mm	m2	12.00	7,007	84,083	543	6,515	
5)	Bach hoe operation	0.6m3	day	0.39	475,957	187,775	33,634	13,269	equipment ownership cost
	Total	Gabion 5.7m3				1,459,266		38,724	
		Gabion 1.0m3				256,012		6,794	

Unit Price

Daily Productivity Data

		Td	Td= α x Ta x B	Ta	B	Adjusted factor AFRICA				1.Net construction day	2.Coefficient of no working day	3. 6m3 Construction days	4. Total m3	5. Construction days	6. Construction month in total (month)
		man	day/10nos.	man /10m	Work Efficiency	JICA					JICA	1. x 2.		3.x 4./ 6.0	1month=30days
	Forman	0.44	0.22*1.00*2.00	0.22	1	2.0				0.44	1.35	0.59	100.00	9.90	0.33
	Skilled labor	1.28	0.32*1.00*2.00	0.32	1	2.0									
	Unskilled labor	2.40	1.20*1.00*2.00	1.2	1	2.0									
	Back hoe 0.6m3 operating h	2.40	hr	Operating hour per day		6.08	hr								
		2.40	/	6.08	=	0.39	day								

(2) Branch Block

Construction Cost

					Local Currency (TZS.)		Foreign Currency (JPY)		Remarks		
7	Unit Price 10m3-Precast pillar-shaped concrete (Branch Block) block construction method			Quantity							
	Description	Dimension	Unit		Unit Price	Amount	Unit Price	Amount	price		
1)	Forman		man	0.66	64,000	42,240	0	0			
2)	Skilled labor		man	1.34	34,000	45,560	0	0			
3)	Unskilled labor		man	3.24	25,000	81,000	0	0			
4)	Branch block	L=1.0m thickness	no.	10.00			15,600	156,000	Japan Yamaguchi Pre. 2013		
5)	Boulder	35cm~	m3	3.20	142,329	455,451			Day work data RAHCO		
6)	In-filling material		m3	6.00	142,329	853,971			Day work data RAHCO		
7)	Backfill material	Crusher-run	m3	2.00	142,329	284,657			Day work data RAHCO		
8)	Filter mat	10mm	m2	10.00	7,007	70,069	543	5,429			
9)	Back hoe operation	0.6m3	day	0.43	475,957	204,662	33,634	14,463	include operator wage, fuel		
10)	Miscellaneous expenses										
	2% of Labor + machine cost		%	2.00	373,462	7,469	0	0			
	Total	Per 10m3				2,045,080		175,891		US$/ m3	TZS./m3
		Per1.0m3				204,508		17,589		248.92	545,052.66

		Manpower Quantity	Daily productivity data per unit construction element the above	Work Efficiency	Adjusted factor AFRICA					1.Net construction day	2.Coefficient of no working day	3. 10m3 Construction days	4. Total m3	5. Construction days	6. Construction month in total (month)
		man	man		JICA						JICA	1. x 2.		4.x 5. / 10.0	1month=30days
	Forman	0.66	0.33	1	2.0					0.66	1.35	0.89	100.00	8.91	0.30
	Skilled labor	1.34	0.67	1	2.0								337		1.00
	Unskilled labor	3.24	1.62	1	2.0										

(3) Filter Unit

Construction Cost

					Local Currency (TZS.)		Foreign Currency (JPY)		Remarks		
8	Unit Price 5.7m3 Filter Unit, (1.25m3 x 4.56 bag)			Quantity							
	Description	Dimension	Unit		Unit Price	Amount	Unit Price	Amount			
1)	Forman		man	0.22	64,000	14,080	0	0			
2)	Skilled labor		man	0.44	34,000	14,960	0	0			
3)	Unskilled labor		man	0.44	25,000	11,000	0	0			
4)	Filter Unit	1.25m3 / bag	bag	4.56	0	0	12,000	54,720	Japan maker list price		
	Stone filling		m3	5.70	142,329	811,273			Japan maker catalog		
5)	Back hoe 0.6m3 operation		day	0.07	475,957	34,425	33,634	2,433	equipment ownership cost		
6)	Rough terrain crane 25 ton		day	0.08	456,812	34,840	32,129	2,450			
7)	Miscellaneous expenses										
	2% of Labor + machine cost		%	2.00	109,305	2,186	4,883	98			
	Total	Filter unit 5.7m3				922,764		59,701		US$/ m3	TZS./m3
		Filter unit 1.0m3				161,888		10,474		166.54	364,668

		Td	Td= α x Ta x B	Ta	B	Adjusted factor AFRICA				1.Net construction day	2.Coefficient of no working day	3. 5.7m3 Construction days	4. Total m3	5. Construction days	6. Construction month in total (month)
		man	day/12m2	man /12m2	Work Efficiency	JICA					JICA	1. x 2.		3.x 4./ 5.7	1month=30days
	Forman	0.22	0.11*1.00*2.00	0.11	1	2.0				0.22	1.35	0.30	100.00	5.21	0.17
	Skilled labor	0.44	0.11*1.00*2.00	0.11	1	2.0							576	m3/month	1.00
	Unskilled labor	0.44	0.22*1.00*2.00	0.22	1	2.0									
	Back hoe 0.6m3 operating h	0.44	hr	Operating hour per day		6.08	hr								
		0.44	/	6.08	=	**0.07**	day								
	Rough terrain crane 25 ton	0.44	hr	Operating hour per day		5.77	hr								
		0.44	/	5.77	=	**0.08**	day								

[1] Quantity refers construction daily productivity in Japan, and JICA's adjusted factor in Africa.

(4) Standard Steel Pile

Construction Cost																						
2	Unit Price 10nos.-Sheet pile(III) 6m, Driving retaining wall foundation (leakage measures)			Quantity	Local Currency (TZS.)		Foreign Currency (JPY)		Remarks													
	Description	Dimension	Unit		Unit Price	Amount	Unit Price	Amount														
1)	Forman		man	0.83	64,000	53,333	0	0														
2)	Skilled labor	tobi-2	man	1.67	34,000	56,667	0	0														
3)	Unskilled labor		man	0.83	25,000	20,833	0	0														
4)	Sheet pile (III) 10nos	400W, 12.0L	ton	3.60	1,466,974	5,281,106	113,657	409,166														
5)	Crawler Mounting vibro hammer								05-10													
	Vibro hammer 60kW		day	0.42	935,582	389,826	69,231	28,846	equipment ownership cost													
6)	Miscellaneous expenses								include operator wage, fuel													
	22% of Labor cost		%	22.00	520,659	114,545	28,846	6,346														
	Total	10nos. Sheet pile				5,916,310		444,359		US$/no 6m	US$ / 1.0m											
		1no. Sheet pile				591,631		44,436		**663.08**	**110.51**											
										US$/ 0.4 m2	TZS./ 0.4 m2											
	Sheet pile (III) : N	24	sheet / day	T	T=10/N x man x Adjusted factor		Adjusted factor AFRICA			276.28	604,969											
				man	man	N	JICA			US$/m2	TZS/m2											
		Forman		0.83	1	24	2.0															
		Skilled labor	tobi-2	1.67	2	24	2.0															
		Unskilled labor		0.83	1	24	2.0															

1 party construction period							
Sheet pile (III) 10nos							
Crawler Mounting vibro hammer							
Vibro hammer 60kW							
1.Net construction day	2.Coefficient of no working day	3.Construction days	10 Nos. of Sheet pile @0.4m	Construction days 1m along	Construction days for total (km)	Construction month in total (month)	
	JICA	1. x 2.	3. L (m along	4.=1. x 2 / 3.	7.39km (4. x km)	1month=30days	
0.83	1.20	1.00	4.00	0.25	1,847.50	61.58	
				24.00 m2/day			
				720 m2/month			

(5) Hat type steel pile

Construction Cost																						
6	Unit Price 10nos.-Sheet pile(Hat type) 6m Driving			Quantity	Local Currency (TZS.)		Foreign Currency (JPY)		Remarks													
	Description	Dimension	Unit		Unit Price	Amount	Unit Price	Amount														
1)	Forman		man	0.57	64,000	36,571	0	0														
2)	Skilled labor	tobi-2	man	1.14	34,000	38,857	0	0														
3)	Unskilled labor		man	0.57	25,000	14,286	0	0														
4)	Sheet pile (Hat type) 10nos	900W, 6.0 L	ton	6.78	1,466,974	9,946,082	113,657	770,597														
5)	Crawler Mounting vibro hammer								05-10													
	Vibro hammer 60kW		day	0.29	1,145,982	327,423	85,517	24,433	equipment ownership cost													
6)	Miscellaneous expenses								include operator wage, fuel													
	18% of Labor + machine cost		%	18.00	417,138	75,085	24,433	4,398														
	Total	10nos. Hat type pile				10,438,305		799,428		US$/no 6m	US$/1.0m											
		1no. Hat type pile				1,043,830		79,943		**1,183.54**	**197.26**											
										US$ / m2	TZS. / m2											
	Sheet pile (Hat type) : N	35	sheet / day	T	T=10/N x man x Adjusted factor		Adjusted factor AFRICA			219.17	479,919											
				man	man	N	JICA															
		Forman		0.57	1	35	2.0															
		Skilled labor	tobi-2	1.14	2	35	2.0															
		Unskilled labor		0.57	1	35	2.0															

1 party construction period							
Sheet pile (Hat type) 10nos							
Crawler Mounting vibro hammer							
Vibro hammer 60kW							
1.Net construction day	2.Coefficient of no working day	3.Construction days	10 Nos. of Sheet pile @0.9m	Construction days 1m along	Construction days for total (km)	Construction month in total (month)	
	JICA	1. x 2.	3. L (m along	4.=1. x 2 / 3.	5.85 km (4. x km)	1month=30days	
0.57	1.20	0.69	9.00	0.08	445.71	14.86	
			Sheet pile total area (m2)		Total month	1moth area	
			35,100		14.86	2,363	

(6) INSEM (In-site Construction Excavated Material)

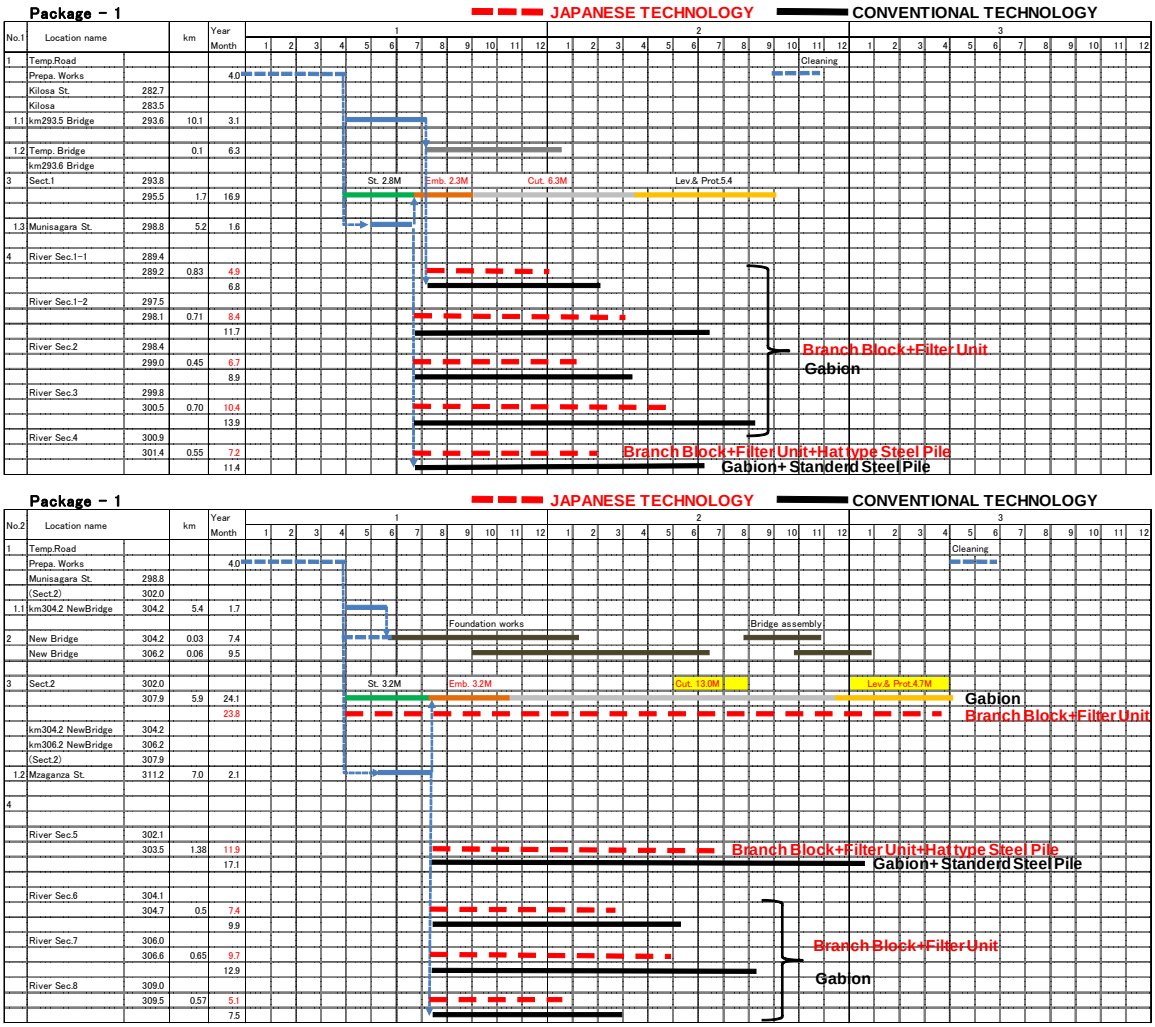
Unit price INSEM is estimated as follows:

- Average price INSEM in Japan=5,541 JPY / m^3[2]
- Average price Normal concrete in Japan=16,000 JPY / m^3
- Average price Normal concrete in TANZANIA is set 270US$ / m^3
- Therefore, estimated INSEM in Tanzania=270 x 5,541/16,000 =9 3.5 US$ / m^3

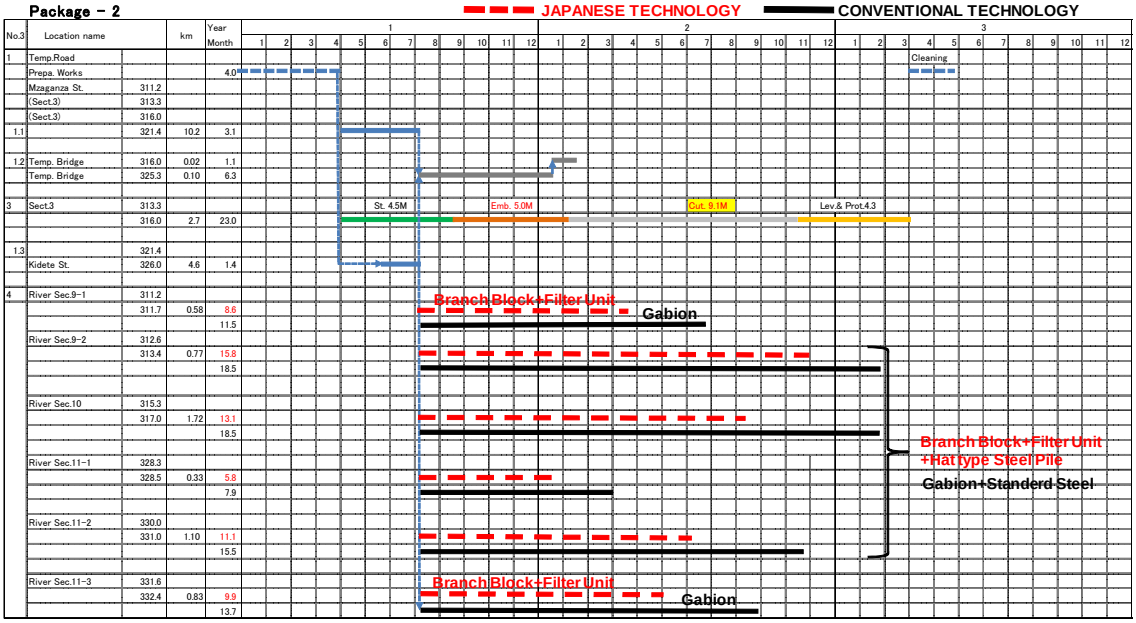
[2] Source: Utilization Guideline for Sabo-Soil-Cement

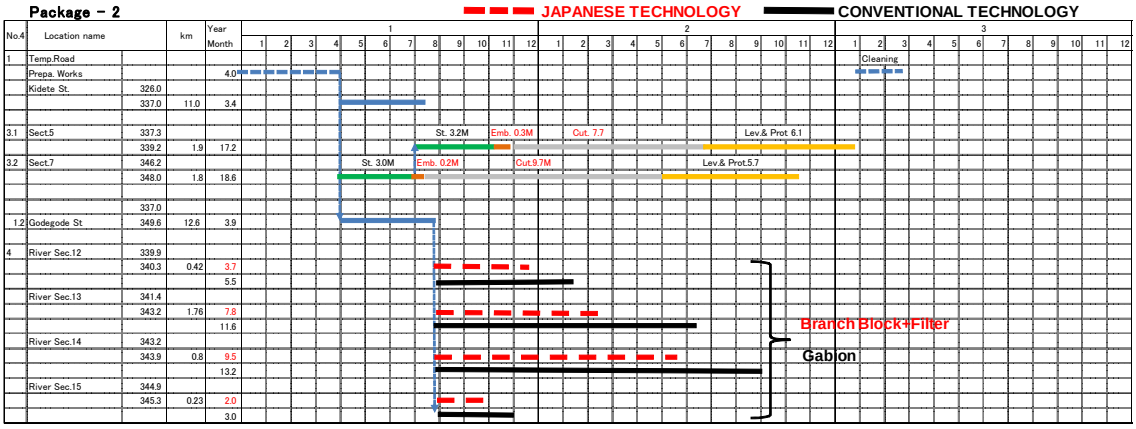
U.2 Shortened Construction Period by Japanese Technology

PACKAGE-1

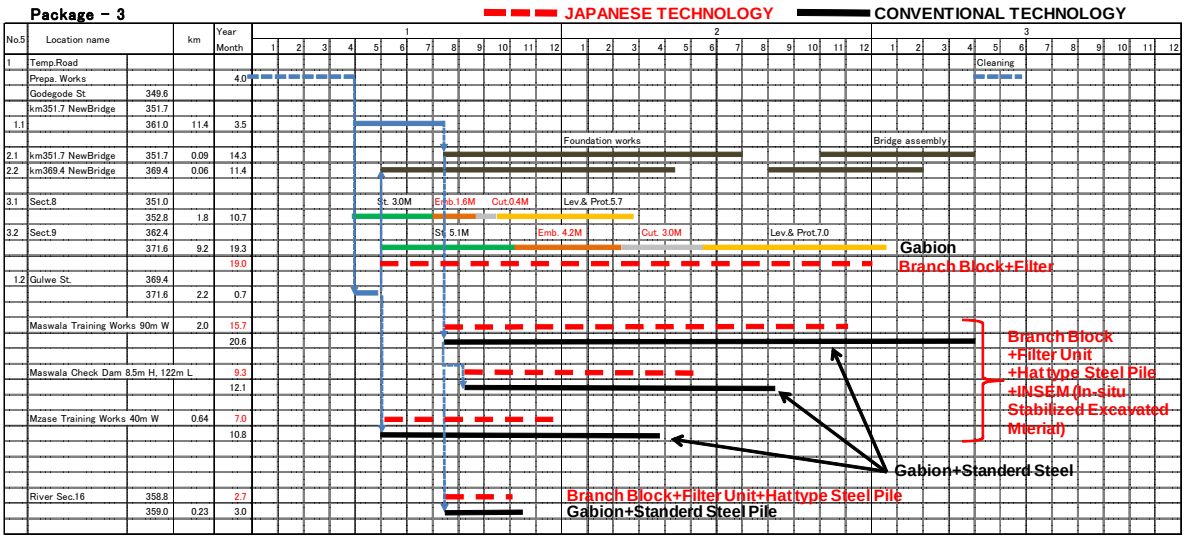


PACKAGE-2





PACKAGE-3



U.3 Comparison for Construction Cost between Conventional and Japanese Technology[3]

Conventional Technology in Main River

Item	Unit Price (TZS)		Calculation (Mil. TZS)																Amount (Mil. TZS)
			Section 1-1	Section 1-2	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9-1	Section 9-2	Section 10	Section 11-1	Section 11-2	Section 11-3	Section 12	Section 13	Section 14	Section 15	Section 16	
Section Length		m	830	710	450	700	550	1380	500	650	570	580	770	1720	330	1100	830	420	1760	800	230	230	Total 15,110.0 m
Average Bank Height		m	4.0	4.0	5.0	5.0	4.0	4.0	5.0	5.0	3.0	5.0	6.0	5.0	5.0	5.0	4.0	3.0	3.0	4.0	3.0	4.0	
Gabion	387,550		2,090.8	1,788.5	1,308.0	2,034.6	1,385.5	3,476.3	1,453.3	1,889.3	1,215.0	1,685.8	2,238.1	4,999.4	959.2	3,197.3	2,090.8	895.2	3,751.5	2,015.3	490.3	579.4	**39,543.6**
Geotextile	17,517		156.3	133.7	100.5	156.3	103.6	259.9	111.7	145.2	87.4	129.5	172.0	384.2	73.7	245.7	156.3	64.4	269.8	150.6	35.3	43.5	**2,979.4**
Excavation	17,517		61.2	52.4	23.3	39.2	43.5	109.3	29.5	65.4	27.9	62.9	71.8	144.0	36.1	120.4	90.9	22.3	96.5	44.6	12.7	12.7	**1,166.5**
Embankment (Backfill)	32,845		172.8	147.8	299.7	260.7	119.0	298.7	114.5	128.7	175.6	257.4	272.4	781.3	63.8	212.8	160.6	76.8	361.9	99.6	23.8	45.3	**4,073.4**
Steel Sheet Pile	604,969		0.0	0.0	0.0	0.0	1,996.4	5,009.1	0.0	0.0	0.0	0.0	2,795.0	6,243.3	1,197.8	3,992.8	0.0	0.0	0.0	0.0	0.0	834.9	**22,069.3**
Concrete	591,211		24.2	20.2	13.5	20.2	97.5	243.0	14.8	18.9	16.2	17.5	135.4	301.4	59.5	193.6	24.2	12.1	48.5	22.9	8.1	42.1	**1,334.0**
Cost (Mil. TZS)			**2,505**	**2,143**	**1,745**	**2,511**	**3,746**	**9,396**	**1,724**	**2,247**	**1,522**	**2,153**	**5,685**	**12,854**	**2,390**	**7,963**	**2,523**	**1,071**	**4,528**	**2,333**	**570**	**1,558**	**71,166.3**
										Total	27,539									Total	42,069		

Japanese Technology in Main River

Item	Unit Price (TZS)		Package-1									Package-2									Package-3		Amount (Mil. TZS)
			Section 1-1	Section 1-2	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9-1	Section 9-2	Section 10	Section 11-1	Section 11-2	Section 11-3	Section 12	Section 13	Section 14	Section 15	Section 16	
Section Length		m	830	710	450	700	550	1380	500	650	570	580	770	1720	330	1100	830	420	1760	800	230	230	Total 14,280.0 m
Average Bank Height		m	4.0	4.0	5.0	5.0	4.0	4.0	5.0	5.0	3.0	5.0	6.0	5.0	5.0	5.0	4.0	3.0	3.0	4.0	3.0	4.0	
Branch Block(geotextile inc.)	545,053		1,809.6	1,547.9	1,226.4	1,907.7	1,199.1	3,008.7	1,362.6	1,771.4	932.0	1,580.7	2,518.1	4,687.5	899.3	2,997.8	1,809.6	686.8	2,877.9	1,744.2	376.1	501.4	**35,444.8**
Filter Unit (Foot protection)	364,668		454.0	388.4	246.2	382.9	300.9	754.9	273.5	355.6	311.8	317.3	421.2	940.8	180.5	601.7	454.0	229.7	962.7	437.6	125.8	125.8	**8,265.2**
Excavation	17,517		61.2	52.4	23.3	39.2	43.5	109.3	29.5	65.4	27.9	62.9	71.8	144.0	36.1	120.4	90.9	22.3	96.5	44.6	12.7	12.7	**1,166.5**
Embankment (Backfill)	32,845		172.8	147.8	299.7	260.7	119.0	298.7	114.5	128.7	175.6	257.4	272.4	781.3	63.8	212.8	160.6	76.8	361.9	99.6	23.8	28.6	**4,056.7**
Hat type Steel Sheet Pile	479,919		0.0	0.0	0.0	0.0	1,583.7	3,973.7	0.0	0.0	0.0	0.0	2,217.2	4,952.8	950.2	3,167.5	0.0	0.0	0.0	0.0	0.0	662.3	**17,507.4**
Concrete	591,211		24.2	20.2	13.5	20.2	97.5	243.0	14.8	18.9	16.2	17.5	135.4	301.4	59.5	193.6	24.2	12.1	48.5	22.9	8.1	42.1	**1,334.0**
Cost (Mil. TZS)			**2,522**	**2,157**	**1,809**	**2,611**	**3,344**	**8,388**	**1,795**	**2,340**	**1,463**	**2,236**	**5,636**	**11,808**	**2,190**	**7,294**	**2,539**	**1,028**	**4,348**	**2,349**	**547**	**1,373**	**67,774.7**
										Total	26,429									Total	39,373		

Conventional Technology in Tributary

	Unit	Quantity			Unit price	2,189.67	Direct Cost	19,360
		Masuwala	Mzase	total	US$	TZS	Mil TZS	Mil JPY
Concrete	m3	17,765	2,122	19,886	270.00	591,211	11,757	657
Gabion (Main body)	m3	18,940	5,970	24,910	176.99	387,550	9,654	540
Gabion (Foot protection)	m3	9,780	2,154	11,934	176.99	387,550	4,625	259
Gravel Facing	m3	9,504	3,072	12,576	20.00	43,793	551	31
Geotextile	m2	41,806	12,303	54,109	8.00	17,517	948	53
Sheet Pile	m2	5,940	1,920	7,860	276.28	604,969	4,755	266
Embankment (Backfill)	m3	13,148	20,072	33,220	15.00	32,845	1,091	61
Sod Facing	m2	13,732	11,930	25,662	5.00	10,948	281	16
Excavation	m3	331,864	22,082	353,946	8.00	17,517	6,200	347
Clearing	m2	34,496	19,666	54,162	1.25	2,737	148	8
						Total	40,010	2,067

Japanese Technology in Tributary

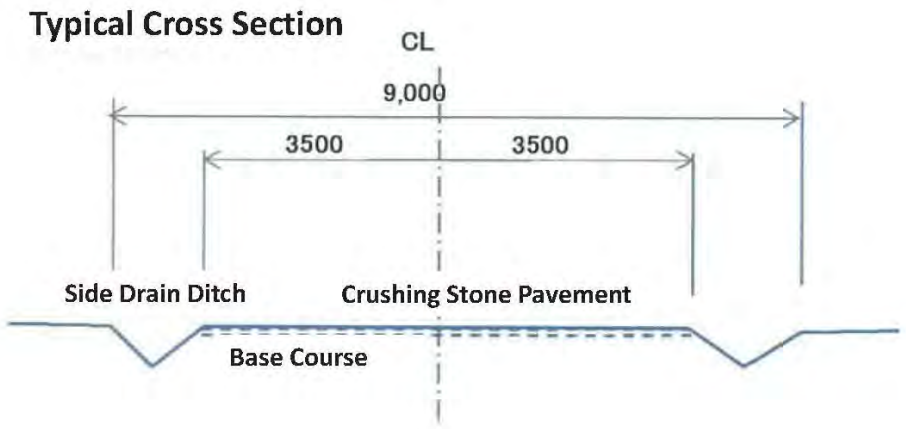
	Unit	Quantity			Unit price	2,189.67	Direct Cost	19,360
		Masuwala	Mzase	total	US$	TZS	Mil TZS	Mil JPY
Concrete	m3	9,543.7	1,705.6	11,249.3	270.00	591,211	6,651	344
Filter Unit(Foot protection)	m3	13,740.0	2,154.0	15,894.0	166.54	364,668	5,796	299
Geotextile	m2	40,846.0	0.0	40,846.0	8.00	17,517	716	37
Sabo Soil Cement	m3	7,324.7	336.0	7,660.7	93.50	204,734	1,568	81
Wet Masonry	m3	888.4	80.0	968.4	200.00	437,934	424	22
Branch Block	m3	9,470.0	2,985.0	12,455.0	248.92	545,053	6,789	351
Gravel Facing	m3	9,504.0	3,072.0	12,576.0	20.00	43,793	551	28
Sheet Pile (Hat type)	m2	5,940.0	1,920.0	7,860.0	219.17	479,919	3,772	195
Embankment (Backfill)	m3	13,148.0	20,071.8	33,219.7	15.00	32,845	1,091	56
Sod Facing	m2	13,732.0	11,929.7	25,661.6	5.00	10,948	281	15
Excavation	m3	331,864.2	22,081.7	353,945.9	8.00	17,517	6,200	320
Clearing	m2	34,496.0	19,666.1	54,162.1	1.25	2,737	148	8
						Total	33,987	1,756

[3] Estimated cost is direct cost, not including contractor's indirect cost, VAT, contingency, and price escalation.

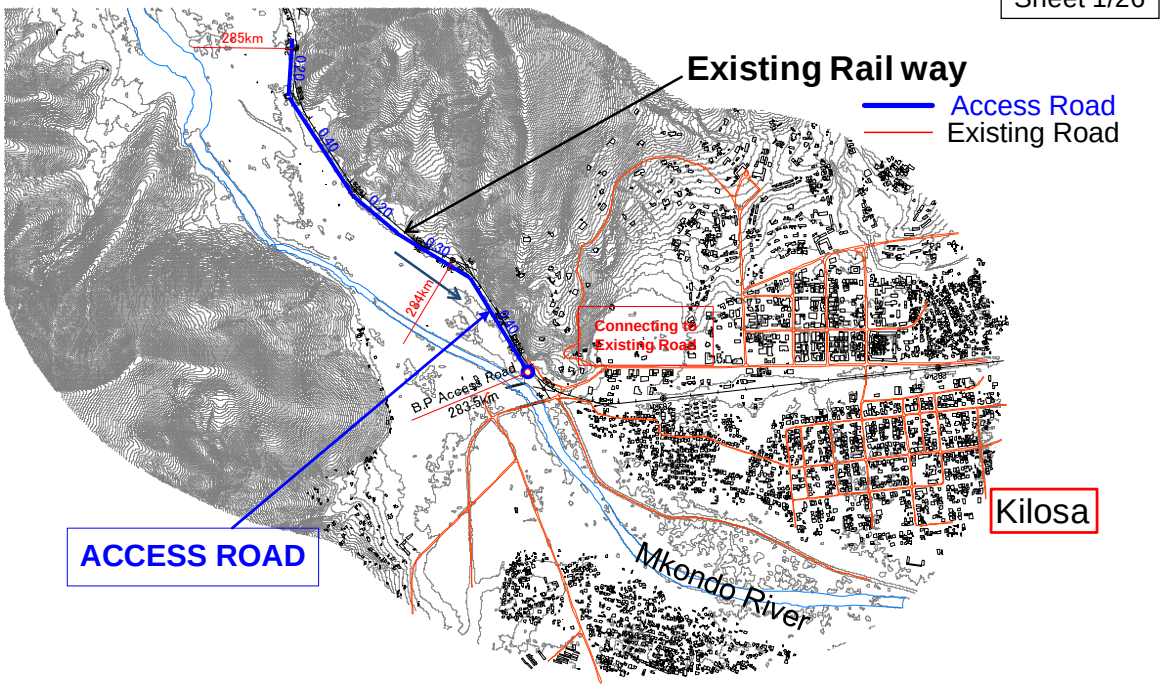
U.4 Access Road Rout Plan

ACCESS ROAD (DRAFT)

(Excavation, Embankment is not shown.)



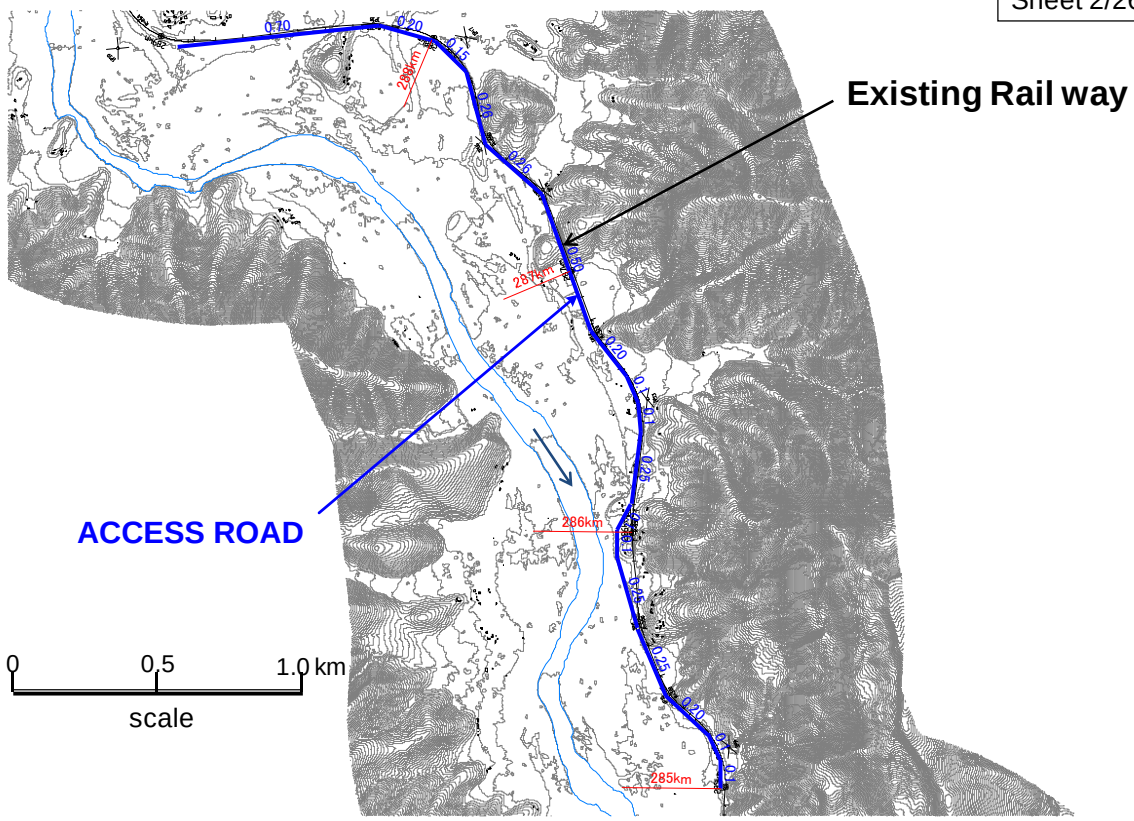
Sheet 1/26



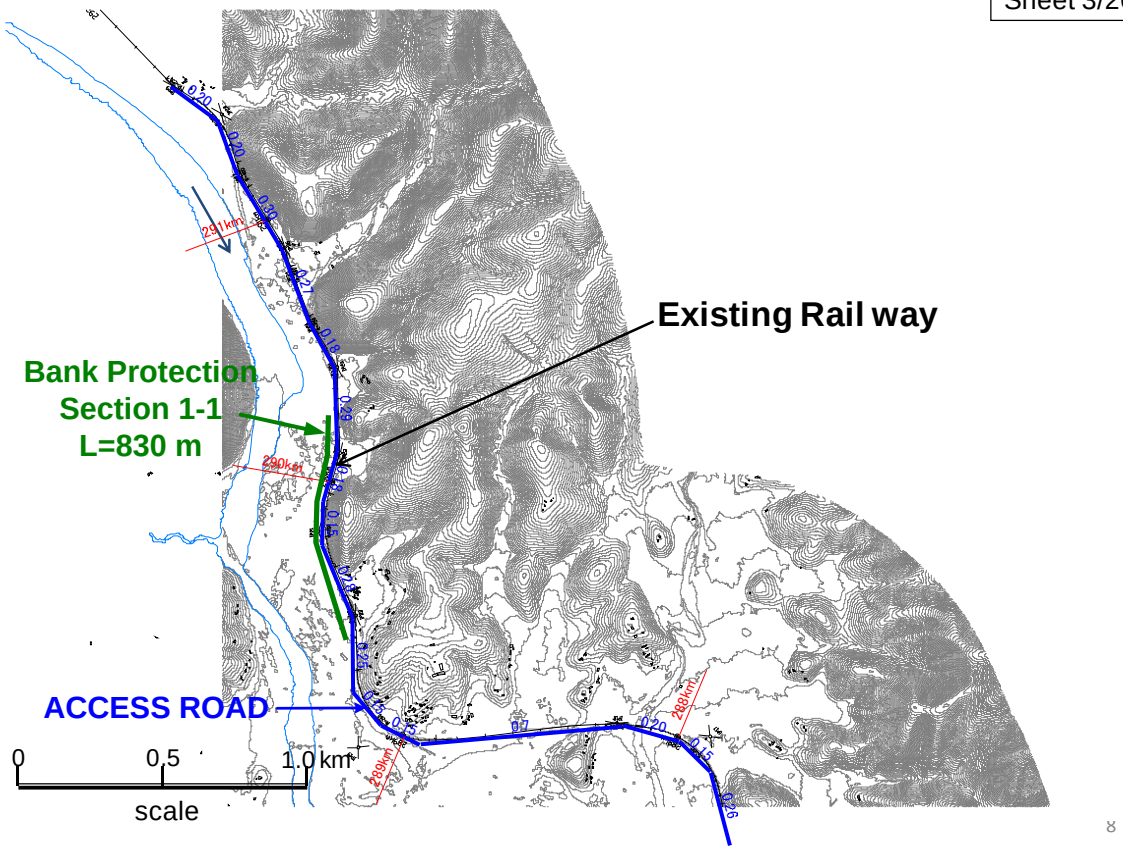
Note: This series of map shows the layout plan of B-2 together with the proposed sites of bank protection.

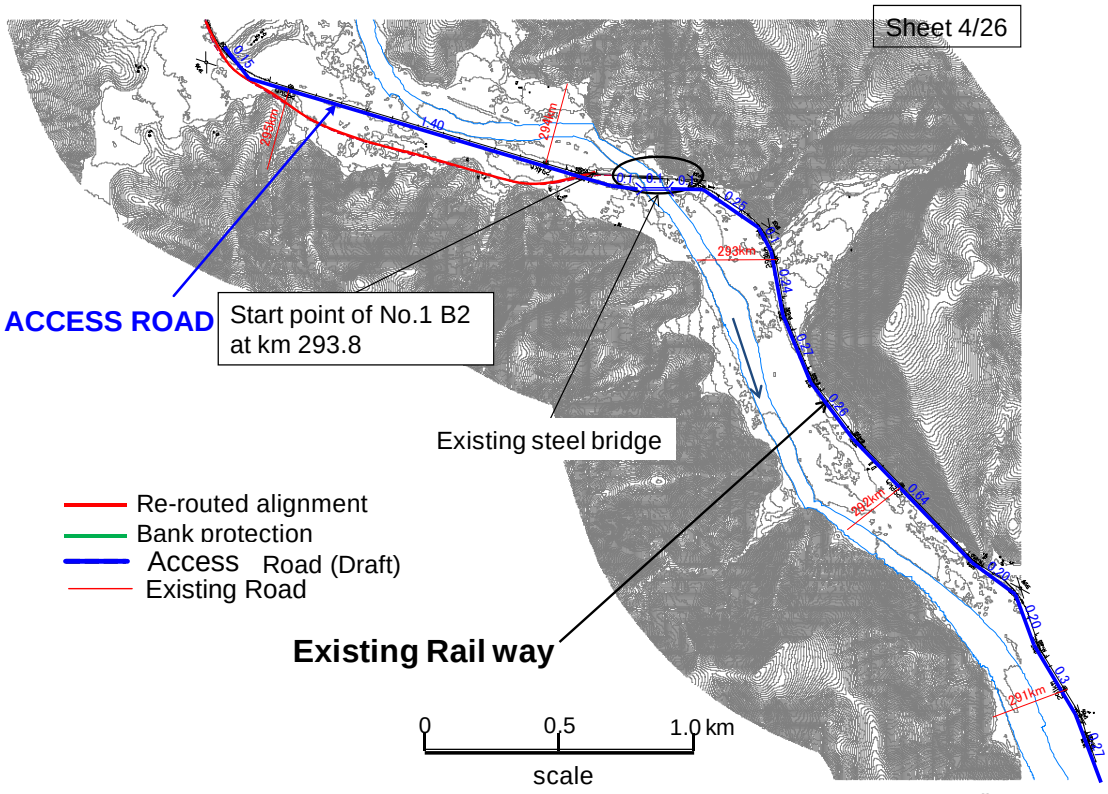
0 0.5 1.0 km
scale

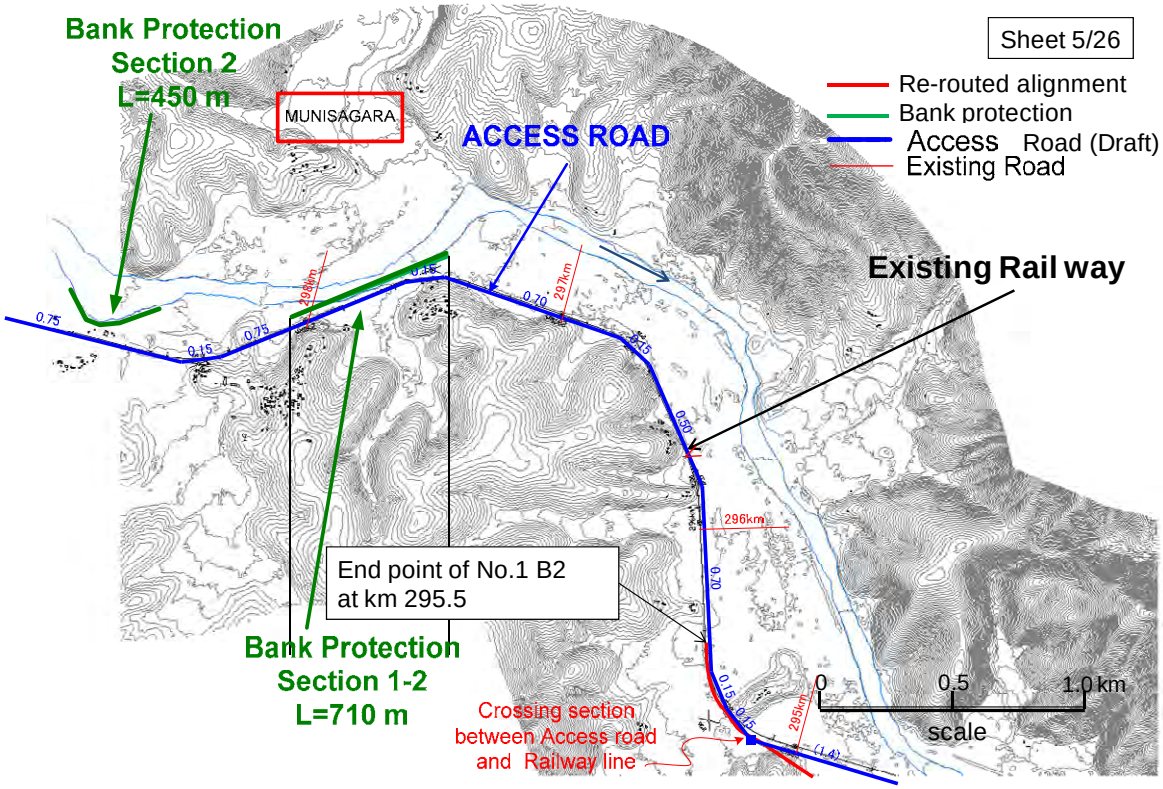
Sheet 2/26

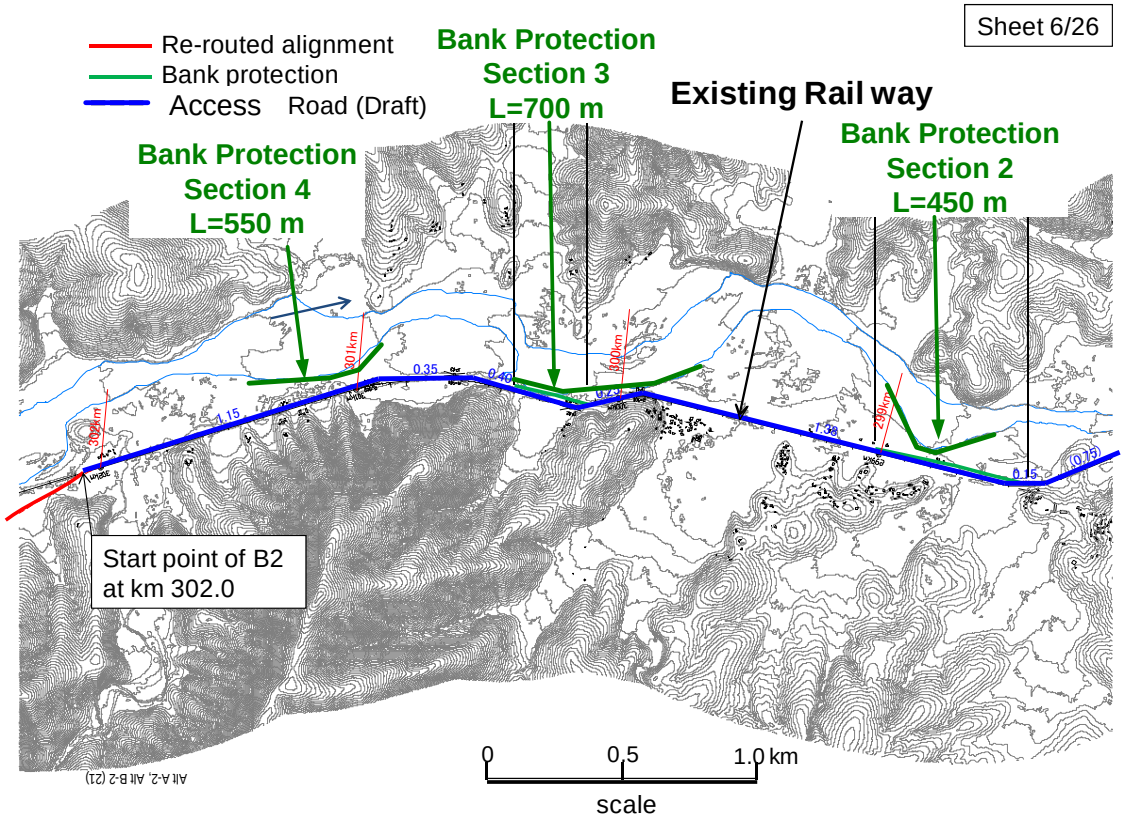


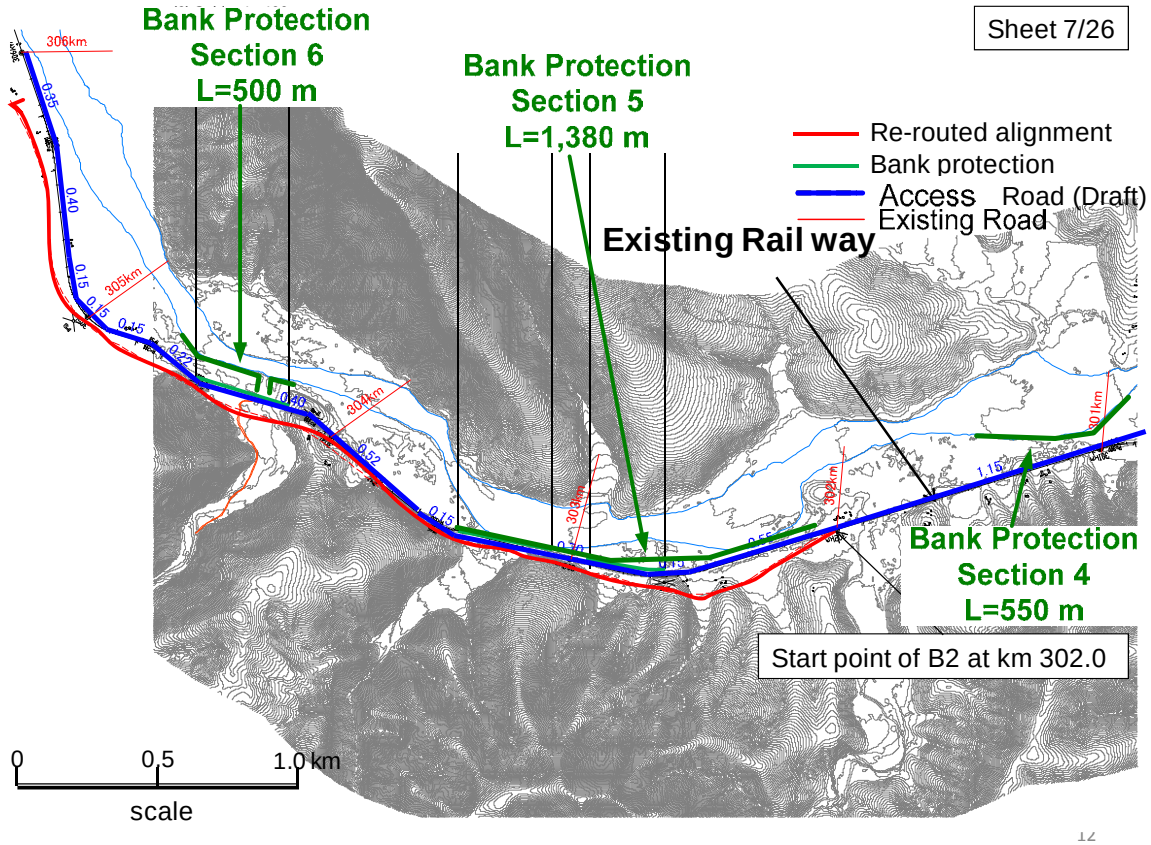
Sheet 3/26

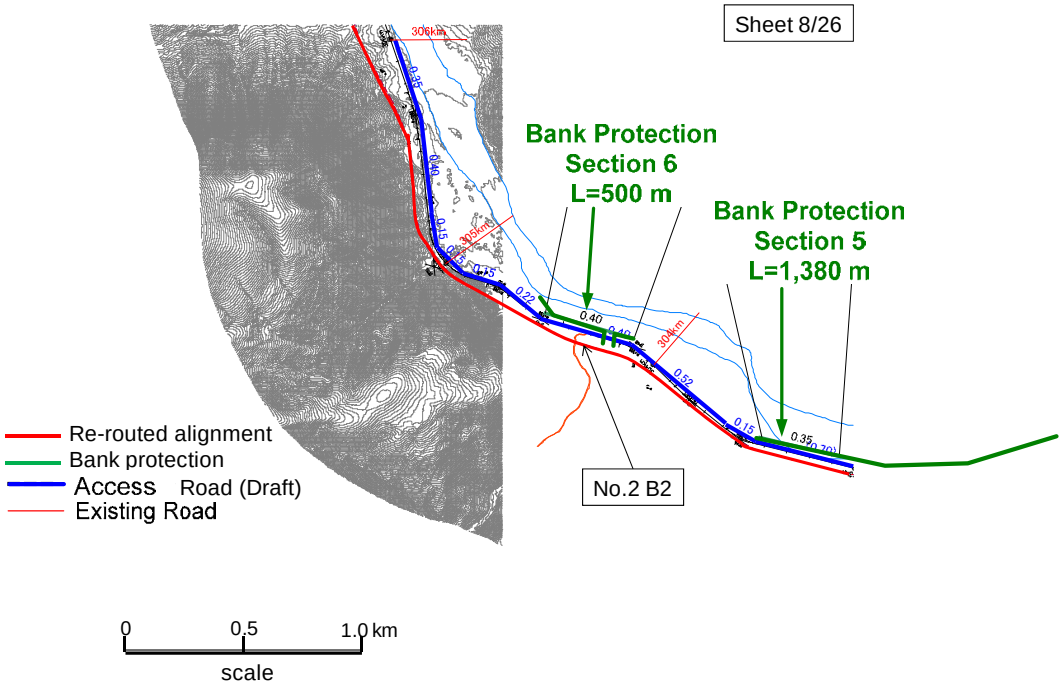


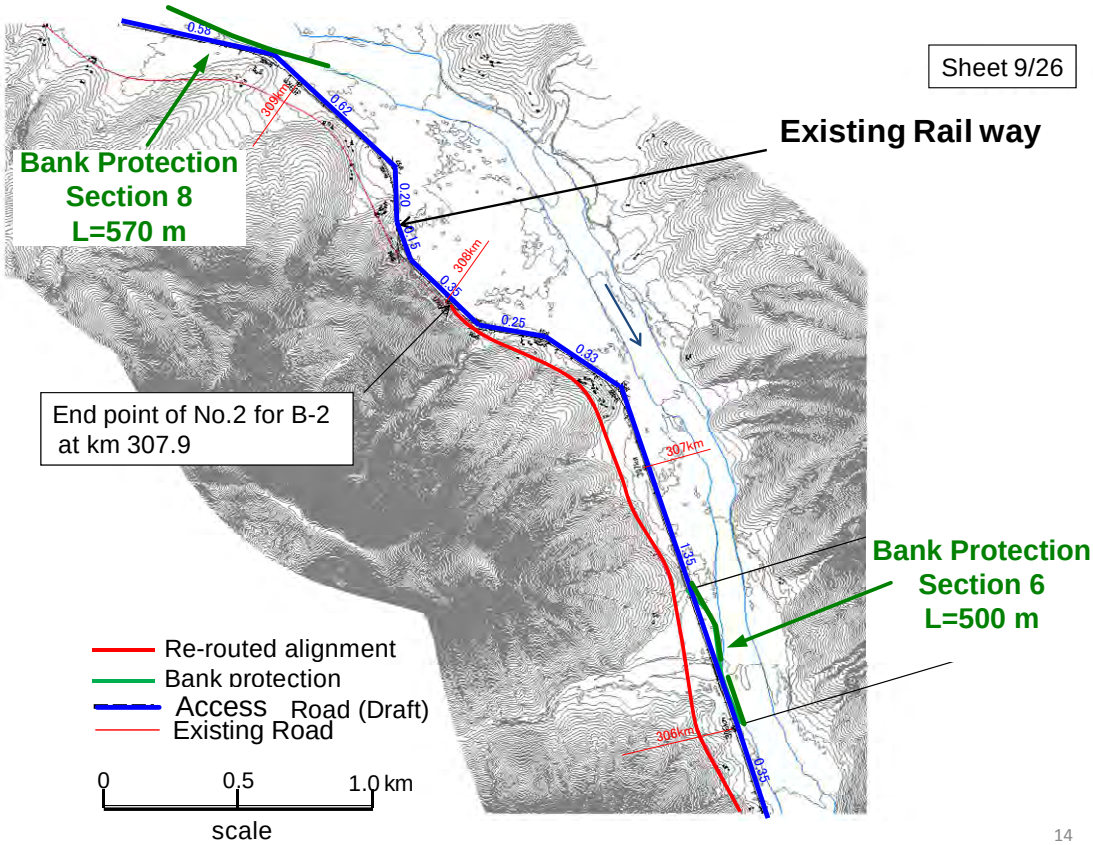

Sheet 4/26
ACCESS ROAD
Start point of No.1 B2
at km 293.8
Existing steel bridge
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
Existing Rail way
0
0.5
1.0 km
scale

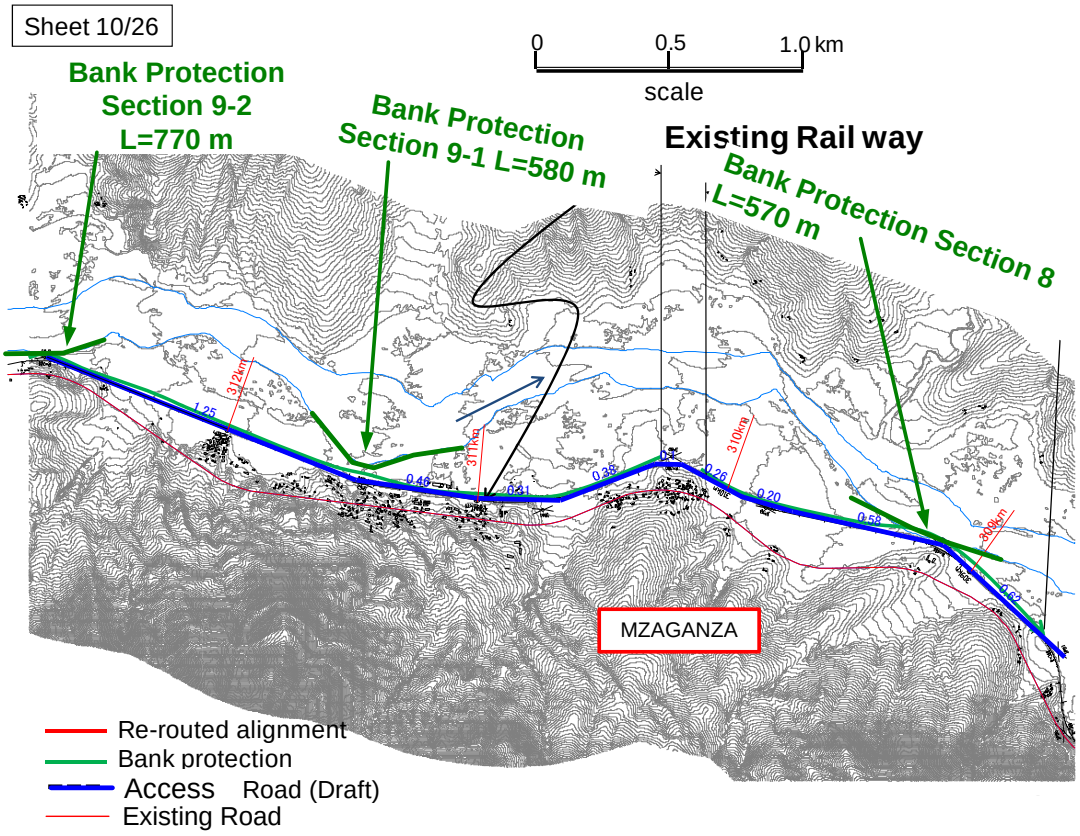

Bank Protection
Section 2
L=450 m
MUNISAGARA
ACCESS ROAD
Sheet 5/26
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
Existing Rail way
End point of No.1 B2
at km 295.5
Bank Protection
Section 1-2
L=710 m
Crossing section
between Access road
and Railway line
0
0.5
1.0 km
scale

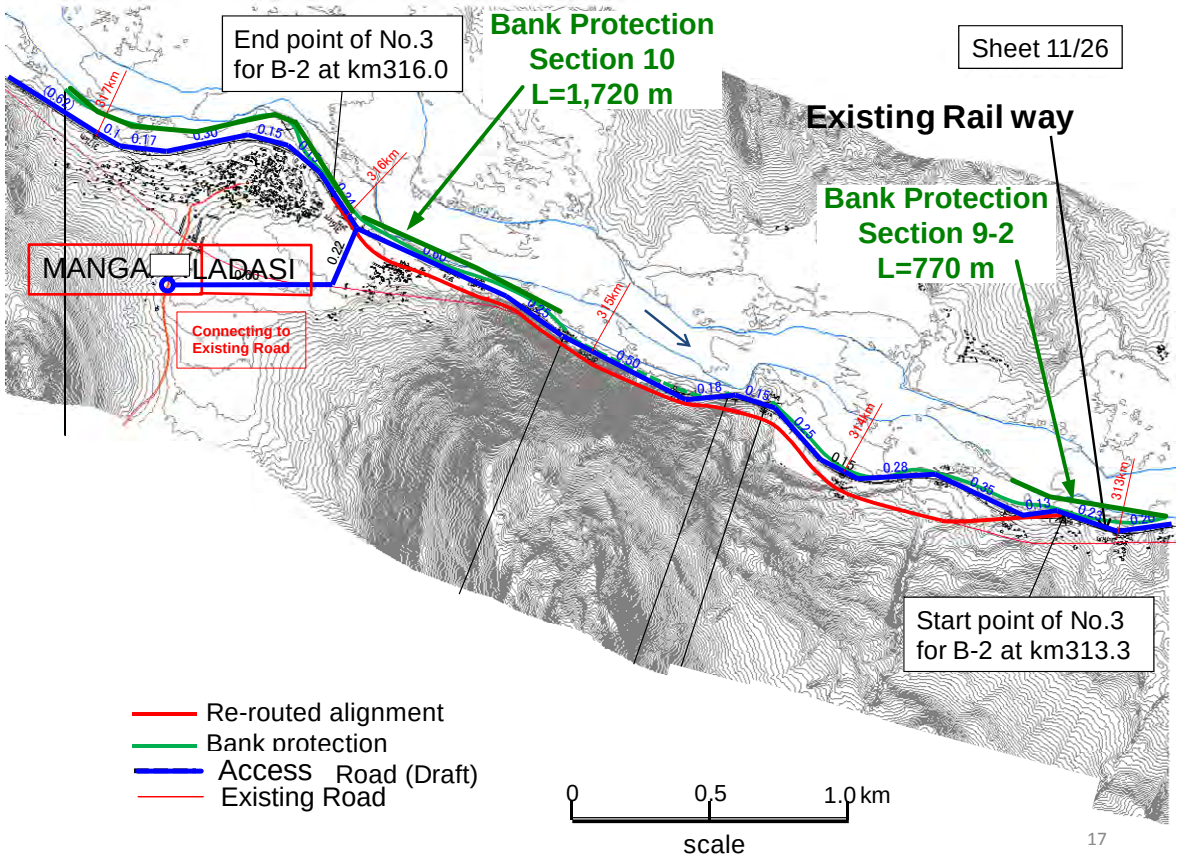

Sheet 6/26
Re-routed alignment
Bank protection
Access Road (Draft)
Bank Protection
Section 3
L=700 m
Existing Rail way
Bank Protection
Section 2
L=450 m
Bank Protection
Section 4
L=550 m
Start point of B2
at km 302.0
0
0.5
1.0 km
scale

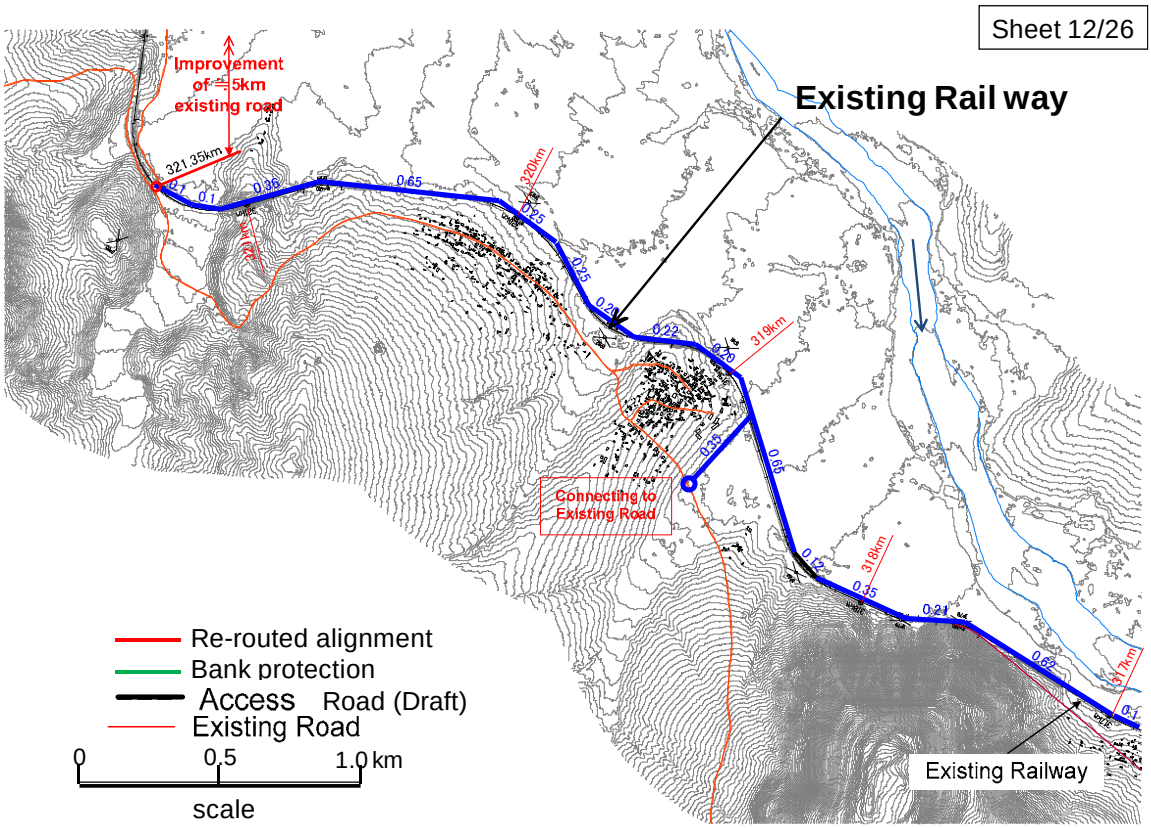

Sheet 7/26
Bank Protection
Section 6
L=500 m
Bank Protection
Section 5
L=1,380 m
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
Existing Rail way
Bank Protection
Section 4
L=550 m
Start point of B2 at km 302.0
0
0.5
1.0 km
scale

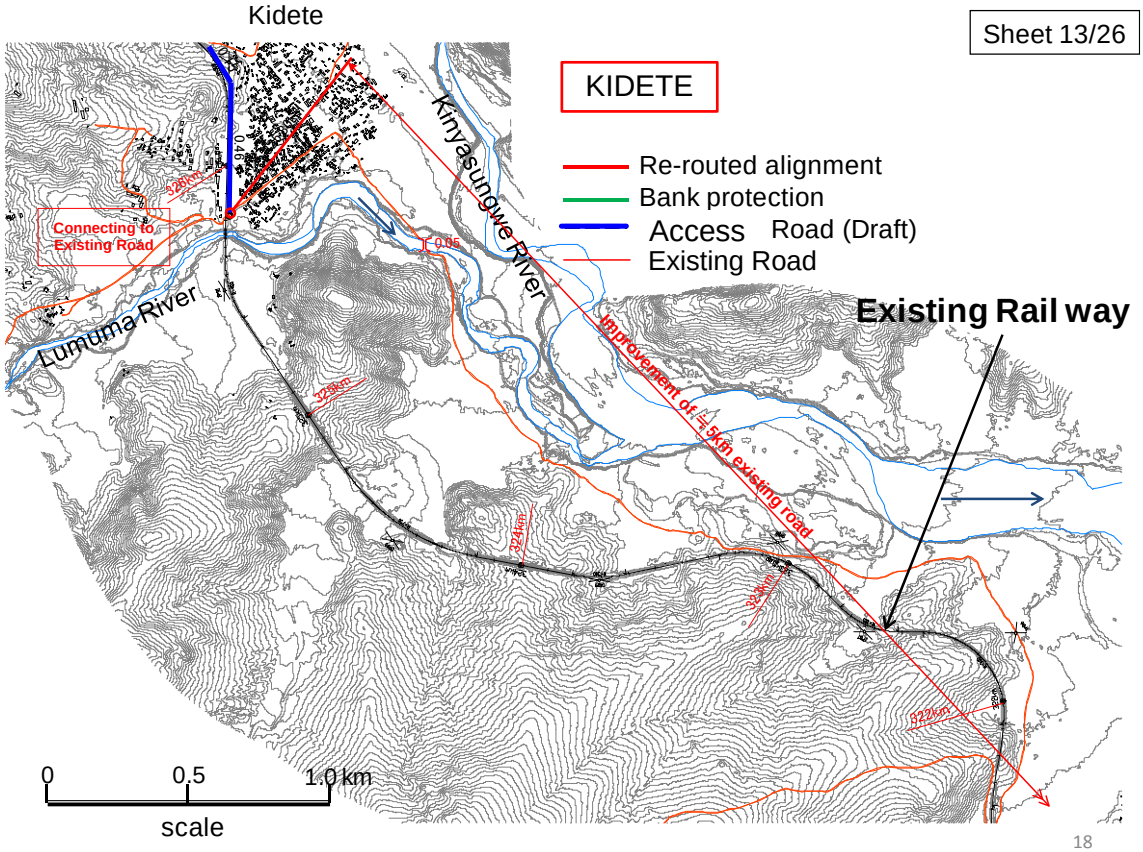

Sheet 8/26
Bank Protection
Section 6
L=500 m
Bank Protection
Section 5
L=1,380 m
No.2 B2
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
0
0.5
1.0 km
scale


Sheet 9/26
Existing Rail way
Bank Protection
Section 8
L=570 m
End point of No.2 for B-2
at km 307.9
Bank Protection
Section 6
L=500 m
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
0
0.5
1.0 km
scale

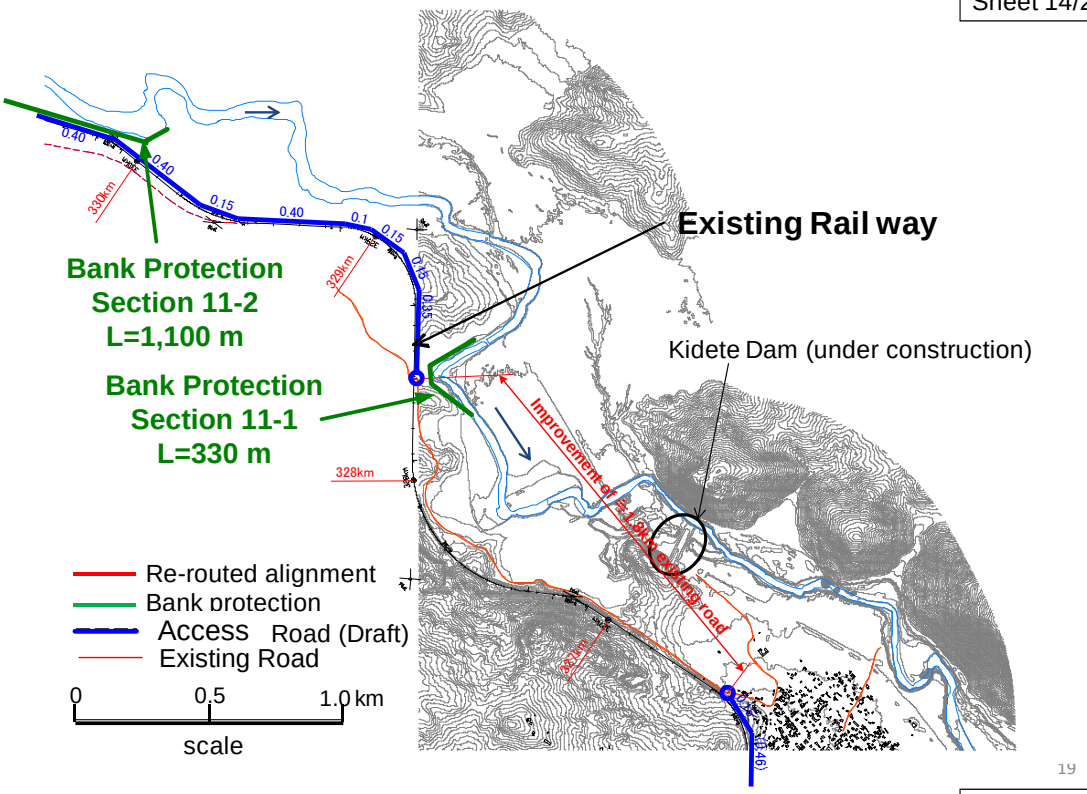

Sheet 10/26
0
0.5
1.0 km
scale
Bank Protection
Section 9-2
L=770 m
Bank Protection
Section 9-1 L=580 m
Existing Rail way
Bank Protection Section 8
L=570 m
MZAGANZA
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road


End point of No.3
for B-2 at km316.0
Bank Protection
Section 10
L=1,720 m
Sheet 11/26
Existing Rail way
Bank Protection
Section 9-2
L=770 m
MANGA LADASI
Connecting to
Existing Road
Start point of No.3
for B-2 at km313.3
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
0
0.5
1.0 km
scale

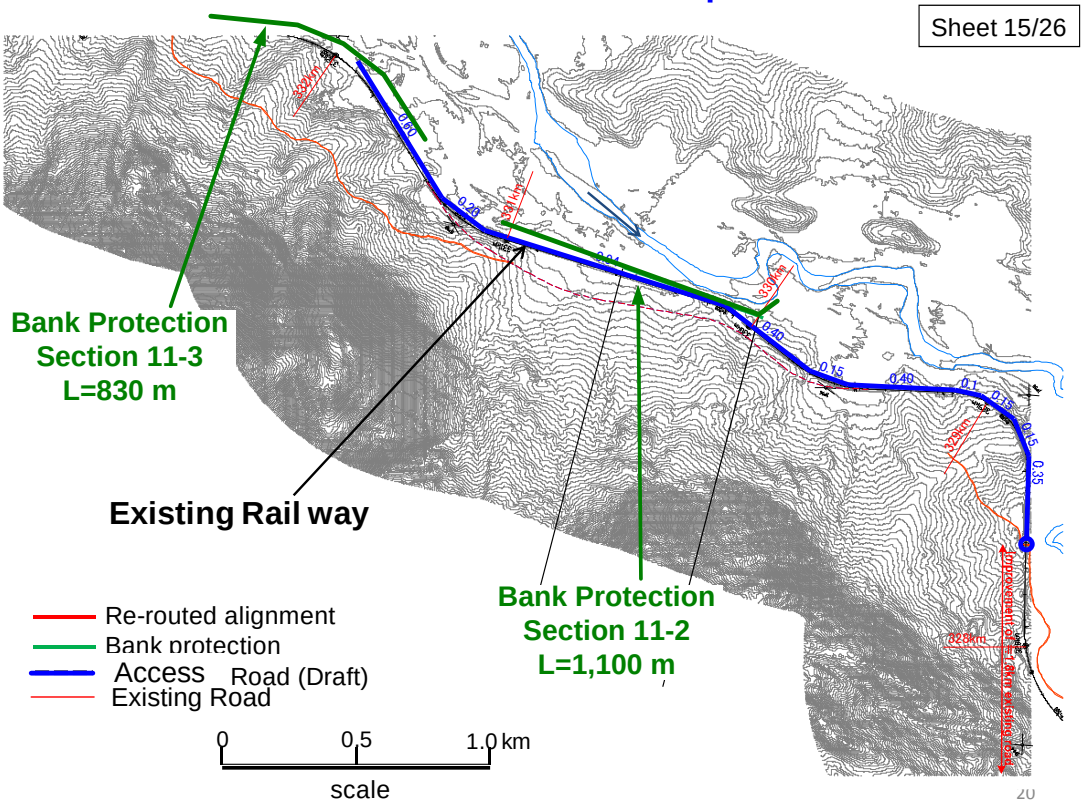

Sheet 12/26
Improvement of ≒5km existing road
Existing Rail way
Connecting to Existing Road
Existing Railway
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
0 0.5 1.0 km
scale


Kidete
Sheet 13/26
KIDETE
Kinyasungwe River
Lumuma River
Connecting to Existing Road
Improvement of ≒5km existing road
Existing Rail way
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
0 0.5 1.0 km
scale

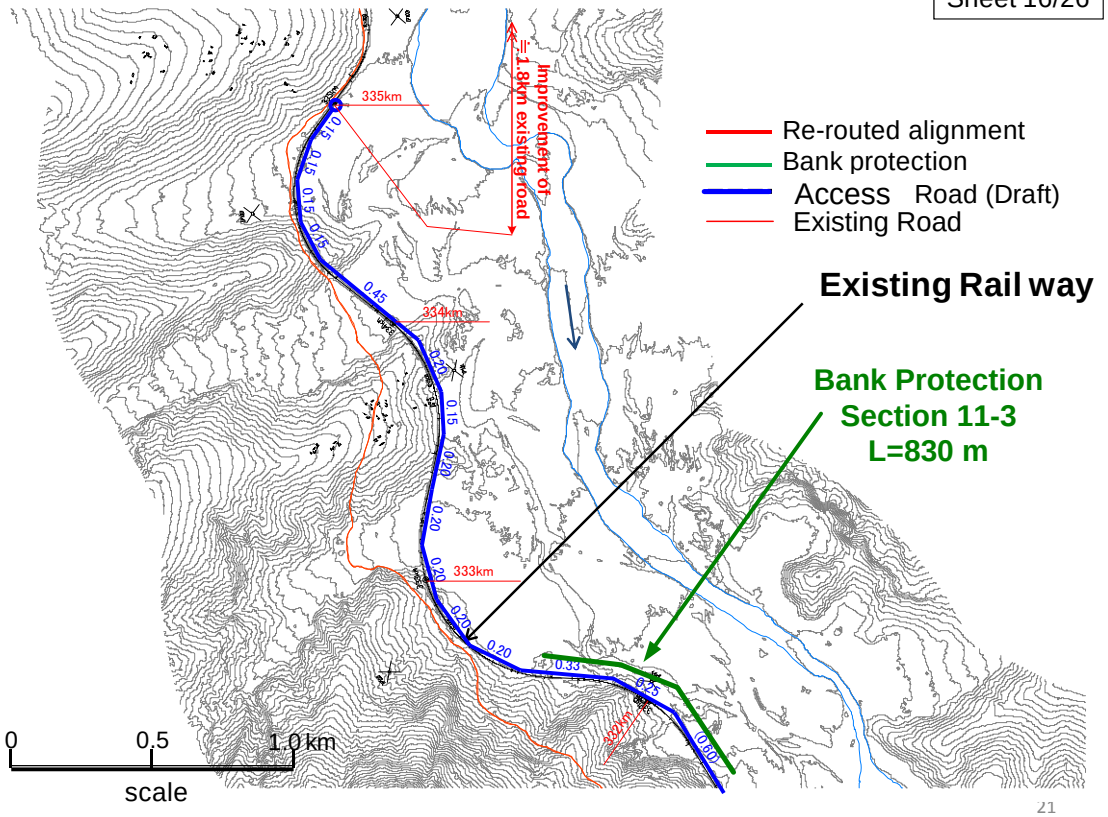
Sheet 14/26



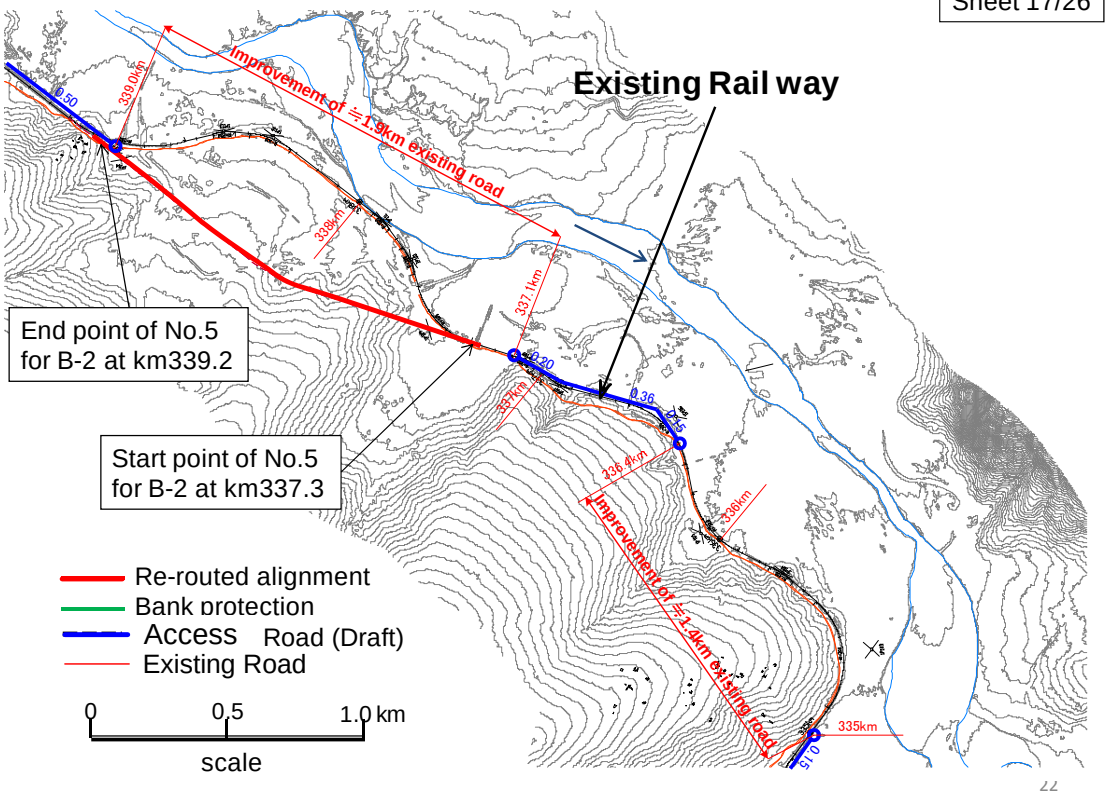
Sheet 15/26

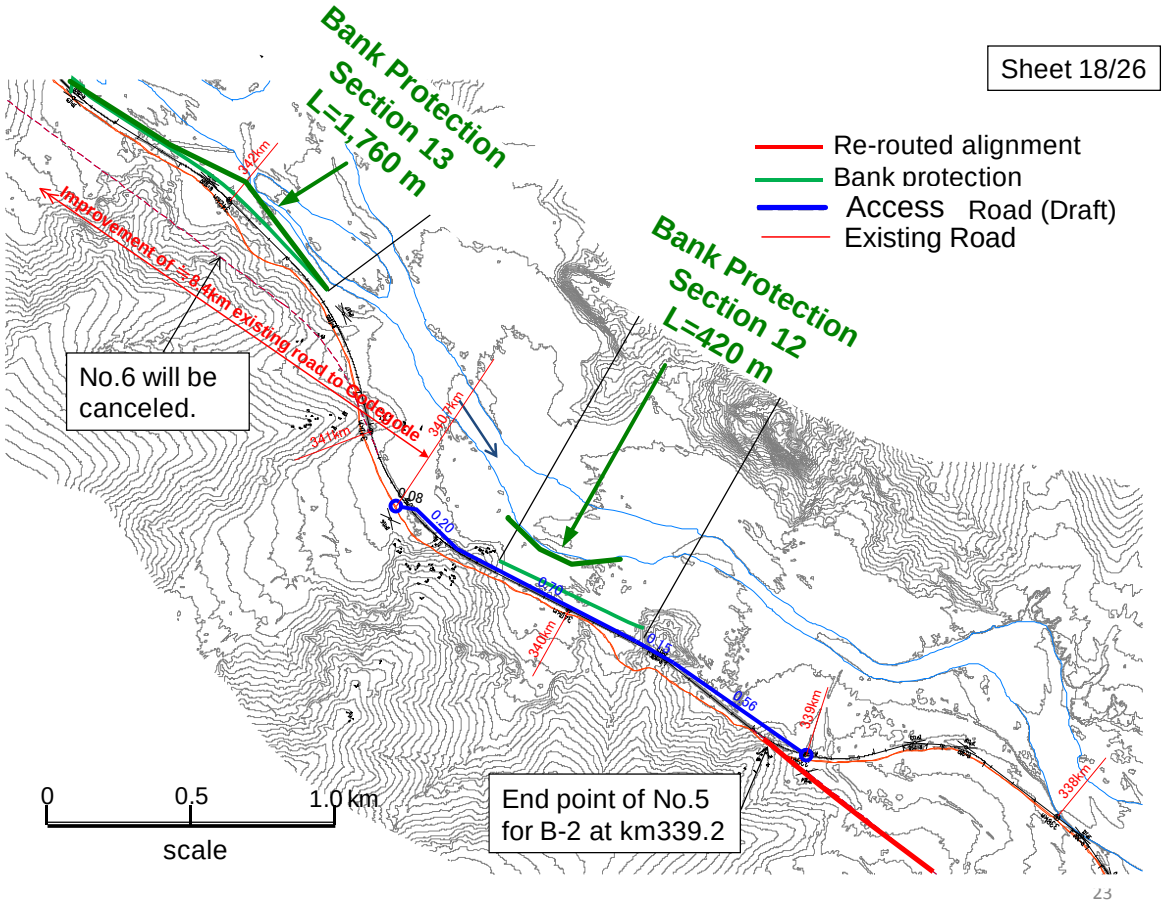


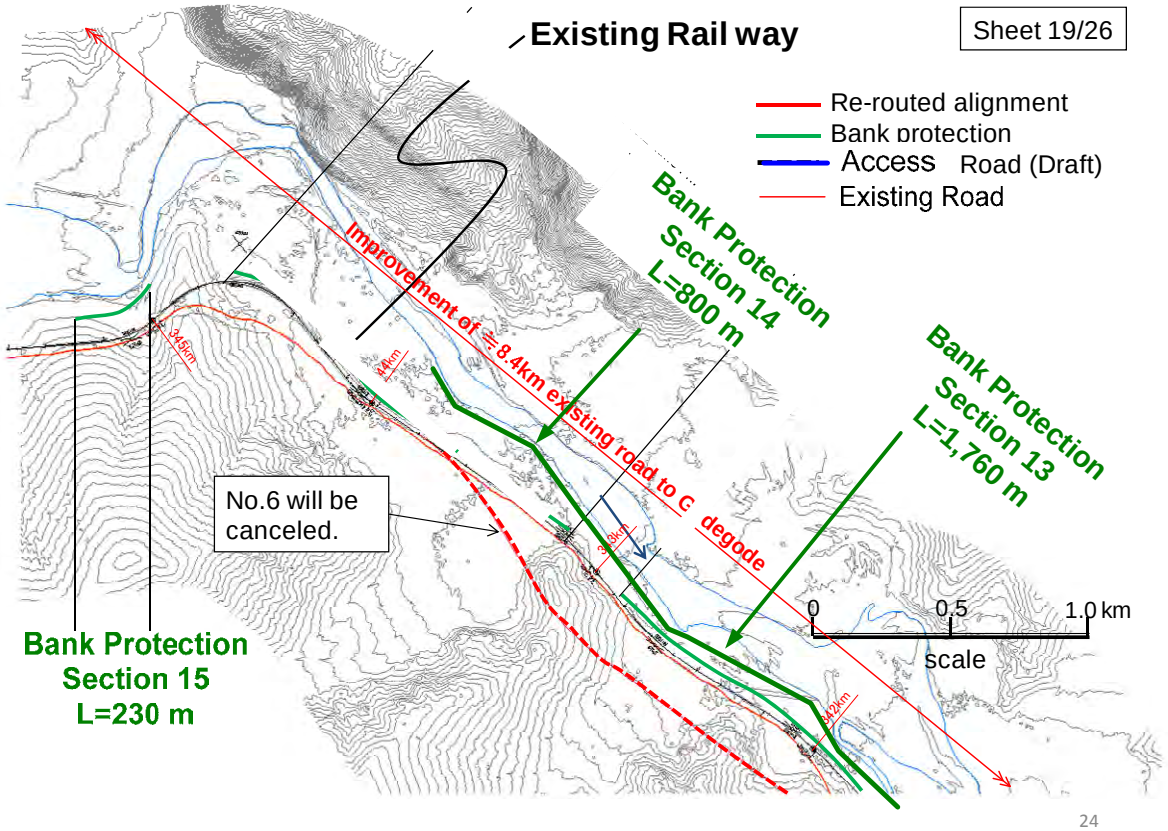
Sheet 16/26

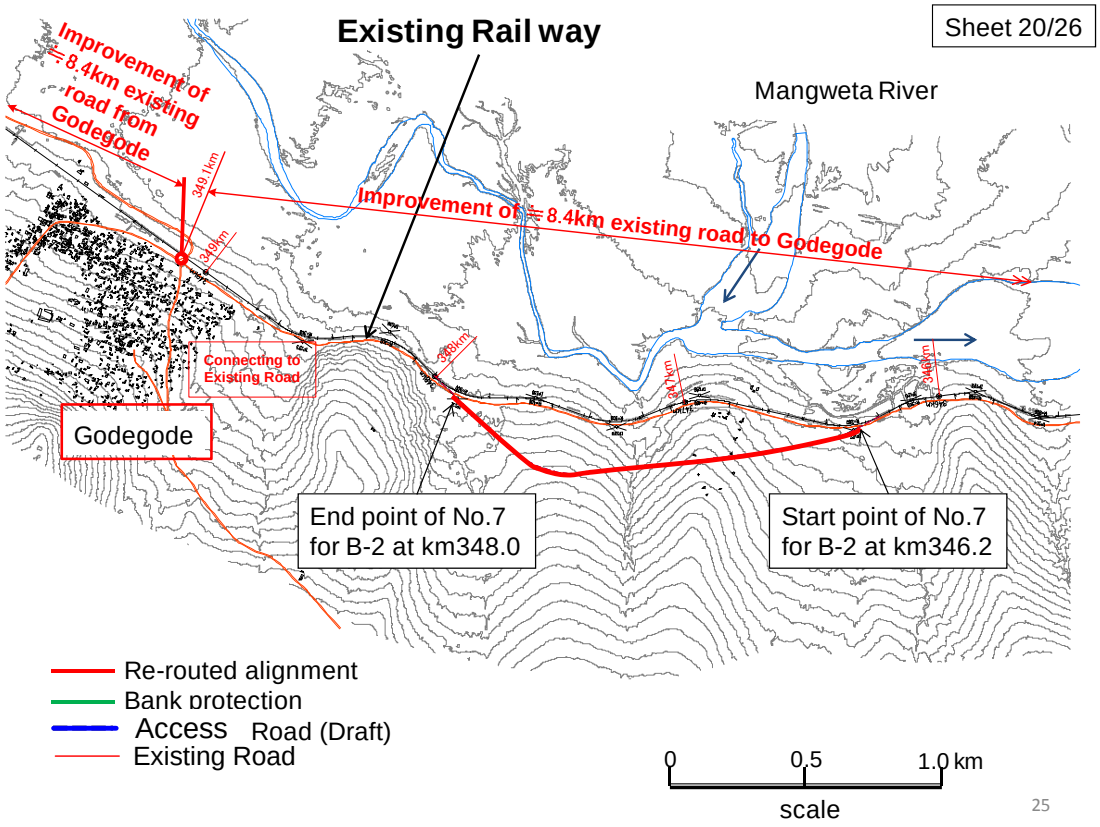


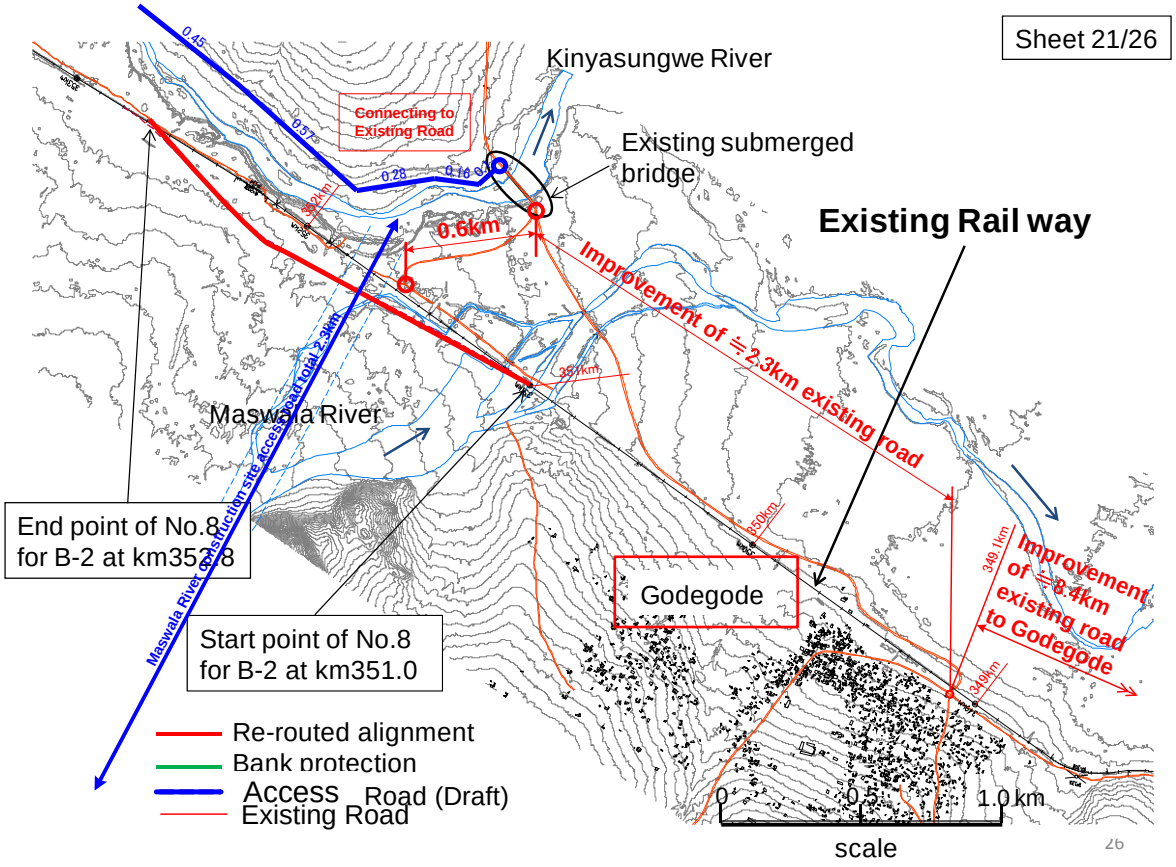
Sheet 17/26




Sheet 18/26
Bank Protection
Section 13
L=1,760 m
Bank Protection
Section 12
L=420 m
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
No.6 will be
canceled.
Improvement of =8.4km existing road to Godegode
End point of No.5
for B-2 at km339.2
0 0.5 1.0 km
scale


Existing Rail way
Sheet 19/26
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
Bank Protection
Section 14
L=800 m
Bank Protection
Section 13
L=1,760 m
Improvement of =8.4km existing road to G degode
No.6 will be
canceled.
Bank Protection
Section 15
L=230 m
0 0.5 1.0 km
scale


Sheet 20/26
Existing Rail way
Mangweta River
Improvement of ≒8.4km existing road from Godegode
Improvement of ≒8.4km existing road to Godegode
Connecting to Existing Road
Godegode
End point of No.7 for B-2 at km348.0
Start point of No.7 for B-2 at km346.2
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
0 0.5 1.0 km
scale
25


Sheet 21/26
Kinyasungwe River
Connecting to Existing Road
Existing submerged bridge
Existing Rail way
0.6km
Improvement of ≒2.3km existing road
Maswala River
Maswala River construction site access road total 2.3km
End point of No.8 for B-2 at km352.8
Start point of No.8 for B-2 at km351.0
Godegode
Improvement of ≒8.4km existing road to Godegode
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
0 0.5 1.0 km
scale
26

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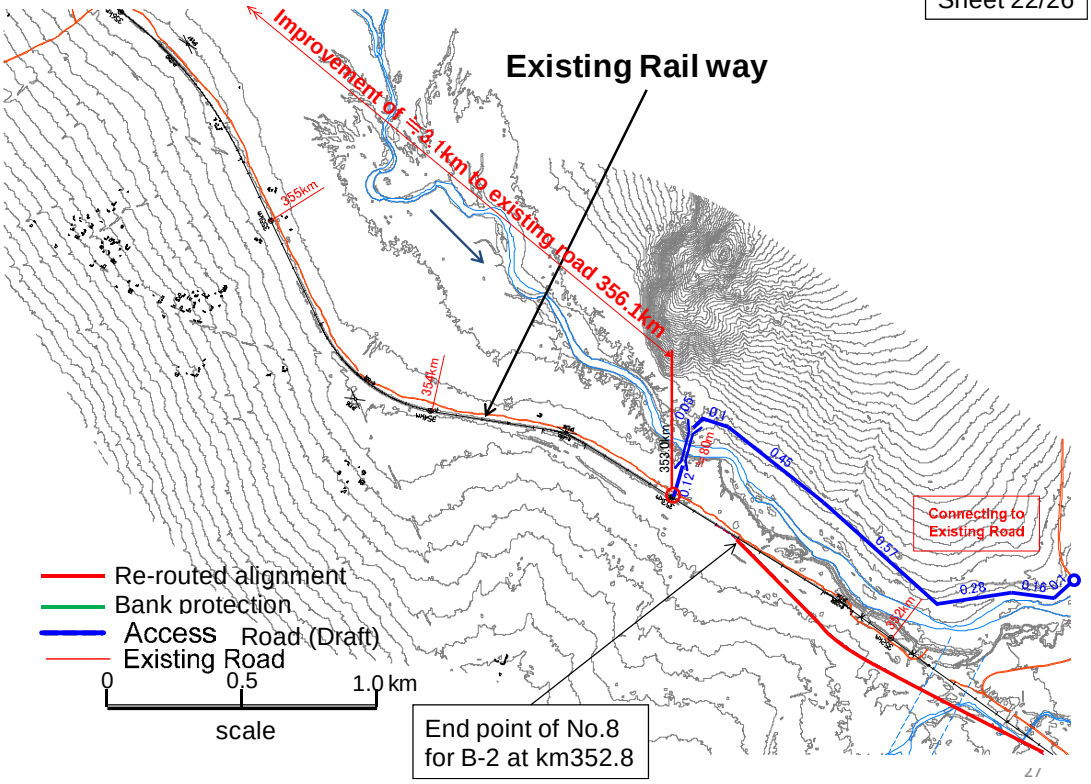
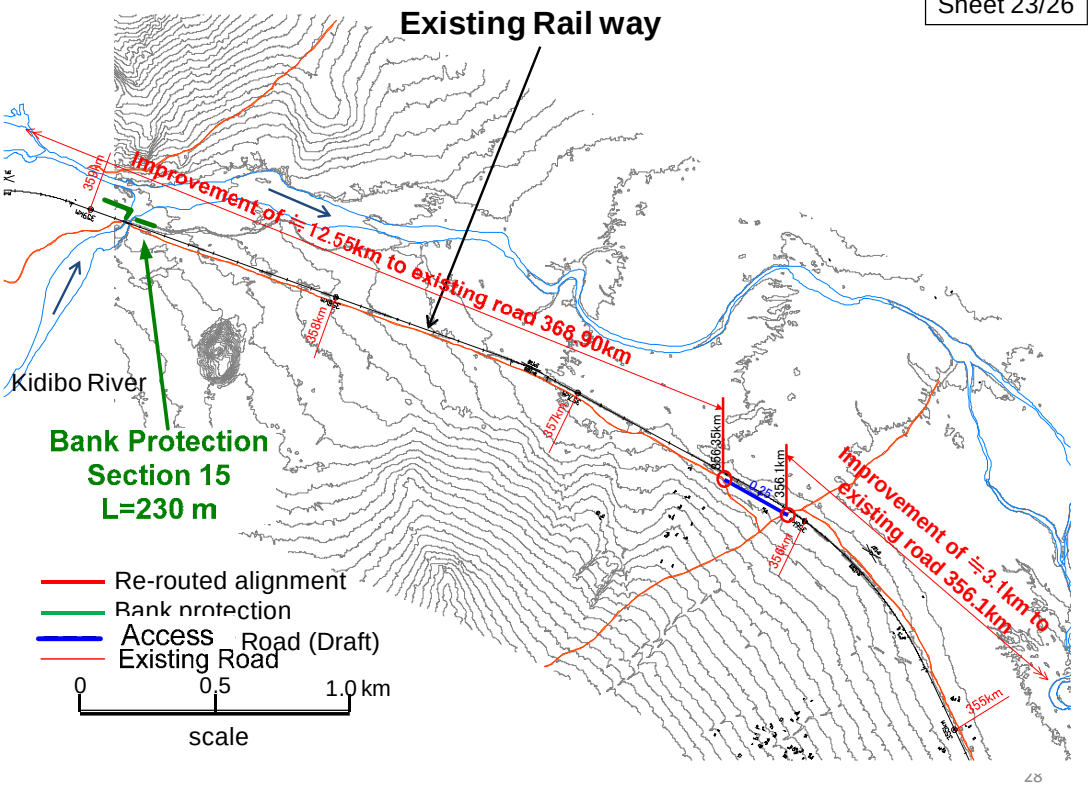
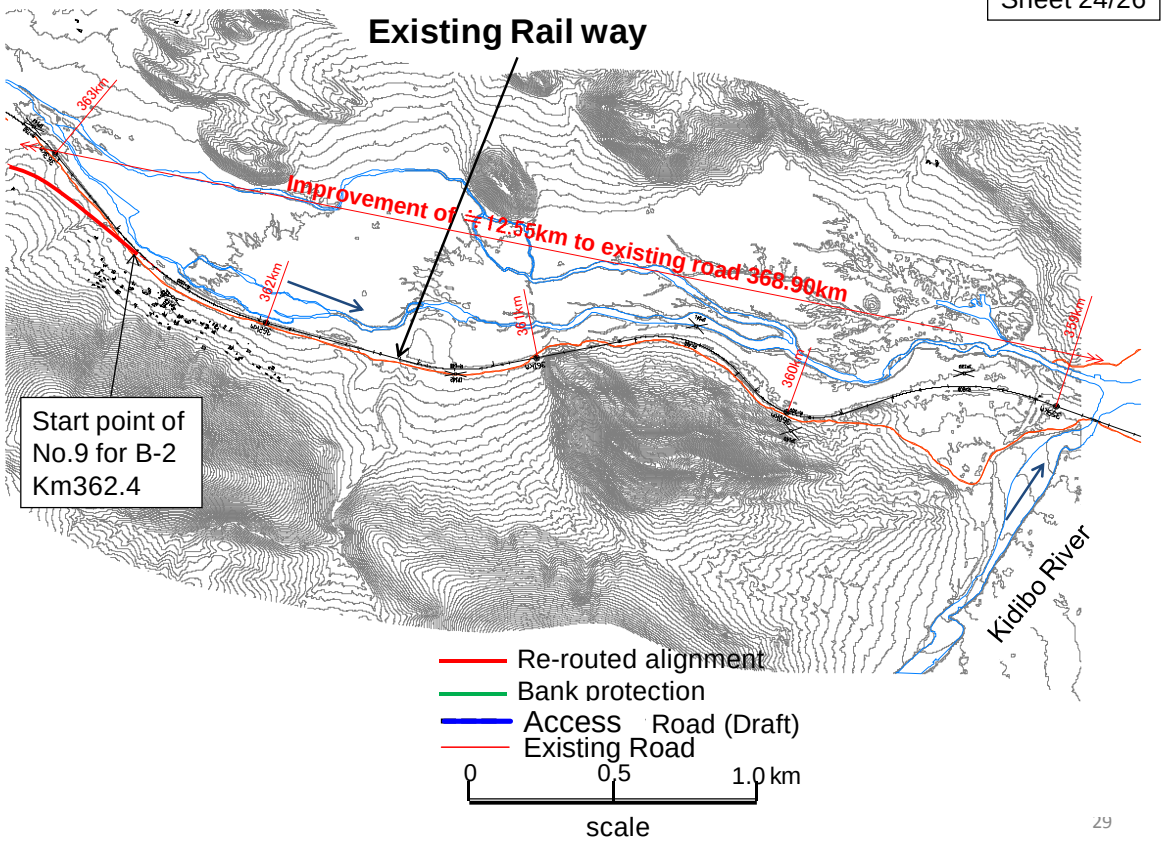


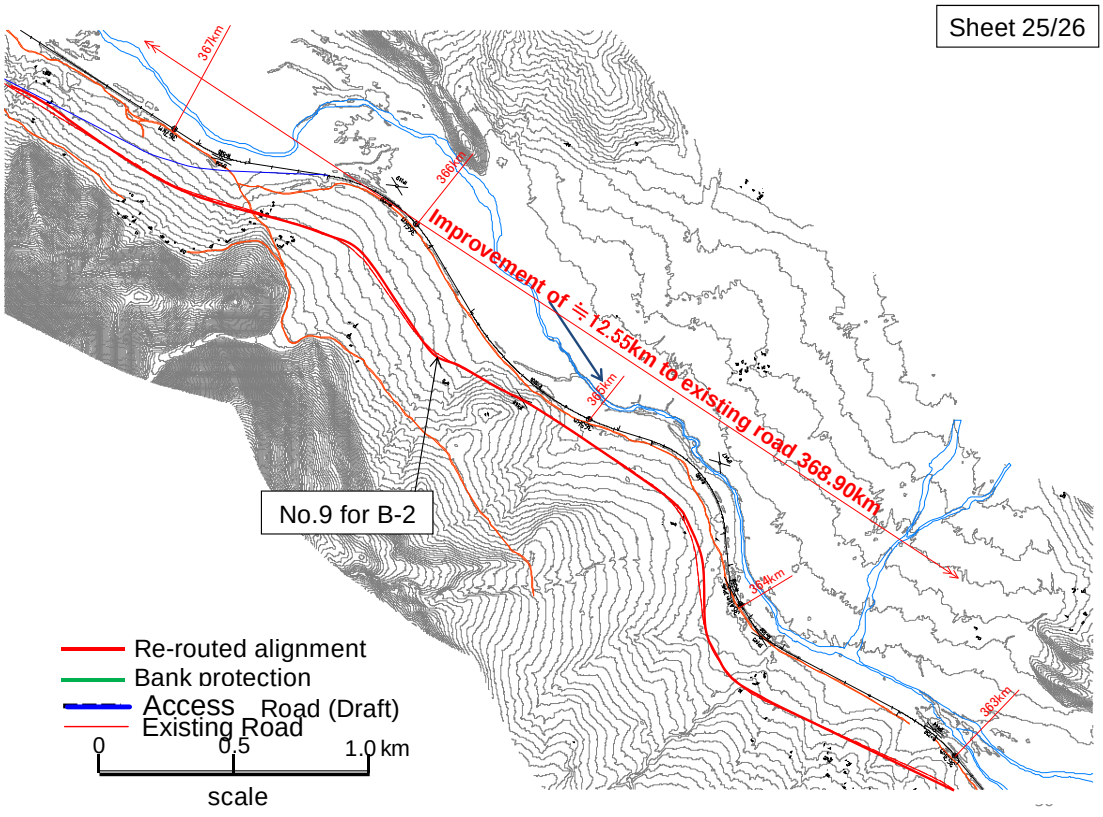
Sheet 23/26

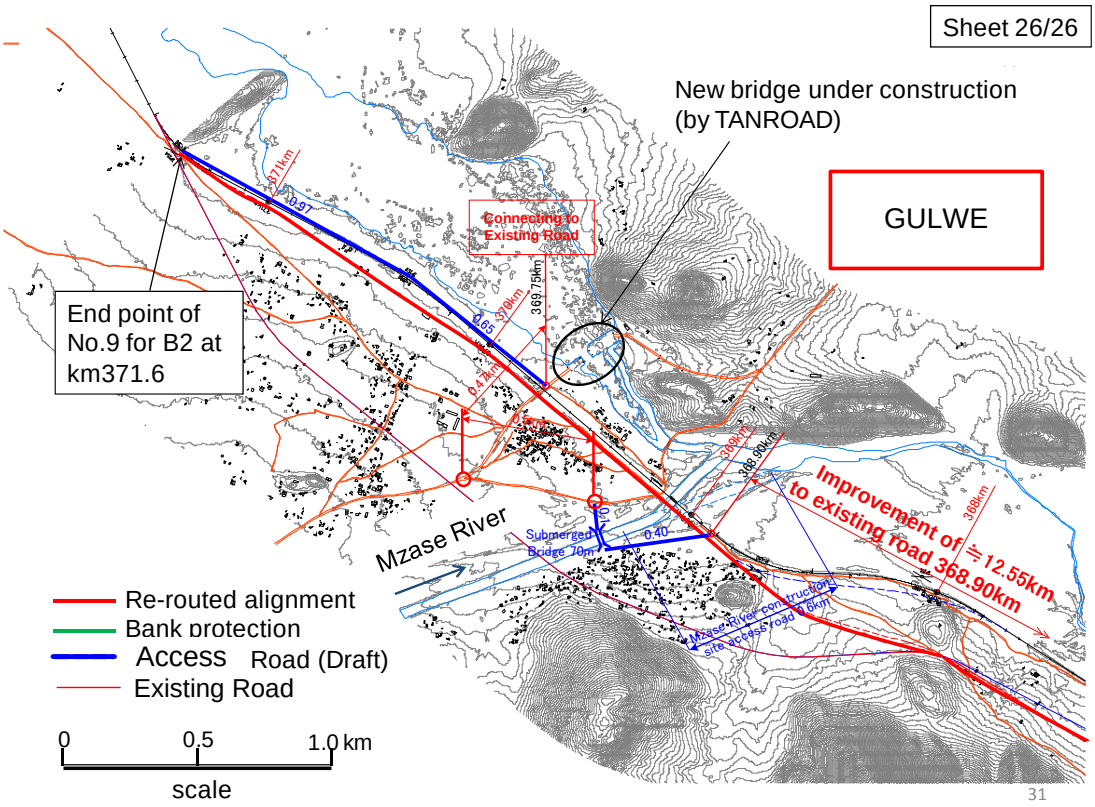


Sheet 24/26



Sheet 25/26




Sheet 26/26
New bridge under construction
(by TANROAD)
GULWE
End point of
No.9 for B2 at
km371.6
Connecting to
Existing Road
Mzase River
Submerged
Bridge 70m
Improvement of ≒12.55km
to existing road 368.90km
Re-routed alignment
Bank protection
Access Road (Draft)
Existing Road
0
0.5
1.0 km
scale

APPENDIX X

ALIGNMENT STATEMENT OF REROUTING LINE

Section 1

IP	Coorginates of Horizontal		Direction	Radius	Transition Length		Remarks
	Northing	Easting			In	Out	
	(m)	(m)		(m)	(m)	(m)	
BP	9252078.386	271755.316					
IP1	9252099.019	271385.364	Left	400	72	72	
IP2	9252051.713	271145.941	Right	400	72	72	
IP3	9252258.950	270381.691	Right	800	49	49	
IP4	9252555.010	269913.631	Right	350	72	72	Attached to Existing Line
EP	9253411.216	269874.083					

Section 1

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
0	9,252,094.196	271,471.836	520.981
20	9,252,095.262	271,451.893	520.981
40	9,252,096.052	271,431.909	520.981
60	9,252,096.288	271,411.912	520.981
80	9,252,095.698	271,391.922	520.981
100	9,252,094.122	271,371.986	520.981
120	9,252,091.597	271,352.148	520.981
140	9,252,088.352	271,332.414	520.981
160	9,252,084.661	271,312.758	520.981
180	9,252,080.796	271,293.135	520.981
200	9,252,076.919	271,273.514	520.981
220	9,252,073.087	271,253.885	520.981
240	9,252,069.526	271,234.205	520.981
260	9,252,066.510	271,214.434	520.981
280	9,252,064.311	271,194.557	520.983
300	9,252,063.096	271,174.596	521.011
320	9,252,062.880	271,154.600	521.073
340	9,252,063.664	271,134.617	521.168
360	9,252,065.445	271,114.699	521.296
380	9,252,068.220	271,094.894	521.458
400	9,252,071.957	271,075.248	521.638
420	9,252,076.455	271,055.762	521.818
440	9,252,081.445	271,036.394	521.998
460	9,252,086.654	271,017.085	522.178
480	9,252,091.889	270,997.782	522.358
500	9,252,097.123	270,978.479	522.538
520	9,252,102.357	270,959.176	522.718
540	9,252,107.591	270,939.873	522.898
560	9,252,112.826	270,920.570	523.078
580	9,252,118.060	270,901.267	523.258
600	9,252,123.294	270,881.964	523.438
620	9,252,128.528	270,862.661	523.618
640	9,252,133.763	270,843.358	523.798
660	9,252,138.997	270,824.055	523.978
680	9,252,144.231	270,804.753	524.158
700	9,252,149.465	270,785.450	524.338
720	9,252,154.700	270,766.147	524.518

Section 1

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
740	9,252,159.934	270,746.844	524.698
760	9,252,165.168	270,727.541	524.878
780	9,252,170.402	270,708.238	525.058
800	9,252,175.637	270,688.935	525.238
820	9,252,180.871	270,669.632	525.418
840	9,252,186.105	270,650.329	525.598
860	9,252,191.339	270,631.026	525.778
880	9,252,196.574	270,611.723	525.958
900	9,252,201.808	270,592.420	526.138
920	9,252,207.042	270,573.118	526.318
940	9,252,212.276	270,553.815	526.498
960	9,252,217.511	270,534.512	526.678
980	9,252,222.746	270,515.209	526.858
1,000	9,252,228.058	270,495.927	527.038
1,020	9,252,233.632	270,476.720	527.218
1,040	9,252,239.640	270,457.645	527.398
1,060	9,252,246.123	270,438.725	527.578
1,080	9,252,253.077	270,419.973	527.758
1,100	9,252,260.497	270,401.401	527.938
1,120	9,252,268.380	270,383.021	528.117
1,140	9,252,276.719	270,364.843	528.272
1,160	9,252,285.510	270,346.879	528.394
1,180	9,252,294.748	270,329.141	528.482
1,200	9,252,304.426	270,311.639	528.537
1,220	9,252,314.537	270,294.384	528.577
1,240	9,252,325.004	270,277.342	528.617
1,260	9,252,335.659	270,260.417	528.657
1,280	9,252,346.351	270,243.514	528.697
1,300	9,252,357.042	270,226.611	528.704
1,320	9,252,367.733	270,209.709	528.644
1,340	9,252,378.424	270,192.806	528.517
1,360	9,252,389.116	270,175.904	528.329
1,380	9,252,399.807	270,159.001	528.129
1,400	9,252,410.498	270,142.099	527.929
1,420	9,252,421.190	270,125.196	527.729
1,440	9,252,431.881	270,108.294	527.529
1,460	9,252,442.576	270,091.393	527.329

Section 1

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
1,480	9,252,453.393	270,074.571	527.129
1,500	9,252,464.588	270,057.999	526.929
1,520	9,252,476.409	270,041.869	526.729
1,540	9,252,489.061	270,026.382	526.529
1,560	9,252,502.576	270,011.643	526.329
1,580	9,252,516.911	269,997.700	526.129
1,600	9,252,532.018	269,984.599	525.929
1,620	9,252,547.849	269,972.381	525.729
1,640	9,252,564.352	269,961.088	525.529
1,660	9,252,581.474	269,950.756	525.329
1,680	9,252,599.157	269,941.418	525.129
1,700	9,252,617.345	269,933.105	524.954
1,720	9,252,635.977	269,925.845	524.822
1,740	9,252,654.994	269,919.661	524.736
1,760	9,252,674.333	269,914.573	524.694
1,780	9,252,693.932	269,910.598	524.696
1,800	9,252,713.723	269,907.734	524.733
1,820	9,252,733.629	269,905.807	524.773
1,840	9,252,753.586	269,904.513	524.813
1,860	9,252,773.562	269,903.536	524.853

Section 2

IP	Coorginates of Horizontal		Direction	Radius	Transition Length		Remarks
	Northing	Easting			In	Out	
	(m)	(m)		(m)	(m)	(m)	
BP	9254242.880	265554.583					
IP1	9253919.710	264501.091	Left	400	72	72	
IP2	9253670.699	264092.792	Right	400	72	72	
IP3	9253916.437	263107.067	Right	600	65	65	
IP4	9254297.936	262625.578	Left	400	72	72	
IP5	9254388.737	262320.828	Right	600	65	65	
IP6	9254741.202	261703.834	Right	400	72	72	
IP7	9255250.935	261678.678	Left	800	49	49	
IP8	9255683.295	261446.174	Right	400	72	72	
IP9	9256203.578	261359.997	Left	400	72	72	
IP10	9256504.646	261202.993	Right	1000	39	39	
IP11	9256934.535	261050.387	Left	400	72	72	
IP12	9257094.259	260677.559	Right	400	72	72	
EP	9257394.300	260370.025					

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
0	9,253,945.062	264,583.737	552.830
20	9,253,939.161	264,564.657	552.910
40	9,253,932.987	264,545.634	552.990
60	9,253,926.288	264,526.791	553.070
80	9,253,918.817	264,508.241	553.150
100	9,253,910.440	264,490.082	553.230
120	9,253,901.207	264,472.342	553.310
140	9,253,891.339	264,454.947	553.390
160	9,253,881.084	264,437.777	553.470
180	9,253,870.679	264,420.696	553.552
200	9,253,860.266	264,403.621	553.660
220	9,253,849.852	264,386.546	553.802
240	9,253,839.438	264,369.471	553.977
260	9,253,829.025	264,352.396	554.176
280	9,253,818.611	264,335.321	554.376
300	9,253,808.198	264,318.246	554.576
320	9,253,797.784	264,301.171	554.776
340	9,253,787.370	264,284.096	554.976
360	9,253,776.957	264,267.021	555.176
380	9,253,766.580	264,249.923	555.376
400	9,253,756.436	264,232.687	555.576
420	9,253,746.768	264,215.180	555.776
440	9,253,737.827	264,197.293	555.976
460	9,253,729.778	264,178.986	556.176
480	9,253,722.654	264,160.300	556.376
500	9,253,716.473	264,141.281	556.576
520	9,253,711.251	264,121.977	556.776
540	9,253,707.000	264,102.436	556.976
560	9,253,703.730	264,082.707	557.176
580	9,253,701.451	264,062.840	557.368
600	9,253,700.168	264,042.883	557.501
620	9,253,699.883	264,022.887	557.568
640	9,253,700.599	264,002.902	557.568
660	9,253,702.312	263,982.978	557.528
680	9,253,705.019	263,963.164	557.488
700	9,253,708.644	263,943.496	557.448
720	9,253,712.941	263,923.964	557.408

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
740	9,253,717.639	263,904.524	557.368
760	9,253,722.472	263,885.117	557.328
780	9,253,727.310	263,865.711	557.288
800	9,253,732.148	263,846.305	557.248
820	9,253,736.985	263,826.898	557.208
840	9,253,741.823	263,807.492	557.168
860	9,253,746.661	263,788.086	557.132
880	9,253,751.499	263,768.680	557.132
900	9,253,756.337	263,749.274	557.176
920	9,253,761.175	263,729.868	557.265
940	9,253,766.013	263,710.462	557.398
960	9,253,770.851	263,691.056	557.576
980	9,253,775.688	263,671.650	557.776
1,000	9,253,780.526	263,652.244	557.976
1,020	9,253,785.364	263,632.838	558.176
1,040	9,253,790.202	263,613.432	558.376
1,060	9,253,795.040	263,594.026	558.576
1,080	9,253,799.878	263,574.620	558.776
1,100	9,253,804.716	263,555.214	558.976
1,120	9,253,809.553	263,535.808	559.176
1,140	9,253,814.391	263,516.402	559.376
1,160	9,253,819.229	263,496.995	559.576
1,180	9,253,824.067	263,477.589	559.776
1,200	9,253,828.905	263,458.183	559.976
1,220	9,253,833.743	263,438.777	560.176
1,240	9,253,838.581	263,419.371	560.376
1,260	9,253,843.419	263,399.965	560.576
1,280	9,253,848.256	263,380.559	560.776
1,300	9,253,853.094	263,361.153	560.976
1,320	9,253,857.932	263,341.747	561.176
1,340	9,253,862.770	263,322.341	561.376
1,360	9,253,867.608	263,302.935	561.576
1,380	9,253,872.446	263,283.529	561.776
1,400	9,253,877.284	263,264.123	561.976
1,420	9,253,882.157	263,244.726	562.176
1,440	9,253,887.233	263,225.381	562.376
1,460	9,253,892.709	263,206.145	562.576

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
1,480	9,253,898.761	263,187.084	562.776
1,500	9,253,905.446	263,168.235	562.976
1,520	9,253,912.754	263,149.620	563.162
1,540	9,253,920.679	263,131.258	563.285
1,560	9,253,929.212	263,113.170	563.342
1,580	9,253,938.343	263,095.377	563.332
1,600	9,253,948.061	263,077.898	563.292
1,620	9,253,958.357	263,060.753	563.252
1,640	9,253,969.219	263,043.960	563.212
1,660	9,253,980.633	263,027.539	563.172
1,680	9,253,992.536	263,011.467	563.132
1,700	9,254,004.766	262,995.643	563.092
1,720	9,254,017.160	262,979.945	563.052
1,740	9,254,029.580	262,964.270	563.012
1,760	9,254,042.001	262,948.594	562.972
1,780	9,254,054.421	262,932.918	562.932
1,800	9,254,066.841	262,917.242	562.892
1,820	9,254,079.262	262,901.566	562.852
1,840	9,254,091.682	262,885.890	562.812
1,860	9,254,104.103	262,870.215	562.772
1,880	9,254,116.523	262,854.539	562.732
1,900	9,254,128.944	262,838.863	562.712
1,920	9,254,141.364	262,823.187	562.726
1,940	9,254,153.785	262,807.511	562.772
1,960	9,254,166.205	262,791.835	562.852
1,980	9,254,178.626	262,776.159	562.952
2,000	9,254,191.046	262,760.484	563.052
2,020	9,254,203.467	262,744.808	563.152
2,040	9,254,215.887	262,729.132	563.252
2,060	9,254,228.307	262,713.456	563.352
2,080	9,254,240.685	262,697.746	563.452
2,100	9,254,252.830	262,681.857	563.552
2,120	9,254,264.517	262,665.628	563.652
2,140	9,254,275.511	262,648.923	563.752
2,160	9,254,285.665	262,631.695	563.852
2,180	9,254,294.944	262,613.980	563.952
2,200	9,254,303.327	262,595.824	564.052

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
2,220	9,254,310.796	262,577.273	564.152
2,240	9,254,317.456	262,558.416	564.252
2,260	9,254,323.546	262,539.366	564.352
2,280	9,254,329.328	262,520.220	564.452
2,300	9,254,335.039	262,501.053	564.552
2,320	9,254,340.750	262,481.885	564.655
2,340	9,254,346.461	262,462.718	564.785
2,360	9,254,352.172	262,443.551	564.942
2,380	9,254,357.882	262,424.383	565.102
2,400	9,254,363.593	262,405.216	565.262
2,420	9,254,369.320	262,386.054	565.422
2,440	9,254,375.238	262,366.949	565.582
2,460	9,254,381.607	262,347.991	565.742
2,480	9,254,388.681	262,329.286	565.902
2,500	9,254,396.649	262,310.944	566.062
2,520	9,254,405.463	262,292.993	566.222
2,540	9,254,414.891	262,275.355	566.382
2,560	9,254,424.683	262,257.916	566.542
2,580	9,254,434.599	262,240.547	566.702
2,600	9,254,444.519	262,223.181	566.862
2,620	9,254,454.440	262,205.815	567.022
2,640	9,254,464.360	262,188.449	567.182
2,660	9,254,474.281	262,171.083	567.342
2,680	9,254,484.201	262,153.716	567.502
2,700	9,254,494.122	262,136.350	567.662
2,720	9,254,504.043	262,118.984	567.822
2,740	9,254,513.963	262,101.618	567.982
2,760	9,254,523.884	262,084.252	568.145
2,780	9,254,533.804	262,066.886	568.336
2,800	9,254,543.725	262,049.520	568.536
2,820	9,254,553.646	262,032.154	568.736
2,840	9,254,563.566	262,014.788	568.936
2,860	9,254,573.487	261,997.421	569.136
2,880	9,254,583.407	261,980.055	569.336
2,900	9,254,593.328	261,962.689	569.536
2,920	9,254,603.249	261,945.323	569.736
2,940	9,254,613.169	261,927.957	569.936

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
2,960	9,254,623.117	261,910.606	570.136
2,980	9,254,633.274	261,893.378	570.336
3,000	9,254,643.876	261,876.420	570.536
3,020	9,254,655.140	261,859.896	570.736
3,040	9,254,667.201	261,843.945	570.936
3,060	9,254,680.044	261,828.615	571.136
3,080	9,254,693.636	261,813.947	571.336
3,100	9,254,707.945	261,799.977	571.536
3,120	9,254,722.934	261,786.739	571.736
3,140	9,254,738.566	261,774.267	571.936
3,160	9,254,754.802	261,762.591	572.136
3,180	9,254,771.601	261,751.742	572.336
3,200	9,254,788.922	261,741.746	572.536
3,220	9,254,806.720	261,732.628	572.715
3,240	9,254,824.952	261,724.411	572.828
3,260	9,254,843.571	261,717.116	572.875
3,280	9,254,862.533	261,710.760	572.855
3,300	9,254,881.787	261,705.360	572.771
3,320	9,254,901.288	261,700.929	572.671
3,340	9,254,920.986	261,697.478	572.571
3,360	9,254,940.829	261,694.988	572.471
3,380	9,254,960.754	261,693.265	572.371
3,400	9,254,980.716	261,692.037	572.271
3,420	9,255,000.690	261,691.028	572.171
3,440	9,255,020.666	261,690.042	572.071
3,460	9,255,040.642	261,689.056	571.971
3,480	9,255,060.617	261,688.057	571.871
3,500	9,255,080.584	261,686.909	571.771
3,520	9,255,100.527	261,685.409	571.671
3,540	9,255,120.427	261,683.424	571.573
3,560	9,255,140.272	261,680.942	571.510
3,580	9,255,160.049	261,677.965	571.491
3,600	9,255,179.745	261,674.494	571.517
3,620	9,255,199.348	261,670.532	571.587
3,640	9,255,218.846	261,666.081	571.701
3,660	9,255,238.227	261,661.144	571.860
3,680	9,255,257.478	261,655.725	572.056

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
3,700	9,255,276.587	261,649.825	572.256
3,720	9,255,295.544	261,643.450	572.456
3,740	9,255,314.335	261,636.603	572.656
3,760	9,255,332.948	261,629.289	572.856
3,780	9,255,351.374	261,621.511	573.056
3,800	9,255,369.599	261,613.276	573.256
3,820	9,255,387.612	261,604.587	573.456
3,840	9,255,405.417	261,595.478	573.656
3,860	9,255,423.082	261,586.101	573.856
3,880	9,255,440.699	261,576.632	574.056
3,900	9,255,458.313	261,567.159	574.256
3,920	9,255,475.928	261,557.687	574.456
3,940	9,255,493.543	261,548.215	574.619
3,960	9,255,511.157	261,538.742	574.716
3,980	9,255,528.772	261,529.270	574.746
4,000	9,255,546.386	261,519.797	574.709
4,020	9,255,564.001	261,510.325	574.630
4,040	9,255,581.616	261,500.853	574.550
4,060	9,255,599.231	261,491.382	574.470
4,080	9,255,616.900	261,482.011	574.390
4,100	9,255,634.742	261,472.976	574.310
4,120	9,255,652.869	261,464.529	574.230
4,140	9,255,671.361	261,456.915	574.150
4,160	9,255,690.209	261,450.233	574.070
4,180	9,255,709.368	261,444.501	573.990
4,200	9,255,728.785	261,439.712	573.910
4,220	9,255,748.374	261,435.686	573.830
4,240	9,255,768.061	261,432.162	573.750
4,260	9,255,787.788	261,428.866	573.670
4,280	9,255,807.519	261,425.598	573.590
4,300	9,255,827.250	261,422.330	573.510
4,320	9,255,846.981	261,419.062	573.430
4,340	9,255,866.712	261,415.794	573.350
4,360	9,255,886.444	261,412.526	573.270
4,380	9,255,906.175	261,409.257	573.190
4,400	9,255,925.906	261,405.989	573.110
4,420	9,255,945.637	261,402.721	573.032

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
4,440	9,255,965.368	261,399.453	572.978
4,460	9,255,985.099	261,396.185	572.958
4,480	9,256,004.831	261,392.917	572.972
4,500	9,256,024.562	261,389.648	573.018
4,520	9,256,044.293	261,386.380	573.094
4,540	9,256,064.024	261,383.112	573.174
4,560	9,256,083.755	261,379.844	573.254
4,580	9,256,103.486	261,376.576	573.334
4,600	9,256,123.211	261,373.271	573.414
4,620	9,256,142.892	261,369.711	573.494
4,640	9,256,162.469	261,365.626	573.574
4,660	9,256,181.865	261,360.754	573.654
4,680	9,256,200.997	261,354.934	573.734
4,700	9,256,219.814	261,348.164	573.814
4,720	9,256,238.274	261,340.473	573.894
4,740	9,256,256.400	261,332.023	573.974
4,760	9,256,274.284	261,323.070	574.054
4,780	9,256,292.040	261,313.865	574.134
4,800	9,256,309.773	261,304.617	574.214
4,820	9,256,327.507	261,295.369	574.294
4,840	9,256,345.240	261,286.122	574.374
4,860	9,256,362.974	261,276.874	574.454
4,880	9,256,380.707	261,267.626	574.534
4,900	9,256,398.441	261,258.378	574.614
4,920	9,256,416.174	261,249.130	574.694
4,940	9,256,433.910	261,239.886	574.774
4,960	9,256,451.692	261,230.733	574.854
4,980	9,256,469.610	261,221.847	574.934
5,000	9,256,487.700	261,213.319	575.014
5,020	9,256,505.957	261,205.153	575.094
5,040	9,256,524.373	261,197.355	575.174
5,060	9,256,542.942	261,189.926	575.254
5,080	9,256,561.654	261,182.866	575.334
5,100	9,256,580.468	261,176.080	575.414
5,120	9,256,599.314	261,169.387	575.494
5,140	9,256,618.162	261,162.696	575.574
5,160	9,256,637.010	261,156.005	575.654

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
5,180	9,256,655.857	261,149.315	575.734
5,200	9,256,674.705	261,142.624	575.814
5,220	9,256,693.553	261,135.933	575.894
5,240	9,256,712.400	261,129.242	575.974
5,260	9,256,731.248	261,122.552	576.054
5,280	9,256,750.088	261,115.840	576.134
5,300	9,256,768.854	261,108.923	576.214
5,320	9,256,787.442	261,101.544	576.294
5,340	9,256,805.731	261,093.456	576.374
5,360	9,256,823.606	261,084.489	576.454
5,380	9,256,841.011	261,074.640	576.534
5,400	9,256,857.901	261,063.933	576.594
5,420	9,256,874.235	261,052.396	576.621
5,440	9,256,889.973	261,040.057	576.614
5,460	9,256,905.073	261,026.946	576.574
5,480	9,256,919.500	261,013.097	576.502
5,500	9,256,933.216	260,998.545	576.422
5,520	9,256,946.189	260,983.325	576.342
5,540	9,256,958.384	260,967.476	576.262
5,560	9,256,969.771	260,951.037	576.182
5,580	9,256,980.323	260,934.050	576.102
5,600	9,256,990.014	260,916.557	576.022
5,620	9,256,998.907	260,898.644	575.942
5,640	9,257,007.218	260,880.453	575.862
5,660	9,257,015.193	260,862.112	575.782
5,680	9,257,023.070	260,843.729	575.702
5,700	9,257,030.946	260,825.345	575.624
5,720	9,257,038.822	260,806.961	575.570
5,740	9,257,046.698	260,788.577	575.530
5,760	9,257,054.579	260,770.195	575.490
5,780	9,257,062.593	260,751.871	575.450
5,800	9,257,070.985	260,733.718	575.410
5,820	9,257,080.000	260,715.866	575.370
5,840	9,257,089.838	260,698.455	575.339
5,860	9,257,100.534	260,681.558	575.341
5,880	9,257,112.060	260,665.216	575.376
5,900	9,257,124.389	260,649.471	575.444

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
5,920	9,257,137.438	260,634.316	575.524
5,940	9,257,151.000	260,619.617	575.604
5,960	9,257,164.861	260,605.201	575.684
5,980	9,257,178.824	260,590.881	575.764

Section 3

IP	Coorginates of Horizontal		Direction	Radius	Transition Length		Remarks
	Northing	Easting			In	Out	
	(m)	(m)		(m)	(m)	(m)	
BP	9258855.274	256042.538					
IP1	9258841.125	255623.062	Right	400	72	72	
IP2	9258942.603	255238.049	Right	400	72	72	
IP3	9259221.279	254987.962	Left	400	72	72	
IP4	9259262.230	254669.203	Right	400	72	72	
IP5	9259421.992	254327.116	Right	600	65	65	
IP6	9259588.454	254097.675	Left	400	72	72	
IP7	9259788.240	253594.030	Right	400	72	72	
EP	9260214.196	253318.027					

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
0	9,258,851.760	255,938.357	602.748
20	9,258,851.086	255,918.368	602.908
40	9,258,850.412	255,898.380	603.068
60	9,258,849.737	255,878.391	603.228
80	9,258,849.063	255,858.402	603.388
100	9,258,848.389	255,838.414	603.548
120	9,258,847.715	255,818.425	603.708
140	9,258,847.040	255,798.437	603.868
160	9,258,846.366	255,778.448	604.028
180	9,258,845.692	255,758.459	604.188
200	9,258,845.018	255,738.471	604.348
220	9,258,844.344	255,718.482	604.508
240	9,258,843.712	255,698.492	604.668
260	9,258,843.350	255,678.496	604.828
280	9,258,843.536	255,658.498	604.988
300	9,258,844.539	255,638.525	605.148
320	9,258,846.526	255,618.626	605.308
340	9,258,849.505	255,598.851	605.468
360	9,258,853.399	255,579.235	605.628
380	9,258,857.961	255,559.763	605.788
400	9,258,862.921	255,540.388	605.948
420	9,258,868.013	255,521.047	606.108
440	9,258,873.111	255,501.707	606.268
460	9,258,878.208	255,482.368	606.428
480	9,258,883.305	255,463.028	606.588
500	9,258,888.402	255,443.689	606.748
520	9,258,893.500	255,424.349	606.908
540	9,258,898.597	255,405.010	607.073
560	9,258,903.695	255,385.670	607.266
580	9,258,908.863	255,366.350	607.466
600	9,258,914.345	255,347.116	607.666
620	9,258,920.401	255,328.056	607.866
640	9,258,927.278	255,309.278	608.066
660	9,258,935.080	255,290.865	608.266
680	9,258,943.792	255,272.864	608.466
700	9,258,953.393	255,255.322	608.666
720	9,258,963.859	255,238.281	608.866

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
740	9,258,975.164	255,221.785	609.066
760	9,258,987.279	255,205.875	609.266
780	9,259,000.174	255,190.589	609.466
800	9,259,013.811	255,175.962	609.666
820	9,259,028.054	255,161.924	609.866
840	9,259,042.697	255,148.302	610.066
860	9,259,057.543	255,134.900	610.266
880	9,259,072.428	255,121.542	610.466
900	9,259,087.313	255,108.184	610.666
920	9,259,102.138	255,094.759	610.866
940	9,259,116.727	255,081.080	611.066
960	9,259,130.883	255,066.953	611.266
980	9,259,144.399	255,052.214	611.466
1,000	9,259,157.163	255,036.820	611.666
1,020	9,259,169.143	255,020.807	611.866
1,040	9,259,180.307	255,004.215	612.066
1,060	9,259,190.628	254,987.086	612.266
1,080	9,259,200.080	254,969.463	612.466
1,100	9,259,208.639	254,951.390	612.666
1,120	9,259,216.284	254,932.911	612.866
1,140	9,259,222.996	254,914.073	613.066
1,160	9,259,228.759	254,894.923	613.266
1,180	9,259,233.557	254,875.510	613.466
1,200	9,259,237.428	254,855.889	613.666
1,220	9,259,240.593	254,836.142	613.866
1,240	9,259,243.319	254,816.329	614.066
1,260	9,259,245.877	254,796.493	614.266
1,280	9,259,248.426	254,776.656	614.466
1,300	9,259,250.980	254,756.820	614.666
1,320	9,259,253.681	254,737.003	614.866
1,340	9,259,256.796	254,717.248	615.066
1,360	9,259,260.596	254,697.614	615.266
1,380	9,259,265.309	254,678.179	615.466
1,400	9,259,270.988	254,659.005	615.666
1,420	9,259,277.617	254,640.137	615.866
1,440	9,259,285.081	254,621.584	616.066
1,460	9,259,293.129	254,603.275	616.266

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
1,480	9,259,301.503	254,585.113	616.466
1,500	9,259,309.965	254,566.991	616.666
1,520	9,259,318.428	254,548.870	616.866
1,540	9,259,326.891	254,530.749	617.066
1,560	9,259,335.354	254,512.627	617.266
1,580	9,259,343.817	254,494.506	617.466
1,600	9,259,352.280	254,476.385	617.666
1,620	9,259,360.743	254,458.264	617.866
1,640	9,259,369.206	254,440.143	618.066
1,660	9,259,377.669	254,422.021	618.266
1,680	9,259,386.133	254,403.901	618.466
1,700	9,259,394.657	254,385.808	618.666
1,720	9,259,403.415	254,367.828	618.866
1,740	9,259,412.586	254,350.055	619.066
1,760	9,259,422.315	254,332.582	619.266
1,780	9,259,432.621	254,315.443	619.466
1,800	9,259,443.487	254,298.654	619.666
1,820	9,259,454.814	254,282.170	619.866
1,840	9,259,466.429	254,265.889	620.066
1,860	9,259,478.163	254,249.693	620.266
1,880	9,259,489.908	254,233.505	620.418
1,900	9,259,501.653	254,217.317	620.490
1,920	9,259,513.398	254,201.128	620.482
1,940	9,259,525.142	254,184.940	620.394
1,960	9,259,536.887	254,168.752	620.226
1,980	9,259,548.601	254,152.541	620.026
2,000	9,259,560.104	254,136.181	619.826
2,020	9,259,571.165	254,119.519	619.626
2,040	9,259,581.542	254,102.424	619.426
2,060	9,259,591.066	254,084.839	619.226
2,080	9,259,599.734	254,066.817	619.026
2,100	9,259,607.729	254,048.486	618.826
2,120	9,259,615.295	254,029.972	618.626
2,140	9,259,622.683	254,011.387	618.426
2,160	9,259,630.058	253,992.796	618.226
2,180	9,259,637.432	253,974.205	618.026
2,200	9,259,644.807	253,955.614	617.826

Section 3

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
2,220	9,259,652.181	253,937.024	617.626
2,240	9,259,659.556	253,918.433	617.426
2,260	9,259,666.930	253,899.842	617.226
2,280	9,259,674.305	253,881.251	617.026
2,300	9,259,681.680	253,862.661	616.826
2,320	9,259,689.054	253,844.070	616.626
2,340	9,259,696.429	253,825.479	616.426
2,360	9,259,703.803	253,806.888	616.226
2,380	9,259,711.178	253,788.298	616.026
2,400	9,259,718.552	253,769.707	615.826
2,420	9,259,725.927	253,751.116	615.626
2,440	9,259,733.320	253,732.533	615.426
2,460	9,259,740.907	253,714.028	615.226
2,480	9,259,748.943	253,695.714	615.026
2,500	9,259,757.668	253,677.720	614.826
2,520	9,259,767.254	253,660.169	614.628
2,540	9,259,777.705	253,643.119	614.468
2,560	9,259,788.995	253,626.613	614.358
2,580	9,259,801.096	253,610.692	614.298
2,600	9,259,813.978	253,595.396	614.288
2,620	9,259,827.608	253,580.762	614.328
2,640	9,259,841.952	253,566.829	614.418
2,660	9,259,856.975	253,553.629	614.558
2,680	9,259,872.637	253,541.194	614.736
2,700	9,259,888.831	253,529.460	614.916
2,720	9,259,905.380	253,518.230	615.096
2,740	9,259,922.118	253,507.283	615.276
2,760	9,259,938.903	253,496.407	615.456

Section 5

IP	Coorginates of Horizontal		Direction	Radius	Transition Length		Remarks
	Northing	Easting			In	Out	
	(m)	(m)		(m)	(m)	(m)	
BP	9271857.889	240144.665					
IP1	9272160.468	239200.093	Right	800	49	49	
EP	9273038.434	238085.132					

Section 5

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
0	9,271,922.888	239,941.754	694.583
20	9,271,928.990	239,922.708	694.755
40	9,271,935.091	239,903.661	694.953
60	9,271,941.192	239,884.614	695.153
80	9,271,947.294	239,865.568	695.353
100	9,271,953.395	239,846.521	695.553
120	9,271,959.496	239,827.474	695.753
140	9,271,965.597	239,808.428	695.953
160	9,271,971.699	239,789.381	696.153
180	9,271,977.800	239,770.335	696.353
200	9,271,983.901	239,751.288	696.553
220	9,271,990.003	239,732.241	696.753
240	9,271,996.104	239,713.195	696.953
260	9,272,002.205	239,694.148	697.153
280	9,272,008.306	239,675.101	697.353
300	9,272,014.408	239,656.055	697.553
320	9,272,020.509	239,637.008	697.753
340	9,272,026.610	239,617.962	697.953
360	9,272,032.712	239,598.915	698.153
380	9,272,038.813	239,579.868	698.353
400	9,272,044.914	239,560.822	698.553
420	9,272,051.016	239,541.775	698.753
440	9,272,057.117	239,522.728	698.953
460	9,272,063.218	239,503.682	699.153
480	9,272,069.319	239,484.635	699.353
500	9,272,075.421	239,465.588	699.553
520	9,272,081.522	239,446.542	699.753
540	9,272,087.623	239,427.495	699.953
560	9,272,093.725	239,408.449	700.153
580	9,272,099.826	239,389.402	700.353
600	9,272,105.927	239,370.355	700.553
620	9,272,112.033	239,351.310	700.753
640	9,272,118.240	239,332.298	700.953
660	9,272,124.738	239,313.383	701.153
680	9,272,131.680	239,294.627	701.353
700	9,272,139.089	239,276.051	701.553
720	9,272,146.960	239,257.665	701.753

Section 5

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
740	9,272,155.288	239,239.482	701.953
760	9,272,164.068	239,221.513	702.153
780	9,272,173.294	239,203.769	702.353
800	9,272,182.961	239,186.261	702.553
820	9,272,193.062	239,169.000	702.753
840	9,272,203.592	239,151.997	702.953
860	9,272,214.544	239,135.262	703.153
880	9,272,225.911	239,118.807	703.353
900	9,272,237.685	239,102.641	703.553
920	9,272,249.810	239,086.736	703.753
940	9,272,262.134	239,070.984	703.953
960	9,272,274.507	239,055.271	704.153
980	9,272,286.880	239,039.558	704.353
1,000	9,272,299.253	239,023.844	704.553
1,020	9,272,311.627	239,008.131	704.753
1,040	9,272,324.000	238,992.418	704.953
1,060	9,272,336.373	238,976.705	705.153
1,080	9,272,348.746	238,960.992	705.353
1,100	9,272,361.119	238,945.279	705.553
1,120	9,272,373.493	238,929.565	705.751
1,140	9,272,385.866	238,913.852	705.901
1,160	9,272,398.239	238,898.139	705.984
1,180	9,272,410.612	238,882.426	706.001
1,200	9,272,422.985	238,866.713	705.951
1,220	9,272,435.359	238,850.999	705.841
1,240	9,272,447.732	238,835.286	705.721
1,260	9,272,460.105	238,819.573	705.601
1,280	9,272,472.478	238,803.860	705.481
1,300	9,272,484.851	238,788.147	705.361
1,320	9,272,497.225	238,772.434	705.241
1,340	9,272,509.598	238,756.720	705.121
1,360	9,272,521.971	238,741.007	705.001
1,380	9,272,534.344	238,725.294	704.881
1,400	9,272,546.717	238,709.581	704.761
1,420	9,272,559.091	238,693.868	704.641
1,440	9,272,571.464	238,678.154	704.521
1,460	9,272,583.837	238,662.441	704.401

Section 5

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
1,480	9,272,596.210	238,646.728	704.281
1,500	9,272,608.583	238,631.015	704.161
1,520	9,272,620.957	238,615.302	704.041
1,540	9,272,633.330	238,599.589	703.921
1,560	9,272,645.703	238,583.875	703.801
1,580	9,272,658.076	238,568.162	703.681
1,600	9,272,670.449	238,552.449	703.561
1,620	9,272,682.823	238,536.736	703.441
1,640	9,272,695.196	238,521.023	703.321
1,660	9,272,707.569	238,505.310	703.201
1,680	9,272,719.942	238,489.596	703.081
1,700	9,272,732.315	238,473.883	702.961
1,720	9,272,744.689	238,458.170	702.841
1,740	9,272,757.062	238,442.457	702.721
1,760	9,272,769.435	238,426.744	702.601

Section 7

IP	Coorginates of Horizontal		Direction	Radius	Transition Length		Remarks
	Northing	Easting			In	Out	
	(m)	(m)		(m)	(m)	(m)	
BP	9276160.496	233129.785					
IP1	9276004.345	232831.994	Right	400	72	72	
IP2	9275949.391	232479.753	Right	5000	20	20	
IP3	9275858.321	231710.681	Right	400	72	72	
EP	9276419.909	231141.727					

Section 7

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
0	9,276,096.062	233,006.905	732.816
20	9,276,086.774	232,989.192	732.970
40	9,276,077.486	232,971.480	733.156
60	9,276,068.198	232,953.767	733.356
80	9,276,058.911	232,936.054	733.556
100	9,276,049.623	232,918.342	733.756
120	9,276,040.415	232,900.588	733.956
140	9,276,031.515	232,882.677	734.156
160	9,276,023.179	232,864.499	734.356
180	9,276,015.654	232,845.971	734.556
200	9,276,009.062	232,827.091	734.756
220	9,276,003.422	232,807.905	734.956
240	9,275,998.732	232,788.464	735.156
260	9,275,994.831	232,768.849	735.356
280	9,275,991.456	232,749.136	735.556
300	9,275,988.336	232,729.381	735.756
320	9,275,985.253	232,709.620	735.956
340	9,275,982.170	232,689.859	736.156
360	9,275,979.087	232,670.098	736.356
380	9,275,976.004	232,650.337	736.556
400	9,275,972.921	232,630.576	736.756
420	9,275,969.838	232,610.815	736.956
440	9,275,966.755	232,591.054	737.156
460	9,275,963.674	232,571.293	737.356
480	9,275,960.631	232,551.526	737.556
500	9,275,957.665	232,531.747	737.756
520	9,275,954.778	232,511.957	737.956
540	9,275,951.971	232,492.155	738.156
560	9,275,949.242	232,472.342	738.356
580	9,275,946.593	232,452.518	738.556
600	9,275,944.024	232,432.684	738.756
620	9,275,941.533	232,412.839	738.956
640	9,275,939.122	232,392.985	739.156
660	9,275,936.765	232,373.125	739.356
680	9,275,934.413	232,353.264	739.556
700	9,275,932.061	232,333.402	739.756
720	9,275,929.709	232,313.541	739.956

Section 7

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
740	9,275,927.357	232,293.680	740.156
760	9,275,925.005	232,273.819	740.356
780	9,275,922.653	232,253.957	740.556
800	9,275,920.301	232,234.096	740.756
820	9,275,917.950	232,214.235	740.956
840	9,275,915.598	232,194.374	741.156
860	9,275,913.246	232,174.512	741.356
880	9,275,910.894	232,154.651	741.556
900	9,275,908.542	232,134.790	741.756
920	9,275,906.190	232,114.929	741.956
940	9,275,903.838	232,095.067	742.156
960	9,275,901.486	232,075.206	742.356
980	9,275,899.135	232,055.345	742.556
1,000	9,275,896.783	232,035.484	742.726
1,020	9,275,894.431	232,015.623	742.829
1,040	9,275,892.079	231,995.761	742.866
1,060	9,275,889.727	231,975.900	742.836
1,080	9,275,887.375	231,956.039	742.739
1,100	9,275,885.023	231,936.178	742.578
1,120	9,275,882.731	231,916.309	742.398
1,140	9,275,880.738	231,896.409	742.218
1,160	9,275,879.323	231,876.461	742.038
1,180	9,275,878.753	231,856.471	741.858
1,200	9,275,879.176	231,836.477	741.678
1,220	9,275,880.597	231,816.530	741.498
1,240	9,275,883.014	231,796.679	741.318
1,260	9,275,886.420	231,776.973	741.138
1,280	9,275,890.806	231,757.462	740.958
1,300	9,275,896.162	231,738.195	740.778
1,320	9,275,902.475	231,719.219	740.598
1,340	9,275,909.728	231,700.583	740.418
1,360	9,275,917.903	231,682.332	740.238
1,380	9,275,926.980	231,664.513	740.058
1,400	9,275,936.936	231,647.170	739.878
1,420	9,275,947.747	231,630.346	739.698
1,440	9,275,959.385	231,614.083	739.518
1,460	9,275,971.821	231,598.422	739.338

Section 7

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
1,480	9,275,984.970	231,583.354	739.158
1,500	9,275,998.626	231,568.742	738.978
1,520	9,276,012.575	231,554.410	738.798
1,540	9,276,026.621	231,540.173	738.618
1,560	9,276,040.671	231,525.939	738.438
1,580	9,276,054.721	231,511.705	738.258
1,600	9,276,068.770	231,497.471	738.078
1,620	9,276,082.820	231,483.237	737.898
1,640	9,276,096.870	231,469.003	737.718
1,660	9,276,110.920	231,454.769	737.538
1,680	9,276,124.969	231,440.535	737.358
1,700	9,276,139.019	231,426.301	737.178
1,720	9,276,153.069	231,412.067	736.998
1,740	9,276,167.118	231,397.833	736.818
1,760	9,276,181.168	231,383.599	736.638
1,780	9,276,195.218	231,369.365	736.484
1,800	9,276,209.267	231,355.131	736.374
1,820	9,276,223.317	231,340.898	736.308
1,840	9,276,237.367	231,326.664	736.270
1,860	9,276,251.416	231,312.430	736.310

Section 8

IP	Coorginates of Horizontal		Direction	Radius	Transition Length		Remarks
	Northing	Easting			In	Out	
	(m)	(m)		(m)	(m)	(m)	
BP	9276381.721	230810.989					
IP1	9277871.122	228734.544	Left	800	49	49	
IP2	9278372.229	227802.302	Right	800	49	49	
IP3	9278775.737	227420.887	Left	800	49	49	
EP	9279186.056	226757.960					

Section 8

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
0	9,277,826.712	228,796.458	750.225
20	9,277,838.340	228,780.189	750.425
40	9,277,849.803	228,763.800	750.625
60	9,277,860.933	228,747.184	750.825
80	9,277,871.647	228,730.296	751.025
100	9,277,881.936	228,713.146	751.225
120	9,277,891.811	228,695.755	751.425
140	9,277,901.398	228,678.202	751.625
160	9,277,910.875	228,660.590	751.825
180	9,277,920.344	228,642.974	752.025
200	9,277,929.813	228,625.357	752.225
220	9,277,939.282	228,607.741	752.425
240	9,277,948.752	228,590.125	752.625
260	9,277,958.221	228,572.509	752.825
280	9,277,967.690	228,554.892	753.025
300	9,277,977.159	228,537.276	753.225
320	9,277,986.629	228,519.660	753.425
340	9,277,996.098	228,502.043	753.625
360	9,278,005.567	228,484.427	753.825
380	9,278,015.036	228,466.811	754.025
400	9,278,024.506	228,449.195	754.225
420	9,278,033.975	228,431.578	754.425
440	9,278,043.444	228,413.962	754.625
460	9,278,052.913	228,396.346	754.825
480	9,278,062.383	228,378.729	755.025
500	9,278,071.852	228,361.113	755.225
520	9,278,081.321	228,343.497	755.425
540	9,278,090.790	228,325.881	755.625
560	9,278,100.260	228,308.264	755.825
580	9,278,109.729	228,290.648	756.025
600	9,278,119.198	228,273.032	756.225
620	9,278,128.667	228,255.416	756.425
640	9,278,138.137	228,237.799	756.625
660	9,278,147.606	228,220.183	756.825
680	9,278,157.075	228,202.567	757.025
700	9,278,166.544	228,184.950	757.214
720	9,278,176.014	228,167.334	757.371

Section 8

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
740	9,278,185.483	228,149.718	757.494
760	9,278,194.952	228,132.102	757.585
780	9,278,204.422	228,114.485	757.665
800	9,278,213.891	228,096.869	757.745
820	9,278,223.360	228,079.253	757.825
840	9,278,232.829	228,061.637	757.905
860	9,278,242.299	228,044.020	757.985
880	9,278,251.768	228,026.404	758.065
900	9,278,261.237	228,008.788	758.145
920	9,278,270.706	227,991.171	758.225
940	9,278,280.176	227,973.555	758.305
960	9,278,289.645	227,955.939	758.385
980	9,278,299.114	227,938.323	758.465
1,000	9,278,308.610	227,920.721	758.545
1,020	9,278,318.280	227,903.214	758.625
1,040	9,278,328.294	227,885.902	758.705
1,060	9,278,338.735	227,868.844	758.785
1,080	9,278,349.599	227,852.053	758.862
1,100	9,278,360.879	227,835.538	758.912
1,120	9,278,372.569	227,819.311	758.929
1,140	9,278,384.660	227,803.380	758.912
1,160	9,278,397.146	227,787.757	758.862
1,180	9,278,410.019	227,772.451	758.785
1,200	9,278,423.270	227,757.472	758.705
1,220	9,278,436.891	227,742.828	758.625
1,240	9,278,450.875	227,728.530	758.545
1,260	9,278,465.175	227,714.548	758.465
1,280	9,278,479.659	227,700.756	758.385
1,300	9,278,494.192	227,687.016	758.305
1,320	9,278,508.727	227,673.278	758.225
1,340	9,278,523.261	227,659.539	758.145
1,360	9,278,537.796	227,645.801	758.048
1,380	9,278,552.330	227,632.062	757.918
1,400	9,278,566.865	227,618.323	757.761
1,420	9,278,581.399	227,604.585	757.601
1,440	9,278,595.933	227,590.846	757.441
1,460	9,278,610.468	227,577.107	757.281

Section 8

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
1,480	9,278,625.002	227,563.369	757.121
1,500	9,278,639.537	227,549.630	756.961
1,520	9,278,654.071	227,535.891	756.801
1,540	9,278,668.606	227,522.153	756.641
1,560	9,278,683.140	227,508.414	756.481
1,580	9,278,697.646	227,494.645	756.321
1,600	9,278,712.000	227,480.719	756.161
1,620	9,278,726.063	227,466.498	756.001
1,640	9,278,739.767	227,451.932	755.841
1,660	9,278,753.102	227,437.028	755.681
1,680	9,278,766.061	227,421.795	755.527
1,700	9,278,778.635	227,406.242	755.404
1,720	9,278,790.817	227,390.381	755.314
1,740	9,278,802.598	227,374.220	755.257
1,760	9,278,813.971	227,357.769	755.234
1,780	9,278,824.940	227,341.045	755.233
1,800	9,278,835.609	227,324.129	755.233

Section 9

IP	Coorginates of Horizontal		Direction	Radius	Transition Length		Remarks
	Northing	Easting			In	Out	
	(m)	(m)		(m)	(m)	(m)	
BP	9282115.396	220144.542					
IP1	9282360.649	219239.759	Right	1000	0	39	Attached to Existing Line
IP2	9282807.129	218672.061	Left	800	49	49	
IP3	9283213.754	217780.069	Right	400	72	72	
IP4	9283838.920	217705.357	Left	400	72	72	
IP5	9284211.859	217146.142	Left	1500	26	26	
IP6	9284448.099	216712.207	Right	400	72	72	
IP7	9284854.716	216429.925	Left	400	72	72	
IP8	9285054.227	215764.458	Right	800	49	49	
IP9	9285577.379	214910.991	Left	800	49	49	
IP10	9285731.002	214364.744	Right	600	65	65	
IP11	9286694.579	213226.603	Left	1500	26	26	
IP12	9287254.208	212397.860	Left	1500	26	26	
IP13	9287443.486	212038.987	Right	500	72	72	
EP	9289315.013	211076.735					

Section 9

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
0	9,282,474.432	219,095.402	772.208
20	9,282,486.614	219,079.540	772.288
40	9,282,498.950	219,063.798	772.368
60	9,282,511.308	219,048.073	772.463
80	9,282,523.667	219,032.349	772.591
100	9,282,536.026	219,016.624	772.753
120	9,282,548.385	219,000.900	772.946
140	9,282,560.744	218,985.175	773.146
160	9,282,573.103	218,969.451	773.346
180	9,282,585.462	218,953.727	773.546
200	9,282,597.821	218,938.002	773.746
220	9,282,610.180	218,922.278	773.946
240	9,282,622.539	218,906.553	774.146
260	9,282,634.898	218,890.829	774.346
280	9,282,647.257	218,875.105	774.546
300	9,282,659.615	218,859.380	774.746
320	9,282,671.974	218,843.656	774.946
340	9,282,684.333	218,827.931	775.146
360	9,282,696.692	218,812.207	775.346
380	9,282,709.051	218,796.483	775.546
400	9,282,721.410	218,780.758	775.746
420	9,282,733.769	218,765.034	775.946
440	9,282,746.097	218,749.285	776.146
460	9,282,758.256	218,733.405	776.346
480	9,282,770.085	218,717.280	776.546
500	9,282,781.510	218,700.865	776.746
520	9,282,792.521	218,684.169	776.946
540	9,282,803.111	218,667.204	777.146
560	9,282,813.274	218,649.979	777.346
580	9,282,823.003	218,632.505	777.546
600	9,282,832.292	218,614.794	777.746
620	9,282,841.139	218,596.858	777.946
640	9,282,849.634	218,578.752	778.146
660	9,282,857.956	218,560.565	778.346
680	9,282,866.252	218,542.367	778.546
700	9,282,874.548	218,524.169	778.746
720	9,282,882.843	218,505.970	778.946

Section 9

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
740	9,282,891.139	218,487.772	779.146
760	9,282,899.435	218,469.574	779.346
780	9,282,907.731	218,451.375	779.546
800	9,282,916.027	218,433.177	779.746
820	9,282,924.323	218,414.979	779.946
840	9,282,932.619	218,396.781	780.146
860	9,282,940.915	218,378.582	780.346
880	9,282,949.211	218,360.384	780.546
900	9,282,957.507	218,342.186	780.746
920	9,282,965.803	218,323.987	780.946
940	9,282,974.098	218,305.789	781.146
960	9,282,982.394	218,287.591	781.342
980	9,282,990.690	218,269.392	781.485
1,000	9,282,998.986	218,251.194	781.562
1,020	9,283,007.282	218,232.996	781.572
1,040	9,283,015.578	218,214.798	781.534
1,060	9,283,023.874	218,196.599	781.494
1,080	9,283,032.170	218,178.401	781.454
1,100	9,283,040.466	218,160.203	781.414
1,120	9,283,048.762	218,142.004	781.374
1,140	9,283,057.057	218,123.806	781.334
1,160	9,283,065.353	218,105.608	781.294
1,180	9,283,073.649	218,087.409	781.254
1,200	9,283,081.945	218,069.211	781.214
1,220	9,283,090.241	218,051.013	781.174
1,240	9,283,098.537	218,032.815	781.134
1,260	9,283,106.833	218,014.616	781.094
1,280	9,283,115.197	217,996.449	781.054
1,300	9,283,123.857	217,978.422	781.014
1,320	9,283,133.055	217,960.664	780.974
1,340	9,283,143.015	217,943.323	780.934
1,360	9,283,153.825	217,926.498	780.894
1,380	9,283,165.463	217,910.236	780.854
1,400	9,283,177.899	217,894.575	780.814
1,420	9,283,191.102	217,879.555	780.774
1,440	9,283,205.040	217,865.214	780.734
1,460	9,283,219.676	217,851.587	780.694

Section 9

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
1,480	9,283,234.976	217,838.709	780.654
1,500	9,283,250.900	217,826.612	780.614
1,520	9,283,267.408	217,815.326	780.574
1,540	9,283,284.460	217,804.878	780.534
1,560	9,283,302.013	217,795.297	780.508
1,580	9,283,320.023	217,786.604	780.514
1,600	9,283,338.445	217,778.822	780.554
1,620	9,283,357.233	217,771.971	780.628
1,640	9,283,376.339	217,766.068	780.734
1,660	9,283,395.717	217,761.126	780.854
1,680	9,283,415.315	217,757.143	780.974
1,700	9,283,435.058	217,753.953	781.094
1,720	9,283,454.879	217,751.289	781.214
1,740	9,283,474.733	217,748.880	781.334
1,760	9,283,494.592	217,746.507	781.454
1,780	9,283,514.451	217,744.134	781.574
1,800	9,283,534.310	217,741.760	781.694
1,820	9,283,554.168	217,739.387	781.814
1,840	9,283,574.027	217,737.014	781.934
1,860	9,283,593.886	217,734.640	782.054
1,880	9,283,613.744	217,732.267	782.174
1,900	9,283,633.601	217,729.878	782.294
1,920	9,283,653.433	217,727.296	782.414
1,940	9,283,673.199	217,724.247	782.534
1,960	9,283,692.836	217,720.463	782.654
1,980	9,283,712.268	217,715.740	782.763
2,000	9,283,731.440	217,710.051	782.840
2,020	9,283,750.303	217,703.411	782.883
2,040	9,283,768.811	217,695.836	782.893
2,060	9,283,786.917	217,687.346	782.870
2,080	9,283,804.577	217,677.962	782.830
2,100	9,283,821.745	217,667.706	782.790
2,120	9,283,838.379	217,656.606	782.750
2,140	9,283,854.437	217,644.688	782.710
2,160	9,283,869.880	217,631.982	782.670
2,180	9,283,884.669	217,618.521	782.630
2,200	9,283,898.766	217,604.337	782.590

Section 9

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
2,220	9,283,912.137	217,589.466	782.550
2,240	9,283,924.751	217,573.948	782.510
2,260	9,283,936.677	217,557.894	782.470
2,280	9,283,948.111	217,541.486	782.430
2,300	9,283,959.273	217,524.890	782.390
2,320	9,283,970.370	217,508.251	782.350
2,340	9,283,981.466	217,491.612	782.310
2,360	9,283,992.563	217,474.972	782.270
2,380	9,284,003.660	217,458.333	782.230
2,400	9,284,014.756	217,441.694	782.190
2,420	9,284,025.853	217,425.055	782.150
2,440	9,284,036.950	217,408.415	782.110
2,460	9,284,048.046	217,391.776	782.070
2,480	9,284,059.143	217,375.137	782.030
2,500	9,284,070.240	217,358.498	781.990
2,520	9,284,081.336	217,341.859	781.950
2,540	9,284,092.433	217,325.219	781.917
2,560	9,284,103.530	217,308.580	781.915
2,580	9,284,114.626	217,291.941	781.946
2,600	9,284,125.723	217,275.302	781.986
2,620	9,284,136.820	217,258.662	782.026
2,640	9,284,147.916	217,242.023	782.066
2,660	9,284,159.013	217,225.384	782.106
2,680	9,284,170.109	217,208.744	782.146
2,700	9,284,181.150	217,192.068	782.186
2,720	9,284,192.002	217,175.268	782.226
2,740	9,284,202.628	217,158.325	782.266
2,760	9,284,213.027	217,141.241	782.306
2,780	9,284,223.198	217,124.021	782.346
2,800	9,284,233.138	217,106.666	782.386
2,820	9,284,242.851	217,089.183	782.426
2,840	9,284,252.427	217,071.625	782.466
2,860	9,284,261.990	217,054.059	782.506
2,880	9,284,271.553	217,036.494	782.546
2,900	9,284,281.116	217,018.928	782.586
2,920	9,284,290.679	217,001.362	782.626
2,940	9,284,300.242	216,983.797	782.666

Section 9

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
2,960	9,284,309.805	216,966.231	782.706
2,980	9,284,319.368	216,948.666	782.746
3,000	9,284,328.931	216,931.100	782.786
3,020	9,284,338.494	216,913.534	782.826
3,040	9,284,348.057	216,895.969	782.866
3,060	9,284,357.620	216,878.403	782.921
3,080	9,284,367.183	216,860.838	783.009
3,100	9,284,376.746	216,843.272	783.126
3,120	9,284,386.309	216,825.706	783.246
3,140	9,284,395.924	216,808.170	783.366
3,160	9,284,405.805	216,790.781	783.486
3,180	9,284,416.185	216,773.687	783.606
3,200	9,284,427.280	216,757.049	783.726
3,220	9,284,439.187	216,740.983	783.846
3,240	9,284,451.882	216,725.531	783.966
3,260	9,284,465.334	216,710.733	784.086
3,280	9,284,479.508	216,696.626	784.206
3,300	9,284,494.369	216,683.245	784.326
3,320	9,284,509.866	216,670.605	784.446
3,340	9,284,525.846	216,658.579	784.566
3,360	9,284,542.127	216,646.963	784.686
3,380	9,284,558.541	216,635.536	784.806
3,400	9,284,574.970	216,624.131	784.926
3,420	9,284,591.399	216,612.725	785.046
3,440	9,284,607.828	216,601.320	785.166
3,460	9,284,624.257	216,589.914	785.286
3,480	9,284,640.686	216,578.509	785.406
3,500	9,284,657.115	216,567.104	785.526
3,520	9,284,673.545	216,555.698	785.646
3,540	9,284,689.974	216,544.293	785.766
3,560	9,284,706.403	216,532.887	785.886
3,580	9,284,722.819	216,521.464	786.006
3,600	9,284,739.110	216,509.862	786.126
3,620	9,284,755.109	216,497.862	786.246
3,640	9,284,770.635	216,485.257	786.366
3,660	9,284,785.529	216,471.913	786.486
3,680	9,284,799.738	216,457.841	786.606

Section 9

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
3,700	9,284,813.226	216,443.076	786.726
3,720	9,284,825.960	216,427.656	786.846
3,740	9,284,837.906	216,411.619	786.963
3,760	9,284,849.037	216,395.005	787.053
3,780	9,284,859.323	216,377.855	787.110
3,800	9,284,868.739	216,360.213	787.133
3,820	9,284,877.261	216,342.122	787.123
3,840	9,284,884.871	216,323.628	787.086
3,860	9,284,891.648	216,304.812	787.046
3,880	9,284,897.825	216,285.791	787.006
3,900	9,284,903.662	216,266.662	786.966
3,920	9,284,909.407	216,247.505	786.926
3,940	9,284,915.150	216,228.347	786.886
3,960	9,284,920.894	216,209.189	786.846
3,980	9,284,926.637	216,190.032	786.806
4,000	9,284,932.381	216,170.874	786.766
4,020	9,284,938.125	216,151.717	786.726
4,040	9,284,943.868	216,132.559	786.686
4,060	9,284,949.612	216,113.402	786.646
4,080	9,284,955.355	216,094.244	786.606
4,100	9,284,961.099	216,075.087	786.566
4,120	9,284,966.842	216,055.929	786.526
4,140	9,284,972.586	216,036.772	786.486
4,160	9,284,978.329	216,017.614	786.446
4,180	9,284,984.073	215,998.456	786.406
4,200	9,284,989.816	215,979.299	786.374
4,220	9,284,995.560	215,960.141	786.383
4,240	9,285,001.304	215,940.984	786.436
4,260	9,285,007.047	215,921.826	786.534
4,280	9,285,012.791	215,902.669	786.676
4,300	9,285,018.535	215,883.511	786.836
4,320	9,285,024.336	215,864.371	786.996
4,340	9,285,030.374	215,845.305	787.156
4,360	9,285,036.826	215,826.375	787.316
4,380	9,285,043.749	215,807.612	787.476
4,400	9,285,051.139	215,789.027	787.636
4,420	9,285,058.991	215,770.634	787.796

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Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
4,440	9,285,067.301	215,752.442	787.956
4,460	9,285,076.062	215,734.464	788.116
4,480	9,285,085.271	215,716.711	788.276
4,500	9,285,094.920	215,699.193	788.436
4,520	9,285,104.985	215,681.910	788.596
4,540	9,285,115.327	215,664.792	788.756
4,560	9,285,125.774	215,647.737	788.916
4,580	9,285,136.226	215,630.686	789.076
4,600	9,285,146.678	215,613.634	789.236
4,620	9,285,157.130	215,596.583	789.396
4,640	9,285,167.582	215,579.531	789.556
4,660	9,285,178.034	215,562.480	789.716
4,680	9,285,188.486	215,545.428	789.876
4,700	9,285,198.938	215,528.377	790.036
4,720	9,285,209.390	215,511.325	790.196
4,740	9,285,219.843	215,494.274	790.356
4,760	9,285,230.295	215,477.222	790.516
4,780	9,285,240.747	215,460.171	790.676
4,800	9,285,251.199	215,443.120	790.836
4,820	9,285,261.651	215,426.068	790.996
4,840	9,285,272.103	215,409.017	791.156
4,860	9,285,282.555	215,391.965	791.316
4,880	9,285,293.007	215,374.914	791.476
4,900	9,285,303.459	215,357.862	791.636
4,920	9,285,313.911	215,340.811	791.796
4,940	9,285,324.364	215,323.759	791.956
4,960	9,285,334.816	215,306.708	792.116
4,980	9,285,345.268	215,289.656	792.276
5,000	9,285,355.720	215,272.605	792.436
5,020	9,285,366.172	215,255.553	792.596
5,040	9,285,376.624	215,238.502	792.756
5,060	9,285,387.076	215,221.450	792.916
5,080	9,285,397.528	215,204.399	793.076
5,100	9,285,407.980	215,187.347	793.236
5,120	9,285,418.432	215,170.296	793.396
5,140	9,285,428.885	215,153.244	793.556
5,160	9,285,439.337	215,136.193	793.713

Section 9

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
5,180	9,285,449.789	215,119.141	793.820
5,200	9,285,460.241	215,102.090	793.860
5,220	9,285,470.693	215,085.038	793.833
5,240	9,285,481.145	215,067.987	793.740
5,260	9,285,491.597	215,050.935	793.580
5,280	9,285,502.049	215,033.884	793.380
5,300	9,285,512.496	215,016.829	793.180
5,320	9,285,522.841	214,999.712	792.980
5,340	9,285,532.911	214,982.433	792.780
5,360	9,285,542.566	214,964.918	792.580
5,380	9,285,551.780	214,947.168	792.380
5,400	9,285,560.547	214,929.192	792.180
5,420	9,285,568.863	214,911.004	791.980
5,440	9,285,576.721	214,892.613	791.780
5,460	9,285,584.117	214,874.031	791.580
5,480	9,285,591.046	214,855.270	791.380
5,500	9,285,597.504	214,836.342	791.180
5,520	9,285,603.493	214,817.260	790.980
5,540	9,285,609.111	214,798.066	790.780
5,560	9,285,614.550	214,778.819	790.580
5,580	9,285,619.965	214,759.566	790.380
5,600	9,285,625.379	214,740.313	790.180
5,620	9,285,630.794	214,721.060	789.980
5,640	9,285,636.209	214,701.807	789.780
5,660	9,285,641.623	214,682.554	789.580
5,680	9,285,647.038	214,663.301	789.380
5,700	9,285,652.452	214,644.048	789.180
5,720	9,285,657.867	214,624.795	788.980
5,740	9,285,663.282	214,605.542	788.780
5,760	9,285,668.696	214,586.288	788.580
5,780	9,285,674.111	214,567.035	788.380
5,800	9,285,679.526	214,547.782	788.180
5,820	9,285,684.940	214,528.529	787.980
5,840	9,285,690.364	214,509.279	787.780
5,860	9,285,695.917	214,490.065	787.580
5,880	9,285,701.794	214,470.949	787.380
5,900	9,285,708.185	214,451.998	787.180

Section 9

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
5,920	9,285,715.197	214,433.268	786.980
5,940	9,285,722.829	214,414.783	786.805
5,960	9,285,731.073	214,396.562	786.680
5,980	9,285,739.919	214,378.626	786.605
6,000	9,285,749.359	214,360.995	786.580
6,020	9,285,759.380	214,343.688	786.605
6,040	9,285,769.973	214,326.725	786.680
6,060	9,285,781.126	214,310.124	786.805
6,080	9,285,792.825	214,293.904	786.980
6,100	9,285,805.045	214,278.072	787.180
6,120	9,285,817.659	214,262.552	787.380
6,140	9,285,830.504	214,247.222	787.580
6,160	9,285,843.424	214,231.955	787.780
6,180	9,285,856.347	214,216.691	787.980
6,200	9,285,869.270	214,201.427	788.180
6,220	9,285,882.193	214,186.163	788.380
6,240	9,285,895.116	214,170.899	788.580
6,260	9,285,908.039	214,155.634	788.780
6,280	9,285,920.962	214,140.370	788.980
6,300	9,285,933.885	214,125.106	789.180
6,320	9,285,946.808	214,109.842	789.380
6,340	9,285,959.731	214,094.578	789.580
6,360	9,285,972.654	214,079.314	789.780
6,380	9,285,985.577	214,064.049	789.943
6,400	9,285,998.500	214,048.785	790.040
6,420	9,286,011.423	214,033.521	790.070
6,440	9,286,024.346	214,018.257	790.070
6,460	9,286,037.269	214,002.993	790.070
6,480	9,286,050.192	213,987.728	790.070
6,500	9,286,063.115	213,972.464	790.070
6,520	9,286,076.038	213,957.200	790.070
6,540	9,286,088.961	213,941.936	790.070
6,560	9,286,101.884	213,926.672	790.070
6,580	9,286,114.808	213,911.407	790.070
6,600	9,286,127.731	213,896.143	790.070
6,620	9,286,140.654	213,880.879	790.070
6,640	9,286,153.577	213,865.615	790.070

Section 9

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
6,660	9,286,166.500	213,850.351	790.070
6,680	9,286,179.423	213,835.086	790.070
6,700	9,286,192.346	213,819.822	790.070
6,720	9,286,205.269	213,804.558	790.070
6,740	9,286,218.192	213,789.294	790.070
6,760	9,286,231.115	213,774.030	790.070
6,780	9,286,244.038	213,758.766	790.033
6,800	9,286,256.961	213,743.501	789.930
6,820	9,286,269.884	213,728.237	789.760
6,840	9,286,282.807	213,712.973	789.560
6,860	9,286,295.730	213,697.709	789.360
6,880	9,286,308.653	213,682.445	789.160
6,900	9,286,321.576	213,667.180	788.960
6,920	9,286,334.499	213,651.916	788.760
6,940	9,286,347.422	213,636.652	788.560
6,960	9,286,360.345	213,621.388	788.360
6,980	9,286,373.268	213,606.124	788.160
7,000	9,286,386.191	213,590.859	787.960
7,020	9,286,399.114	213,575.595	787.760
7,040	9,286,412.037	213,560.331	787.560
7,060	9,286,424.960	213,545.067	787.360
7,080	9,286,437.883	213,529.803	787.160
7,100	9,286,450.806	213,514.538	786.976
7,120	9,286,463.729	213,499.274	786.836
7,140	9,286,476.652	213,484.010	786.741
7,160	9,286,489.575	213,468.746	786.689
7,180	9,286,502.498	213,453.482	786.680
7,200	9,286,515.421	213,438.218	786.680
7,220	9,286,528.344	213,422.953	786.680
7,240	9,286,541.267	213,407.689	786.680
7,260	9,286,554.190	213,392.425	786.680
7,280	9,286,567.113	213,377.161	786.680
7,300	9,286,580.036	213,361.897	786.680
7,320	9,286,592.959	213,346.632	786.680
7,340	9,286,605.882	213,331.368	786.680
7,360	9,286,618.805	213,316.104	786.680
7,380	9,286,631.728	213,300.840	786.680

Section 9

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
7,400	9,286,644.635	213,285.561	786.680
7,420	9,286,657.410	213,270.173	786.680
7,440	9,286,669.981	213,254.618	786.680
7,460	9,286,682.343	213,238.897	786.680
7,480	9,286,694.495	213,223.012	786.680
7,500	9,286,706.434	213,206.967	786.680
7,520	9,286,718.158	213,190.763	786.680
7,540	9,286,729.665	213,174.405	786.680
7,560	9,286,740.963	213,157.902	786.680
7,580	9,286,752.161	213,141.331	786.680
7,600	9,286,763.354	213,124.756	786.680
7,620	9,286,774.546	213,108.181	786.680
7,640	9,286,785.739	213,091.607	786.680
7,660	9,286,796.931	213,075.032	786.680
7,680	9,286,808.124	213,058.457	786.680
7,700	9,286,819.316	213,041.882	786.680
7,720	9,286,830.509	213,025.307	786.680
7,740	9,286,841.702	213,008.732	786.680
7,760	9,286,852.894	212,992.157	786.680
7,780	9,286,864.087	212,975.583	786.680
7,800	9,286,875.279	212,959.008	786.680
7,820	9,286,886.472	212,942.433	786.680
7,840	9,286,897.665	212,925.858	786.680
7,860	9,286,908.857	212,909.283	786.680
7,880	9,286,920.050	212,892.708	786.680
7,900	9,286,931.242	212,876.133	786.680
7,920	9,286,942.435	212,859.558	786.680
7,940	9,286,953.627	212,842.984	786.680
7,960	9,286,964.820	212,826.409	786.680
7,980	9,286,976.013	212,809.834	786.680
8,000	9,286,987.205	212,793.259	786.680
8,020	9,286,998.398	212,776.684	786.680
8,040	9,287,009.590	212,760.109	786.680
8,060	9,287,020.783	212,743.534	786.680
8,080	9,287,031.976	212,726.960	786.680
8,100	9,287,043.168	212,710.385	786.680
8,120	9,287,054.361	212,693.810	786.680

Section 9

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
8,140	9,287,065.553	212,677.235	786.680
8,160	9,287,076.746	212,660.660	786.680
8,180	9,287,087.938	212,644.085	786.680
8,200	9,287,099.131	212,627.510	786.680
8,220	9,287,110.324	212,610.936	786.680
8,240	9,287,121.516	212,594.361	786.680
8,260	9,287,132.709	212,577.786	786.680
8,280	9,287,143.901	212,561.211	786.680
8,300	9,287,155.094	212,544.636	786.680
8,320	9,287,166.287	212,528.061	786.680
8,340	9,287,177.479	212,511.486	786.680
8,360	9,287,188.672	212,494.911	786.680
8,380	9,287,199.864	212,478.337	786.680
8,400	9,287,211.038	212,461.749	786.680
8,420	9,287,222.069	212,445.066	786.680
8,440	9,287,232.878	212,428.239	786.677
8,460	9,287,243.462	212,411.269	786.645
8,480	9,287,253.818	212,394.160	786.580
8,500	9,287,263.946	212,376.914	786.482
8,520	9,287,273.843	212,359.534	786.350
8,540	9,287,283.507	212,342.024	786.192
8,560	9,287,292.949	212,324.393	786.032
8,580	9,287,302.285	212,306.706	785.872
8,600	9,287,311.615	212,289.016	785.712
8,620	9,287,320.945	212,271.325	785.552
8,640	9,287,330.276	212,253.635	785.392
8,660	9,287,339.606	212,235.945	785.232
8,680	9,287,348.936	212,218.255	785.072
8,700	9,287,358.272	212,200.567	784.912
8,720	9,287,367.720	212,182.940	784.752
8,740	9,287,377.471	212,165.478	784.592
8,760	9,287,387.712	212,148.300	784.432
8,780	9,287,398.594	212,131.522	784.272
8,800	9,287,410.139	212,115.192	784.113
8,820	9,287,422.327	212,099.336	783.976
8,840	9,287,435.140	212,083.981	783.873
8,860	9,287,448.557	212,069.151	783.803

Section 9

Chainage	Coordinates of Horizontal		Rail Level
(m)	Northing (m)	Easting (m)	(m)
8,880	9,287,462.555	212,054.869	783.766
8,900	9,287,477.114	212,041.158	783.760
8,920	9,287,492.210	212,028.040	783.760
8,940	9,287,507.818	212,015.537	783.760
8,960	9,287,523.913	212,003.667	783.760
8,980	9,287,540.470	211,992.451	783.760
9,000	9,287,557.462	211,981.905	783.760
9,020	9,287,574.824	211,971.978	783.760
9,040	9,287,592.435	211,962.500	783.760
9,060	9,287,610.183	211,953.280	783.760

APPENDIX Z

Geotechnical Investigation

Geotechnical Investigation Works on the Preparatory Survey on Flood Protection Measures for Central Railway Line in the United Republic of Tanzania

Kilosa – Gulwe Section

Ground Investigation Report

May 2015

C.Labs(Tz)
Draw, Build, Test

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REPORT TITLE:

Geotechnical Investigation for the Preparatory Survey on Flood Protection Measures for the Central Railway Line between Kilosa and Gulwe

Report No:	**PROJECT LOCATION:**	**DATE:**
CL-S083/S0820	Kilosa – Gulwe Section of Centraql Railway	18th May 2015
CLIENT: PADECO COMPANY LTD. (JICA study team)		**AUTHOR:** Jotham Ntensibe Yustino Kwingwa Victor Salema

Background:

In February 2015, PADECO Company Limited of 6-17-19 Shinbashi, Minato-ku, Tokyo, 105-0004, JAPAN requested C-Labs to carry out a Geotechnical Investigation for the Preparatory Survey on Flood Protection Measures for the Central Railway Line between Kilosa and Gulwe in the United Republic of Tanzania. The Investigation was a component of a JICA study team.

This report contains the findings of the geotechnical investigation.

This report is presented as a purely factual report of the tests results as required by the terms of reference.

SECTION	
●Geotechnical Soils Bitumen Asphalt Chemistry Cement Concrete	

List of Symbols

MSL	Mean Sea Level
SPT	Standard Penetration Test – with a 63.5kg hammer
N, N_{60}	SPT value, corrected SPT value
USCS	Unified Soil classification system
BSCS	British soil classification system
LL, PL, PI	Liquid Limit, Plastic Limit, Plasticity Index
NMC, w	Natural Moisture Content, moisture content
SG, G	Specific Gravity
U4 / U100	Undisturbed sample – 4 inches / 100mm diameter
DS	Disturbed Sample
GWT	Ground Water Table
γ, γ_w	Unit weight of soil (gamma), Unit weight of water
c	Soil cohesion. Units of pressure, kPa
s_u	Undrained shear strength. Units of pressure, kPa
ϕ	Angle of friction (phi)
α	Adhesion Factor
Ks	Coefficient of Earth Pressure
k	permeability
OCR	Over consolidation ratio
m_v	Coefficient of volume compressibility
Es	Elasticity Modulus
μ	Poisson's Ratio
e, e_0	Void Ratio, Initial void ratio
c_r	Compression / Compressibility index
c_s	Recompression index
s_e	settlement
S	Degree of saturation
σ, p	Overburden pressure, soil pressure
u	Pore pressure

CONTENTS

1.0 TERMS OF REFERENCE

In summary, the investigation was tasked to carry out the following.

1) Drilling Site: 10 sites between Kilosa and Igandu along the Central Corridor Railway

2) Core Drilling including Standard Penetration Test (SPT) including sampling and Laboratory Tests, to a depth of 30m or to a depth where 5.0 meter thickness of more than 50 N values of STP can be confirmed

SPT's were envisaged in all the boreholes and samples for laboratory tests were envisaged for boreholes 3, 6 and 10 as shown in the following table – based on expected soil / rock profile indicated.

Depth	Ground formations	Drilling site No.1, 2, 4, 5, 7, 8, 9		Drilling site No.3, 6, 10		
		STP	Sampling	STP	Sampling	Rock tests
0m	Cohesive soil (clay, semi clay, sandy clay)	o		o		
2m		o		o	o	
4m		o		o	o	
6m		o		o	o	
8m	Non-Cohesive soil (sand, pebbles)	o		o	o	
10m		o		o	o	
12m		o		o	o	
14m		o		o	o	
16m	Weathered rock of less than 50 N values	o		o		
18m		o		o		
20m		o		o		
22m		o		o		
24m		o		o		
26m	Weathered and/or un-weathered rock of more than 50 N values	o		o		o
28m		o		o		
30m		o		o		

On exploration, it was found that the depth of rock was quite different. The depth to rock was found to be as follows:

Table 2: Depth of soil, weathered rock and intact rock investigated in each borehole

	Depth of Soil - to Weathered Rock	Depth of Weathered Rock	Depth of intact Rock
BH 1	0 - 30m	--	--
BH 2	0 - 30m	--	--
BH 3	0 – 1m	1.0 – 14.0m	14.0 – 26.2m
BH 4	0 – 3m	3.0 – 13.5m	13.5 – 22.4m
BH 5	0 – 13.5m	13.5 – 21.0m	21.0 – 26.7m
BH 6	0 – 2.0m	2.0 – 17.0m	17.0 – 22.0m
BH 7	0 – 11.0m	12.0 – 13.0m	13.0 – 18.0m
BH 8	0 – 15.7m	15.7 – 20.0m	20.0 – 26.8m
BH 9	0 – 9.5m	9.5 – 28.0m	28.0 – 33.0m
BH 10	0 – 12.0m	12.0 – 23.7m	23.7 – 30.8m

Boreholes 3 and 6 had a very shallow soil profile. The highlighted boreholes had at least 5m of soil before encountering rock. No rock was encountered in boreholes 1 and 2. U4 Soil samples were taken at about 2m intervals in each borehole and visual and strength assessment made of the rock in each borehole. Considerably more was done than was required in the ToR so as to present a better understanding of the soil and rock types along the investigated route.

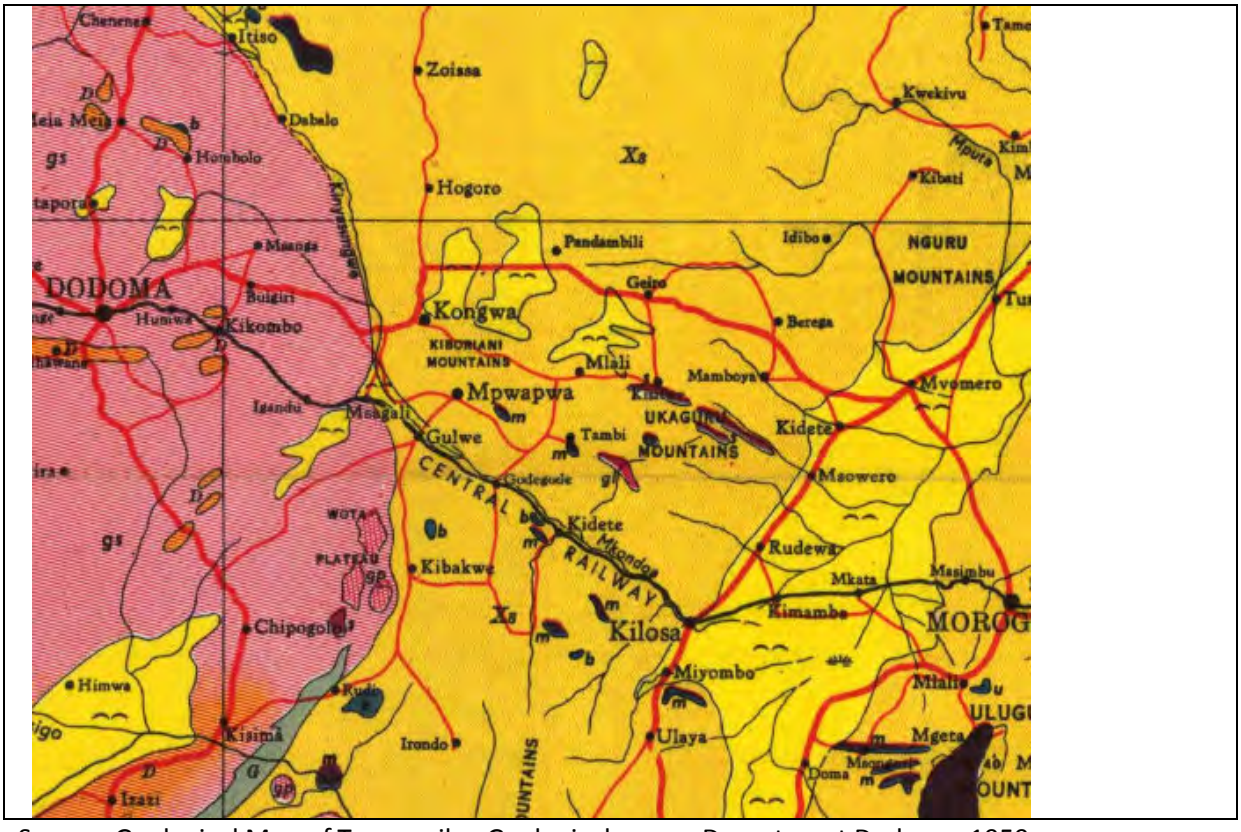
2.0 SITE LOCATION

The Central Railway Line between Kilosa and Gulwe runs in the valley of the NW-SW flowing river Mkondoa along which the altitude falls from about 790m in Gulwe to 520m in Kilosa. The river collects from the mountains including Ukaguru, Kiboriani, Ulugaro mountains at the western fringes of the Wami/Ruvu catchment. Many rock outcrops are found on the Kilosa end of the project and past Gode Gode towards Gulwe. The hydraulics of the tributaries from the surrouinding mountains have caused disruptions on the operation of the existing central railway line. The railway runs general south of the river.

Figure 1: Topography of the Project area

3.0 GEOLOGY

The two maps below illustrate the general geology of the project route.



Source: Geological Map of Tanganyika, Geological survey Department Dodoma, 1959

Figure 2a. Typical Geology between Kilosa and Gulwe

Xs = Usagaran Archean formations. Marble; Quartzite; Graphite Schist;, Chlorite, Amphiboles, Mica and Kyanite Schist; Hornblende, Biotite and garnet gneiss; acid gneiss; granulite; charnockite.

m= metagabbros (Archean)

b= un-metamorphorsed gabbroic and anorthositic rocks, as well as more or less metamorphosed peridotite, pyroxenite, and serpentine (mainly Pre-Cambrian)

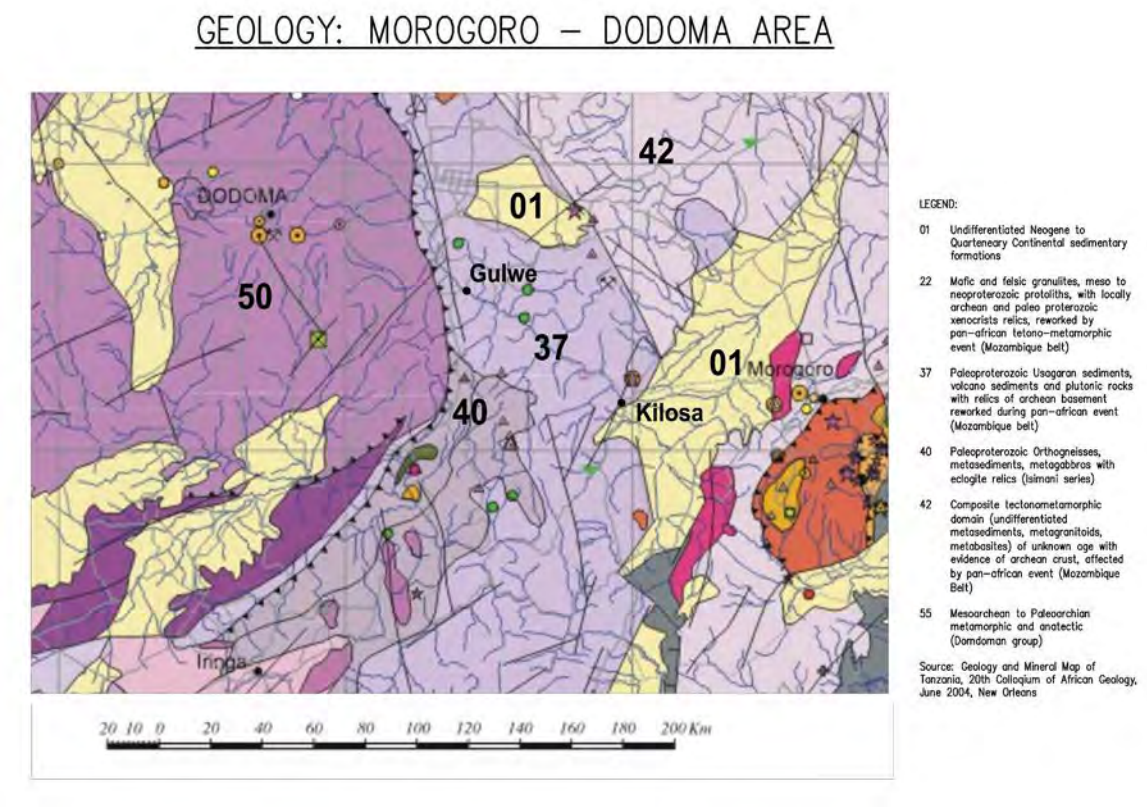


Figure 2b. Typical Geology between Kilosa and Gulwe.

3.1 Key geological formations.

Metapsammitic granulites of the Usagara Archean formations.

The Archean rocks in Central Tanzania (2.5 – 4 billion years old) consist of belts of greenstone (volcano-sedimentary) sequences, found within a larger region of predominantly younger granitic rocks.

But in the Usagaran formations found in Central and Eastern Tanzania including the project area, a later Pan African tectonic-thermal Pretorozoic event occurred (0.5 to 2.5 billiom years), and a variety of high grade metamorphic rocks of both sedimentary and igneous origin were formed from the Archean . Amphibolite grade metamorphic assemblages predominate related to the granitization amd migmatization of the event, the same that effected the Mozambican Belt[1]. The structural trends are mostly North to South.

[1] A brief Introduction to the Geology and Mining Inductry of Tanzania, SIKA Resources Inc, Oct 2011 Toronto Ontario

4.0 INVESTIGATION METHODOLOGY:

4.1 Location of the boreholes:

The location of the boreholes was selected by the client. A total of ten boreholes were drilled close to bridge locations, on the side opposite to the river. The GPS locations and a map of the physical locations is found in Table 1 and figure 3 below . The boreholes are numbered from Kilosa to Gulwe. BH10 is at the highest altitude on the Gulwe end. BH1 is at the lowest altitude on the Kilosa end.

Table 1: Location of the Boreholes

Label	Easting*	Northing	Distance from previous point, km**	Height with respect to Railway	Approximate Elevation***
BH01	268587.5	9254399.7	0	-0.762	534.2
BH02	263190.7	9254193.7	5.40	-0.492	557.0
BH03	256366.8	9259116.3	8.41	-0.660	604.7
BH04	253383.1	9260250.5	3.19	-1.295	618.4
BH05	242421.1	9268380.1	13.64	-1.875	675.2
BH06	239638.8	9272439.0	4.92	+0.150	697.0
BH07	232655.0	9276368.3	8.01	-1.143	733.8
BH08	222325.4	9282245.6	11.88	-0.425	769.1
BH09	217353.6	9284422.9	5.42	-0.762	778.8
BH10	213838.6	9286420.2	4.04	-0.462	785.0

*UTM Arc 1960 Zone 37

**straight line distances. Not measured along rail.

***elevations provided by client

Figure 3: Locations of the boreholes

4.2 Boring Methods

The primary method used was rotary drilling using 120mm and 150mm bits and bentonite fluid. Before SPT and sampling, the boreholes were cleaned and sufficient length of sample was taken to ensure an uncontaminated undisturbed sample was obtained in each U100 sampler. The SPT's were carried out immediately after sampling in clean boreholes.

Boreholes 1 and 2 had no rock formations. They were investigated to 30m depth. All the other holes had rocks at various depths as illustrated in Table 2 above. These boreholes were drilled through hard weathered rock with SPT > 50 but with poor rock recovery, and into intact rock with good rock recovery for at a depth of at least 5m. Intact rock was found between 13 and 28m deep. Single HQ (61mm nominal diameter cores) and NQ (47mm nominal diameter cores) core barrels were used. The latter was used after about 2m of drilling in hard intact rock.

4.3 Sampling:

The following samples were taken as boring progressed:

- 100mm dia undisturbed soil samples were taken every 2m in boreholes 1 and 10 wherever possible. Undisturbed soil samples were taken every 4m in all other boreholes. Sampling was only required @2m to a depth of 15m in Boreholes 3, 6 and 10 in the terms of reference. However it was found that boreholes 3 and 6 had very shallow soil profiles less than 2m deep. The soil samples were spread out over boreholes 2,5, 7 and 9.
- Disturbed samples were taken from the SPT sampler but they were mostly used for visual classification on site rather than Laboratory tests.

- Continuous samples of the rock were taken for visual descriptions and strength testing. The recovery in highly weathered rock was generally poor – as expected.

4.4 In-situ Tests

SPT sounding was carried out every 2m in each borehole to refusal (taken as N > 50blows). Thereafter drilling continued without SPT's .

4.5 Laboratory Tests Carried Out

Laboratory tests on the undisturbed soil samples have been carried out as follows.

Table 2: Laboratory Tests carried out on soil samples

On the Undisturbed Samples	• Particle Size Analysis on all samples, including hydrometer method on selected samples	BS 1377 Part2: 1990
	• Atterberg's limits on all samples	BS 1377 Part2: 1990
	• Bulk Density on all samples	BS 1377 Part2: 1990
	• Natural Moisture Content	BS 1377 Part2: 1990
	• Determination of undrained shear strength Su on clay samples, UU tests	BS 1377 Part7: 1990
	• Direct shear on predominantly sandy samples	BS 1377 Part7: 1990
	• One dimensional Consolidation Properties on clay samples	BS 1377 Part5: 1990
On disturbed SPT Samples	No Lab tests. Only a visual assessment.	

Classification testing (grading and plasticity) was carried out on undisturbed samples so as to show progression of the classification of soil with depth in each borehole.

The Sandy Clay soils were tested using the direct shear apparatus to obtain angle of friction ϕ'. The cohesive soils were tested for Total stress (UU) to determine the undrained cohesive strength s_u of the soil.

A number of additional soil properties have been obtained from the test results including estimates of Elastic modulus, Coefficient of volume compressibility, the compression and unloading /recompression indices and the over-consolidation ratio. These can be found in the summarized test results in **Appendix A** and the detailed test results in the following appendices.

6 samples of ground water were tested for pH, Chloride content and Sulphate content.

A visual assessment of the Rock cores was carried out to determine Rock Quality designation index and in addition, the bulk density, porosity and UCS strength and point load index were determined at about 1 – 2m interval depths for each borehole. Tests were carried out in accordance with the recommendations of the International Society of Rock Mechanics ISRM.

5.0 SOIL TEST RESULTS

5.1 Soil summaries

A summary of the findings in each borehole can be found on the borehole logs in **Appendix B**. The logs contain:

- Field Soil descriptions,
- SPT results,
- A summary of the Classification Results,

5.2 Detailed Results

A summary of the laboratory tests on each sample can be found in **Appendix B**. Detailed results of the testing can be found in **Appendix C to E**. The results for each borehole include
:

- Results of the Particle size analysis including hydrometer tests results
- Results of the Atterberg's limits test including Linear Shrinkage
- Results of the Shear tests including Direct shear, Unconsolidated Undrained Triaxial Tests (UU).
- The Consolidation test results. One dimensional consolidation tests were only carried out on undisturbed cohesive samples.

In the summaries, the soil has been classified to the British Soil Classification System (BSCS) found in BS 5930 – *Code of practice for site investigations*, but also to the Unified Soil Classification System (USCS). The former has clearer **descriptions** of the plasticity of the clays and silts and in our experience, correlates more closely to the field descriptions. But the USCS classification is more widely used for **analysis** and has appropriately been used in this report

Boreholes 2, 3, 4, 7 and 10 have predominantly granular material consisting of clayey sands, clayey gravels and sand. Borehole 8 has low plasticity fines and clays and Borehole 5 has potentially expansive clays and silts of high plasticity.

6.0 OBSERVATIONS AND TEST RESULTS ON THE ROCK CORES:

6.1 Lithology:

Field descriptions of the Lithology can be found in Appendix A3 to A10. The descriptions include pictures of the rock cores and an estimation of the Rock Quality Designation.

- No rock was encountered in Boreholes 1 and 2 up to 30m drill depth
- Boreholes 3 and 4 consists predominantly of metamorphosed sandstone.
- Boreholes 5 to 10 consist of complex gneiss formations from both sedimentary and igneous protoliths.

6.2 Lab Tests on Rocks

Tests on the rocks included UCS and Point Load Index tests for strength, Bulk density, moisture and porosity. These results can be found in **Appendix F** and **Appendix G.**

The density of the rocks varies from 2.4 to 3.0. The least porous rocks (<0.7) are found in the lower portions of Boreholes 3 (below 14m) and borehole 4 (below 13.5m) and at various levels in borehole 10. The strongest rocks are also found in these three boreholes with average UCS values greater than 55MPa. Borehole 4 however had weak rock at its bottom.

.Relatively porous rocks (>1.5) were found in Boreholes 8, and on the upper portions of boreholes 5 (above 25m) and Borehole 1 (above 14m). The weakest rock is found in Borehole 5 with a UCS average less than 25MPa.

These figures highlight the large variation and observed complexity of the rock formation,

7.0 CHEMICAL TESTS ON WATER

The table below has a summary of the chemical tests on water collected from the boreholes. No ground water was encountered in Boreholes 3, 4 and 10.

Table 3 : Results of Chemical Tests on Ground Water

	pH	Chloride content Cl^- , mg/l	Sulphate Content SO_4^- , mg/l
BH1	7.62	92.2	311.7
BH2	7.56	74.4	365.9
BH 3	-	-	-
BH 4	-	-	-
BH5	7.26	42.5	280.0
BH6	7.72	85.1	209.7
BH7	7.73	88.6	219.5
BH8	7.71	95.7	286.9
BH9	7.53	85.1	382.7
BH 10	-	-	-

It can be seen that the sulphate content in the water is quite high. Detailed test result sheets can be found in **Appendix H**

END

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LIST OF APPENDICES

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PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH01 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH01 **PROJECT NO:** S0820
BORE DATE: 06-09/Apr/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9 254 399.7 **SURFACE ELEVATION:** 532
EASTING: 268 587.5 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
532	0.0				(0.0 to 0.5) Organic soil			
531	1.0	U4	GC G.S.F = 42.36.22 PI = 14		(0.5 to 4.0) Riverine SAND	3,5,5	0 50	
530	2.0							
529	3.0	U4	SW G.S.F = 30.68.03 PI = NP			3,4,6		
528	4.0				(4.0 to 9.9) Black Cotton CLAY			
527	5.0	U4	SC G.S.F = 40.18.43 PI = 40			7,7,8	0 50	
526	6.0							
525	7.0	U4	MH G.S.F = 00.00.100 PI = 25			9,18,14		Drilling stopped at 7.0m. Resumed 7/04
524	8.0							
523	9.0	U4	CL G.S.F = 18.18.64 PI = 26			5,6,8		
522	10.0				(9.9 to 13.0) Brown Silty SAND + layers of CLAY			
521	11.0	U4	SC G.S.F = 05.69.26 PI = 13			10,19,16	0 50	Drilling stopped at 11.5m. Resumed 8/04
520	12.0							
519	13.0				(13.0 to 23.0) Dark brown Silty CLAY			
518	14.0					10,11,10		
517	15.0	U4	SC G.S.F = 07.58.35 PI = 14					

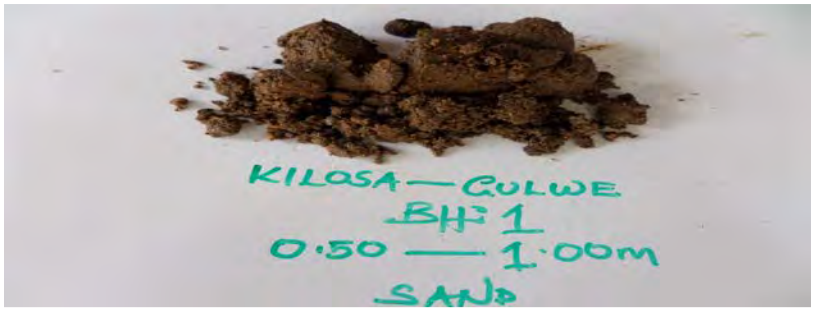
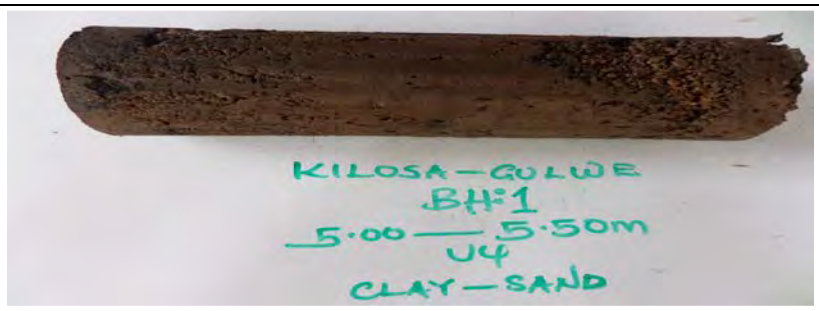
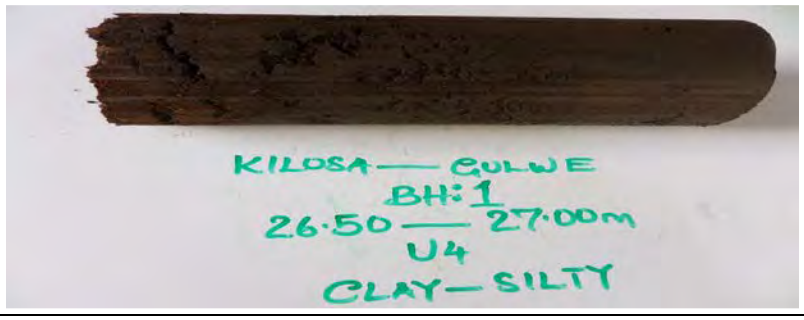
C.Labs(Tz)
Draw, Build, Test

PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH01 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH01 **PROJECT NO:** S0820
BORE DATE: 06-09/Apr/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9 254 399.7 **SURFACE ELEVATION:** 532
EASTING: 268 587.5 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
516	16.0					5,16,21	0 50	
515	17.0					7,9,13		
514	18.0							
513	19.0	U4	SC G.S.F = 10.53.37 PI = 18			10,8,10		Drilling stopped at 18.5m Resumed 9/04
512	20.0							
511	21.0					8,16,20	0 50	
510	22.0							
509	23.0	U4	SC G.S.F = 06.54.40 PI = 24		(23.0 to 29.5) Brown Silty CLAY	8,12,15		
508	24.0							
507	25.0					18,17,12		
506	26.0						0 50	
505	27.0	U4	CL G.S.F = 02.48.50 PI = 23			13,16,19		No Sample recovered in SPT
504	28.0							
503	29.0					17,19,24		

PHOTOS BH1

0.00m-3.50m	
3.50m-9.50m	
9.95m-13.00m	
13.00m-23.00m	
23.00m-29.45m	

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PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH02 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH02 **PROJECT NO:** S0820
BORE DATE: 06-08Apr/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9254 193.7 **SURFACE ELEVATION:** 554
EASTING: 263 190.6 **CHECKED BY:** J.N

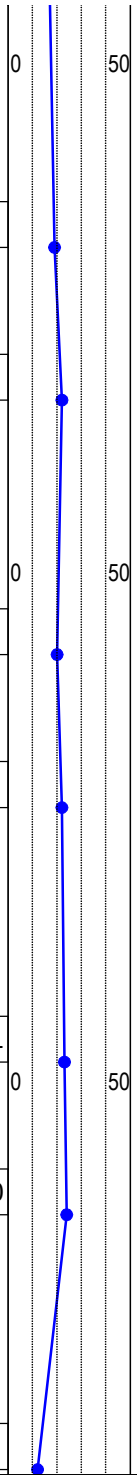
ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
554	0.0				(0.0 to 29.0) Brown Silty SAND			
553	1.0	U4	SW-SM G.S.F = 52.39.09 PI = NP			3,2,1	0 50	
552	2.0							
551	3.0					6,5,6		
550	4.0							
549	5.0	U4	SW-SM G.S.F = 42.51.07 PI = NP			7,7,10	0 50	
548	6.0							
547	7.0					10,13,15		
546	8.0							
545	9.0	U4	CL G.S.F = 20.21.59 PI = 25			5,5,7		Drilling stopped at 9.0m. Resumed 07/04
544	10.0							
543	11.0					8,11,11	0 50	
542	12.0							
541	13.0							
540	14.0					6,7,6		
539	15.0					9,9,8		

C.Labs(Tz)
Draw, Build, Test

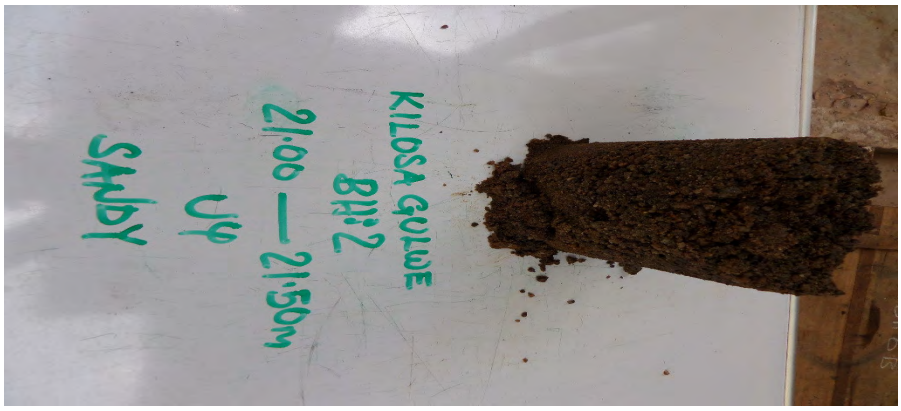
PROJECT: Kilosa-Gulwe Central Railway. JICA Study
LOCATION: BH02 **CLIENT:** PADECO Co. Ltd

DRILLING METHOD: Rotary Drilling
B/HOLE NO: BH02 **PROJECT NO:** S0820
BORE DATE: 06-08Apr/15 **FIELD SUPERVISOR:** V.S
NORTHING: 9254 193.7 **SURFACE ELEVATION:** 554
EASTING: 263 190.6 **CHECKED BY:** J.N

ELEV. (M.)	DRILL DEPTH	SAMPLE TYPE AND NO.	USCS	PROFILE	DESCRIPTION	SPT BLOWS	SPT PLOT	REMARKS
538	16.0							
537	17.0	U4	SW G.S.F = 73.24.03 PI = NP			7,9,10		
536	18.0							
535	19.0					9,12,10		Drilling stopped at 19.5m. Resumed 8/04
534	20.0							
533	21.0	U4	SW-SM G.S.F = 22.72.07 PI = NP					
532	22.0					8,8,12		
531	23.0					8,7,15		
530	24.0							
529	25.0	U4	SW-SM G.S.F = 30.61.09 PI = NP					
528	26.0					11,12,11		
527	27.0					12,14,10		
526	28.0							
525	29.0				(29.0 to 30.0) Grey SAND			
524	30.0					6,4,8		



PHOTOS BH2

0.00m	
	
	
	

PHOTOS BH2

29.95m