NILE BASIN INITIATIVE
NILE EQUATORIAL LAKES SUBSIDIARY ACTION PROGRAMME
(NELSAP)

STUDY ON THE INTERCONNECTION OF THE ELECTRICITY NETWORKS OF THE NILE EQUATORIAL LAKES COUNTRIES

FEASIBILITY REPORT
VOLUME 2 C – UGANDA-KENYA INTERCONNECTION
LINE ROUTE AND GEOTECHNICAL INVESTIGATIONS

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SOGREAH CONSULTANTS
RSW INTERNATIONAL inc.
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LIST OF ABBREVIATIONS

AFSEC	African Electrotechnical Standardization Commission / Commission Electrotechnique Africaine de Normalisation
BAD	Banque Africaine de Développement
PEAC	Central Africa Power Pool / Pool énergétique de l'Afrique Centrale
CEEAC	Communauté Economique des Etats de l'Afrique Centrale (ECCAS)
CEPGL	Communauté Economique des Pays des Grands Lacs
DEM	Digital Elevation Model
DRC / RDC	Democratic Republic of Congo / République Démocratique du Congo
EAPP	East African Power Pool / Pool énergétique de l'Afrique de l'Est
EGL	Energie des pays des Grands Lacs (Burundi, RDC, Rwanda)
EDF / FED	European Development Fund / Fond Européen de Développement
ERA	Electricity Regulatory Authority (Uganda)
KenGen	Kenya Electricity Generating Company Ltd
KPLC	The Kenya Power and Lighting Co. Ltd
MEM	Ministère de l'Energie et des Mines / Ministry of Energy and Mining
MoI	Ministry of Infrastructures / Ministère des Infrastructures
MNT	Modèle numérique de terrain
NBI / IBN	Nile Basin Initiative / Initiative du Bassin du Nil
NEL	Nile Equatorial Lakes
NEL-CU	Coordination unit for NELSAP
NELSAP	Nile Equatorial Lakes Subsidiary Action Programme
PAALEN	Programme Auxiliaire d'Action des pays des Lacs Equatoriaux du Nil
PPA	Power Purchase Agreement / Contrat d'achat d'énergie
PREBU	Programme de réhabilitation du Burundi
SADC	Southern Africa Development Community / Communauté pour le développement de l'Afrique Australe
SAPP	Southern Africa Power Pool / Pool énergétique de l'Afrique Australe
SINELAC	Société internationale d'électricité des pays des grands lacs
SNEL	Société National d'Electricité (RDC)
SRTM	Shuttle Radar Topography Mission
UEGCL	Uganda Electricity Generation Company Ltd
UETCL	Uganda Electricity Transmission Company Ltd
UPDEA	Union des Producteurs, Transporteurs et Distributeurs d'Energie Electrique d'Afrique / Union of Producers, Transporters and Distributors of Electric Power in Africa
USAID	Agence pour le Développement International des Etats Unis
WAPP	West Africa Power Pool

1.
LINE ROUTE SURVEY

1.1. GENERAL

A line route survey was conducted by sub-consultants at the Uganda – Kenya interconnection section.

The interconnection transmission line route of Uganda – Kenya has been planned by KPLC and UETCL to follow parallel the existing Owen Falls – Tororo – Lessos 132 kV transmission line.

1.2. SCOPE OF WORK FOR LINE ROUTE SURVEY AND SOIL INVESTIGATIONS

1. Introduction

The survey and soil investigation works will be carried out on the line route the Uganda – Kenya interconnection transmission line at Kenya. The proposed line route follows the existing Lessos – Tororo – Jinja 132 kV line.

The length of the proposed line is approximately 132 km in Kenya and 127 km in Uganda.

2. Survey

The purpose for this survey work in the feasibility study phase is to get mapped all the features along the proposed line route. Furthermore, the results of the survey will provide coordinates (UTM coordinate system) of all the features. The survey shall be carried out by means of GPS equipment.

The features to be surveyed and mapped shall include, but not being limited to:

- All kind of buildings (permanent and temporary);
- Overhead lines and cables (electric and telecommunication) crossings;
- Underground cables crossings;
- Pipelines crossings;
- Roads (paved or unpaved, including tracks and paths) crossings;
- Railways crossings;
- Walls;
- Fences;
- Tanks;
- Other firm obstacles, which differ from the general shape of the ground;
- Rivers, brooks, etc. crossings;
- Soil types (see also chapter 3);
- Protected areas;
- Vegetation (which type);

- Pasturelands;
- Cultivated (agricultural) areas: type of crops; and
- Angle points of the existing 132 kV OHTL.

The line route shall be mapped to the distance of 15 m on both sides of the centre line.

The levels (altitudes) of following objects are to be measured:

- Roads and railways;
- crossing of overhead lines and towers;
- water levels (actual water level with date and time and HW-level);
- buildings, tanks;
- fences and walls, etc.

The survey shall be based on topographical maps of scale 1:50 000 and the required map sheets for this line route are as follows:

Kenya	Uganda
• 103/4	• 62/3
• 103/1	• 72/1
• 102/2	• 72/2
• 102/1	• 64/4
• 88/3	• 63/3
• 87/4	• 63/4
• 64/3	• 64/3

All the existing access roads on the line route area shall be marked on the route map. The existing roads from main road to the line route if any shall be listed with description of condition.

3. Marking

Every angle points shall be pegged out at site by using concrete pegs with numbering AP1, AP2 … etc. starting from Lessos substation in Kenya and from Bujagali substation in Uganda.

4. Soil Investigation

The bearing capacity of soil and soil type shall be estimated visually at adequate intervals and soft soil areas on the right-of-way shall be mapped in order to avoid tower setting at these areas.

The areas, where there is risk of landslides above or below the tower shall be mapped as well as the areas of exposed to erosion.

Above and beyond at certain intervals and wherever the soil type changes substantially an actual soil test shall be carried out. The purpose of the soil test is to determine and verify the soil parameters for foundation design.

The sub soil conditions shall be determined by standard penetration test (SPT-probing) and laboratory analysis. Standard penetration test shall be carried out at around 10 km, or when the soil type changes dramatically, intervals according to BS or other equivalent standard. The number of blows (N-values) for every 150 mm penetration shall be recorded. The total quantity of SPT-probing shall be 20, maximum.

The geology and hazardous lands maps shall be provided.

5. Recording and Reporting

The results of the survey work shall be recorded on maps to the extent as reasonable and in separate report in all details determined, including list of coordinates.

The maps of an appropriate scale shall be in AutoCAD format.

1.3. KENYA

(Tororo -) Ugandan Border – Lessos

The interconnection transmission line section in Kenya starts from Ugandan Border some 10 km from Tororo substation and follows the existing Tororo – Lessos 132 kV transmission line.

At Feasibility Study phase it was conducted a field survey by two sub-consultants: Aero Survey Mapping Ltd. carried out the line route survey and Earthview Geoconsultants Ltd. carried out soil investigations along the surveyed line route, both based on the Scope of Work presented in Chapter 1.2. The reports are in Annex 1 – Survey and Mapping Report, and Annex 2 – Characterization of Sites for the Construction of Pylons between Lessos and Tororo.

1.4. UGANDA

Bujagali – Tororo - Kenyan Border

The interconnection transmission line Uganda – Kenya starts in Uganda from planned Bujagali HPP's substation about 10 km to northwest from Owen Falls in Jinja and joins to existing Owen Falls – Tororo 132 kV transmission line in Buwenda village. Then the interconnection line follows parallel the existing line route mainly, only one deviation from that has been planned starting from Waitambogwe village and returning back in Buwanga area. The reason for this deviation is the old Jinja – Tororo road, which goes too close to the existing line and quite dense dwelling areas between the line and road, therefore there are not space enough for the interconnection line in the vicinity of the existing line. The length of diversion stretch is about 32 km.

At Feasibility Study phase it was conducted a field survey by a sub-consultant: Power Networks (U) Ltd. carried out the line route survey and soil investigations along the surveyed line rocute, both based on the Scope of Work presented in Chapter 1.2. Teclab Ltd. provided laboratory tests and analysis. The reports are in Annex 3 – Survey Report, and Annex 4 – Geotechnical Investigations Report.

2. LINE PLAN AND PROFILE

2.1. KENYA

The line route map of Lessos – Tororo line is in Annex E. The plan and profile sheets of Lessos - Tororo are in Annex F

2.2. UGANDA

The line route map of Bujagali – Tororo line is in Annex G. The plan and profile sheets are in Annex H.

ANNEX A. SURVEY AND MAPPING REPORT (KENYA)

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LESSOS REPORT

1. Introduction – Detailed Survey of Proposed 220 kV line (Lessos – Tororo)

2. Angle Towers Coordinate Description Angle Poles/Towers

3. Proposal along 132 kV line for design alteration as to the effect of property damage/public utilities to accommodate 220 kV Line -
   - Ikoli M/Centre
   - Kibachenje School
   - Sieria Primary Sch.

These are evident sections subject to alteration of 132 kV Line Towers on the basis of social, economic and cost strategic assessment.

4. Features along the proposed 220 kV line.

- Sugar Cane Plantation
- Maize Farms
- Cattle raring Land
- Cassava
- Potatoes
- Banana farms
- Pineapples
- Homestead (Huts& permanent buildings)
- River Crossing
- Tea Farm
- Cattle Grazing/Grassland
- Shrubs
- Natural Forest Trees
- Market Centre
- Postal and Telecommunication Lines
- Power lines
- Barbed wire /hedge fences
- Shrubs
- Natural / artificial forests
- Swampy plains
- Boreholes/ and wells

MALAVA/IKOLI CENTRE

Angle point 10 is the first angle at which two tying proposals are made for 220 kV line of which one will be adopted at appropriate later stage after economic and social benefit assessment.

Two proposals are: -

i) 220 kV line to run clearing the Ikoli Market Centre and Primary School.

ii) The line is proposed to run through T.274 and T.273 of the existing 132 KV line by shifting to the left the same.

NB:-

The above two proposals are made to give room for decision making whether its viable to restrict the expansion of Ikoli Public utilities by running the proposed 220 kV line on the right or its uneconomical to uproot Tower 274 and 273 of the existing 132 kV line hence shifting to the left by same standard way leave margin.

However, considerations are necessary at some stage to determine the future status of the Primary School as per proposed plan for 220 kV line passing through selected angle points.

It will be economical to leave the school standing its present position by the fact that its a community based strategic consideration to be located where it is to serve as a public utility on the basis of social and economic interest.

Similarly, it’s apparently prudent to look at the underlying effects oriented on, Health factor, security, disaster management and expansion of such a school if enclosed between this two high voltage lines (existing 132 kV and proposed 220 kV line) at extent enclosure of 250m Diameter difference.

The private property worth of greater value was considered to be avoided at the level to which the angles were created as shown. Among other reasons costs was to stand out to be higher if the line is to pass over the schools and shops apart from the proposed route.

CONCRETING OF ANGLE POINTS

Lessos to Tororo along the proposed 220 kV line of Distance 132 Km has 31 Angle Points.

16 Angle points as detailed in separate parts of this report are concreted with iron pins.

15 Angle points along the route randomly are not concreted as stated in terms of contract. This is reserved on reasons highlighted in the later part of the report. These 15 angles points instead were coordinated and marked by temporary marks (Wooden peg surrounded by three tones/boulders).

REASONS FOR NOT CONCRETING

The local people along the route where we proposed the line proved difficult and adamant in allowing us to concrete in their respective pieces of land.

The argument was that they were not formally informed about the new line being proposed through their land and it was to be until this had been done before allowing anybody to plant beacons of any nature in their pieces of land.

The fear on the same while we were carrying about the field work was that although Angle points were properly coordinated, those which we managed to concrete are likely to be uprooted on the same sentiments. We did this work at several stages getting the accompaniment of the Village Administrators to pass the preliminary information of our assignment to the regions.

By doing so, that is how we managed to place Angle beacons to nearly half of the proposed 220 kV line Angle points and detailed picking of features along the route. However, this in its totality did not affect extensively the picking of details along the route, though reservations by people remained on how casually we were approaching it.

As shown in the attached list is classified details of all Angle points for proposed 220 kV (see Appendix A).

SECTION MUSAGA SUBSTATION TO SIBEMBE

New double Circuit 33 kV transmission lines are under construction as shown on a detailed map, the points were virtually coordinated and no heights were determined apart from sections we found poles erected.

Within the same section, vegetation is mainly characterized by sugar cane plantation and partially by maize farming; significant part of the existing 132 kV centre line is well defined with impassible access road, for motor vehicle which occasionally is used by cattle and local people. Several existing 132 kV towers are in swampy areas especially when crossing River Nzoia which is wide to an estimate of 350m during peak rain seasons in the region.

This serves to be the same scenario for the detailed proposed 220 kV line which is running parallel to 132 kV O/H line.

As shown on the route map, River Kuywa and Khalaba have similar effects on both existing 132 kV and proposed 220 kV O/H lines though of lesser magnitude in comparison to Nzoia River.

At Sibembe, 33KV O/H transmission substation has to be put under consideration whether to run 220 kV fly over or generate minor diversion of this major transmission line or be future use to upgrade step-down to substation .

HEIGHT OF FEATURES & HEIGHT ABOVE SEA LEVEL

Road/Power Line Crossing Points Ndaptwaba Centre, Ikoli Centre, Kakamega – Malava Road, Musaga Substation, Sibembe Substation, Busia – Malaba Road Crossing.

Height of the power line which we crossed over are 33 kV and 11kV and low voltage service lines which the pole heights range from 9– 11 meters which has to be added to the respective height above sea level shown on the proposed 220 kV line route map.

Height of River Crossing is indicated on the map with the real time and date when it was picked.

Height of House/Buildings is averagely 6.0m – 8.5m limits for both temporary and permanent. The type of buildings structures that we found the proposed line going over are largely temporary homes characterized by iron sheets roofing and mud walled, some are grass thatched (Huts) with mud walls. Permanent buildings happened to be crossed over at the Shopping Centers where we crossed the power lines mentioned in the earlier parts of the report.

We have very few costly buildings on our map report where we found costly private buildings either crossed over or which lies within the way leave.

Height mentioned above is to be added to the height above sea level taken at various sections of the proposed line where such features were found as shown on the line map

Height of Barbed Fence ranged from 1.5 – 2.3m. Height of Hedge fences ranged from 2.5 – 4.0m exceptionally in very few occasions along the proposed route.

Height of Postal and Telecommunications lines was (7.0 – 8.5m) crossed over at Ndaptabwa Shopping Centre, Kakamega – Malava Road and Sibembe Centre. Respective Height above sea level is shown on the route map.
No water tanks along the proposed route were evident during survey.

Borehole/well and water catchments points were picked and shown on the route map.

FEATURES

Along the proposed 220 kV line, apparent vegetation changes, type of farming activity and the present nature of the land use is indicted on the route map surveyed.

Only features on the right side of 132 kV existing line up to the way leave trace limit were surveyed and mapped together with the precise location of the existing 132 kV transmission towers from Lessos – Tororo. Vegetation cover close to the line was adequately mapped too.

Coordinates of features surveyed are in UTM System.

At the plotting stage the route section from Lessos to Tororo is put on Grid system to allow easy identification of features by coordinate mapping. As mentioned before, grid interval is 200 m at the scale of 1: 2000 which was found appropriate; should hard copy be required.

LOCATION FOR AP'S

The districts which the angle points are covered

AP1 – AP5	-	NANDI DISTRICT
AP6 – AP17	-	MALAVA LUGARI
AP21	-	KAKAMEGA
AP18 – AP31	-	BUNGOMA

NB
The whole project is covered in five administrative districts:

Nandi
Lugari/Malava
Kakamega
Bungoma
Teso

COMMENTS

Nearly 95% of the line route proposed is inaccessible with motor vehicles. This is due to Farming along the route and/or Swamps and floods caused by heavy rains. No bridges at river crossing points.

Recommendations

For effective work of any nature along this high voltage transmission lines both 132 kV existing and 220 kV proposed, priority for constructing/maintenance underneath between the two lines has to be considered as part of the cost effective approach in terms of construction and maintenance of the line.

The effect of farming along or near the towers necessitated erosion on many 132 kV towers. This has left substantial number of towers weakened at the base. Farming has to be barred/limited or appropriate control measure to be taken.

However, this is likely to be the same case for the proposed 220 kV line.

NB: The above are observations and opinions of the surveyor and are subject to change.

THE MANAGER
AERO SURVEY MAPPING LIMITED

ANNEX B. CHARACTERIZATION OF SITES FOR THE CONSTRUCTION OF PYLONS BETWEEN LESSOS AND TORORO (KENYA)

CHARACTERIZATION OF SITES FOR THE CONSTRUCTION OF PYLONS BETWEEN LESSOS AND TORORO

By

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Executive summary

The assessment and evaluation of the area between Lessos and Tororo for the purpose of constructing electricity pylons, was done on the basis of assessment of environmental conditions and soil properties. The environmental factors examined included land use, slopes and land cover. The quantitive and visual evaluation of these factors provided the basis of predicting the risk of erosion, landslide and mass movement above and below the proposed sites for the pylons. The physical and engineering properties of soil were examined for purposes of evaluating the bearing capacity of the soil and its stability for pylon construction. This was supported by collection of biophysical information, geologic soil mapping, using GPS, standard soil survey techniques and GIS. The soil properties were assessed using the standard physical and laboratory methods for evaluating the properties of soils for the purpose of engineering construction. The specific engineering properties evaluated were: maximum safe bearing capacity, the depth of the soil to hard material, natural soil moisture content and liquid limit. The result shows that over 50% of the points examined were relatively stable with no of erosion, landslide and mass movement potential. These soils are mainly Luvisols, Vertisols, Nitisols and Andosols and Lixisols. The remaining area had varied problems that may impair the stability of the site for engineering construction (Table 1). All the soils of the proposed site had a bearing capacity 2.5 times the estimated pylon load of 100kN/m^2

Table 1 Stability of the proposed sites for engineering construction

Observation No.	Erosion risk, landslide and mass movement	Stability of environment for engineering construction
1	None	Poor drainage conditions and seasonal waterlogging may render the site unstable.
2	None	Very stable
3	None	Very stable
4	High potential risk of erosion	Currently stable

5	None	Very stable
6	Very severe erosion	Relatively low
7	None	Stable
8	High erosion risk	Stable
9	Low risk of erosion	Stable
10	High risk of erosion, overwash and material movement down the slope	Relatively low
11	None	Relatively high
12	None	Stability low due to poor drainage, inundation and shrinking clay
13	None	Stability low due to poor drainage and shrinking clay
14	None	Stable
15	None	Stable
16	None	Stable
17	None	Stability may be hampered by the shrinking clay and poor drainage condition
18	None	Very stable
19	None	Very stable
20	None	Very poor drainage conditions and waterlogging may hamper the stability
21	None	Very poor drainage conditions, shrinking clay, waterlogging and the river influence, may hamper the stability.

1. General Introduction

1.1 The Report Content

This report contains the evaluation of an area in western Kenya for the construction of electricity pylons to connect the power supply in Kenya with that of Uganda. The approximately 50 meter wide traverse covered started from Lessos in Kenya to Tororo in Uganda. The total length covered approximately 132 kilometres traversing different terrains with different rocks, soils and landform conditions.

For easy readability and reference, the report is divided into two parts. The first part describes the general surface characteristics including the type of soil mantle, the topography, the drainage conditions, the slopes and the landforms covering the entire traverse. The description is based on field work that was carried out in the months of November and December 2006 and additional work in February.

The second part of the report evaluates some of the soil properties that are considered important for construction of structures. All the mentioned properties will not necessarily be measured but important ones will be measured and the results reported. They constitute ground soil investigations though part of the ground investigations are covered in the first part of the report. Important soil properties reported on are discussed in the following subsections of this report together with the determined values.

1.2 Purpose of the current report

To conduct field investigations and present a report on the geotechnical and soil conditions considered important for the construction of electricity pylons carrying heavy transmission power lines.

1.3 Objectives

To observe, measure and assess soil properties along the proposed power-line at 10 kilometer intervals as the basis for evaluating their physical as well as engineering properties for construction of foundation and electricity pylons to transmit 132 Kilovolt of power between Lessos in Kenya and Tororo in Uganda.

1.4 Methodology

The methodology used comprised two major components, namely:

(1) Description of general environmental characteristics to aid in visual assessment of the soil bearing capacity, risks of erosion above and below the probable location of the pylons and possibility of occurrence of landslides and mass movement;

(2) The engineering properties of soil for the quantitative assessment of the soil bearing capacity in relation to estimated load for each pylon of about 100 kNm^2. The environmental characteristics included general soil conditions, land use, landforms, vegetation, land management and erosion features. These were observed and described on a site measuring 50 x 50 metres.. Auger borings, were made to check the spatial coverage of similar or dissimilar soil conditions on the site based on colour and texture. Soil profile pits were sunk to a depth of 4 metres to determine layering (Plate 1), the general structure of the soil and to confirm the presence or absence of water by observing soil colour and by observing the presence or absence of mottles in the soil profile.

Plate 1 Soil profile

The soil profile was dug at 10 km interval to the depth of at least 4 m, depending on the presence of the bedrock or extremely compact layer. Different soil layers were identified and studied on the basis of soil characteristics such as colour, texture, depth, consistence, erodibility and drainage.

(3) The engineering properties included maximum safe bearing capacity of the soil, depth to hard formation, liquid limit and natural soil moisture content. The maximum safe bearing capacity of the soil was determined using the results of shear box tests, based on the analysis of Mohr Stress Circle and Coulomb Equation. The depth to hard layer was determined using dynamic sounding (Plate 2).

This involved determination of the time taken by the rod of specified dimension to penetrate 1 meter soil depth at different soil layers, when subjected to force of specified magnitude. The test continued until a layer was incurred through which the rod could not penetrate. That particular depth was noted for different soil profiles, each profile representing the probable location of the pylon.

Plate 2 Dynamic sounding test at different depth

(4) The liquid limit was determined using Casagrande apparatus. In this method, about 120 grams of soil was mixed with distilled water, and moisture content at which of the two sections of the soil, made with standard grove, touched each other, when subjected to 25 blows per minute. The natural soil moisture content was determined by oven drying a disturbed sample for 24 hours at 105° C.

(5) The soil samples for the determination of the engineering properties were collected from the well selected sections of the traverse due to either the presence of similar or dissimilar soils. Table 1 below shows the points where the engineering soil samples were proposed be collected or where penetration tests will be carried out.

Table 2: Description of the sites used for measuring the soil engineering properties

Specific site used for measuring the soil engineering properties	GPS Points Longitude Latitude	Recommended sampling depth	Remarks
Pylon Point number 1 at Lessos	755326 E 24335 N	4 meter	A lot of human interventions observed to improve the poor drainage conditions. The point is highly accessible.
Angle point number, about 4 km from Lessos	751953 E 26156 N	4 meter	Represents typical deep red soils with well developed soil structure and also highly accessible. This observation represents pylon points numbers 2 and 3. It is also highly accessible.
Pylon point number 4 (Sangaro)	727588 E 39285 N	4 meter	This profile is similar to the one at pylon point number 5 in the natural forest.

Pylon point number 6 (Nangurunya)	710325 E 45339 N	1.5 meter	The murrum and gravelly layer is incurred at the depth of 1.2. Therefore, the engineering sampling need not go beyond 1.5 m.
Pylon point 7 (Sundulo)	700558 E 47786 N	3 meters	The soil has three distinct layer, occurring within 3 meter depth, namely: sandy clay, clay and petroplinthic material
Angle points 3 (Musaka Sub-Station)	692624 E 50005 N	0.5 meter	The soils are shallow, stony and gravelly and lying on relatively stable environment.
Angle point 4 (Musaka Sub-Station)	692494 E 50078 N	4 meter	The soils are clay on lower slopes which is imperfectly drained.
Pylon point 8 (Sivilie)	690886 E 50400 N	2 meters	The soils are moderately deep, sandy clay to clay over murrum. This represents pylon point number 9. So the tests should be done either in number 8 or 9 depending on accessibility.

Angle point 6 (kharanda)	679805 E 53166 N	4 meter	Has a unique textural characteristics as follows: sandy clay loam (0-30 cm); clay loam (30-60) and clay >60 cm
Pylon point 11 (Namuini)	662370 E 59575 N	4 meter	Very poor drainage conditions with water standing on the surface, with heavy compact clay. This represents pylon point number 12.
Pylon point 12 (Miyanga)	652422 E 61581 N	2 meter	Sandy clay soil overlying heavy and compact clay layer on the murrum hit at 2 m.

2. Background Information and General Description of the Study Area

2.1 Location and infrastructure of the study area

The project area covered four districts namely: Nandi, Kakamega, Bungoma and Busia all in the western part of Kenya. Land use in the area was predominated by intensive agriculture covering nearly 90% with sparse agriculture and forests covering the rest 10% of the area with each at nearly 5% of the remaining land portion along the traverse.

Location of the project area in western Kenya is shown in Figure 1.

Location Map of the surveyed area

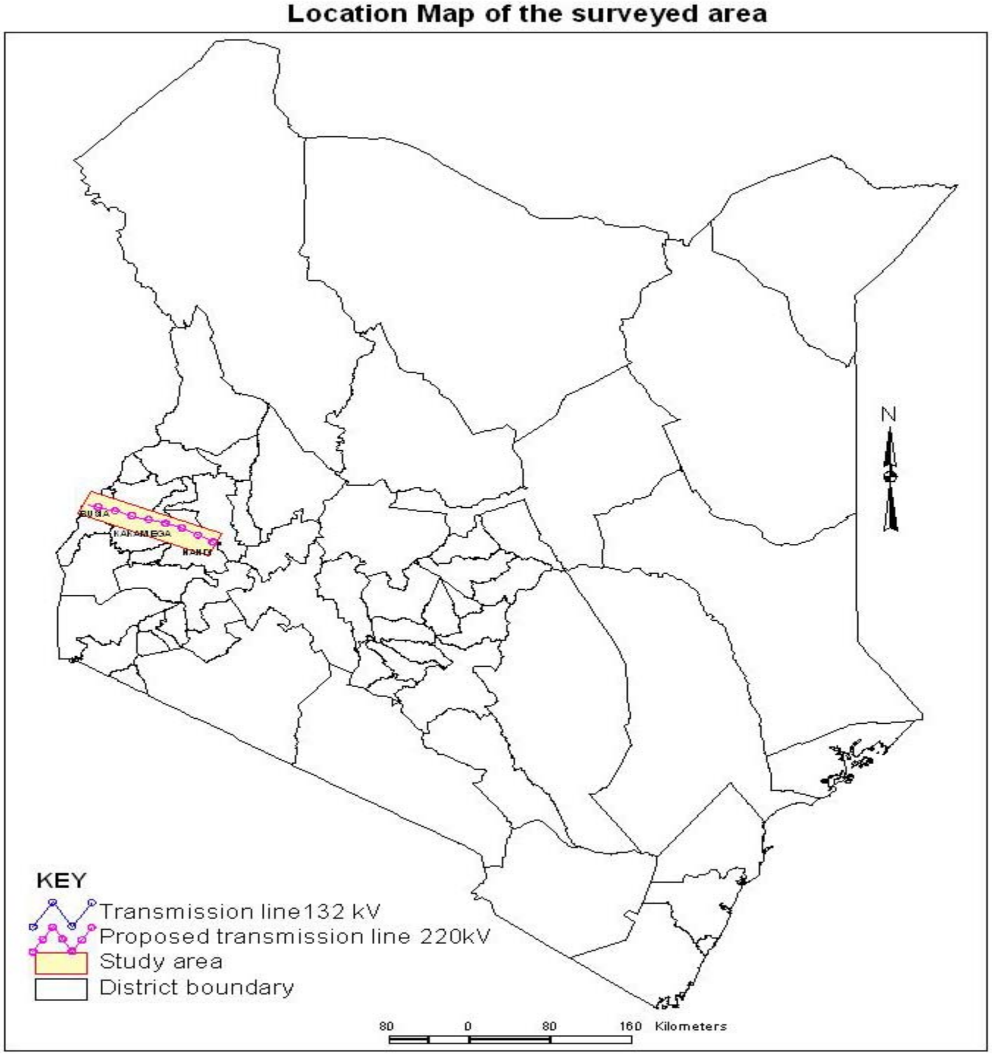


Figure 1: Location of the project area in the western part of Kenya covering Nandi, Kakamega, Bungoma and Busia districts

2.2 Physiography

The area is generally gently undulating in places hills and uplands, sloping into bottomlands. In within the project sites, the physiography is gentle slopping uplands (slopes 1-3 %) grading into flat to very gentle sloping bottom levels.

Drainage conditions and water paws the water flows the surrounding hills and uplands

2.3 General geology of the study area

The geology for most parts of the area is characterized by Archaean granite/greenstone terrain typical of western Kenya around Lake Victoria. From the west along the Kenya-Uganda border eastward, the rocks are part of the upper sequence of the two supracrustal Archaean sequences forming the Tanganyika Shield. *The two sequences of supracrustal rocks recognised in the Western Kenya greenstone belt are the older dominantly volcanic Nyanzian Group and the younger dominantly sedimentary Kavirondian Group*

The geology along the traverse from the Busia border point is represented by the archaean granite-greenstone belt. The most common supracrustal rocks are represented by *the Nyanzian Group which consists of a diverse range of compositions including mafic lavas ranging from basaltic andesites, through andesites, dacites to rhyolites. Also included in this sequence are the andesitic agglomerates, tuffs, volcanic ashes and red chert beds.* The other group of rocks are the Kavirondian metasediments which consist of cyclic alternations of metamorphosed arenaceous represented by grits and argillaceous rock types represented by shales, mudstones grading into slates, with occasional rudaceous types represented by conglomerates. The sediments form a mixture of rocks with gradation within these rocks being very common. The metasediments occupy what appears to be a remnant of a large depression trending east-west from the west of Eldoret town to the Uganda border in the west. Their structures have been interpreted in terms of simple east west striking folds. The fold limbs are steep, and in most cases approaching vertical. No faults are visible along the profile line.

The dominant rocks found to the north of Kakamega town are the intrusive granitoid rocks of the Tanganyika greenstone sequence. The two large batholiths of the Mumias granite and the Maragoli granite sandwich *the Nyanzian and Kavirondian groups. The granites show lithological and textural variations from granodiorites through adamallites, granites to microgranites.*

High grade rocks of the Mozambique belt are found around the Kapsabet area. The rocks here are composed of migmatites, augen gneisses, politic schists and gneisses. Away from the traverse are found marbles, orthogneisses, and amphibolites. Nearer to Lessos relatively younger phonolitic lavas underlie the deep soils, but because of the deep soils, it is not easy to see the phonolitic rocks.

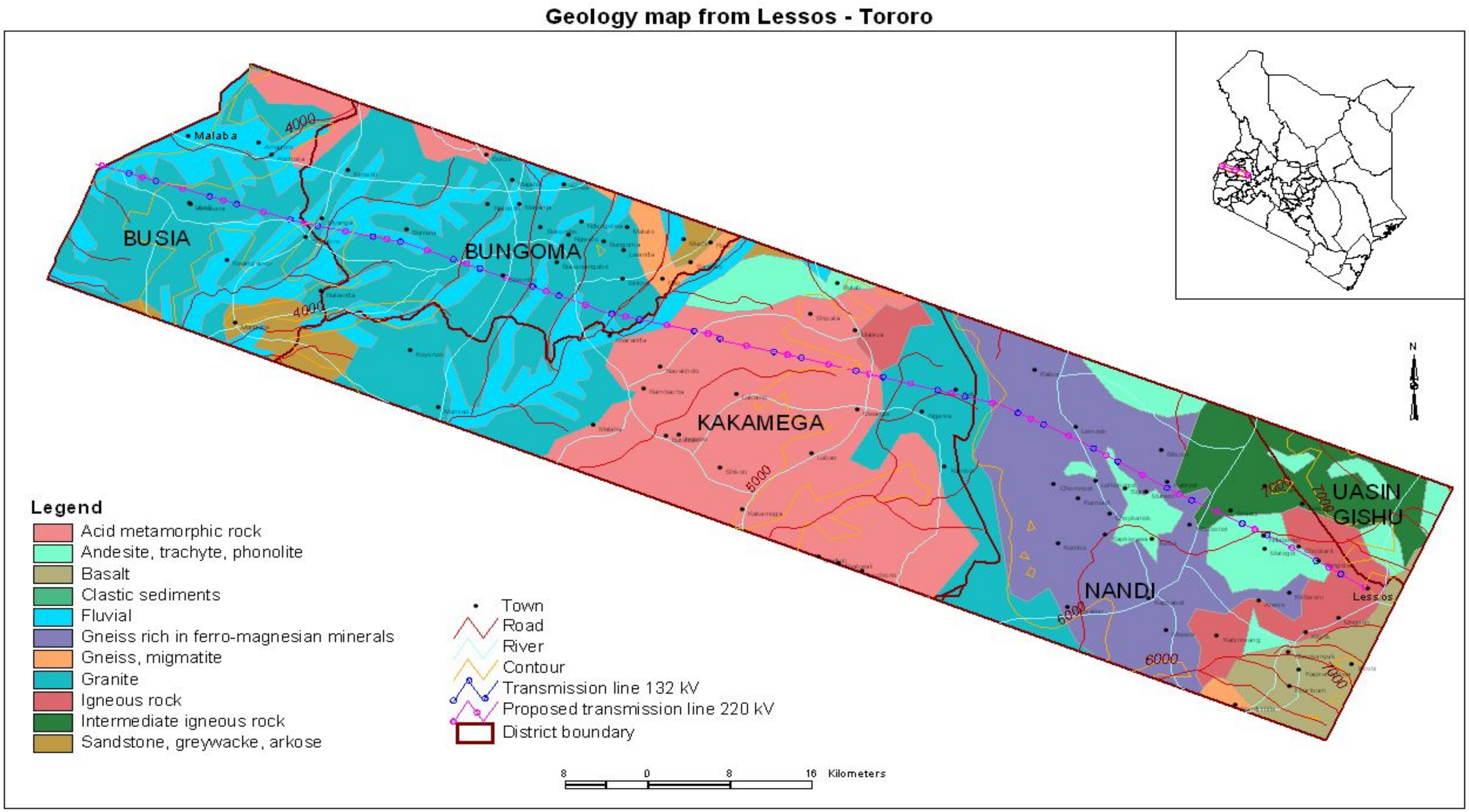


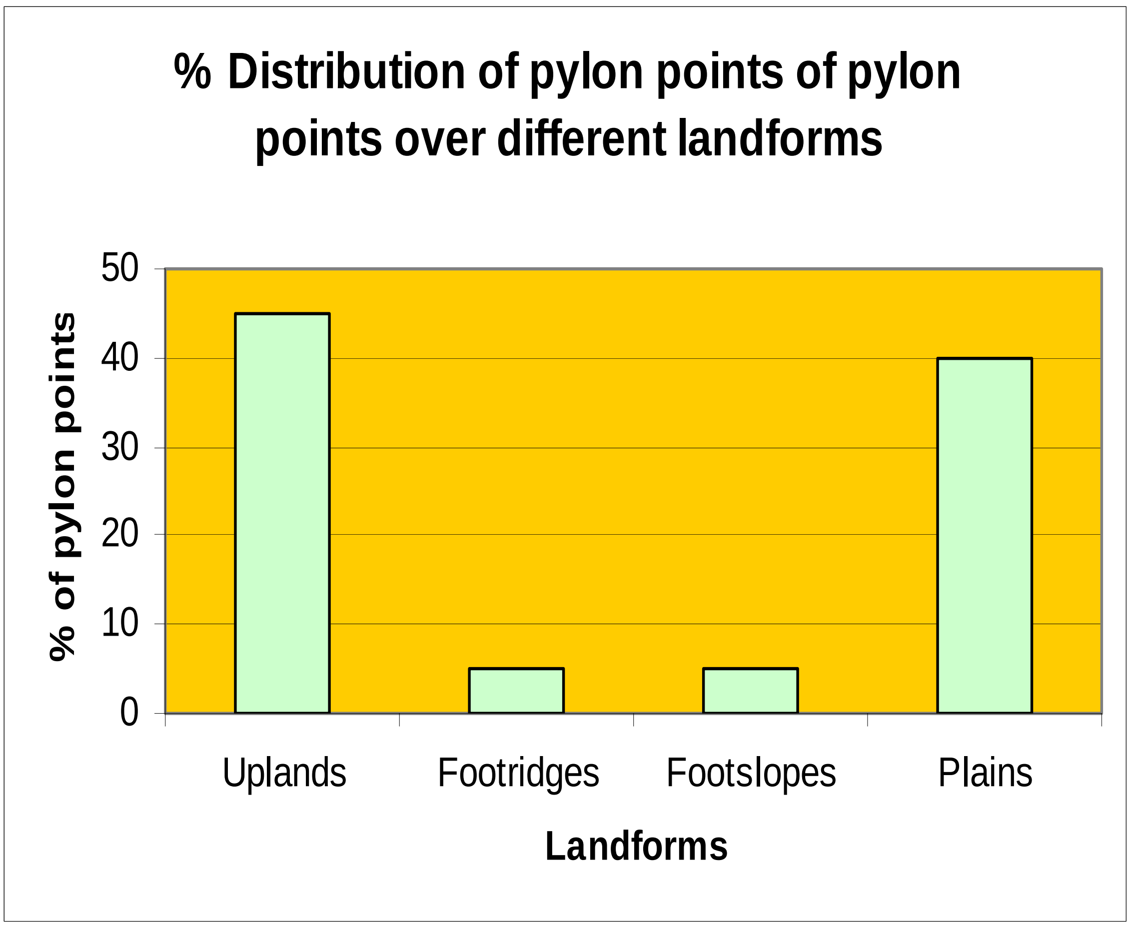
Figure 2: Geological map of the study area

2.4 General landforms and physiography of the project area

The physiography of the area ranges from plain, bottomlands, uplands to foot ridges, with slopes ranging from flat to rolling. The low-lying areas include bottomlands, valleys and interfluves (Figure 3).

The low-lying areas, including the plains have slopes ranging from 0 to 5%. The soil types in most of these areas have drainage problems, attributed to by flat topography and relatively low water permeability. These areas are prone to seasonal flood. Considerable quantity of the flood water is derived from the uplands and ridges. The uplands and ridges have rolling topography with slopes varying from 2-50%.

The location of the pylon in different physiographic positions has a very important bearing with regards to its stability in relation to water movement, erosion and seasonal flooding. Figure 3a shows the percentage distribution of the pylon points in relation to physiography.



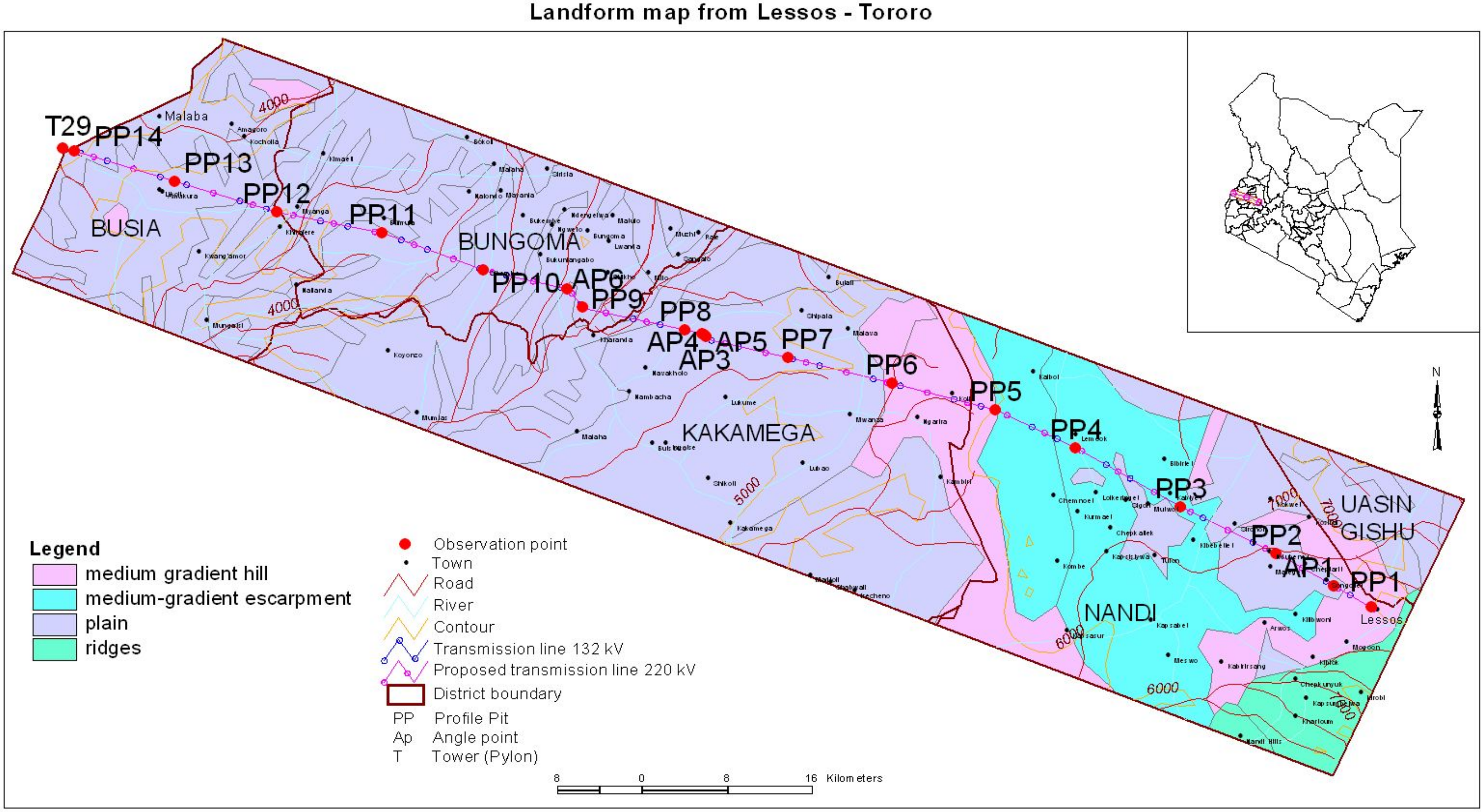


Figure 3: Landform map of the study showing the proposed and existing power transmission line

2.5 Land use types of the project area in relation to physiography and major soils

The broad land utilization types are annual cropping, horticulture, forest and in places perennial crops. Man crops/plants are maize, beans, sugar cane, cabbages, kales, tomatoes, , cassava, agro forestry/natural forest, and in places, tea. It would be of interest to appreciate the general patterns of land use in relation to physiography and major soils (Table 3).

Table 3 Estimated % of different land use types in different physiographic units

Crop	Upland	Footridges	Footslopes	Plains and bottomlands
Tea	40	45	10	<5
Horticulture	20	20	20	40
Cassava	5	10	5	80
Maize/beans	10	10	10	70
Agroforestry	35	30	30	5
Natural forest	15	20	60	<5

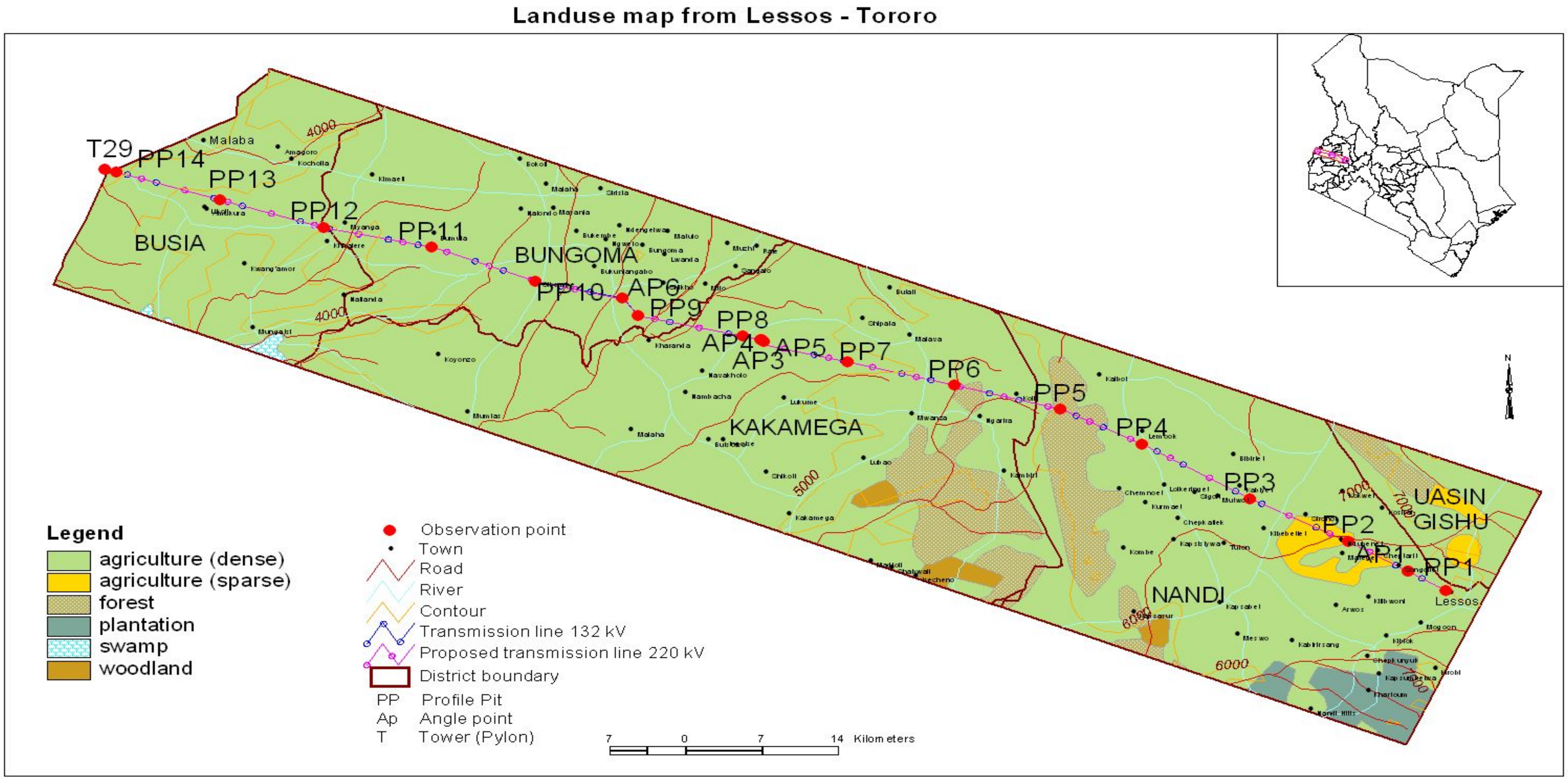


Figure 4: land use types in the proposed project area

2.6 General soil characteristics of the project area

The soils are generally well drained, moderately deep to extremely deep, loose, friable to firm, sandy loam to clay, in places poorly drained with seasonal flooding and stagnic properties. The drainage conditions and texture of the specific sampling points are indicated in Figures 5 and 6. Most soils have moderate to strong structure, very low silt/clay ratio. This explains why most soils have good drainage conditions and reasonably high water holding capacity. Table 4 indicates

The soils being generally deep with good physical conditions, have low erodibility, hence relatively low risks of erosion.

Although most soils are moderately deep to extremely deep, there are some areas where the soils are shallow (Figure 7). The shallow soils are generally gravelly and cemented murrum with low water uptake and retention characteristics, thereby resulting into high volume of run-off, particularly in areas with steep slopes.

The slopes vary from flat to moderately steep (Figure 8). Although quite a good number of sampling points have relatively steep slopes, there is relatively low risks of erosion because the effects of the slopes are counterbalanced by generally good land cover.

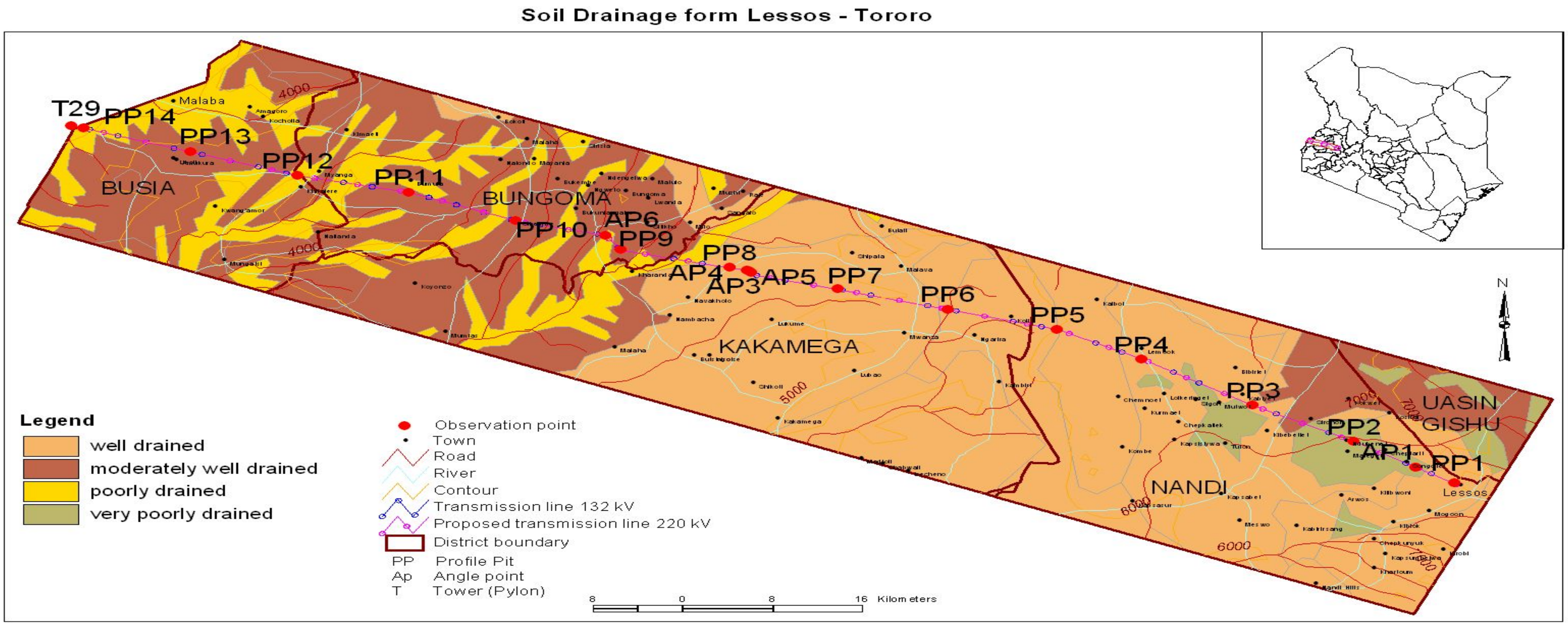


Figure 5: Soil drainage along the proposed traverse of the project area

Soil Texture from Lessos - Tororo

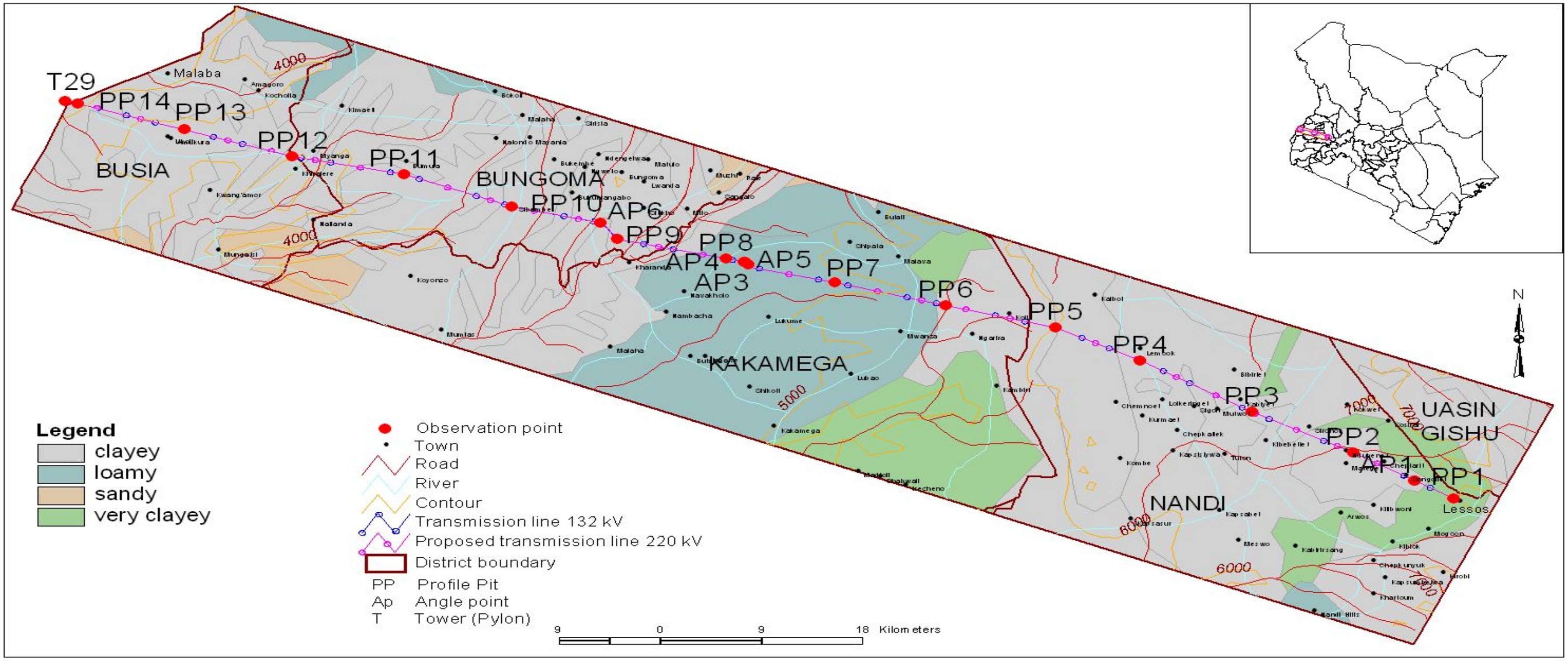


Figure 6: Soil texture kinds along the proposed traverse of the project area

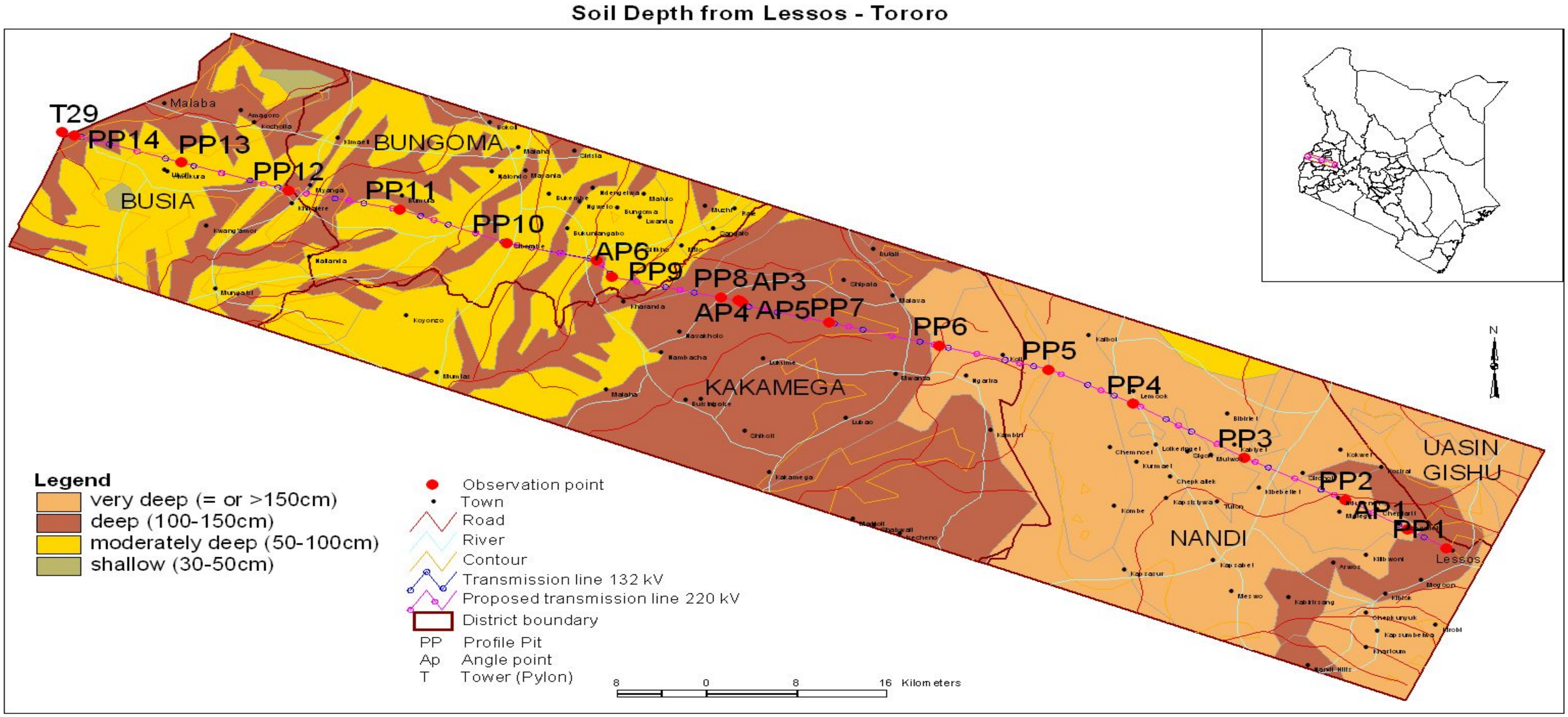


Figure 7: Depth classes of the soils along the proposed project area and traverse

Slope map from Lessos - Tororo

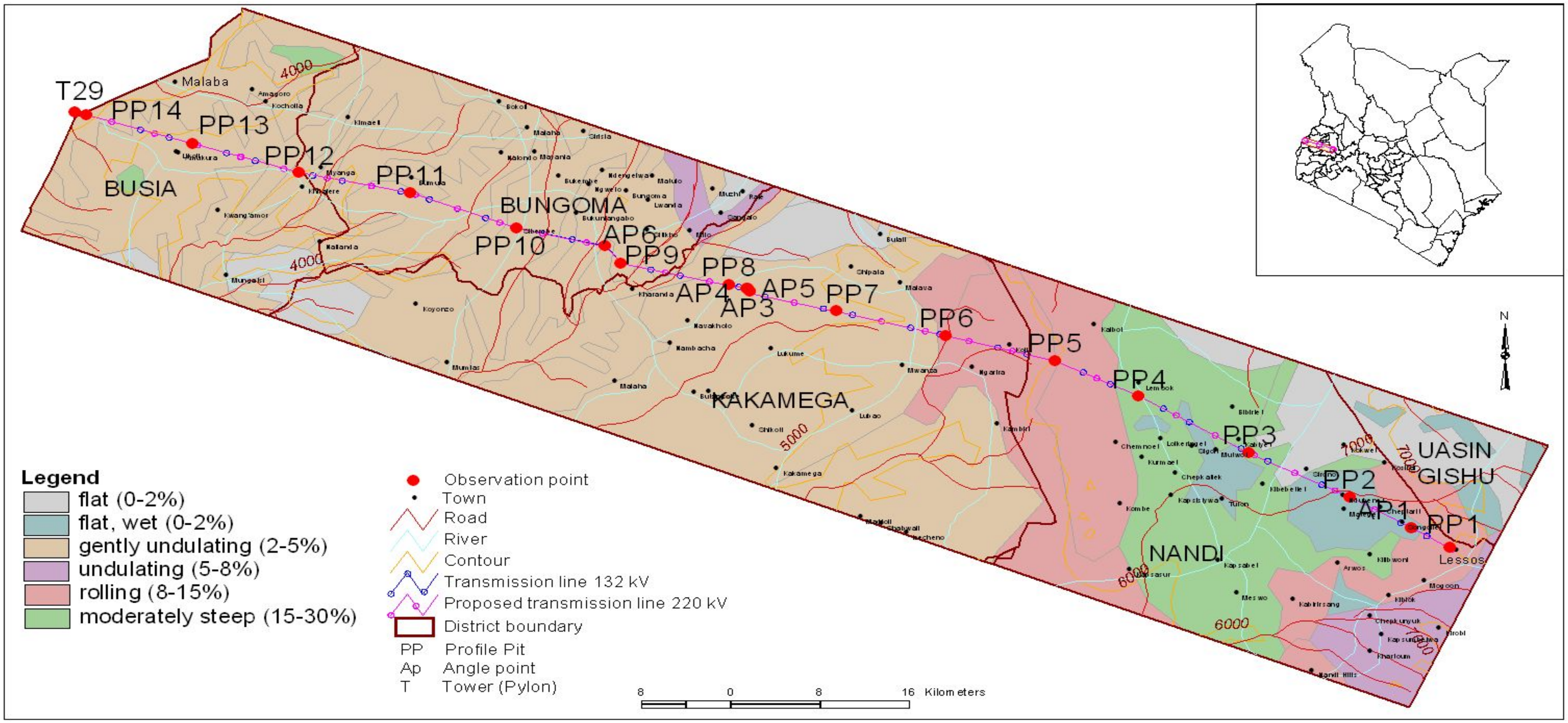


Figure 8: Map showing slope classes along the proposed and existing powerline traverse

3 Site and Soil characteristics along the Lessos-Tororo Traverse

3.1 Observation Point No 1

Reference Location: Profile Pit No 1 at the Lessos Power Station. (PP1)
Geographic Coordinates: Latitude: 24353 N and Longitude: 755333 E *(UTM coordinate system zone 36)*

Topography, landform and land use: The slope is 0-4%, uplands, fallow/cultivated area, adjacent to the Lessos power station (a road cut observation). The area is covered with grass generally constituting a 90% grass cover with a very stable environment (Plate 3).

The soils: The soils are poorly drained to well drained, very deep and very friable reddish brown. The consistence when wet is sticky and plastic and lacks soapy and smeary behavior. The structure is strong and characterized by strong soil peds that are evidently present as floccules, granules and blocky agglomerates that adhere to each other with clear planes of cleavage even under wet conditions. The soil mantle and structure presents a stable medium against internal and external forces. The proposed pylon site is located in the bottomland, which is poorly drained. A combination of the spring water from the upper part and parched ground water, cause inundation (Plate 4). The major soils are Nitisols and Luvisols.

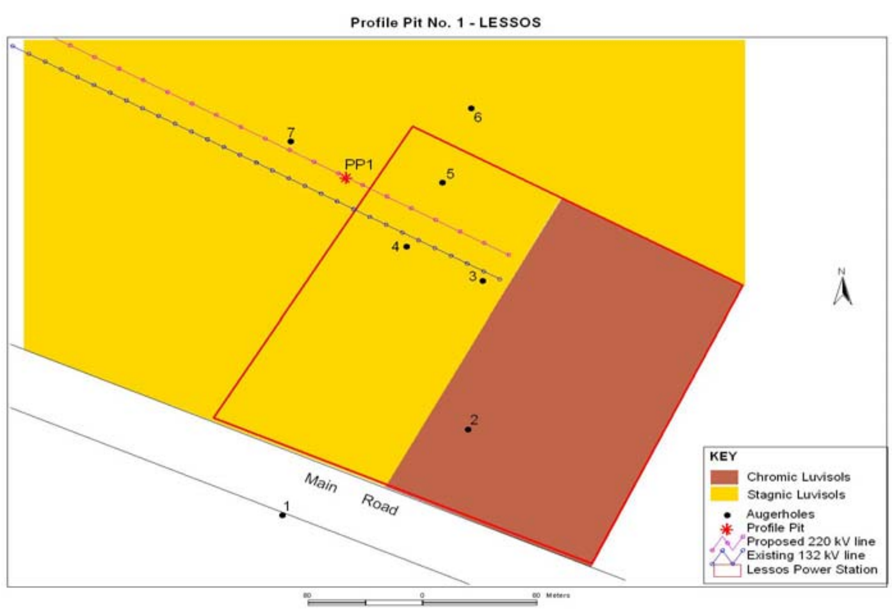


Figure 9: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 1.

Erosion risk and bearing capacity: Low due to grass cover and gentle slope. No evidence of erosion is observed in the area (Plate 1).

Plate 3: Stable environment

.

Upper part of the site

Materials of soil excavated from the surrounding areas and compacted to form a terrace with steep sides and flat top on which the engineering structures are constructed. The grass cover is over 95%, making the soil stable against the water flow through seepage and erosion (Plate 3).

Plate 4: Poorly drained conditions

Poorly drained bottomlands

The site proposed for the construction of the pylon is strongly inundated during the rainy season by a combination of the rainwater, spring water and the ground water. In the area where the old pylon is located, the problem is solved by the raising the ground, using soil materials of assorted grain size, from fine textured clay to course gravel.

Soil Colour: Reddish brown
Soil Structure: Evidence of stable structure is terms the well aggregated foccules.
Soil Layering:
Texture: Clay-with appropriate silt/clay soil
Soil Consistence: silky and plastic, very friable when moist, has no smeary consistence characteristic of soil with poor structure due to high the concentration

Structure: Soil structure well developed peels will clear structural planes of separation.
Depth: greater than 1.5 m (exact depth if available)
Drainage: well drained soils with no wet or moist layers.

3.2 Observation Point No 2

Reference Location: The angle point No 1 at 4 km from Lessos (AP1)

Geographic Coordinates: Latitudes: 26156 N and Longitudes: 751953 E *(UTM coordinate system zone 36)*

Topography, landform and land use:
The physiography of the area is upland, with flat to very gently sloping. The ground cover is 90%.

The soils: The soil is very deep with well developed stable structure typical of a Nitisol (Plate 6). The top soil is relatively darker because of high organic matter content, with floccules and granules which are distinct and stable, making this area very stable environment for the pylon. The rest of the soil profile consist of well formed peds with shiny planes of cleavage.

Erosion risk and bearing capacity: There is little erosion risk (Plate 5) because the topography is nearly flat with good cover.

A combination of good ground cover and relatively gently slopes and little disturbance through human influence make the majority of the sampling points stable against landslides, slumping and mass movement that may interfere with the functions of the pylon. However, there are isolated cases where poor ground cover and land degradation processes are a problem

Plate 5: Good land cover and stable conditions

Plate 6: A typical Nitisol

The red soils in the between Lessos and Tororo and mainly Nitisols. The soils occurs predominantly on the uplands and footridges. Most of them are extremely deep and well drained with well formed, stable structure, with clear planes of cleavage. They have very high water uptake and retention characteristics, hence no inundation and poor drainage conditions are experienced during the rainy season. This, together with non-shrinking and expanding clay, as well as good grass cover make the soil very stable against external forces such as erosivity and human influence.

3.3 Observation Point No 3

Reference Location: Profile Pit No 2 at Ndubenet. (PP2)

Geographic Coordinates: Latitudes: 29236 N and Longitudes: 746471 E *(UTM coordinate system zone 36)*

Topography, landform and land use

The physiography of the area is a footslope. The general slope is 10%. The area is cultivated and irrigated horticultural crops such as cabbages and kales.

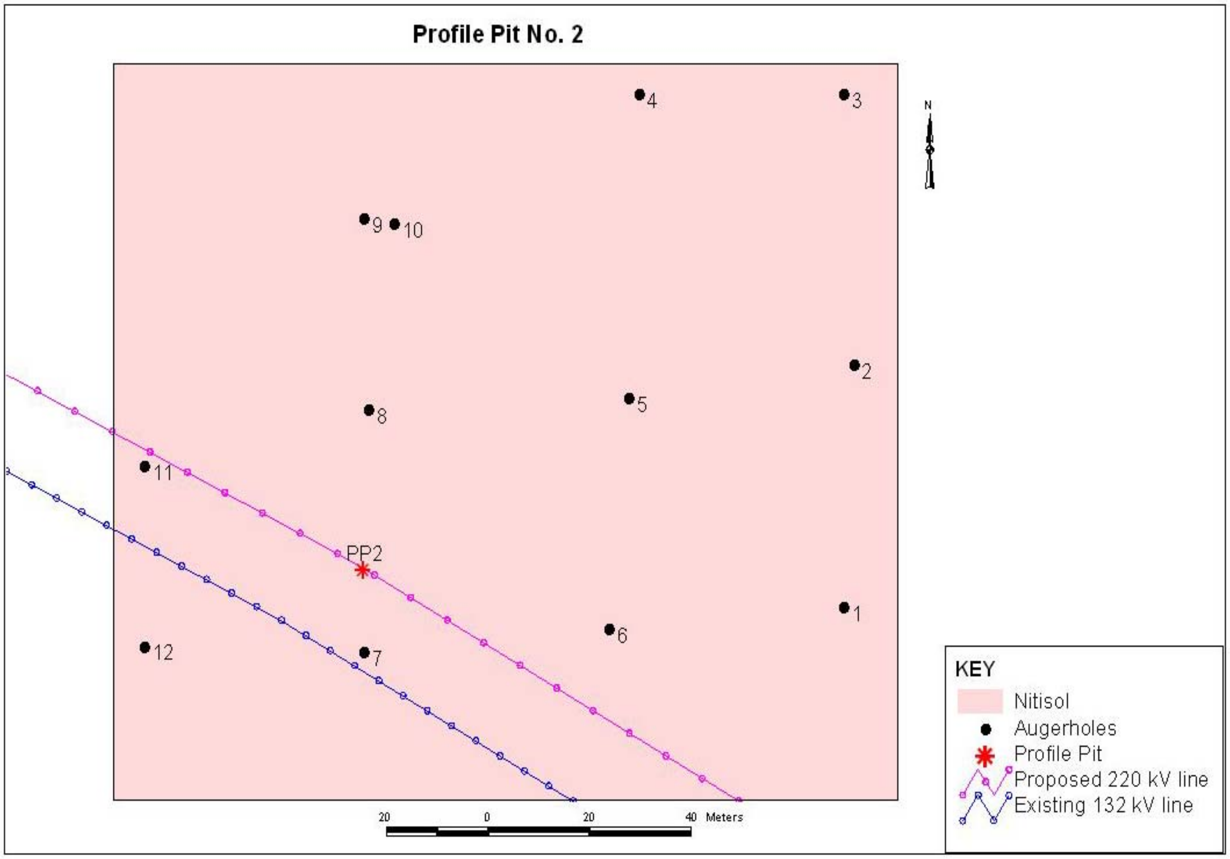


Figure 10: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 3.

Topography, landform and land use: The physiography is upland with slopes 0-1%. The area is fallow with over 90% grass cover.

The soils: The soils are well drained, very deep and very friable red clay. The consistence when wet is sticky and plastic and friable when moist. The soil structure is strong sub-angular block, forming clear planes of separation with shiny ped surfaces, typical of Nitisol .

Erosion risk and bearing capacity: Although the slopes are rather high, the risks of erosion are low. This is because of sustainable management practices such as strip cropping, grass strip, fallowing, mulching and crop rotation (Plate 10). All these practices are on the upper part of the proposed site for pylon construction, so that there is no risk of erosion above or below the pylon. The soil bearing capacity is reasonably high because of the stable soil structure.

Soil Colour: Reddish brown to red
Soil Structure: Very strong blocky structure
Soil Layering: > 3 horizons
Texture: Clay
Soil Consistence: stick and plastic when wet, very friable when moist
Depth: greater than 1.5 m
Drainage: well drained

3.4 Observation Point No 4

Reference Location: Profile Pit No 3 at Kokwet. (PP3)

Geographic Coordinates: Latitudes: 33645 N and Longitudes: 737487 E *(UTM coordinate system zone 36)*

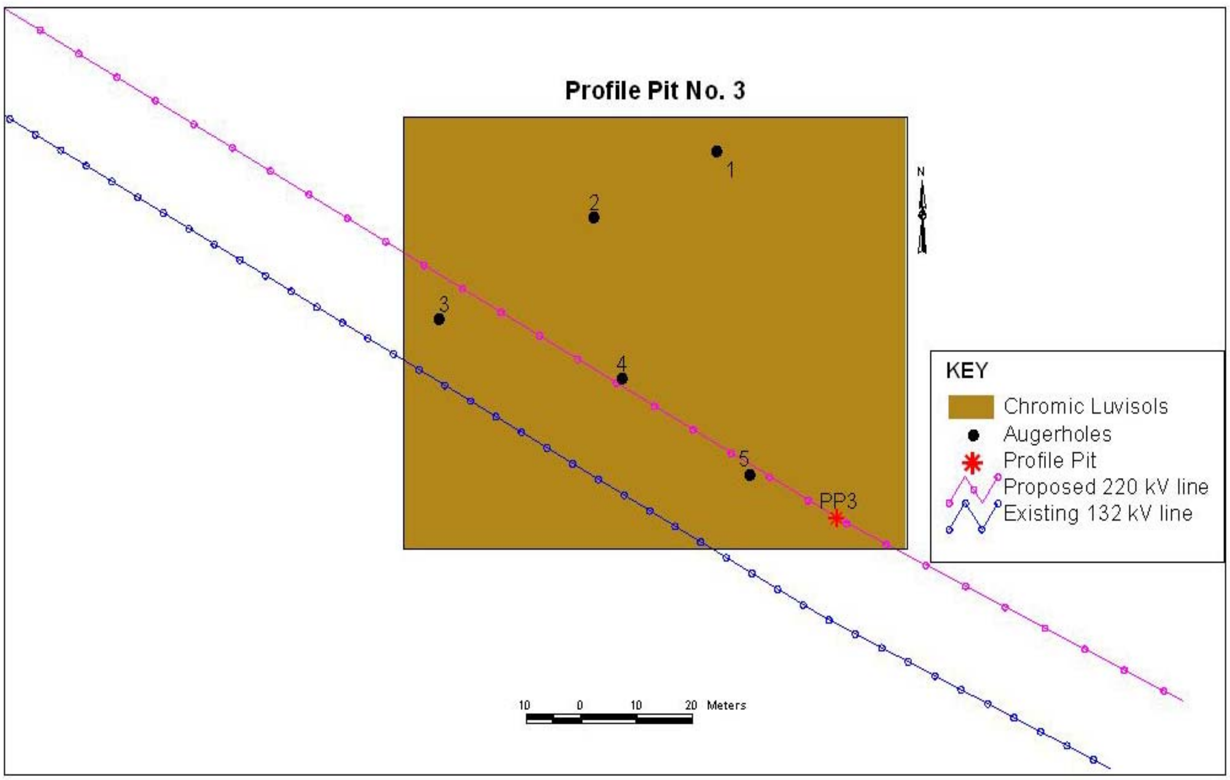


Figure 11: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 4.

Topography, landform and land use: The general physiographic of the area is upland, hills and foot slopes. The general slope is 8%. The area is fallow with 95% cover.

The soils: The soils well drained, very deep, friable silty clay loam to clay with morphological characteristics typical of Andosols.

Erosion risk and bearing capacity: Currently there is no evidence of serious erosion risk, although the slope goes up to more than 8%. This is because the ground cover is over 95% with little disturbances due to human influence. However, there is high potential erosion risk. The topsoil being silty clay loam to silty clay, with low bulk density, means high erodibility, which upon slight disturbance, may pose high rosion risk, particularly in consideration of steep slopes.

Soil Colour: Reddish brown
Soil Structure: moderately strong to strong sub-angular
Soil Layering: > 3 horizons
Texture: Clay
Soil Consistence: stick and plastic when wet, friable when moist
Depth: > 1.5 m
Drainage: well drained

3.5 Observation Point No 5

Reference Location: Profile Pit No 4 at Sangaro (PP4)

Geographic Coordinates: Latitudes: 39285 N and Longitudes: 727588 E *(UTM coordinate system zone 36)*

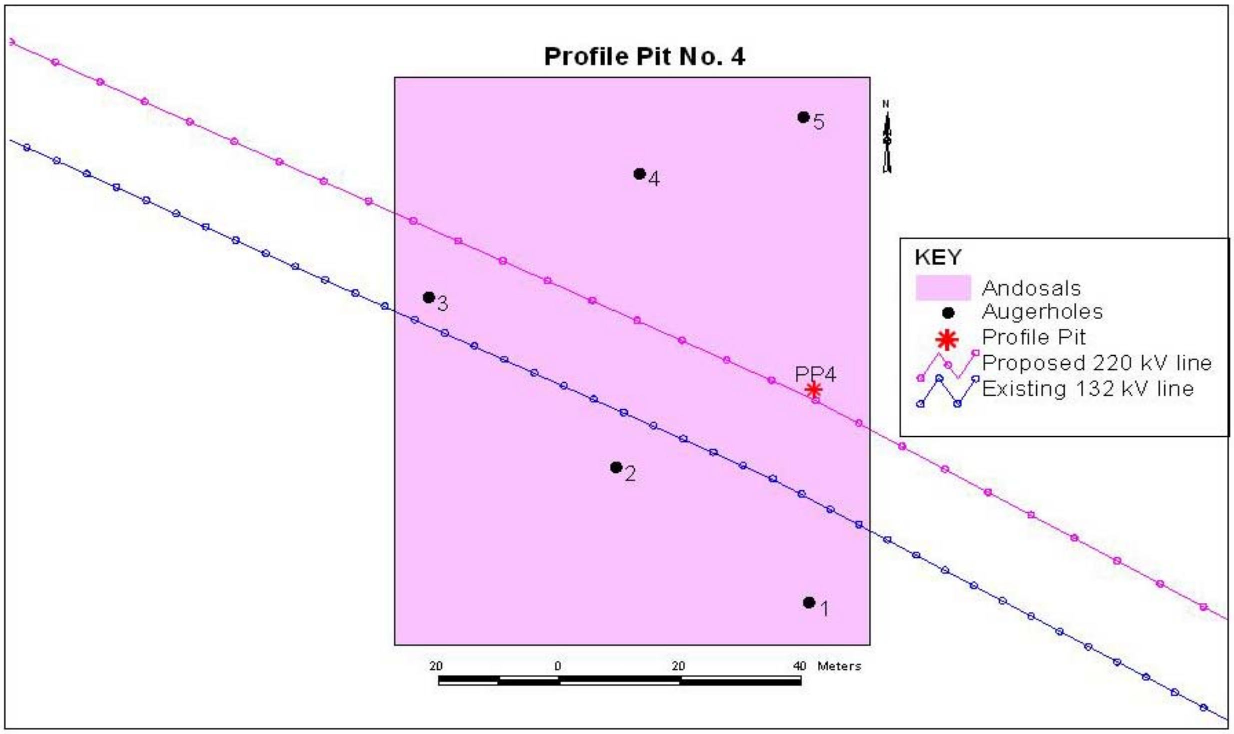


Figure 12: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 5.

Topography, landform and land use: The area is generally uplands, mountains and footslopes under forest

The soils: The soils are well drained, friable when moist, sticky and plastic when wet. These are typical Andosols (Plate 7)..

Erosion risk and bearing capacity: Currently there no evidence of erosion although the slope goes up to 8%. This is because the ground cover is over 95%, with little human disturbance. However, there is high potential risk or erosion susceptibility. The top soil being silty clay to clay loam, with low bulk density, means high erodibility, which, with slight disturbance, may pose high erosion risk, particularly when considering relatively high silt content. These factors reduce the soil bearing capacity. In addition, high concentrated water flow from the current diverted culverts from the road towards the proposed pylon location may cause instability to the structure unless the location or water flow pathways are changed.

Soil Colour: very dark grey to reddish brown
Soil Structure: moderately strong sub-angular block
Soil Layering: > 3 horizons
Texture: silty clay to clay loam
Soil Consistence: stick and plastic when wet, friable when moist
Depth: 2m
Drainage: well drained

3.6 Observation Point No 6

Reference Location: Profile Pit No 5 at Chemakas Forest (PP5)

Geographic Coordinates: Latitudes: 42858 N and Longitudes: 720066 E *(UTM coordinate system zone 36)*

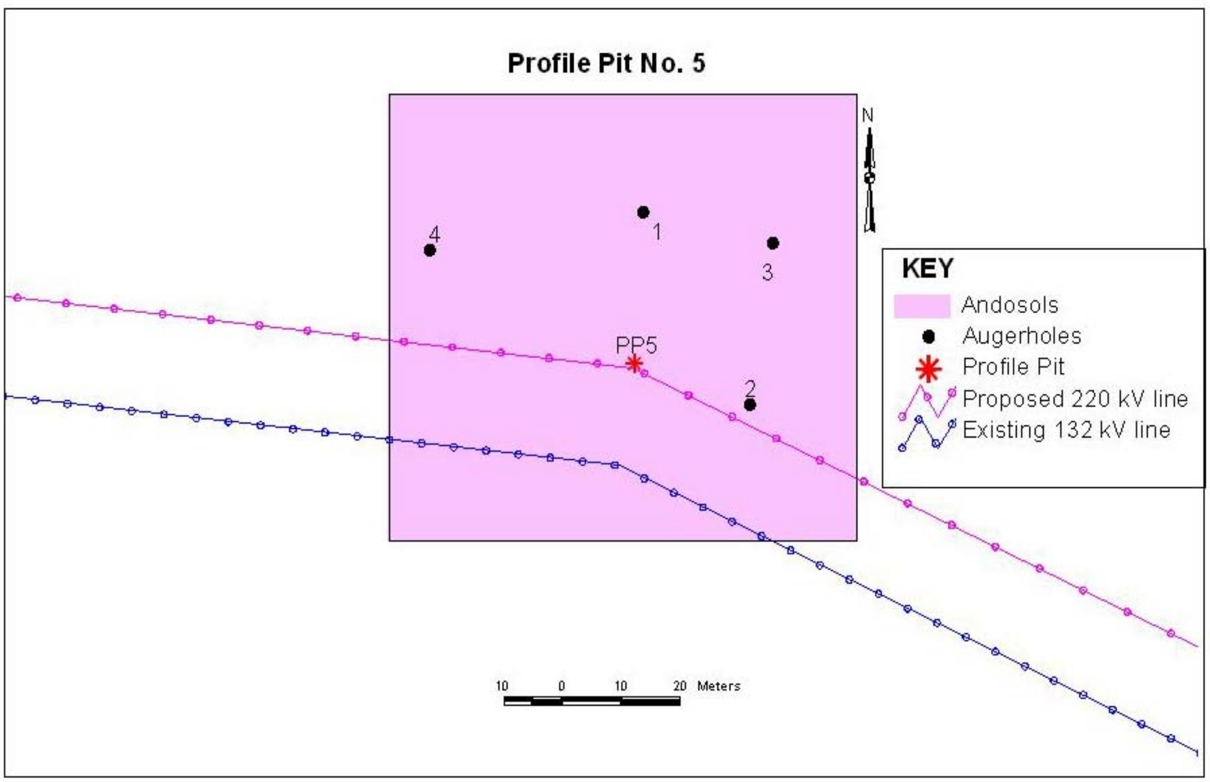


Figure 13: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 6.

Topography, landform and land use: The physiography of the area is upland with undulating to very steep slopes; in places hills and footslopes. The slope is 1-4%. The site is located in the forest.

The soils: The soils are well drained, deep to very deep, friable reddish brown, silty clay to clay. These soils are Andosols (Plate 7).

Erosion risk and bearing capacity: The pylon is located in relatively stable environment, with generally good ground cover and stable soil structure, in places with rock outcrops. However, the concentrated flow of water on the road, leading to pylon site, may cause instability to the structure. In places, weathering rock materials are at 1.2 m depth. This further explains the stability of the pylon area and high soil bearing capacity.

Soil Colour: dark reddish brown
Soil Structure: moderately strong sub-angular block
Soil Layering: > 3 horizons
Texture: silty clay to clay loam
Soil Consistence: stick and plastic when wet, friable when moist
Depth: 1.2m
Drainage: well drained

Plate 7: Typical Andosols

The Andosols are some of the major soil types found between Lessos and Tororo. There found in the uplands and footslopes on the forest landscapes. They have very low bulk density, very light and friable, hence susceptible to win erosion and water erosion. However, currently, there is no evidence of any erosion, because of good forest and grass cover.

For this particular pylon point, there is a need to identify appropriate mitigation strategy to counterbalance the effects of land degradation taking place along the track

3.7 Observation Point No 7

Reference Location: Profile Pit No 6 at Nangurunya. (PP6)

Geographic Coordinates: Latitudes: 45339 N and Longitudes: 710325 E *(UTM coordinate system zone 36)*

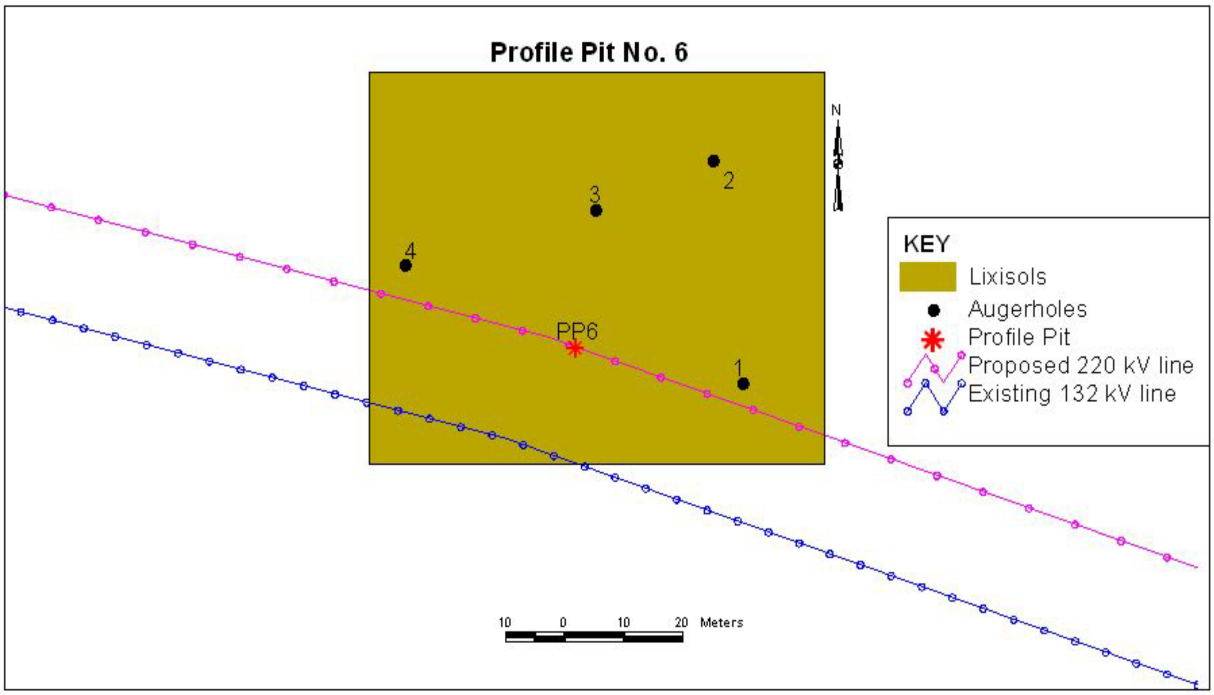


Figure 14: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 7.

Topography, landform and land use: The area is on upland, on a homestead, adjacent to the road, with the slope over 4%. The ground cover is over 65%

The soils: The soils are well drained, shallow to very deep, gravelly, friable, yellowish red clay. The top soil is clay, while at 1.2 m it becomes gravelly clay. Between 1.2 and 2 m is murrum. There is variation is soil depths, ranging from 10 to 200 cm. These soils are Lixisols.

Erosion risk and bearing capacity: The excessive water flows through the road is causing very severe erosion, thereby threatening the stability of the old pylon (Plate 8). The exposure of the foundation footing of the pylon and the depth to which the soil has been removed by erosion is indicative of the severity of land degradation (Plate 9)

Soil Colour: dark reddish brown
Soil Structure: moderately strong sub-angular blocky
Soil Layering: > 3 horizons
Texture: silty clay to clay loam
Soil Consistence: stick and plastic when wet, friable when moist
Depth: 1.2m
Drainage: well drained

The water flow taking place along the road is directly flowing into the pylon. Therefore, the proposed location for the new pylon should be on the area above this point on stable soil with cemented murrum at the depth ranging from 10 to 30 cm. The negative effects of erosion is noted in 6, where there is a threat to expose the foundation footing of the old pylon.

Plate: 8 High erosion risk along the road

The concentrated flow enhanced by the road has continually dug the soil towards the foundation footing to a depth more than 1 meter. It is remaining less than a meter to reach the foundation footing of the old pylon. This will disrupt the stability of the structure, hence its function. Therefore, this factor has to be taken into account when designing and constructing the new pylon.

Plate: 9 Threat against the pylon foundation

3.8 Observation Point No 8

Reference Location: The angle point No 2 near Ikoli primary school (AP2)

Geographic Coordinates: Latitudes: 43280 N and Longitudes: 716418 E *(UTM coordinate system zone 36)*

Topography, landform and land use: The area is located on upland, the main land are being sugar cane. At the profile point, sugarcane plantation provides good ground cover nearly 100%. Where the sugarcane has been harvested etc, residues similarly provides nearly 100% cover. The general slope is 5%. The area is adjacent to the profile where the old tower occupies and is cultivated with cassava and sweet potatoes on up and down the slopes with risk of erosion.

The soils: The soils are well drained, deep, dark grayish brown, sandy clay loam to clay (Luvisols)

Erosion risk and bearing capacity: There is no evidence of slumping, landslide or land degradation. Therefore, the proposed pylon site is on relatively stable environment. However, the old pylon is at risk because it is located below the cultivated area with poor land cover, and where ploughing is done up and down the slope. The cropping system comprises cassava and potatoes that provide poor ground cover against 6% slope. An evidence of sand overwash, especially along the road along the road adjacent to the old pylon is indicated of high erosion risks. In this soil, there are three distinct layers with differing soil bearing capacity, namely: sandy clay, clay and petroplinthic materials.

Soil Colour: dark grayish brown
Soil Structure: weak to moderately strong sub-angular blocky
Soil Layering: > 3 horizons
Texture:
Soil Consistence:
Depth:
Drainage: well drained

3.9 Observation Point No 9

Reference Location: Profile Pit No 7 at Sundulo (PP7)

Geographic Coordinates: Latitudes: 47786 N and Longitudes: 700558 E *(UTM coordinate system zone 36)*

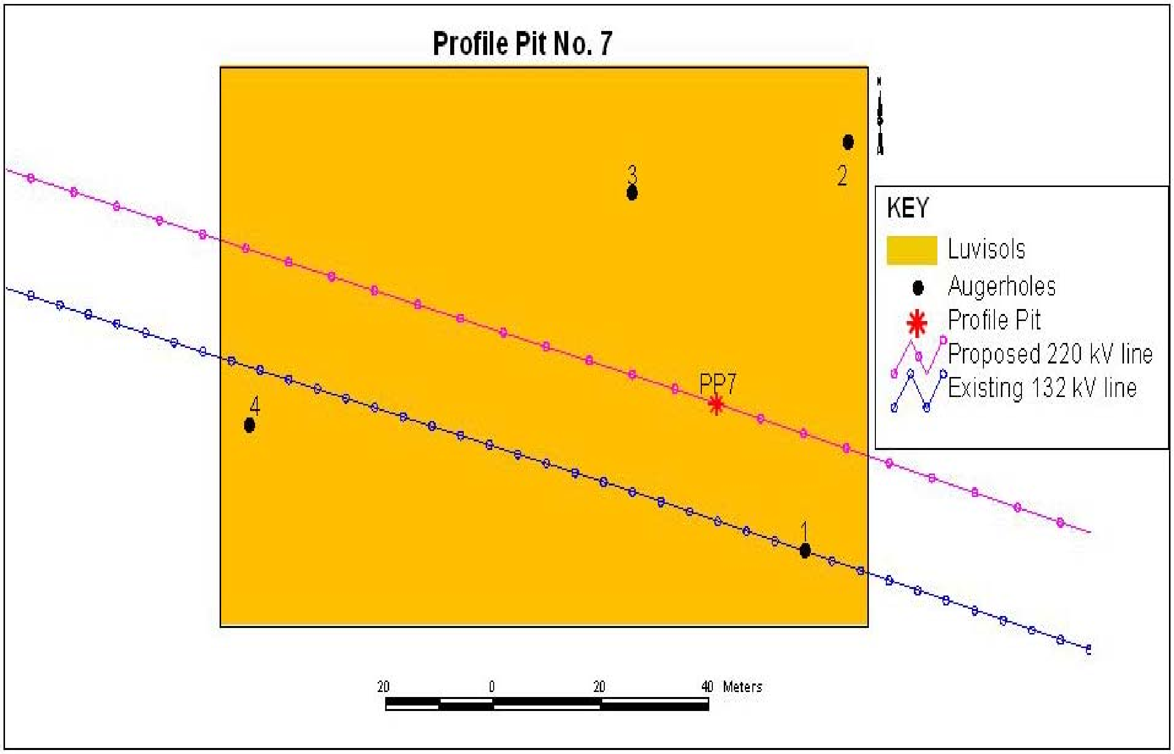


Figure 15: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 9.

Topography, landform and land use: The physiography is uplands on slopes, varying from 0-10%. The main land use is sugar cane. The upper part of the slope, above the proposed pylon site, is uncultivated. The lower part has bench terraces to check the run-off and erosion. The ground cover of the upper part is about 60%.

The soils: The soils on the upper part of the slope are shallow to moderately deep, firm yellowish red, gravelly, sandy clay to clay, over murrum at the depth of 60 cm. The soils on the lower part of the slope are moderately deep to deep (80-110 cm), firm, dark yellowish brown clay, over weathering parent material.

Erosion risk and bearing capacity: There is slight sand overwash on the upper part of the slope

Soil Colour: Dark yellowish brown to yellowish red
Soil Structure: Moderate to strong sub-angular blocky
Soil Layering: > 3 horizons
Texture: Gravelly sandy clay to clay
Soil Consistence: Sticky and plastic when wet, friable when moist
Depth: 2 m
Drainage: well drained

3.10 Observation Point No 10

Reference Location: The angle point No 3, near Musaka sub-station (AP3)

Geographic Coordinates: Latitudes: 50005 N and Longitudes: 692624 E *(UTM coordinate system zone 36)*

Topography, landform and land use: This is located on the upland on 0-6% slope. The main land use is sugar cane, but the site for the proposed pylon is on fallow area under grass, with ground cover over 70%.

The soils: The soils on the top and sloping parts of the upland are well drained, shallow to moderately deep, reddish brown, friable gravelly clay loam to clay. The soils on the lower part of the upland, next to the river, are imperfectly drained, deep, black, firm clay. These soils are Acrisols and vertisols.

Erosion risk and bearing capacity: The generally shallow soils on gravelly and cemented murrum causes low water uptake, resulting into the lateral flow down the slope on the slowly permeable gravelly layer. This, combined with run-off, cause erosion and accumulation of materials down the slope. Therefore, the appropriate location of the pylon is the upper part of the slopes, which are relatively stable. The shallow soil depth to murrum in the upper part of the slope provides stable conditions for pylon foundation. The proposed pylon location is on a heavy clay throughout the depth, which is extremely compact, with higher moisture content than the soils on the upper part of the slope, indicating water accumulation from the upper part.

Soil Colour: Very dark reddish brown to black
Soil Structure: Weak to strong angular blocks
Soil Layering: 3 horizons
Texture: Gravelly clay to clay
Soil Consistence: Firm when moist, sticky and plastic when wet.
Depth: 0.3-120 m
Drainage: Well drained to imperfectly drained

3.11 Observation Point No 11

Reference Location: The angle point No 4, near Musaka sub-station (AP4)

Geographic Coordinates: Latitudes: 50078 N and Longitudes: 692494 E *(UTM coordinate system zone 36)*

Topography, landform and land use: The site is located on the uplands with slopes 0-10%. The upland has a wide base and gently sloping sides towards the interfluves. The proposed pylon site on a flat, cultivated area with poor ground cover.

The soils: The soils are well drained, very deep, red clay. These soils are Nitisols.

Erosion risk and bearing capacity: The erosion is very low and the bearing capacity of the soil is moderately high.

Soil Colour: Red

Soil Structure: Strong angular and sub-angular blocks with shiny surfaces typical of a Nitisol.
Soil Layering: 4
Texture: Clay
Soil Consistence:
Depth: >3 m
Drainage: Well drained

Soil engineering stability:

3.12 Observation Point No 12

Reference Location: The angle point No 5, near Musaka sub-station (AP5)

Geographic Coordinates: Latitudes: 49804 N and Longitudes: 692823 E *(UTM coordinate system zone 36)*

Topography, landform and land use: The point is located on a typical plain with slope 0-0.5%. The site is on the fallow area with land cover over 80%. The land use in the surrounding area is mainly cassava.

The soils: The soils are imperfectly drained to poorly drained, very deep, firm, cracking clay. The soils are Vertisols.

Erosion risk and bearing capacity: Erosion risk is extremely low. However, poor drainage conditions, seasonal flooding, the shrinking, cracking and expanding type of clay, may cause some instability to the engineering structure, rendering low rating of the soil bearing capacity.

Soil Colour: Very dark gray
Soil Structure: Moderately strong angular blocks
Soil Layering: 4
Texture: Clay
Soil Consistence: Very firm, when moist, sticky and plastic when wet
Depth: >3 m
Drainage: Imperfectly drained to poorly drained
Soil engineering stability:

3.13 Observation Point No 13

Reference Location: Profile Pit No 8 at Sivilie (PP8)

Geographic Coordinates: Latitudes: 50400 N and Longitudes: 690886 E *(UTM coordinate system zone 36)*

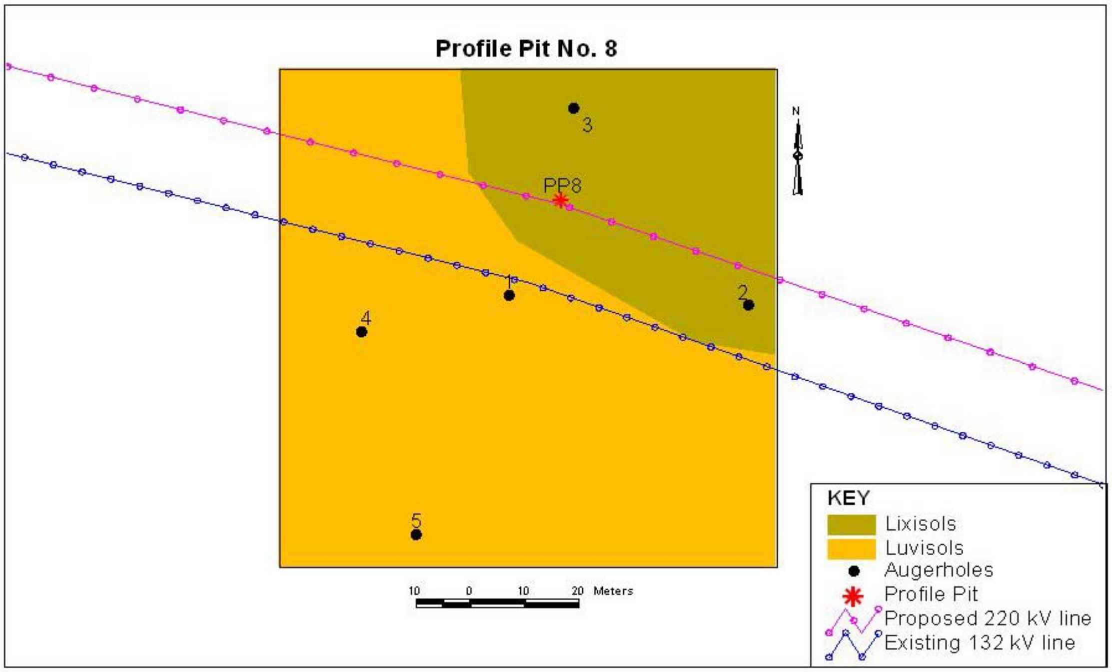


Figure 16: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 13.

Topography, landform and land use: The area is located on a level plain, slope 0%. It is cultivated with maize, sugar cane and potatoes.

The soils: The soils are poorly drained, deep, firm, cracking and shrinking clay (Plate 10)**.** The soils are vertisols.

Erosion risk and bearing capacity: Being on a level plain, with firm and stable soil structure, erosion risk is very low. However, it suitability as a foundation material is rendered low by the cracking and shrinking clay, with fluctuating soil moisture regimes.

Soil Colour: Very dark grayish brown to black
Soil Structure: Weak to moderately strong sub-angular blocks

Soil Layering: > 4 horizons
Texture: Clay
Soil Consistence: Very firm when moist, sticky and plastic when wet, friable when moist
Depth: >3 m
Drainage: Imperfectly drained to poorly drained

Plate: 10 Firm and highly compact profile

The heavy, firm and compact clay in the sub-soil accounts for extremely low water uptake into the soil surface. This causes the impeded drainage thereby resulting into poor drainage conditions and inundation during the rainy season. However this may not cause a serious problem to an engineering structure because the sub-soil being firm and compact allows little water into the soil profile. The water only stands on the surface and is subjected to evaporation

3.14 Observation Point No 14

Reference Location: Profile Pit No 9, Near Kharanda (PP9)

Geographic Coordinates: Latitudes: 52858 N and Longitudes: 681229 E *(UTM coordinate system zone 36)*

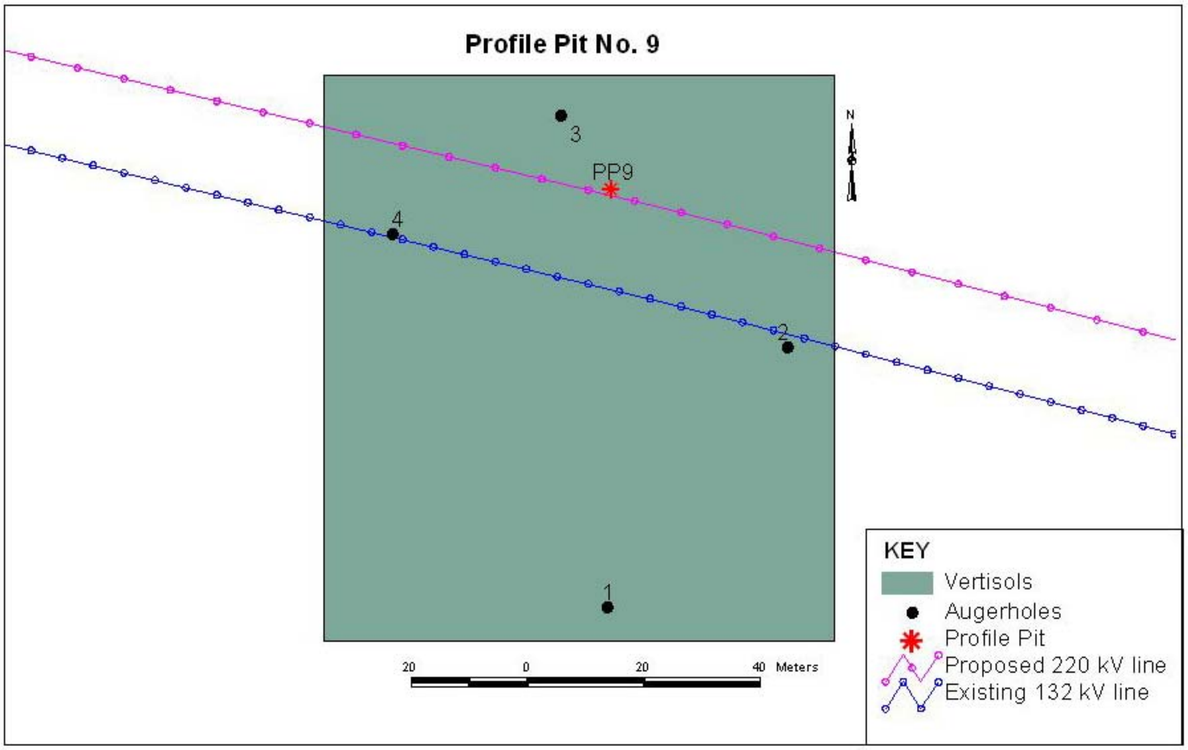


Figure 17: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 14

Topography, landform and land use: The area is located on a plain surrounded by the uplands, with slopes 0-2%. Land use is cassava, maize and cowpeas.

The soils: The soils are well drained, deep, sandy loam, overlying dense clay layer, on a weathering parent material at 2 m depth. The soils are Luvisols.

Erosion risk and bearing capacity: There is plenty sand over-wash, indicative of movement of materials from the surrounding uplands (Plate 15). The soil, as foundation material, is good due to the presence sandy loam, overlying dense and compact, non-cracking clay, over bedrock at 2 meter.

Soil Colour: Dark reddish brown
S**oil Structure:** weak to strong angular and sub-angular blocky
Soil Layering: > 3 horizons
Texture: Gravelly clay to clay

Soil Consistence: Slightly sticky and plastic to sticky and plastic when wet, friable when moist.
Depth: 2 m
Drainage: well drained

3.15 Observation Point No 15

Reference Location: The angle point No 6, near Kharanda (AP6)

Geographic Coordinates: Latitudes: 53166 N and Longitudes: 679805 E *(UTM coordinate system zone 36)*

Topography, landform and land use: This is located on sugar plantation on a plain, with the slope of <1%

The soils: The clay content increases with the depth. At the depth of 0-30 cm the top soil sandy clay loam, while it is clay loam at 30-60 cm. Beyond 60 cm, the texture is clay. The soil is well drained, friable and very deep. These soils are Luvisols.

Erosion risk and bearing capacity: Erosion is nil, no evidence of landslide and mass movement

Soil Colour: Dark reddish brown
Soil Structure: Weak to strong angular and sub-angular blocks
Soil Layering: >3
Texture: Sandy clay to clay
Soil Consistence: Slightly sticky and plastic
Depth: 2 m
Drainage: Well drained

3.16 Observation No 16

Reference Location: Profile Pit No 10, near Sipembe Power Sub-station (PP10)

Geographic Coordinates: Latitudes: 56068 N and Longitudes: 671881 E *(UTM coordinate system zone 36)*

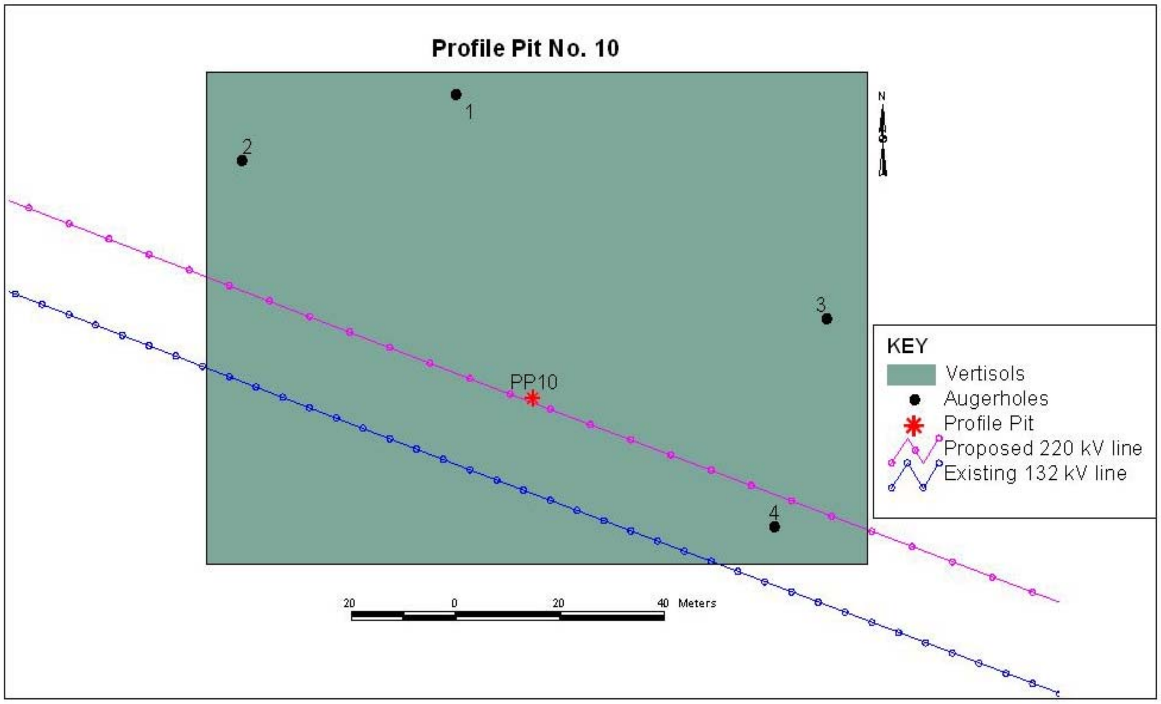


Figure 18: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 16

Topography, landform and land use: The physiographic of the area is upland with flat top and sloppy side. General slope 0 – 2%; cover less than 10% cultivated.

The soils: The soils are well drained, very deep, red clay

Erosion risk and bearing capacity: The soil lies in a very stable environment – no slumping, sliding or evidences of serious erosion. In this profile, when deemed necessary the engineering tests can be done up to 4m. However this observation is represented by the tests in to the angle point no.1 which is also red clay of a Nitisol. The soil goes up to 3m to hit the weathering rock material murrum layer. The 3 m layer is clay.

Soil Colour: red
Soil Structure: strong angular and sub-angular block with shiny ped surfaces
Soil Layering: > 3 horizons

Texture: clay
Soil Consistence: sticky and plastic when wet, friable when moist
Depth: 4m
Drainage: well drained

3.17 Observation Point No 17

Reference Location: Profile Pit No 11, at Namuini (PP11)

Geographic Coordinates: Latitudes: 59575 N and Longitudes: 662370 E *(UTM coordinate system zone 36)*

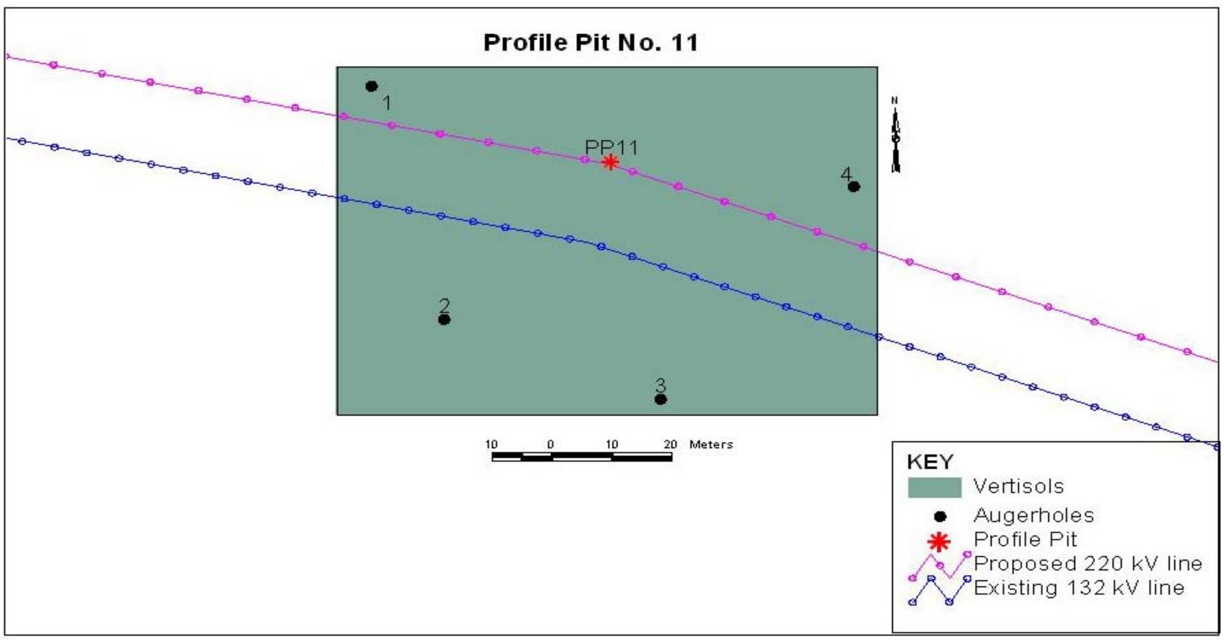


Figure 19: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 17

Topography, landform and land use: The point is located on a typical plain with 0% slope. The area is fallow with 80% grass cover. Land use in the surrounding area is cassava.

The soils: imperfectly to poorly drained soils, deep, firm cracking clay **(**Vertisols)

Erosion risk and bearing capacity: The soil is extremely firm and not very sticky but very plastic. The clay mineralogy is cracking type and yellowish brown in colour. The area is poorly drained as is indicated by

many red mottles. From the visual assessment of the soil, it has reasonable bearing capacity because the flooding water does not penetrate much into the soil because of relatively low Perrier and there is no lateral movement with the soil profile along the soil interfaces since the slope is flat. The soil is blackly and clay loam on the first 20 cm and the rest is Olivier brown, much mottle.
The bearing capacity should be tested to a depth of 4m and be compared to no. 1 were there is similar drainage problems.

Soil Colour: Very dark grey to black
Soil Structure: moderately strong angular blocky with shiny ped surfaces
Soil Layering: > 3 horizons
Texture: clay
Soil Consistence: sticky and plastic when wet and firm when moist.
Depth: 4m
Drainage: poorly drained

3.18 Observation Point No 18

Reference Location: Profile Pit No 12, at Miyanga (PP12)

Geographic Coordinates: Latitudes: 61581 N and Longitudes: 652422 E *(UTM coordinate system zone 36)*

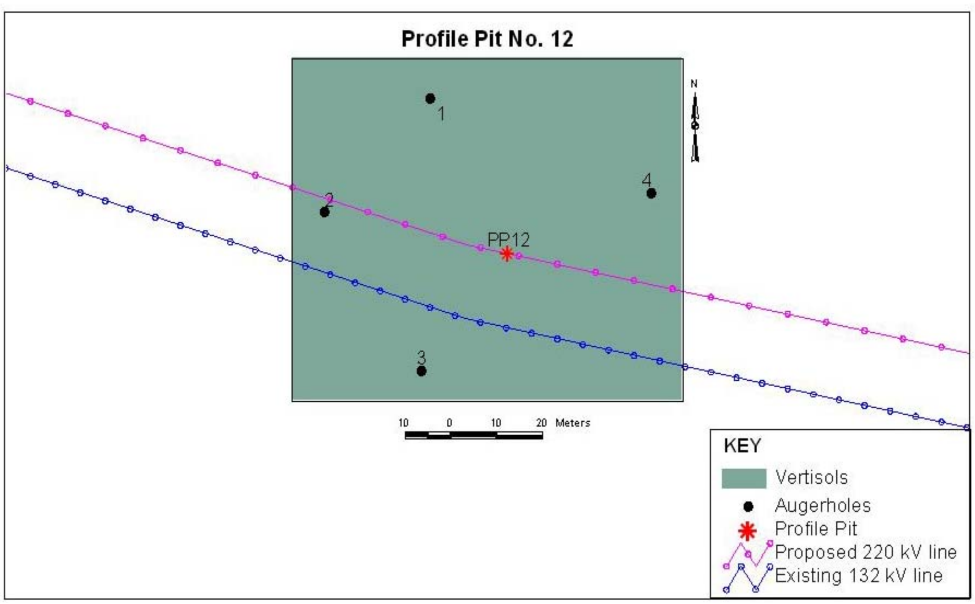


Figure 20: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 18

Topography, landform and land use: This is located on a level plain 0%. The area is a cultivated with maize, sugarcane and potatoes.

The soils: The soils are poorly drained soils, deep, firm cracking and shrinking clay **(**Vertisols)

Erosion risk and bearing capacity: The drainage condition is extremely poor with water standing on the surface condition of water logging is common in this unit (Plate 11). The clay is extremely plastic but relating test sticky like most clay. It behaves like pastor or parish. It is extremely firm and it is the shrinking and cracking type of clay. It is a cultivated area with maize, sugarcane and potatoes. A part firm inundation, flooding and water logging, land degradation through erosion is nil. The soil is black and clay loam/ sandy clay on the firm 10cm, but olivine brown with red mottles in the soil with huge anti-hills going up 2.5m high.

The water moves lateral with the soil profile because of the inundation and water logging. There is also surface movement through the drainage channels towards the semi profile. There is water milking on the profile.

Soil Colour: Very dark grayish brown to black
Soil Structure: weak to moderately strong angular blocky
Soil Layering: > 3 horizons
Texture: clay
Soil Consistence: very sticky and plastic when wet and extremely firm when moist.
Depth: 4m
Drainage: poorly drained

Low water permeability because of the impeded drainage causes the water to stand on the surface after the rains.

The observed management strategies on the ground by most farmers are raised cumber bed, which not only results into improved porosity, but also reduced compactness, thereby improving the water uptake and retention capacity

Plate 11: Poor drainage conditions

3.19 Observation Point No 19

Reference Location: Profile Pit No 13, at Amukura (PP13)

Geographic Coordinates: Latitudes: 61569 N and Longitudes: 652412 E *(UTM coordinate system zone 36)*

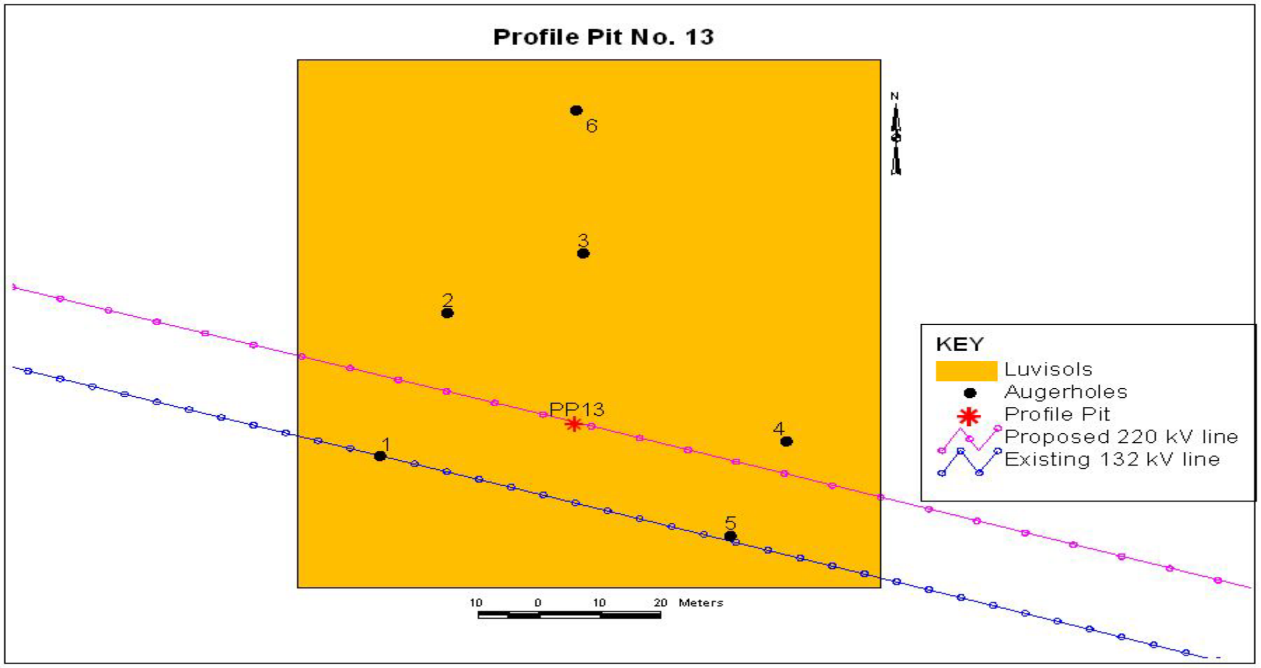


Figure 21: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 19

Topography, landform and land use: The area is located on a plain, surrounded by the uplands, with slopes 0-2%. Landuse is cassava, maize and cowpeas

The soils: The soils are well drained, deep, sandy loam overlying dense clay layer, on a weathering parent material at 2m depth (Plate 11)

Erosion risk and bearing capacity: The soils are loam to sandy clay loam. There is plenty of sand overwash, indicative of the movement of material from the surrounding uplands. In this profile the rock is at 2m depth. This profile is located on a structured plain much gently undulating slopes (0 – 2%).
(Plate 12) for the sand over wash
The soil is sandy loam topsoil overlying clay layer on the weathering parent material at the depth of 80 cm. the clay is none cracking type. These soils being a mixture of sand and none cracking clay provides very stable environment for engineering construction.

Soil Colour: dark reddish brown
Soil Structure: weak to strong sub-angular blocky
Soil Layering: > 3 horizons

Texture: clay
Soil Consistence: slightly sticky and plastic when wet and friable when moist.
Depth: 2m
Drainage: well drained

This is a double profile in which the sandy layer overlies the compact clay layer. The sandy materials have been washed and transported from the surrounding uplands, hills and footslopes. For engineering construction, the soil is very good

Plate 12: Profile with course textured over clay

3.20 Observation Point No 20

Reference Location: Profile Pit No 14, near Tororo (PP14)

Geographic Coordinates: Latitudes: 67332 N and Longitudes: 633404 E *(UTM coordinate system zone 36)*

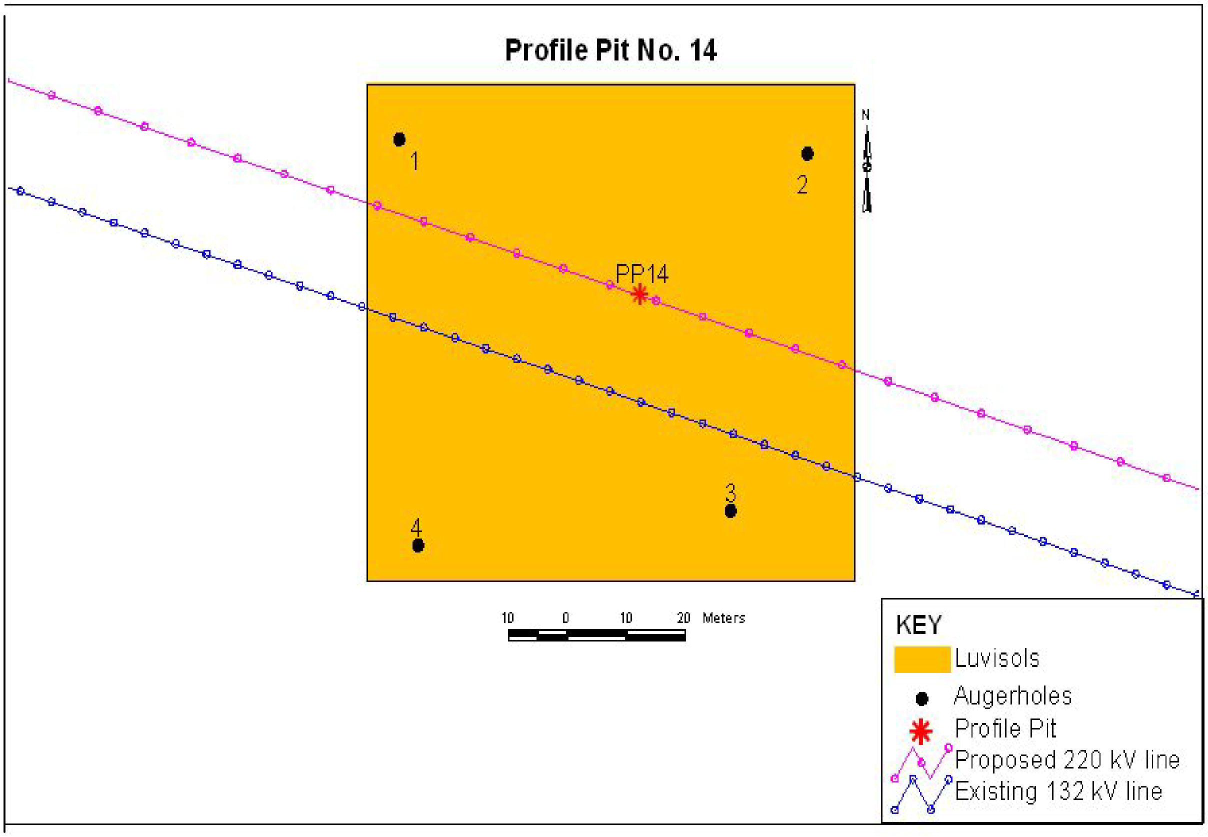


Figure 22: A GIS map showing the location of the soil profile pit, the location of the auger borings and the generally covered area on observation No 20

Topography, landform and land use: This profile is located on a structured plain much gently undulating slopes (0 %). The main land use type is maize.

The soils: The soils are well drained, deep, sandy loam overlying dense clay layer, on a weathering parent material at 2m depth **(**Luvisols)

Erosion risk and bearing capacity: The drainage condition is extremely poor with water standing on the surface condition of water logging is common in this unit. The area is Swampy meaning that the pylon would be erected in water-logged ground near a river (Plate 13), which borders Kenya and Uganda. The pylon is at risk and already KPL has put stones to repair the pylon. There is no accessibility to the pylon due to water.
Soil Colour: dark reddish brown
Soil Structure: weak to strong sub-angular blocky
Soil Layering: > 3 horizons
Texture: clay

Soil Consistence: slightly sticky and plastic when wet and friable when moist.
Depth: 2m
Drainage: well drained

3.21 Observation Point No 21

Reference Location: Tower 29 (T29), near Tororo at the border between Kenya and Uganda
Geographic Coordinates: Latitudes: 67641 N and Longitudes: 632338 E *(UTM coordinate system zone 36)*

Topography, landform and land use: This pylon is located on a structured plain much gently undulating slopes (0 %). The main land use type is palm like trees.

Erosion risk and bearing capacity: The drainage condition is extremely poor with water standing on the surface condition of water logging is common in this unit. The area is Swampy meaning that the pylon would be erected in water-logged ground near a river(Plate 13), which borders Kenya and Uganda. The pylon is at risk and already KPL has put stones to repair the pylon. There is no accessibility to the pylon due to water. These soils are Luvisols and vertisols.

Poor drainage conditions and waterlogging may require the construction of the raised grounds the same way it is in Lessos in a similar conditions to improve the environmental stability for the pylon construction.

Plate 13: Waterlogged conditions

4. The Engineering Properties of the Soils at selected Sites

4.1 Soil engineering properties

Soil engineering investigations are normally carried out to obtain information on the physical properties of soil and rock underlying (and sometimes adjacent to) a site to design earthworks and foundations for proposed structures and for repair of distress to earthworks and structures caused by subsurface conditions. For this project geotechnical investigations including surface exploration and subsurface exploration using geophysical methods were used to obtain data about the sites. Subsurface exploration involving soil sampling and laboratory testing of the soil samples retrieved were carried out.

Surface exploration including geologic mapping, geophysical methods, and photogrammetry were used to give an insight and to observe the physical conditions at the sites.

Ground investigation was the major means of obtaining information which assisted in the reporting on the planning, design and construction of the project. The work was divided into two stages – The first phase of investigations was carried out during the months of November and December and gave a good background on the nature of further investigations required for the project. It included surface investigation (topographic survey, service placement, estimation of excavation volumes, surface grades needed for drainage), and the subsurface investigations (location of ground water, soil types, soil depth to required bearing capacity, soil properties, etc).

The second phase of the investigation was to obtain information about the soil conditions below the surface. This involved geophysical investigations. This enabled us to observe the soils conditions below the surface, and also included obtaining samples, and determining physical properties of the soils and rocks from test pits and trenches.

The engineering properties of soil examined were:

- Maximum safe bearing pressure
- Depth to hard formation
- Liquid limit
- Natural soil moisture content

The measured engineering properties of the soils are indicated in Table 4. The measurements were made at seven sites that were considered to represent all the soils in the project area. The measurements were made using shear box test.

4.2 Maximum safe bearing pressure and depth to hard formation

When a structure, such as pylon is constructed on the ground, its load has to be transferred to the underground soil in such a manner that no damage occurs to the structure. There are two factors that need to be considered in designing the foundation of the structure:

(1) The load applied to the soil should be such that the induced stress in the soil is less than its bearing capacity.

(2) The settlement in the soil is such that it is within the tolerance limit of the structure, i.e., differential settlements should neither cause damage to the structure beyond unacceptable level nor interfere with the functions of the structure.

The maximum safe bearing capacity is, thus defined as the maximum pressure which may be applied to the soil such that the two fundamental requirements are satisfied. The foundation of the pylon should, therefore, be designed such that the allowable bearing capacity of the soil is not exceeded. The foundations may be in the form of footings, rafts, piles or wells. Footings and rafts may be adopted when the surface soils is capable of adequately supporting the loads of the structure, which in this case, is over 100kN/m^2 (estimated load for each pylon). Piles and wells are adopted when the surface soils are weak; hence loads need to be transferred to greater depth of the soil. The maximum safe bearing capacity of the soil for the representative observation points is given in Table 2. These are to be compared with load for each pylon to evaluate the probability of failure if the structure is constructed on the soil. On average, the bearing capacity of the soils is 2.5 times the estimated load for each pylon, indicating that it is safe to construct the structure. In addition, the ground formation on the natural state gives a very firm and stable formation at the depths between 1.5 and 3 m as is indicated by the results of the dynamic test for the representative sampling points (Table 4 and results shown on graphs).

Site investigation on selected points for the geo-technical investigations were carried out along the proposed power line. This work included the following tasks:-

- Dynamic Sounding.
- Excavation and sampling of disturbed samples from test pits at the selected points.
- Analysis of samples collected for engineering properties of the soils.

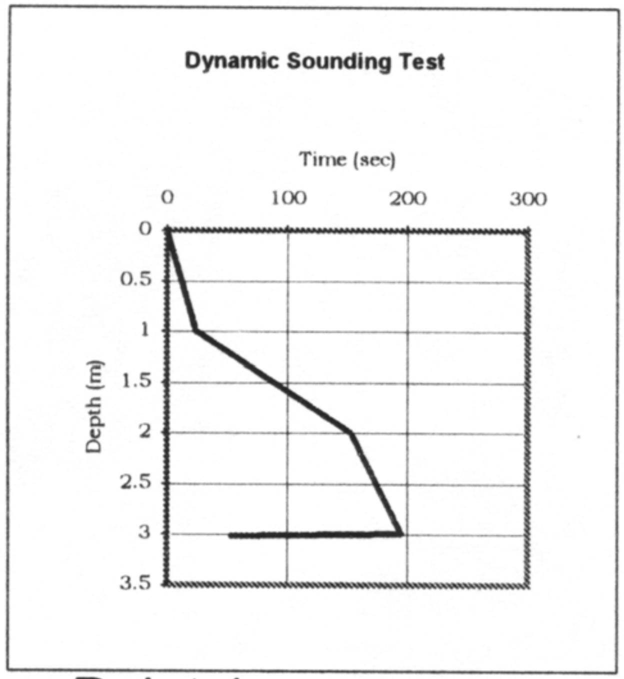
The proposed power line traverses different terrains, topography and vegetations as it runs through the different regions. The points investigated are located to represent different natural elevations soil conditions and engineering expectations.

The Test-pits were positioned to investigate different observed conditions at the site. Out of ten test-pits dug at the various sites, three distinct soil types were observed during the investigation. Black/grey clays, Red Clays and Gravel soils. These were observed to be influenced by the ground drainage conditions. These soils are what are commonly referred to as tropical soils. These are usually highly weathered soils, rich in oxides of iron and aluminium.

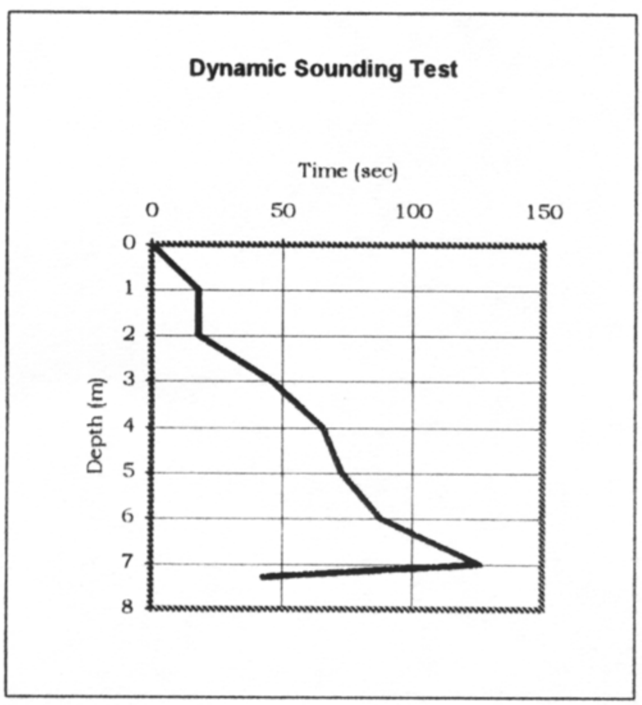
Table 4: Engineering properties of the soils measured in the field at representative sites

Sampling point No.	**Representing Observation Point Numbers**	**UTM GPS coordinates** Longitude Latitudes	**Depth of the test hole**	**Natural moisture content (%)**	**Liquid limit (%)**	**Maximum safe bearing pressure**	**Depth to hard formation from dynamic test (m)**
1		755326E 25353N	1.5	49.7			3.0
Angle point 1		751953E 26156N	2.0	35.3	64	240	7.3
4		727588E 39285N	1.5	21.5	38	250	4.8
Angle point 3		692624E 50005N	1.5	22.2			3.0
8		690886E 50400N	1.5	22.1		244	3.9
Angle point 6		679805E 53190N	1.5	24.3			3.6
6		710325E 47786N	2.0		44	267	>5.0
7		700558E 47786N	2.0	25.1		266	>4.0
11		662370E 59575N	1.5	19.3		234	6
12		652422 E 61581 N	2.0	46.3		270	5

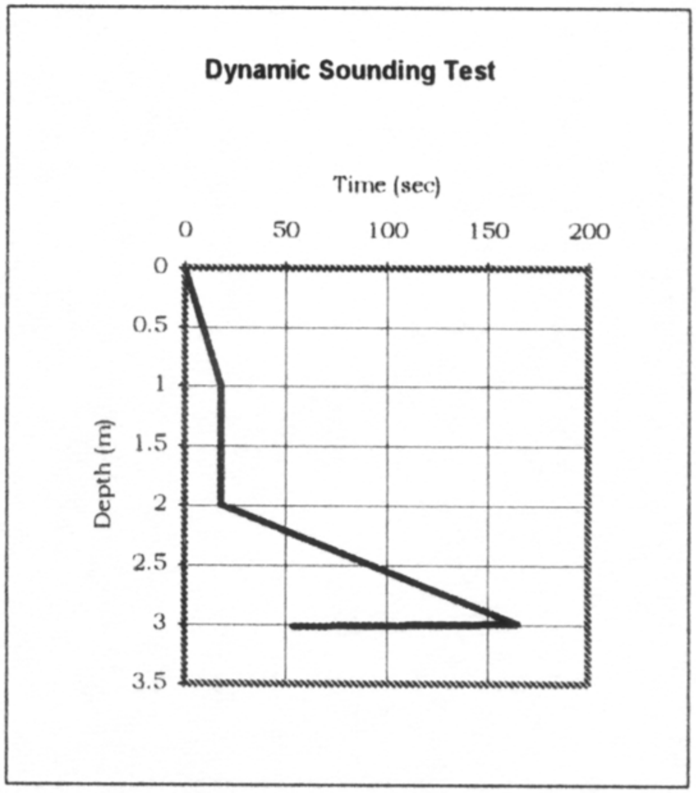
Dynamic test for representative sampling points.



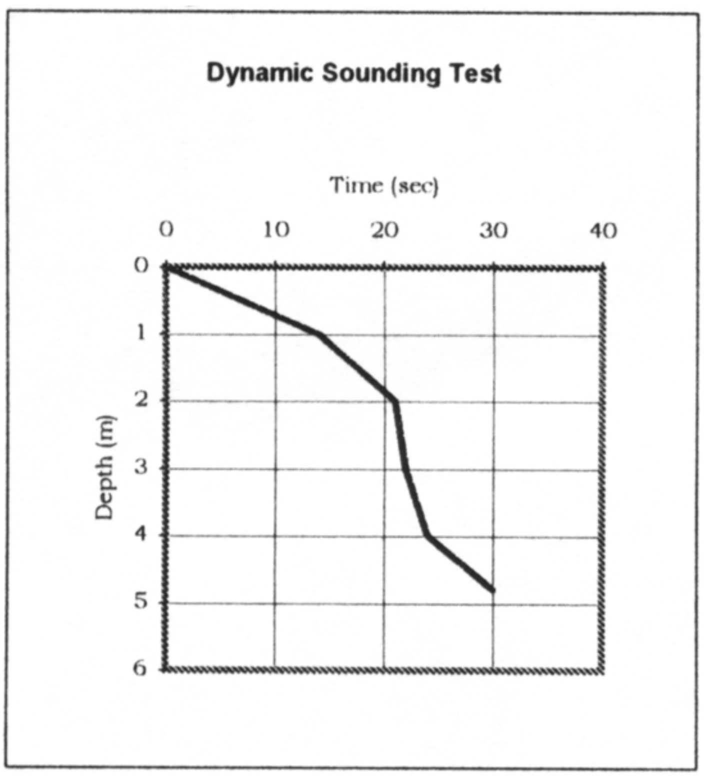
Point 1



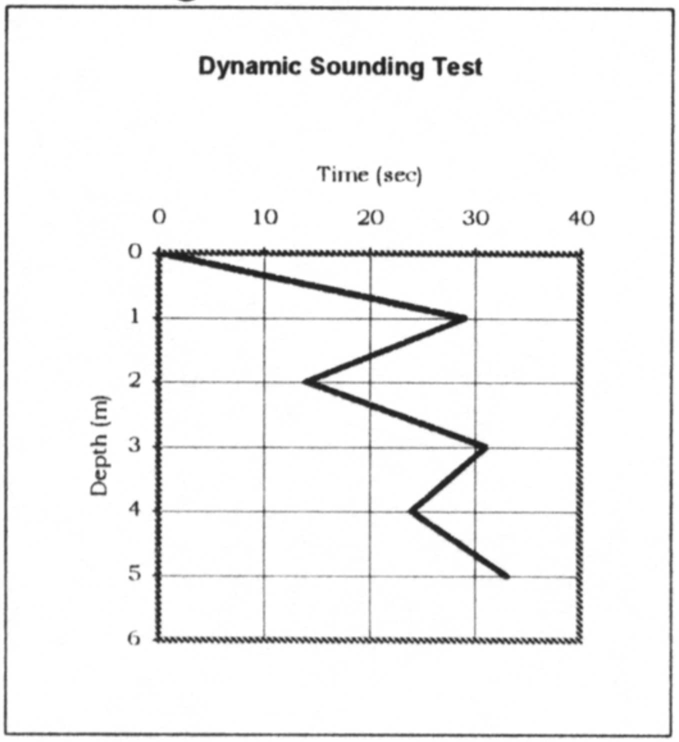
Angle Point 1



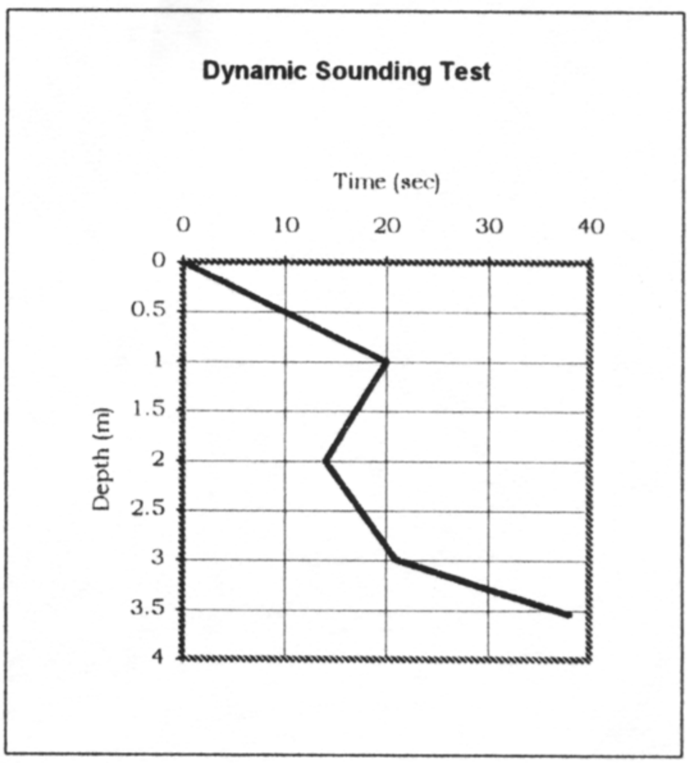
Angle Point 3



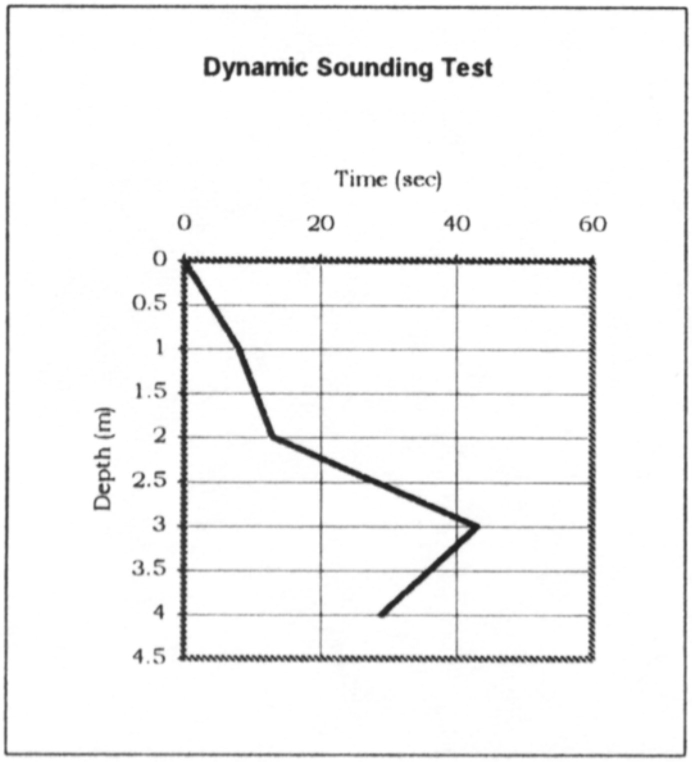
Angle Point 4



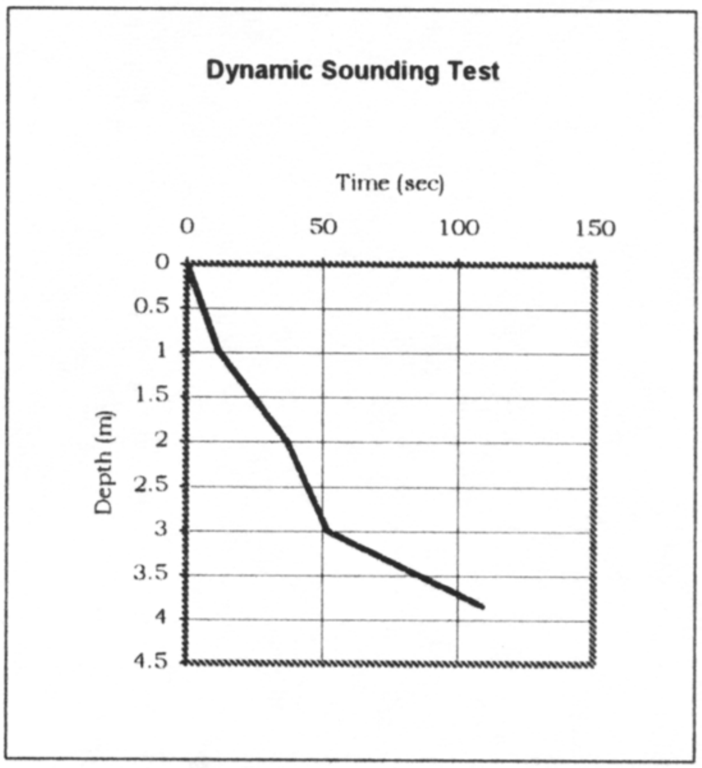
Point 6



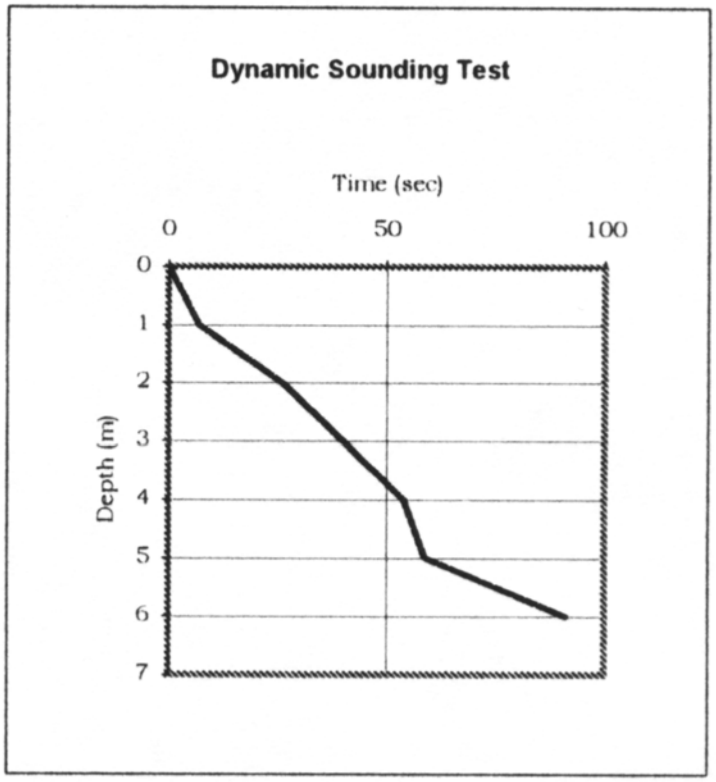
Angle Point 6



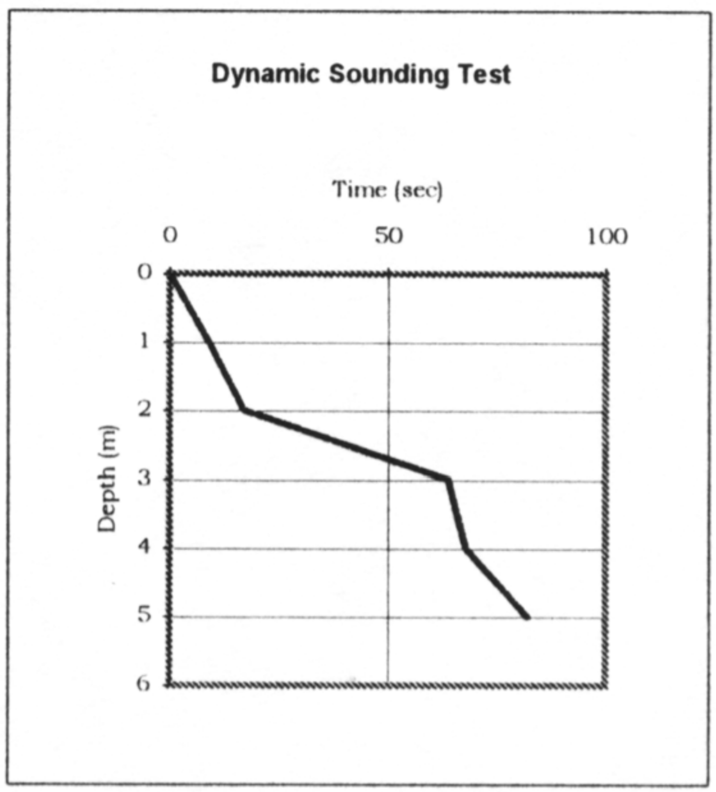
Point 7



Point 8



Point 11



Point 12

4.3 Natural moisture content and the liquid limit

It should be noted that the soil investigations were carried out when sporadic rains were experienced so the ground was near saturation, hence two-phase system. In a two phase solid-liquid system, the liquid, usually water, exists in pores of the soil. The natural moisture content for most soils is high. High moisture content reflects on soil's capacity to absorb and retain rain water, which, through deep percolation, recharges ground water. Soils with relatively low water absorbing capacity are most likely to generate more run-off, hence environmental degradation. However, the water retention capacity may be limited by shallow soil depth as outlined in the general description of soils in the first section of this report. According the Public Road Administration Classification of liquid limit, given by Garg (1987), liquid limit greater than 40% and not exceeding 60% is safe for engineering construction. This criterion is met by most of the soils observed, and in combination with the occurrence of hard material, makes the soil suitable for the construction of pylon (Table 5).

4.4 Observation from the field and Shear Box tests

From the field and the Shear Box test results carried out at the different locations, the following observations are made;

1. The ground formation on the natural state gives a very firm or stiff and stable formation at depths between 1.5 and 3m at all the sites. Dynamic sounding tests support this conclusion.

2. Profile of the sub-soils shows that there exists, very firm Natural SOILS at shallow depths below existing ground level.

3. Depth to Water table and subsequent water regime is not known.

4. At all the test points, shear test results indicate Safe bearing pressures at 1.5m depths of a maximum pressure **of 200** kN/m^2. This therefore should be the recommended safe bearing pressure.

5. Tropical soils are likely to be locally non-homogeneous and in-situ.

6. These soils exhibit several unique characteristics that influence their classification, properties and behaviour during construction as follows:
   a. Cemented particle aggregates and clusters are susceptible to breakdown,
   b. Properties may be changed significantly on drying,
   c. Hardening may develop on drying,
   d. In-situ moisture content is likely greater than optimum water content for compaction,
   e. Density, plasticity index, and compressibility are commonly lower, whereas strength and permeability are higher than values obtained for temperate zone soils of similar Liquid limits.

6. The Natural moisture contents are high, but not uncommon for these types of soils. It should be noted that these investigation were made when sporadic rains were experienced so the ground were fairly dump.

7. Presences of water normally have characteristic influence on tropical soils.

   - Red soils are normally susceptible to collapse potential
   - Whereas grey to black clays exhibit high swell potential.

5 Conclusions and Recommendations

An analysis was made from the subsurface and surfacial site characteristics and the measured engineering properties and out of which the observed sites were classified as either stable or unstable (Table 4).

Table 5: Stability of the proposed sites for engineering construction

Observation No	Erosion risk, landslide and mass movement	Stability of environment for engineering construction
1	None	Poor drainage conditions and seasonal waterlogging may render the site unstable. Major soils are Luvisols and Nitisols
2	None	Very stable. Major soils are Nitisols
3	Non	Very stable. Major soils are Nitisols.
4	High potential risk of erosion	Currently stable. Major soils are Andosols.
5	None	Very stable. Major soils are Andosols.
6	Very severe erosion	Relatively low. Major soils are Andoisols.
7	Non	Stable. Major soils are Lixisols.
8	High erosion risk	Stable. Major soils are Luvisols.
9	Low risk of erosion	Stable. Major soils are Luvisols and Acrisols.
10	High risk of erosion, overwash and material movement down the slope	Low stability. The major soils are Acrisols (top part) and Vertisols (in the bottomlands).
11	None	Very stable. Major soils are Nitisols.
12	None	Stability low due to poor drainage, inundation and shrinking clay. Major soils are Vertisols.
13	None	Stability low due to poor drainage and shrinking clay. Major soils are Vertisols.
14	None	Stable. Major soils are Luvisols.
15	None	Stable. Major soils are Luvisols.
16	None	Stable. Major soils are Nitisols.

17	None	Stability may be hampered by the shrinking clay and poor drainage condition. Major soils are Vertisols.
18	None	Very stable. Major soils are Vertisols.
19	None	Very stable. Major soils are Luvisols.
20	None	Very poor drainage conditions and waterlogging may hamper the stability. Major soils are Luvisols
21	None	Very poor drainage conditions, shrinking clay, waterlogging and the . Major soils are Luvisols and Vertisols.river influence, may hamper the stability.

Based on the findings outlined in Table 4, the following are recommended:

1. The exact pylon weight and location be established, based on the stability of the environment and the expected loads.

2. A more detailed analysis of engineering properties be carried out for the design of the foundation footing.

ANNEX C. SURVEY REPORT (UGANDA)

STUDY ON THE INTERCONNECTION OF ELECTRICITY NETWORKS OF THE NILE EQUATORIAL LAKES COUNTRIES (NELSAP) – UGANDA – KENYA INTERCONNECTION

Survey Report

1.Project and Scope of Services

1.1 The Project

NELSAP under the Nile Basin Initiative is carrying out a study on the interconnection of the electricity Networks of the Nile Equatorial Lakes Countries. This report is part of the whole study and is restricted to the topographical survey for the feasibility study on interconnection Transmission lines Uganda-Kenya and Uganda –Rwanda.

1.2 The Scope of Services

The services will generally consist of identification of line route by fixing angle points, and a topographical survey of the line route and descriptions of the line route as identified. The topographical survey will be done in the region 50 metres on either side of the centreline.

The general objectives of the study include:

i. the definition of a specific line routing based on fixed angle points and a corridor width of 100 meters (changed to 90 metres where the 220kV line runs parallel to 132kV lines), as defined in the pre-feasibility study report for the transmission lines for Uganda – Kenya and Uganda – Rwanda Interconnection project.The definition of the line routing shall take into consideration the issues outlined and recommendations made in the Environmental Impact Statement report.
ii. The optimisation of the routing taking into account the aim of avoiding dwellings and to mitigate environmental impact.

The specific objectives for the survey work in the feasibility study phase is:

a) to get mapped all the features along the proposed line routes
b) to provide UTM coordinates of all the features as measured by means of Global Positioning System(GPS)

The features captured included:

- All types of buildings (permanent and temporary)
- Overhead lines and cables(electric and telecommunication) crossings
- Underground cable crossngs
- Pipelines
- Roads(paved or unpaved, including tracks and paths)
- Railway crossings

- Walls, fences, tanks
- River brooks
- Protected areas
- Vegetation type
- Pasturelands
- Cultivated areas and type of crops
- Angle Points of existing 132 kV OVTL

The line routes were mapped to a distance of 50 metres on both sides of the centre line.
The levels of the following objects/features were measured:

- Roads and Railways
- Crossing of overhead lines and towers
- Water levels at the time of measurement
- Buildings
- Fences and walls.

c) to identify and determine the optimum alignment of the routing within the pre-feasibility report specified transmission corridor.
d) To provide a line route description of the elaborated line routing
e) To provide other information necessary for enabling the employer to satisfy that all environmental concerns and and consequences are are fully intergrated into the project.
f) Presentation of the results of the Survey work in form of maps to the extent as reasonable and in a separate report all details determined including list of coordinates.

1.3 Marking

Every angle point was marked by Concrete pegs with numbering AP ---(see photographs).

1.4 This Report

The purpose of this draft survey report is to present the data on the selected line route, the major problems encountered and the considerations made.

This report presents the routing by listing of coordinates for angle and dead end towers where possible, adetailed descripion of the routing and angle tower positions and photos taken during the survey,as well as the routing shown on 1:50,000maps and the available 1:10,000 Autocad maps. **Total Length AP1-AP 19A i.e. Bujagali –Tororo is 119km aproximately and Tororo – Malaba is 8km approximately.**

2. LINE ROUTING SURVEY

2.1. FIELD RECONNAISSANCE

The field recconnaissance started on 31st January 2007 from Bujagali Switchyard towards Tororo and further on to Malaba. The reconnaissance was completed on 3rd February 2007 at the existing substation at Tororo.

2.2 SURVEY FOR ANGLE POINTS

a) Where the line passes in new area far from existing 132kV line:
The angle points coordinates were scaled from the available map. The scaled coordinates were then entered into the Global Positioning System (GPS). Using the GPS in Navigation mode, the angle point position was fixed on the ground. The point would then be excavated up to 0.3 metres and concreted with a nail inserted to mark observation point. The angle point Number would then be engraved in the wet cement(e.g.AP1).

The procedure was repeated for all angle points far from the existing line.

b) Where new line is parallel to existing 132kV line:
For the purpose of the survey a fixed distance between the new and the old line have been decided upon. Following the detailed design an adjustment by some meters can easily be done The consultant has for the purpose of marking in the the field made approximately 40m to the old line angle tower and along its bisector.This was based on details in the prefeasibility report and recommendations from the TORs.
Note that the GPS used in fixing the angle points and details has submeter accuracy. This one works in a standalone mode. To improve on the accuracy Differential position fixing methods using DATAGRID GPS were used. The post processing resulted into coordinates as indicated –table 1.

2.2.1 SURVEY METHODOLOGY:

Three to four DATAGRID GPS receivers were used to survey and co-ordinate the pre-selected angle points. Avector between each adjacent angle point was ensured, and an occasional cross vector was introduced by redundancy.
It was imperative to co-ordinate the positions of the angle points with respect to the Uganda National Grid Mapping System,and this was achieved through the inclusion of four control points spread over the project site. Primary control was located near Buwenda(close to Bujagali) and Mwiri,while two points from recent mapping control in Iganga was located close to the proposed line. Apart from ensuring that the angle points were on a correct co-ordinates system, it also provided a check to the GPS vectors by running aGPS traverse between the control points. The vectors checked well,and on a whole, the results proved to be very favourable.

In certain cases where the control points were not available, the leap frog method was used to convert a former rover postion into a base position and move forward with the original base becoming the rover.

3.0. DETAIL SURVEY

The terms of reference and objectives of the survey stipulated the type of features to be captured (See Scope of services above). The survey therefore involved capturing coordinates of all detail points within the proposed corrdor of 50 metres either side of the centreline. The details were captured using standalone GPS receivers- PRO-XRS with sub-meter accuracy.

The main principle applied during the detailed survey was to minimise the impact of the transmission line construction on population and evironment.

Due to a high density of population near existing roads, this aim resulted in the transmission line being routed in rural areas a bit far from existing line e.g AP12,AP13 and AP14. Areas around Bugembe and Wanyange are heavily built. At the time of the initial survey the space along the existing 132kV OFPS – Tororo was un-occupied. Things have now changed and the proposed line was re –routed.

For the routing on the Uganda- Kenya interconnection, the following can be noted:

- The distance between the centre line of the proposed line and the 132kV line (angle towers) towers(co-ordinated position) was eventually fixed as minimum40m. This was based on information from the prefeasibility report.
- Angle towers 6A, 6B, 6C, 6D, 6E have been pegged after assessing the impossibility of using the old proposal as the area is heavily populated now.
- The road crossing at Kakira AP7 near Tower No.500. The proposed line was pushed away from the 40 metres position along the bisector. This position was falling in the Jinja- Bugiri road.
- At the railway crossing – AP9 The angle point was pushed approximately 50 metres away from Tower No.484 because the point 40 metres away was lying in an existing road. It is not easy to notice the angle as the deviation is only 2 degrees.
- AP11 to AP15 were placed in the villages where there are virtually no settlements seen. Access to angle point 13 was very difficult. The footpath/roads were hardly motorable.
- The section AP15-AP16 has some rock outcrops in some areas. Design considerations will take care of clearances in this area.
- AP17A was not occupied. At the time of survey, the area was submerged. The coordinates were derived from offsetting by 40 metres along the bisector of angle of the old line. River Malaba is crossed at this location and at the time of the survey, the waters had swelled. At the time of survey, water level was 1075.98 metres above sea level.
- Between AP19 and DE2(AP19A), the proposed line crosses the existing 132kV Tororo – Opuyo – Lira. The future plans for the wooden line is: to be relocated as developments associated with 220kV switchgear are implemented.
- Near AP19, there is a school and a church. The school bathrooms and toilets that may be affected can always be relocated.

On the map, most of the buildings indicated as houses are actually grass thatched semi-permanent houses.

220kV Tororo –Malaba

DE3 (AP20A) The position is a few metres from the proposed subststation land (220/132/33kV)

The substation layout is not yet known. The point will be accurately fixed after the design of the substation. It is also at this time that the relocation of 33kv outcoming lines will be decided.

- AP20A – AP20- Line point at Malaba – The line runs cloe to the existing 132kV Tororor - Malaba

Towards the border there is a brief passage in a sanctuary (see 1:250,000 map of the area).

The levels of the following objects/features were measured and are indicated as spot heights on the 1:10,000 detail map:

- Roads and Railways
- Crossing of overhead lines
- Water levels at the time of measurement
- Buildings
- Fences and walls.

Note that the proposed route runs on the Left hand side of the existing 132kV OFPS-Tororo-Malaba. The route does not cross the transmission line.

220kV Overhead line,Bujagali – Tororo

Angle Point co-ordinates
System: UTM Zone 36(30 E to 36E)

Angle	Northing	Easting	Section Length	Cumulative distance	Altitude	Remarks
			(metres)	(Chain age)		
AP1(DE1)	55200.95	514793.91			1133.09	Dead end tower at Bujagali
AP2	56022.56	514720.56	824.88	824.88	1106.24	
AP3	56249.92	515395.71	712.4	1537.28	1113.41	
AP4	53905.72	518132.65	3603.63	5140.91	1144.04	
AP5	52313.18	518973.68	1800.98	6941.89	1159.94	
AP6	52430.99	519180.77	238.26	7180.15	1174.9	
AP6A	53854.22	523942.3	4969.68	12149.83	1195.74	
AP6B	53557.06	524515.77	645.89	12795.72	1180.57	
AP6C	55370.13	527551.15	3535.64	16331.36	1219.99	
AP6D	54848.43	528996.78	1536.89	17868.25	1241.07	
AP6E	53619.49	530223.83	1736.65	19604.9	1178.38	

AP6F	53673.01	530736.19	515.15	20120.05	1157.98	
AP7	53615.19	530929.33	201.61	20321.66	1143.1	
AP8	53914.54	533949.3	3034.77	23356.43	1163.69	
AP9	54741.87	536192.83	2391.21	25747.64	1196.55	
AP10	58322.96	544619.64	9156.16	34903.8	1218.44	
AP11	58699.04	545500.56	957.84	35861.64	1141.46	
AP12	59045.86	557296.69	11801.23	47662.87	1163.38	
AP13	62643.66	570593.44	13774.89	61437.76	1088.18	
AP14	61244	577534.54	7080.81	68518.57	1112.91	
AP15	60422.05	577947.09	919.67	69438.24	1113.48	Adjacent to tower 355
AP16	60676.15	592678.7	14734	84172	1156.81	
AP17	62742.39	602816.43	10346	94518	1091.61	
AP17A	64635.51	607030.16	4619	99138	1075.98	NOT MARKED-GROUND IS UNDER WATER FROM RIVER MALABA
AP18	71697.19	617879.86	12945	112083	1116.62	
AP19	71956.85	622095.67	4224	116307	1143.16	
AP19A(DE 2)	70954.99	624392.73	2506	118813	1163.22	AT TORORO SUBSTSTION

220kV Overhead Line, Tororo-Malaba

Angle point co-ordinates
System:UTM Zone 36(30E to 36E)

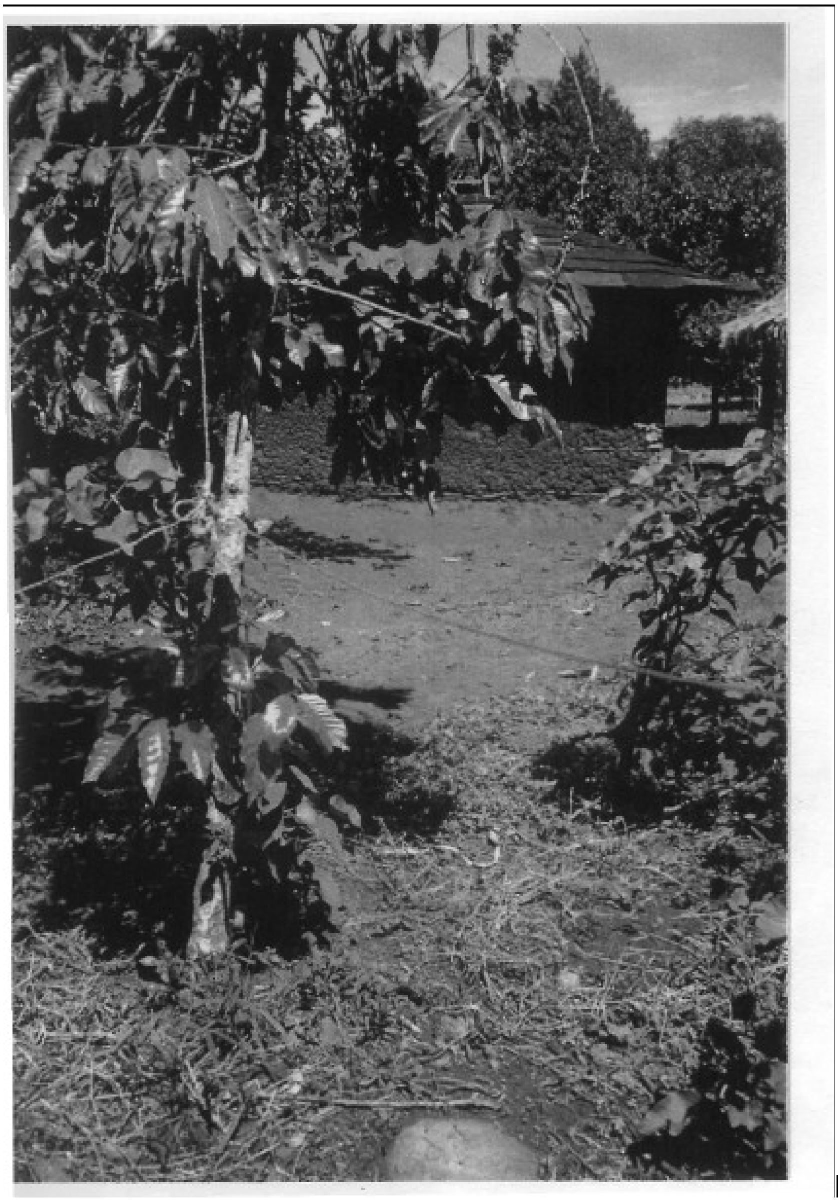
Site	Northings (m)	Eastings (m)	Section length	Chainage	ALTITUDE	Remarks
AP 20A(DE 3)	70890.97	624466.31			1163.12	At Tororo Substation
AP20	69635.48	626712.9	2574	2574	1220.81	
LP MAL ABA	68090.64	631893.79	5406	7980	1112.29	AT BORDER WITH KENYA

Total Length AP1-AP 19A i.e. Bujagali –Tororo is 119km aproximately and Tororo – Malaba is 8km approximately.

The information is depicted on maps of 1:10,000 in Autocad and also on map sheets at 1:50000 ad 1:250,000.

Picture taken at AP4-Bujagali- Tororo

Picture taken at AP5. A tower on the existing 132kV OFPS –Tororo is in the background.

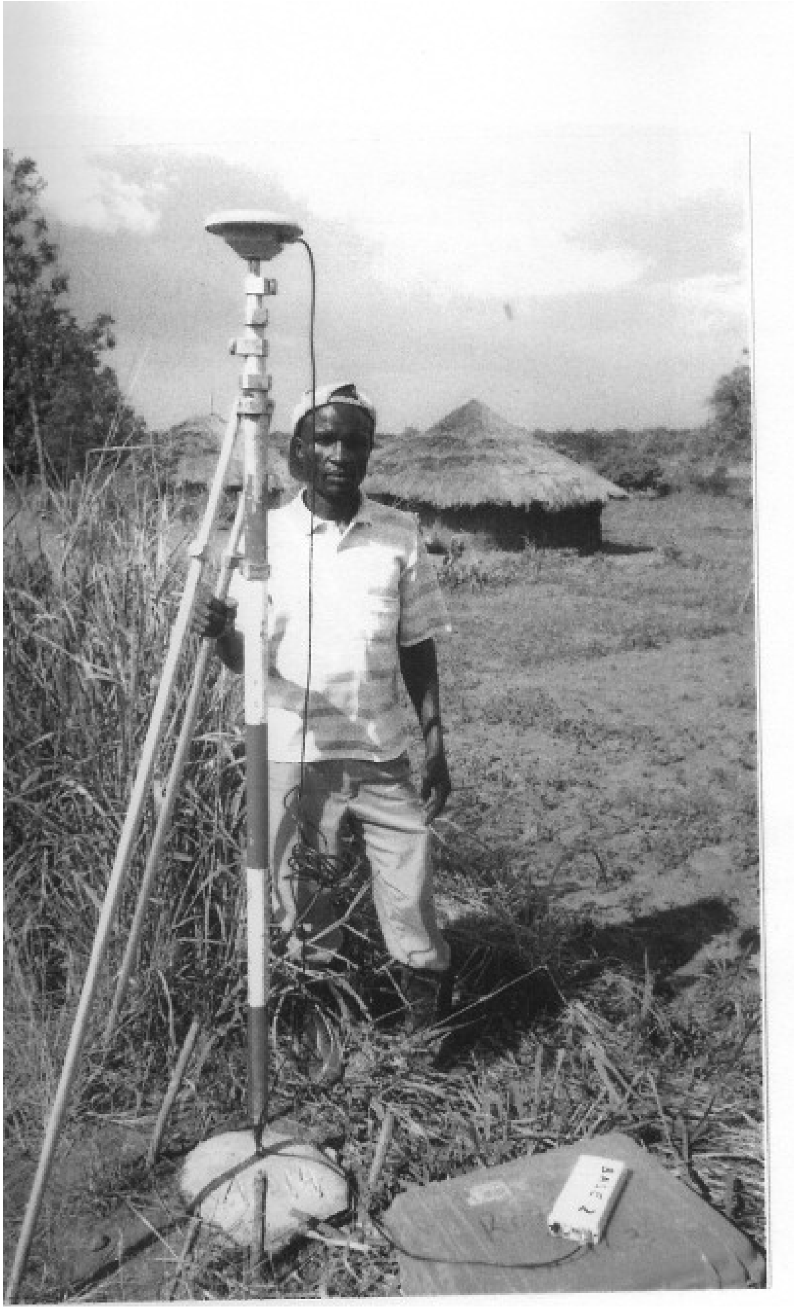


Picture taken at AP6-Crops in this part are mainly coffee, and Cassava.

Picture taken at AP6-Crops in this part are mainly coffee, and Cassava.

Survey of 220kV Bujagali- Toror. Photograph taken at AP11

Survey of 220Kv Bujagali –Toror. Typical access road of the 132Kvofps – Tororo.



Survey of 220Kv Bujagali – Tororo. Photograph taken at AP14

Survey of 220kV Bujagali-Tororo. Photograph taken at AP15.

ANNEX D. GEOTECHNICAL INVESTIGATIONS REPORT (UGANDA)

Geotechnical Investigations Report

March 2007

Feasibility Study on Interconnection Transmission Lines
Uganda – Kenya and Uganda – Rwanda

POWER NETWORKS Uganda Limited

Table of Contents

ANNEXES:

1 INTRODUCTION

1.1 General

This report gives a description of geotechnical conditions on the feasibility study routes for the interconnection transmission lines from; Bujagali to Tororo (Uganda - Kenya) and Mbarara to Mirama (Uganda – Rwanda).

A sites investigation programme was carried out from February 2007 to March 2007 to determine geotechnical conditions at the sites and to provide data for foundation design and construction related to civil works. More specifically, the scope of work included the following tasks: -

- Evaluating the soil bearing capacity
- Geologic mapping
- Conducting soil tests
- Compiling a technical report

1.2 Site investigations

A number of test pits were excavated and mapped. Dynamic cone penetration (DCP) tests were carried out in most test pits as well as in-situ density measurements. In summary the following activities were carried out: -

a) Excavation of 20 test pits using pick axes, hoes and spades. (13 on the proposed Bujagali - Tororo route and 7 on the proposed Mbarara – Mirama route). Locations of the test pits are shown on Drawings BT/GT/001 and MM/GT/001 in Annex 4.

b) DCP testing in 16 test pits (9 on the proposed Bujagali - Tororo route and 7 on the proposed Mbarara – Mirama route)

c) In-situ density tests in 15 test pits (10 on the proposed Bujagali - Tororo route and 5 on the proposed Mbarara – Mirama route)

d) Reconnaissance for potential construction materials

e) Geologic mapping. Geologic maps are presented on drawings BT/GT/002 and MM/GT/002 in Annex 4.

f) Laboratory testing was carried out to further identify the soils and rocks, and obtain parameters for determining their strength characteristics. The tests were done on disturbed soil samples. Laboratory testing was carried out at Teclab Ltd in Kampala. Testing procedures followed the appropriate British Standard practices. Laboratory testing included: -

- Moisture content
- Particle size distribution
- Atterberg limits

Dynamic Cone Penetration tests were carried out to derive the bearing capacities as opposed to Standard Penetration Tests (SPT) because available SPT equipment in Uganda can only be mounted on drill rigs, which would not have easily accessed most places.

General geologic maps and reports relating to the site areas were reviewed, notable among these; - The Uganda Geology 1966 by R. MacDonald.

All geotechnical data currently available, comprising laboratory test results, test pit reports, terrain photographs, and sites investigations activity photographs are presented in the Annexes.

2 Bujagali – Tororo Route

2.1 Location and Access

Bujagali is located in Eastern Uganda, near Jinja town, about 80 km from Kampala. Tororo is located about 131 km from Jinja by road. The proposed line is about 127 km in length and traverses a generally flat terrain. For most part, the proposed line runs parallel to the existing 132KV line from Jinja to Tororo sub station.

Access to most of the tower points for the proposed route is good considering that for much of the route there is already an existing access for the 132KV line. Some places, especially in swampy areas like Kibimba may not the easily accessible especially in the rainy seasons. Many of the swamps are shallow and are used for rice cultivation.

2.2 Regional Geology

The Bujagali –Tororo line traverses rock systems of the Buganda-Toro and Nyanza-Kavirondian, as well as Granitoid formations of precambrain age. Pleistocene to recent age sediments, alluvium and black soils are also encountered in some places like at Kibimba. Karoo-Ecca shales of palaeozoic age containing Glossopteris flora occur in small apparently down faulted outliners near Bugiri, while carbonatite rocks occur in Tororo area.

2.3 Site Geology

Amphibolote rocks underly the area of Bujagali up to around Magamaga, although rock exposure is rare. Quartzite rocks outcrop at Magamaga and are belived to border the amphibolites to the east. Near Waitambogwe granite rock outcrops, and continue all the way to Busolo area near Kibimba. Some cherty quartzites outcrop near Bugiri. Kibimba area is underlain by alluvium black soils. There is a lack of rock exposure between Kibimba area and Tororo, and laterite duricrust is common. Tororo area is mainly underlain with Carbonatite rock.

In most of the area, the rocks have undergone deep tropical weathering, producing an overburden that grades from mature residual soil through completely decomposed and weathered rock to fresh bed rock with depth.

Test pits were excavated to map the subsurface conditions and the findings are presented in Annex 1, and in the laboratory report in Annex 5.

This area has no known geological hazards.

2.4 Construction materials

A brief reconnaissance was done on possible sources of coarse and fine aggregates that can be used in the construction works.

Coarse aggregates can be obtained by opening up quarries at the many granite rock occurrences, or utilizing Amphibolite rock from the Jinja Municipal quarry at Masese.

A number of beach sand deposits with sufficient quantities of good quality sand exist along the shores of Lake Victoria. Most of the deposits are privately owned and are intermittently exploited for local use. One such deposit is found in Lwanika, about 40 Km from Jinja town, in the present day Mayuge district.

3 MBARARA - MIRAMA ROUTE

3.1 Location and Access

Mbarara is located in Western Uganda, about 282 km from Kampala. The proposed line is about 60 km in length and traverses hilly rolling terrain.

Access to most of the tower points for the proposed route is fair to good as in most places the line route is not far from motorable access roads. However in some swampy areas access may be difficult as in Nyabugando village (AP14), Kitojo parish, Rukoni sub-county, Ntungamo district. See terrain photos Annex 2.

3.2 Regional Geology

Mbarara to Mirama is underlain mainly by the Karagwe ankolean system of Precambrian age and afew Granitoid formations. Pleistocene to recent age sediments, alluvium and black soils are also encountered.

The Karagwe Ankolean system (Kibaran belt) is one of the major geological features of central and eastern Africa. It stretches generally along a NNE-SSW alignment. This system represents a low grade metamorphosed sequence of sediments.

Folding is abundant in the rocks of the Karagwe Ankolean system. The folds are generally open, having wavelengths of 8 -16 km, becoming tight with synclinal keels between adjacent arena granites. Regional thrusts of large scale are not known within the Karagwe Ankolean system of Uganda. Axial plane cleavages, however, are common within these folds (King and de Swardt 1970) and might have played an important role as planes of weakness for the subsequent development of certain faults that are observed to strike parallel to and also replace or even displace the limbs of some folds (King and de Swardt 1970).

3.3 Site Geology

Most of the hills are covered by argillaceous formations, while some are capped by quartzite horizons. The valley areas are generally steep, and some valleys have small streams running at their bases.

Shales, Quartzites and Granites are the dominant rock types in the area. The area is folded and faulted giving rise to a hilly terrain.

The shales are the dominant rocks in the area and show variation in color. There are the reddish brown ferrugnised shales and gray-purple shales. The shales contain many structural features like bedding, cleavage and jointing. Due to regional metamorphism, a change from shales to phyllites can be noticed.

The quartzites are light to brown colored, and jointed.

The granite rocks are light colored, medium to coarse grained, and with a massive texture.

Test pits were excavated to map the subsurface conditions and the findings are presented in Annex 1, and in the laboratory report in Annex 5.

This area has not experienced any known geological hazards in recent times. Despite being a hilly area, landslides are unheard of in the region.

3.4 Construction materials

Coarse aggregates can be obtained by opening up a quarry at the granite rock occurrences in Kitwe.

Small sand deposits exist in some valleys but their quantities are not known and the quality may not be very good. Alternatively fine aggregate may be obtained from the crushed rock.

4 BIBLIOGRAPHY

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King, B.C & Swardt, A.M.J. de. (1970: Problems of Structure and Correlation in the Precambrian Systems of Central and Western Uganda. Geological Survey of Uganda

Pallister, J.W. 'The Geology of Southern Mengo,' Report 1, Geological Survey of Uganda, 1959

Annex 1 – Test pit logs and photos

Table 1: Test pit logs and Pit photos – Bujagali Tororo route

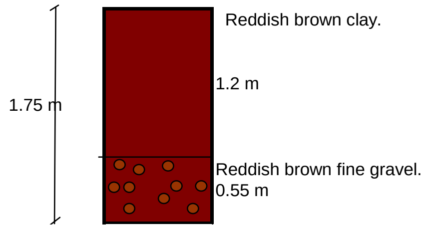
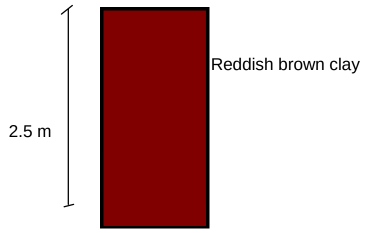
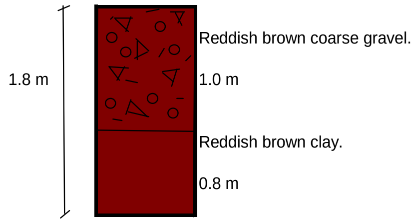
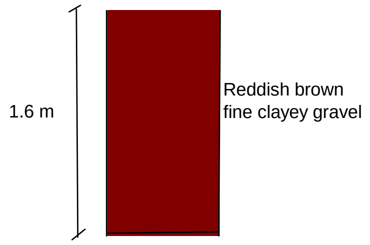
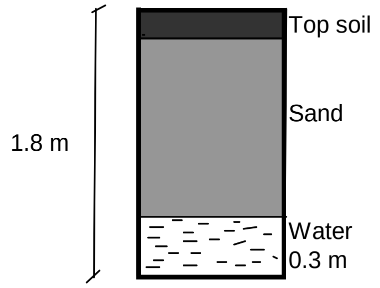
Test Pit No.	Coordinates (UTM)	Locality (Area)	Test Pit Log	Pit photo
B-TP1	N 55206 E 514780	Kikubamutwe/ Bujagali [Sub station]		
B-TP2	N 52315 E 518974	Buwenda		
B-TP3	N 53856 E 523924	Wakitaka		
B-TP4	N 53915 E 533951	Gomoja (Kakira Sugar Plantation)		
B-TP5	N 58698 E545700	Waitambogwe		

Table 1: Test pit logs and Pit photos – Bujagali Tororo route

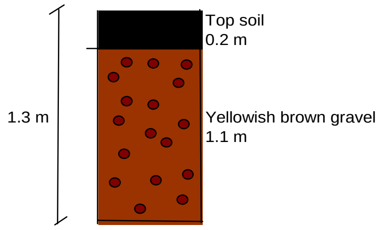
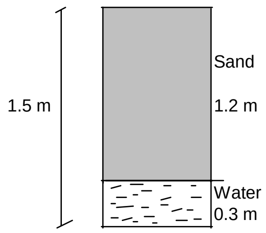
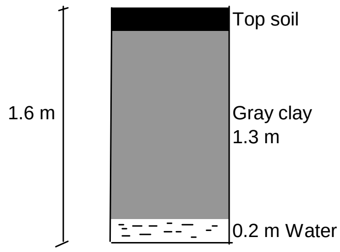
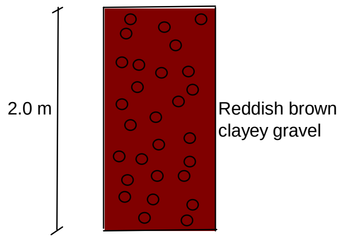
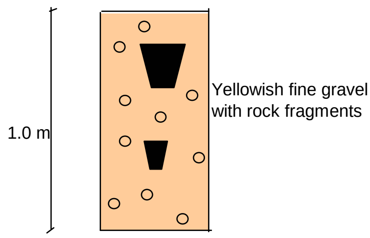
Test Pit No.	Coordinates (UTM)	Locality (Area)	Test Pit Log	Pit photo
B-TP6	N 59051 E 557300	Buwaiswa		
B-TP7	N 61700 E 567225	Nakivumbi		
B-TP8	N 62700 E 570650	Bukenke/ Bugodandala		
B-TP9	N 60676 E 577950	Magoola		
B-TP10	N 60676 E 592677	Busolo		

Table 1 (Continued): Test pit logs and Pit photos – Bujagali Tororo route

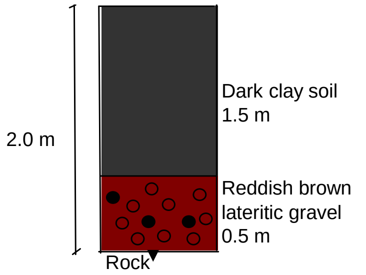
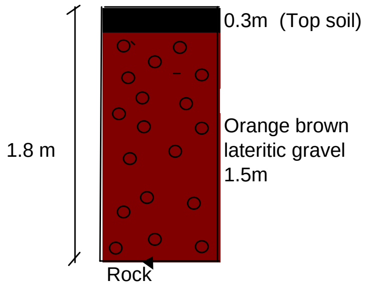
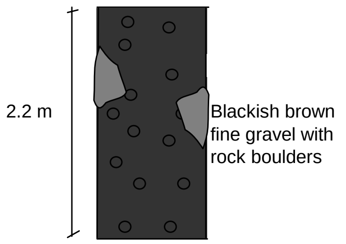
Test Pit No.	Coordinates (UTM)	Locality (Area)	Test Pit Log	Pit photo
B-TP11	N 62716 E 602698	Namuwombi		
B-TP12	N 71697 E 618880	Pimori		
B-TP13	N 69635 E 626712	Agoloto B		

Table 2: Test pit logs and Pit photos – Mbarara Mirama route

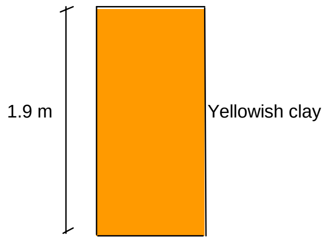
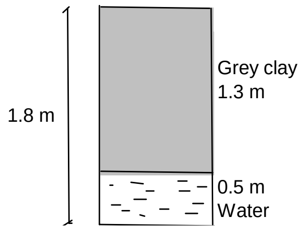
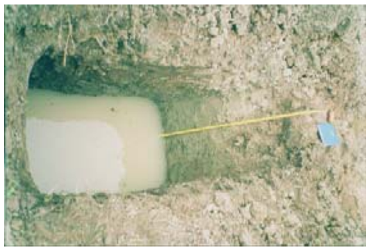
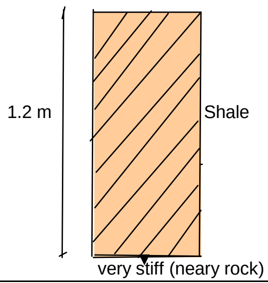
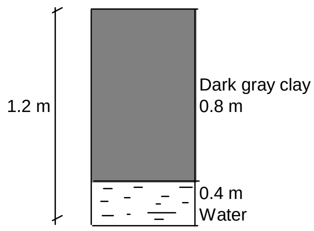
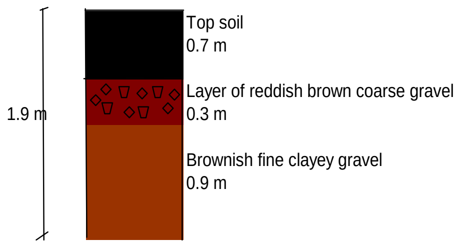
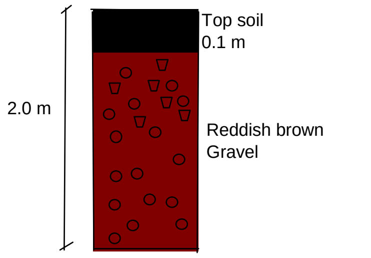
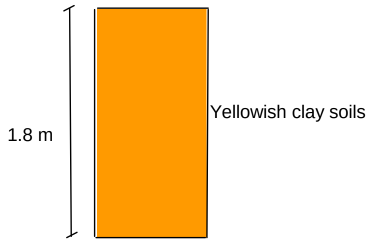
Test Pit No.	Coordinates (UTM)	Locality (Area)	Test Pit Log	Pit photo
M-TP1	N 9933947 E 234127	Mbarara Stock farm [AP1] Mbarara substation		
M-TP2	N 9925480 E 230120	Katukure/ Nyarubingo [AP4]		
M-TP3	N 9919776 E 224151	Mweya/ Kitoha [AP8]		
M-TP4	N 9910329 E 222220	Kigando/ Ngugo [AP11]		
M-TP5	N 9901700 E 222450	Nyabugando/ Kitojo [AP14]		

Table 2 (Continued): Test pit logs and Pit photos – Mbarara Mirama route

Test Pit No.	Location	Locality (Area)	Test Pit Log	Pit photo
M-TP6	N 9892269 E 219646	Kitwe [AP16]		
M-TP7	N 9889431 E 216228	Rwembogo/ Nshenyi [AP17] Mirama Substation		

Annex 2 – General terrain photos

Table 3: Terrain photos - Bujagali Tororo route

 **Bujagali site at substation area (AP1)**	 **Bujagali site general vegetation**
 **Gomoja/Kakira terrain, facing Bujagali (AP8)**	 **Gomoja/Kakira terrain, facing Tororo (AP8)**
 **Waitambogwe Terrain (AP11) facing Tororo**	 **Buwaiswa terrain (AP12), facing Tororo**

Table 3 (Continued): Terrain photos - Bujagali Tororo route

 **Bukenke/Bugodandala terrain (AP13), facing Tororo**	 **Terrain between Busolo and Bugiri area (AP16)**
 **Terrain at Busolo (AP16) area. Outcropping granite rock boulders common in the area**	 **Terrain between Busolo and Kibimba area**
 **Pimori terrain (AP18), facing Tororo**	 **Agoloto/Tororo terrain (AP20), facing Malaba**

Table 4: Terrain photos - Mbarara Mirama route

 **Terrain at Mbarara Substation area (AP1) facing old substation on Ibanda road**	 **Terrain at Mbarara substation area facing Mirama**
 **Terrain at area between AP3 and AP4**	 **Terrain at katukure (AP4) area, facing Mbarara**
 **Terrain at Mweya/Kitoha area (AP8), facing Mirama**	 **Terrain Kigando/Ngugo area (AP11)**

Table 4(Continued): Terrain photos - Mbarara Mirama route

 **Terrain Nyabugando/Kitojo area (AP14), facing Mirama**	 **Access through swamp to Nyabugando/ Kitojo (AP14)**
 **Terrain at Kitwe (AP16), facing Mbarara**	 **Terrain at Rwembogo/ Mirama substation (AP17), facing Mbarara**
 **Rock structure at Mweya**	 **Rock structure at road cutting between Mweya and Bugamba**

Annex 3 – Field activity photos

Table 5: Field activity photos

Dynamic Cone Penetration (DCP) test being carried out in one of the test pits

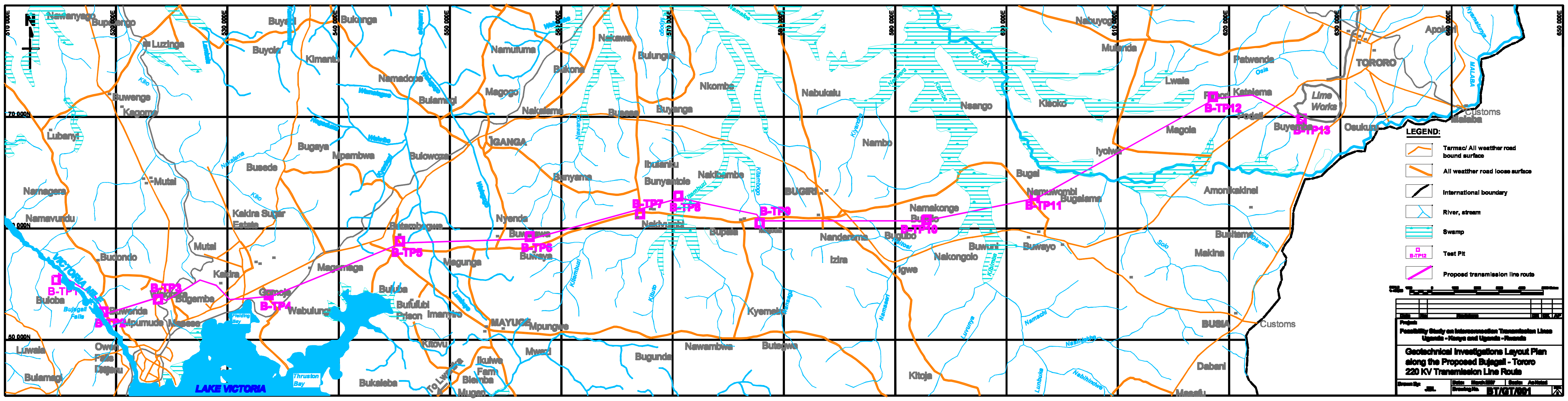
In-situ density test being conducted in one of the test pits

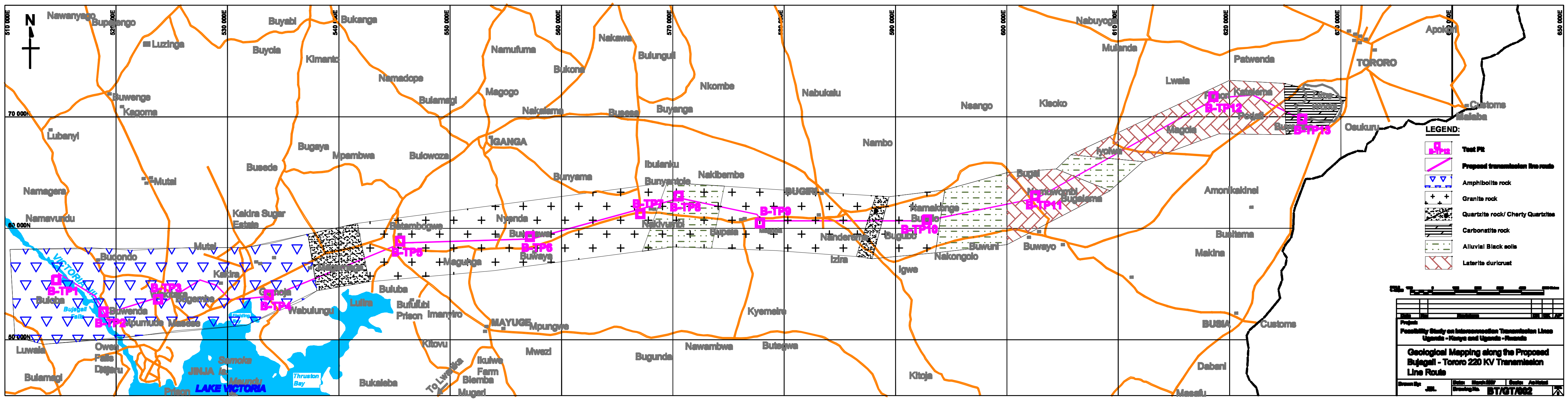
Weight measurements for in-situ density tests

In-situ density test being conducted in one of the test pits

General field work activities at Bukenke/ Bugodandala

Annex 4 – Drawings


LEGEND:
Tarmac/ All weather road bound surface
All weather road loose surface
International boundary
River, stream
Swamp
Test Pit
Proposed transmission line route
Project:
Feasibility Study on Interconnection Transmission Lines Uganda - Kenya and Uganda - Rwanda
Geotechnical Investigations Layout Plan along the Proposed Bujagali - Tororo 220 KV Transmission Line Route
Drawn By: JBL
Date: March 2007
Scale: As Noted
Drawing No. BT/GT/001
LAKE VICTORIA
TORORO
IGANGA
BUGIRI
MAYUGE
BUSIA
B-TP1
B-TP2
B-TP3
B-TP4
B-TP5
B-TP6
B-TP7
B-TP8
B-TP9
B-TP10
B-TP11
B-TP12
B-TP13


LEGEND:
Test Pit
Proposed transmission line route
Amphibolite rock
Granite rock
Quartzite rock/ Cherty Quartzites
Carbonatite rock
Alluvial Black soils
Laterite duricrust
Project:
Feasibility Study on Interconnection Transmission Lines Uganda - Kenya and Uganda - Rwanda
Geological Mapping along the Proposed Bujagali - Tororo 220 KV Transmission Line Route
Drawn By: JBL
Date: March 2007
Scale: As Noted
Drawing No. BT/GT/002
LAKE VICTORIA
TORORO
IGANGA
BUGIRI
MAYUGE
BUSIA
JINJA

Annex 5 – Laboratory report

Teclab ltd

THE ENGINEERS LABORATORY

Project: Feasibility Study on Interconnection Transmission Lines Uganda-Kenya & Uganda-Rwanda

Client: M/s Power Networks (U) Ltd.

March 2007.

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LIST OF TABLES

1. INTRODUCTION

At the request of M/S POWER NETWORKS (U) LTD., M/S Teclab Ltd. carried out geo-technical investigations along the electricity interconnection transmission line routes linking Uganda to Kenya and Rwanda through the Jinja - Tororo existing transmission line and the newly proposed Mbarara - Mirama border transmission line respectively.

The purpose of the geo-technical investigations was to determine the nature and incidence of different soil and rock types along the routes in order to obtain suitable geotechnical data for the design of appropriate foundations and earthworks.

The scope of the investigations was as follows;

i. Excavating test pits to 1.5 and 2.5m depths at 10Km intervals to determine the soil profile along both routes,
ii. Conducting Dynamic Cone Penetration Tests at 10Km intervals along both routes,
iii. Carrying out In-situ density tests using the sand replacement method.
iv. Sampling of soils and rocks for inspection, description and laboratory analysis,
v. Using the In-situ and Penetration test results obtain a rough estimate of the bearing capacity in accordance with Jennings et al (1973),
vi. Compiling a technical report.

The site investigations were conducted from the 14th to the 19th of February 2007 and this report forms the key output of the exercise and documents the field/site and laboratory activities that were carried out and the major findings are included in the subsequent chapters. Chapter 2 describes the site, whereas chapters 3 and 4 summarize the field and laboratory work executed respectively. Discussion of the field and laboratory results is covered in Chapter 5, and Chapter 6 details the evaluation of the bearing capacities. Chapter 7 contains the conclusions.

The detailed field records and laboratory test results are attached as Appendices herein.

2. THE SITE

The Jinja – Tororo site follows the existing 132 KV electricity transmission line that traverses a flat terrain and starts and ends at Bujagali and Tororo Boarder post respectively. The Mbarara – Mirama site in a new alignment traversing a hilly rolling terrain from Mbarara town to Mirama Boarder post.

Geologically, a Precambrian base of granite and gneisses, quartzites, schists, phylites and amphibolites underlie the Jinja – Tororo site. The soils covering the site are derived from the weathering of those underlying rocks. The Mbarara – Mirama site is underlain with Precambrian base of shales and phyllites, mica schist of the Karagwe-Ankolean system with swamp deposits and alluvium of the Holocene system.

The upper profiles of the Jinja – Tororo alignment have brown to red clayey gravels due to the presence of high contents of iron, and they attain a deeper coloration when found near more basic rocks where as the upper profiles of the Mbarara – Mirama alignment have grayish to yellowish clays with traces of brownish fine gravels.

3. FIELD WORK

3.1 General

The field exploratory activities were conducted in accordance with BS 5930: 1981 "Code of Practice for Site Investigations". These included test pit excavation, dynamic cone penetration tests, determining the level of occurrence of ground water, In-situ density tests and sampling of soils.

3.2 Test Pit excavation, Sampling, In-situ density tests and Dynamic Cone Penetration Tests

3.2.1 Test Pit excavation

The use of test pits as an investigation technique offers a quick and economical method for obtaining reliable geotechnical information for a variety of engineering solutions and was favored by the engineer during these investigations.

Twenty (20) test pits were excavated in total, thirteen (13) along Jinja – Tororo and seven (7) along Mbarara – Mirama routes using pick axes, hoes and spades. Test pits were located at 10Km intervals and were excavated to an average depth of 2.0m from the existing ground levels along both sites.

For each test pit the following was carried out:

- Soil profiling and recording the thickness of the existing soil layers.
- Sampling of the existing soil material for classification analysis
- Collecting disturbed samples from depths ranging between of 1.5 and 2.5m.

The existing soil lifts have been determined based on test pit investigations on site and are shown in the test pit excavation logs in ***appendix 1***.

3.2.2 Soil and or Rock Sampling

Soils and or rocks were retrieved from the sides of the excavated test pits, visually inspected, labeled and taken for laboratory analysis as disturbed soil samples (D-35).

3.2.3 In-situ density tests

Insitu Density Tests were included in the geotechnical investigation field work programme to determine the degree of compaction of the existing natural and fill material. The sand replacement method was used for this test in accordance with the requirements of BS 1377 Part 9.

The in place dry density was determined by forming a hole in the existing material and dividing the mass of the retrieved soil by the volume of the hole, the latter being determined by filling the hole with fine sand of a known density equal to 1.36 g/cc. The soil retrieved from the hole was dried to a constant mass in the laboratory.

The advantage of this test is that it gives an accurate value of in-situ dry density.

The dry densities were derived in KN/m^3 and used to correlate with the penetration results to obtain rough estimates of bearing capacities.

3.2.4 Dynamic Cone Penetration (DCP) Tests

DCP testing was carried out during dry conditions along both routes.

The DCP equipment used was a “Leonard Farnell and Co.” Standard TRRL penetrometer having the following characteristics;

- 8kg falling hammer
- 575 mm drop height
- 60◦ cone having a diameter of 20mm

A total of twenty (20) DCP tests were carried out with one test in each test pit so as to study the behavior of the underlying soils when subjected to loads.

The penetration tests were carried out to a depth of approximately 1.0m relative to the bottom of each test pit .Generally, the route along Jinja – Tororo presented difficulties during penetration in some areas unlike along Mbarara – Mirama route.

The results of the DCP test shown in appendix 2 have been converted to CBR values using the following empirical relationships between CBR values and penetration resistance.

Log_{10} (CBR) =2.632 -1.28 Log_{10} (Penetration resistance in mm per blow) …..[Kleyn and Van Heereden]

Log_{10} (CBR) =2.48 -1.057 Log_{10} (Penetration resistance in mm per blow) …..[TRL]

4. LABORATORY TESTING

Laboratory testing was carried out to further identify the soils and rocks, and obtain parameters for predicting their strength characteristics. Identification tests were done on disturbed soil samples. The tests were conducted according to the standard methods listed in Table 4.1 below.

Table 4.1: ***Laboratory Tests and their Standard test methods***

Name of Test	Standard Test Method	Sample Quality
Moisture content	BS 1377: Part 2: 1990	Disturbed
Particle size distribution	BS 1377: Part 2: 1990	Disturbed
Liquid limit	BS 1377: Part 2: 1990	Disturbed
Plastic limit	BS 1377: Part 2: 1990	Disturbed
Plasticity Index	BS 1377: Part 2: 1990	Disturbed

A full summary of the laboratory test results is presented herein as ***Appendix 2***.

5. INTERPRETATION OF FIELD AND LABORATORY TEST RESULTS

5.1 Field Results

5.1.1 Visual Results

Both sites were investigated up to an average depth of 3.0m with 1.0m covered using a dynamic cone penetrometer starting from the bottom of the excavated test pit. The Jinja – Tororo interconnection transmission line alignment was found to predominantly have gneiss rocks in various degrees of weathering whereas the Mbarara – Mirama interconnection transmission line alignment was found to predominantly have intrusive granites and Precambrian shales and phyllites with some alluvial swamp deposits.

5.1.2 Ground Water

Ground water was encountered in test pits 5, 7 and 8 along Jinja – Tororo route and test pits 2 and 4 along the Mbarara – Mirama route.

5.1.3 Dynamic Cone Penetration Tests (DCP)

On the basis of the DCP tests conducted in each test pit, the Jinja – Tororo and Mbarara Mirama border routes have been categorized into geotechnical units of varying strengths and stiffness as summarized in Tables 5.1 and 5.2 respectively.

Table 5.1: ***<u>In-situ description of the soil consistency along the existing Jinja – Tororo 220KV electricity transmission line route.</u>***

Test Pit No.	**Unit No.**	**Depth of occurrence (m)**	**Consistency**	Description
1	1	0.2-1.2	Medium dense	Weathered gneiss
	2	1.2-3.0	Very dense	Gneiss
2	1	0.2-3.5	Loose to medium dense	Gravelly Clay
3	1	0.5-1.0	Medium dense	Weathered gneiss
	2	1.0-2.8	dense	Weathered gneiss
4	1	0.5-2.6	Loose to medium dense	Gravelly Clay
5	1	0.5-3.0	Loose	Sand
6	2	0.2-1.5	Very dense	Weathered gneiss
7	1	0.2-1.5	Medium dense	Sand
8	1	0.1-1.5	Firm	Clay
9	1	0.2-3.0	Dense	Weathered gneiss
10	1	0.1-2.0	Very dense	Weathered gneiss
11	1	0.2-1.5	Firm	Clay
	2	1.5-3.0	Medium dense	Clayey Gravel
12	1	0.5-2.6	Medium dense	Weathered gneiss
13	1	0.2-3.5	Medium dense	Gravelly Clay

I

Table 5.2: In-situ description of the soil consistency along the newly proposed Mbarara – Mirama transmission line route

Test Pit No.	**Unit No.**	**Depth of occurrence (m)**	**Consistency**	Description
1	1	0.2-3.0	Very Firm	Clay
2	1	0.2-2.0	Dense	Clay
	2	2.0-3.0	Loose to medium dense	Sandy Clay
3	1	0.1-1.5	Very dense	Shale
	2	+1.5	Very Stiff	Weathered Precambrian rock
4	1	0.2-1.5	Dense	Clay
	2	1.5-2.5	Loose to medium dense	Sandy Clay
5	1	0.7-1.0	Dense	Coarse grained Gravel
	2	1.0-2.0	Dense	Clayey Gravel
6	1	0.1-2.0	Very dense	Clayey Gravel
7	1	0.2-3.0	Very Firm	Clay

5.2 Laboratory Test Results

5.2.1 Classification Test Results

Laboratory classification test results identified the soils along Jinja -Tororo route as gravelly clays of low plasticity and sandy clays with high plasticity which are residual products of weathering of gneiss rock. The Mbarara – Mirama route was found to be predominantly underplayed with clays of a high plasticity. *See **Appendix 3** for detailed test results.*

6. EVALUATION OF THE SOIL BEARING CAPACITY

The maximum pressures the soils and rocks are capable of resisting have been estimated from the laboratory test results, soil consistency observations, field dry densities and the bearing ratio values computed using the penetration resistance values that were obtained in the field. In the absence of information regarding the footing dimensions, a 1.0m square footing has been adopted. Further assumptions include the following:

i) The relationship between penetration resistance values and the allowable bearing pressure of cohesionless soils is valid;

ii) A Local shear failure mechanism;

iii) The factor of safety against local shear failure is 3;

iv) The maximum allowable settlement is 25mm.

The bearing capacity evaluations for Jinja – Tororo and Mbarara – Mirama routes are summarized in Tables 6.1 and 6.2 respectively.

Table 6.1: ***Soil/rock bearing capacities along the Jinja – Tororo route***

Test Pit No.	**Depths (m)**	**Approximate Bearing Capacity (KPa)**
1	1.5	400
2	1.5	150
3	1.5	300
4	1.5	350

5	1.5	200
6	1.5	350
7	1.5	100
8	1.5	150
9	1.5	450
10	1.5	300
11	1.5	350
12	1.5	500
13	1.5	250

Table 6.2: **Soil/rock bearing capacities along the Mbarara – Mirama route**

Test Pit No.	Depths (m)	Approximate Bearing Capacity (KPa)
1	1.5	350
2	1.5	200
3	1.5	500
4	1.5	150
5	1.5	300
6	1.5	350
7	1.5	400

The above are approximate bearing capacities at foundation depths of 1.5m.

7. CONCLUSIONS AND RECOMMENDATIONS

i. Jinja – Tororo alignment was investigated up to a maximum depth of 3.0m. It was found to contain a gneiss rock exhibiting various degrees of weathering.

ii. Water table was encountered in test pits 5, 7 and 8 at depths of 1.5m, 1.2m, and 1.4m respectively along Jinja – Tororo route and in test pits 2 and 4 at depths of 1.3m and 0.8m respectively along Mbarara-Mirama. The water table along Jinja – Tororo route is lower than the water table along Mbarara – Mirama border route.

iii. The soils along both routes are not likely to loose bearing strengths with slight moisture content increments.

iv. Evaluations indicate that the soil strata along both routes have unconfined strength values greater than 200 KPa. except for areas dominated by a high water table.

v. The recommended bearing capacity for a 1.0m square footing at a foundation depth of 1.5 m is 300 KPa.

8. BIBLIOGRAPHY

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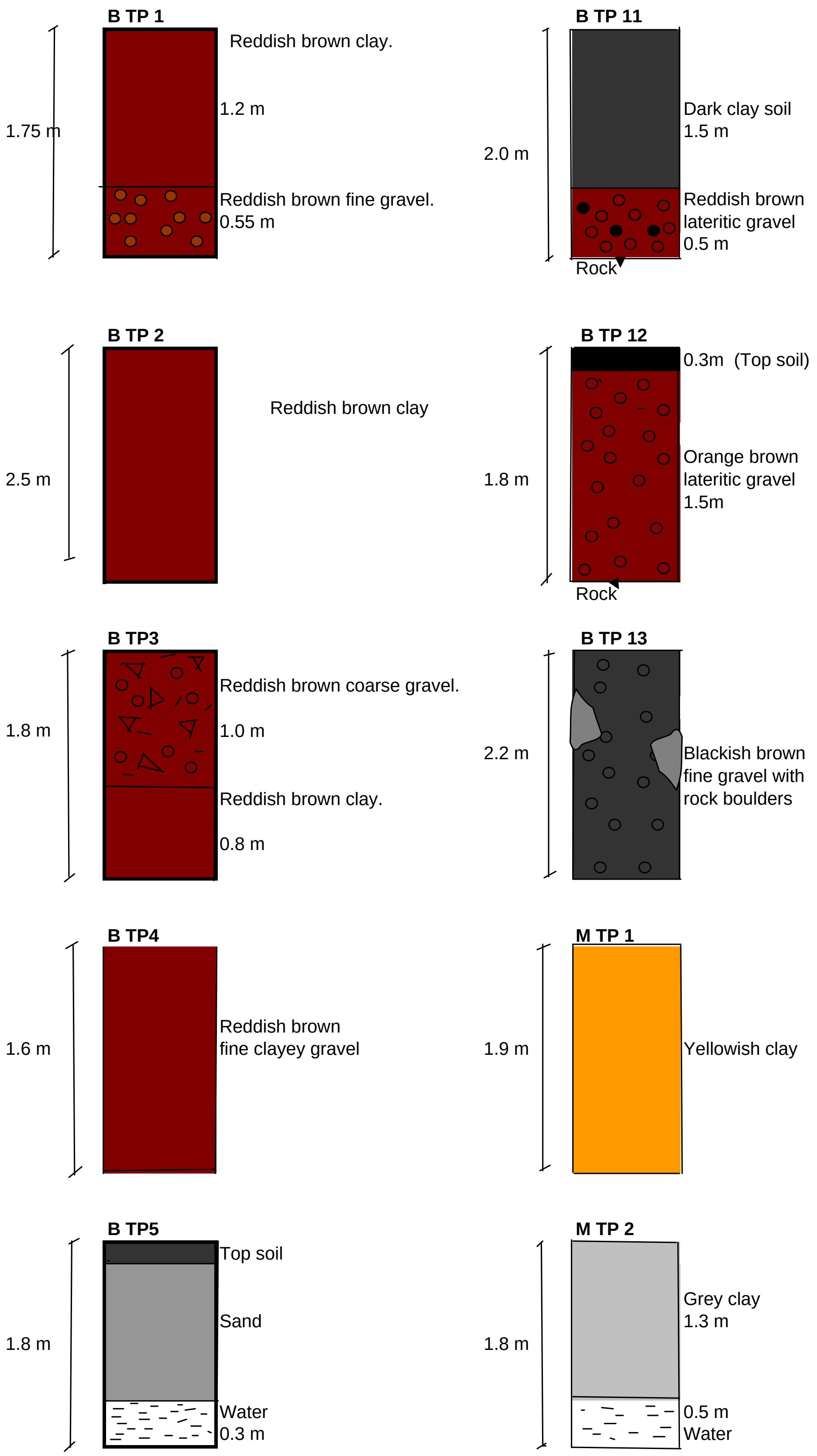
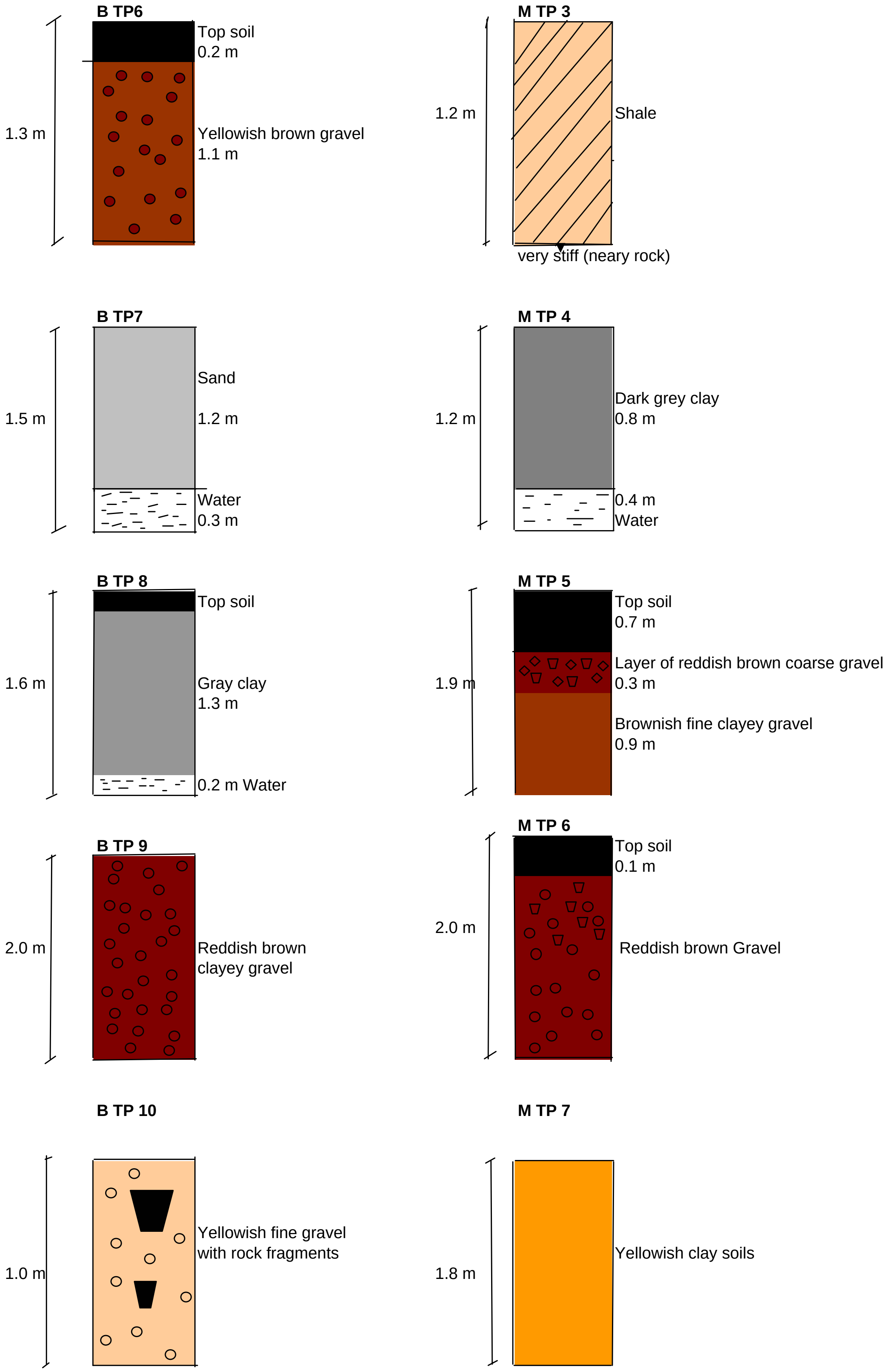
Appendix 1


B TP 1
1.75 m
Reddish brown clay.
1.2 m
Reddish brown fine gravel.
0.55 m
B TP 11
2.0 m
Dark clay soil
1.5 m
Reddish brown
lateritic gravel
0.5 m
Rock
B TP 2
2.5 m
Reddish brown clay
B TP 12
1.8 m
0.3m (Top soil)
Orange brown
lateritic gravel
1.5m
Rock
B TP3
1.8 m
Reddish brown coarse gravel.
1.0 m
Reddish brown clay.
0.8 m
B TP 13
2.2 m
Blackish brown
fine gravel with
rock boulders
B TP4
1.6 m
Reddish brown
fine clayey gravel
M TP 1
1.9 m
Yellowish clay
B TP5
1.8 m
Top soil
Sand
Water
0.3 m
M TP 2
1.8 m
Grey clay
1.3 m
0.5 m
Water


B TP6
1.3 m
Top soil
0.2 m
Yellowish brown gravel
1.1 m
M TP 3
1.2 m
Shale
very stiff (neary rock)
B TP7
1.5 m
Sand
1.2 m
Water
0.3 m
M TP 4
1.2 m
Dark grey clay
0.8 m
0.4 m
Water
B TP 8
1.6 m
Top soil
Gray clay
1.3 m
0.2 m Water
M TP 5
1.9 m
Top soil
0.7 m
Layer of reddish brown coarse gravel
0.3 m
Brownish fine clayey gravel
0.9 m
B TP 9
2.0 m
Reddish brown
clayey gravel
M TP 6
2.0 m
Top soil
0.1 m
Reddish brown Gravel
B TP 10
1.0 m
Yellowish fine gravel
with rock fragments
M TP 7
1.8 m
Yellowish clay soils

Appendix 2

Summary of laboratory test results for the proposed Trial pits/Areas.

Sample Identification	Sample Description	% passing the given standard sieves														GM	PM	PP	LL	PL	PI	NM	Dry Density
		75	50	37.5	20	10	5.0	2.0	1.18	0.600	0.425	0.300	0.212	0.150	0.075								
		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm				%	%	%	%	Kg/m^3
B TP1	Reddish brown with fine gravel	100	100	100	100	99	85	53	47	44	42	41	40	39	38	1.67	622	562	38.8	24.0	14.8	11.0	1448
B TP2	Reddish brown clay soil	100	100	100	100	100	100	98	98	97	97	97	96	96	95	0.10	2548	2493	51.8	25.5	26.3	26.0	1012
B TP 3	Reddish brown clay soil	100	100	100	100	100	100	97	96	96	95	95	95	95	94	0.14	2662	2623	57.0	29.1	27.9	20.0	1478
B TP4	Reddish brown with fine gravel	100	100	100	100	98	85	68	63	60	59	58	58	57	56	1.16	1921	1824	62.3	29.9	32.4	21.0	1693
B TP5	Sand	100	100	100	100	100	100	99	95	72	57	40	29	18	6	1.37	1433	158	25.5	0.0	25.0	14.0	1431
B TP 6	Gravel: Yellowish brown	100	100	100	97	84	53	31	25	20	18	16	15	14	12	2.39	279	186	34.8	19.4	15.4	11.0	1981
B TP 7	Sand	100	100	100	100	100	100	100	98	94	91	79	52	25	3	1.06	2361	81	26.0	0.0	26.0	13.0	1015
B TP 8	Grey clay															3.00	0	0	34.7	18.1	16.6	17.5	1430
B TP 9	Gravel: Reddish brown	100	100	100	97	92	70	55	51	47	45	42	42	42	40	1.60	948	854	49.7	28.5	21.2	10.5	2024
B TP 10	Yellowish fine gravel with rock fragments	100	100	100	100	99	95	77	60	45	38	34	31	27	24	1.62	900	564	24.0	0.0	24.0	7.2	1332
B TP 11	Lateritic gravel	100	100	100	92	76	57	42	37	33	31	29	27	25	23	2.03	939	702	30.0	0.0	30.0	9.2	
B TP 12	Lateritic gravel	100	100	100	100	83	54	33	28	24	23	21	20	18	16	2.28	740	507	32.3	0.0	32.3	9.5	
B TP 13	Dark fine gravel	100	100	100	98	94	77	35	32	31	31	29	28	26	24	2.11	354	273	30.1	18.5	11.6	11.5	1627
M TP 1	Yellowish Brown clay soils	100	100	100	100	100	99	97	96	92	91	87	81	72	64	0.49	1330	938	36.0	21.3	14.7	11.0	1803
M TP 2	Grey clay															3.00	0	0	24.2	10.8	13.4	20.0	1521
M TP 3	Shale material															3.00	0	0	25.0	0.0	25.0	16.6	
M TP 4	Dark grey clay															3.00	0	0	62.5	25.0	37.5	47.2	1047
M TP 5	Brownish gravelly material.	100	100	100	100	95	91	83	80	77	75	74	71	67	62	0.80	1175	969	48.3	32.7	15.6	20.0	1196
M TP 6	Gravel: reddish brown	100	100	100	97	89	77	65	61	50	42	38	36	33	31	1.62	475	350	32.8	21.6	11.3	13.0	1272
M TP 7	Yellowish brown clay soils	100	100	100	100	100	100	100	98	94	91	79	52	25	3	1.06	1044	36	27.1	15.1	11.5	11.0	1737

Key:
GM- Grading modulus
PM-Plasiticity modulus
PP-Plasiticity product
PL-Plastic limit
PI-Placiticity index
NM- Natural moisture
LL-Liquid limit

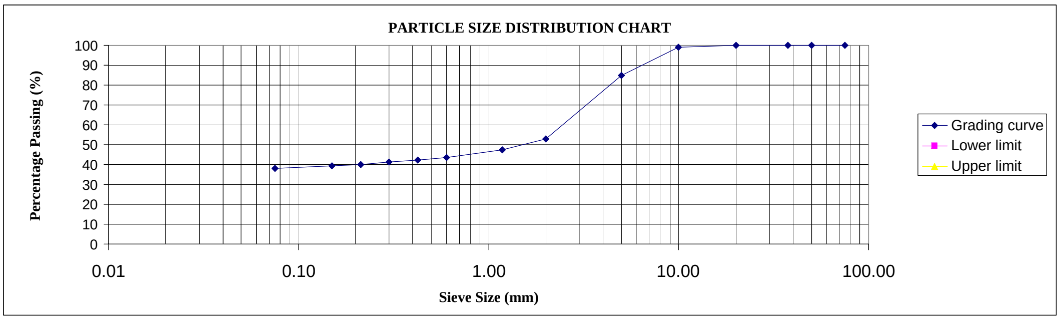
Appendix 3

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA		
Location/Source:	B TP1		
Soil Description:		**Client :**	NELSAP
Sample Reference:		**Sampling Date:**	
Technician:		**Testing Date:**	

Dry weight, M_3: 1500

B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing) Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	0	0.0	100		
10	10	15	1.0	99		
5.00	5.00	210	14.0	85		
2.00	2.00	480	32.0	53		
1.18	1.18	85	5.7	47		
0.60	0.60	55	3.7	44		
0.425	0.425	20	1.3	42		
0.300	0.300	15	1.0	41		
0.212	0.212	20	1.3	40		
0.150	0.150	10	0.7	39		
0.075	0.075	20	1.3	38		
Percentage Finer than 0.075 mm Sieve		38.0				



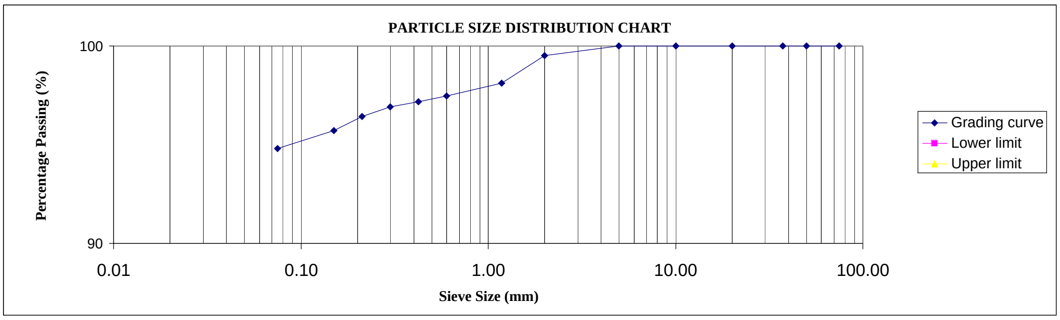
S.P Kisitu
For Teclab Ltd

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA					
Location/Source:						
Soil Description:		**Client :**	NELSAP			
Sample Reference:	BT 2	**Sampling Date:**				
Technician:		**Testing Date:**				

Dry weight, M_3: 700

B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing)	
					Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	0	0.0	100		
10	10	0	0.0	100		
5.00	5.00	0	0.0	100		
2.00	2.00	3.4	0.5	100		
1.18	1.18	9.8	1.4	98		
0.60	0.60	4.5	0.6	97.5		
0.425	0.425	2.1	0.3	97.2		
0.300	0.300	1.8	0.3	96.9		
0.212	0.212	3.4	0.5	96.4		
0.150	0.150	5	0.7	95.7		
0.075	0.075	6.4	0.9	94.8		
Percentage Finer than 0.075 mm Sieve		94.8				



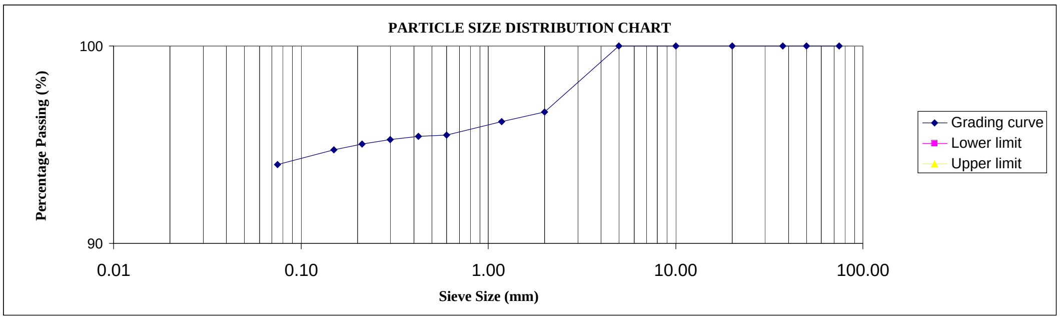
S.P Kisitu
For Teclab Ltd

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA				
Location/Source:					
Soil Description:		**Client :**	NELSAP		
Sample Reference:	BT 3	**Sampling Date:**			
Technician:		**Testing Date:**			

Dry weight, M_3: 600

B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing)	
					Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	0	0.0	100		
10	10	0	0.0	100		
5.00	5.00	0	0.0	100		
2.00	2.00	20	3.3	97		
1.18	1.18	3	0.5	96		
0.60	0.60	4	0.7	95.5		
0.425	0.425	0.5	0.1	95.4		
0.300	0.300	1	0.2	95.3		
0.212	0.212	1.3	0.2	95.0		
0.150	0.150	1.7	0.3	94.8		
0.075	0.075	4.5	0.8	94.0		
Percentage Finer than 0.075 mm Sieve		94.0				



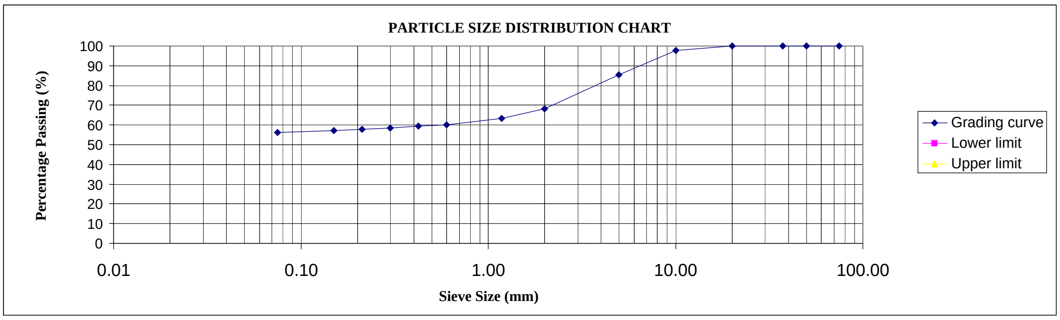
S.P Kisitu
For Teclab Ltd

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA					
Location/Source:						
Soil Description:		**Client :**	NELSAP			
Sample Reference:	BT 4	**Sampling Date:**				
Technician:		**Testing Date:**				

Dry weight, M_3: 1400

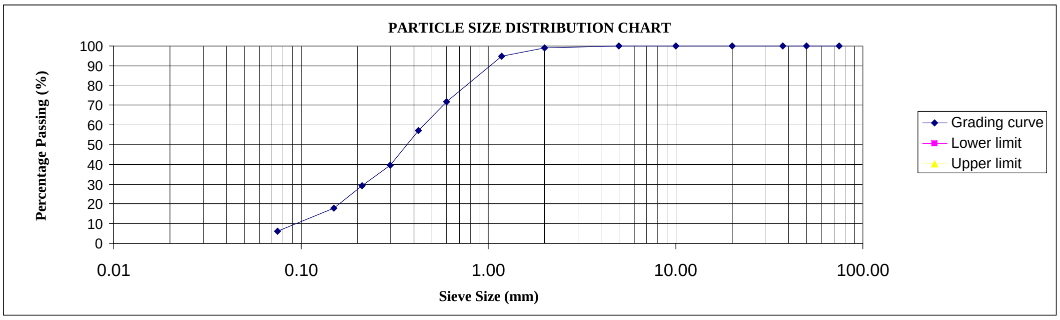
B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing)	
					Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	0	0.0	100		
10	10	30	2.1	98		
5.00	5.00	175	12.5	85		
2.00	2.00	240	17.1	68		
1.18	1.18	70	5.0	63		
0.60	0.60	45	3.2	60.0		
0.425	0.425	10	0.7	59.3		
0.300	0.300	12	0.9	58.4		
0.212	0.212	10	0.7	57.7		
0.150	0.150	10	0.7	57.0		
0.075	0.075	10	0.7	56.3		
Percentage Finer than 0.075 mm Sieve		56.3				



S.P Kisitu
For Teclab Ltd

PARTICLE SIZE DETERMINATION

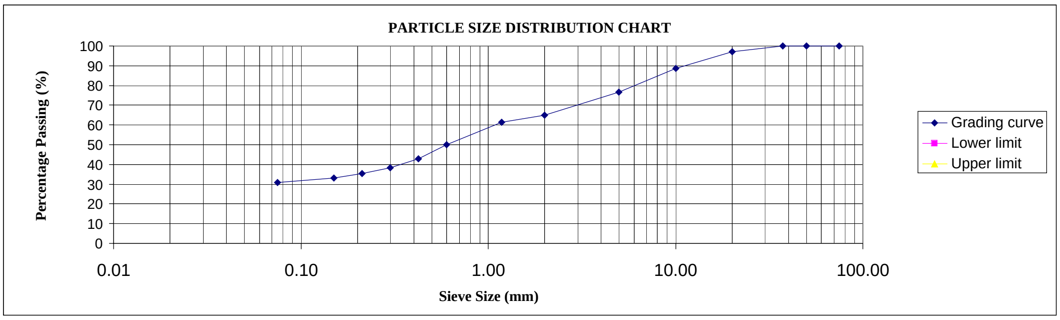
Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA					
Location/Source:						
Soil Description:			**Client :**	NELSAP		
Sample Reference:	BT5		**Sampling Date:**			
Technician:			**Testing Date:**			
	Dry weight, M_3:	480				
B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing) Lower limit	Specified limits (%ge passing) Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	0	0.0	100		
10	10	0	0.0	100		
5.00	5.00	0	0.0	100		
2.00	2.00	5	1.0	99		
1.18	1.18	20	4.2	95		
0.60	0.60	110	22.9	71.9		
0.425	0.425	70	14.6	57.3		
0.300	0.300	85	17.7	39.6		
0.212	0.212	50	10.4	29.2		
0.150	0.150	55	11.5	17.7		
0.075	0.075	55	11.5	6.3		
Percentage Finer than 0.075 mm Sieve						



S.P Kisitu
For Teclab Ltd

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA					
Location/Source:						
Soil Description:		**Client :**	NELSAP			
Sample Reference:	BT6	**Sampling Date:**				
Technician:		**Testing Date:**				
	Dry weight, M_3:	2000				
B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing) Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	60	3.0	97		
10	10	165	8.3	89		
5.00	5.00	240	12.0	77		
2.00	2.00	235	11.8	65		
1.18	1.18	75	3.8	61		
0.60	0.60	225	11.3	50.0		
0.425	0.425	145	7.3	42.8		
0.300	0.300	90	4.5	38.3		
0.212	0.212	55	2.8	35.5		
0.150	0.150	45	2.3	33.3		
0.075	0.075	45	2.3	31.0		
Percentage Finer than 0.075 mm Sieve						



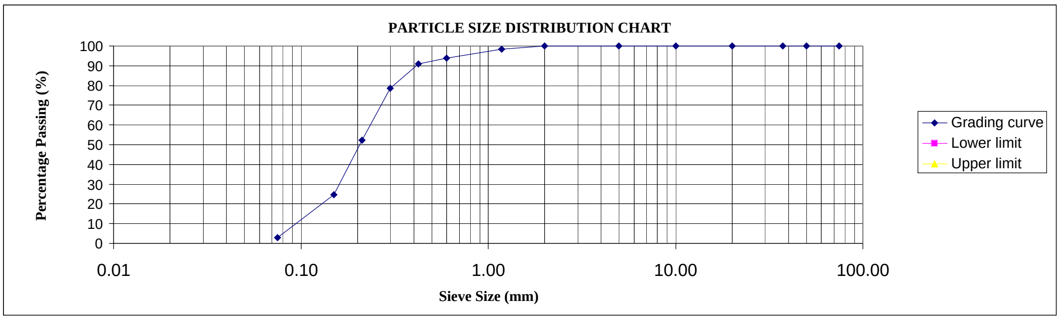
S.P Kisitu
For Teclab Ltd

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA		
Location/Source:			
Soil Description:		**Client :**	NELSAP
Sample Reference:	BT7	**Sampling Date:**	
Technician:		**Testing Date:**	

Dry weight, M_3: 325

B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing) Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	0	0.0	100		
10	10	0	0.0	100		
5.00	5.00	0	0.0	100		
2.00	2.00	0	0.0	100		
1.18	1.18	5	1.5	98		
0.60	0.60	15	4.6	93.8		
0.425	0.425	10	3.1	90.8		
0.300	0.300	40	12.3	78.5		
0.212	0.212	85	26.2	52.3		
0.150	0.150	90	27.7	24.6		
0.075	0.075	70	21.5	3.1		
Percentage Finer than 0.075 mm Sieve						



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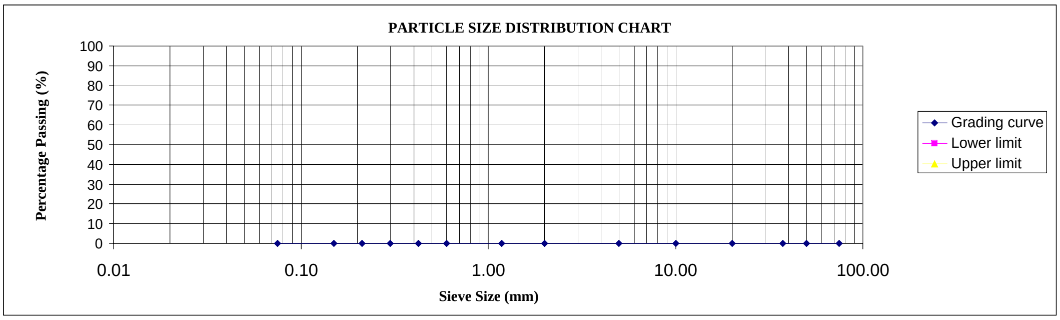
For Teclab Ltd

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA					
Location/Source:						
Soil Description:			**Client :**	NELSAP		
Sample Reference:	B TP 8		**Sampling Date:**			
Technician:			**Testing Date:**			
	Dry weight, M_3:					
B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing) Lower limit	Upper limit
75.00	75.00	0	#DIV/0!	#DIV/0!		
50.00	50.00	0	#DIV/0!	#DIV/0!		
37.50	37.50	0	#DIV/0!	#DIV/0!		
20.00	20.00	0	#DIV/0!	#DIV/0!		
10	10	0	#DIV/0!	#DIV/0!		
5.00	5.00	0	#DIV/0!	#DIV/0!		
2.00	2.00	0	#DIV/0!	#DIV/0!		
1.18	1.18	5	#DIV/0!	#DIV/0!		
0.60	0.60	15	#DIV/0!	#DIV/0!		
0.425	0.425	10	#DIV/0!	#DIV/0!		
0.300	0.300	40	#DIV/0!	#DIV/0!		
0.212	0.212	85	#DIV/0!	#DIV/0!		
0.150	0.150	90	#DIV/0!	#DIV/0!		
0.075	0.075	70	#DIV/0!	#DIV/0!		
Percentage Finer than 0.075 mm Sieve						



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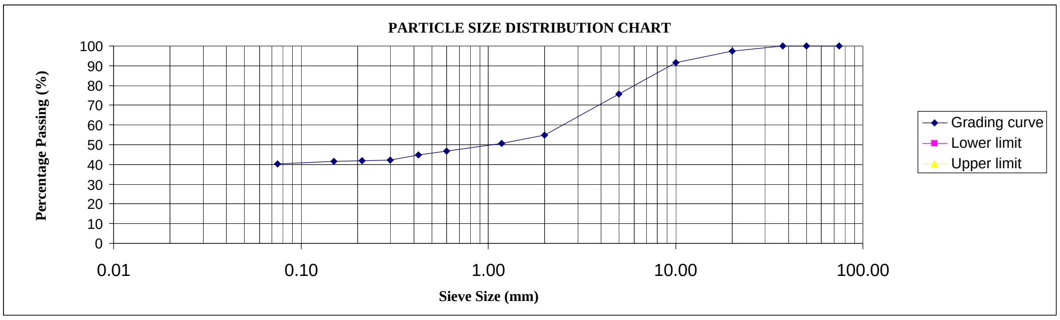
PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA					
Location/Source:						
Soil Description:			**Client :**	NELSAP		
Sample Reference:	BT9		**Sampling Date:**			
Technician:			**Testing Date:**			
	Dry weight, M_3:	1500				
B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing) Lower limit	Specified limits (%ge passing) Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	40	2.7	97		
10	10	85	5.7	92		
5.00	5.00	240	16.0	76		
2.00	2.00	310	20.7	55		
1.18	1.18	65	4.3	51		
0.60	0.60	60	4.0	46.7		
0.425	0.425	30	2.0	44.7		
0.300	0.300	35	2.3	42.3		
0.212	0.212	5	0.3	42.0		
0.150	0.150	5	0.3	41.7		
0.075	0.075	20	1.3	40.3		
Percentage Finer than 0.075 mm Sieve						



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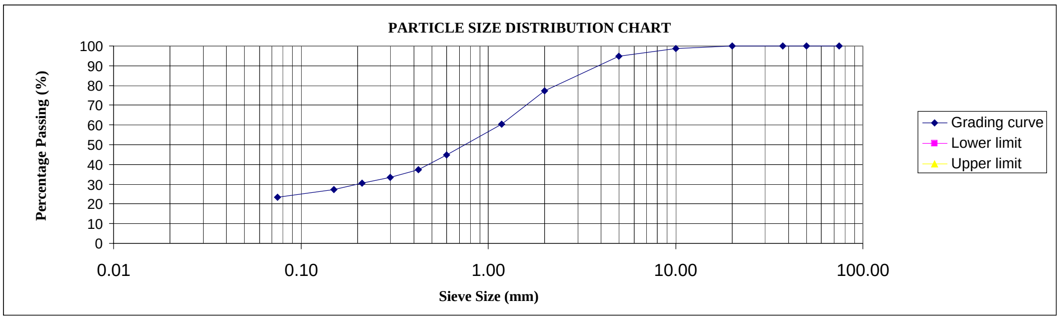
PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA		
Location/Source:			
Soil Description:		**Client :**	NELSAP
Sample Reference:	BT10	**Sampling Date:**	
Technician:		**Testing Date:**	

Dry weight, M_3: 2000

B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing)	
					Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	0	0.0	100		
10	10	25	1.3	99		
5.00	5.00	80	4.0	95		
2.00	2.00	350	17.5	77		
1.18	1.18	340	17.0	60		
0.60	0.60	310	15.5	44.8		
0.425	0.425	145	7.3	37.5		
0.300	0.300	80	4.0	33.5		
0.212	0.212	60	3.0	30.5		
0.150	0.150	65	3.3	27.3		
0.075	0.075	75	3.8	23.5		
Percentage Finer than 0.075 mm Sieve						



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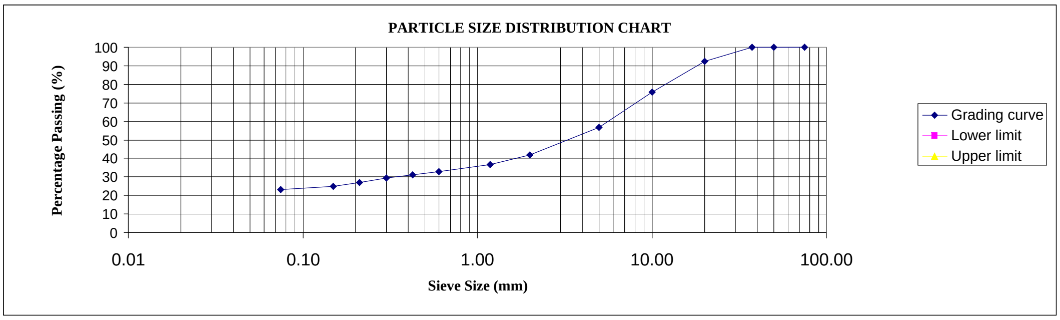
For Teclab Ltd

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA		
Location/Source:			
Soil Description:		**Client :**	NELSAP
Sample Reference:	BT11	**Sampling Date:**	
Technician:		**Testing Date:**	

Dry weight, M_3: 1520

B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing)	
					Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	115	7.6	92		
10	10	255	16.8	76		
5.00	5.00	290	19.1	57		
2.00	2.00	225	14.8	42		
1.18	1.18	80	5.3	37		
0.60	0.60	55	3.6	32.9		
0.425	0.425	25	1.6	31.3		
0.300	0.300	30	2.0	29.3		
0.212	0.212	35	2.3	27.0		
0.150	0.150	30	2.0	25.0		
0.075	0.075	25	1.6	23.4		
Percentage Finer than 0.075 mm Sieve						



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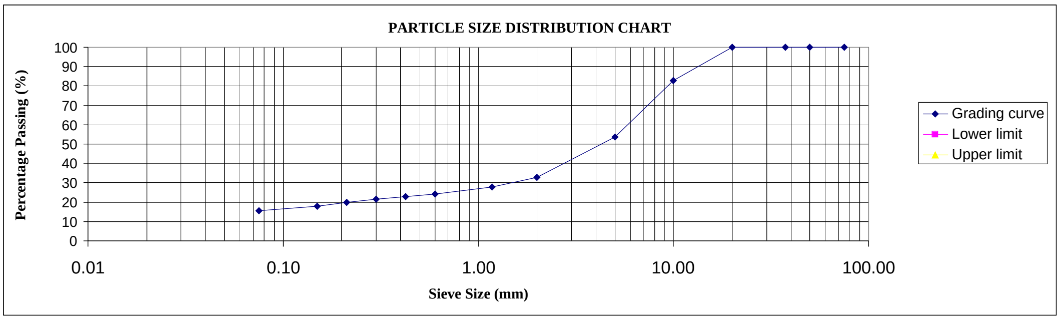
For Teclab Ltd

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA		
Location/Source:			
Soil Description:		**Client :**	NELSAP
Sample Reference:	BT12	**Sampling Date:**	
Technician:		**Testing Date:**	

Dry weight, M_3 : 700

B.S. sieve (mm)	Aperture size (mm)	Partial weight retained (g)	Percentage retained (%)	Percentage Passing (%)	Specified limits (%ge passing)	
					Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	0	0.0	100		
10	10	120	17.1	83		
5.00	5.00	205	29.3	54		
2.00	2.00	145	20.7	33		
1.18	1.18	35	5.0	28		
0.60	0.60	25	3.6	24.3		
0.425	0.425	10	1.4	22.9		
0.300	0.300	10	1.4	21.4		
0.212	0.212	10	1.4	20.0		
0.150	0.150	15	2.1	17.9		
0.075	0.075	15	2.1	15.7		
Percentage Finer than 0.075 mm Sieve						



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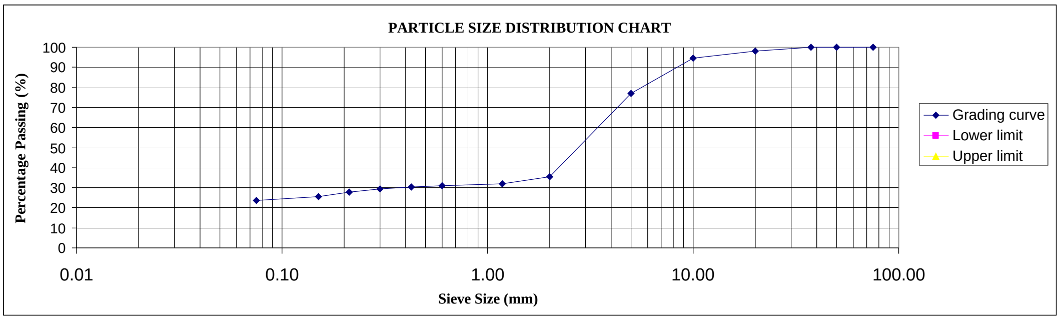
For Teclab Ltd

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA				
Location/Source:					
Soil Description:		**Client :**	NELSAP		
Sample Reference:	BT13	**Sampling Date:**			
Technician:		**Testing Date:**			

Dry weight, M_3: 2150

B.S. sieve (mm)	Aperture size (mm)	Partial weight retained (g)	Percentage retained (%)	Percentage Passing (%)	Specified limits (%ge passing) Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	40	1.9	98		
10	10	80	3.7	94		
5.00	5.00	375	17.4	77		
2.00	2.00	895	41.6	35		
1.18	1.18	70	3.3	32		
0.60	0.60	25	1.2	30.9		
0.425	0.425	10	0.5	30.5		
0.300	0.300	25	1.2	29.3		
0.212	0.212	30	1.4	27.9		
0.150	0.150	50	2.3	25.6		
0.075	0.075	45	2.1	23.5		
Percentage Finer than 0.075 mm Sieve						



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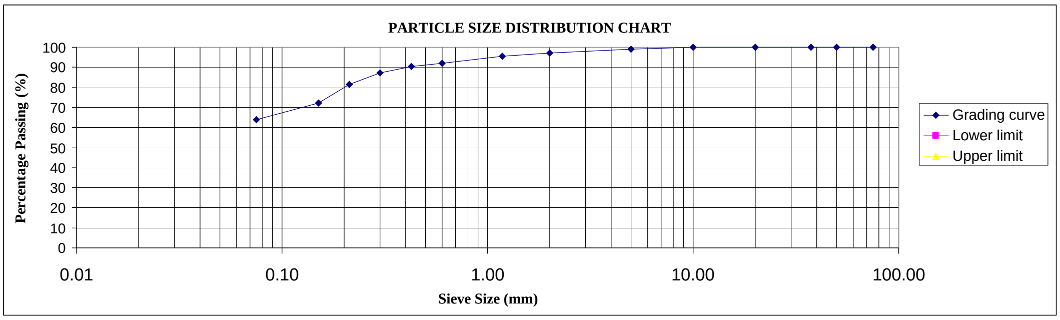
For Teclab Ltd

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA					
Location/Source:						
Soil Description:			**Client :**	NELSAP		
Sample Reference:	M TP 1		**Sampling Date:**			
Technician:			**Testing Date:**			
	Dry weight, M_3:	600				
B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing)	
					Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	0	0.0	100		
10	10	0	0.0	100		
5.00	5.00	5	0.8	99		
2.00	2.00	12	2.0	97		
1.18	1.18	10	1.7	96		
0.60	0.60	20	3.3	92.2		
0.425	0.425	10	1.7	90.5		
0.300	0.300	20	3.3	87.2		
0.212	0.212	35	5.8	81.3		
0.150	0.150	55	9.2	72.2		
0.075	0.075	50	8.3	63.8		
Percentage Finer than 0.075 mm Sieve						



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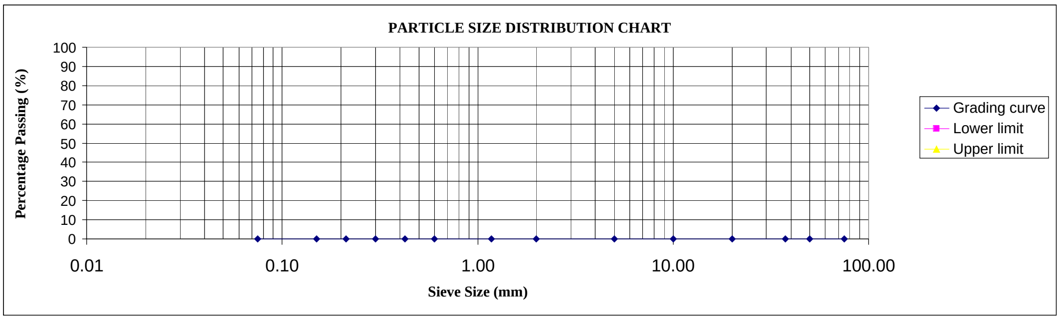
PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA		
Location/Source:			
Soil Description:		**Client :**	NELSAP
Sample Reference:	M TP 1	**Sampling Date:**	
Technician:		**Testing Date:**	

Dry weight, M_3: 0

B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing)	
					Lower limit	Upper limit
75.00	75.00	0	#DIV/0!	#DIV/0!		
50.00	50.00	0	#DIV/0!	#DIV/0!		
37.50	37.50	0	#DIV/0!	#DIV/0!		
20.00	20.00	0	#DIV/0!	#DIV/0!		
10	10	0	#DIV/0!	#DIV/0!		
5.00	5.00	5	#DIV/0!	#DIV/0!		
2.00	2.00	12	#DIV/0!	#DIV/0!		
1.18	1.18	10	#DIV/0!	#DIV/0!		
0.60	0.60	20	#DIV/0!	#DIV/0!		
0.425	0.425	10	#DIV/0!	#DIV/0!		
0.300	0.300	20	#DIV/0!	#DIV/0!		
0.212	0.212	35	#DIV/0!	#DIV/0!		
0.150	0.150	55	#DIV/0!	#DIV/0!		
0.075	0.075	50	#DIV/0!	#DIV/0!		
Percentage Finer than 0.075 mm Sieve						



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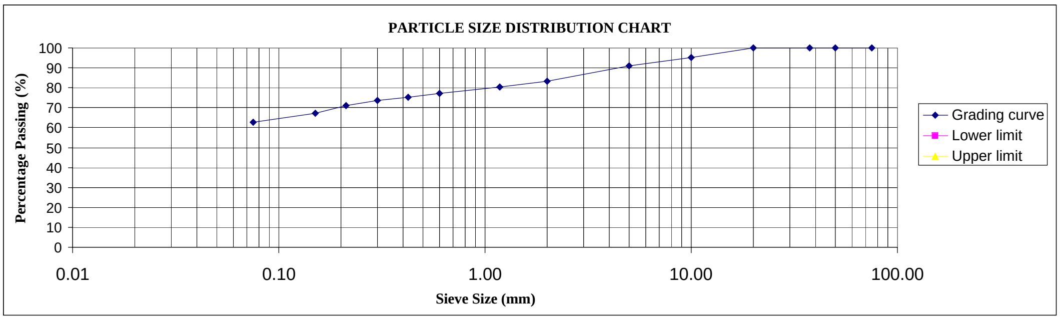
PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA				
Location/Source:					
Soil Description:		**Client :**	NELSAP		
Sample Reference:	M TP 1	**Sampling Date:**			
Technician:		**Testing Date:**			

Dry weight, M_3: 1475

B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing) Lower limit	Specified limits (%ge passing) Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	0	0.0	100		
10	10	70	4.7	95		
5.00	5.00	65	4.4	91		
2.00	2.00	110	7.5	83		
1.18	1.18	45	3.1	80		
0.60	0.60	45	3.1	77.3		
0.425	0.425	30	2.0	75.3		
0.300	0.300	25	1.7	73.6		
0.212	0.212	35	2.4	71.2		
0.150	0.150	60	4.1	67.1		
0.075	0.075	65	4.4	62.7		
Percentage Finer than 0.075 mm Sieve						



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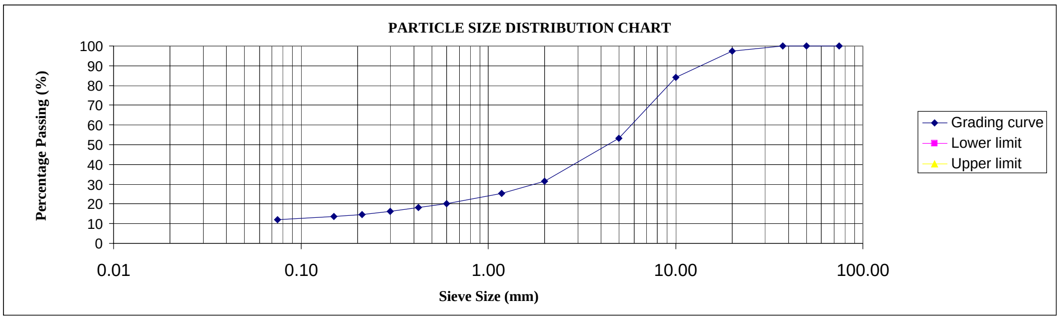
For Teclab Ltd

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA					
Location/Source:						
Soil Description:			**Client :**	NELSAP		
Sample Reference:	M TP 6		**Sampling Date:**			
Technician:			**Testing Date:**			
	Dry weight, M_3:	1770				
B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing)	
					Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	45	2.5	97		
10	10	235	13.3	84		
5.00	5.00	545	30.8	53		
2.00	2.00	390	22.0	31		
1.18	1.18	105	5.9	25		
0.60	0.60	95	5.4	20.1		
0.425	0.425	35	2.0	18.1		
0.300	0.300	35	2.0	16.1		
0.212	0.212	25	1.4	14.7		
0.150	0.150	20	1.1	13.6		
0.075	0.075	25	1.4	12.1		
Percentage Finer than 0.075 mm Sieve						

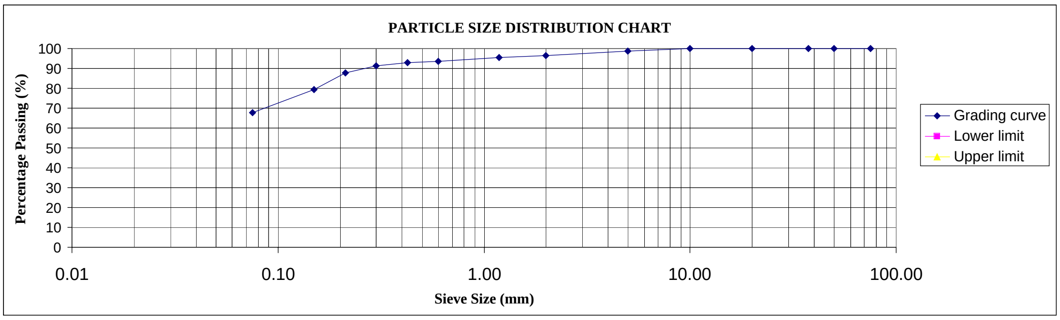


S.P Kisitu
For Teclab Ltd

PARTICLE SIZE DETERMINATION

Project:	FEASIBILITY STUDY ON INTER CONNECTION TRANSMISSION LINES UGANDA- KENYA AND UGANDA -RWANDA					
Location/Source:						
Soil Description:			**Client :**	NELSAP		
Sample Reference:	M TP7		**Sampling Date:**			
Technician:			**Testing Date:**			
	Dry weight, M_3:	600				

B.S. sieve (mm)	**Aperture size (mm)**	**Partial weight retained (g)**	**Percentage retained (%)**	**Percentage Passing (%)**	Specified limits (%ge passing)	
					Lower limit	Upper limit
75.00	75.00	0	0.0	100		
50.00	50.00	0	0.0	100		
37.50	37.50	0	0.0	100		
20.00	20.00	0	0.0	100		
10	10	0	0.0	100		
5.00	5.00	7.2	1.2	99		
2.00	2.00	14	2.3	96		
1.18	1.18	5	0.8	96		
0.60	0.60	13	2.2	93.5		
0.425	0.425	4	0.7	92.8		
0.300	0.300	10	1.7	91.1		
0.212	0.212	20	3.3	87.8		
0.150	0.150	50	8.3	79.5		
0.075	0.075	70	11.7	67.8		
Percentage Finer than 0.075 mm Sieve						



S.P Kisitu
For Teclab Ltd

Test Location Kikubamutwe (Bujagali- Tororo)

Test No B -TP1

Zero Reading	20						
Number of Blows	**Penetration/Depth (mm)**	**Penetration Corrected for Zero Reading (mm)**	**Penetration Depth per set of blows**	**Cummulative Blows**	**Rate of Penetration (mm/Blow)**	**CBR Value (Kleyn and Van Heereden)**	**CBR Value (TRL)**
0	20	0		0	0		
5	53	33	33	5	7	38.3	41.1
5	65	45	12	10	2	139.7	119.7
10	72	52	7	20	1	676.5	440.3
10	97	77	25	30	3	132.6	114.7
10	102	82	5	40	1	1040.7	628.3
15	111	91	9	55	1	824.1	518.2
15	120	100	9	70	1	824.1	518.2
15	125	105	5	85	0	1748.7	964.5
20	135	115	10	105	1	1040.7	628.3
20	160	140	25	125	1	322.1	238.5
15	172	152	12	140	1	570.2	382.3
15	180	160	8	155	1	958.2	586.9
15	185	165	5	170	0	1748.7	964.5
15	193	173	8	185	1	958.2	586.9
20	205	185	12	205	1	824.1	518.2
20	210	190	5	225	0	2527.2	1307.3
20	225	205	15	245	1	619.3	409.3
20	235	215	10	265	1	1040.7	628.3
20	245	225	10	285	1	1040.7	628.3
20	252	232	7	305	0	1642.8	916.1

Test Location Buwenda (Bujagali- Tororo)

Test No BTP-2

Zero Reading	50						
Number of Blows	**Penetration/Depth (mm)**	**Penetration Corrected for Zero Reading**	**Penetration Depth per set of blows**	**Cummulative Blows**	**Rate of Penetration (mm/Blow)**	**CBR Value (Kleyn and Van Heereden)**	**CBR Value (TRL)**
0	50	0		0	0		
1	118	68	68	1	68	1.9	3.5
1	170	120	52	2	52	2.7	4.6
1	230	180	60	3	60	2.3	4.0
1	289	239	59	4	59	2.3	4.1
1	356	306	67	5	67	2.0	3.5
1	397	347	41	6	41	3.7	6.0
1	440	390	43	7	43	3.5	5.7
1	498	448	58	8	58	2.4	4.1
1	553	503	55	9	55	2.5	4.4
1	607	557	54	10	54	2.6	4.5
1	660	610	53	11	53	2.7	4.5
1	718	668	58	12	58	2.4	4.1
1	763	713	45	13	45	3.3	5.4
2	845	795	82	15	41	3.7	6.0
2	900	850	55	17	28	6.2	9.1
2	950	900	50	19	25	7.0	10.1
2	1000	950	50	21	25	7.0	10.1
2	1050	1000	50	23	25	7.0	10.1
2	1103	1053	53	25	27	6.5	9.5
2	1150	1100	47	27	24	7.5	10.7

Test Location Wakitaka (Bujagali- Tororo)

Test No B TP-3

Zero Reading	**55**						
Number of Blows	Penetration/Depth (mm)	Penetration Corrected for Zero Reading	Penetration Depth per set of blows	Cummulative Blows	Rate of Penetration (mm/Blow)	CBR Value (Kleyn and Van Heereden)	CBR Value (TRL)
0	55	0		0	0		
2	93	38	38	2	19	9.9	13.4
2	125	70	32	4	16	12.3	16.1
4	193	138	68	8	17	11.4	15.1
4	245	190	52	12	13	16.1	20.1
4	293	238	48	16	12	17.8	21.8
4	342	287	49	20	12	17.3	21.4
4	399	344	57	24	14	14.3	18.2
4	450	395	51	28	13	16.5	20.5
4	497	442	47	32	12	18.3	22.3
4	552	497	55	36	14	15.0	18.9
4	607	552	55	40	14	15.0	18.9
4	651	596	44	44	11	19.9	23.9
4	692	637	41	48	10	21.8	25.8
4	738	683	46	52	12	18.8	22.8
4	780	725	42	56	11	21.1	25.2
4	827	772	47	60	12	18.3	22.3
4	868	813	41	64	10	21.8	25.8
4	907	852	39	68	10	23.2	27.2
4	947	892	40	72	10	22.5	26.5
4	994	939	47	76	11.75	18.3	22.3
4	1047	992	53	80	13.25	15.7	19.7
4	1088	1033	41	84	10.25	21.8	25.8

Test Location Gomoja (Bujagali- Tororo)

Test No B-TP 4

Zero Reading	50						
Number of Blows	Penetration/Depth (mm)	Penetration Corrected for Zero Reading	Penetration Depth per set of blows	Cummulative Blows	Rate of Penetration (mm/Blow)	CBR Value (Kleyn and Van Heereden)	CBR Value (TRL)
0	50	0		0	0		
2	97	47	47	2	24	7.5	10.7
2	135	85	38	4	19	9.9	13.4
4	207	157	72	8	18	10.6	14.2
4	300	250	93	12	23	7.6	10.9
4	367	317	67	16	17	11.6	15.4
4	443	393	76	20	19	9.9	13.4
4	512	462	69	24	17	11.2	14.9
4	572	522	60	28	15	13.4	17.3
4	653	603	81	32	20	9.1	12.6
4	780	730	127	36	32	5.1	7.8
4	845	795	65	40	16	12.1	15.9
4	890	840	45	44	11	19.3	23.4
4	915	865	25	48	6	41.0	43.5
4	965	915	50	52	13	16.9	20.9
4	1000	950	35	56	9	26.7	30.5
4	1035	985	35	60	9	26.7	30.5
4	1070	1020	35	64	9	26.7	30.5
4	1107	1057	37	68	9	24.9	28.8
2	1132	1082	25	70	13	16.9	20.9

Test Location Buwaiswa (Bujagali- Tororo)

Test No B TP-6

Zero Reading	20						
Number of Blows	Penetration/Depth (mm)	Penetration Corrected for	Penetration Depth per set of	Cummulative Blows	Rate of Penetration	CBR Value (Kleyn and Van	CBR Value (TRL)
0	20	0		0	0		
10	65	45	45	10	5	62.5	61.6
10	88	68	23	20	2	147.6	125.2
10	109	89	21	30	2	165.8	137.9
10	125	105	16	40	2	234.8	183.8
10	139	119	14	50	1	278.6	211.6
10	150	130	11	60	1	379.3	273.1
10	168	148	18	70	2	202.0	162.2
10	203	183	35	80	4	86.2	80.3
10	216	196	13	90	1	306.3	228.9
10	227	207	11	100	1	379.3	273.1
10	236	216	9	110	1	490.4	337.6
10	250	230	14	120	1	278.6	211.6
10	260	240	10	130	1	428.5	302.0
10	272	252	12	140	1	339.4	249.1
10	285	265	13	150	1	306.3	228.9

Test Location Bugodandala (Bujagali- Tororo)

Test No B -TP 8

Zero Reading	98						
Number of Blows	**Penetration/Depth (mm)**	**Penetration Corrected for Zero Reading**	**Penetration Depth per set of blows**	**Cummulative Blows**	**Rate of Penetration (mm/Blow)**	**CBR Value (Kleyn and Van Heereden)**	**CBR Value (TRL)**
0	98	0		0	0		
2	245	147	147	2	74	1.8	3.2
2	328	230	83	4	42	3.6	5.9
2	395	297	67	6	34	4.8	7.4
2	447	349	52	8	26	6.6	9.6
2	488	390	41	10	21	9.0	12.4
1	505	407	17	11	17	11.4	15.1
4	563	465	58	15	15	14.0	17.9
4	612	514	49	19	12	17.3	21.4
4	665	567	53	23	13	15.7	19.7
4	711	613	46	27	12	18.8	22.8
4	750	652	39	31	10	23.2	27.2
4	792	694	42	35	11	21.1	25.2
4	840	742	48	39	12	17.8	21.8
4	890	792	50	43	13	16.9	20.9
4	931	833	41	47	10	21.8	25.8
4	970	872	39	51	10	23.2	27.2
4	1000	902	30	55	8	32.5	35.9
2	1020	922	20	57	10	22.5	26.5
2	1040	942	20	59	10	22.5	26.5
2	1060	962	20	61	10	22.5	26.5

Test Location Magoola (Bujagali- Tororo)

Test No B- TP 9

Zero Reading	**30**						
Number of Blows	Penetration/Depth (mm)	Penetration Corrected for Zero Reading	Penetration Depth per set of blows	Cummulative Blows	Rate of Penetration (mm/Blow)	CBR Value (Kleyn and Van Heereden)	CBR Value (TRL)
0	30	0		0	0		
10	110	80	80	10	8	29.9	33.5
10	174	144	64	20	6	39.8	42.4
10	223	193	49	30	5	56.0	56.3
10	272	242	49	40	5	56.0	56.3
10	337	307	65	50	7	39.0	41.8
10	411	381	74	60	7	33.1	36.4
10	480	450	69	70	7	36.2	39.2
10	560	530	80	80	8	29.9	33.5
10	624	594	64	90	6	39.8	42.4
10	670	640	46	100	5	60.8	60.2
10	720	690	50	110	5	54.6	55.1
10	775	745	55	120	6	48.3	49.8
10	820	790	45	130	5	62.5	61.6
10	860	830	40	140	4	72.7	69.8
10	910	880	50	150	5	54.6	55.1
10	988	958	78	160	8	30.9	34.4
10	1050	1020	62	170	6	41.5	43.9

Test Location Busolo (Bujagali- Tororo)

Test No B- TP 10

Zero Reading	20						
Number of Blows	Penetration/Depth (mm)	Penetration Corrected for Zero Reading	Penetration Depth per set of blows	Cummulative Blows	Rate of Penetration (mm/Blow)	CBR Value (Kleyn and Van Heereden)	CBR Value (TRL)
0	**20**	**0**		**0**	**0**		
5	75	55	55	5	11	19.9	23.9
5	96	76	21	10	4	68.3	66.3
5	119	99	23	15	5	60.8	60.2
5	138	118	19	20	4	77.6	73.6
5	160	140	22	25	4	64.3	63.1
5	180	160	20	30	4	72.7	69.8
5	197	177	17	35	3	89.5	82.8
5	208	188	11	40	2	156.2	131.2
5	220	200	12	45	2	139.7	119.7
5	232	212	12	50	2	139.7	119.7
5	245	225	13	55	3	126.1	110.0
5	262	242	17	60	3	89.5	82.8
5	278	258	16	65	3	96.7	88.3
5	293	273	15	70	3	105.0	94.6
5	309	289	16	75	3	96.7	88.3
5	323	303	14	80	3	114.7	101.7
5	324	304	1	85	0	3362.6	1655.1

Test Location Tororo-Angoloto (Bujagali- Tororo)

Test No B-TP 13

Zero Reading	80						
Number of Blows	Penetration/Depth (mm)	Penetration Corrected for Zero Reading	Penetration Depth per set of blows	Cummulative Blows	Rate of Penetration (mm/Blow)	CBR Value (Kleyn and Van Heereden)	CBR Value (TRL)
0	80	0		0	0		
2	245	165	165	2	82.5	1.5	2.8
2	**365**	**285**	**120**	**4**	**60**	**2.3**	**4.0**
2	450	370	85	6	42.5	3.5	5.7
2	475	395	25	8	13	16.9	20.9
2	488	408	13	10	7	39.0	41.8
2	495	415	7	12	4	86.2	80.3
5	510	430	15	17	3	105.0	94.6
5	535	455	25	22	5	54.6	55.1
5	565	485	30	27	6	43.2	45.4
5	600	520	35	32	7	35.5	38.6
5	635	555	35	37	7	35.5	38.6
5	663	583	28	42	6	47.2	48.9
5	698	618	35	47	7	35.5	38.6
5	730	650	32	52	6	39.8	42.4
5	760	680	30	57	6	43.2	45.4
5	790	710	30	62	6	43.2	45.4
5	821	741	31	67	6	41.5	43.9
5	863	783	42	72	8	28.1	31.8
5	900	820	37	77	7	33.1	36.4
5	930	850	30	82	6	43.2	45.4

Test Location Mbarara stock farm (Mbarara-Mirama)

Test No M- TP 1

Zero Reading	30						
Number of Blows	Penetration/Depth (mm)	Penetration Corrected for Zero Reading	Penetration Depth per set of blows	Cummulative Blows	Rate of Penetration (mm/Blow)	CBR Value (Kleyn and Van Heereden)	CBR Value (TRL)
0	30	0		0	0		
10	**90**	**60**	**60**	**10**	**6**	**43.2**	**45.4**
10	137	107	47	20	4.7	59.1	58.8
10	184	154	47	30	5	59.1	58.8
10	239	209	55	40	6	48.3	49.8
10	291	261	52	50	5	51.9	52.9
10	343	313	52	60	5	51.9	52.9
10	393	363	50	70	5	54.6	55.1
10	436	406	43	80	4	66.2	64.6
10	482	452	46	90	5	60.8	60.2
10	533	503	51	100	5	53.2	54.0
10	588	558	55	110	6	48.3	49.8
10	640	610	52	120	5	51.9	52.9
10	689	659	49	130	5	56.0	56.3
10	743	713	54	140	5	49.5	50.8
10	797	767	54	150	5	49.5	50.8
10	848	818	51	160	5	53.2	54.0
10	897	867	49	170	5	56.0	56.3
10	945	915	48	180	5	57.5	57.5
10	992	962	47	190	5	59.1	58.8
10	1040	1010	48	200	5	57.5	57.5
5	1070	1040	30	205	6	43.2	45.4

Test Location Katukuru (Mbarara-Mirama)

Test No M -TP 2

Zero Reading	138						
Number of Blows	**Penetration/Depth (mm)**	**Penetration Corrected for Zero Reading**	**Penetration Depth per set of blows**	**Cummulative Blows**	**Rate of Penetration (mm/Blow)**	**CBR Value (Kleyn and Van Heereden)**	**CBR Value (TRL)**
0	138	0		0	0		
4	314	176	176	4	44	3.4	5.5
4	449	311	135	8	34	4.7	7.3
4	555	417	106	12	27	6.5	9.5
4	626	488	71	16	18	10.8	14.4
4	661	523	35	20	9	26.7	30.5
4	711	573	50	24	13	16.9	20.9
4	740	602	29	28	7	33.9	37.2
4	771	633	31	32	8	31.2	34.7
4	802	664	31	36	8	31.2	34.7
4	829	691	27	40	7	37.2	40.1
4	858	720	29	44	7	33.9	37.2
4	891	753	33	48	8	28.8	32.5
4	921	783	30	52	8	32.5	35.9
4	955	817	34	56	9	27.7	31.4
4	969	831	14	60	4	86.2	80.3
2	984	846	15	62	8	32.5	35.9

Test Location Mweya (Mbarara-Mirama)

Test No M- TP 3

Zero Reading	55						
Number of Blows	Penetration/Depth (mm)	Penetration Corrected for Zero Reading	Penetration Depth per set of blows	Cummulative Blows	Rate of Penetration (mm/Blow)	CBR Value (Kleyn and Van Heereden)	CBR Value (TRL)
0	55	0		0	0		
5	**65**	**10**	**10**	**5**	**2**	**176.5**	**145.1**
5	67	12	2	10	0.4	1384.7	795.5
5	68	13	1	15	0	3362.6	1655.1
10	69	14	1	25	0	8165.8	3443.5
10	70	15	1	35	0	8165.8	3443.5

Test Location Ngugo (Mbarara-Mirama)

Test No M -TP 4

Zero Reading	51									
Number of Blows	Penetration/Depth (mm)	Penetration Corrected for Zero Reading	Penetration Depth per set of blows	Cummulative Blows	Rate of Penetration (mm/Blow)	CBR Value (Kleyn and Van Heereden)	CBR Value (TRL)			
0	51	0		0	0					
2	90	39	39	2	20	9.6	13.1			
2	123	72	33	4	17	11.8	15.6			
2	175	124	52	6	26	6.6	9.6			
2	270	219	95	8	48	3.1	5.1			
2	314	263	44	10	22	8.2	11.5			
2	354	303	40	12	20	9.3	12.7			
2	391	340	37	14	18.5	10.2	13.8			
2	425	374	34	16	17	11.4	15.1			
2	454	403	29	18	14.5	14.0	17.9			
2	483	432	29	20	14.5	14.0	17.9			
2	511	460	28	22	14	14.6	18.6			
2	539	488	28	24	14	14.6	18.6			
2	570	519	31	26	15.5	12.8	16.7			
2	595	544	25	28	12.5	16.9	20.9			
2	**611**	**560**	**16**	**30**	**8**	**29.9**	**33.5**			
2	629	578	18	32	9	25.7	29.6			
2	648	597	19	34	10	24.0	28.0			
2	669	618	21	36	11	21.1	25.2			
2	690	639	21	38	11	21.1	25.2			
2	709	658	19	40	10	24.0	28.0			
4	743	692	34	44	9	27.7	31.4			
4	776	725	33	48	8	28.8	32.5			
4	807	756	31	52	8	31.2	34.7			
4	841	790	34	56	9	27.7	31.4			
4	871	820	30	60	8	32.5	35.9			
4	902	851	31	64	8	31.2	34.7			

Test Location Nyabugando (Mbarara-Mirama)

Depth of Test

Test No M- TP 5

Zero Reading	50						
Number of Blows	Penetration/Depth (mm)	Penetration Corrected for Zero Reading	Penetration Depth per set of blows	Cummulative Blows	Rate of Penetration (mm/Blow)	CBR Value (Kleyn and Van Heereden)	CBR Value (TRL)
0	50	0		0	0		
5	144	94	94	5	18.8	10.0	13.6
5	223	173	79	10	15.8	12.5	16.3
5	300	250	77	15	15.4	12.9	16.8
5	378	328	78	20	15.6	12.7	16.6
5	467	417	89	25	17.8	10.8	14.4
5	**532**	**482**	**65**	**30**	**13**	**16.1**	**20.1**
5	637	587	105	35	21	8.7	12.1
5	682	632	45	40	9	25.7	29.6
5	724	674	42	45	8	28.1	31.8
5	760	710	36	50	7	34.2	37.5
5	800	750	40	55	8	29.9	33.5
5	842	792	42	60	8	28.1	31.8
5	900	850	58	65	12	18.6	22.6
5	950	900	50	70	10	22.5	26.5
5	995	945	45	75	9	25.7	29.6
5	1033	983	38	80	8	32.0	35.4

Test Location Kitye (Mbarara-Mirama)

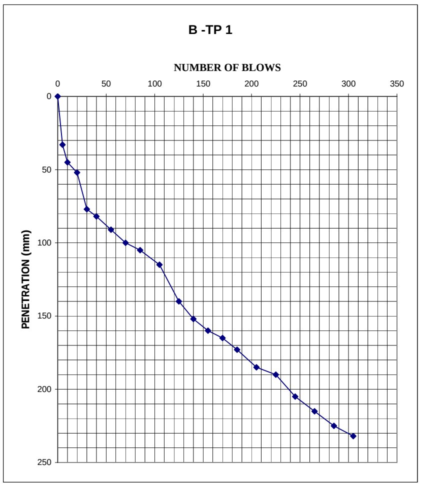
Test No M- TP 6

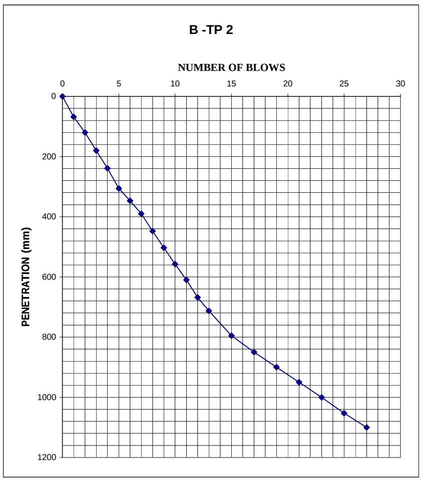
Zero Reading	44						
Number of Blows	Penetration/Depth (mm)	Penetration Corrected for Zero Reading	Penetration Depth per set of blows	Cummulative Blows	Rate of Penetration (mm/Blow)	CBR Value (Kleyn and Van Heereden)	CBR Value (TRL)
0	44	0		0	0		
10	105	61	61	10	6.1	42.3	44.7
10	142	98	37	20	3.7	80.3	75.8
10	177	133	35	30	3.5	86.2	80.3
10	200	156	23	40	2.3	147.6	125.2
10	227	183	27	50	2.7	120.2	105.7
10	250	206	23	60	2.3	147.6	125.2
10	264	220	14	70	1.4	278.6	211.6
15	**331**	**287**	**67**	**85**	**4.5**	**63.1**	**62.1**
20	378	334	47	105	2.35	143.6	122.4
20	445	401	67	125	3	91.2	84.1
20	529	485	84	145	4	68.3	66.3
20	590	546	61	165	3	102.8	92.9
20	622	578	32	185	2	234.8	183.8
20	640	596	18	205	1	490.4	337.6
20	693	649	53	225	3	123.1	107.8
20	760	716	67	245	3	91.2	84.1
20	798	754	38	265	2	188.4	153.2
20	848	804	50	285	3	132.6	114.7
20	917	873	69	305	3	87.8	81.6
20	990	946	73	325	4	81.7	76.9
10	1015	971	25	335	3	132.6	114.7

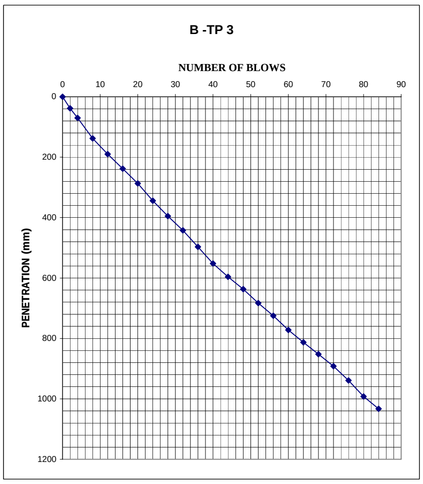
Test Location Rwembogo (Mbarara-Mirama)

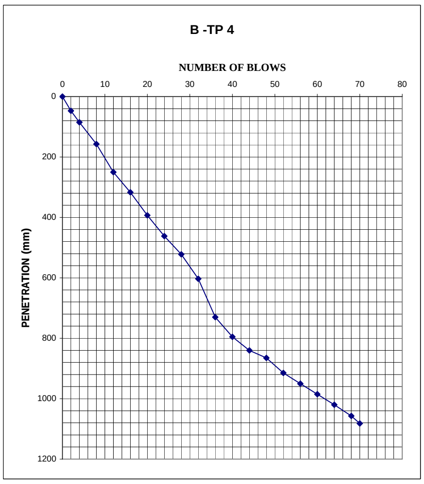
Test No M- TP 7

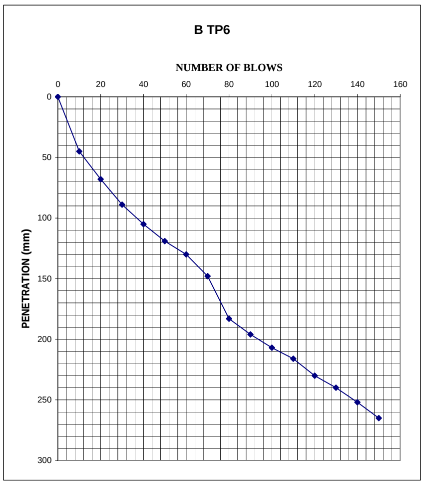
Zero Reading	30						
Number of Blows	Penetration/Depth (mm)	Penetration Corrected for Zero Reading	Penetration Depth per set of blows	Cummulative Blows	Rate of Penetration (mm/Blow)	CBR Value (Kleyn and Van Heereden)	CBR Value (TRL)
0	30	0		0	0		
10	90	60	60	10	6	43.2	45.4
10	123	93	33	20	3.3	93.0	85.5
15	146	116	23	35	1.5	248.0	192.2
10	172	142	26	45	2.6	126.1	110.0
10	**201**	**171**	**29**	**55**	**2.9**	**109.7**	**98.0**
10	231	201	30	65	3	105.0	94.6
10	262	232	31	75	3	100.7	91.3
10	290	260	28	85	3	114.7	101.7
10	320	290	30	95	3	105.0	94.6
10	350	320	30	105	3	105.0	94.6
10	380	350	30	115	3	105.0	94.6
10	410	380	30	125	3	105.0	94.6
10	440	410	30	135	3	105.0	94.6
10	466	436	26	145	3	126.1	110.0
20	525	495	59	165	3	107.3	96.2
20	585	555	60	185	3	105.0	94.6
20	642	612	57	205	3	112.1	99.8
20	694	664	52	225	3	126.1	110.0
20	745	715	51	245	3	129.3	112.3
20	790	760	45	265	2	151.8	128.2
20	845	815	55	285	3	117.4	103.7
20	900	870	55	305	3	117.4	103.7

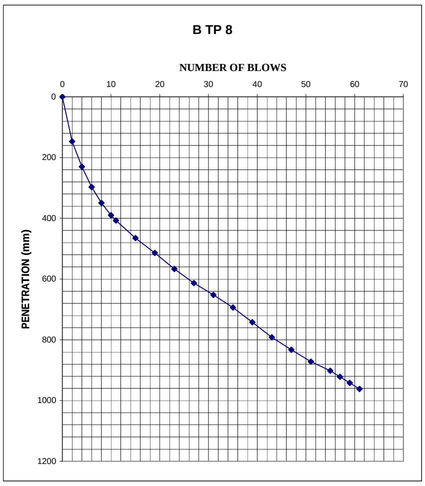

B -TP 1
NUMBER OF BLOWS
0 50 100 150 200 250 300 350
PENETRATION (mm)
0 50 100 150 200 250

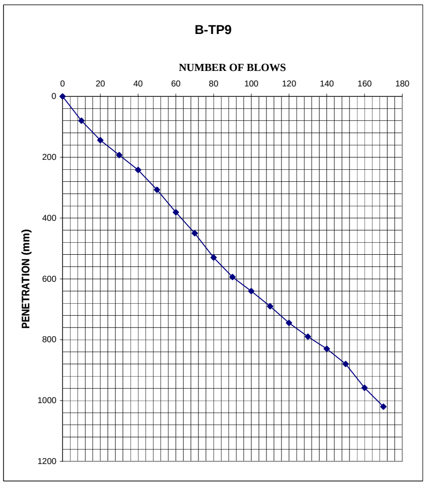

B -TP 2
NUMBER OF BLOWS
0 5 10 15 20 25 30
PENETRATION (mm)
0 200 400 600 800 1000 1200

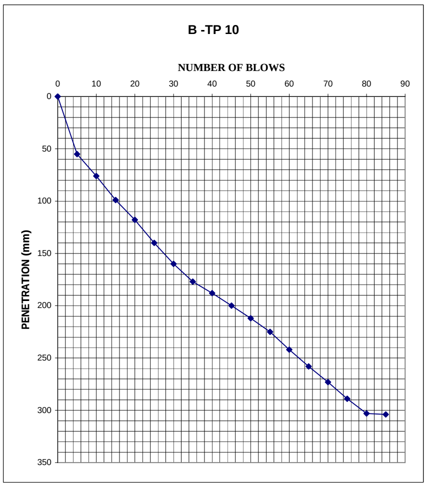

B -TP 3
NUMBER OF BLOWS
0 10 20 30 40 50 60 70 80 90
PENETRATION (mm)
0 200 400 600 800 1000 1200

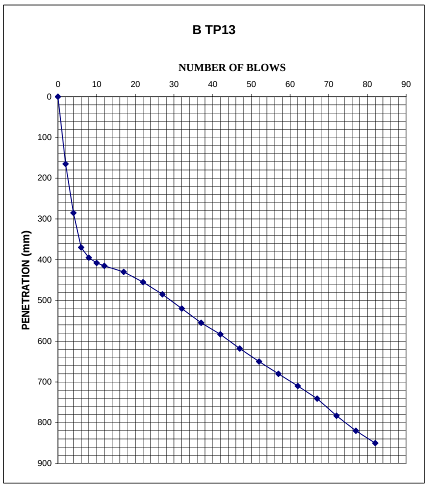

B -TP 4
NUMBER OF BLOWS
0 10 20 30 40 50 60 70 80
PENETRATION (mm)
0 200 400 600 800 1000 1200

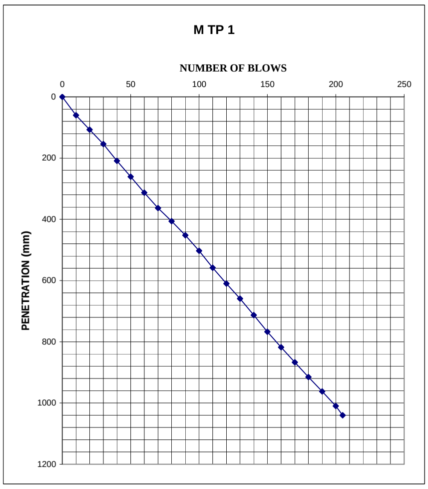

B TP6
NUMBER OF BLOWS
PENETRATION (mm)

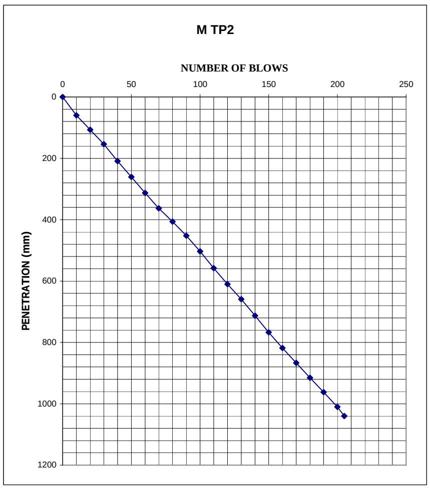

B TP 8
NUMBER OF BLOWS
PENETRATION (mm)

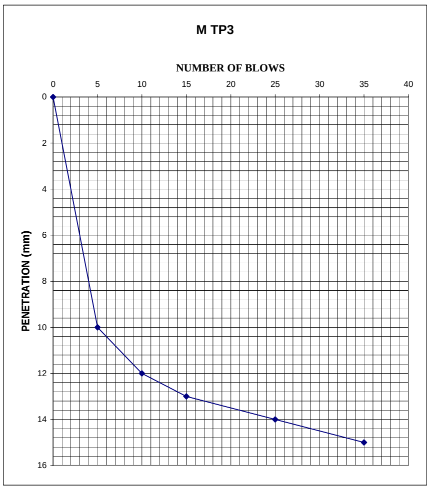

B-TP9
NUMBER OF BLOWS
PENETRATION (mm)

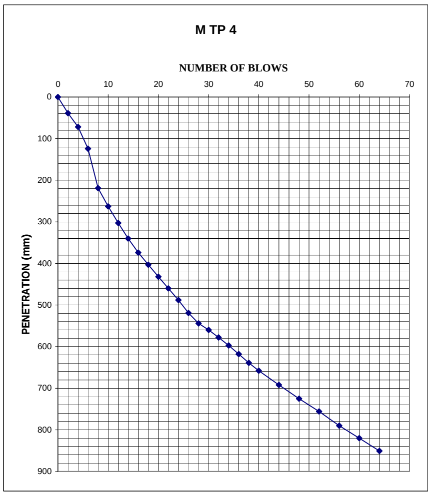

B -TP 10
NUMBER OF BLOWS
PENETRATION (mm)

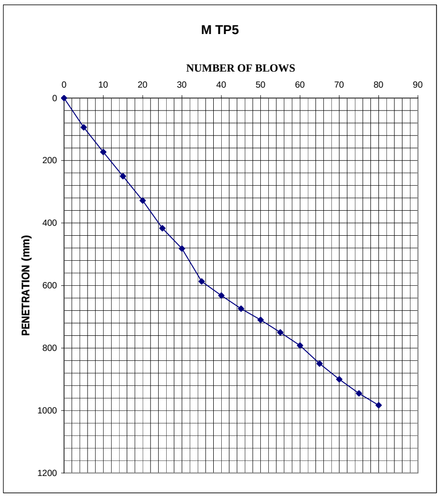

B TP13
NUMBER OF BLOWS
PENETRATION (mm)

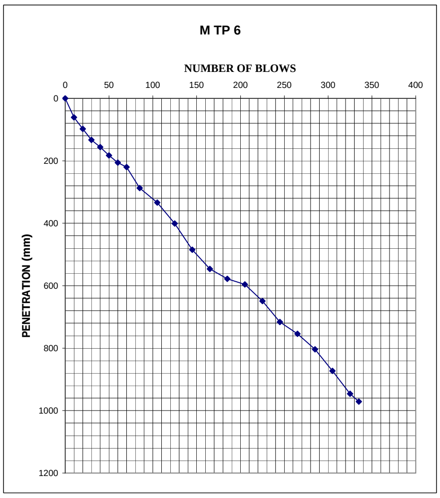

M TP 1
NUMBER OF BLOWS
PENETRATION (mm)

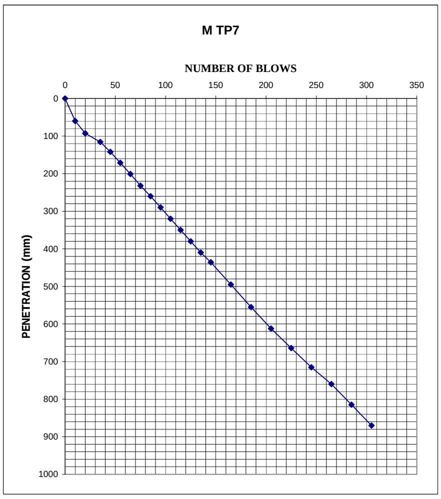

M TP2
NUMBER OF BLOWS
PENETRATION (mm)

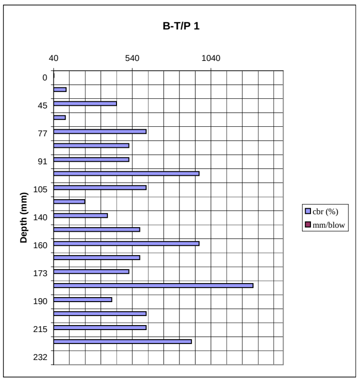

M TP3
NUMBER OF BLOWS
PENETRATION (mm)

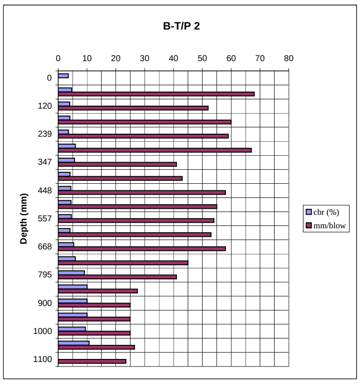

M TP 4
NUMBER OF BLOWS
PENETRATION (mm)

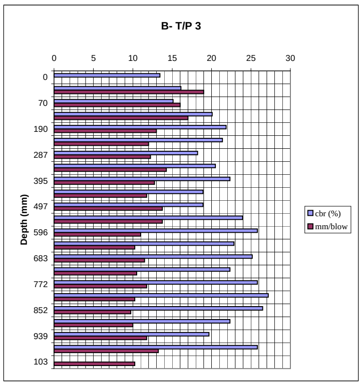

M TP5
NUMBER OF BLOWS
PENETRATION (mm)

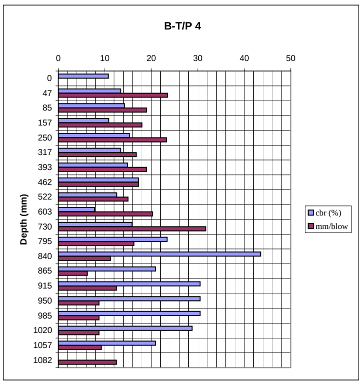

M TP 6
NUMBER OF BLOWS
PENETRATION (mm)

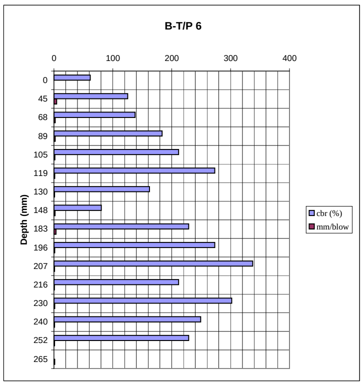

M TP7
NUMBER OF BLOWS
PENETRATION (mm)

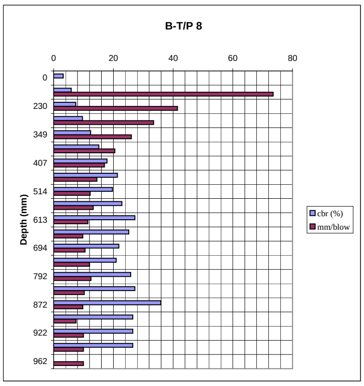

B-T/P 1
Depth (mm)
cbr (%)
mm/blow

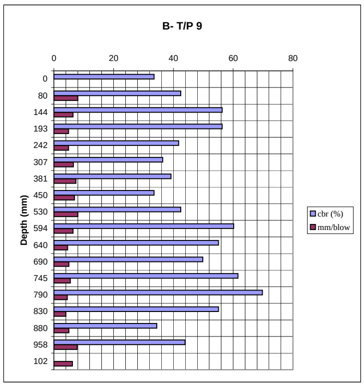

B-T/P 2
Depth (mm)
cbr (%)
mm/blow

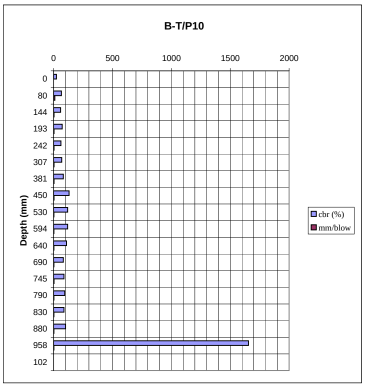

B- T/P 3
Depth (mm)
cbr (%)
mm/blow

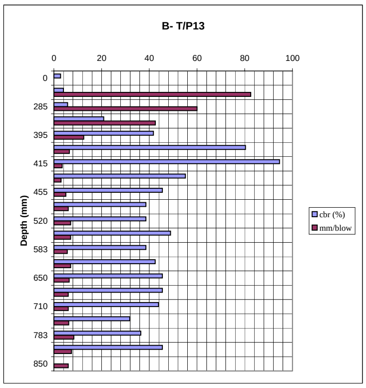

B-T/P 4
Depth (mm)
cbr (%)
mm/blow

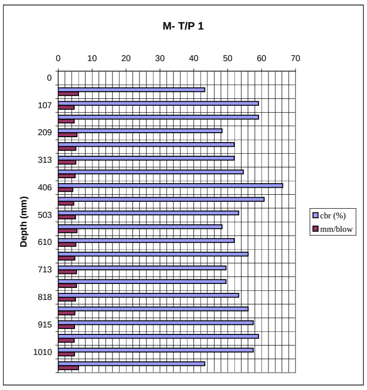

B-T/P 6
Depth (mm)
cbr (%)
mm/blow

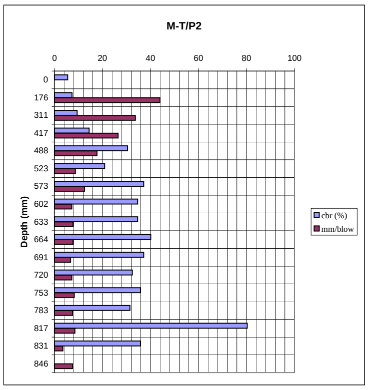

B-T/P 8
Depth (mm)
cbr (%)
mm/blow

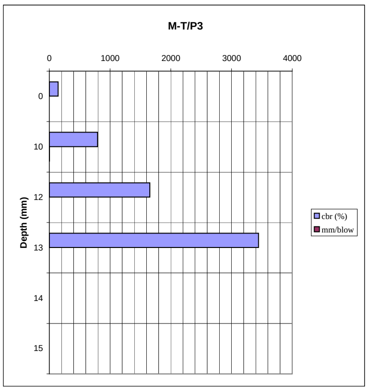

B- T/P 9
0 20 40 60 80
Depth (mm)
0
80
144
193
242
307
381
450
530
594
640
690
745
790
830
880
958
102
cbr (%)
mm/blow

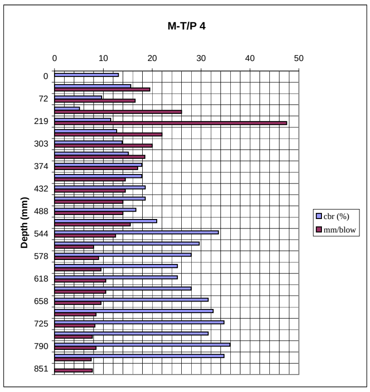

B-T/P10
0 500 1000 1500 2000
Depth (mm)
0
80
144
193
242
307
381
450
530
594
640
690
745
790
830
880
958
102
cbr (%)
mm/blow

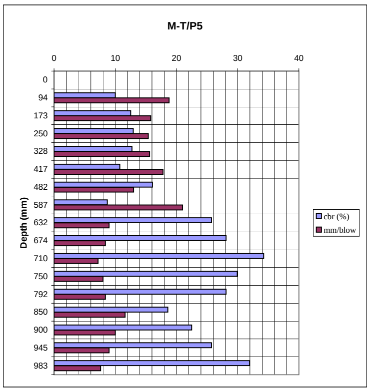

B- T/P13
0 20 40 60 80 100
Depth (mm)
0
285
395
415
455
520
583
650
710
783
850
cbr (%)
mm/blow

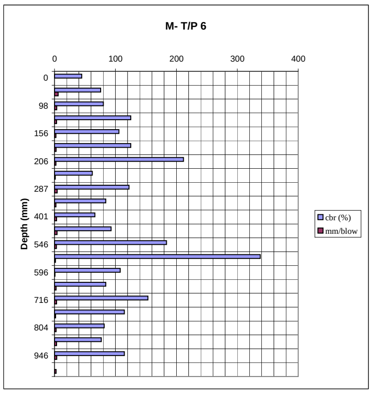

M- T/P 1
0 10 20 30 40 50 60 70
Depth (mm)
0
107
209
313
406
503
610
713
818
915
1010
cbr (%)
mm/blow

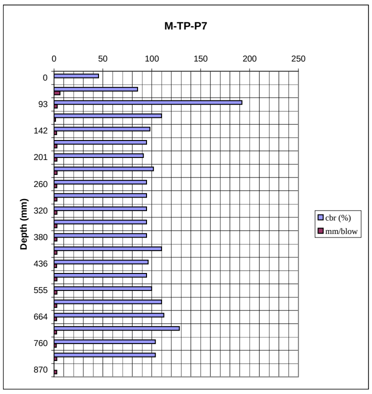

M-T/P2
0 20 40 60 80 100
Depth (mm)
0
176
311
417
488
523
573
602
633
664
691
720
753
783
817
831
846
cbr (%)
mm/blow


M-T/P3
0 1000 2000 3000 4000
Depth (mm)
0
10
12
13
14
15
cbr (%)
mm/blow


M-T/P 4
Depth (mm)
cbr (%)
mm/blow


M-T/P5
Depth (mm)
cbr (%)
mm/blow


M- T/P 6
Depth (mm)
cbr (%)
mm/blow


M-TP-P7
Depth (mm)
cbr (%)
mm/blow

EXCELLENCE THROUGH PRECISION AND INTEGRITY

DETERMINATION OF IN SITU DENSITY

Project: **Feasibility study on inteconnection transmission lines Uganda-Kenya & Uganda-Rwanda**

Client: M/s power networks (U)

Location:

Bulk Density of Sand **1.36** g/cm^3

Material Discription :

Method BS 1377- PART 9:1990

Material Source:

Date of Test

Test Pit Number		**B -1**	**B -2**	**B -3**	**B -4**	**B -5**	**B- 6**	**B- 7**	**B- 8**	**B- 9**	**B -10**
Depth of hole	(mm)	150	150	150	150		90			110	85
Mass of wet soil	(gms)	4600	3750	4580	3870	192	3240	134	198	3560	2270
Mass of sand before pouring in	(gms)	16800									
Mass of sand after pouring in hc	(gms)	11500	11430	11870	12820		13380			12370	13230
Mass of sand in hole and cone	(gms)	5300	5370	4930	3980		3420			4430	3570
Mass of sand in cone	(gms)	1402									
Mass of sand in hole	(gms)	3898	3968	3528	2578	160	2018	160	160	2168	2168
Volume of hole	(cm^3)	2866	2918	2594	1896	118	1484	118	118	1594	1594
Bulk density of soil	(Kg/m^3)	1605	1285	1766	2042	1632	2184	1139	1683	2233	1424
Moisture Content Determination											
Container Number		**PD**	**15**	**7B**	**70**	**4T**	**TI**	**5**	**WE**	109.0	10
Mass of wet soil + container	(gms)	148.8	152.2	102.8	156.5	181.5	149.3	195.8	**123.4**	71.7	116
Mass of dry soil + container	(gms)	138.6	127.3	90.0	135.2	163.0	138.4	178.9	**107.6**	66.4	111
Mass of Container		44.7	34.9	24.2	31.7	31.3	31.7	40.0	**18.3**	15.0	28
Moisture content	(%)	10.9	26.9	19.5	20.6	14.0	10.2	12.2	17.7	10.3	6.9
Dry density of soil from hole	(Kg/m^3)	1448	1012	1478	1693	1431	1981	1015	1430	2024	1332

Teclab ltd
THE ENGINEERS LABORATORY

EXCELLENCE THROUGH PRECISION AND INTEGRITY

DETERMINATION OF IN SITU DENSITY

Project: **Client:**

Location: **Bulk Density of Sand** **1.36** g/cm^3

Material Discription : **Method** BS 1377- PART 9:1990

Material Source: **Date of Test**

Test Pit Number		**B-12**	**B- 13**	**M- 1**	**M-2**	**M-3**	**M-4**	**M-5**	**M-6**	**M-7**
Depth of hole	(mm)	100	150	80				80	90	80
Mass of wet soil	(gms)	2030	5010	2730	214		180	2235	2400	2640
Mass of sand before pouring in hole	(gms)	16800								
Mass of sand after pouring in hole	(gms)	12670	11640	13535		9550		13280	13120	13525
Mass of sand in hole and cone	(gms)	4130	5160	3265		7250		3520	3680	3275
Mass of sand in cone	(gms)	1402								
Mass of sand in hole	(gms)	2728	3758	1863	160	5848	160	2118	2278	1873
Volume of hole	(cm^3)	2006	2763	1370	118	4300	118	1557	1675	1377
Bulk density of soil	(Kg/m^3)	1012	1813	1993	1819	#VALEUR!	1530	1435	1433	1917
Moisture Content Determination										
Container Number		**42**	**RI**	**AQ**	**1B**	**19**	**7**	**HP**	**BA11**	**AY**
Mass of wet soil + container	(gms)	137.1	151.8	126.5	147.0	147.5	148.1	147.4	182.8	161.3
Mass of dry soil + container	(gms)	126.9	139.7	116.1	125.4	133.3	116.0	129.2	167.7	148.9
Mass of Container		16.6	34.1	17.5	15.0	47.5	46.5	38.1	48.6	29.2
Moisture content	(%)	9.2	11.5	10.5	19.6	16.6	46.2	20.0	12.7	10.4
Dry density of soil from hole	(Kg/m^3)	926	1627	1803	1521	#VALEUR!	1047	1196	1272	1737

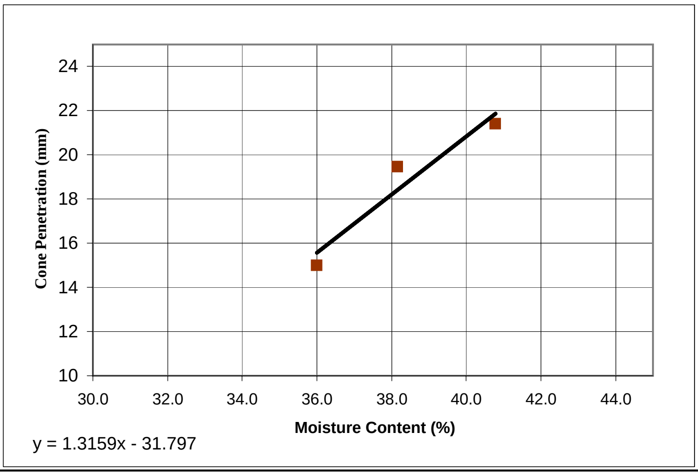
S.P. Kisitu
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	B tp 1	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		Y	KD			
Mass of wet soil + container	g	11.5	17.00			
Mass of dry soil + container	g	10.0	15.50			
Mass of container	g	3.8	9.20			
Mass of moisture	g	1.50	1.50			
Mass of dry soil	g	6.20	6.30			
Moisture content	%	24.19	23.81			24.00

LIQUID LIMIT		1		2		3		4		5	
Initial dial gauge reading	mm	0	0	0	0	0	0				
Final dial gauge reading	mm	15	15	19.5	19.4	21.3	21.5				
Cone Penetration	mm	15	15	19.5	19.4	21.3	21.5				
Average cone penetration	mm	15		19.45		21.4					
Container no.		M		702		W					
Mass of wet soil + container	g	36.7		43.90		45.30					
Mass of dry soil + container	g	29.5		34.40		34.90					
Mass of container	g	9.5		9.50		9.40					
Mass of moisture	g	7.20		9.50		10.40					
Mass of dry soil	g	20.00		24.90		25.50					
Moisture content	%	36.0		38.2		40.8					



LIQUID LIMIT	38.8	%
PLASTIC LIMIT	24.0	%
PLASTICITY INDEX	14.8	%

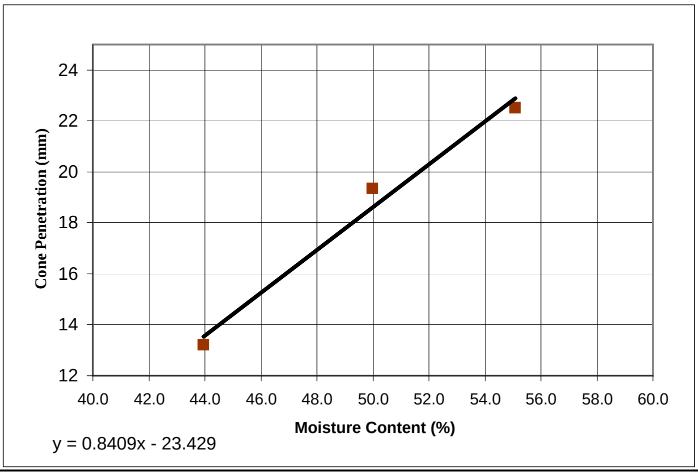
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	B TP2	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		B1	BJ			
Mass of wet soil + container	g	15.20	14.10			
Mass of dry soil + container	g	14.00	13.20			
Mass of container	g	9.50	9.50			
Mass of moisture	g	1.20	0.90			
Mass of dry soil	g	4.50	3.70			
Moisture content	%	26.67	24.32			25.50

LIQUID LIMIT		1		2		3		4		5	
Initial dial gauge reading	mm	0	0	0	0	0	0				
Final dial gauge reading	mm	13.2	13.2	19.2	19.5	22.5	22.5				
Cone Penetration	mm	13.2	13.2	19.2	19.5	22.5	22.5				
Average cone penetration	mm	13.2		19.35		22.5					
Container no.		117		702		65					
Mass of wet soil + container	g	40.9		26.90		40.70					
Mass of dry soil + container	g	32.9		21.10		31.50					
Mass of container	g	14.7		9.50		14.80					
Mass of moisture	g	8.00		5.80		9.20					
Mass of dry soil	g	18.20		11.60		16.70					
Moisture content	%	44.0		50.0		55.1					



LIQUID LIMIT	51.8	%
PLASTIC LIMIT	25.5	%
PLASTICITY INDEX	26.3	%

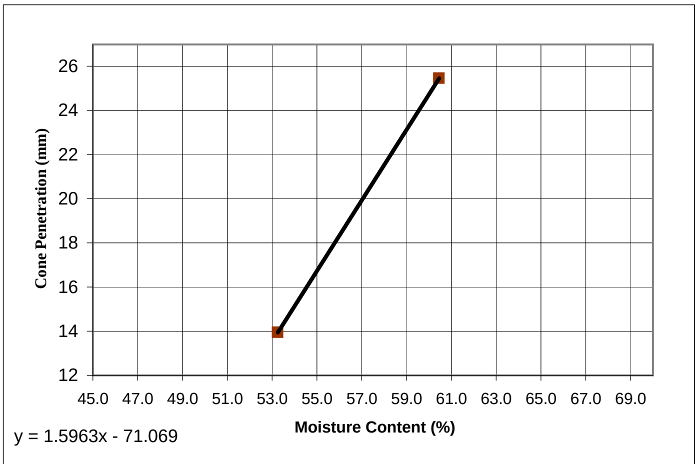
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	B TP3	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		KD	BU			
Mass of wet soil + container	g	16.20	16.00			
Mass of dry soil + container	g	14.60	14.60			
Mass of container	g	9.10	9.80			
Mass of moisture	g	1.60	1.40			
Mass of dry soil	g	5.50	4.80			
Moisture content	%	29.09	29.17			29.13

LIQUID LIMIT		1		2		3	4		5	
Initial dial gauge reading	mm	0	0	0	0					
Final dial gauge reading	mm	13.9	14	25.4	25.5					
Cone Penetration	mm	13.9	14	25.4	25.5					
Average cone penetration	mm	13.95		25.45						
Container no.		10		OO						
Mass of wet soil + container	g	42.9		43.10						
Mass of dry soil + container	g	33.1		32.70						
Mass of container	g	14.7		15.50						
Mass of moisture	g	9.80		10.40						
Mass of dry soil	g	18.40		17.20						
Moisture content	%	53.3		60.5						



LIQUID LIMIT	57.0	%
PLASTIC LIMIT	29.1	%
PLASTICITY INDEX	27.9	%

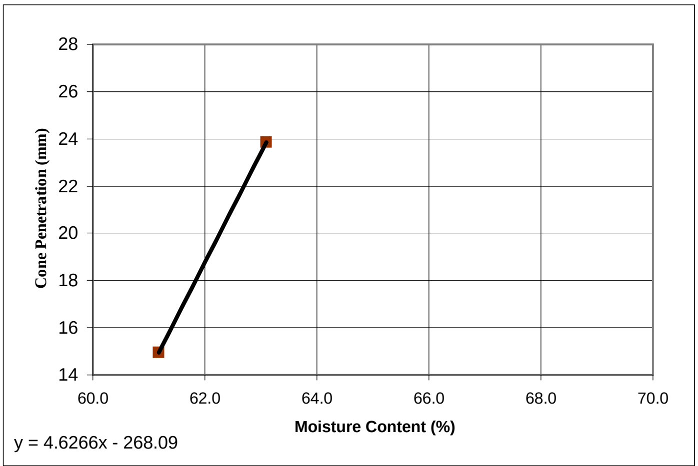
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	B TP4	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		Y	503			
Mass of wet soil + container	g	9.90	10.30			
Mass of dry soil + container	g	8.50	8.80			
Mass of container	g	3.80	3.80			
Mass of moisture	g	1.40	1.50			
Mass of dry soil	g	4.70	5.00			
Moisture content	%	29.79	30.00			29.89

LIQUID LIMIT		1		2		3		4		5	
Initial dial gauge reading	mm	0	0	0	0						
Final dial gauge reading	mm	15.0	14.9	23.8	23.9						
Cone Penetration	mm	15.0	14.9	23.8	23.9						
Average cone penetration	mm	14.95		23.85							
Container no.		642		6300							
Mass of wet soil + container	g	37		29.60							
Mass of dry soil + container	g	26.6		21.79							
Mass of container	g	9.6		9.40							
Mass of moisture	g	10.40		7.81							
Mass of dry soil	g	17.00		12.39							
Moisture content	%	61.2		63.1							



LIQUID LIMIT	62.3	%
PLASTIC LIMIT	29.9	%
PLASTICITY INDEX	32.4	%

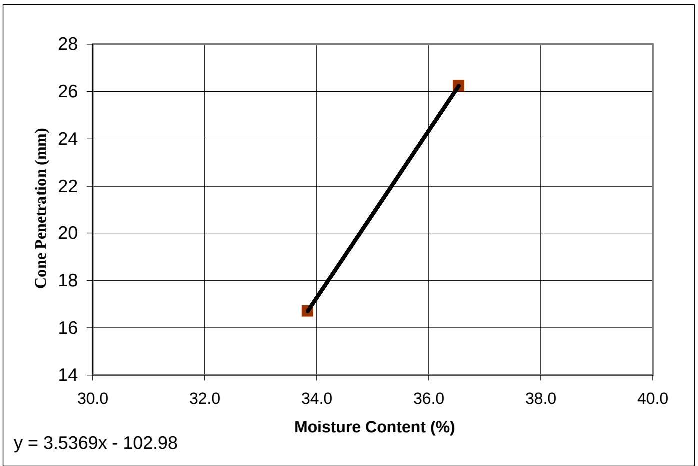
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	B TP6	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		O	PO			
Mass of wet soil + container	g	17.60	15.10			
Mass of dry soil + container	g	16.20	14.20			
Mass of container	g	9.20	9.40			
Mass of moisture	g	1.40	0.90			
Mass of dry soil	g	7.00	4.80			
Moisture content	%	20.00	18.75			19.38

LIQUID LIMIT		1		2		3	4		5	
Initial dial gauge reading	mm	0	0	0	0					
Final dial gauge reading	mm	16.7	16.7	26.3	26.2					
Cone Penetration	mm	16.7	16.7	26.3	26.2					
Average cone penetration	mm	16.7		26.25						
Container no.		BU		Y						
Mass of wet soil + container	g	36.3		37.90						
Mass of dry soil + container	g	29.6		30.30						
Mass of container	g	9.8		9.50						
Mass of moisture	g	6.70		7.60						
Mass of dry soil	g	19.80		20.80						
Moisture content	%	33.8		36.5						



LIQUID LIMIT	34.8	%
PLASTIC LIMIT	19.4	%
PLASTICITY INDEX	15.4	%

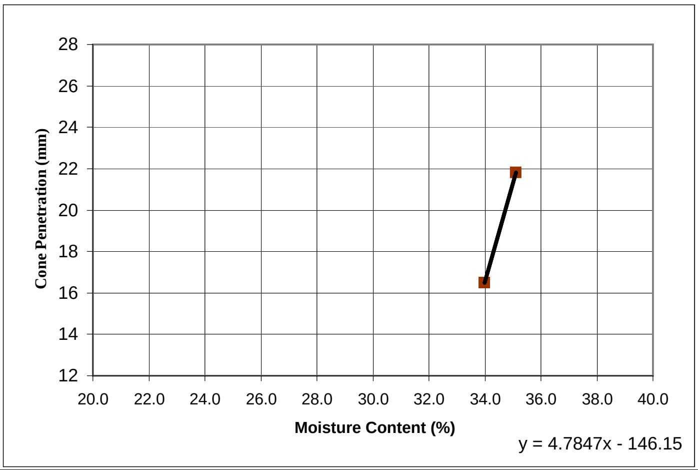
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	B TP8	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		VD	I			
Mass of wet soil + container	g	10.50	9.70			
Mass of dry soil + container	g	9.50	8.80			
Mass of container	g	4.00	3.80			
Mass of moisture	g	1.00	0.90			
Mass of dry soil	g	5.50	5.00			
Moisture content	%	18.18	18.00			18.09

LIQUID LIMIT		1		2		3		4		5	
Initial dial gauge reading	mm	0	0	0	0	0	0				
Final dial gauge reading	mm	16.5	16.5	21.8	21.8						
Cone Penetration	mm	16.5	16.5	21.8	21.8						
Average cone penetration	mm	16.5		21.8							
Container no.		Z2		6300							
Mass of wet soil + container	g	53		42.50							
Mass of dry soil + container	g	41.0		33.90							
Mass of container	g	5.7		9.40							
Mass of moisture	g	12.00		8.60							
Mass of dry soil	g	35.30		24.50							
Moisture content	%	34.0		35.1							



LIQUID LIMIT	34.7	%
PLASTIC LIMIT	18.1	%
PLASTICITY INDEX	16.6	%

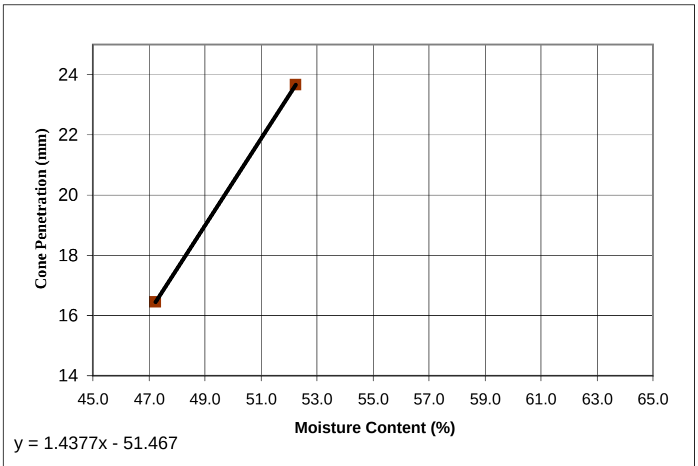
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	B TP9	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		SNO	182			
Mass of wet soil + container	g	9.50	13.20			
Mass of dry soil + container	g	8.20	11.40			
Mass of container	g	3.70	5.00			
Mass of moisture	g	1.30	1.80			
Mass of dry soil	g	4.50	6.40			
Moisture content	%	28.89	28.13			28.51

LIQUID LIMIT		1		2		3	4		5	
Initial dial gauge reading	mm	0	0	0	0					
Final dial gauge reading	mm	16.5	16.4	23.7	23.6					
Cone Penetration	mm	16.5	16.4	23.7	23.6					
Average cone penetration	mm	16.45		23.65						
Container no.		600		TU						
Mass of wet soil + container	g	33.6		36.50						
Mass of dry soil + container	g	25.9		27.20						
Mass of container	g	9.6		9.40						
Mass of moisture	g	7.70		9.30						
Mass of dry soil	g	16.30		17.80						
Moisture content	%	47.2		52.2						



LIQUID LIMIT	49.7	%
PLASTIC LIMIT	28.5	%
PLASTICITY INDEX	21.2	%

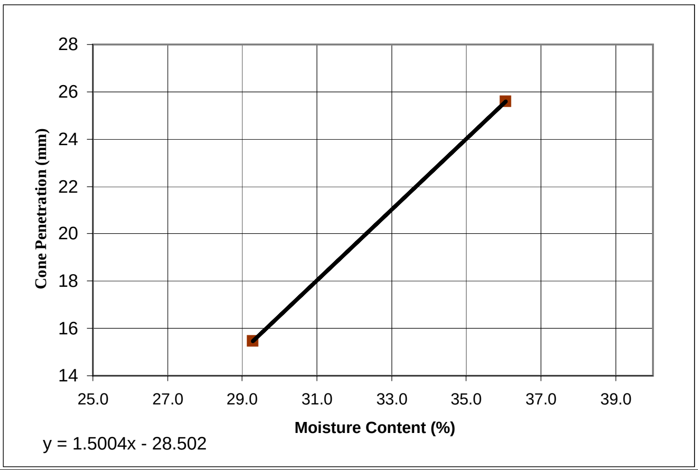
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	B TP11	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.						
Mass of wet soil + container	g					
Mass of dry soil + container	g					
Mass of container	g					
Mass of moisture	g					
Mass of dry soil	g					
Moisture content	%					#DIV/0!

LIQUID LIMIT		1		2		3		4		5	
Initial dial gauge reading	mm	0	0	0	0						
Final dial gauge reading	mm	15.5	15.4	25.7	25.5						
Cone Penetration	mm	15.5	15.4	25.7	25.5						
Average cone penetration	mm	15.45		25.6							
Container no.		L		Y							
Mass of wet soil + container	g	35.4		37.80							
Mass of dry soil + container	g	29.6		30.30							
Mass of container	g	9.8		9.50							
Mass of moisture	g	5.80		7.50							
Mass of dry soil	g	19.80		20.80							
Moisture content	%	29.3		36.1							



LIQUID LIMIT	32.3	%
PLASTIC LIMIT	#DIV/0!	%
PLASTICITY INDEX	Non plastic	%

Checked by: *S.P.Kisitu*
Laboratory Engineer

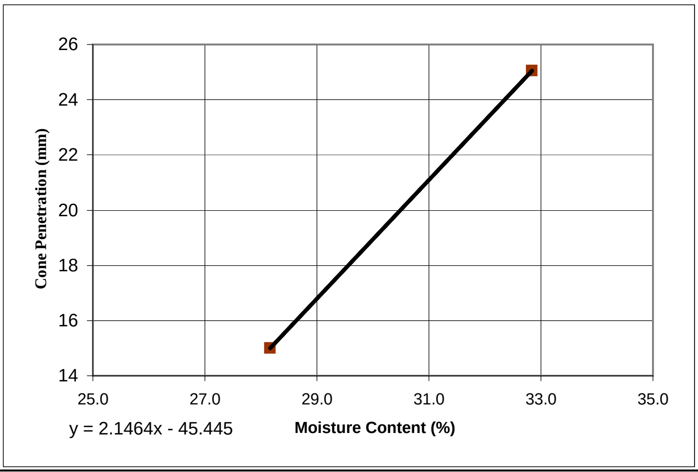
PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project: **Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**

Location:	B TP12	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.						
Mass of wet soil + container	g					
Mass of dry soil + container	g					
Mass of container	g					
Mass of moisture	g					
Mass of dry soil	g					
Moisture content	%					#DIV/0!

LIQUID LIMIT		1		2		3	4		5	
Initial dial gauge reading	mm	0	0	0	0					
Final dial gauge reading	mm	15.0	15	25.0	25.1					
Cone Penetration	mm	15.0	15	25	25.1					
Average cone penetration	mm	15		25.05						
Container no.		SNO		TU						
Mass of wet soil + container	g	26		36.70						
Mass of dry soil + container	g	21.1		30.00						
Mass of container	g	3.7		9.60						
Mass of moisture	g	4.90		6.70						
Mass of dry soil	g	17.40		20.40						
Moisture content	%	28.2		32.8						



LIQUID LIMIT	30.5	%
PLASTIC LIMIT	#DIV/0!	%
PLASTICITY INDEX	Non plastic	%

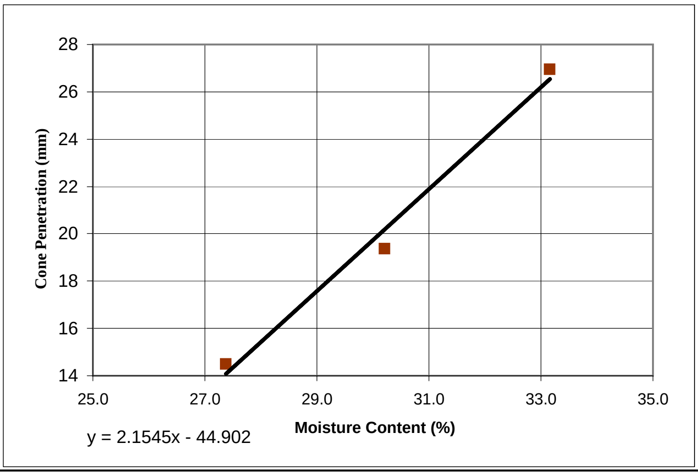
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	B TP13	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		204	182			
Mass of wet soil + container	g	12.60	11.80			
Mass of dry soil + container	g	11.50	10.70			
Mass of container	g	5.40	4.90			
Mass of moisture	g	1.10	1.10			
Mass of dry soil	g	6.10	5.80			
Moisture content	%	18.03	18.97			18.50

LIQUID LIMIT		1		2		3		4		5	
Initial dial gauge reading	mm	0	0	0	0	0	0				
Final dial gauge reading	mm	14.5	14.5	19.5	19.2	27	27				
Cone Penetration	mm	14.5	14.5	19.5	19.2	26.9	27				
Average cone penetration	mm	14.5		19.35		26.95					
Container no.		LN		I		620					
Mass of wet soil + container	g	44.3		40.00		34.60					
Mass of dry soil + container	g	36.8		32.90		28.30					
Mass of container	g	9.4		9.40		9.30					
Mass of moisture	g	7.50		7.10		6.30					
Mass of dry soil	g	27.40		23.50		19.00					
Moisture content	%	27.4		30.2		33.2					



LIQUID LIMIT	30.1	%
PLASTIC LIMIT	18.5	%
PLASTICITY INDEX	11.6	%

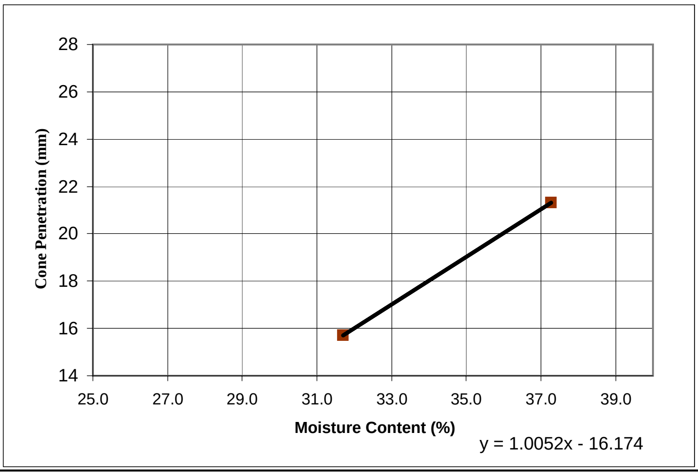
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	M TP1	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		O	W			
Mass of wet soil + container	g	16.50	18.00			
Mass of dry soil + container	g	15.30	16.40			
Mass of container	g	9.20	9.40			
Mass of moisture	g	1.20	1.60			
Mass of dry soil	g	6.10	7.00			
Moisture content	%	19.67	22.86			21.26

LIQUID LIMIT		1		2		3		4		5	
Initial dial gauge reading	mm	0	0	0	0	0	0				
Final dial gauge reading	mm	15.5	15.9	21.4	21.2						
Cone Penetration	mm	15.5	15.9	21.4	21.2						
Average cone penetration	mm	15.7		21.3							
Container no.		KA		BH							
Mass of wet soil + container	g	25.2		32.50							
Mass of dry soil + container	g	20		26.20							
Mass of container	g	3.6		9.30							
Mass of moisture	g	5.20		6.30							
Mass of dry soil	g	16.40		16.90							
Moisture content	%	31.7		37.3							



LIQUID LIMIT	36.0	%
PLASTIC LIMIT	21.3	%
PLASTICITY INDEX	14.7	%

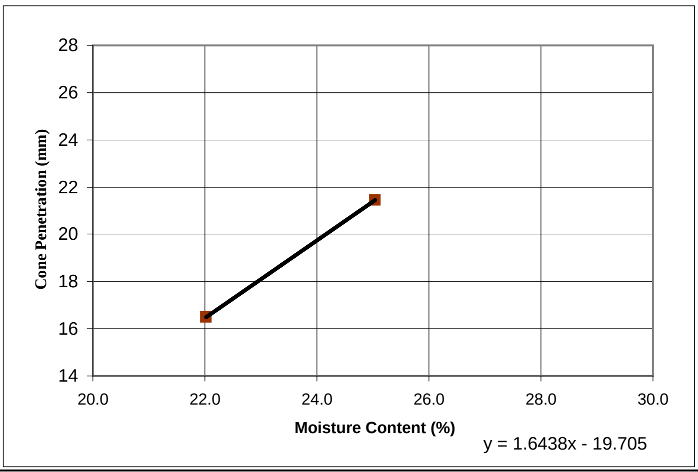
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	M TP2	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		ka	XB			
Mass of wet soil + container	g	11.70	11.40			
Mass of dry soil + container	g	11.00	10.60			
Mass of container	g	3.60	4.00			
Mass of moisture	g	0.70	0.80			
Mass of dry soil	g	7.40	6.60			
Moisture content	%	9.46	12.12			10.79

LIQUID LIMIT		1		2		3		4		5	
Initial dial gauge reading	mm	0	0	0	0	0	0				
Final dial gauge reading	mm	16.4	16.6	21.4	21.5						
Cone Penetration	mm	16.4	16.6	21.4	21.5						
Average cone penetration	mm	16.5		21.45							
Container no.		204		182							
Mass of wet soil + container	g	53.7		47.50							
Mass of dry soil + container	g	45		38.97							
Mass of container	g	5.5		4.90							
Mass of moisture	g	8.70		8.53							
Mass of dry soil	g	39.50		34.07							
Moisture content	%	22.0		25.0							



LIQUID LIMIT	24.2	%
PLASTIC LIMIT	10.8	%
PLASTICITY INDEX	13.4	%

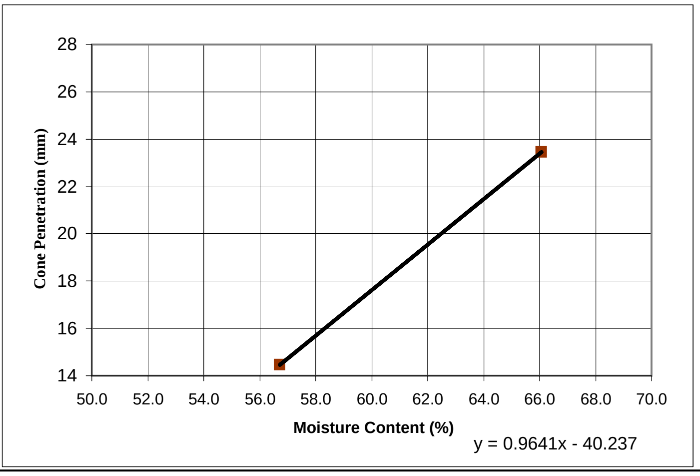
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	M TP 4	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		SNO	620			
Mass of wet soil + container	g	10.70	14.30			
Mass of dry soil + container	g	9.30	13.30			
Mass of container	g	3.70	9.30			
Mass of moisture	g	1.40	1.00			
Mass of dry soil	g	5.60	4.00			
Moisture content	%	25.00	25.00			25.00

LIQUID LIMIT		1		2		3		4		5	
Initial dial gauge reading	mm	0	0	0	0	0	0				
Final dial gauge reading	mm	14.5	14.4	23.4	23.5						
Cone Penetration	mm	14.5	14.4	23.4	23.5						
Average cone penetration	mm	14.45		23.45							
Container no.		Y		503							
Mass of wet soil + container	g	30.6		31.20							
Mass of dry soil + container	g	20.9		20.30							
Mass of container	g	3.8		3.80							
Mass of moisture	g	9.70		10.90							
Mass of dry soil	g	17.10		16.50							
Moisture content	%	56.7		66.1							



LIQUID LIMIT	62.5	%
PLASTIC LIMIT	25.0	%
PLASTICITY INDEX	37.5	%

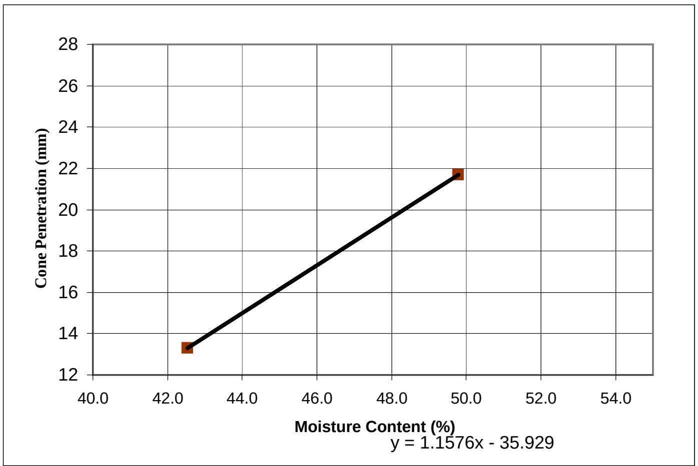
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	M TP5	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		Z	187			
Mass of wet soil + container	g	12.50	13.80			
Mass of dry soil + container	g	10.70	11.70			
Mass of container	g	5.10	5.40			
Mass of moisture	g	1.80	2.10			
Mass of dry soil	g	5.60	6.30			
Moisture content	%	32.14	33.33			32.74

LIQUID LIMIT		1		2		3		4		5	
Initial dial gauge reading	mm	0	0	0	0	0	0				
Final dial gauge reading	mm	13.4	13.2	21.7	21.7						
Cone Penetration	mm	13.4	13.2	21.7	21.7						
Average cone penetration	mm	13.3		21.7							
Container no.		642		TU							
Mass of wet soil + container	g	34.4		44.50							
Mass of dry soil + container	g	27		32.90							
Mass of container	g	9.6		9.60							
Mass of moisture	g	7.40		11.60							
Mass of dry soil	g	17.40		23.30							
Moisture content	%	42.5		49.8							



LIQUID LIMIT	48.3	%
PLASTIC LIMIT	32.7	%
PLASTICITY INDEX	15.6	%

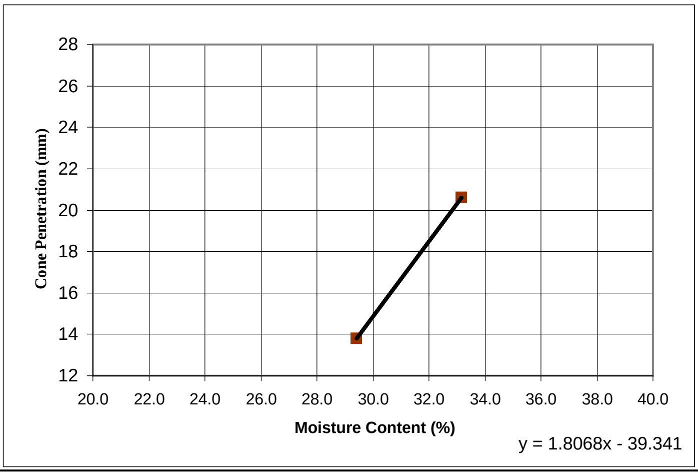
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	M-TP 6	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		503	204			
Mass of wet soil + container	g	12.80	14.90			
Mass of dry soil + container	g	11.20	13.20			
Mass of container	g	3.80	5.30			
Mass of moisture	g	1.60	1.70			
Mass of dry soil	g	7.40	7.90			
Moisture content	%	21.62	21.52			21.57

LIQUID LIMIT		1		2		3		4		5	
Initial dial gauge reading	mm	0	0	0	0	0	0				
Final dial gauge reading	mm	13.7	13.9	20.4	20.8						
Cone Penetration	mm	13.7	13.9	20.4	20.8						
Average cone penetration	mm	13.8		20.6							
Container no.		620		LN							
Mass of wet soil + container	g	44.9		37.50							
Mass of dry soil + container	g	36.9		30.50							
Mass of container	g	9.7		9.40							
Mass of moisture	g	8.00		7.00							
Mass of dry soil	g	27.20		21.10							
Moisture content	%	29.4		33.2							



LIQUID LIMIT	32.8	%
PLASTIC LIMIT	21.6	%
PLASTICITY INDEX	11.3	%

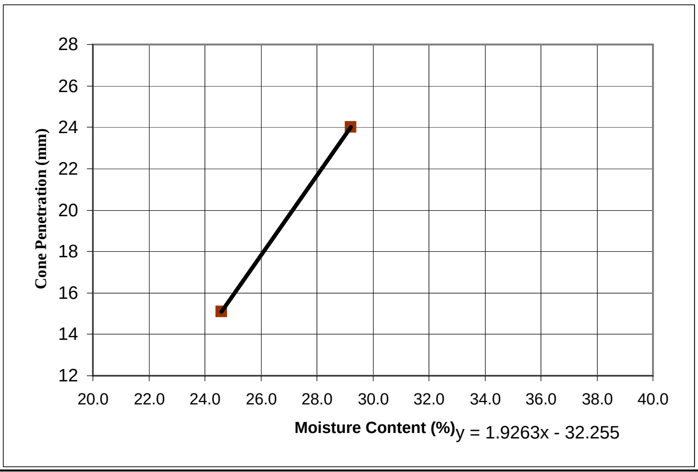
Checked by: *S.P.Kisitu*
Laboratory Engineer

PLASTIC LIMIT AND LIQUID LIMIT (CONE PENETROMETER)

Project:	**Feasibility study on inteconnection Transmission Lines Uganda-Kenya & Uganda- Rwanda**		
Location:	M TP7	Sample Source:	
Soil Description			
Sampling Date:		Test Method	BS1377 part 2 1990.
Testing Date:		Technician	Marriam.

PLASTIC LIMIT	Test no.	1	2	3	4	Average
Contauner no.		Y	600			
Mass of wet soil + container	g	16.80	16.10			
Mass of dry soil + container	g	15.80	15.23			
Mass of container	g	9.50	9.60			
Mass of moisture	g	1.00	0.87			
Mass of dry soil	g	6.30	5.63			
Moisture content	%	15.87	15.45			15.66

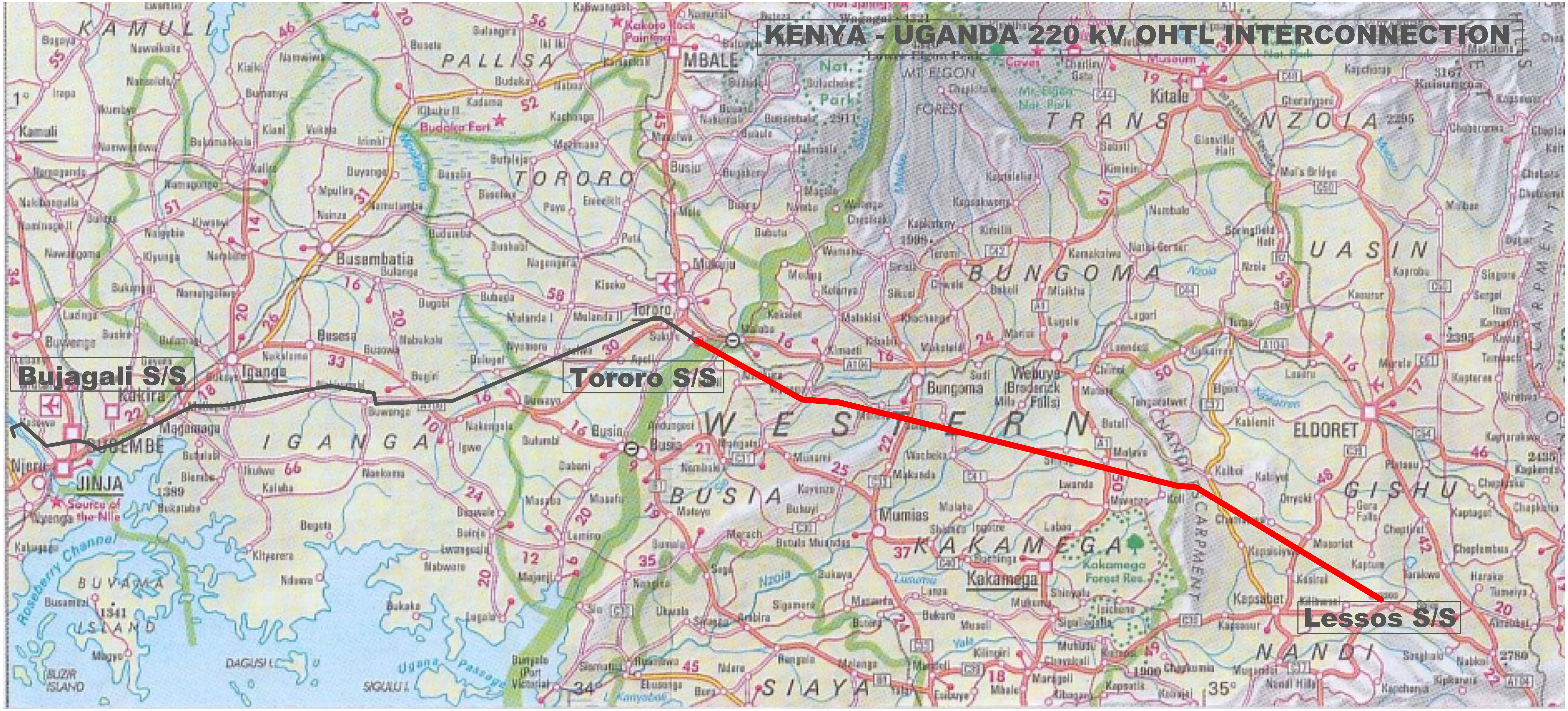
LIQUID LIMIT		1		2		3		4		5	
Initial dial gauge reading	mm	0	0	0	0	0	0				
Final dial gauge reading	mm	15.0	15.2	23.9	24.1						
Cone Penetration	mm	15	15.2	23.9	24.1						
Average cone penetration	mm	15.1		24							
Container no.		36		Z2							
Mass of wet soil + container	g	44.9		49.50							
Mass of dry soil + container	g	39.0		39.60							
Mass of container	g	15.0		5.70							
Mass of moisture	g	5.90		9.90							
Mass of dry soil	g	24.00		33.90							
Moisture content	%	24.6		29.2							



LIQUID LIMIT	27.1	%
PLASTIC LIMIT	15.7	%
PLASTICITY INDEX	11.5	%

Checked by: *S.P.Kisitu*
Laboratory Engineer

ANNEX E. LINE ROUTE MAP LESSOS – TORORO


KENYA - UGANDA 220 kV OHTL INTERCONNECTION
Bujagali S/S
Tororo S/S
Lessos S/S
MBALE
JINJA
ELDORET
Kitale
Tororo
Busia
Bungoma
Webuye
Mumias
Kakamega
Kapsabet
Iganga
Busembatia
KAMULI
PALLISA
TORORO
IGANGA
BUSIA
WESTERN
BUNGOMA
KAKAMEGA
TRANS NZOIA
UASIN GISHU
NANDI
SIAYA

ANNEX F. PLAN AND PROFILE LESSOS – TORORO

KENYA – UGANDA INTERCONNECTION:
LESSOS – UGANDAN BORDER
LIST OF PLAN AND PROFILE SHEETS 1 – 21

Sheet No.	Stretch in Metres	Tower Numbers	Quantity of Towers
1	0 – 5 859	1 - 19	19
2	5 859 – 12 275	19 - 37	18
3	12 275 – 17 802	37 - 54	17
4	17 802 – 24 235	54 - 74	20
5	24 235 – 28 537	74 - 86	12
6	28 537 – 34 788	86 - 104	18
7	34 788 – 40 302	104 - 123	19
8	40 302 – 47 370	123 - 146	23
9	47 370 – 54 307	146 - 166	20
10	54 307 – 60 769	166 - 185	19
11	60 769 – 67 511	185 - 205	20
12	67 511 – 74 232	205 - 224	19
13	74 232 – 79 469	224 - 239	15
14	79 469 – 85 378	239 - 256	17
15	85 378 – 91 264	256 - 273	17
16	91 264 – 98 839	273 - 295	22
17	98 839 – 105 709	295 - 315	20
18	105 709 – 111 253	315 - 331	16
19	111 253 – 118 568	331 - 352	21
20	118 568 – 125 084	352 - 371	19
21	125 084 – 127 632	371 - 378	8

Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

NELSAP
STUDY ON THE INTERCONNECTION THE ELECTRICITY NETWORKS OF THE NILE EQUATORIAL LAKES COUNTRIES

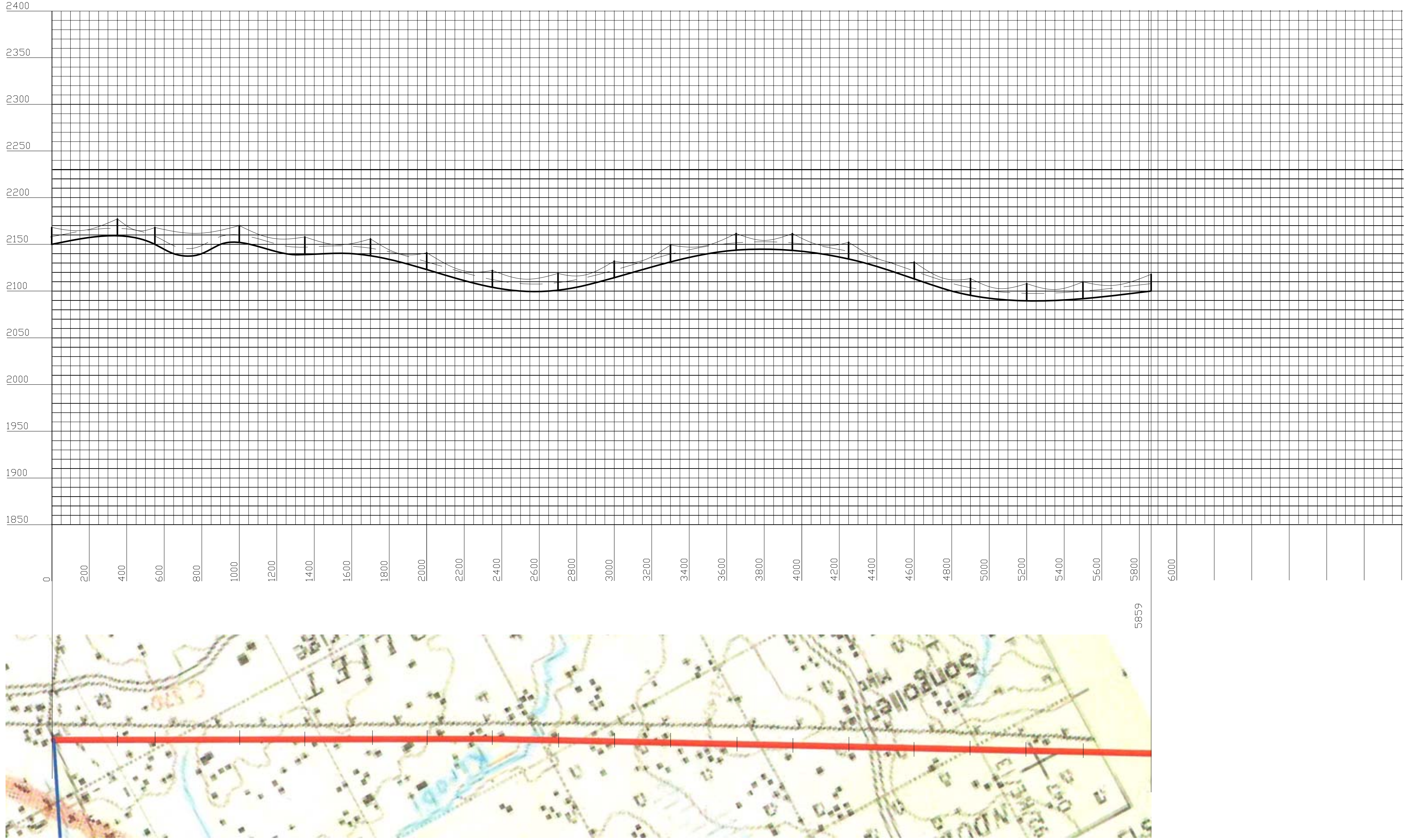
PAALEN
ETUDE D' INTERCONNECTION DES RESEAUX ELECTRIQUES DES PAYS DES LACS EQUATORIAUX DU NIL

FEASIBILITY REPORT / RAPPORT DE FAISABILITE

KENYA - UGANDA - INTERCONNECTION
PLAN AND PROFILE
LESSOS - TORORO: SHEETS 1 - 21

N° H L KU 122 a

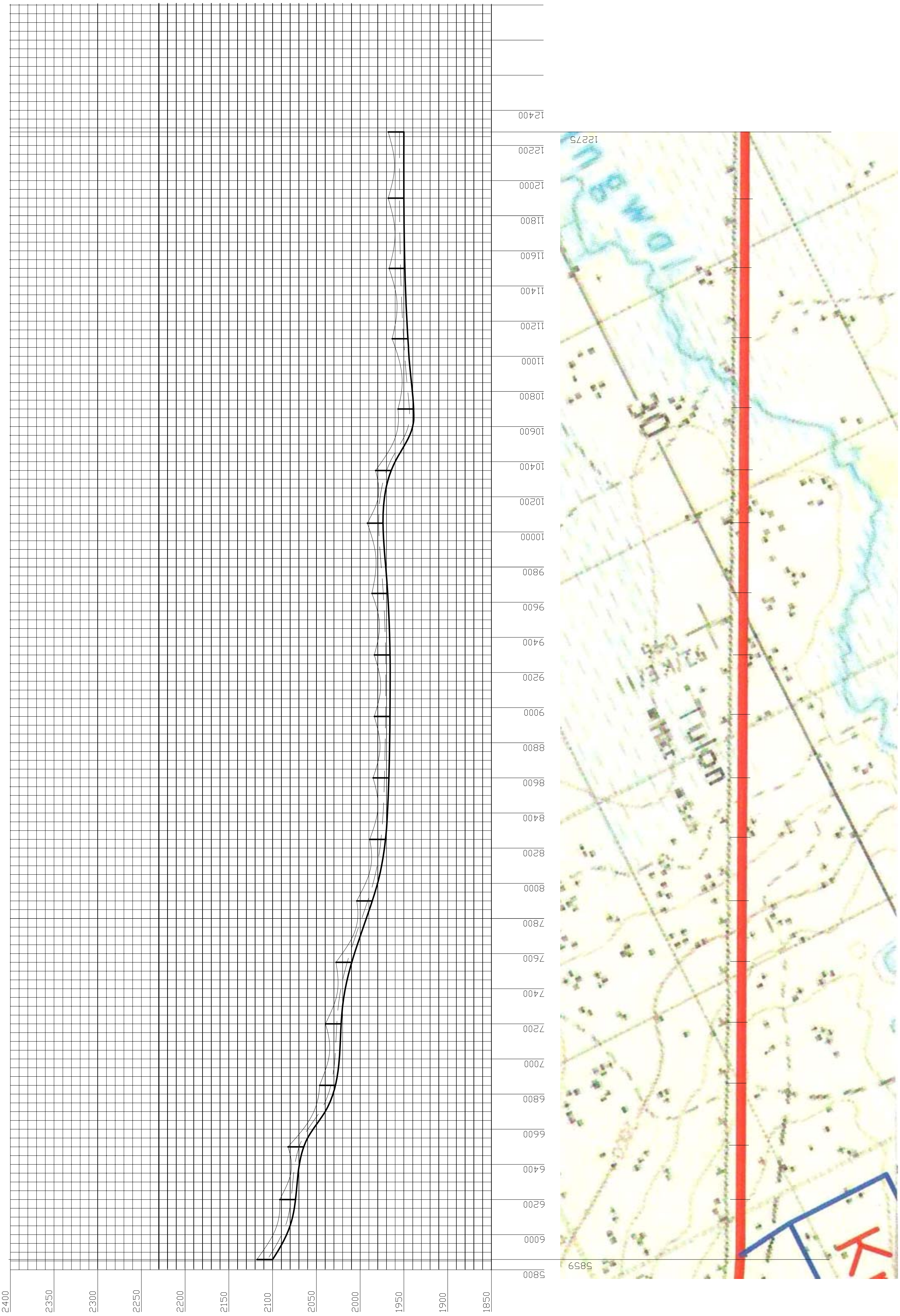
Date : October 22, 2007



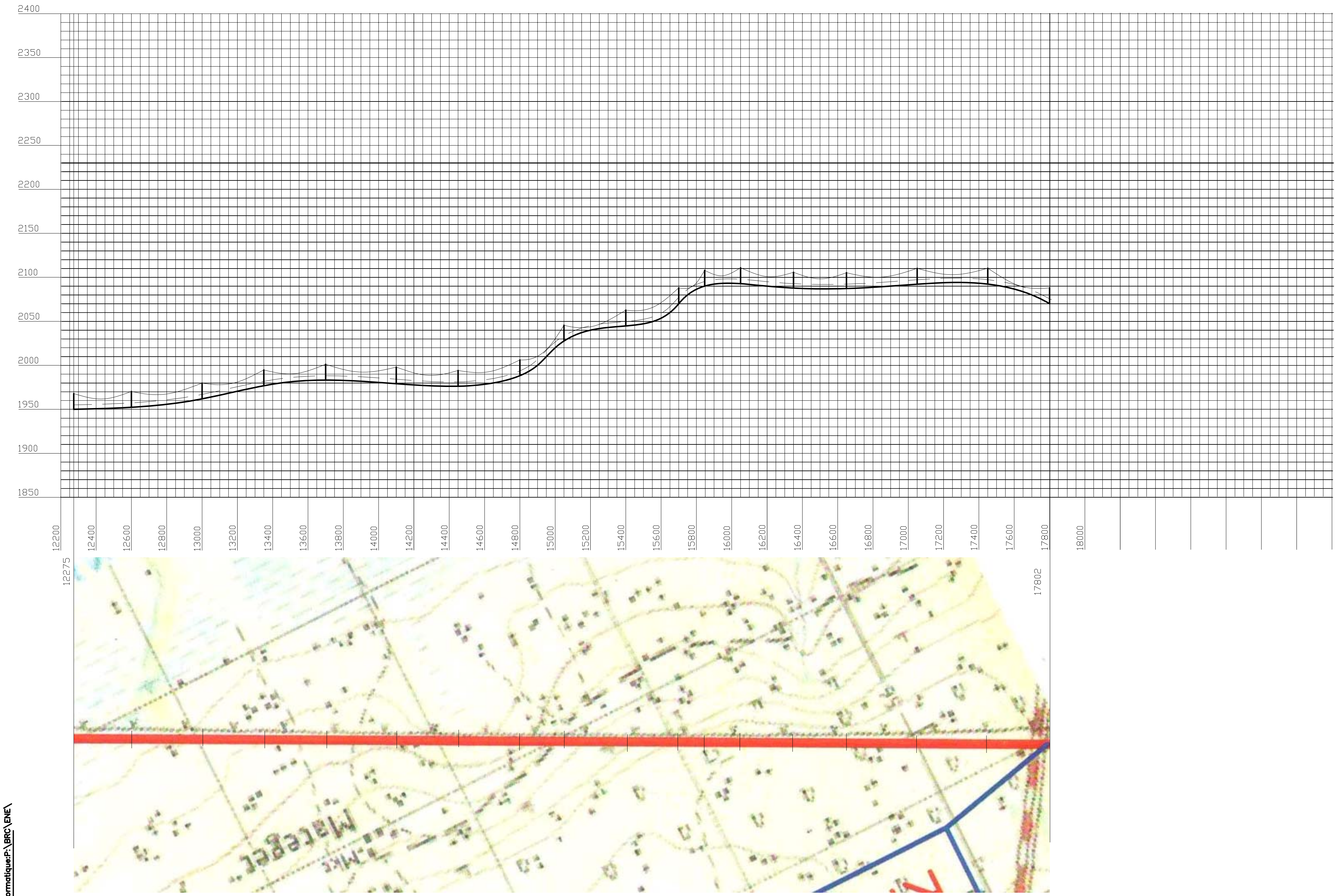
Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 122 - Sheet 1

Drawing No. HL KU 122 - Sheet 2

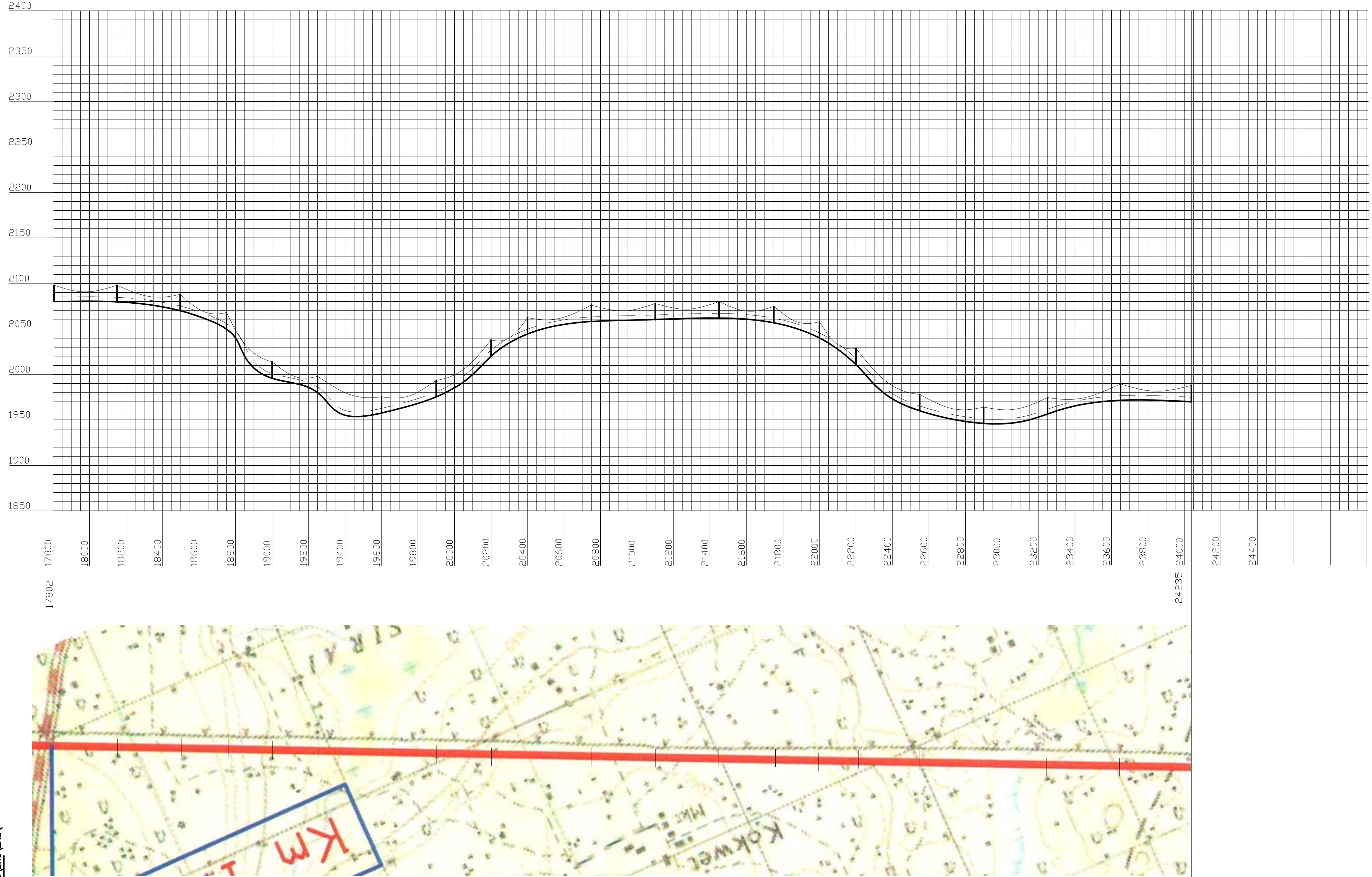


Dessiné par: ALX
Contrôlé par: XDS
Référence informatique:P:\BRC\ENE\



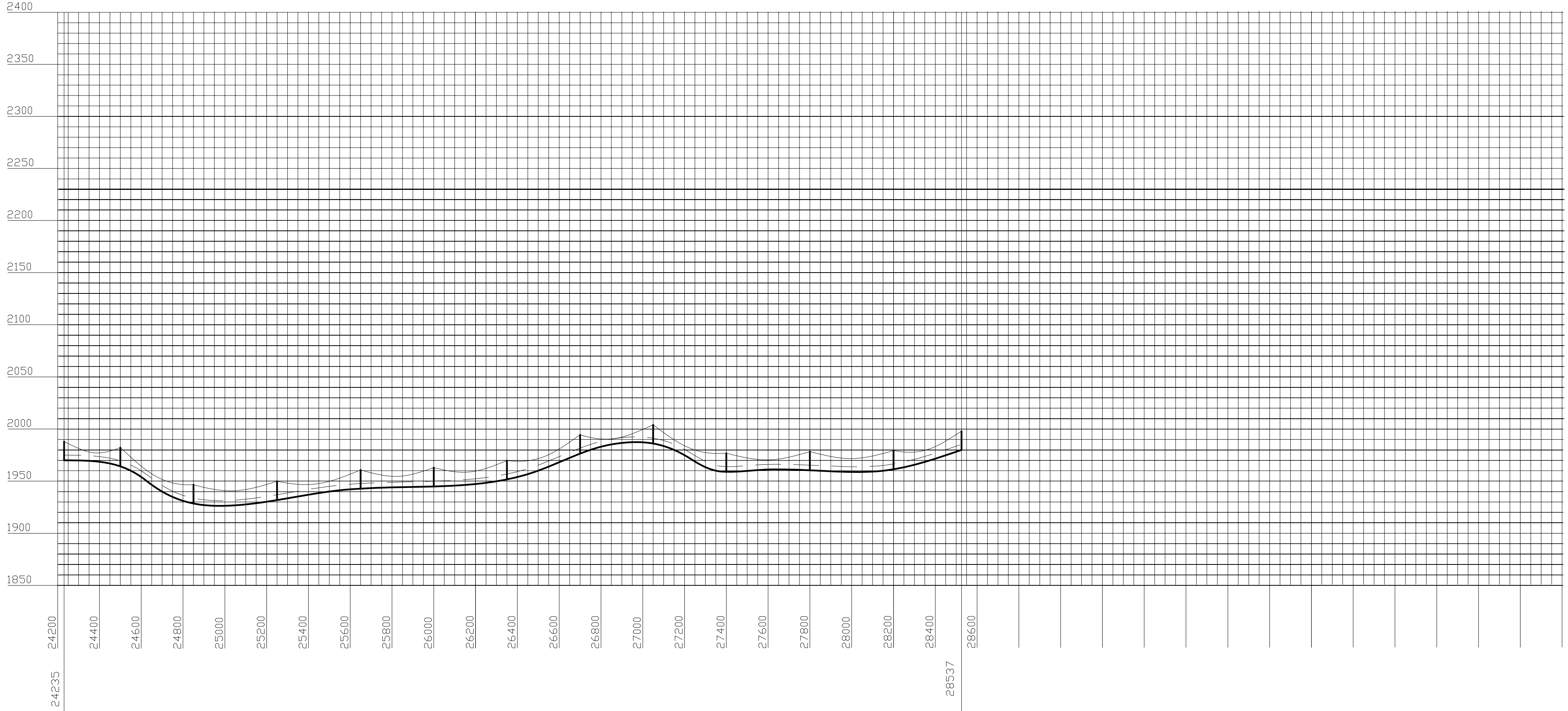
Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 122 - Sheet 3



Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 122 - Sheet 4



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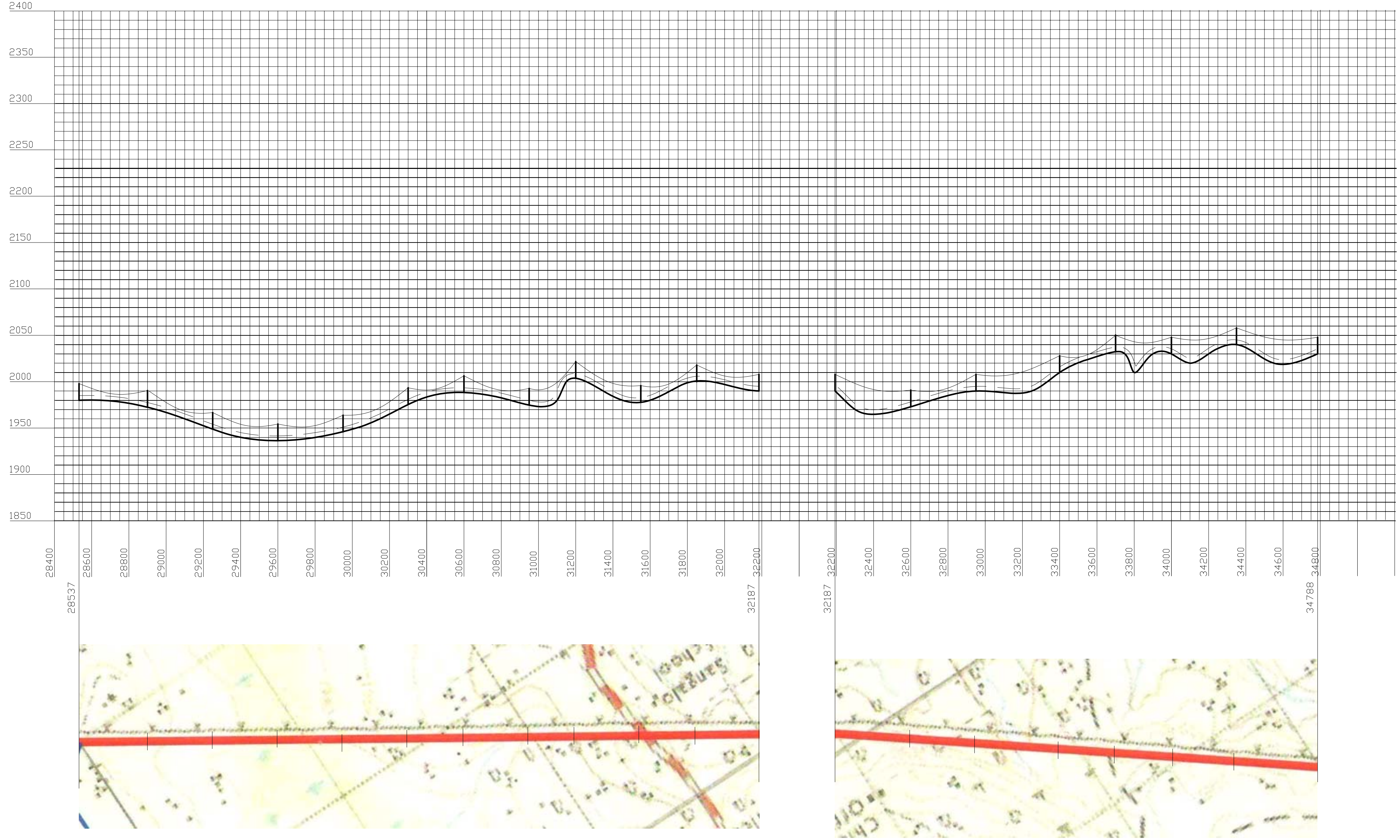
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

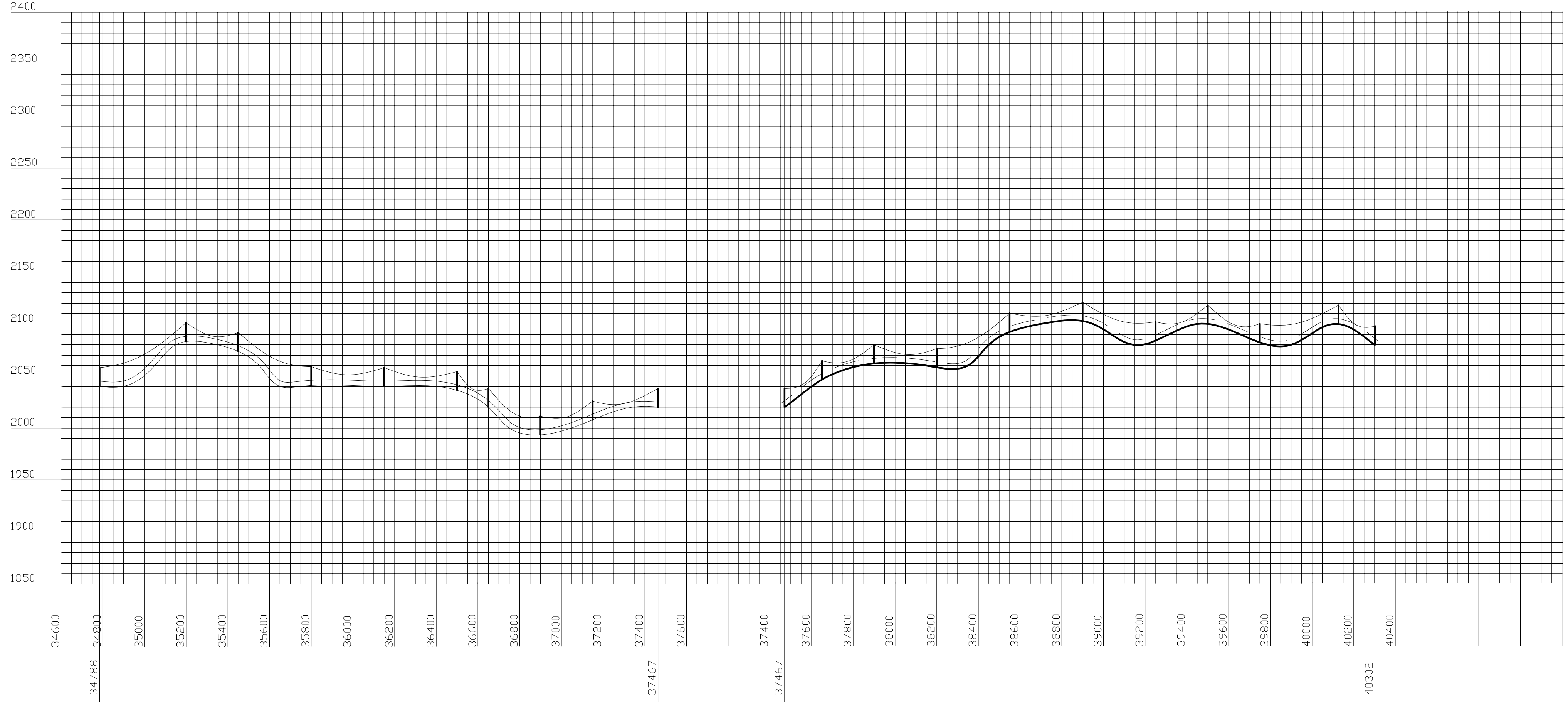
Drawing No. HL KU 122 - Sheet 5

Drawing No. HL KU 122 - Sheet 6



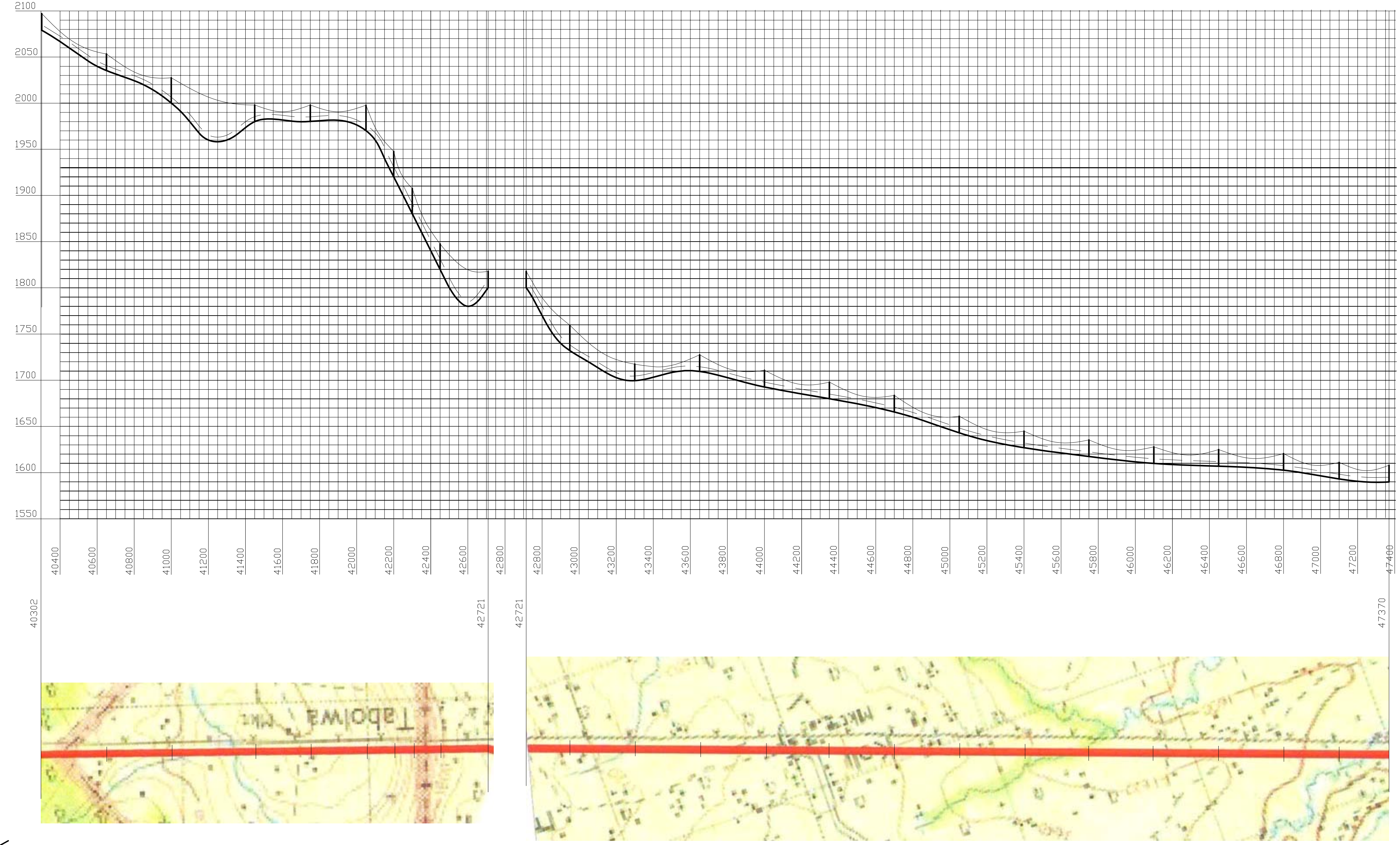
Dessiné par: ALX Controlé par: XDS

Référence informatique:P:\BRC\ENE\



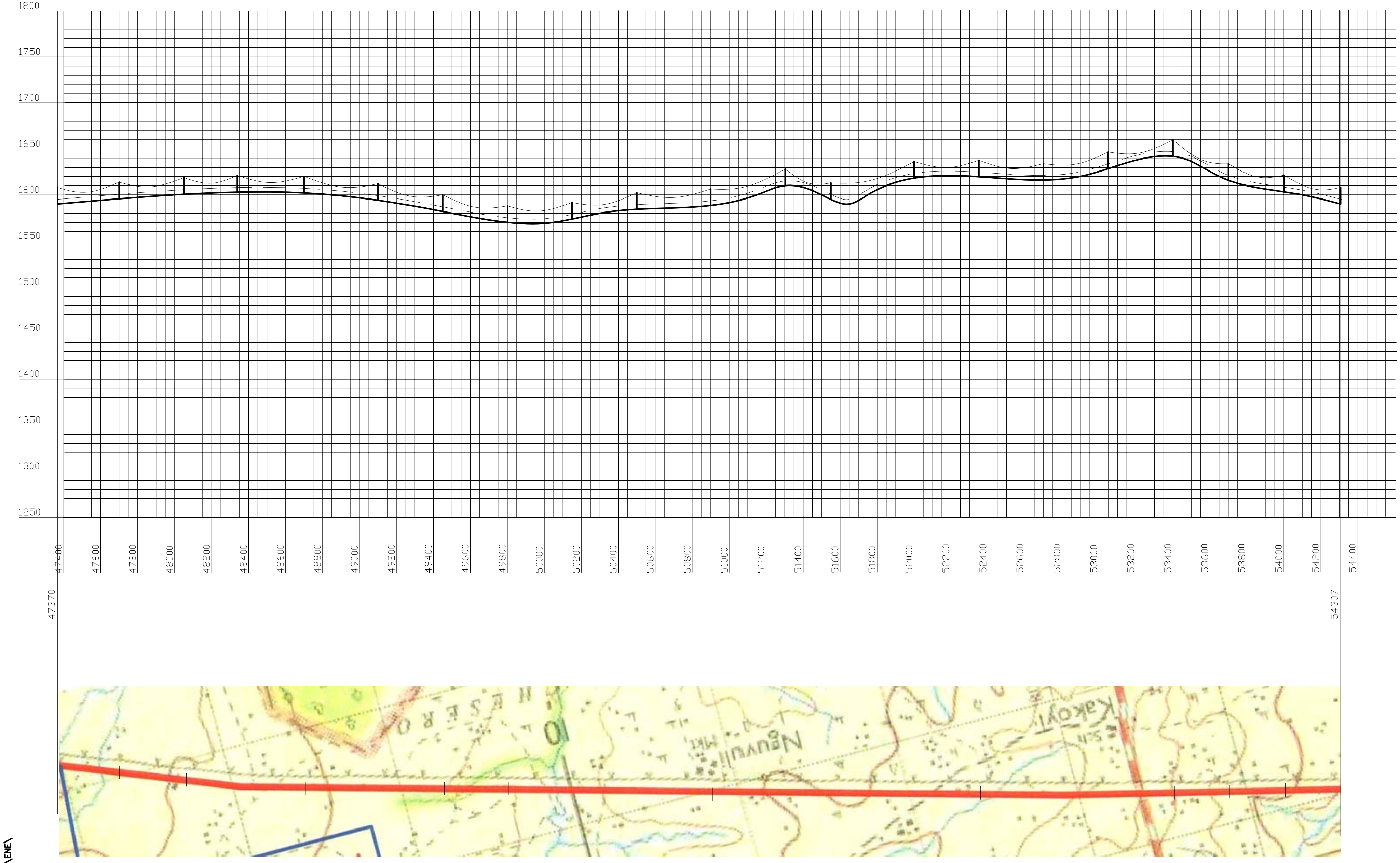
Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 122 - Sheet 7



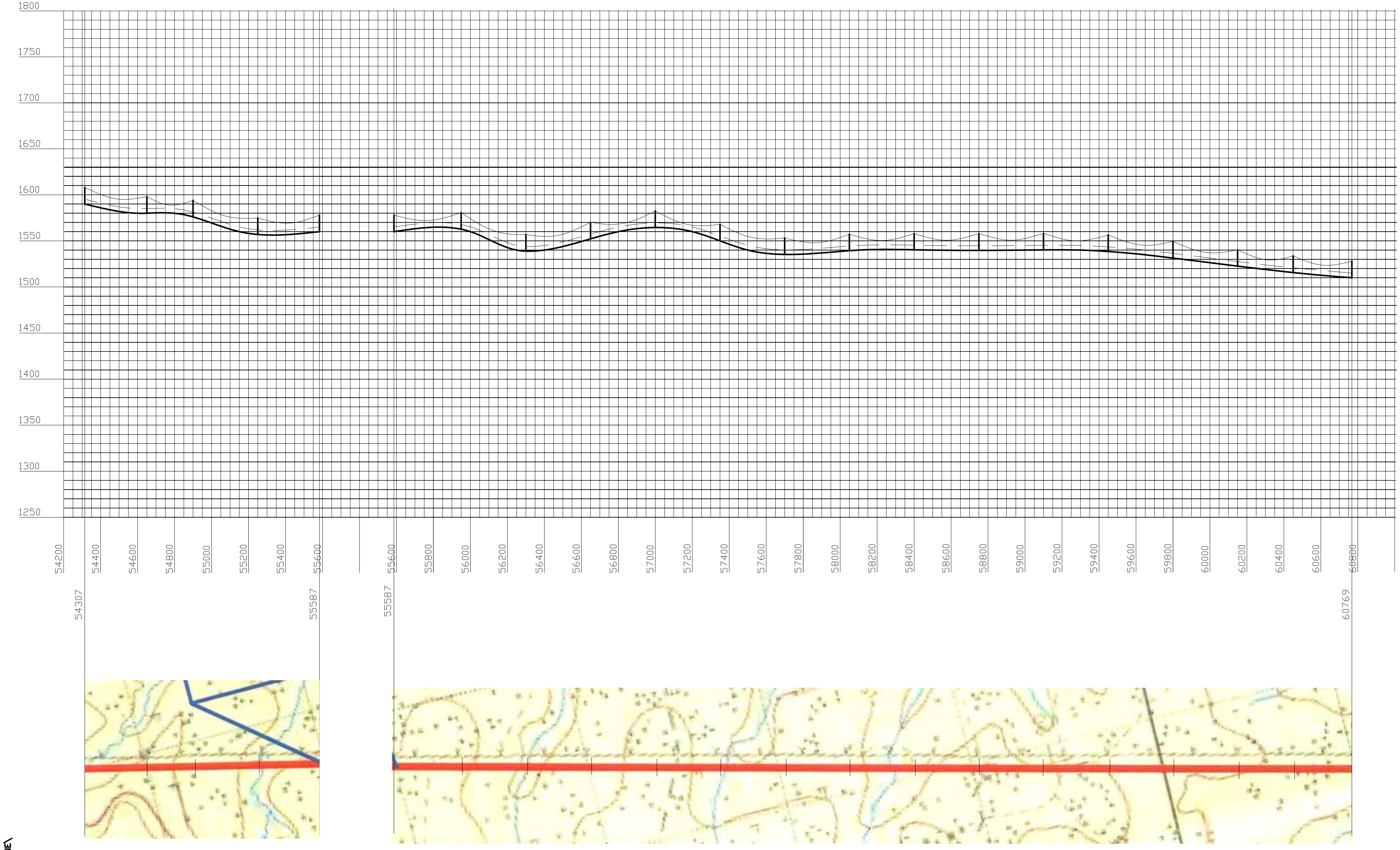
Dessiné par: ALX Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 122 - Sheet 8



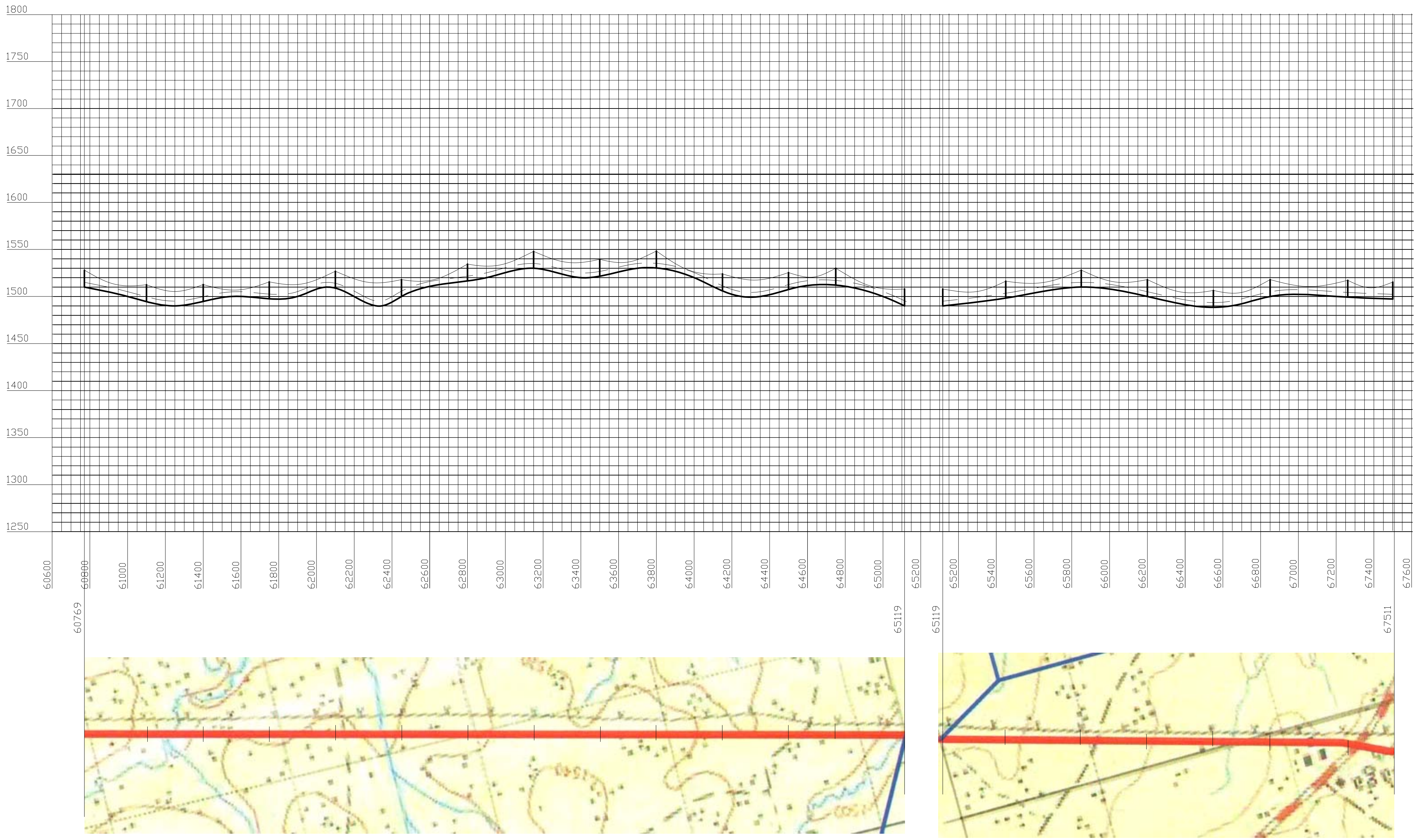
Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 122 - Sheet 9



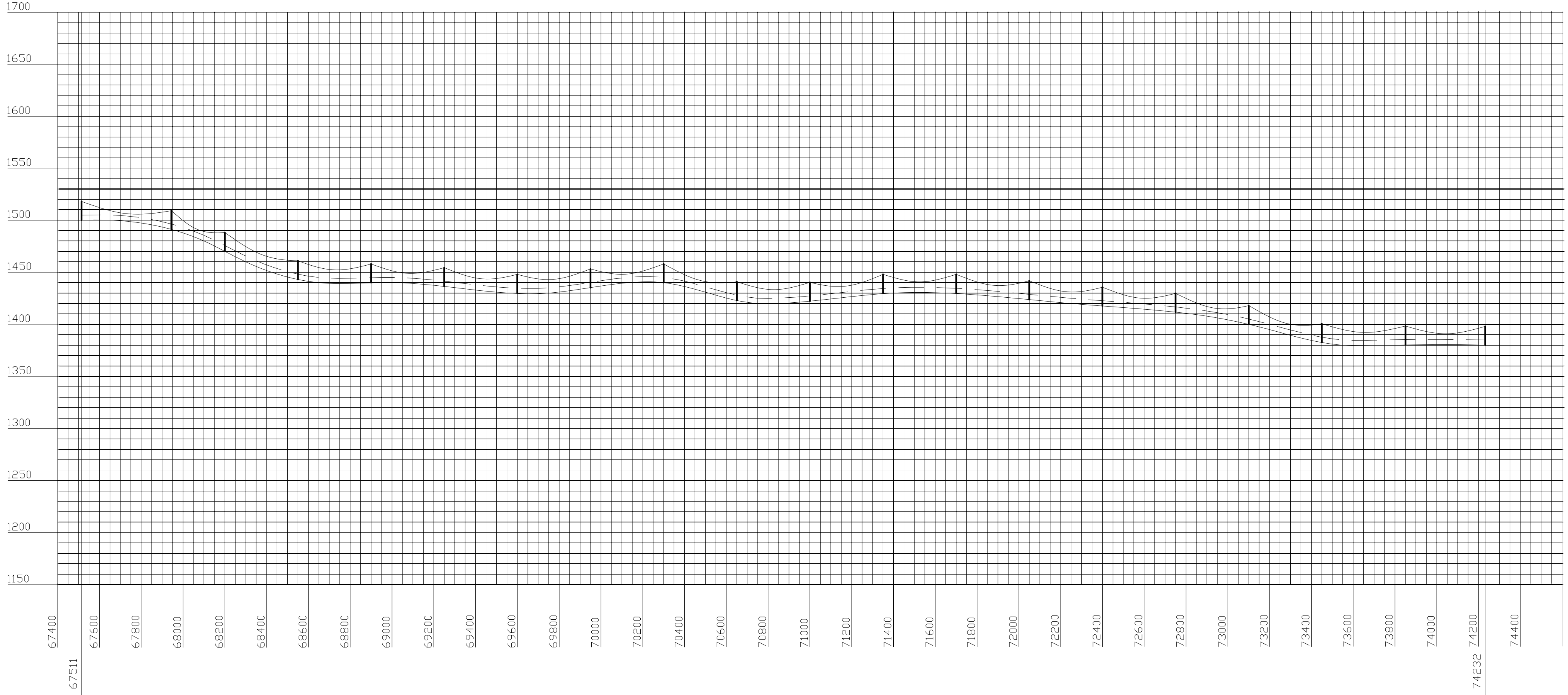
Dessiné par: ALX Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 122 - Sheet 10



Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

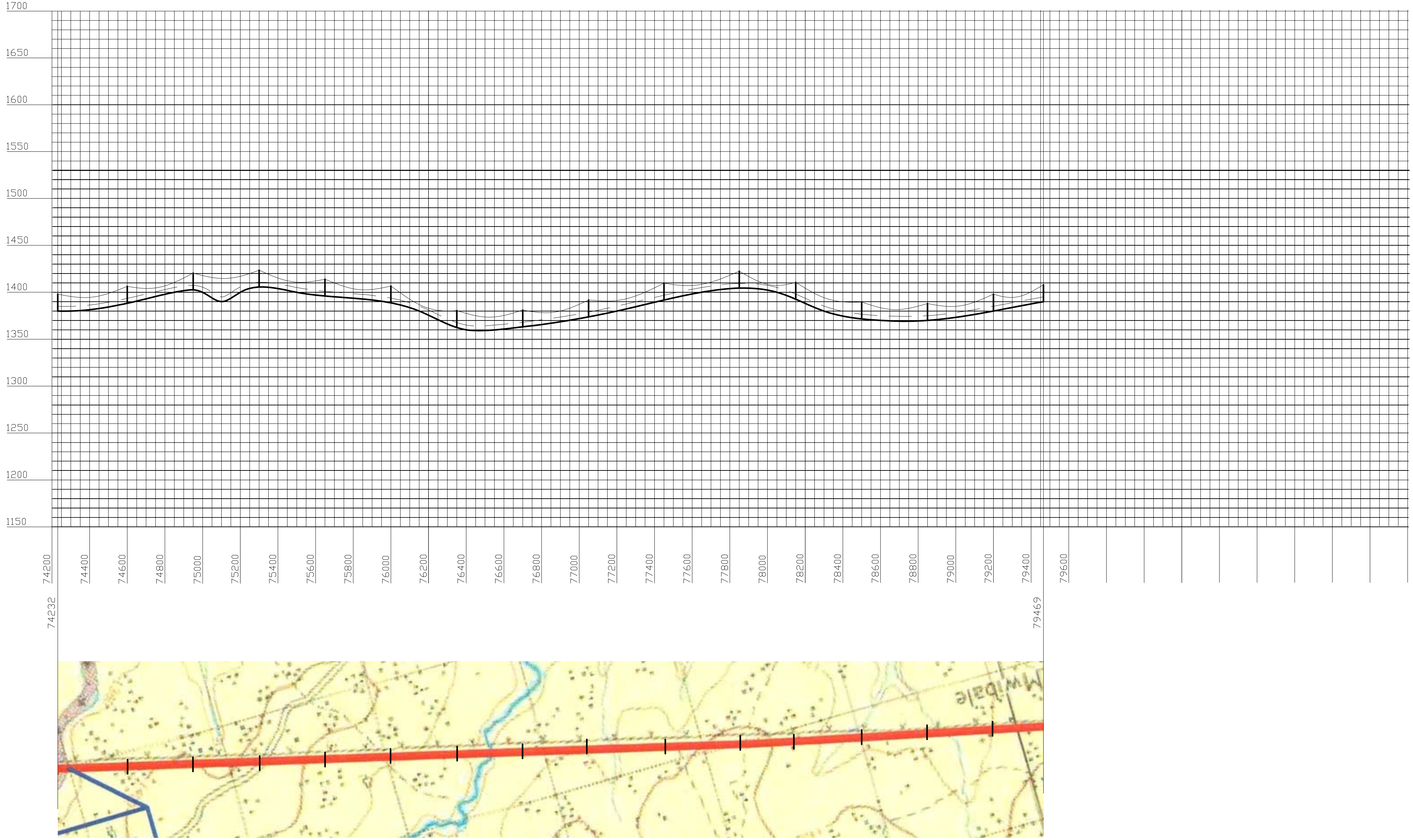
Drawing No. HL KU 122 - Sheet 11



Dessiné par: ALX Controlé par: XDS

Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 122 - Sheet 12



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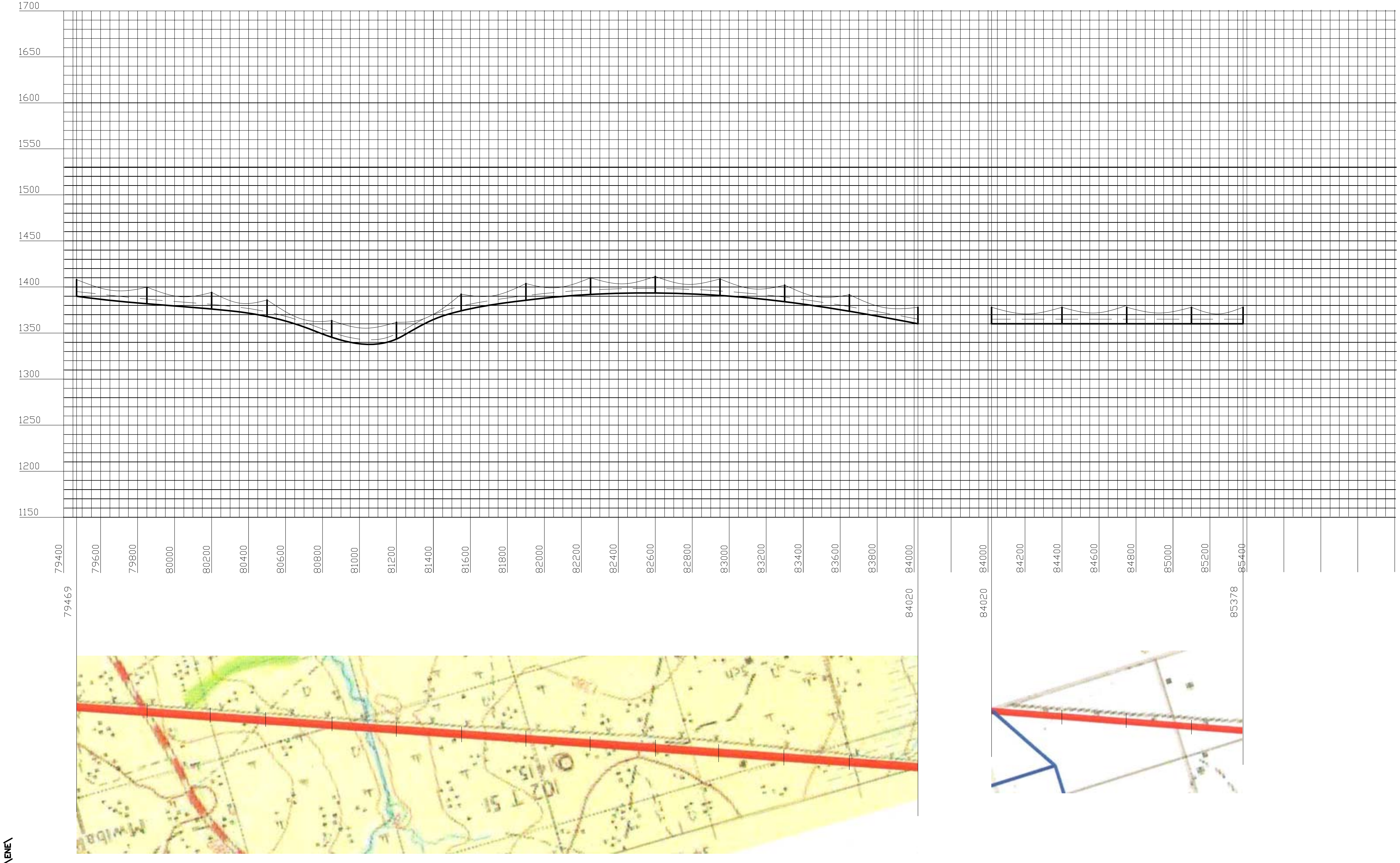
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 122 - Sheet 13



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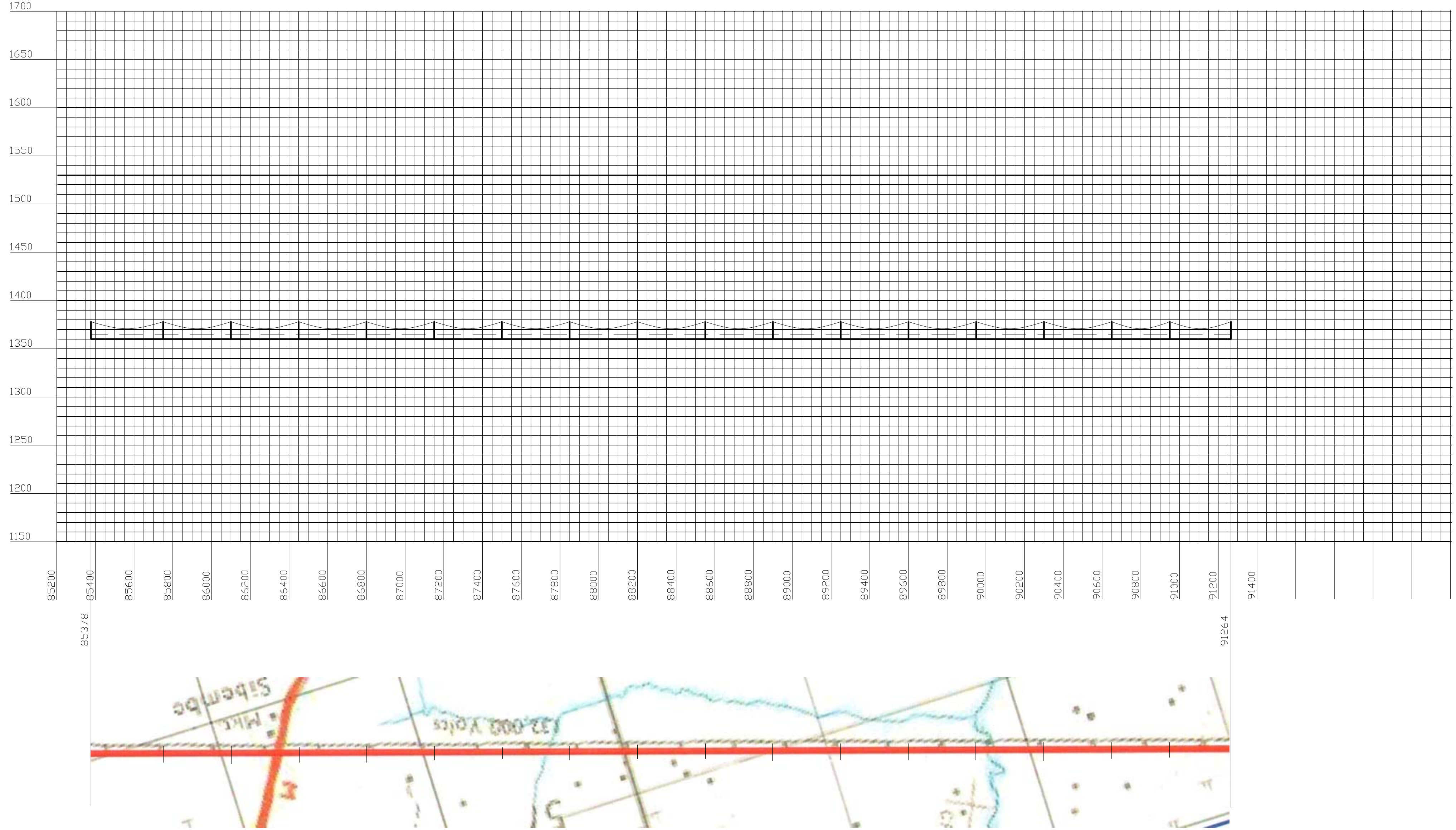
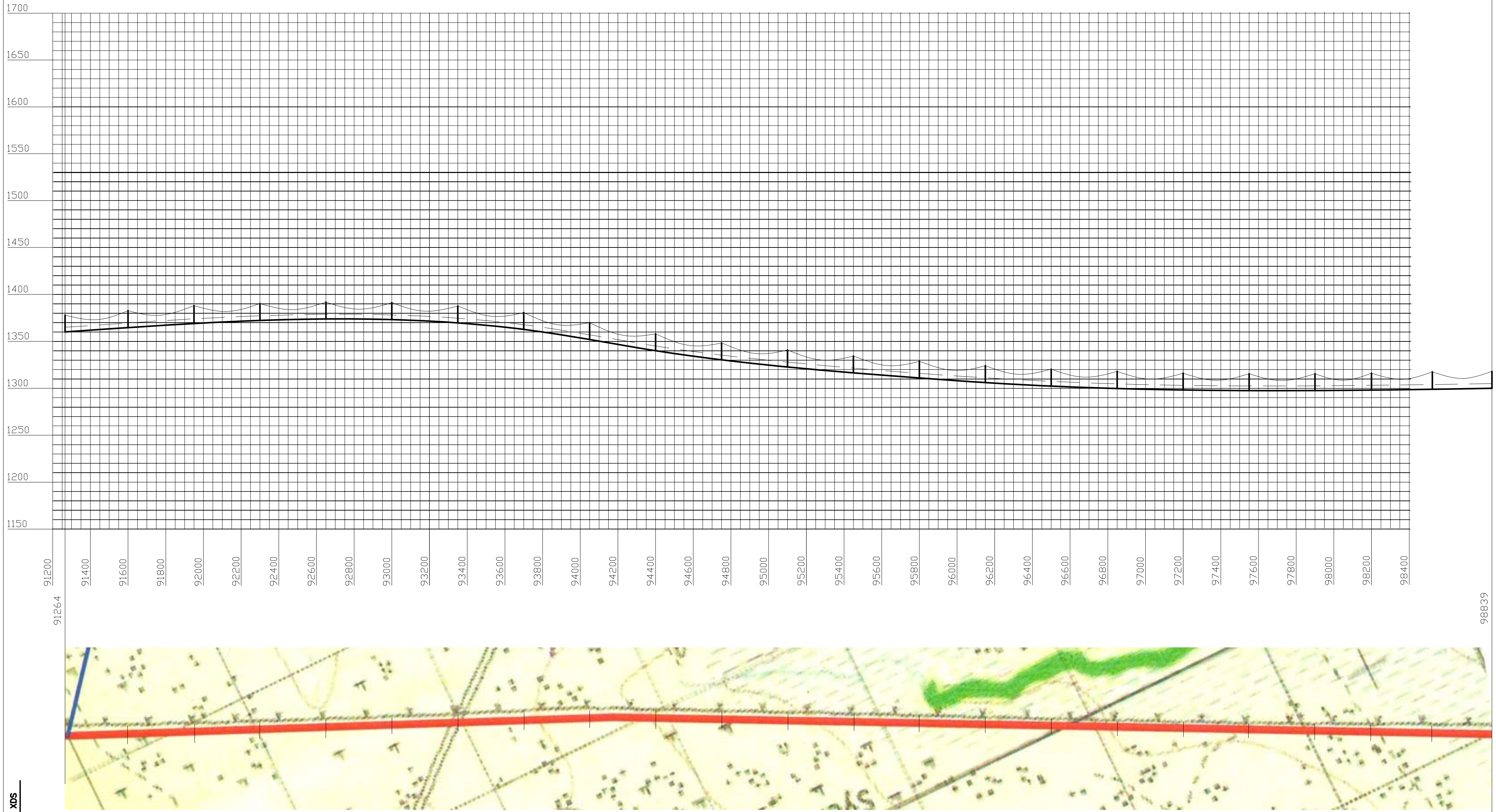
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 122 - Sheet 14



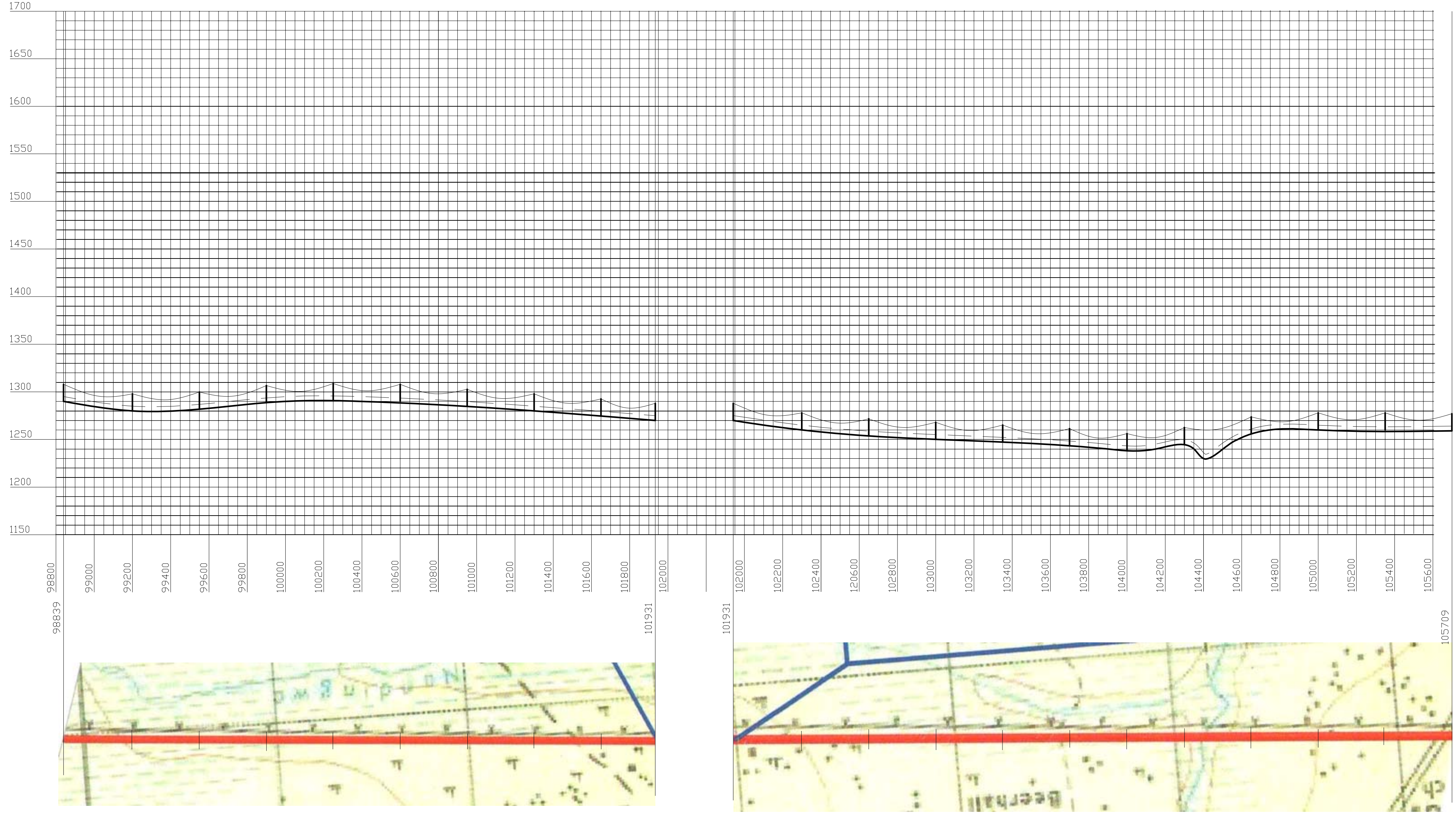
Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 122 - Sheet 15



Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

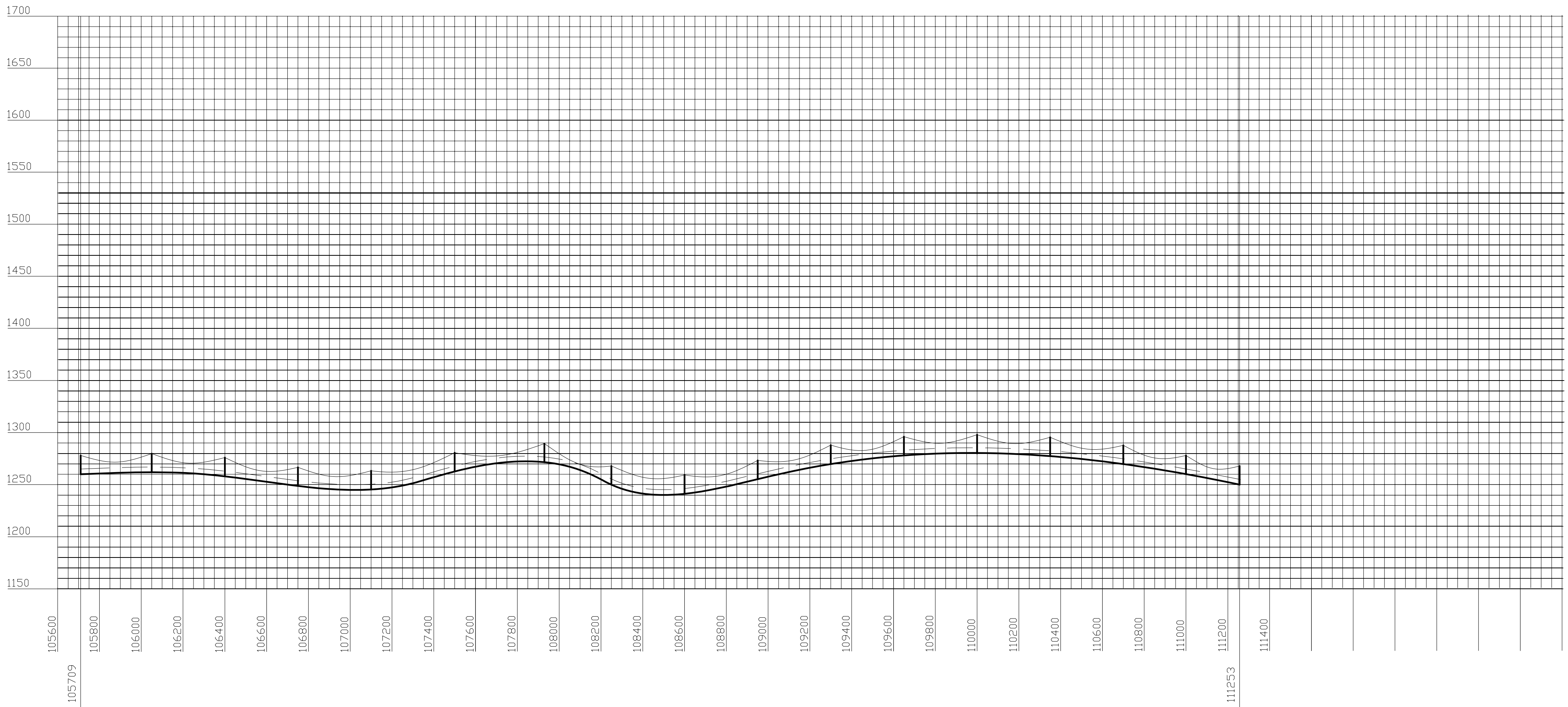
Drawing No. HL KU 122 - Sheet 16



Dessiné par: ALX Controlé par: XDS

Référence informatique:P:\BRC\ENE\

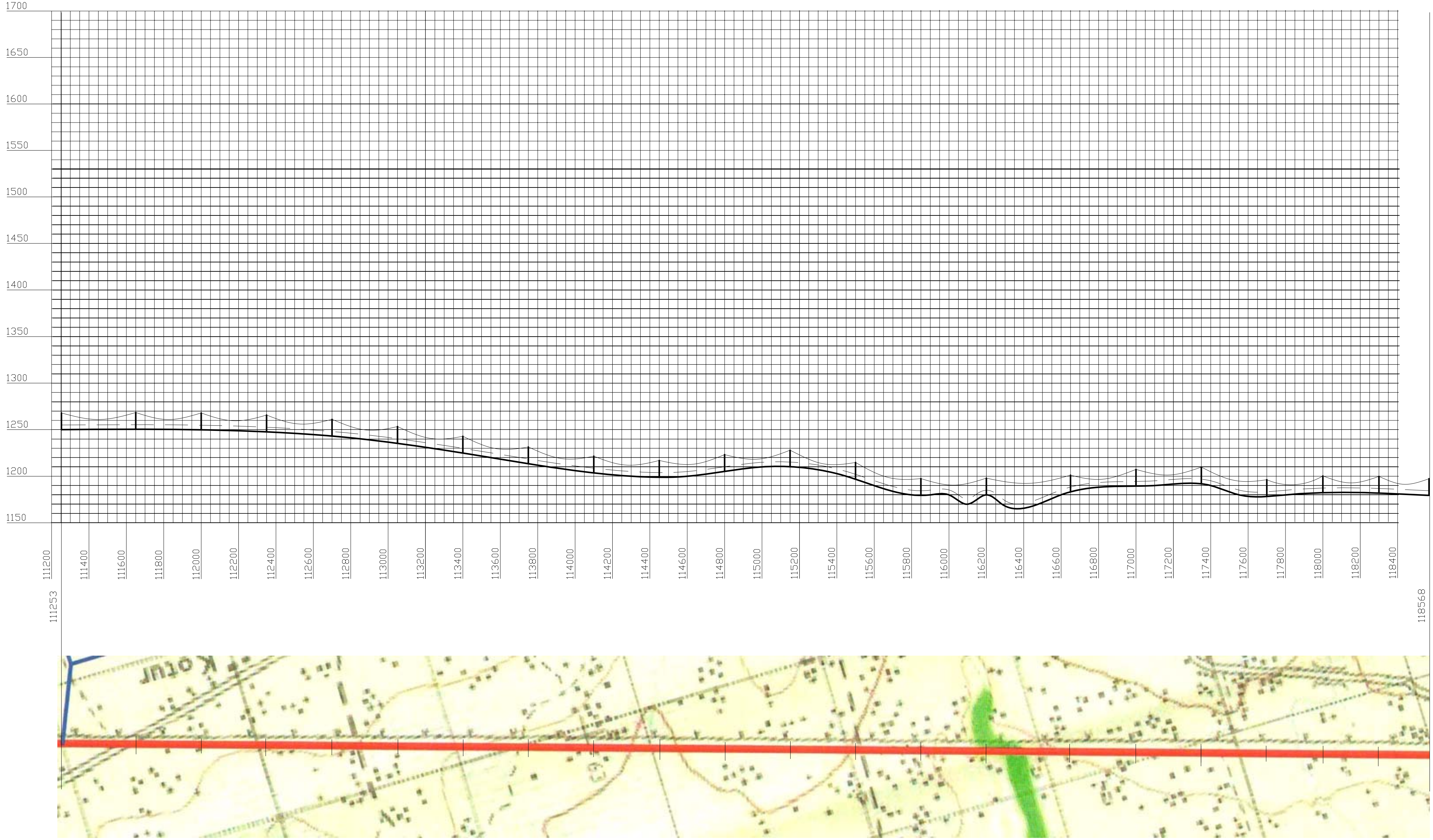
Drawing No. HL KU 122 - Sheet 17



Dessiné par: ALX Controlé par: XDS

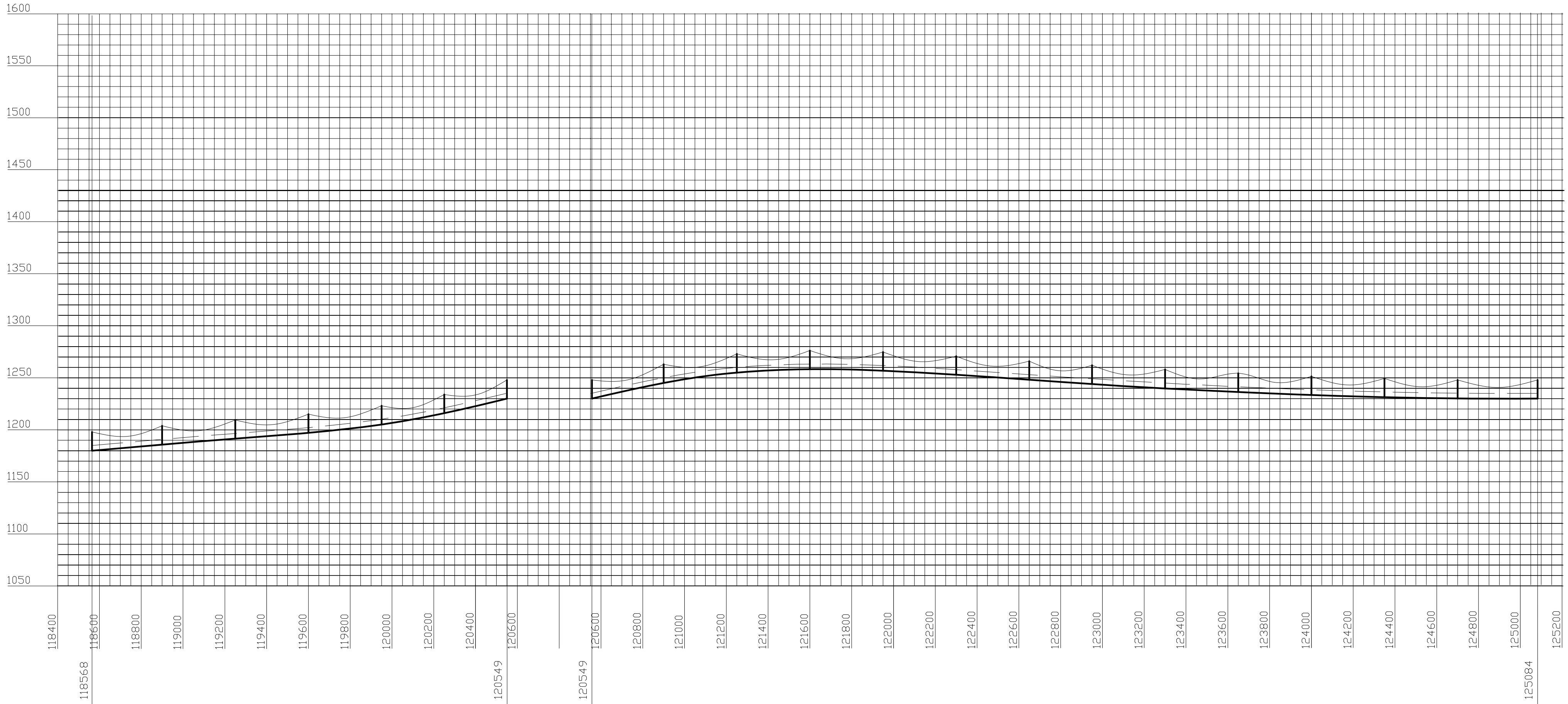
Référence informatique:P:\BRC\ENE\

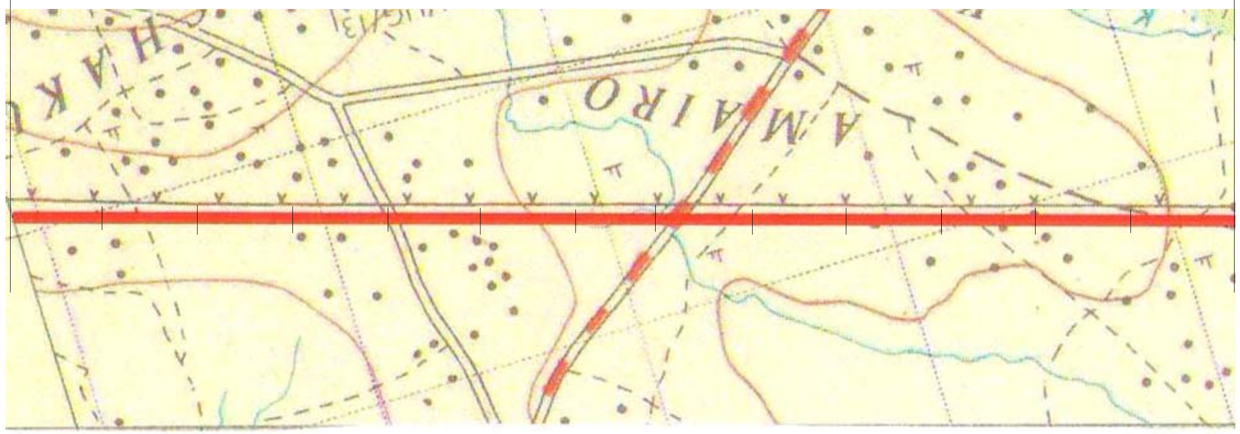
Drawing No. HL KU 122 - Sheet 18



Dessiné par: ALX Controlé par: XDS
Référence informatique:P:\BRC\ENE\

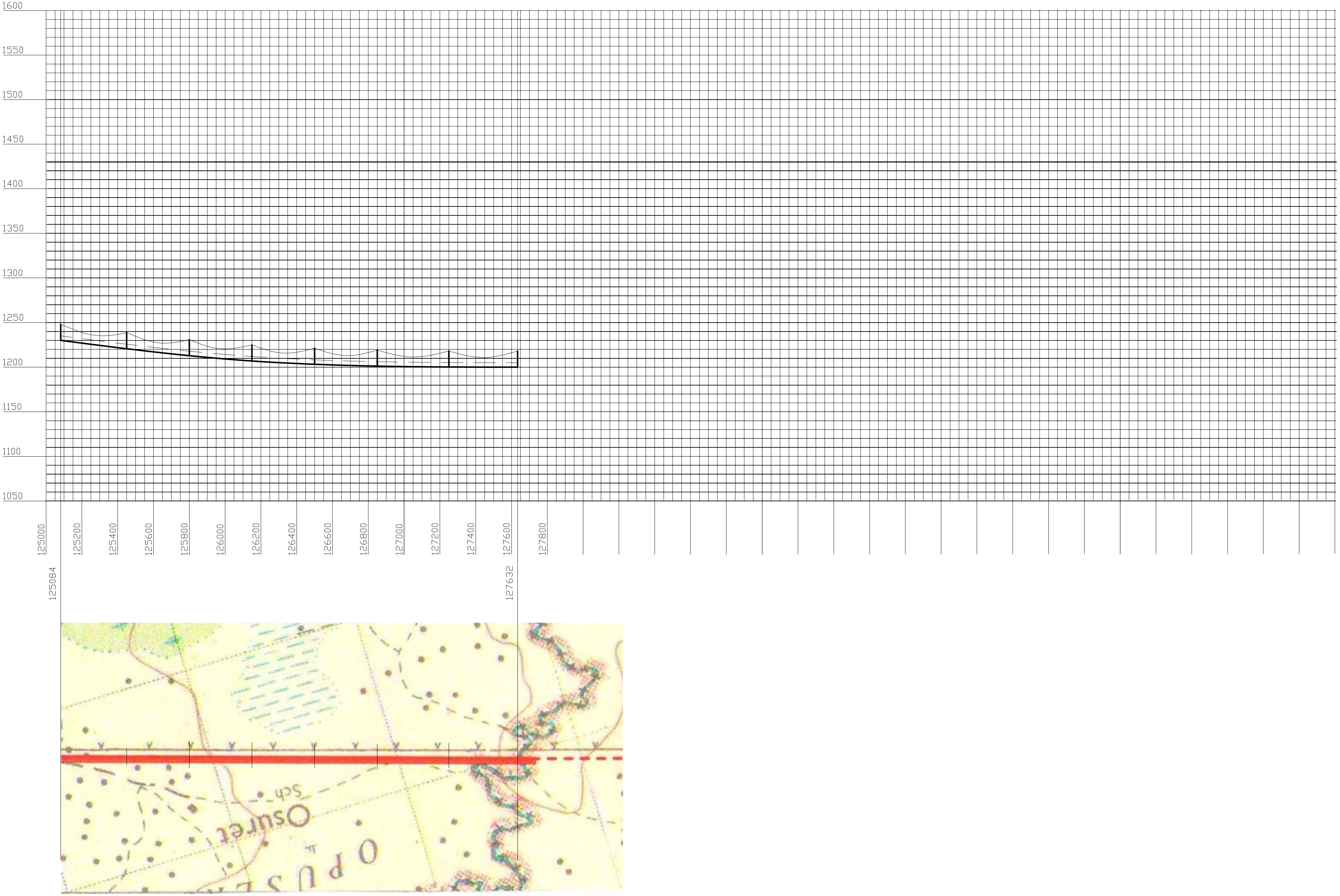
Drawing No. HL KU 122 - Sheet 19





Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

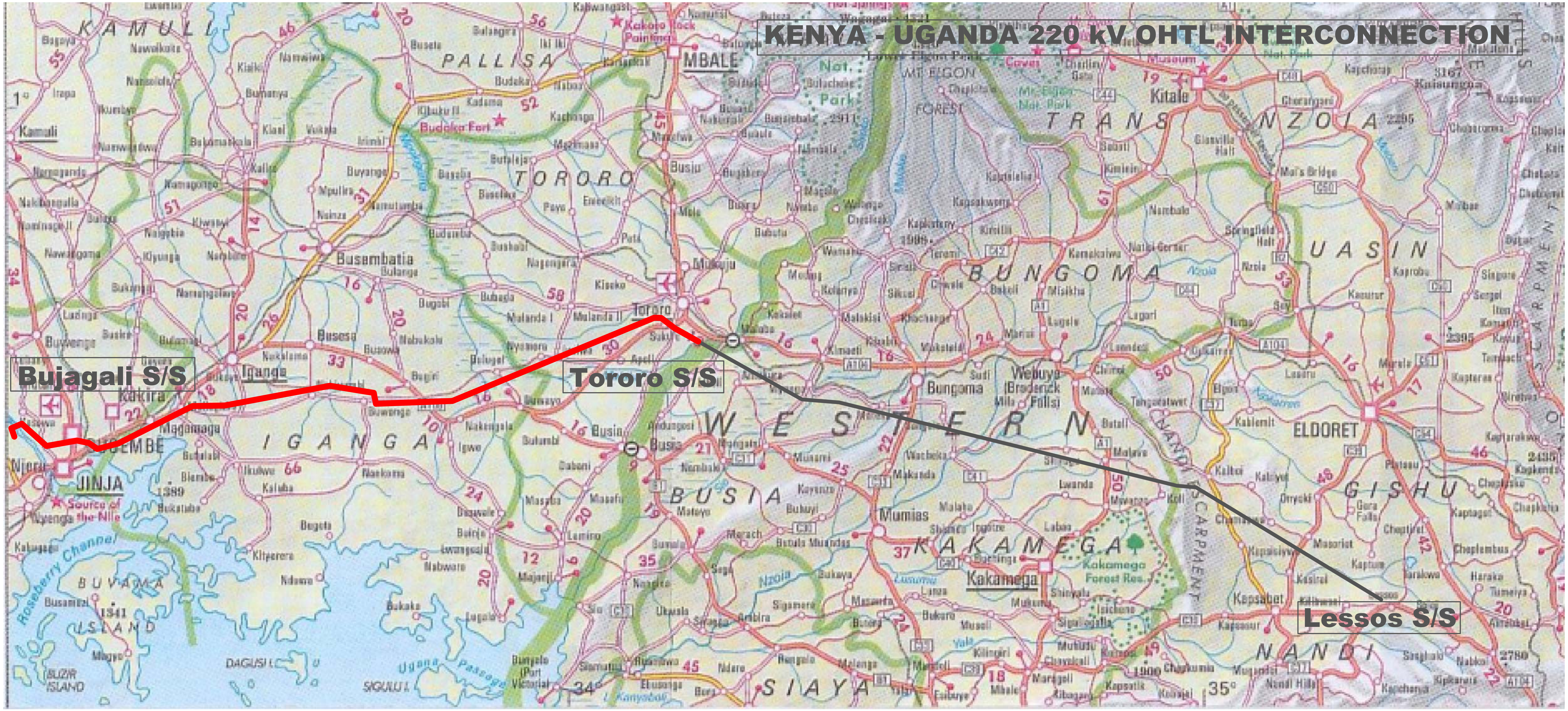
Drawing No. HL KU 122 - Sheet 20



Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 122 - Sheet 21

ANNEX G. LINE ROUTE MAP BUJAGALI – TORORO


KENYA - UGANDA 220 kV OHTL INTERCONNECTION
Bujagali S/S
Tororo S/S
Lessos S/S

ANNEX H. PLAN AND PROFILE BUJAGALI – TORORO

KENYA – UGANDA INTERCONNECTION:
BUJAGALI – (TORORO) KENYAN BORDER
LIST OF PLAN AND PROFILE SHEETS 1 – 21

Sheet No.	Stretch in Metres	Tower Numbers	Quantity of Towers
1	0 – 2 930	1 - 18	18
2	2 930 – 7 009	18 – 29	11
3	7 009 – 13 598	29 – 48	19
4	13 598 – 19 179	48 – 65	17
5	19 179 – 25 819	65 - 84	19
6	25 819 – 32 819	84 – 105	21
7	32 819 – 39 767	105 – 123	18
8	39 767 – 46 162	123 – 142	19
9	46 162 – 53 150	142 – 162	20
10	53 150 – 60 022	162 – 181	19
11	60 022 – 66 883	181 - 201	20
12	66 883 – 73 478	201 - 220	19
13	73 478 – 80 193	220 - 239	19
14	80 193 – 87 088	239 - 259	20
15	87 088 – 92 972	259 - 276	17
16	92 972 – 97 498	276 - 289	13
17	97 498 – 102 886	289 - 304	15
18	102 886 – 109 504	304 - 323	19
19	109 504 – 115 083	323 - 339	16
20	115 083 – 121 372	339 - 358	19
21	121 372 – 127 213	358 - 375	17

Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

NELSAP
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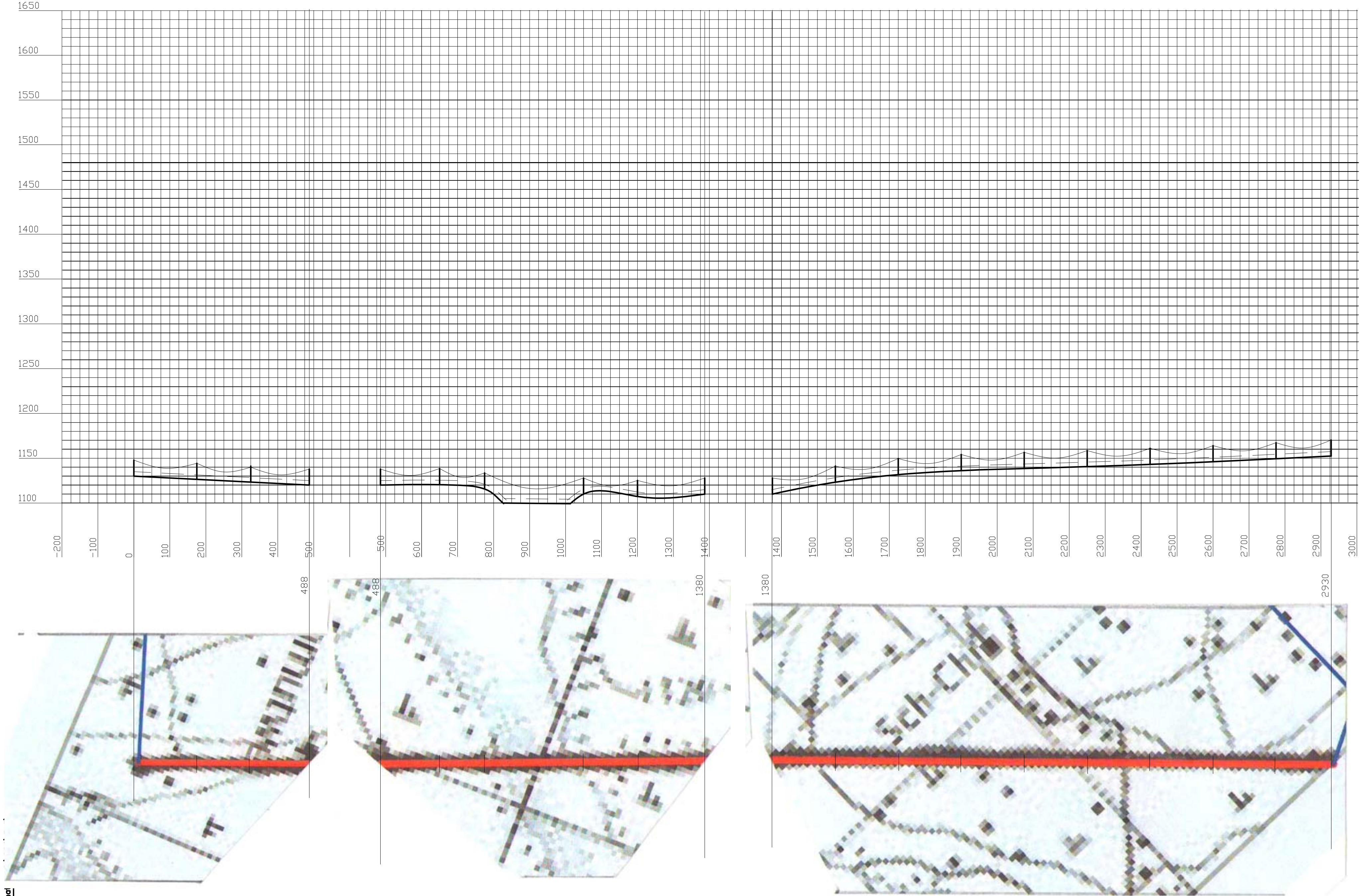
PAALEN
ETUDE D' INTERCONNECTION DES RESEAUX ELECTRIQUES DES PAYS DES LACS EQUATORIAUX DU NIL

FEASIBILITY REPORT / RAPPORT DE FAISABILITE

KENYA - UGANDA - INTERCONNECTION
PLAN AND PROFILE
BUJAGALI - TORORO: SHEETS 1 - 21

N° H L KU 121 a

Date : October 29, 2007

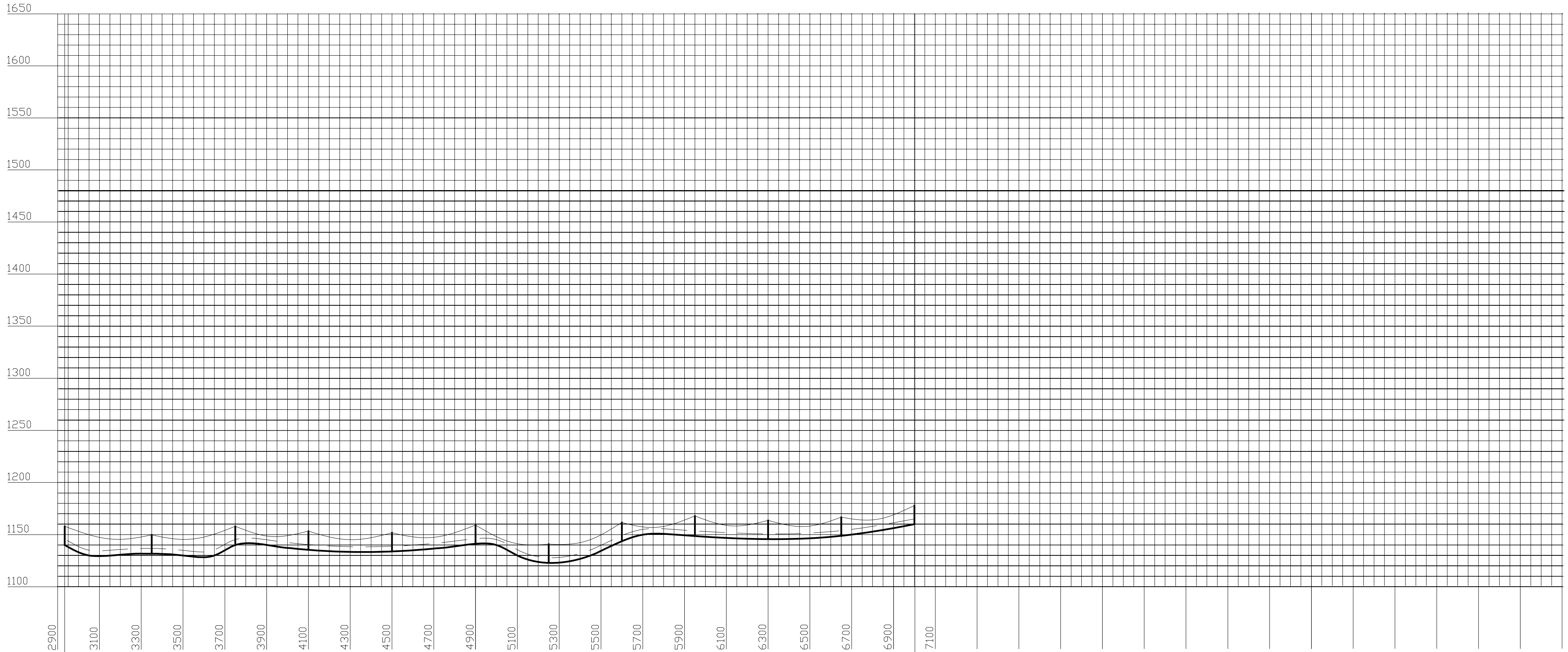


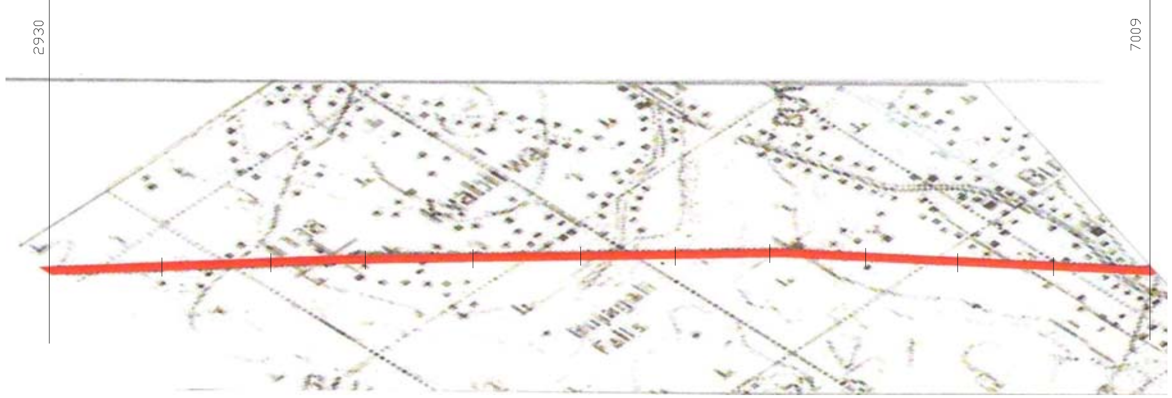
Dessiné par: ALX

Contrôlé par: XDS

Référence informat

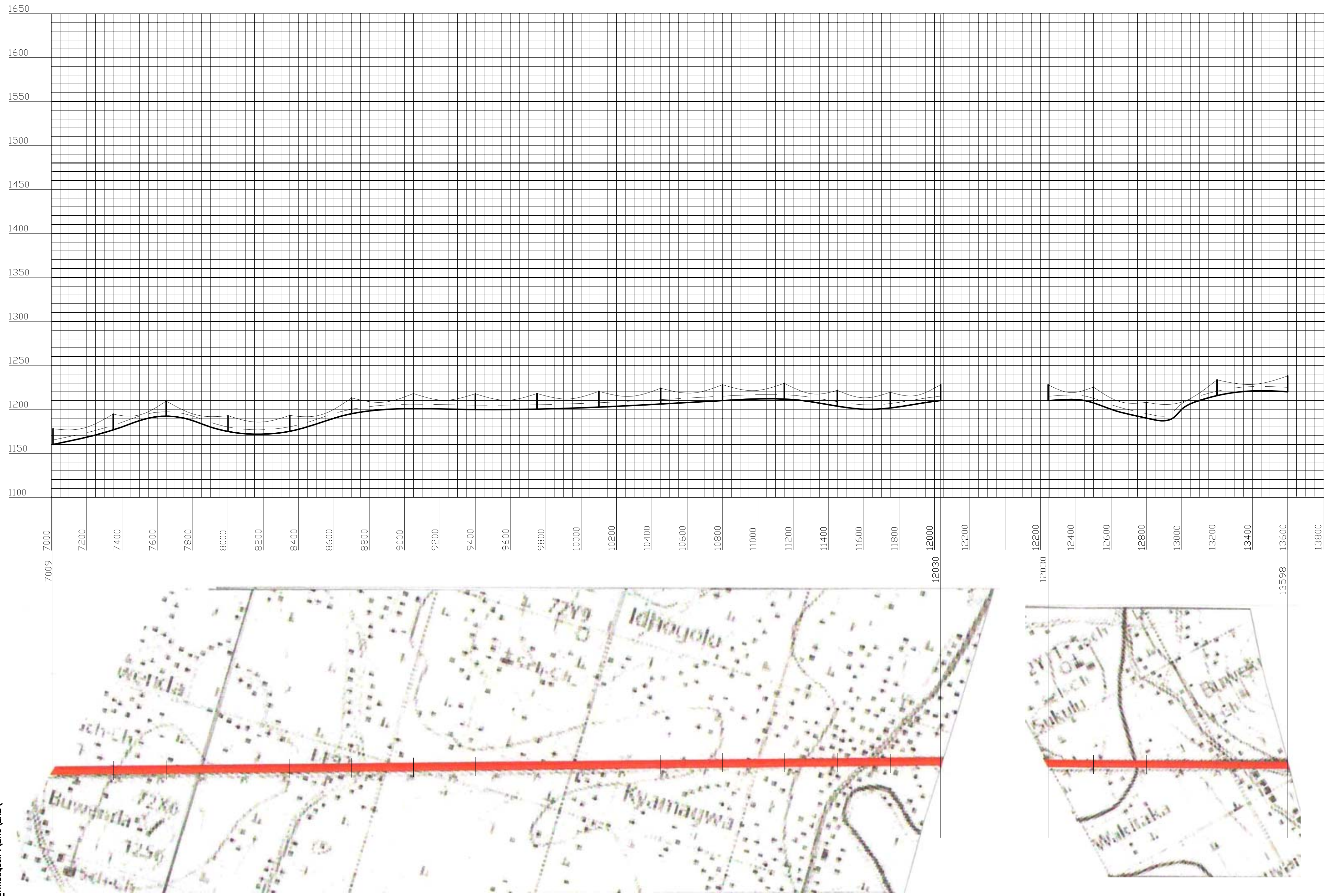
Drawing No. HL KU 121 - Sheet 1





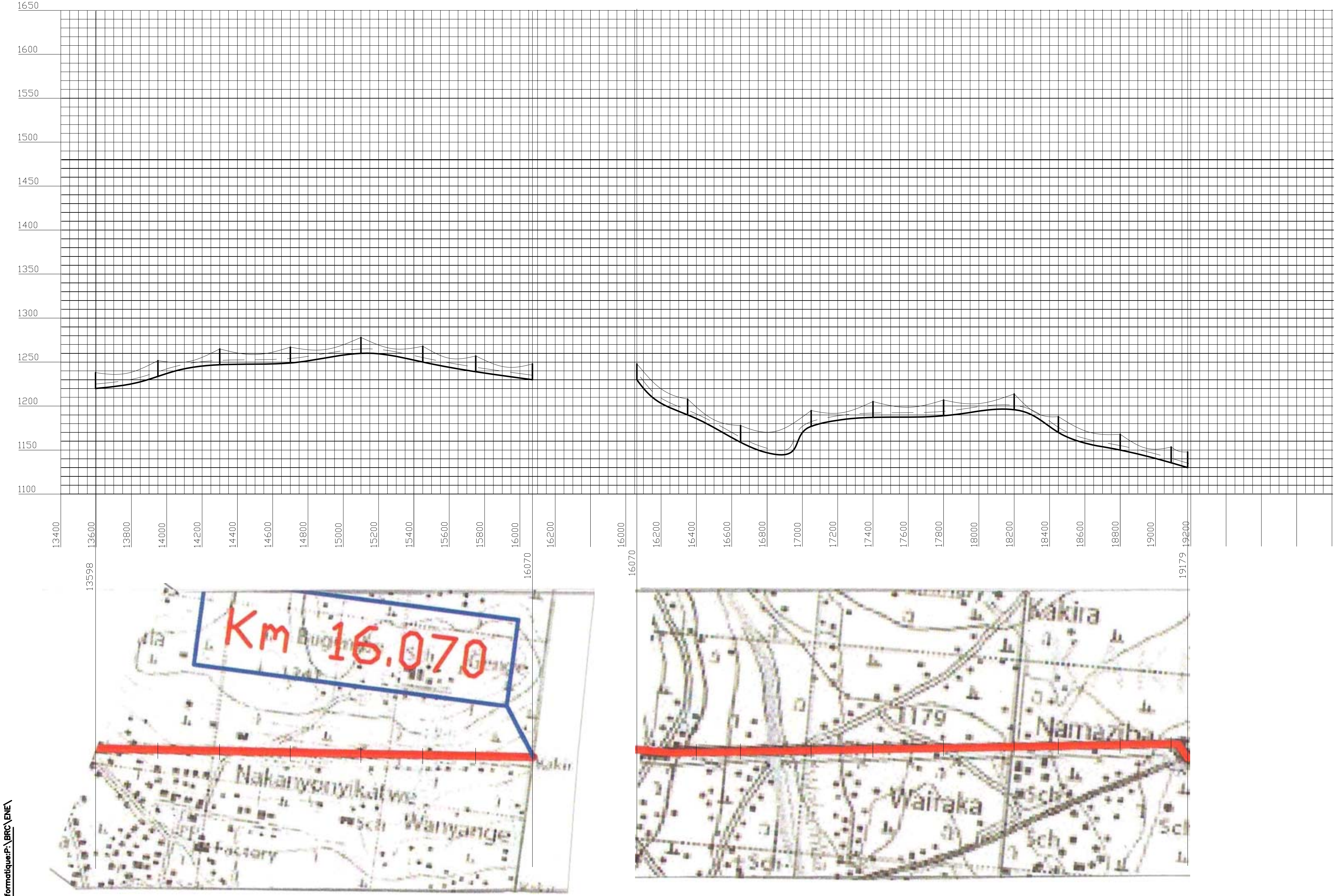
Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 121 - Sheet 2



Drawing No. HL KU 121 - Sheet 3

Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\



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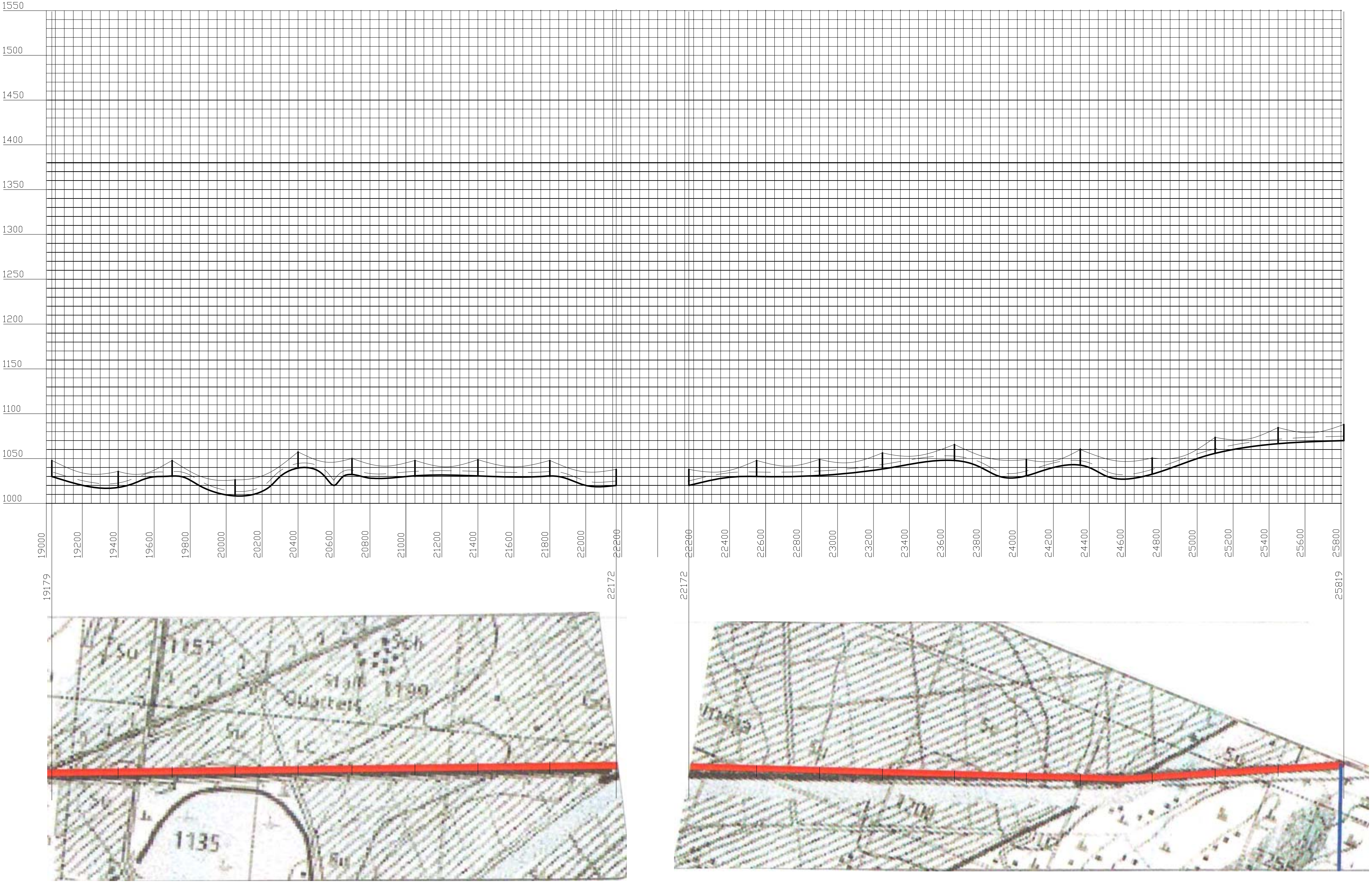
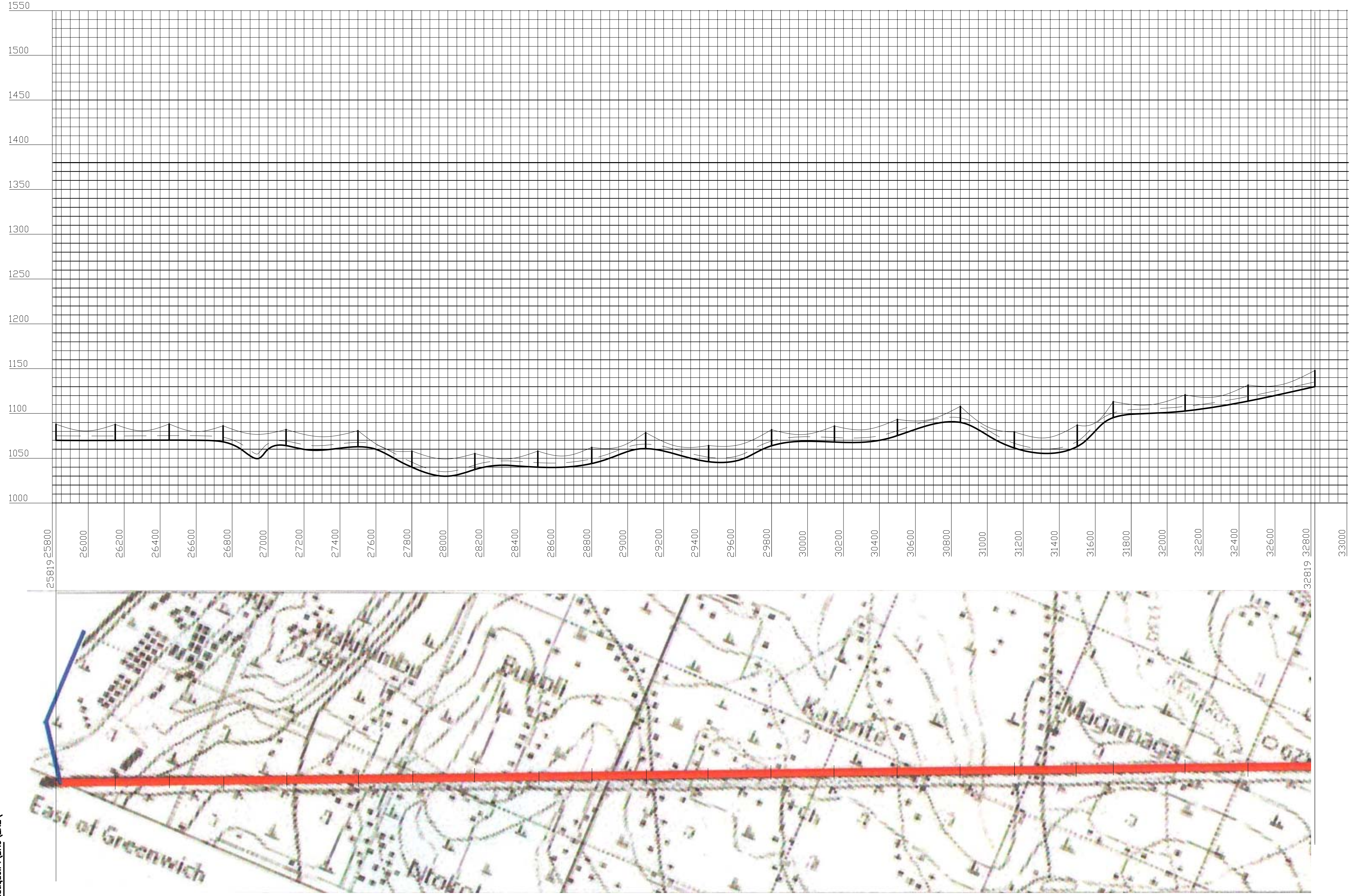
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 121 - Sheet 4



Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

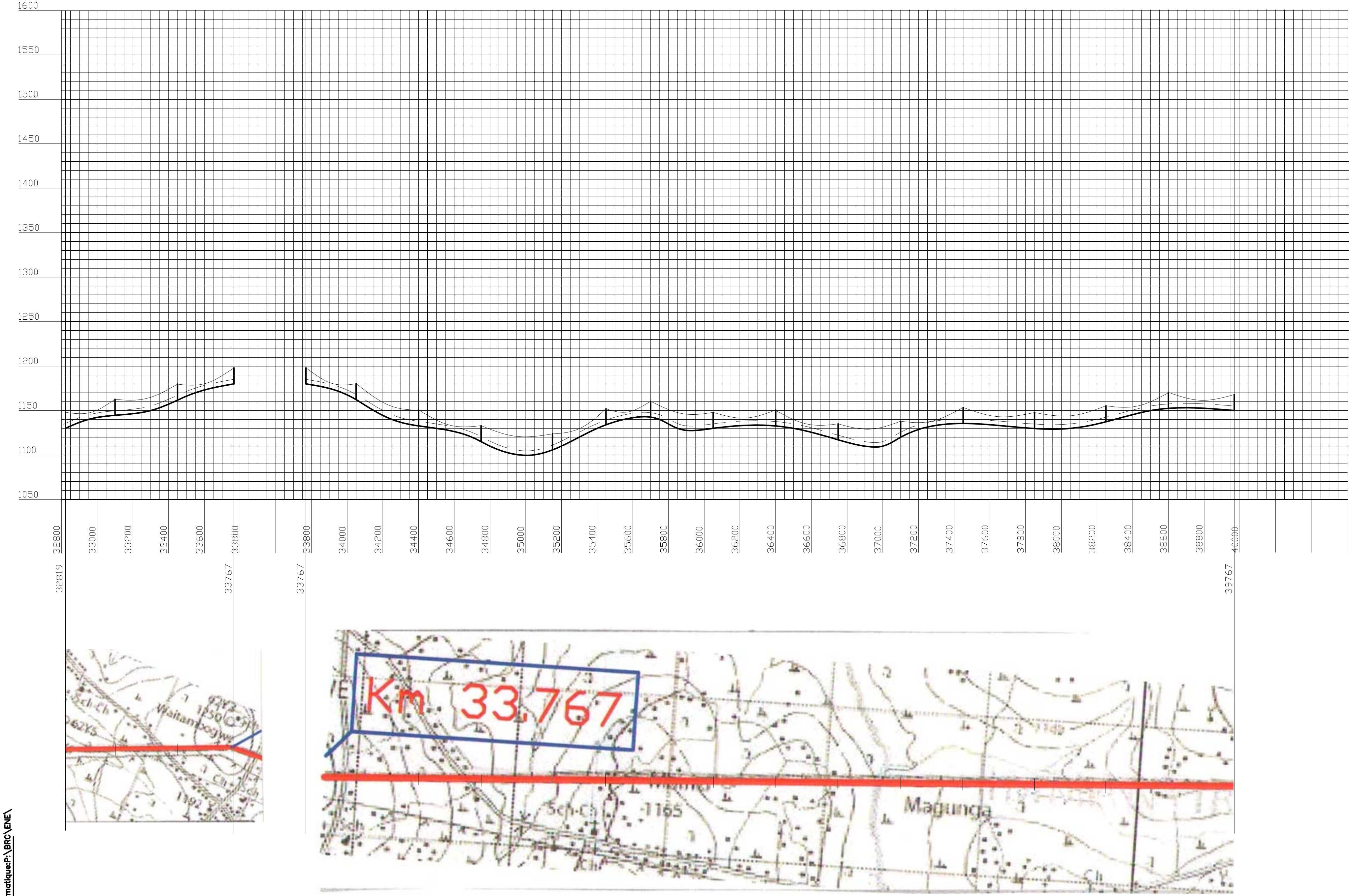
Drawing No. HL KU 121 - Sheet 5



Dessiné par: ALX Controlé par: XDS

Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 121 - Sheet 6

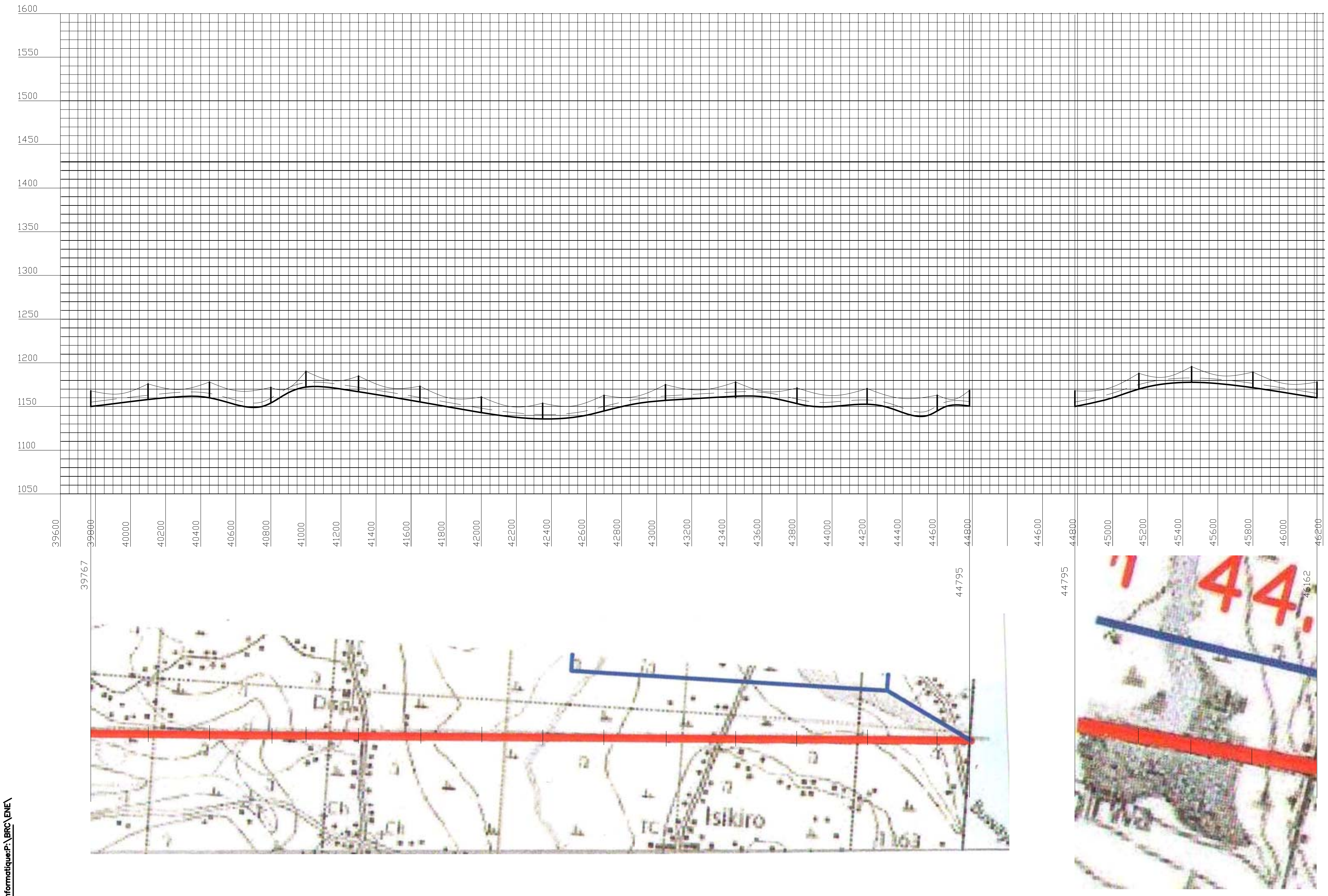


Dessiné par: ALX

Controlé par: XDS

Référence informatique:P:\BRC\ENE\

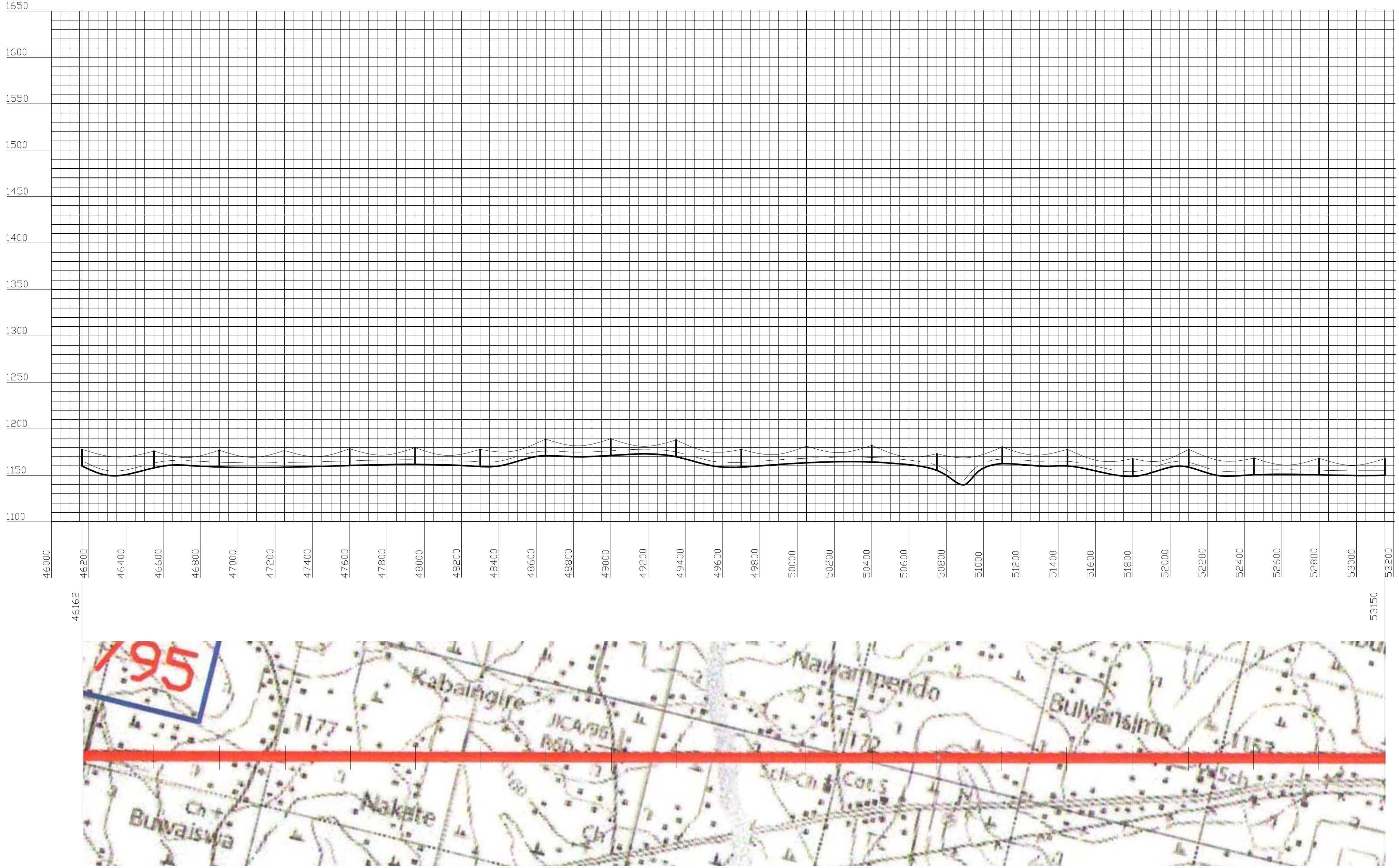
Drawing No. HL KU 121 - Sheet 7



Drawing No. HL KU 121 - Sheet 8

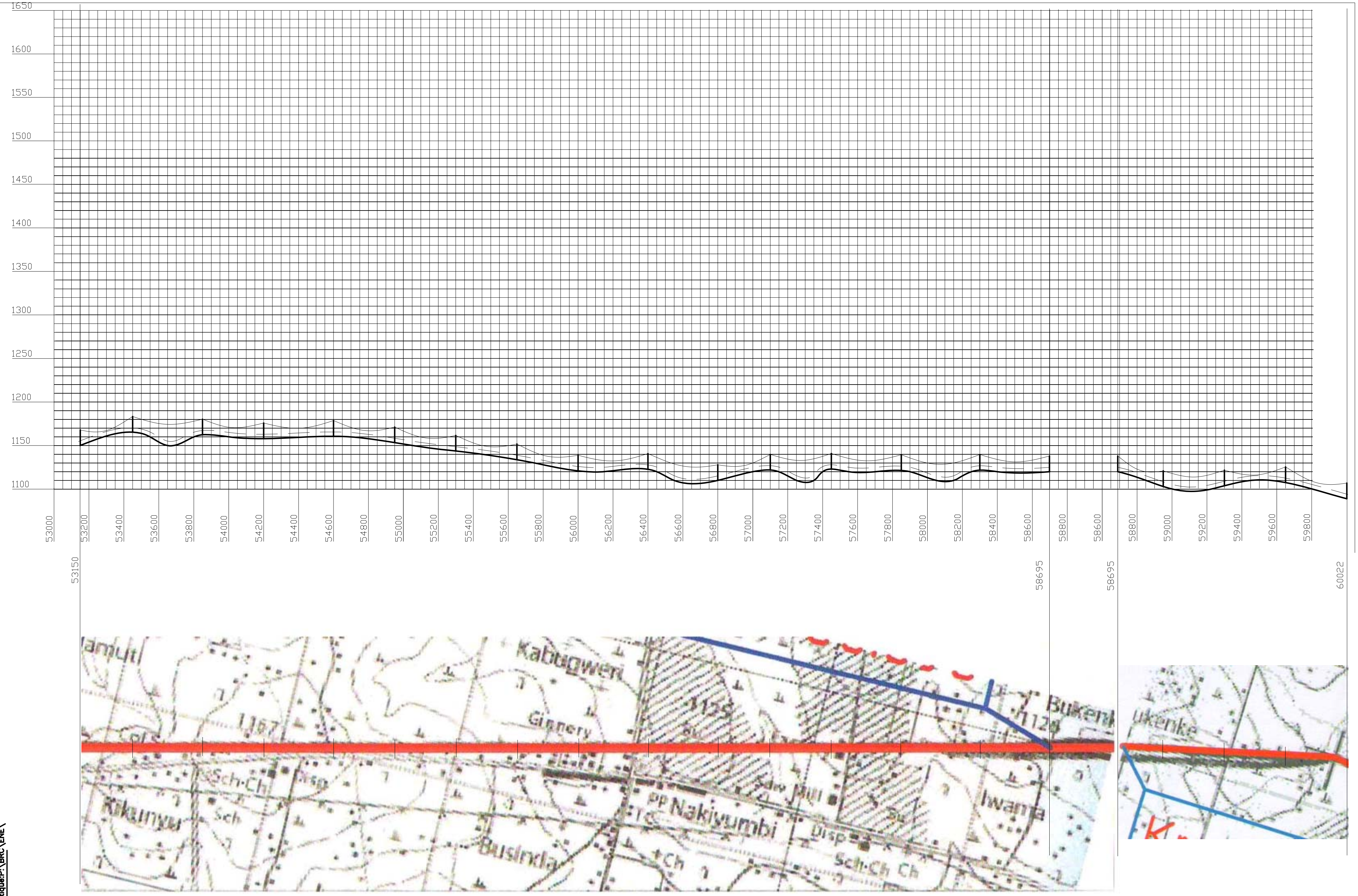
Dessiné par: ALX Controlé par: XDS

Référence informatique:P:\BRC\ENE\



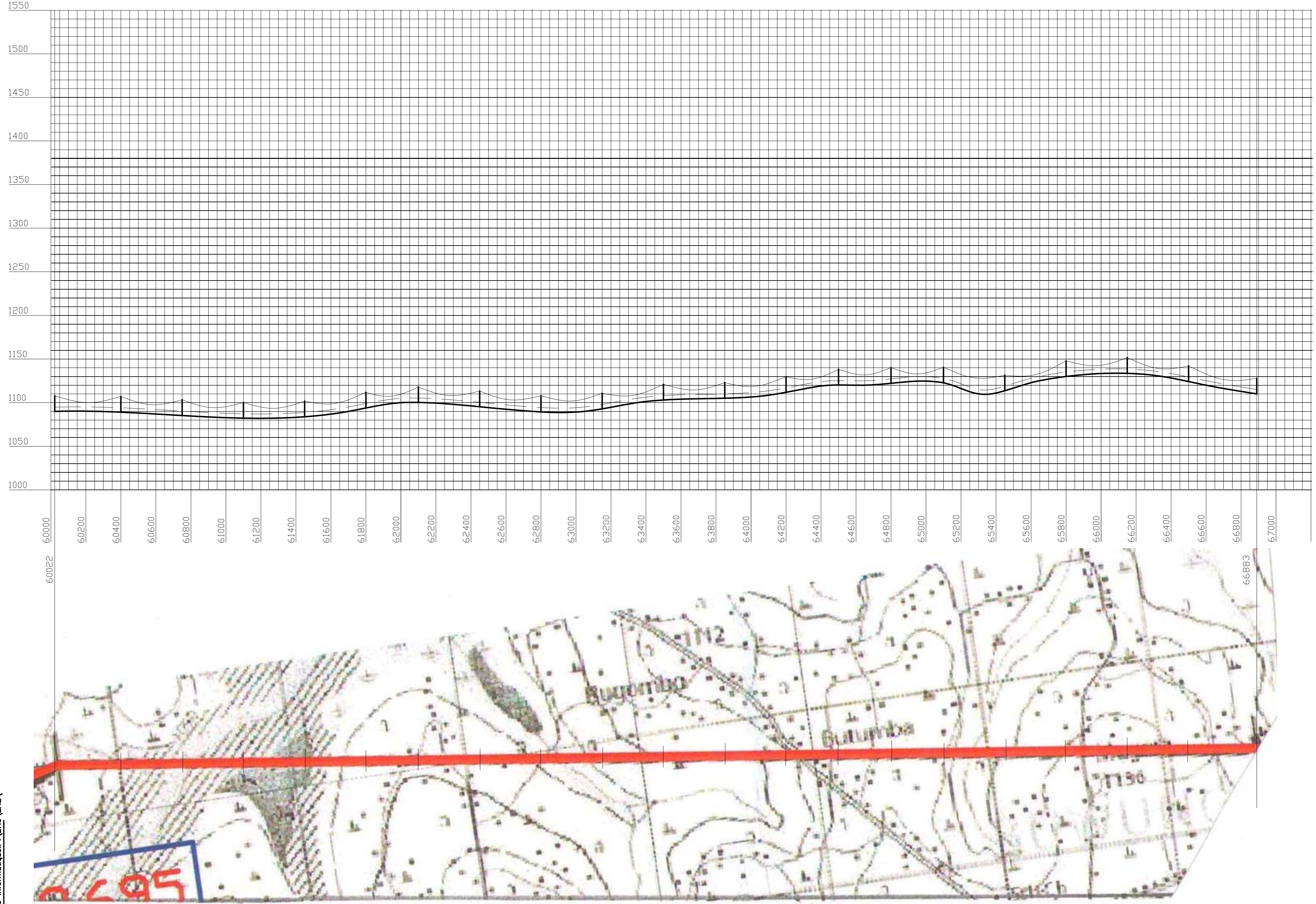
Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 121 - Sheet 9



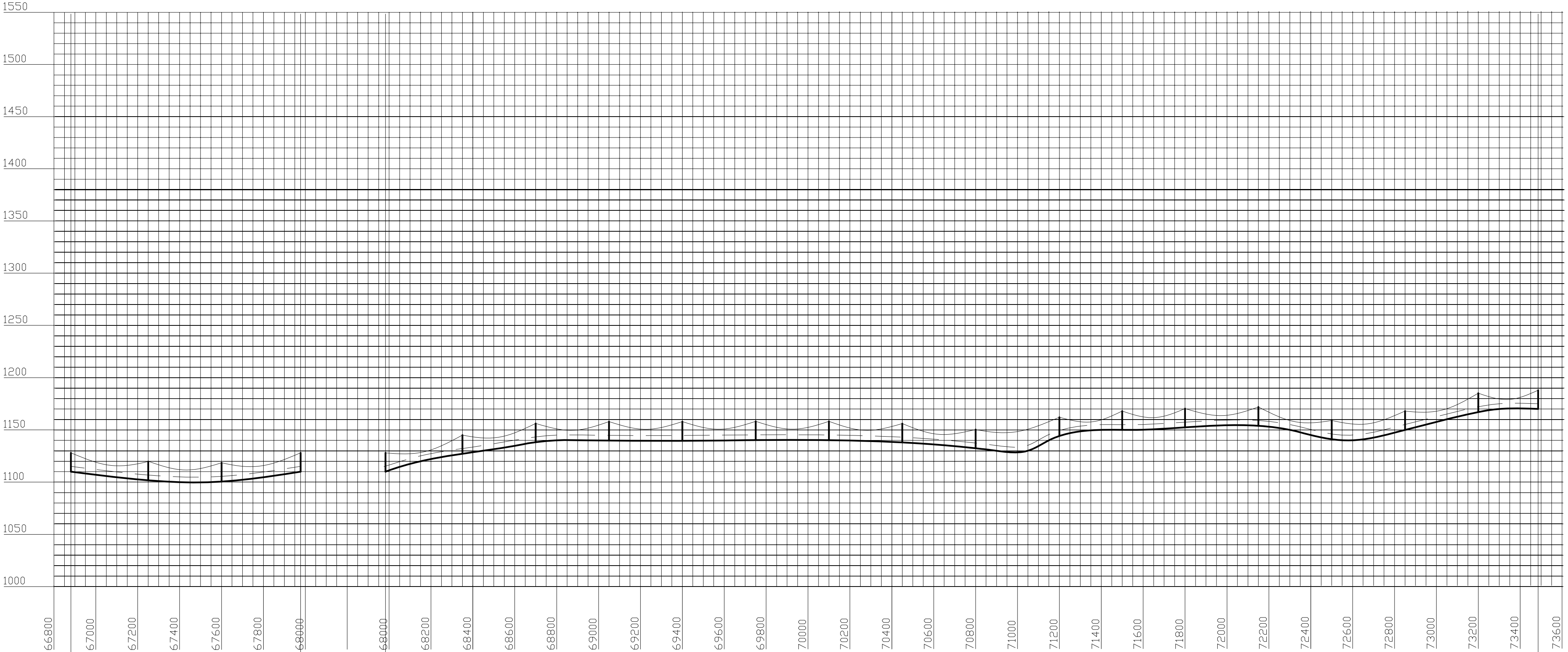
Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

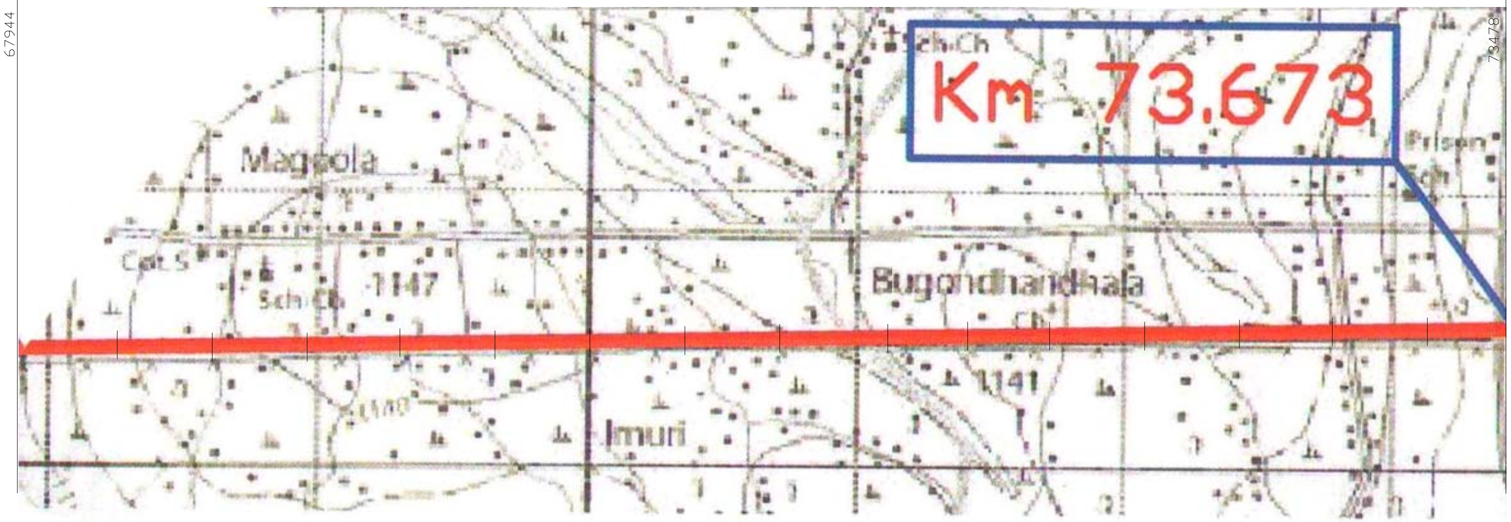
Drawing No. HL KU 121 - Sheet 10



Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

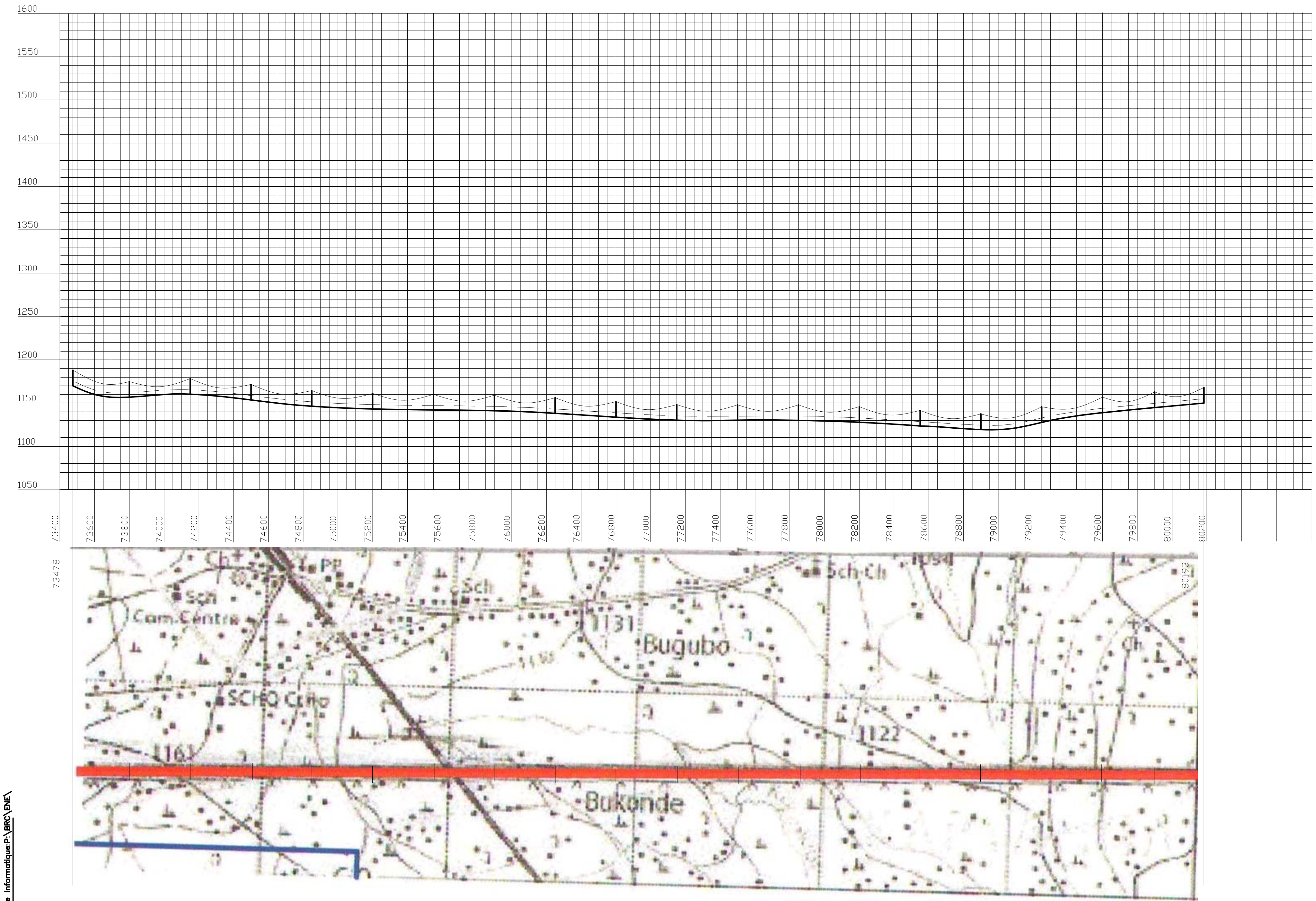
Drawing No. HL KU 121 - Sheet 11





Dessiné par: ALX Controlé par: XDS
Référence informatique:P:\BRC\ENE\

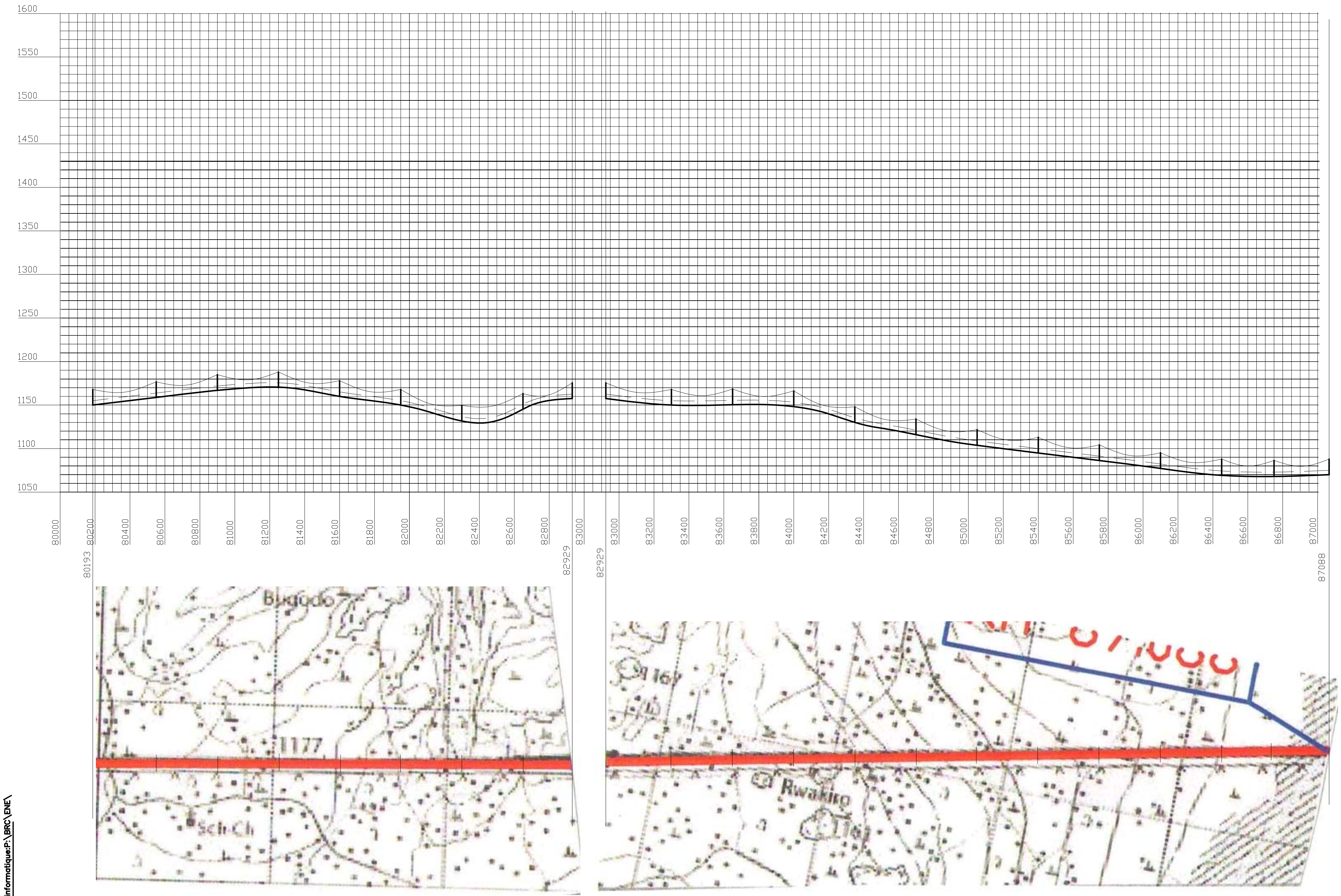
Drawing No. HL KU 121 - Sheet 12



Dessiné par: ALX Controlé par: XDS

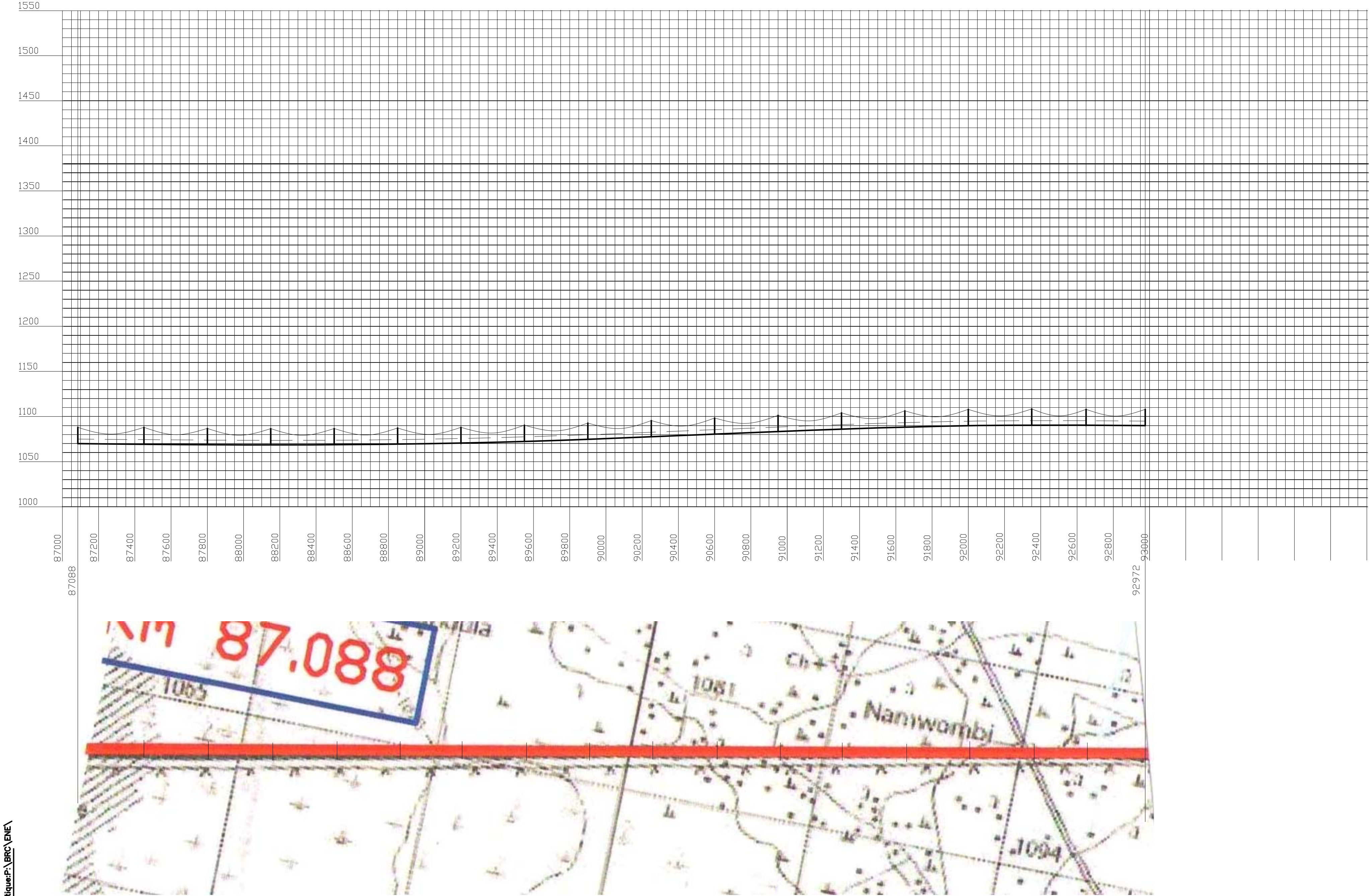
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 121 - Sheet 13



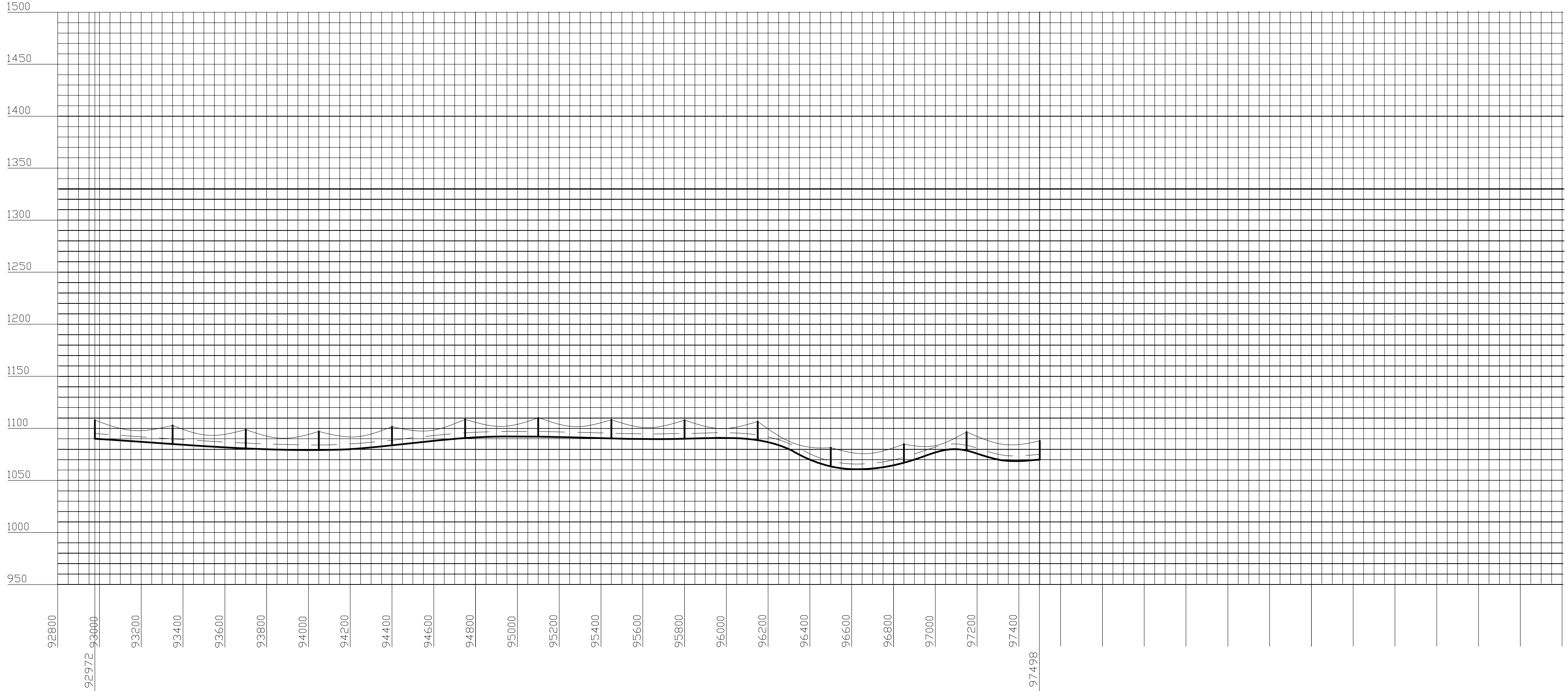
Drawing No. HL KU 121 - Sheet 14

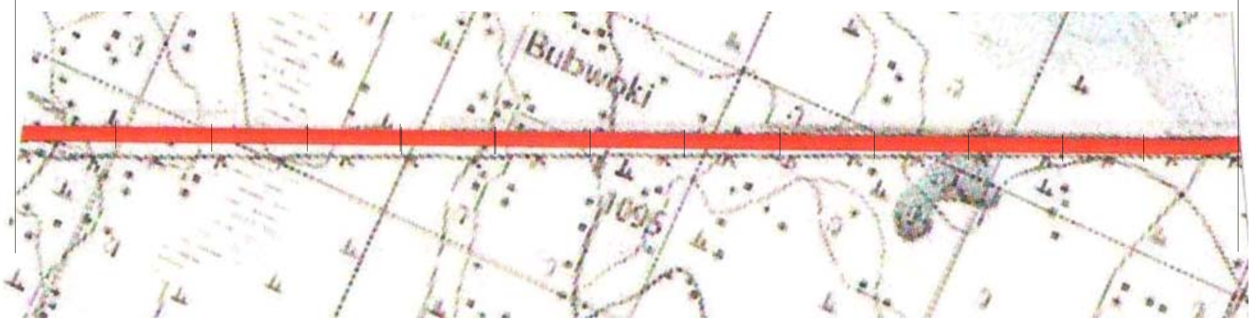
Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\



Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

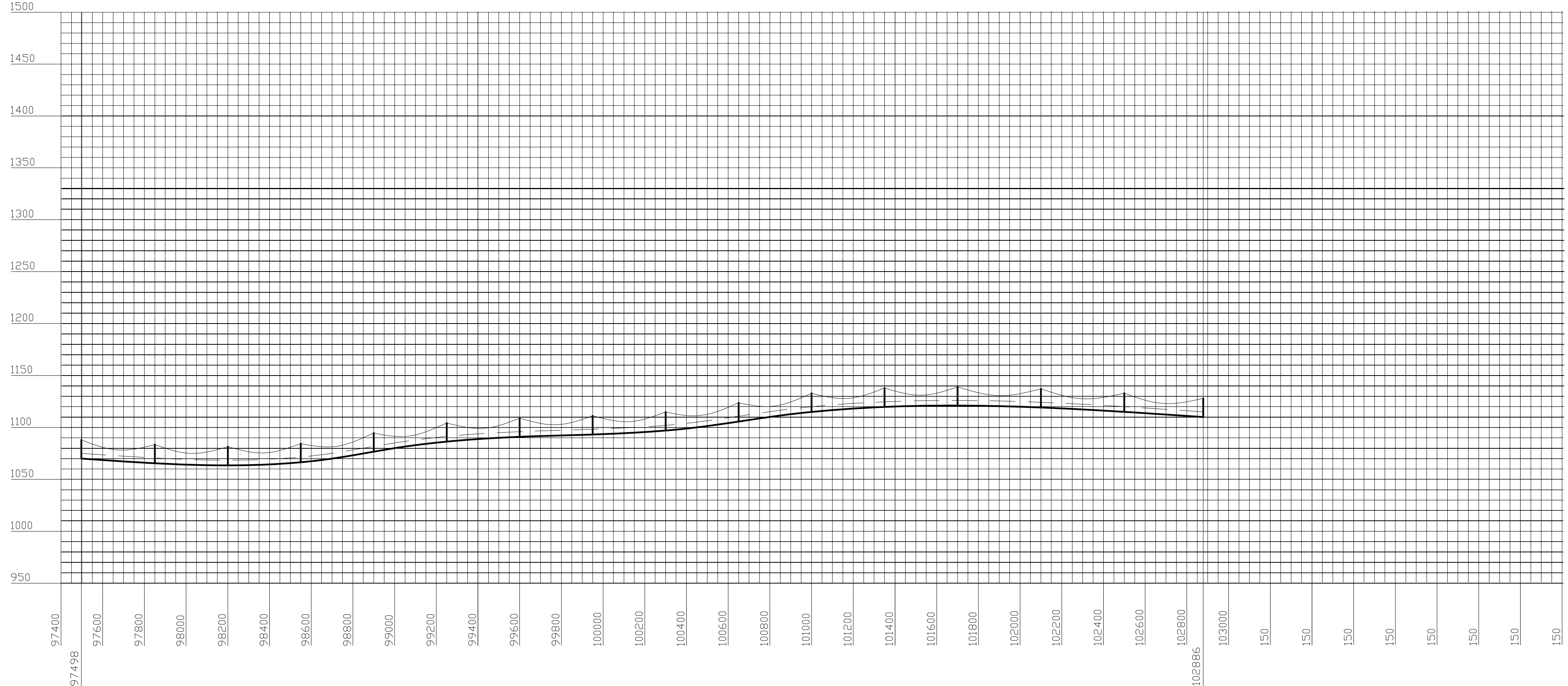
Drawing No. HL KU 121 - Sheet 15

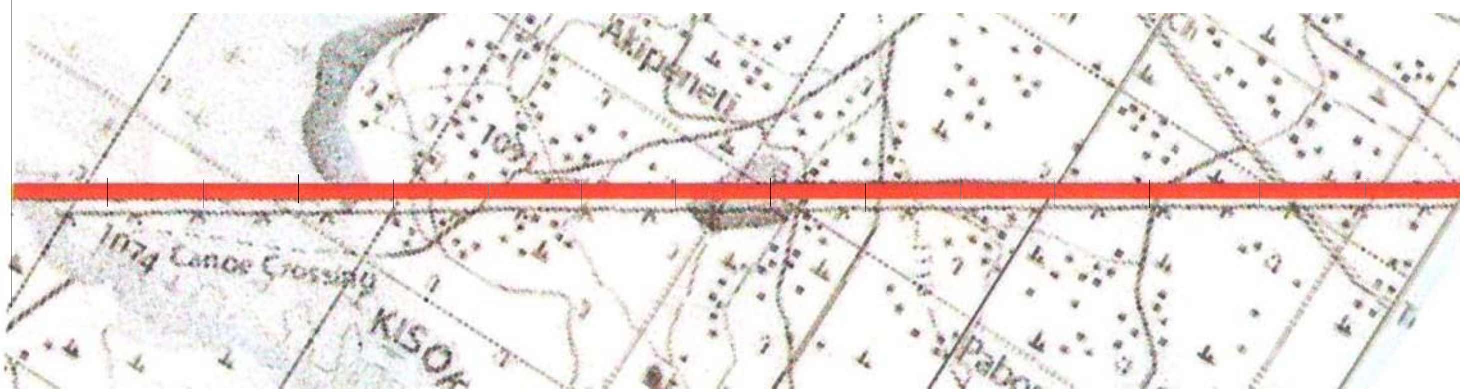




Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

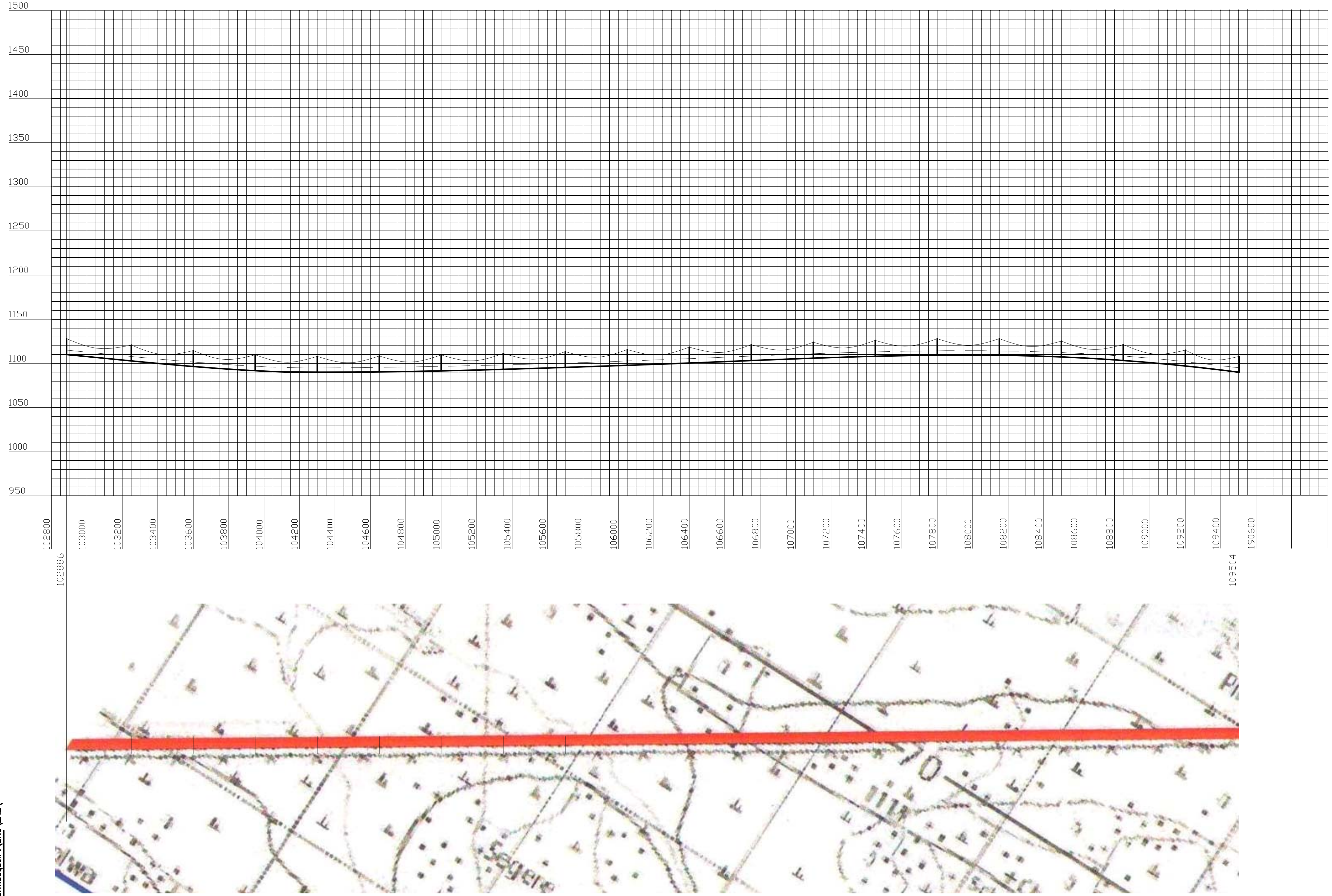
Drawing No. HL KU 121 - Sheet 16





Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

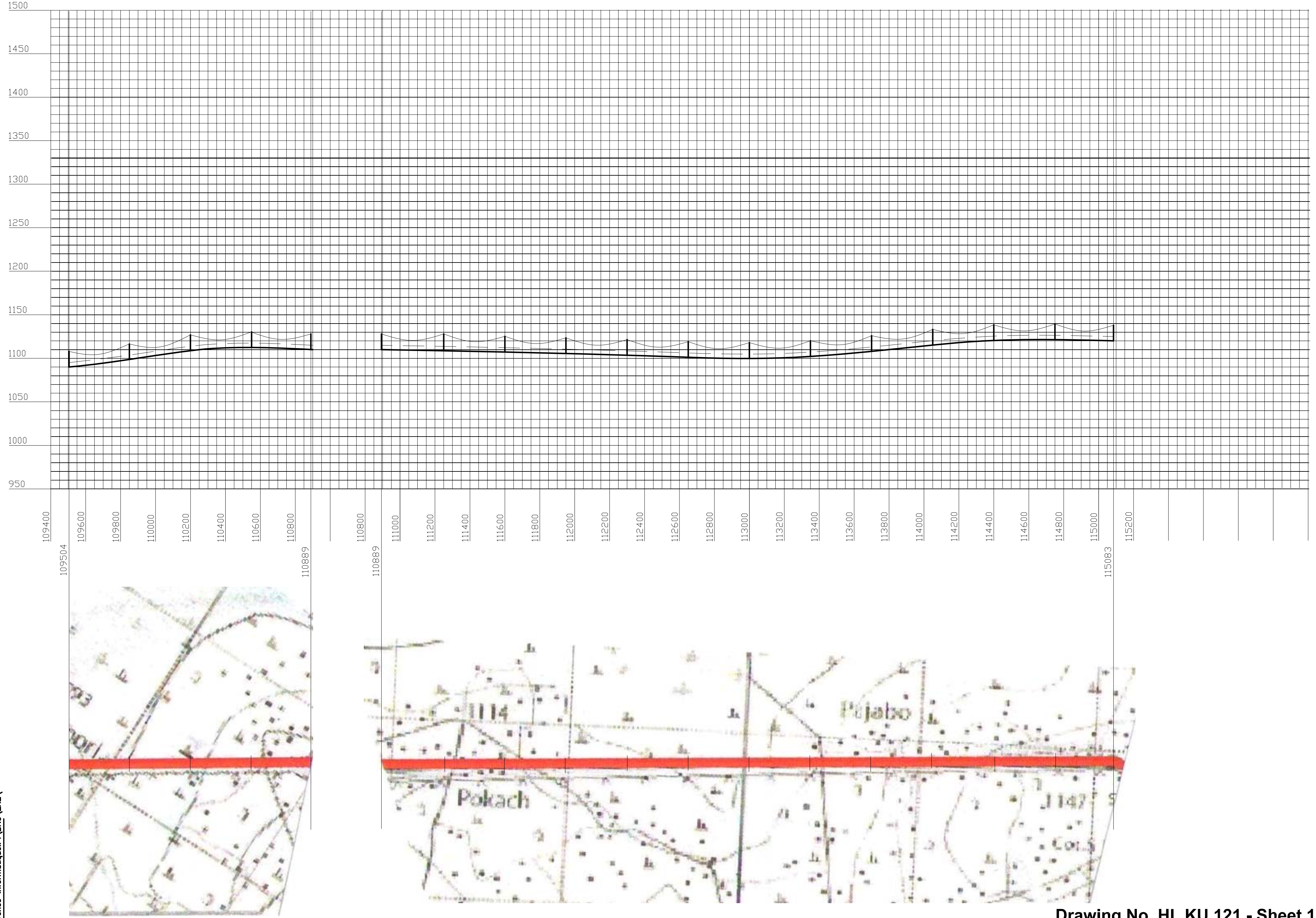
Drawing No. HL KU 121 - Sheet 17



Dessiné par: ALX Controlé par: XDS

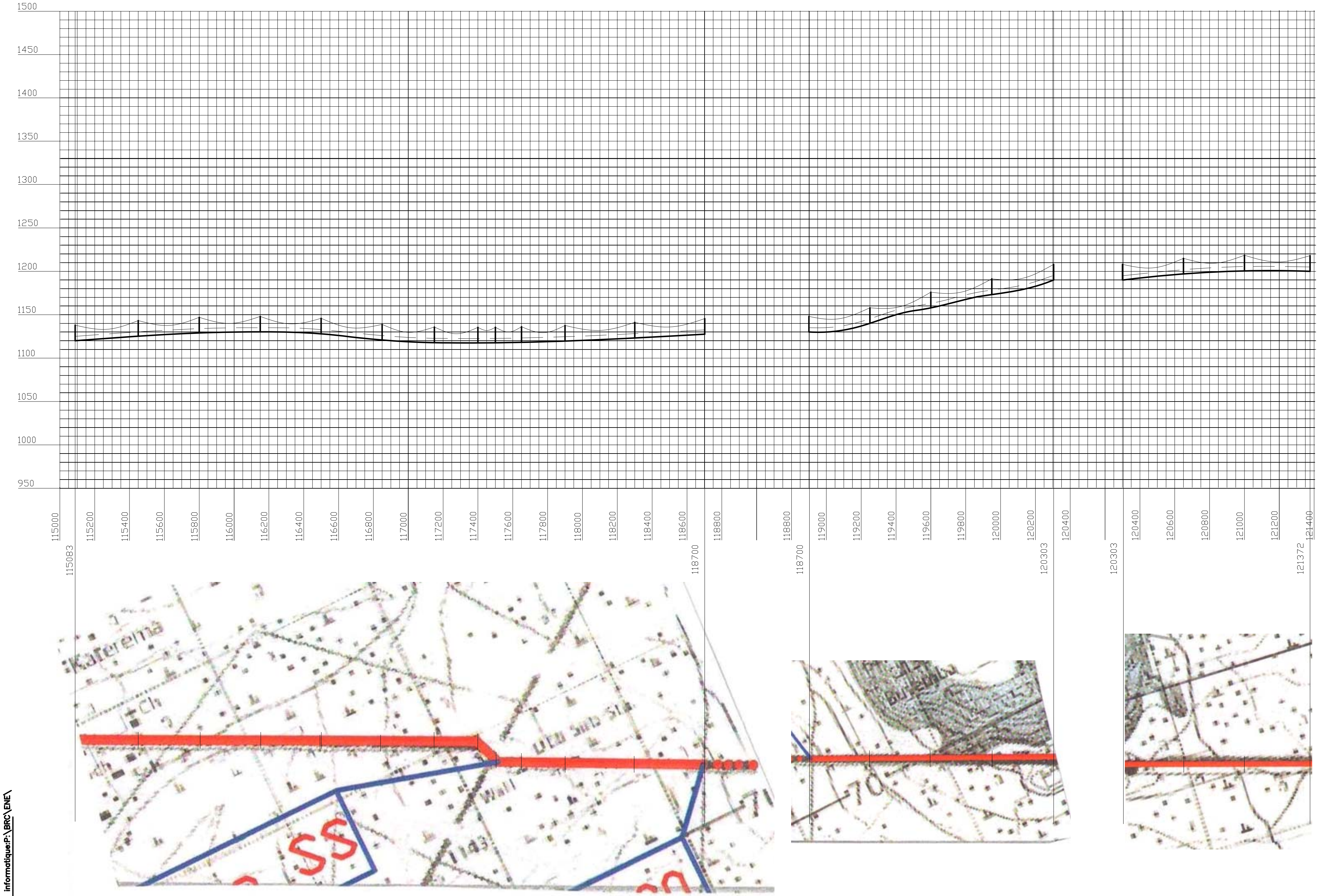
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 121 - Sheet18



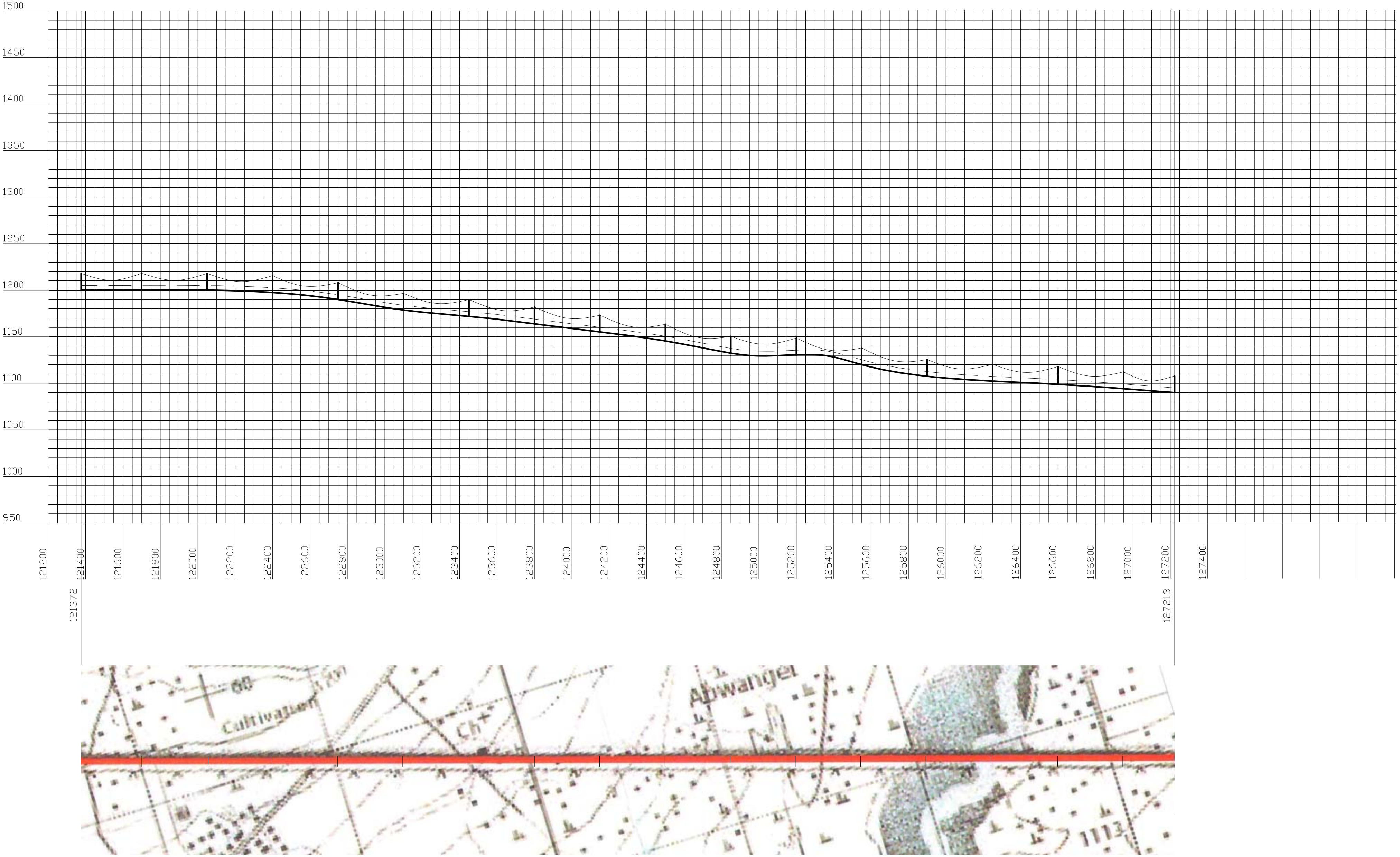
Drawing No. HL KU 121 - Sheet 19

Dessiné par: ALX Controlé par: XDS
Référence informatique:P:\BRC\ENE\



Drawing No. HL KU 121 - Sheet 20

Dessiné par: ALX
Contrôlé par: XDS
Référence informatique:P:\BRC\ENE\



Dessiné par: ALX
Controlé par: XDS
Référence informatique:P:\BRC\ENE\

Drawing No. HL KU 121 - Sheet 21