DRAFT

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

Rusumo Falls
Hydroelectric Power Development Project
Power Generation Plant
Final Feasibility Study

FINAL FEASIBILITY DESIGN REPORT
VOLUME 1
EXECUTIVE SUMMARY

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JANUARY 2012

SNC-LAVALIN International

NILE BASIN INITIATIVE

Nile Equatorial Lakes Subsidiary Action Program
(NELSAP)

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VOLUME 1 EXECUTIVE SUMMARY

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The Final Feasibility Design Report (the "Report") is presented in five volumes:

- *Volume 1 – Executive Summary*
- *Volume 2 – Main Report*
- *Volume 3 – Maps and Drawings*
- *Volume 4 – Annex I: Hydrotechnical Studies Report*
- *Volume 5 – Annex II: Geological and Geotechnical Site Investigations Report*

This is *Volume 1 – Executive Summary*

In the present Report, the "Client" refers to the Nile Basin Initiative / NELSAP Coordination Unit, and the "Consultant" refers to SNC-Lavalin International Inc. ("SNC-Lavalin"); the "Study" refers to the Feasibility Study of the Rusumo Falls Hydroelectric Generation Plant and Related Project Area, and the "Project" refers to the Regional Rusumo Falls Hydroelectric Project.

TABLE OF CONTENTS

Page

1. SUMMING-UP ___ 1
2. PROJECT DATA SHEETS ___ 1
3. INTRODUCTION AND BACKGROUND INFORMATION ___ 5
3.1 The Regional Rusumo Falls Hydroelectric and Multipurpose Project ___ 5
3.2 SNC-Lavalin's Mandate ___ 5
4. PROJECT AREA FEATURES ___ 7
4.1 Location – Topography ___ 7
4.2 Geology and Geotechnics ___ 7
4.2.1 Geological Context of Rusumo Falls Hydroelectric Project ___ 7
4.2.2 Construction Materials ___ 8
4.2.3 Seismicity ___ 9
4.3 Hydrology ___ 9
4.3.1 General Characteristics ___ 9
4.3.2 Time Series of Flows ___ 10
4.3.3 Flood Studies ___ 11
4.3.4 Backwater Studies ___ 11
4.3.5 Storage Studies ___ 12
4.3.6 Sedimentation ___ 13
5. ENERGY AND POWER OUTPUT ___ 15
5.1 Energy Generation ___ 15
5.2 Impact on Flow Regime Downstream ___ 15
5.3 Impact on Lake Rweru Levels ___ 15
5.4 Impact of Climate Change ___ 17
5.5 Impact of Reservoir Sedimentation ___ 18
6. ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS ___ 19
7. PROJECT DESCRIPTION AND LAYOUT ___ 27
7.1 Summary of the Scheme Main Characteristics ___ 27
7.2 Hydraulic Structures ___ 27
7.2.1 Diversion Works ___ 27
7.2.2 Dam and Spillway ___ 28
7.2.3 Water Intake ___ 29
7.2.4 Headrace Tunnel ___ 29
7.2.5 Surge Shaft and Chamber ___ 30
7.2.6 Tailrace ___ 30
7.3 90 MW Powerhouse ___ 30
7.4 220 kV Substation ___ 31
8. EXECUTION PROGRAM ___ 33
9. PROJECT COSTS ___ 35
10. ECONOMIC ANALYSIS ___ 39

11. FINANCIAL ANALYSIS ____ 43

MAIN DRAWINGS

LIST OF TABLES

Page

Table 1 Rusumo Falls Hydroelectric Project Main Figures ___ *1*
Table 2 Project Area Data ___ *1*
Table 3 Hydroelectric Plant Data Sheet ___ *2*
Table 4 Kagera River at Rusumo Falls – Flood Frequency ___ *11*
Table 5 Impact on Lake Rweru Surface Elevation ___ *12*
Table 6 Climate Change Impact on Generation Capability ___ *18*
Table 7 Generation Capability after 100 Years of Sedimentation ___ *18*
Table 8 Summary of Environmental and Social Impacts and Mitigation Measures ___ *21*
Table 9 Cost Estimate Summary ___ *36*
Table 10 Economic Evaluation Results ___ *40*

LIST OF FIGURES

Page

Figure 1 Rusumo Falls Hydroelectric Project Proposed Layout ___ *1*
Figure 2 Annual Flow at Rusumo Falls (1940-2009) ___ *10*
Figure 3 Variation of Effective Live Storage with Reservoir Level ___ *12*
Figure 4 Change in Reservoir Effective Storage due to Sedimentation ___ *13*
Figure 5 Daily Inflow and Outflow Duration Curve (1971-2009) – Firm Target = 40.6 MW ___ *15*
Figure 6 Lake Rweru Daily Levels with and without the Dam – Dry Year ___ *16*
Figure 7 Lake Rweru Daily Levels with and without the Dam – Average Year ___ *16*
Figure 8 Lake Rweru Daily Levels with and without the Dam – Wet Year ___ *17*
Figure 9 Rusumo Fall Project Layout Superimposed over Aerial Photography (2009) ___ *27*
Figure 10 Breakdown of Total Project Cost ___ *37*

1. SUMMING-UP

The Rusumo Falls Hydroelectric Power Development Project with an installed capacity of 90 MW is intended to supply power to Burundi, Rwanda and Western Tanzania, via interconnections with the national grids, as well as to provide rural electrification to the communities located within the Rusumo Falls vicinity.

The site of the proposed dam is located a few hundred meters upstream of the international bridge that crosses the Kagera River at the border between Rwanda and Tanzania. From there, the flow will be diverted through a tunnel to a 90 MW power station housing 3 x 30 MW Kaplan turbines which is built in the rock cliff that overlooks the Mitako Basin where the flow will be passed back to the Kagera River.

The dam will impound a reservoir of a surface area of some 200 km^2 and will provide a live storage of 184 x 10^6 m^3 at Full Supply Level of 1323.5 masl.

Potential generation output, cost and impacts are summarized in Table 1 below.

Table 1 Rusumo Falls Hydroelectric Project Main Figures

FSL = 1323.5 masl IC = 90 MW		
Energy	Firm Total	**356 GWh (40.6 MW)** **497 GWh**
Basic Project Cost (January 2012)		**USD 319 million**
Number of Project Affected People (January 2012 Estimate)		**9000 Households**
Total Project Development Cost (January 2012)		**USD 428 million**

Economics have indicated that the Project as a whole would provide net benefits of some USD 261 million (10% discount rate) based on average energy generation of 497 GWh.

Figure 1 Rusumo Falls Hydroelectric Project Proposed Layout

2. PROJECT DATA SHEETS

Table 2 Project Area Data

Location	
Location	At Rusumo Falls, on the Kagera River about 2 km downstream of its confluence with the Ruvubu River, at the border of Rwanda and Tanzania, where the main road connecting the two countries crosses the river.
Coordinates WGS 84 – UTM	Dam 36S 253,445mE, 9,736,333mN Intake 36S 253,454mE, 9,736,298mN Powerhouse 36S 253,805mE, 9,736,646mN
Coordinates SR 92	Dam X = 587,075 E Y = 9,736,452 N Intake X = 587,084 E Y = 9,736,417 N Powerhouse X = 587,436 E Y = 9,736,764 N
Road Access	From Kigali, Rwanda, through Kibungo (157 km). From Dar-es-Salaam, Tanzania, by Highway T3 through Morogoro, Dodoma, Singida, Nzega, Isaka, Nyakanasi (about 1400 km).
Hydrology	
Catchment Area at Rusumo Falls	30,700 km^2
Average Annual Inflow	210 m^3/s (1940-2009), 233 m^3/s (1971-2009)
Mean Annual Rainfall on Catchment Area	1069 mm (1971-2005)
Net Annual Evapotranspiration	823 mm
Runoff Coefficient	0.23
Peak flow for 10-year flood	542 m^3/s
Peak flow for 20-year flood	602 m^3/s
Construction Flood (40-year flood)	659 m^3/s
Peak flow for 100-year flood	732 m^3/s
Peak flow for 1000-year flood	905 m^3/s
Inflow Design Flood (10,000-year flood)	1074 m^3/s
Probable Maximum Flood (PMF)	1620 m^3/s

Geology of the Project Site

The geological formations encountered within the perimeter of the dam and the reservoir, near the foothills of the Kibaran range belong to four large groups, *i.e.*: (1) the schists and quartzophyllites, locally folded and faulted, slightly metamorphic; (2) the basic intrusive formation composed of local amphibolites outcrops; (3) limited granite; and (4) alluvial, colluvial and eluvial formations. The Project site is traversed by 19 faults that have limited impact on civil structures.

All civil structures are to be founded on sound quartzophyllites, the quarries may be located in amphibolites or granite and the borrow area for impervious material will be located in laterite soils made of completely decomposed rocks. Sand and gravel is not available in the vicinity and will have to be fabricated from quarry material.

Table 3 Hydroelectric Plant Data Sheet

	Unit	
Storage Reservoir		
Full Supply Level (FSL)	masl	1323.5
Minimum Operating Level (MOL)	masl	1322.0
Reservoir Capacity at FSL	hm^3	208.3
Dead Storage at MOL	hm^3	23.8
Live Storage	hm^3	184.5
Reservoir Area at FSL	km^2	197.1
Water Level (1,000-year flood with all gates open)	masl	1322.7
Maximum Water Level (10,000-year flood with all gates open – Power Plant Shutdown)	masl	1323.5
Exceptional Maximum Water Level, Check Flood (100-year flood with 1 gate closed – Power Plant Shutdown)	masl	1323.64
Extreme Water Level (PMF with all gates open – Power Plant Shutdown)	masl	1325.9
Hydraulic Structures		
Dam		
Type		Gravity
Total Length (including Spillway)	m	177
Maximum Height above Foundation	m	13.9
Upstream Stoplogs		Yes (1 set)
Total Concrete Quantity (including Spillway and Intake)	m^3	29,900
Total Excavation Quantity - Common (including Spillway and Intake)	m^3	31,750
Total Excavation Quantity – Rock (including Spillway and Intake)	m^3	54,550
Spillway		
Type		Gated Spillway
Spillway Total Length	m	45
Effective Sill/Crest Length	m	33
Sill/Crest Level	masl	1315.81
Maximum Discharge for Design Flood	m^3/s	1074
Gates: Number		3
Type		Radial with flap gate
Dimensions (w x h)	m	11 x 8
Water Intake		
Type		Lateral inlet headrace tunnel portal type
Inlet Dimensions (w x h)	m	36.4 x 17.69
Sill Level	masl	1302.37
Equipment		Trashracks and stoplogs
Longitudinal Slope of Base Slab	deg	23.4
Horizontal length of the Inlet up to Tunnel Portal	m	25.06
Diversion of the River		
Type		Canal
Width	m	17
Length	m	275
Longitudinal Slope	%	0.15
Excavation Quantity – Common	m^3	50,200
Excavation Quantity - Rock	m^3	40,900
Upstream Cofferdam		
Type		Earth and Rockfill
Height	m	7

	Unit	
Length	m	165
Earthfill Quantity	m^3	24,100
Excavation Quantity	m^3	4,000
Headrace Tunnel		
Main Tunnel: Length from U/S to D/S portals	m	610
Dimensions (w x h)	m	D-shape 11 x 14.3 top of crown
Nominal Longitudinal Slope	deg	1.75
Trifurcation branches: Length	m	30
Concrete Quantity	m^3	2,700
Excavation Quantity - Rock	m^3	85,000
Surge Shaft		
Type		Vertical in rock
Main Chamber: Diameter	m	41
Height	m	35
Bottom Level	masl	1315.80
Connection Shaft: Diameter	m	8
Height	m	36.7
Bottom Level	masl	1279.14
Water Levels: Maximum	masl	1329.67
Minimum	masl	1317.32
Excavation Quantity - Common	m^3	1,000
Excavation Quantity - Rock	m^3	52,800
Tailrace Canal		
Width	m	45
Longitudinal Slope	%	0.01
Riprap Quantity	m^3	8,600
Excavation Quantity - Common	m^3	10,400
Excavation Quantity - Common	m^3	64,500
Powerhouse		
Building		
Type		Surface
Sub-structure		Concrete
Super-structure		Steel
Overall Dimension (l x w)	m	85 x 50
Main Floor Elevation	masl	1301.5
Turbine Axis Elevation	masl	1280.2
Foundation Elevation	masl	1268.3
Total Concrete Quantity	m^3	42,000
Excavation Quantity - Common	m^3	19,500
Excavation Quantity - Rock	m^3	217,930
Turbines		
Number of Units		3
Type		Kaplan, vertical axis
Rated Discharge	m^3/s	116.9
Speed	rpm	187.5
Generators		
Number of Units		3
Rated Power	MW	30
Power Factor		0.9
Output Voltage	kV	12
Generator Transformers		
Number of Units		2
Rated Power ONAN/ONAF	MVA	53 / 70
Primary/Secondary Voltage	kV	12 / 220
Heavy Mechanical Equipment		

	Unit	
Type of Upstream Inlet Valves		Butterfly
Draft Tube Gates (w x h)		2 gates (5.5 x 5.6)
Capacity of Overhead Travelling Crane	t	110
Substation		
Type		Conventional
Plane Dimensions (l x w)	m	190 x 80
Voltage Levels	kV	220
Energy / Power		
Maximum Plant Discharge	m^3/s	357
Installed Capacity	MW	90
Average Power	MW	56.7
Firm Energy	GWh/yr	356
Secondary Energy	GWh/yr	141
Average Energy	GWh/yr	497
Capacity Factor	%	63

3. INTRODUCTION AND BACKGROUND INFORMATION

3.1 THE REGIONAL RUSUMO FALLS HYDROELECTRIC AND MULTIPURPOSE PROJECT

The Regional Rusumo Falls Hydroelectric Project (RRFP) is a hydropower project under joint development by Burundi, Rwanda and Tanzania. The Rusumo Falls are located on the border of Rwanda and Tanzania, and the main road connecting the two countries passes over the Project site.

The Regional Rusumo Falls Hydroelectric Project is being developed within the overall Kagera Basin Integrated Development Framework, which is part of the Nile Basin Initiative (NBI) and its Nile Equatorial Lakes investment program, NELSAP.

The Project as a whole includes the following main elements:

- A hydroelectric power station over the Rusumo Falls of 90 MW, to be shared between the three countries;
- Transmission facilities connecting the hydroelectric power plant of Rusumo Falls to the national grids of Rwanda and Burundi, and supply electricity to the western provinces of Tanzania, which are currently not connected to the country's national grid;
- At the Project level a joint utility/institutional mechanism for the co-management of power generation and distribution to national utilities.

In June 2007, the Nile Basin Initiative / NELSAP retained SNC-LAVALIN International Inc. to provide consultancy services to conduct the feasibility studies of the power generation plant, including the assessment of the Project's environmental and social impacts, and related Project area development. A separate feasibility study has been undertaken by FICHTNER – RSWI for the transmission lines linked to the hydropower plant.

3.2 SNC-LAVALIN'S MANDATE

The feasibility study of the power generation plant undertaken by SNC-Lavalin (the Study) aims at validating and explaining the feasibility of the Rusumo Falls Hydroelectric Project by taking into account technical, economic, environmental and social issues. It also aims at producing the documents that riparian countries, financial donors and other investors will need to make an informed decision regarding the implementation of the Project.

The Study covers all aspects of the Project to help the authorities of the countries involved and the funding agencies to choose the best possible option.

SNC-Lavalin's Feasibility Study has been divided into two phases:

(1) A preliminary design phase to explore three alternatives using the available head and water resource, and

(2) The full feasibility and basic design study phase assessing one preferred option based on a joint decision by the countries.

The first phase was completed in October 2008. At that time, the Full Development Scheme (FDS) with a reservoir level set at 1325 masl was selected as the preferred development option, but it was also recognized that a more precise analysis was required using the improved topography that would subsequently become available fron a LiDAR topographic survey of the flooded area. The LiDAR survey took place in 2009 and the Study was interrupted between March 2009 and November 2010.

The second phase of the Study started in November 2010 on the basis of the development option selected by the countries, *i.e.*, the FDS. However, during the course of this phase of the Study, it became apparent that, at the considered 1325 masl reservoir elevation, the number of Project affected people and associated resettlement costs far exceeded preliminary estimates.

In September 2011, the countries decided that the reservoir level should be lowered to 1323.5 masl. This Intermediate Development Scheme (IDS) was hence adopted as a basis for final design of the Rusumo Falls Hydroelectric Project which is presented in the present Report.

4. PROJECT AREA FEATURES

4.1 LOCATION – TOPOGRAPHY

The aerial LiDAR survey of the Project area (structures location at Rusumo Falls as well as flooded and surrounding areas), in Burundi, Rwanda and Tanzania, was conducted in July 2009. The total area covered is 54 000 ha (540 km^2). The surveyed area extends from the dam in the Kagera River up to the Nyabarongo River upstream of Lake Rweru and some 60 km upstream in the Ruvubu River, at least up to elevation 1335 masl.

The aerial LiDAR survey was carried out using an aircraft mounted LiDAR system that scanned the ground below with a 70 kHz laser resulting in a dense DEM of the ground surface, and objects above the ground. Digital color images (pixel size of 15 cm) were also taken from the aircraft to produce color orthophotos of the area.

The relative vertical accuracy is 15 cm RMS, and horizontal 20 cm RMS.

The whole survey was calculated in WGS84 UTM 36 South with ellipsoidal heights.

4.2 GEOLOGY AND GEOTECHNICS

4.2.1 Geological Context of Rusumo Falls Hydroelectric Project

Dam

The dam will be founded on slightly weathered to sound quartzophyllite encountered at depths varying between 3 and 4 meters below ground level on both banks of the Kagera River. Residual soil and highly weathered rock were observed between the ground surface and the slightly weathered to sound rock. No significant geological feature is expected at the dam location.

Upstream Cofferdam

On both banks, the upstream cofferdam must be founded on competent residual soil or weathered rock. Therefore, all existing backfill material and loose soil found on the river banks within the footprint of the cofferdam should be removed prior to fill placement. The removal of approximately 1 to 2 m of loose soil will be required on both banks. In the river, all fill materials are dumped without prior stripping.

Diversion channel

Excavation of the diversion channel will be carried out, from top to bottom, in surficial backfill material, residual soil, highly weathered rock with residual soil and slightly weathered to sound bedrock. According to investigations performed in this area, sound bedrock is found at depths varying between 8 and 12 m. No faults or other geological features are expected at the diversion channel location.

Water Intake

The water intake will be founded in sound to slightly weathered quartzophyllites.

Tunnel

The tunnel will be excavated in sound to slightly weathered quartzophyllites and will be unlined except in fault zones. Based on the investigations performed, six faults are expected to intersect the tunnel excavation. It is assumed that 5 of these faults will be minor; the 6th fault is assumed to affect a band of rock 12 m thick.

Penstocks and Manifold

Excavation of the penstocks and manifold will be performed in sound to slightly weathered quartzophyllites.

Surge Shaft

The surge shaft will be excavated in sound to slightly weathered quartzophyllites. Its location is dictated by its proximity to the powerhouse and by the fault lines found in the rock mass. From the initial rock evaluation it can be concluded that the rock is competent enough not to warrant concrete lining. No significant geological features are foreseen.

Powerhouse

The powerhouse will be founded on sound quartzophyllites except for the downstream portion of the Unit 1 draft tube where it could be founded on weathered rock (on a approximate area of 10 x 2 m). Further investigation will confirm the sound rock profile at this location.

The presence of a shear zone located towards the downstream section of the powerhouse, near the junction with the tailrace canal, is expected. This fault appears to be some 4 m wide and seems to run sub-parallel to the powerhouse upstream wall. It is assumed that this fault could affect a band of rock 10 m thick.

Tailrace

The site of the tailrace was investigated in 1987 and 2009. It is expected that the upstream portion of the tailrace will be excavated in, and founded on, soft to stiff, saturated silt or clay material, including a black clay deposit near the powerhouse, while the downstream portion will mostly be founded on rock. The presence of colluvium of undetermined thickness, sloping at the material angle of repose is suspected on the right side of the tailrace channel, immediately downstream of the powerhouse.

4.2.2 Construction Materials

Coarse Aggregate

A potential quarry is located in Kiyanzi, approximately 8 km West of the Rusumo Falls. This quarry appears to be mostly constituted of quartzite. The short-term AAR test results show that the rock is non-reactive. However, before concluding that this rock could be used as aggregate for concrete production, a long-term AAR test should be carried out to demonstrate that the rock is non-reactive.

Fine Aggregate

A source of fine aggregate is located in Rwanda along an existing dirt track, approximately 2 km South-West of the international border at Rusumo Falls, and 350 m North of the Kagera River left shoreline. It is believed that small scale processing or some mixing at the source of extraction would produce a material that would comply with the typical specification for particle size distribution of fine aggregate material. Alkali-aggregate reaction tests indicate that the fine aggregate originating from Borrow Area 2 is non-reactive. The potential area inside of which fine aggregate could be extracted is estimated to be 48.900 m^2. The proven volume of fine aggregate is evaluated to be in the order of 18,100 m^3.

Impervious Material

A source of low permeability material is located in Rwanda along the international road connecting Kigali and Tanzania, at a distance of 1 km from the border at the Project site. The proven volume of impervious soil that could be extracted from the borrow area is estimated at 25,000 m^3.

Rockfill

It is estimated that a total of 126,400 m^3 of rockfill will be required for the construction of the upstream cofferdam (19,600 m^3), permanent access roads (39,500 m^3), tailrace surface protection (8,600 m^3) and closure dike (58,300 m^3). Rock material originating from the excavation of the headrace tunnel could be used for road construction or be disposed of off-site at designated spoil areas.

4.2.3 Seismicity

According to a seismology assessment based on the probabilistic method, the Project area is characterized by a moderate seismicity ($M \leq 6$) and low PGA values ($PGA \leq 0.1g$).

4.3 HYDROLOGY

4.3.1 General Characteristics

The Kagera River is the main tributary flowing into Lake Victoria whose catchment covering constitutes the headwaters of the White Nile.

The Kagera River headwaters arise in the highlands of Rwanda and Burundi. The main tributaries are the Ruvubu River and the Nyabarongo River. Upon leaving Lake Rweru, the Nyabarongo River changes name and becomes the Kagera River (or Akagera). It then flows over about 60 km along the boundary between Rwanda and Burundi until its confluence with the Ruvubu River about 2 km upstream from Rusumo Falls. Downstream from the Ruvubu confluence, the Kagera River flows along the Rwanda/Tanzania boundary.

From Lake Rweru area and over 60 km down to Rusumo Falls, the Kagera River meanders in wetlands occupied mostly by papyrus and floating water hyacinth carried by the current. The average slope is about 0.006%. About 2 km downstream of its confluence with the Ruvubu River, the Kagera goes through the Rusumo Falls gorges. The falls drop approximately 20 m over some 60 m before going through a succession of rapids and dropping another 10 m over about 1 km. Further downstream the valley broadens again into wetlands with mostly papyrus vegetation.

The Kagera River at Rusumo Falls has a drainage area of 30,700 km^2.

4.3.2 Time Series of Flows

The Kagera River basin being located in an equatorial region, the time series of flows has to be statistically representative. A 30-year period was considered as a minimum required to include a sufficient number of wet and dry spells to enable the evaluation of the river hydro potential with an acceptable degree of confidence.

Usable flow data was available from 12 stations located within or near the Rusumo Falls basin. Data for some of the stations go back to 1940, the earlier records containing many gaps and values of dubious reliability. The following five stations were retained:

- Nyabarongo River near Kigali (Station No. 70005);
- Kagera River at Rusumo Falls (Station No. 70003);
- Kagera River at Kyaka Ferry;
- Ruvubu River at Gitega;
- Ruvubu River at Muyinga Ferry.

Records from Station No. 70003 are considered as the most important since that station is located at the dam site. Data from all other stations were therefore used to complete and augment the existing dataset at Rusumo Falls using correlation techniques. Rainfall-runoff modeling was also used where appropriate to complete the series. Figure 2 below shows the observed and reconstituted flows at Rusumo Falls for the 70-year period from 1940 to 2009.

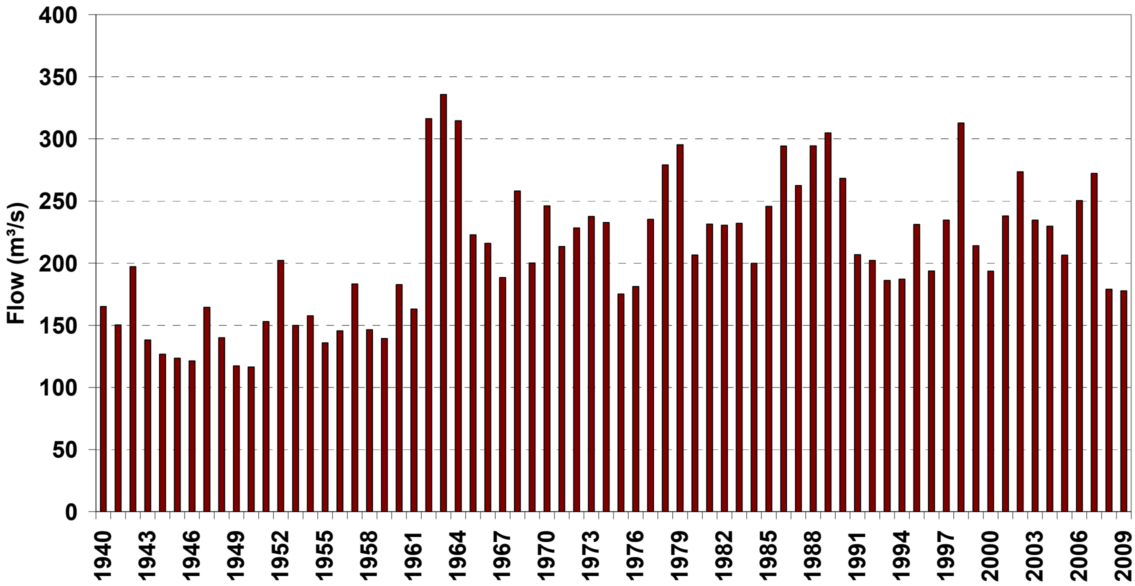

Figure 2 Annual Flow at Rusumo Falls (1940-2009)

There is a marked discontinuity in average yearly flows before and after 1961, the runoff being clearly higher in the post 1961 stretch.

The 39-year sub-period from 1971 to 2009 was selected as representative for the energy and sedimentation studies. The average flow for the selected period is 233 m³/s. In comparison the 1940 to 1961 average was 151 m³/s.

4.3.3 Flood Studies

Floods of given return periods were computed from flood frequency analysis. Flood frequency analysis was carried out on the set observed daily peaks as well as on the augmented set consisting of recorded peaks (36 values) and peaks estimated by rainfall-runoff modeling (14 values) for a total of 50 values. Table 4 lists the flood magnitudes obtained for pertinent return periods.

The 10,000-year flood was adopted as the Inflow Design Flood for the Rusumo Falls Hydroelectric Project, with an inflow peak equal to 1074 m³/s.

Table 4 Kagera River at Rusumo Falls – Flood Frequency

Return Period (Years)	Flood Peak (m^3/s) Log-Pearson III	Remark
2	369	Mean Annual Flood
20	602	Used for assessing limits of flooded areas
40	659	Diversion Design Flood
100	732	Flooding easement
10,000	1074	Inflow Design Flood (IDF)

4.3.4 Backwater Studies

The topography of the Kagera basin upstream of Rusumo Falls is such that the reservoir will not behave as a level pool but more like a wide river channel. This condition will have a direct influence on;

- The available storage for energy generation; and
- The extent and timing of inundated areas upstream.

Water surface profile analysis was therefore carried out for the Kagera River valley (including the Ruvubu tributary) upstream of Rusumo Falls in order to determine to what degree the levels in and around Lake Rweru would be influenced by the presence of a dam at Rusumo Falls.

Downstream of the falls, water surface profiles were established to validate the tailwater rating curve for the power plant.

Given the particular topography, the river and reservoir system behavior was also verified under unsteady flow conditions, especially to compute the reservoir effective live storage during operation.

Water Surface Profiles – Steady State

The steady-state simulation of the water surface profiles was carried out for natural conditions and for water levels at the dam of 1322, 1322.5, 1323 and 1323.5 masl. The results are summarized in Table 5 below.

Table 5 Impact on Lake Rweru Surface Elevation

	Q = 233 m³/s (Mean flow)		Q = 369 m³/s (2-Yr flood)		Q = 602 m³/s (20-Yr flood)		Q = 732 m³/s (100-Yr flood)	
Level at Dam Site	Lake Level (m.a.s.l.)	ΔH* (m)	Lake Level (m.a.s.l.)	ΔH* (m)	Lake Level (m.a.sl.)	ΔH* (m)	Lake Level (m.a.s.l.)	ΔH* (m)
Natural (no dam)	1324.80	---	1325.14	---	1325.83	---	1326.18	---
1322 m.a.s.l.	1324.81	0.01	1325.15	0.01	1325.84	0.01	1326.19	0.01
1322.5 m.a.s.l.	1324.82	0.02	1325.16	0.02	1325.85	0.02	1326.19	0.01
1323 m.a.s.l.	1324.82	0.02	1325.17	0.03	1325.86	0.03	1326.21	0.03
1323.5 m.a.s.l.	1324.82	0.02	1325.21	0.07	1325.90	0.07	1326.24	0.06

* ΔH = difference between level with dam and level under natural conditions.

Results show that the incremental rise (ΔH) in water level in Lake Rweru for all discharges is relatively small.

4.3.5 Storage Studies

Unsteady flow simulations were carried out to estimate the reservoir effective storage. The model was run by simulating a constant net withdrawal from storage with the outflow exceeding the inflow by a given amount, and the level at the dam initially set at the Full Supply level (FSL) of 1323.5 masl. The excess outflow was maintained until the level at the dam reached the Minimum Operating Level (MOL) of 1322.0 masl. The live storage available (between FSL = 1325 masl and MOL = 1322 masl) was computed for an inflow of 130 m³/s and an outflow of 160 m³/s. This combination represents a typical dry season inflow condition and an outflow corresponding to firm power generation with reservoir drawdown. The effective live storage for the reservoir with FSL = 1323.5 masl was thus found to be 184 Mm³. The variation of available storage with the water level at the dam is shown in Figure 3.

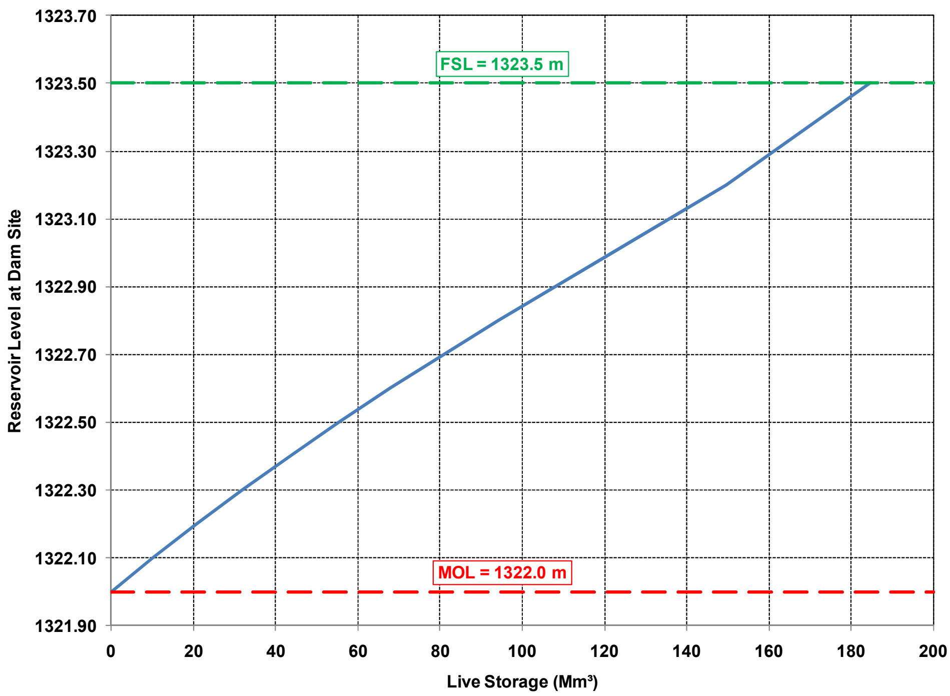

Figure 3 Variation of Effective Live Storage with Reservoir Level

4.3.6 Sedimentation

Sedimentation studies were carried out to evaluate the change of available storage in the short and long term due to reservoir siltation.

The simulation was carried out with the water level at the dam being set at the FSL, *i.e.*, 1323.5 masl. The results of the simulation revealed the following:

- Most of the Kagera River sediment load (nearly 99%) is deposited in and around Lake Rweru upstream;
- While a significant portion of the Ruvubu River load also settles upstream and all along the river channel, the greater part of the suspended solid (about 61%) is carried towards the dam site.

The results of the simulation showed that the effective live storage after 100 years would decrease by about 25% (from 184.5 to 139 Mm³). The resulting storage curves for the reservoir are shown in Figure 4.

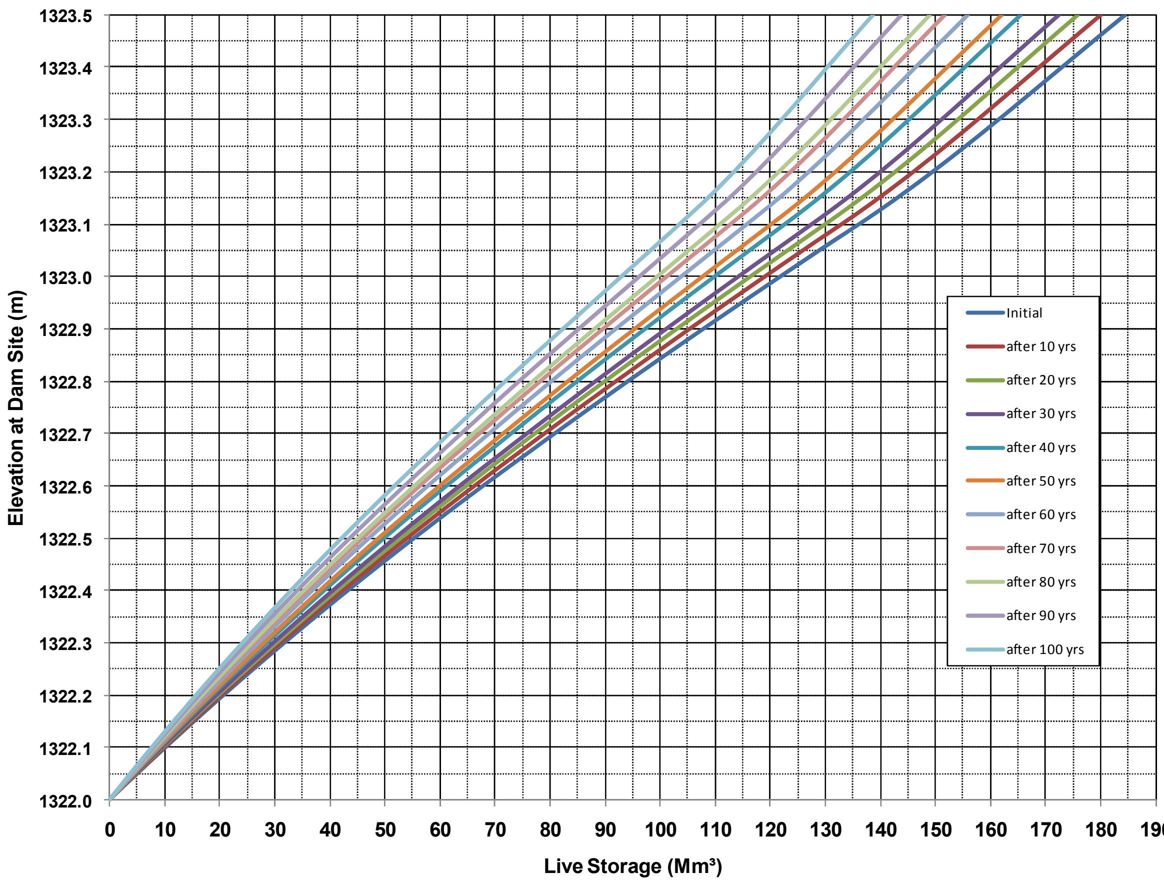

Figure 4 Change in Reservoir Effective Storage due to Sedimentation

5. ENERGY AND POWER OUTPUT

5.1 ENERGY GENERATION

The reservoir and power plant operation simulation was carried out using a daily time step on the 1971-2009 flow series for the 90 MW powerhouse and reservoir at FSL = 1323.5 masl, for an effective live storage of 184 Mm³.

The simulation on the 39-year inflow sequence gave the following results:

- Average annual generation = 497 GWh
- Firm annual generation (95% exceedance, monthly, event based) = 356 GWh
- Firm generation expressed as monthly mean output = 40.6 MW

5.2 IMPACT ON FLOW REGIME DOWNSTREAM

The global effect on the outflow regime is illustrated in Figure 5. It is seen that the outflow regime will be affected by the regulation to a certain extent for flows that are below the long term mean (230 m^3/s). The outflow will be lower than natural by up to 10% for intermediate flows (230 > Q > 170 m^3/s) and higher than natural by up to 28% for low flows (Q < 170 m^3/s).

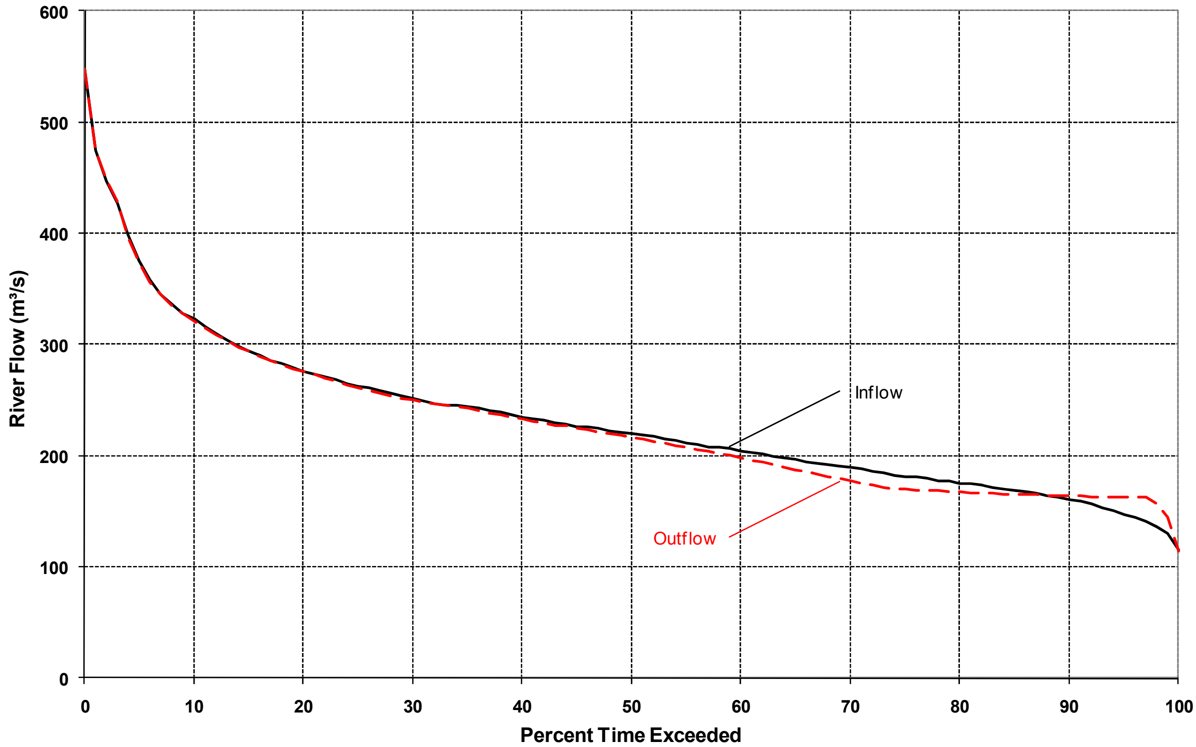

Figure 5 Daily Inflow and Outflow Duration Curve (1971-2009) – Firm Target = 40.6 MW

5.3 IMPACT ON LAKE RWERU LEVELS

The extent of the impact of the Rusumo Falls Project development on levels at Lake Rweru was studied considering the plant operation during an average, a wet and a dry year.

The results are summarized graphically in Figure 6 to Figure 8.

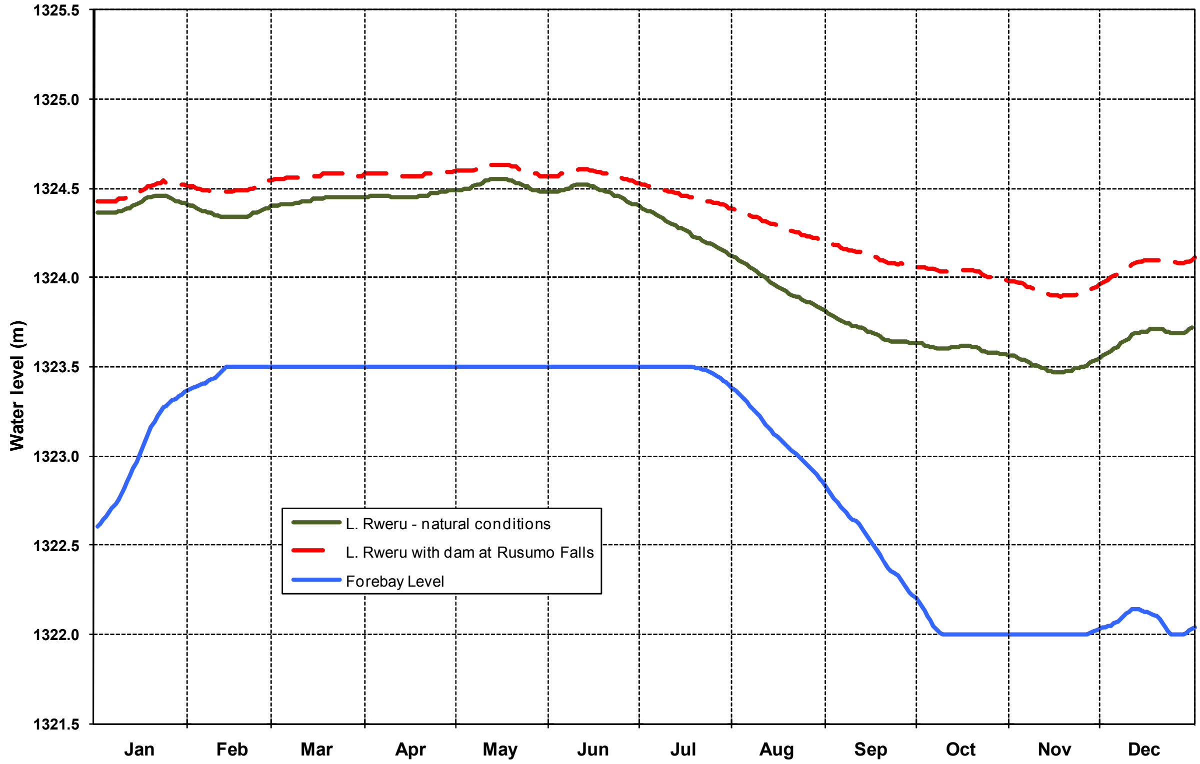

Figure 6 Lake Rweru Daily Levels with and without the Dam – Dry Year

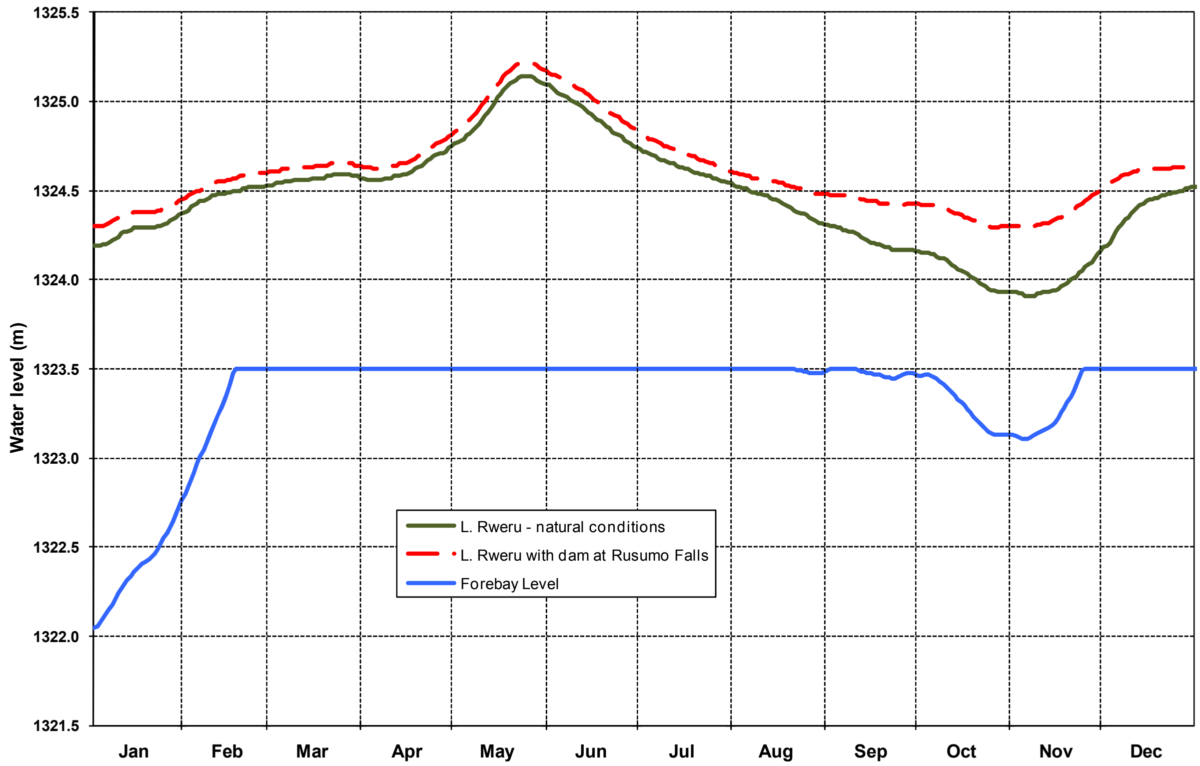

Figure 7 Lake Rweru Daily Levels with and without the Dam – Average Year

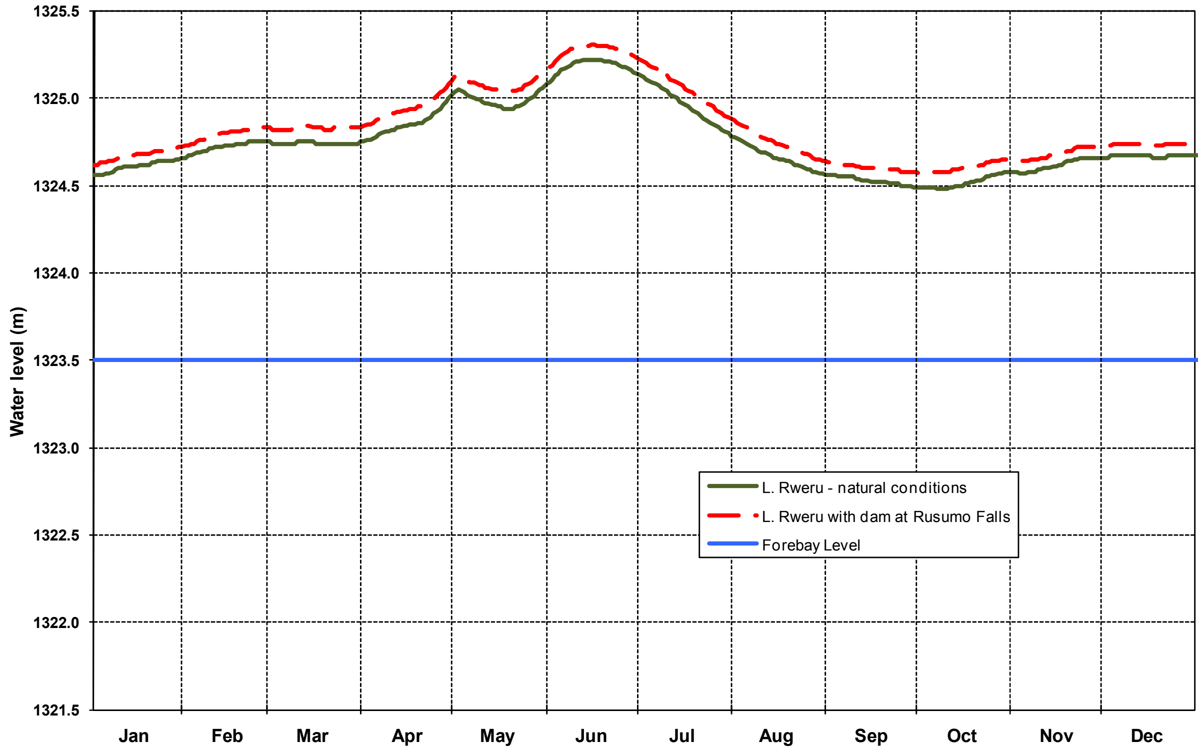

Figure 8 Lake Rweru Daily Levels with and without the Dam – Wet Year

From these figures the following observations can be made:

- The lake levels follow the same seasonal pattern irrespective of dry or wet hydrologic conditions.
- The incremental lake levels (between the natural conditions and those with the dam in place) tend to be more perceivable during the dry part of any year when levels both upstream and downstream are low.
- The increment rarely exceeds 10 cm and when it does, it occurs when the lake level is low (October-November).

The presence of the dam and reservoir extends the duration of higher-than-natural levels in Lake Rweru only when the latter drops below elevation 1324.5 masl. The duration of flood levels (> 1324.5 masl) in the lake with the dam in place does not increase when compared to the corresponding duration for flood levels under natural conditions

5.4 Impact of Climate Change

Climate change, in the context of the Rusumo Falls Project, specifically refers to global warming and its consequences on the hydrology of the basin. Information gathered from recent UNDP publications confirmed the general rising trend in temperature and provided forecasts for the ensuing changes in precipitation.

Based on past phenomena and model predictions on increasing rainfall in the basin in the future, increases in annual runoff of 10, 15, 20 and 30% were considered, taking into account the seasonal repartition of such rainfall increases.

The 1971-2009 flow series was modified accordingly to produce long term annual flows for four new series given by:

- Mean for 10% runoff increase = 256 m³/s
- Mean for 15% runoff increase = 267 m³/s
- Mean for 20% runoff increase = 279 m³/s
- Mean for 20% runoff increase = 302 m³/s

Generation capability was then estimated by simulation as for the base case. The results from the additional simulations carried out on the modified daily records for the 39 years are summarized in Figure 6.

Table 6 Climate Change Impact on Generation Capability

Scenario	Average Energy		Firm Energy		
	GWh/Year	Change	MW	GWh/Year	Change
Base Case	497	---	40.6	356	---
Runoff Increase of 10%	538	8.2%	42.8	375	5.3%
Runoff Increase of 15%	557	12.1%	44.2	387	8.7%
Runoff Increase of 20%	576	15.9%	45.4	398	11.8%
Runoff Increase of 30%	610	22.7%	48.0	420	18.0%

It shows that there could be significant increase in both firm and average energy. The percent change, with respect to the base case, in average energy for each scenario is higher than the corresponding percentage change in firm energy. This is attributable to the following:

- The high installed capacity, and hence turbine maximum discharge, can absorb much of the increase in runoff before spilling becomes necessary.
- The not so large increase in precipitation during the dry season is reflected in the dry season base flow.
- Firm flow is mainly determined by the drawdown on the accumulated pre-dry season volume.

5.5 IMPACT OF RESERVOIR SEDIMENTATION

Generation simulation was carried out using the downgraded storage curve for the reservoir to evaluate the generation capability of the plant with the partially silted reservoir. The results are summarized in Table 7.

Table 7 Generation Capability after 100 Years of Sedimentation

		Base Case	After 100 Years
1	Average Annual Energy (GWh)	497	496
2	Change with respect to Base Case	----	< 1%
3	Firm Energy (GWh)	356	347
4	Firm Energy (MW equivalent):	40.6	39.6
	Change with respect to Base Case	----	- 2.5%

6. ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS

An Environmental and Social Impact Assessment (ESIA) was carried out in parallel to the feasibility design and has identified several negative and positive environmental and social impacts.

In order to identify the various impacts, the following components were studied:

Physical Environment
Climate and Micro-climate
Geology
Seismic Activity
Topography
Bathymetry of Lake Rweru
Pedology
Hydrogeography
Hydrology
Sediment Transport
Water Quality
Noise and Vibration
Greenhouse Gas emissions

Biological Environment
Vegetation: Aquatic & Phytoplankton, Wetland and Terrestrial Vegetation
Wildlife & fauna: Zooplankton, Benthic Communities, Ichthyofauna, Herpetofauna, Bird Fauna, Mammals
Valued Ecosystems
Potentially Dangerous or Harmful Resources
Species with Conservation Concern
Ecosystems in Danger, Valued and/or Protected

Socio-economic Environment
Institutional Strengthening
Land Tenure
Demography, Population Movements and Resettlement
Agriculture and Arboriculture
Fishing, Logging
Hunting and Harvesting Activities
Infrastructure and Utilities
Economic Spinoff on Local Quarries and Borrow Pits
Tourist Activities and Resources
Quality of Life, Health
Security, Peace and Conflict
Vulnerable People
Valued Landscapes
Employment and Economic Activities

The main impacts on the physical environment are related to the flooding of 17,000 ha and the water level fluctuation which will affect 1700 ha on the shore of the reservoir. The construction of the diversion channel, the water intake, the power plant as well as the presence of cofferdams will temporarily and locally change the hydrological conditions of the Kagera River. This impact will be felt locally at the construction site since the same amount of water as in natural conditions will be evacuated downstream of the working site. There is also an increased risk of bank erosion particularly near the dam area and during heavy rains. The main area to be impacted is the construction area where earthworks, blasting and filling material in the river for the construction of the cofferdams will be undertaken, and around the reservoir mainly during the impoundment period. The presence of suspended sediment in the water stream may have the adverse effect of silting in shallow areas with low flow velocities.

The main impacts on the biological environment are related to the loss of habitats due to the water level increase which will affect 10,800 ha of land (most of it for less than 50 cm). The lands that will be submerged are mainly swampy lowlands (marshlands) occupied by papyrus and reeds vegetation. There is also flooding of 240 ha of tree savannah area which includes plantations and shrubs. The creation of a reservoir and the reduction of the water velocity may lead to the proliferation of invasive plant species such as the water hyacinth. Another potential impact may be on species of special concern such as the crocodile and the python sebae mainly during the impoundment period if it coincides with the nesting and incubation periods. However this impact should be avoided since the impoundment will probably take place during the rainy period.

The main impact on the socioeconomic environment is the involuntary displacement of households and persons who depend on the land. The number of Project Affected People (PAP – people to be resettled or to be compensated for the loss of agricultural land) is currently being estimated at over 9000 households (about 45,000 people). This figure represents mainly households harvesting in marshlands. Another concern is migration induced by the construction phase which will affect communities and villages surrounding the construction site. These impacts may include housing issues, spread of disease, alcohol and drug abuse. There will also be an increased pressure on existing logging resources, given that charcoal wood remains the principal source for cooking in the Project area.

The Project will also bring about many positive impacts. In addition to job creation of 1000 or so positions over a 4-year period during the construction phase, the Project will bring about economic repercussions to the Region. The Rusumo Hydroelectric Project will benefit the national economy of Burundi, Rwanda and Tanzania by developing their natural renewable resources which will allow the production of about 500 GWh of electricity per year for more than 50 years.

Table 8 in the following pages presents all impacts related to the Project and their mitigation measures. Most of the mitigation measures presented with each impact refer to management plans which describe specific measures to be taken in order to minimize any negative environmental or social impact. These management plans include:

General Management Plans:
No 1: Obtaining required permits
No 2: Management of project changes
No 3: Stakeholder management plan
No 4: Grievance management plan
No 5: Local Resource Development Initiative (LRDI)
No 6: Human resources management plan (working conditions and training)
No 7: Migration management plan
No 8: Management of health and safety of contractor and supplier employees
No 9: Management of health and safety of local population
No 10: Prevention and fight against HIV/AIDS and other STDs

Management Plans for Specific Types of work:
No 11: In-stream work
No 12: Earthwork, excavation and drilling
No 13: Quarry, borrow pit, overburden disposal sites and other stockpiles management
No 14: Worksite rehabilitation and demobilization

Management Plans for Specific Environmental Components:
No 15: Air Quality
No 16: Dust control
No 17: Greenhouse gas management
No 18: Noise and vibration
No 19: Surface and groundwater
No 20: Control of erosion and sediment discharge into watercourses
No 21: Management of contaminated soils
No 22: Management of contaminated waters

Biological Environment
No 23: Plants
No 24: Fish
No 25: Wildlife
No 26: Biodiversity

Socio Economic Environment
No 27: Transportation and traffic
No 28: Management of nuisances associated with construction and operation
No 29: Access to water and basic sanitary facilities in affected villages
No 30: Management of domestic wastes and aquatic vegetation debris
No 31: Management of hazardous wastes
No 32: Cultural heritage and sacred sites

LADP: Local Area Development Plan (Separate report
RAP: Resettlement Action Plan (Separate report)

Table 8 Summary of Environmental and Social Impacts and Mitigation Measures

Form No.*	Affected Component	Project Phases	Impact Origin	Impact Description	Residual Impact Significance	Mitigation Measures
PHYSICAL ENVIRONMENT						
P-01	Climate and Micro-climate	Operation	Extension of the water body and climate changes	• The extension of the water body will affect very slightly the immediate surroundings of the reservoir. • Climate changes could affect the precipitation and therefore the energy production. In the project area the climate changes may induce an increase of the run-off in the coming year.	According to the methodology used to assess the impacts, the impacts on physical components are described qualitatively and quantitatively when possible but they are not assessed since they are valued only in regards to specific biological or socio-economic components of the environment. However the impacts on these components are taken into account and are used as input to assess the impact on the biological and socio-economic components.	The capacity of the power plant is set up at 90 MW. The load factor being 65%, if the river discharge increases, there is then flexibility to produce more electricity with the same facilities.
P-02	Geology and seismicity	Operation	Impoundment of the reservoir	• The impoundment of the reservoir could have an impact to the seismicity of the area but since the water body will be relatively small and the water level will be raised by less than four meters, the project will not have any impact on seismicity.		No measures proposed
P-03	Hydrogeology	Operation	Rising of the water level in the reservoir	• Slight increase in the water table at proximity of the reservoir.		No measures proposed
P-04	Hydrology of the river	Construction & Operation	Creation of the reservoir and water management	• Slight increase of the water level in the lake Rweru from less than 10 cm at high flow to less than 50 cm for low flow. • Slight reduction of the flood downstream of the dam. • Slight increase in the low flow downstream of the dam.		At the start of the commissioning stage, the reservoir should be filled up during flood flow period (mid-April to end of June) in order to reduce impact of decreasing flow downstream during the reservoir filling.
P-05	Sedimentation	Operation	The impoundment of the reservoir will modify the sediment dynamics	• Since the Nyabarongo marshland and Lake Rweru already intercepts a great proportion of the sediment, the creation of the reservoir on the Kagera River will not significantly affect the amount of sediment coming to the falls. Moreover, simulation shows that it will not affect significantly the life expectancy of the reservoir.		No measures proposed
P-06	Soil erosion	Construction & Operation	• Deforestation; • Earth work and water level variation around the reservoir.	• During the **construction period**, deforestation and the removal of topsoil will lead to a possible erosion of bare lands during heavy rains. • During the **operation period**, the periodic water fluctuation will be favourable to erosion around the reservoir.		As mitigation measures, five Management Plans are proposed to mitigate the possible impacts of the project on the soil erosion and the sedimentation. Three of these plans address specific activities: • In-stream Work. • Earthworks and Excavation. • Quarries and Borrow Pit Management Plan. • Another plan addresses the general thematic of the Control of Erosion and Sediment Discharge into watercourses. • Finally, the plans for management of contaminated soils and management of contaminated waters take care of the emergency situations such as oil spill or other spill contaminants.
P-07	Ground and surface water quality	Construction & Operation	• Construction activities; • Impoundment of the reservoir; • Water management.	• During the construction period, the installation of cofferdams, the construction of the water intake and power plant could alter the water quality due to the supply and re-suspension of the sediment. • During the construction and operation periods, there will be an increase in suspended solids and a risk of water contamination in the event of a spill. • During the operation, the creation of a reservoir and the modifications of the hydraulic conditions might lead to a slight modification of water quality.		Five Management Plans are proposed to mitigate the possible impacts of the project on the soil erosion and the sedimentation. Three of these plans address specific activities: • In-stream work. • Earthworks and excavation. • Quarries and borrow pit management plan. Two other plans address the general thematic of the surface and groundwater quality and the control of erosion and sediment discharge into watercourses.

Form No.*	Affected Component	Project Phases	Impact Origin	Impact Description	Residual Impact Significance	Mitigation Measures
P-08	Noise and vibration	Construction	Construction work and transportation by trucks	• Increase in the ambient noise for the population living near the construction site.		• The general management plan addresses the Grievance Management. This plan will propose how any unexpected complaints regarding noise or vibration will be managed during the construction period. • A second plan addresses the general thematic of noise and vibration.
P-09	Production of Greenhouse Gases (GHG)	Operation	GHG emissions come from carbon dioxide released by decay of flooded biomass and from methane produced by decay of biomass under anoxic conditions at the bottom of the reservoir	• Slight increase in the GHG emission of the water body for a few years. • Net annual GHG reduction (or avoided emissions) ranging of about 300,000 tons.		A follow up of the production of electricity should be implemented to document the effective reduction in the GHG specific to the project compared to thermal power production.
BIOLOGICAL ENVIRONMENT						
B-01	Aquatic vegetation and phytoplankton	Construction & Operation	Works in water, impoundment of the reservoir and water management	• Augmentation of the nutriments will induce an increase of phytoplankton. • Reduction of velocity favourable to water hyacinth.	Low	Implementation of the following Management plans: • Works in Water Courses • Vegetation Debris
B-02	Wetland vegetation	Operation	Reservoir impoundment and water management	• Slight increase in the lower water level mostly in the rivers and on the lake Rweru, (approximately 50 cm) this may affect the papyrus slightly. • Possible proliferation of water hyacinth due to the reduction of the water velocity.	Low	Implementation of the following Management plans: • Water Management Plan. • Vegetation Debris.
B-03	Terrestrial vegetation	Construction & Operation	• Construction activities; Reservoir impoundment; • Increased need for wood for the incoming population of workers in the project site.	• Destruction of the terrestrial vegetation.	Very low	Implementation of the following Management plans: • Rehabilitation and demobilisation of the construction areas. • Dust control management plan. • Flora management plan.
B-04	Zooplankton	Construction & Operation	• Construction works in water; • Impoundment of the reservoir; • Water management.	• Modification to the hydraulic conditions. • Slight modification to the water quality. • Slight increase in the biomass of zooplankton without affecting the diversity of the species.	Low	Implementation of the following Management plans: • Works in water. • Erosion control. • Water management.
B-05	Benthos	Construction & Operation	Modification to the hydraulic conditions and water quality	• Slight reduction of the riparian habitat for the benthic organisms.	Low	Implementation of the following Management plans: • Works in water. • Erosion control. • Water management.
B-06	Ichthyofauna	Construction & Operation	• Loss of habitat; Impoundment of the reservoir; • Modification to the hydraulic conditions.	• Increase in productivity; Slight modification to the habitats.	Low	Implementation of the following Management plans: • Works in water. • Erosion control. • Water management.
B-07	Herpetofauna	Construction & Operation	Impoundment of the reservoir	• Killing of a cohort of valued species (Crocodylus niloticus and Python sebae) if the impoundment takes place during the nesting and egg hatching period.	Low	Impoundment of the reservoir will occur in the peak of the wet season (between mid-April and end of June) and will avoid the nesting and egg incubation period for Crocodylus niloticus (period of 3 months in dry season) and for Python sebea (between .
B-08	Birds	Construction & Operation	• Construction activities; • Impoundment of the reservoir; • Water management.	• Loss and disturbance of habitat. • Loss of a cohort of birds during the impoundment.	Low	The impoundment should take place after or before the brooding period as stated in the Water Management Plan. The other plans to implement are: • Rehabilitation and demobilisation of the construction areas. • Dust control management plan. • Flora management plan.

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Form No.*	Affected Component	Project Phases	Impact Origin	Impact Description	Residual Impact Significance	Mitigation Measures
B-09	Mammals	Construction & Operation	• Construction works; • Loss of habitat.	• Reduction of the marshland available for habitat.	Low	Implementation of the following Management plans: • Rehabilitation and demobilisation of the construction areas. • Dust Control Management plan. • Flora Management Plan.
B-10	Valued Ecosystem	Construction & Operation	• Construction activities; • Impoundment of the reservoir; • Water management.	• Reduction of the marshland habitat.	Medium	Implementation of the following Management plans: • Rehabilitation and demobilisation of the construction areas. • Dust control management plan. • Flora management plan. • Biodiversity management plan. • Water management plan.
HUMAN ENVIRONMENT						
S-01	Institutions	Construction & Operation	• Construction activities; • Impoundment of the reservoir and water management	• Increased pressure on the governmental institutions to manage the incoming workers, the RAP and the LADP.	Medium	Implementation of the following Management plans: • Local Area Development Plans. • Resettlement Action Plan. • Stakeholders Management Plan. • Grievance Management Plan. • Local Resource Development Initiative. • Migration Management Plan.
S-02	Land Tenure	Construction	• Establishment of the flowage easement and • Clearing of land required for the construction of the hydroelectric facilities	• Modification to the land tenure and resettlement of the PAP.	High	Implementation of the Resettlement Action Plan (Separate report).
S-03	Demography, population movements and Resettlement	Construction	Impoundment of the reservoir, construction activities, migration of workers	• Increased population pressure in the project area and reduction of the land resources.	High	Implementation of the following Management plans: • Resettlement Action Plan to compensate losses and restore their production capacities. • Local Area Development Plan to maximize social and economic impacts locally and regionally. • Migration Management Plan to help minimize the conflicts between newcomers and the local population. • Local Resource Development Initiative (LRDI): Through innovative mechanisms of community engagement and participation we are able to identify income generating activities and key interventions that trigger local economic improvement.
S-04	Agriculture and Arboriculture	Construction & Operation	Flooding of agricultural land	• Losses of agricultural land.	High	Implementation of the following Management plans: • The Resettlement Action Plan to compensate for the loss of production and to re-establish the production capacity. (Separate report) • The Local Area Development Initiative to maximize the project's social and economic impacts locally and regionally. (Separate report) • The Flora management plan to minimize the deforestation and the impact on plantations.
S-05	Fishing	Construction & Operation	Creation of a permanent reservoir in the study area	• Increased water volume, significant impact on fishing potential.	High	Implementation of the following Management plans: • The Local Area Development Area Plan to mobilize appropriate resources to enable government stakeholders to maximize project`s social and economic impacts in the study zone. • The Fauna Management Plan and the Newcomer Management Plan to minimize fishing activities during the flooding season and facilitate the reproduction of the species. • The Biodiversity Management Plan to promote the sustainable management of

Form No.*	Affected Component	Project Phases	Impact Origin	Impact Description	Residual Impact Significance	Mitigation Measures
						fishing species through the adoption of practices that integrate conservation needs and economic development priorities.
S-06	Logging	Construction	• Construction activities; • Migration of workers.	• Increased pressure on agroforestry resources at the construction site.	Medium	Implementation of the following Management plans: • Flora Management Plan to secure re-vegetation re-growth and planting trees through maintenance activities. This vegetation replacement will very quickly have positive impacts in the area since the vegetation cover will be maintained for the lifetime of the project. • Management plan to control earthworks and excavation activities that would minimize, to the extent possible, vegetation removal and deforested surface area.
S-07	Traffic and Land Infrastructure	Construction	• Construction activities; • Migration of workers.	• Increased traffic on roads leading to the construction site.	Low	Implementation of the following Management plans: • Dust control management plan in order to prevent dust emissions from movement and circulation of construction machinery and vehicles on unpaved roads/trials. • Transportation and vehicle traffic management plan to prevent risk of accidents related to increased traffic issues and maintain acceptable quality of life for communities affected by the project.
S-08	Communication Infrastructures	Construction Operation & Decommissioning	Economic development in the study area following the start up of construction activities	• Opportunities for improvement of telecommunication network.	High	Implementation of the Local Area Development Plan to maximize the project's main economic and social benefits at the local and regional scale.
S-09	Health and Education services	Construction	Migration of workers in the study zone	• Increasing demand for health and education services in the study area.	High	Implementation of the Resettlement Action Plan and Local Area Development Plan. If applied, both mitigation measures will transform the impact from negative to positive.
S-10	Management of Residual Materials, Hazardous Waste and Wastewater	Construction & Operation	• Construction and operation phases; • Migration of workers.	• Risk of residual material and hazardous waste on human and animal health through the contamination of the soils, surface waters and groundwater.	Low	Implementation of the following Management plans: • Hazardous waste and wastewaters management plan to minimize risk of contamination of surface and ground water during both construction and operational phases. • Flora and Fauna management plans to provide a protection plan for species at risk. • Health and Safety Management Plan.
S-11	Re-construction of flooded infrastructures	Construction & Operation	• Construction works; • Creation of a permanent reservoir.	• Loss of access to other villages and revenue. (Some roads and small business along the rivers will be permanently flooded).	Medium	Reconstitution of affected roads (on level or outside flooded area) Local Area Development Plan.
S-12	Construction of Dam Infrastructures	Construction	• Construction of Dam facility; • Migration of workers.	• Construction of temporary infrastructures in the construction site. • Increasing demand on essential services. • Job creation.	Medium	Implementation of the following Management plans: • Worksite Rehabilitation and Demobilization. • Local Area Development Plan.
S-13	Quarries and mineral deposits	Construction	Construction site	• Increase of demand for quarries around the construction area.	Medium	Implementation of the following Management plans: • The Resettlement Action Plan to identify indications on compensation and resettlement measures to be deployed for small businesses. • Quarries and Borrow Pit Management Plan to minimize disturbance to flora and fauna. • Local Area Development Plan to provide and improve economic opportunities for local business.
S-14	Tourism	Construction Operation & Decommissioning	Construction of the Dam on Rusumo Falls	• Permanent Loss of Rusumo Falls as a touristic attraction.	Low	• Integrate tourism as part of the Local Area Development Plan to promote the dam and the hydropower plan as a touristic attraction in the area within an environmental and cultural context.
S-15	Cultural Heritage	Construction & Operation	• Construction work; • Creation of a permanent reservoir.	• Possible impacts on cultural-sensitive sites.	Low	Implementation of Cultural heritage and sacred sites plan.

Form No.*	Affected Component	Project Phases	Impact Origin	Impact Description	Residual Impact Significance	Mitigation Measures
S-16	Quality of Life	Construction & Operation	• Construction site; • Economic activities during the construction period.	• Improve access to key services; risk of gender inequality.	Low	Implementation of the following Management plans: • Local Area Development Plan. • Local Resource Development Initiative. • Resettlement Action Plan.
S-17	Development of Infectious Diseases	Construction & Operation	Migration of workers	• Increased risk of sexually transmitted diseases in the construction zone.	Medium	Implementation of the following Management plans: • Health and Security plan for populations. • Awareness and Prevention campaign to prevent the spread of sexually-transmitted diseases.
S-18	Development of water-borne diseases - Malaria	Construction & Operation	Development of water-borne diseases - Malaria	• Increase of mosquitoes' range of action and malaria spreads in further villages.	Medium	Implementation of the following Management plans: • Health and Security plan for populations. • Local Area Development Plan.
S-19	Safety of workers and people	Construction	Construction works	• H&S issues of the workforce during the construction activities.	Low	Implementation of the following Management plans: • Workplace Health and Safety Plan. • Sub-contractors Health and Safety Plans. • Health and Security Plan for Population. • Grievance Management Plan.
S-20	Creation of a reservoir; economic opportunities	Construction & Operation	• Creation of a reservoir; • Economic opportunities.	• Possibilities of exacerbation of previous land-related disputes; unequal distribution of economic benefits of the project.	Medium	Implementation of the following Management plans: • Resettlement Action Plan. • Local Area Development Plan. • Local Resource Development Initiative. • Cultural Heritage and sacred sites plan. • Flora Management Plan. • Grievance Management Plan.
S-21	Vulnerable Population	Construction & Operation	• Construction works; • Migration of workers.	• Increasing disparities of the project's benefits on vulnerable populations.	High	Implementation of the following Management plans: • Resettlement Action Plan to identify vulnerable people in each household and plan adequate measures to improve their livelihoods. • Local Area Development Plan to share the benefits of the economic opportunities to vulnerable population. • Local Resource Development Initiative to increase the participation of women into the workforce. • Grievance Management Plan.
S-22	Employment and Economic Activities	Construction & Operation	Construction and operation of the dam and its facilities.	• Increasing Economic Opportunities and Employment during the lifelong phase of the project.	High	Implementation of the following Management plans: • Local Area development Plan. • Local Resource Development Initiative. • Stakeholder Engagement Management Plan. • Grievance Management Plan. • Monitoring measures.

7. PROJECT DESCRIPTION AND LAYOUT

7.1 SUMMARY OF THE SCHEME MAIN CHARACTERISTICS

The general layout of the Rusumo Falls hydroelectric scheme is presented in Plate Nr. RRFP-14 and depicted in Figure 9. It consists in a gated dam/spillway (movable dam) located just upstream of the falls and oriented perpendicular to the river channel, power facilities on the right bank and a substation on the left bank.

The Full Supply Level at the headpond is set at 1323.5 masl with a tailwater level at 1293.10 masl for full plant capacity (1289.60 masl with only one unit running).

The power facilities, except for the substation, are located entirely on the right bank of the Kagera River in Tanzania, while the river diversion works are located on the left bank, in Rwanda. The main power features comprise: an intake structure, a headrace tunnel, a surge tank, a tunnel trifurcation, a surface powerhouse, and a tailrace channel. The main dam forming the reservoir is composed of an intake structure located on the right bank, a gated spillway structure adjacent to the intake, and two non-overflow concrete dam sections closing the left and right embankments.

Figure 9 Rusumo Fall Project Layout Superimposed over Aerial Photography (2009)

7.2 HYDRAULIC STRUCTURES

7.2.1 Diversion Works

Temporary diversion of the river during construction is planned to be achieved at least cost through the open cut canal excavated in the left abutment of the dam.

The diversion works will thus be comprised of a 265 m long channel on the left bank and a 167 m long cofferdam. The diversion channel's intake is located 150 m upstream of the falls while the outlet is located just past the downstream rapids roughly 16 m above the river. The channel is sized for the construction site flood of 602 m^3/s (1 in 40 year occurrence).

Since the canal is located on the Rwandan (left) bank, it will cut off the international road leading to the existing bridge. Therefore, a temporary bridge spanning approximately 60 m over the diversion channel will be required to make possible for the traffic to continue passing between Rwanda and Tanzania during construction.

The cofferdam is located approximately 100 m upstream of the falls. The alignment of its axis was optimized with respect to the location of the dam's left abutment, the size and projected limits of the required excavations for the diversion channel, and also with respect to the location of headrace tunnel's intake portal.

The cofferdam is constituted of two rockfill shoulders and a clayey silt core. At both the upstream and downstream sides, geotextile is placed between the fine grained core material and coarse rockfill in lieu of a filter zone and additional transition zones typically required for stability purposes. Both shoulders will be constituted of rockfill with dimensions varying as construction progresses.

7.2.2 Dam and Spillway

The dam and spillway structures are located just upstream of the falls and oriented perpendicular to the Kagera River channel.

The axis is chosen at a point in the river where the length of the dam is the shortest.

The dam is of concrete gravity type. It also accommodates a three-gated spillway on its right side, adjacent to the power intake. The solution of a gated combined dam/spillway allows regulation of the headpond water level and the river flows at all times.

Total opening of the spillway has been distributed into three sluices closed off by radial (tainter) gates 11 m wide. The radial gates are designed to spill 1074 m^3/s (IDF) when all three are open.

The sill of the spillway is at the 1315.80, which is about 1 m below the current riverbed.

The in-between spillway piers are fitted with stoplog guides just upstream of the radial gates..

The embankments are closed by concrete gravity sections having their crest at 1328.00.

A new 2-lane roadway will be constructed on the upstream side of the dam/spillway structures. Upon completion of the Project, part of, or all, the traffic passing on the existing bridge can be diverted over this new roadway. A separate deck downstream of the roadway will be dedicated to serving the spillway without interference with traffic and provides designated access for the dam operations and maintenance personnel. A mobile crane will be able to extend its outriggers to install and remove the stoplogs as required from the deck.

7.2.3 Water Intake

The water intake is located on the right bank of the Kagera River with its upstream face at about 105º with a line formed by the dam/spillway structure. A rock face is excavated to develop the headrace tunnel portal and the concrete structure is built in this excavation.

The intake structure has an approach apron that is trapezoidal in shape. It has a starting width of 68.4 m at the river bed level which is reduced to 36.4 m at the trashrack invert. The entrance to the power intake is 13.43 m lower than the sill of the spillway.

The approach canal upstream of the power intake is inclined at a 35.8%. Unless during a more comprehensive rock testing it is found otherwise, no concrete lining is deemed necessary for the approach canal at this time.

7.2.4 Headrace Tunnel

The alignment of the headrace tunnel takes into account the overall hydraulic criteria as well as any restraints imposed by geological site conditions. There are numerous polygonal faults in the rock mass that should be eluded or their impact be mitigated by rock mechanic techniques. The headrace tunnel at the intake is aligned almost perpendicular with the right bank and parallel with the dam axis. The tunnel descends at an angle of approximately 23.4 degrees to provide maximum rock cover above the crown of the tunnel over the shortest possible distance. Once the headrace tunnel reaches a sufficient depth it changes direction almost 90 degrees in an easterly direction to continue in a straight line to the powerhouse. This section of the tunnel has a slope of 1.75 degrees. The headrace tunnel then undergoes trifurcation leading into 5.4 m diameter penstocks before entering the scroll cases in the powerhouse.

Ahead of the trifurcation, the invert of the headrace tunnel slopes down over 15 m to a 1m deep rock trap across the tunnel. This is to prevent loose rock reaching the butterfly valves.

The headrace tunnel will be of inverted D shape to allow excavation of the sound to slightly weathered quartzophyllites by top heading followed by benching. In view of rock conditions, the tunnel will be unlined except in fault zones; it will have a width of 11 m and a height of 14.3 m while the vertical side walls will have a height of 11,55 m. The height of the crown arch is thus equal to one quarter of the tunnel width, a stable configuration.

The entire trifurcation (or manifold) is concrete lined.

The manifold extends from Sta. 615 to Sta. 640 of the conveyance system and makes the transition between the unlined headrace tunnel and the 3 concrete lined penstocks. The manifold’s excavated span varies from a minimum of 11 m at the upstream end to a maximum of 20 m.

The three penstocks extend from the manifold to the powerhouse, a distance of some 30 meters; the penstocks have a steel liner with concrete backing from Sta. 640 to the powerhouse. The 5.4 m diameter penstocks do not undergo reduction downstream of the trifurcation. Their diameter is maintained through the butterfly valves and to the spiral cases.

7.2.5 Surge Shaft and Chamber

A 41 m diameter, circular, surge chamber upstream of the trifurcation is excavated entirely in rock, *i.e.*, it has no concrete walls above ground. The surge chamber location is dictated by its proximity to the powerhouse and by the fault lines found in the rock mass.

An 8 m diameter vertical shaft along with a horizontal tunnel section connects the surge chamber to the headrace tunnel.

7.2.6 Tailrace

The tailrace canal is located in the Mitako Basin and is oriented N-NE. It is comprised of 2 linear segments with a 3.5° change in direction at Sta. 96. The total length of the tailrace is 246 m. The width of the tailrace decreases from 55 m to 45 m between elevations 1271.9 masl, which corresponds to the elevation at the extremity of the draft tubes, and elevation 1288.0 masl, where the invert is founded. This variation in width is achieved inside a distance of 66 m, specifically between Sta. 30 and Sta. 98. Three excavation benches are required between the draft tubes and the invert.

7.3 90 MW POWERHOUSE

The powerhouse is of the surface type. It is located on the south side of the rapids on the right bank of the Kagera River in the rock cliff that overlooks the Mitako Basin. The powerhouse will be seated on sound rock.

The criteria used to identify the best location for the powerhouse are influenced by the geology of the rock, the hydraulic head between the reservoir and the tailrace, the hydraulic losses caused by the length of the headrace tunnel and to a lesser extent the proximity of the surge tank to the powerhouse.

Since polygonal fault lines run across the rock mass, it is important to locate the powerhouse, the surge tank, tunnel and the three penstocks so that the influence of the of the fault lines is minimized or it is within reasonable design limits. In addition, other factors such as minimizing excavation and avoided jointed rock zones were considered as well as the presence of a marginally stable talus at the right side of the tailrace.

The powerhouse comprises three 30 MW Kaplan units. Ahead of the spiral cases each unit is fitted with a butterfly valve.

The powerhouse building is a braced steel structure designed to support the weight of the roof and the 110 t overhead runway crane that is dedicated to servicing the powerhouse during the construction phase and the subsequent maintenance through the life of the powerhouse. The overall dimensions of the building are 89.7 by 32.6 m.

The building will be clad by steel sheet panels having vertical flutes.

Apart from housing the turbine/generator units, the powerhouse building accommodates the service bay, the mechanical and electrical workshops, as well as the oil room, the cable and piping galleries and the control room.

7.4 220 kV SUBSTATION

The 220 kV substation forming a platform of 190 m x 80 m is located on the left bank of the Kagera River, on the hill overlooking the river at elevation 1504 masl, in relatively flat area. It is positioned such that the outgoing line gantries are facing South.

The interconnection transmission line route between the powerhouse and the substation was selected so as to provide a safe and economical route. Two double circuit steel towers are required on the both sides of the Kagera River, with the span length over the river gorge being about 500 m. The total length of the transmission line from the powerhouse to the substation is about 1 kilometer.

Each generator step-up transformer is connected to 220 kV double busbar. Selection of the double bus scheme increases the reliability of the operation.

The substation is arranged with 220 kV double bus, two (2) incoming, six (6) outgoing overhead lines, one (1) tie breaker and one (1) spare bay, gantry and apparatus structures. Out of the six (6) outgoing bays, one (1) bay for the transmission line to Burundi (Gitega), two (2) bays for transmission lines to Rwanda (Birembo near Kigali), two (2) bays are for transmission lines to Tanzania (Biharamulo in the nortwesterrn part of Tanzania), and one (1) bay for 10 MVA auxiliary and distribution services transformer.

8. EXECUTION PROGRAM

From a construction perspective, the Rusumo Falls Hydroelectric Project can be considered a relatively small-to-medium scale hydroelectric project. Therefore in order to attract qualified international contractors, there should not be too many contracts. A reasonable packaging would be two or three contracts. It is anticipated that construction works will be split into two main separate contract packages: one contract package for the civil works an admeasurement / unit prices and rates type of contract, and another one for the electrical and mechanical works under a lump-sum type of contract.

It is anticipated that the tendering process will start in January 2013, after international contractors have been prequalified to bid, so that contract be awarded end of August 2013. First power would be on line in January of the year 2018, some 53 months after award.

A summary of the Project schedule is shown on next page.

Regional Rusumo Falls Hydroelectric Project

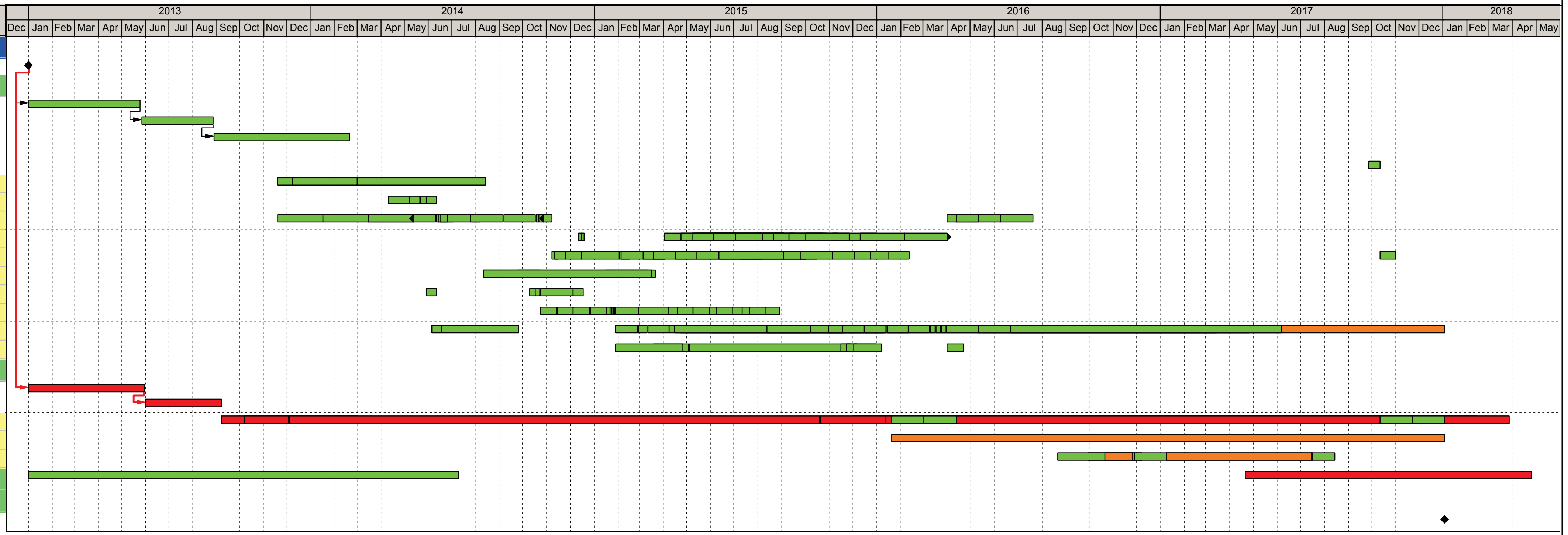
Final Feasibility

Construction Schedule - SUMMARY

NILE BASIN INITIATIVE

Nile Equatorial Lakes Susbsidiary Action Program (NELSAP)

Activity ID	Activity Name	Start	Finish
Rusumo Falls - Full Development - 90 MW		01-Jan-13	25-Apr-18
0000-010	Project Release	01-Jan-13	
1000 - Civil Works		01-Jan-13	02-Jan-18
1000-010	Civil Works Tender	01-Jan-13	25-May-13
1000-020	Civil Works Tender Evaluation & Award	27-May-13	27-Aug-13
1000-030	Civil Works Contractor Mobilization	28-Aug-13	19-Feb-14
1000-040	Reservoir Impoundment	27-Sep-17	11-Oct-17
1100 - Temporary Works		18-Nov-13	13-Aug-14
1200 - Access Roads		10-Apr-14	11-Jun-14
1300 - Diversion Works		18-Nov-13	20-Jul-16
1400 - Dam & Spillway		12-Dec-14	01-Apr-16
1500 - Intake		07-Nov-14	31-Oct-17
1600 - Power Tunnel		11-Aug-14	20-Mar-15
1700 - Surge Shaft		29-May-14	18-Dec-14
1800 - Penstocks		24-Oct-14	29-Aug-15
1900 - Powerhouse		05-Jun-14	02-Jan-18
2000 - Tailrace		29-Jan-15	22-Apr-16
5000 - Electrical and Mechanical Works		01-Jan-13	27-Mar-18
5000-010	Electrical and Mechanical Work Tender	01-Jan-13	31-May-13
5000-020	Electrical and Mechanical Work Tender Evaluation & Award	01-Jun-13	06-Sep-13
5100 - Turbine-Generators		07-Sep-13	27-Mar-18
5200 - Auxiliary Systems		20-Jan-16	02-Jan-18
5300 - Susbstation		22-Aug-16	14-Aug-17
6000 - Resettlement Action Plan		01-Jan-13	25-Apr-18
10000 - Transmission Lines (By Others)		02-Jan-18	02-Jan-18
10000-010	End of Construction		02-Jan-18



Remaining Level of Effort | Actual Work | Critical Remaining Work

Actual Level of Effort | Remaining Work | Milestone

Rev. PA - January 2012

SNC·LAVALIN

9. PROJECT COSTS

The cost estimate for the 90 MW Rusumo Falls Hydroelectric Project has been prepared based on unit and lumpsum prices applied to the quantities of major work items calculated for the various components of the Project.

The time basis of all costs is January 2012, no escalation.

The cost estimate includes taxes on locally purchased items. Imported materials, together with the main permanently installed mechanical and electrical equipment, has been assumed free of import duty.

The cost estimate of the civil works is based on the construction works being executed under a single "Contract for Civil Works" awarded after international competitive tender procedures.

Rates are taken from cost data based on research conducted by SNC-Lavalin in Rwanda and Tanzania. The job is planned on working five days of 10 hours per week, with the exception of the tunnel excavation, planned on two shifts of ten hours. Diesel fuel is priced at USD 1.30 per liter, as is gasoline. The two largest cost components of the permanent materials, bulk cement at USD 50/t and reinforcing steel at USD 1,800/t, together account for over 76% of the total permanent materials.

The capital costs for the mechanical and electrical works of each scheme have been evaluated by considering separately (1) the hydro-mechanical equipment, (2) the turbine-generator sets and auxiliaries, (3) the power transformers, the substation and the control and communications equipment, and (4) the transmission lines interconnection.

Table 9 overleaf presents the summary of the Project cost estimate and Figure 10 depicts the breakdown of the Project total investment costs.

Table 9 Cost Estimate Summary

ART.	DESCRIPTION	TOTAL PRICE (2012 USD)
	CIVIL WORKS	
100	ADDITIONAL TESTS AND SITE INVESTIGATIONS (BY OWNER)	1 320 521
200	SITE FACILITIES AND HOUSING	26 601 718
300	EXCAVATIONS	36 931 048
400	BACKFILL	5 278 050
500	CONCRETE	33 993 310
600	REINFORCEMENT AND STEEL	22 328 260
700	GROUTING AND DRAINAGE	428 380
800	ROCK SUPPORT	3 132 900
900	MISCELLANEOUS	4 813 950
	Contingency allowance for civil surface works (15 %)	17 129 272
	Contingency allowance for civil underground works (20 %)	3 862 494
	TOTAL CIVIL WORKS	**155 819 902**
1000	**MECHANICAL AND ELECTRICAL WORKS**	114 439 000
	- Contingency allowance for mechanical and electrical works (10%)	11 443 900
	TOTAL MECHANICAL AND ELECTRICAL WORKS	**125 882 900**
	TOTAL DIRECT AND INDIRECT CONSTRUCTION COST	**281 702 802**
	ENGINEERING, ADMINISTRATION AND SUPERVISION OF CIVIL WORKS CONTRACT PACKAGE (15%)	23 372 985
	ADMINISTRATION AND SUPERVISION OF MECHANICAL AND ELECTRICAL WORKS CONTRACT PACKAGE (8%)	10 070 632
	OWNER'S DEVELOPMENT COST (1.5%)	4 225 542
	TOTAL PROJECT BASIC COST	**319 371 962**
1100	**SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACTS & MITIGATION**	89 915 000
	- Contingency allowance (10%)	8 991 500
	TOTAL SOCIO-ECONOMIC AND ENVIRONMENTAL COST	**98 906 500**
	ADMINISTRATION AND SUPERVISION OF RAP IMPLEMENTATION	9 890 650
	TOTAL PROJECT COST	**428 169 112**

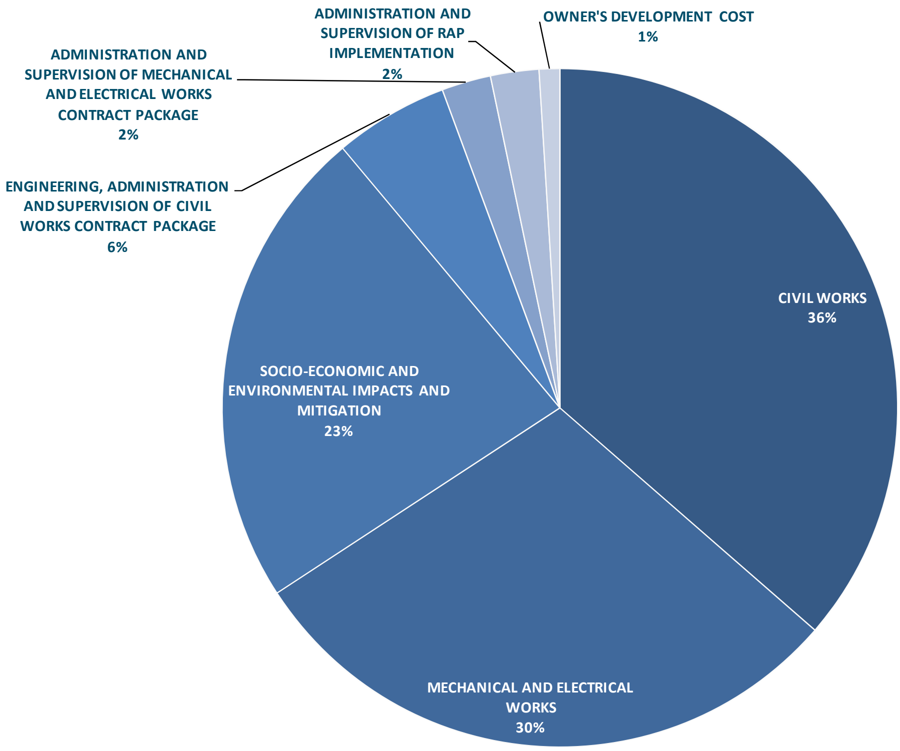


Figure 10 Breakdown of Total Project Cost

10. ECONOMIC ANALYSIS

The main direct costs of the Rusumo Falls Hydroelectric Project are obviously associated with the investment, including the environmental and social mitigation costs. Operations, maintenance, and environmental annual costs have also to be considered.

Benefits of the Project are associated with the avoided cost (savings) brought by displacing investments and operation costs in more expensive and inefficient thermal plants, not only in the three countries involved, but also in the Region, in the long term perspective of an integrated East African power grid.

Different methodologies can be used to quantify these avoided costs, one is the willingness to pay (WtP) concept; however, in countries with significant amounts of unsatisfied demand and low electrification levels, such as Burundi, Rwanda and Western Tanzania, it is very difficult to compute reasonable values of the WtP. Alternatively, the Long Run Marginal Cost (LRMC) can be used as a measure of the cost in the long run to serve an additional kWh of demand. The WtP is usually higher than the LRMC in countries with deficits and low electrification levels; hence the estimation of benefits based on LRMC would tend to be conservative.

The following assumptions were made for the economic evaluation of the RRFP:

- Period of analysis: Construction period plus 30 years of operation (two 15 years operational periods), including a residual value in the year 31 considering that a hydro project has a technical life of 50 years.
- Reference date: January 2012 for the investment cost and the present value calculation.
- Discount rate: 10%
- Useful technical life: 50 years
- Useful economic life: 30 years
- Fuel price: EIA/DOE forecast (2011-2020 levelized crude oil price forecast USD 112.9/bbl) for the avoided cost in Medium Speed Diesel scenario, and World Bank forecast (2011-2020 levelized crude oil price forecast USD 89.5/bbl) for sensitivity analysis for an alternative scenario.
- LRMC Calculation: The information was taken from the EAPP/EAC Regional Power System Master Plan and Grid Code Study.
- Investment cost of the project: Updated cost including construction cost, environmental, engineering and contingency (feasibility level cost estimate of January 2012), including transmission cost to connect the Project to each country (only the cost associated with the capacity need by the RRFP), excluding taxes, subsidies, interest during construction, sunk costs and inflation. One third of the investment cost is assigned to each country.
- Generation of the Project: Average production from the simulation using the hydrology 1971-2009 (497 GWh/year). Two additional scenarios are prepared for high and low hydrology. One third of the energy is assigned to each country.

The following scenarios were analyzed:

- Base: This scenario corresponds to the reference case with average generation, expected demand growth, expected fuel price, base cost estimation, LRMC according to the EAPP-RPSMP
- Hyd-H: Similar to the base case but with higher generation (10% runoff increase - 538 GWh).
- Hyd-L: Similar to the base case with lower generation (10% runoff decrease - 450 GWh).
- Invest +10%: Similar to the base case with 10% of increase of the investment cost.
- LRMC -10%: Similar to the base case with 10% of reduction of the LRMC.
- Delay-2y: Similar to the base case with a delay of 2 years on the on-power date of the Project.
- MSD-EIA: Similar to the base case replacing the LRMC by the levelized cost of a Medium Speed Diesel plant using the EIA/DOE fuel forecast (USD 23.65/GJ for Diesel Oil).
- MSD-BM: Similar to the MSD-EIA using the World Bank fuel forecast (USD 18.68/GJ for Diesel Oil).

Results of the analysis are presented in Table 10 below.

Table 10 Economic Evaluation Results

Burundi							Rwanda						
Scenario	Present Value (MUSD)			EIRR	B/C	PBP	Scenario	Present Value (MUSD)			EIRR	B/C	PBP
	Benefit	Cost	NPV			years		Benefit	Cost	NPV			years
Base	249	118	131	19.2%	2.1	3.5	Base	222	118	104	17.6%	1.9	4.0
Hyd-H	270	118	152	20.4%	2.3	3.3	Hyd-H	240	118	122	18.7%	2.0	3.7
Hyd-L	226	118	108	17.8%	1.9	3.9	Hyd-L	201	118	83	16.2%	1.7	4.4
Inv+10%	249	129	120	17.9%	1.9	3.9	Inv+10%	222	129	93	16.3%	1.7	4.4
LRMC-10%	224	118	106	17.7%	1.9	3.9	LRMC-10%	200	118	82	16.1%	1.7	4.4
Delay-2y	206	117	89	15.4%	1.8	5.5	Delay-2y	206	117	89	14.2%	1.6	6.0
MSD-EIA	225	118	107	17.7%	1.9	3.9	MSD-EIA	225	118	107	17.7%	1.9	3.9
MSD-WB	187	118	69	15.3%	1.6	4.7	MSD-WB	187	118	69	15.3%	1.6	4.7
Tanzania							**RRFP**						
Scenario	Present Value (MUSD)			EIRR	B/C	PBP	Scenario	Present Value (MUSD)			EIRR	B/C	PBP
	Benefit	Cost	NPV			years		Benefit	Cost	NPV			years
Base	144	118	26	12.1%	1.2	6.1	Base	615	354	261	16.5%	1.7	4.3
Hyd-H	155	118	37	13.0%	1.3	5.7	Hyd-H	666	354	312	17.5%	1.9	4.0
Hyd-L	130	118	12	11.0%	1.1	6.8	Hyd-L	557	354	203	15.1%	1.6	4.8
Inv+10%	144	129	15	11.1%	1.1	6.8	Inv+10%	615	387	228	15.2%	1.6	4.7
LRMC-10%	129	118	11	10.9%	1.1	6.8	LRMC-10%	553	354	200	15.1%	1.6	4.8
Delay-2y	119	117	2	10.1%	1.0	8.1	Delay-2y	508	351	157	13.4%	1.4	6.3
MSD-EIA	225	118	107	17.7%	1.9	3.9	MSD-EIA	675	354	321	17.7%	1.9	3.9
MSD-WB	187	118	69	15.3%	1.6	4.7	MSD-WB	561	354	208	15.3%	1.6	4.7

The expected economic return of the Rusumo Falls Hydroelectric Project is high and robust to adverse outturns in key parameters:

- For the base case the net present value of the Project as a whole brought to January 2012 amounts to USD 261 million, the EIRR to 16.5%, the B/C to 1.7 and the payback period to 4.3 years.
- For all sensitivity analyses and the countries involved the NPV is positive, the EIRR higher than 10% and the B/C ratio higher than 1.

The 90 MW Rusumo Falls Project could be called to play a complementary role to the 141 MW Rusizi III Project as a power supplier and a stabilizer of the Central and Eastern Africa power grid.

11. FINANCIAL ANALYSIS

The financial viability of the Project was evaluated based on a 70% debt and 30% equity capital structure and its tariff (energy selling price) has been worked out based on the cost-plus approach for the estimate of the Annual Revenue Requirement (ARR). Two scenarios were formulated to assess the ARR and the levelized tariff as well as the Project financials:

(1) Case A

Interest rate on debt was set at 0% and equity at 0% on a no-profit basis in order to keep tariffs affordable and competitive with alternative generating options.

(2) Case B

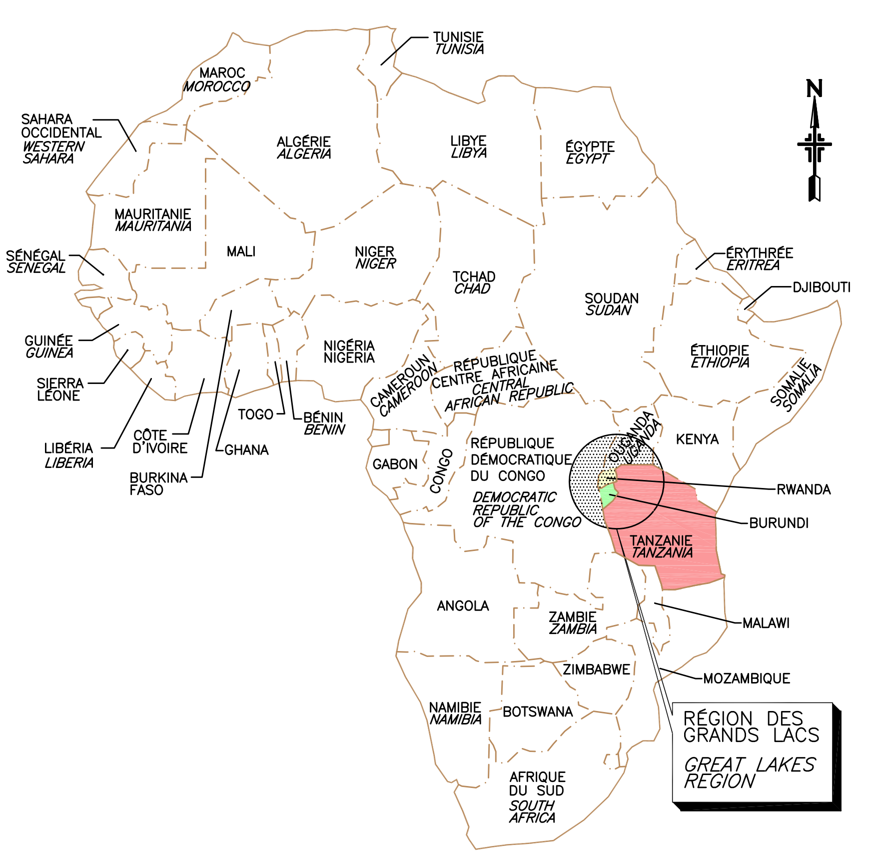
Interest rate on debt was set at 7%, and return on equity at 8% for government or public shareholders, since it is considered a public investment, representing the high end of the tariff.

The analysis has shown that the levelized tariffs vary from USD 0.052/kWh to USD 0.115/kWh based on the assumptions given in Case A and B. The derived Project tariff appears to be competitive and attractive in the market considering the average electricity selling price in the involved countries (USD 0.12/kWh). The financial performance for Case B shows that the project provides positive NPV, higher return than WACC, and 8.5% of FIRR to the investor(s).

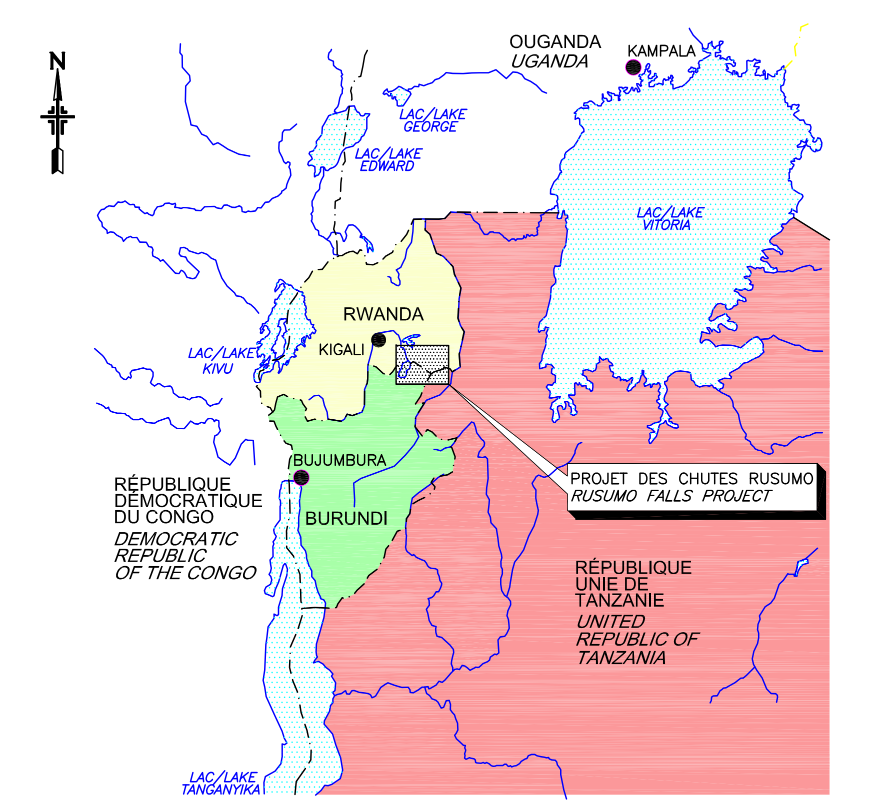
The sensitivity analyses have indicated that the factors having the strongest effects on the levelized tariff of the Project for a given percentage variation are the interest rate on long term debt and the rate of return on equity. The variation of Project capital cost and average annual energy also has a significant impact on the Project levelized tariff.

MAIN DRAWINGS

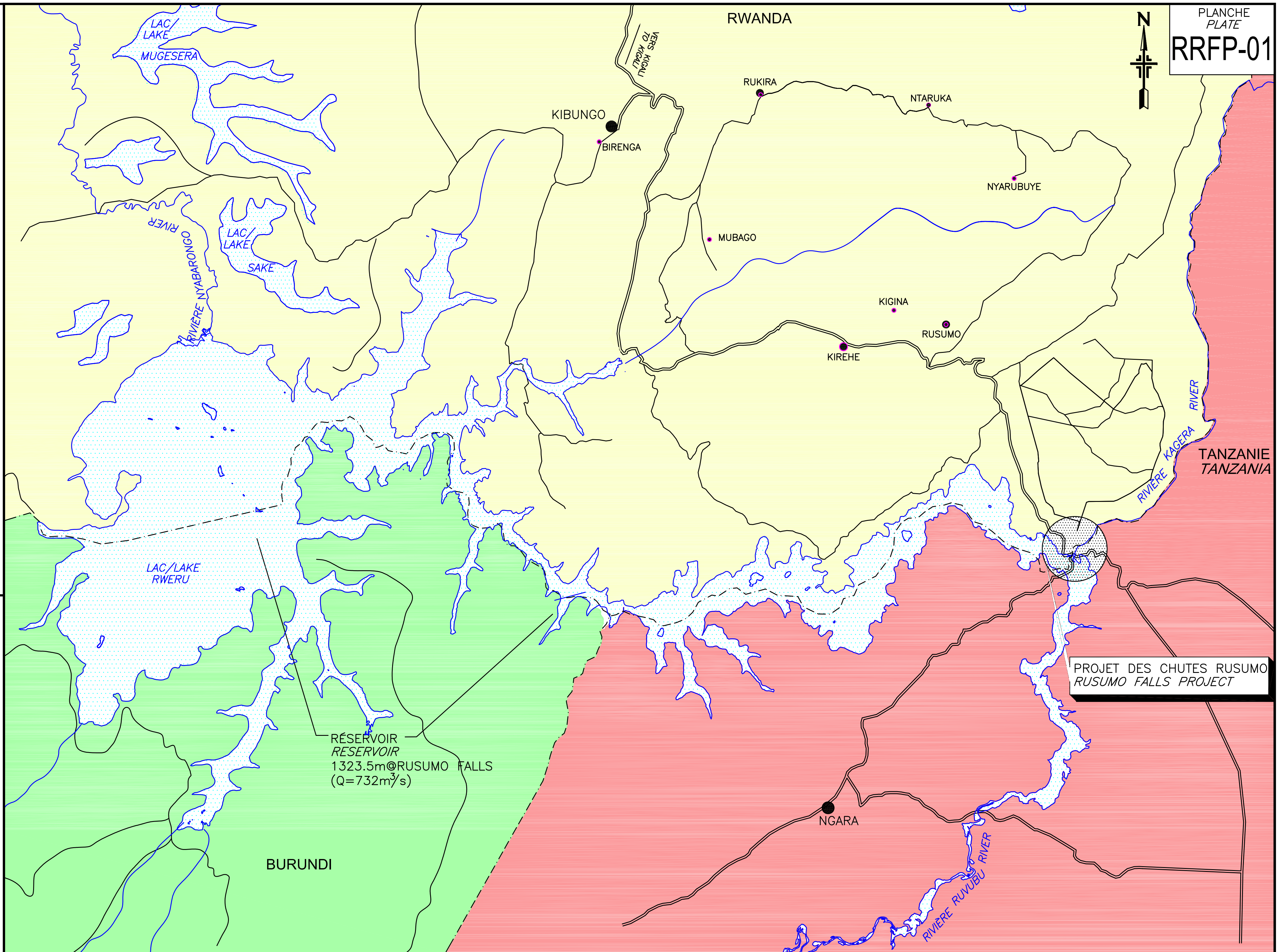
RRFP-01	LOCATION PLAN
RRFP-14	GENERAL LAYOUT – PLAN VIEW
RRFP-17	DIVERSION – PLAN AND SECTIONS
RRFP-19	SPILLWAY AND POWER INTAKE – PLAN VIEW
RRFP-20	SPILLWAY – ELEVATIONS, SECTIONS AND ISOMETRIC VIEW
RRFP-21	POWER INTAKE – LONGITUDINAL PROFILE AND SECTION
RRFP-22	WATER CONVEYANCE SYSTEM – PLAN AND LONGITUDINAL SECTION
RRFP-24	POWERHOUSE – TRANSVERSE SECTION
RRFP-25	POWERHOUSE – LONGITUDINAL SECTION
RRFP-31	TAILRACE CANAL, PROFILE, SECTIONS AND DETAIL
RRFP-33	MAIN SINGLE LINE DIAGRAM



AFRIQUE
AFRICA



RÉGION DES GRANDS LACS
GREAT LAKES REGION



ZONE DU PROJET
PROJECT AREA

PLANCHE
PLATE
RRFP-01

LÉGENDE:
LEGEND:

- FRONTIÈRE / *FRONTIER*
- EAU / *WATER*
- ROUTES PRINCIPALES / *MAIN ROADS*
- ROUTES SECONDAIRES / *SECONDARY ROADS*

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NILE BASIN INITIATIVE
Nile Equatorial Lakes Subsidiary Action Program (NELSAP)

PROJET / *PROJECT*: PROJET HYDROÉLECTRIQUE RÉGIONAL DES CHUTES RUSUMO / *REGIONAL RUSUMO FALLS HYDROELECTRIC PROJECT*

TITRE / *TITLE*: PLAN DE SITUATION / *LOCATION PLAN*

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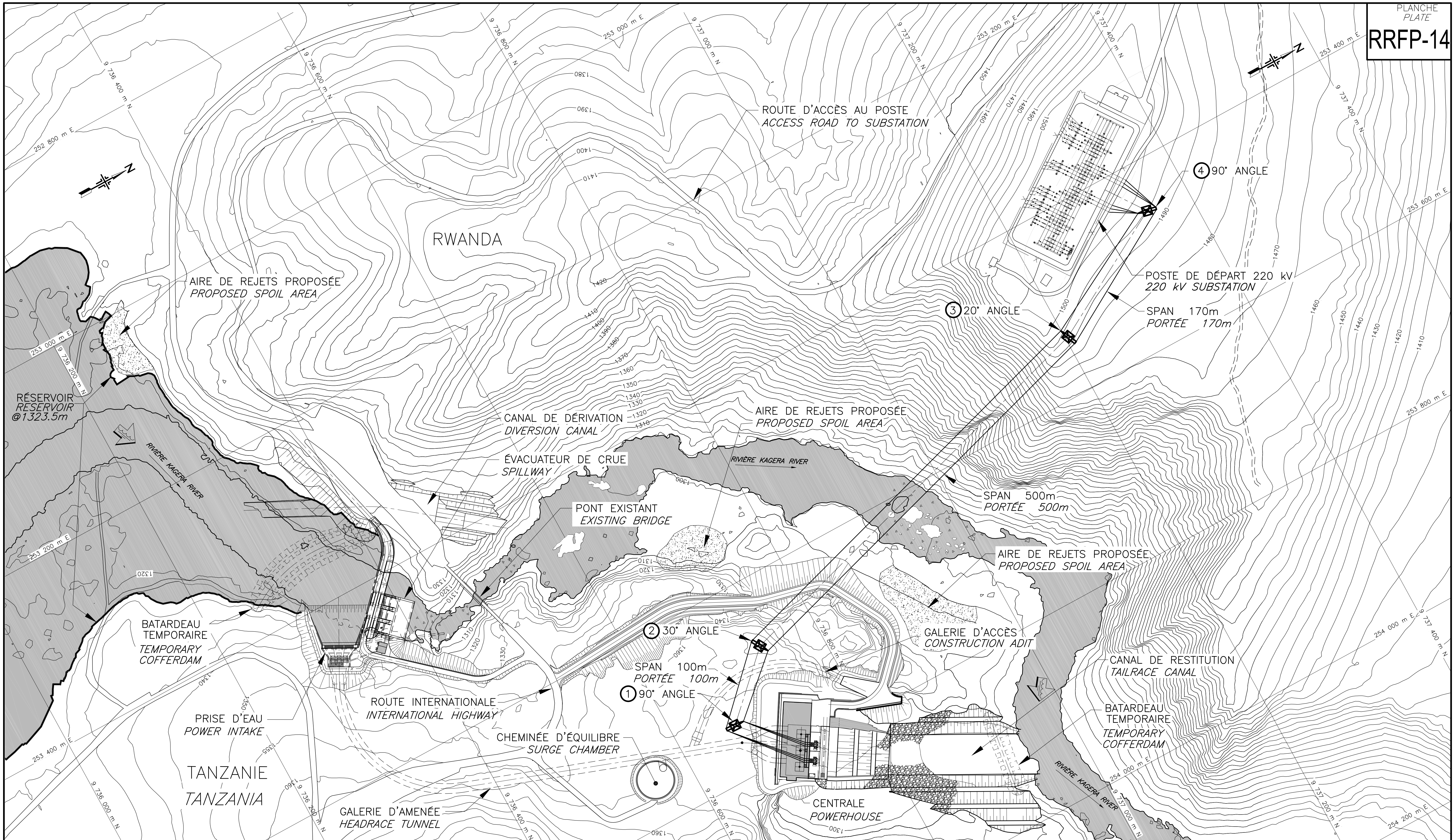
PLANCHE
PLATE

RRFP-14



NOTES:

1. LE SYSTÈME DE COORDONNÉES UTILISÉ EST LE "UTM WGS 84"
   THE COORDINATE SYSTEM IS THE "UTM WGS 84".
2. COURBES DE NIVEAU GÉNÉRÉES À PARTIR D'UN NUAGE DE POINTS ISSU D'UN LEVÉ LIDAR FOURNI PAR SOUTHERN MAPPING COMPANY (SEPTEMBRE 2009).
   TOPOGRAPHY WITH 1 M CONTOUR INTERVAL DERIVED FROM LIDAR POINTS PROVIDED BY SOUTHERN MAPPING COMPANY (SEPTEMBER 2009).

0 40 80 120 160 m

RAPPORT 1 : 4 000
SCALE 1 : 4,000

SNC·LAVALIN International

NILE BASIN INITIATIVE
Nile Equatorial Lakes Subsidiary Action Program (NELSAP)

PROJET / *PROJECT*: PROJET HYDROÉLECTRIQUE RÉGIONAL DES CHUTES RUSUMO / *REGIONAL RUSUMO FALLS HYDROELECTRIC PROJECT*

TITRE / *TITLE*: VUE EN PLAN GÉNÉRALE — *GENERAL LAYOUT PLAN VIEW*

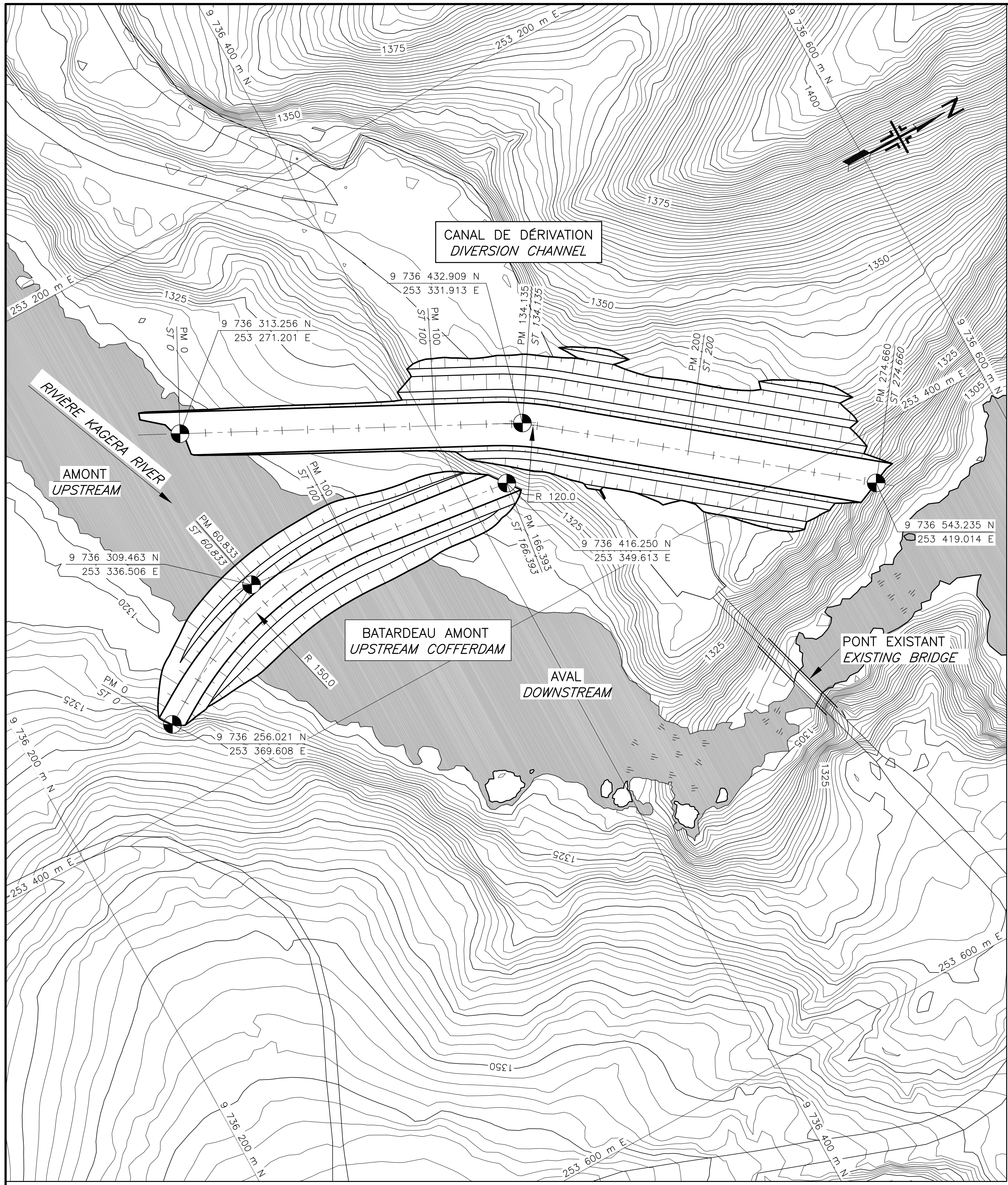
No DESSIN/*DRAWING No.* 605084-EGTO-40DD-9001.dwg

REV. 01

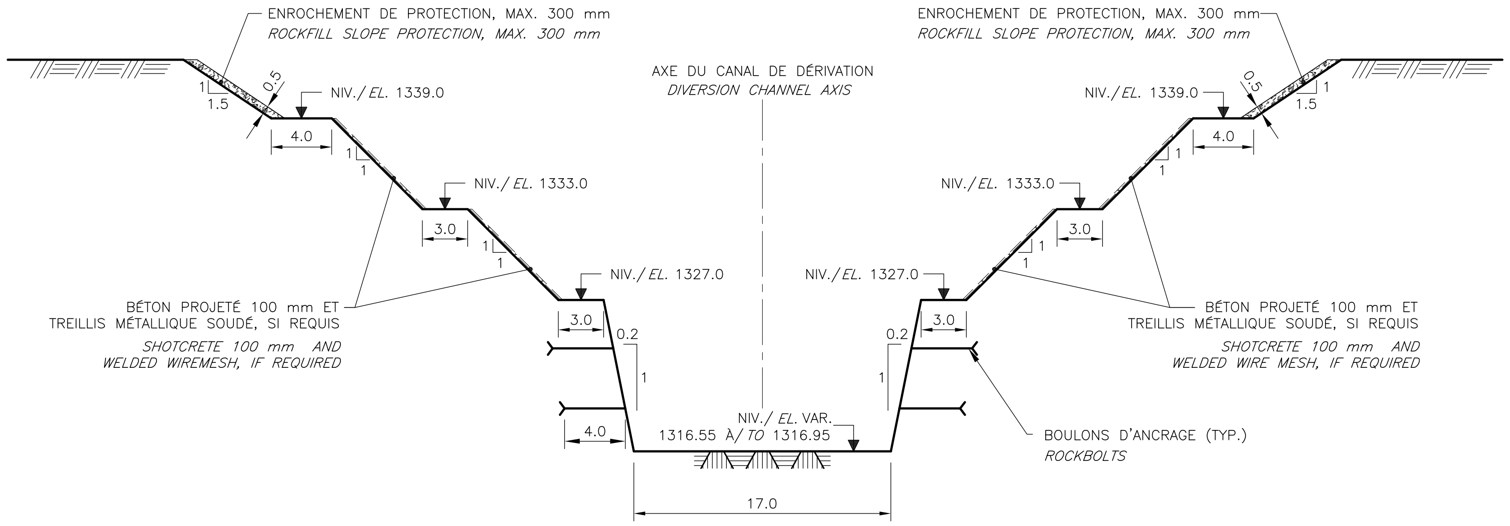
605084-EGTO-40DD-9001-01.dwg

2012.01.26/3:34pm

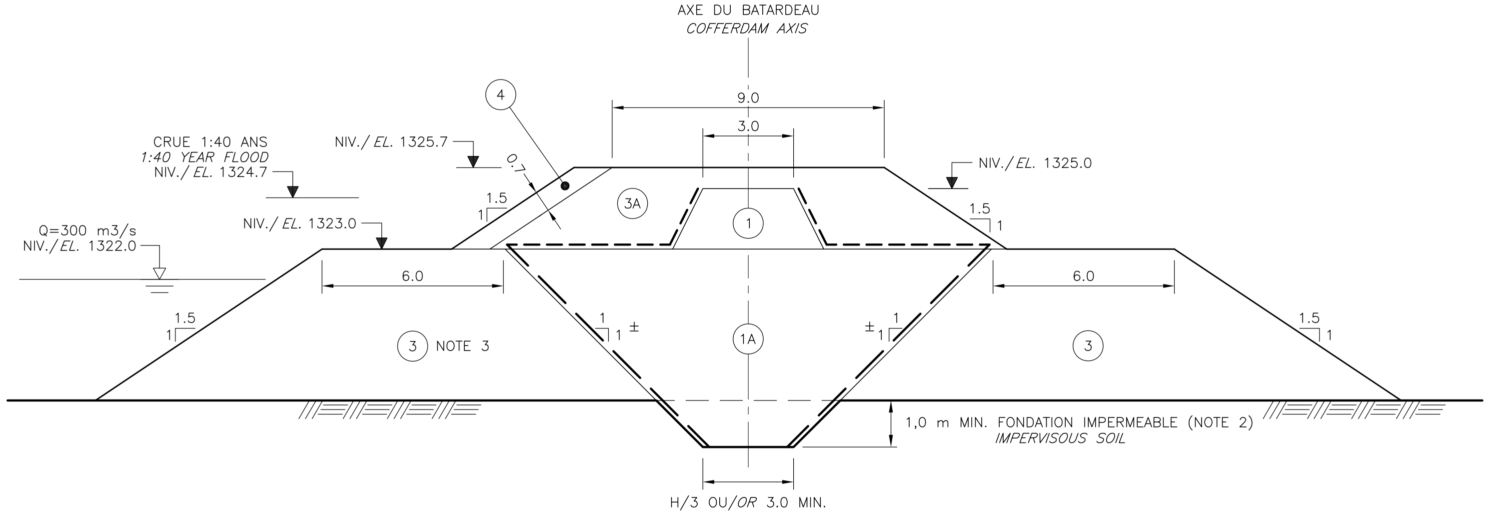
PLANCHE
PLATE
RRFP-17



PLAN



CANAL DE DÉRIVATION – COUPE TYPE
DIVERSION CHANNEL – TYPICAL SECTION
1 : 500



BATARDEAU AMONT – COUPE TYPE
UPSTREAM COFFERDAM – TYPICAL SECTION
1 : 250

LÉGENDE:
LEGEND:

- (1) SOL RÉSIDUEL – COMPACTÉ / *RESIDUAL SOIL – COMPACTED*
- (1A) SOL RÉSIDUEL – DÉVERSÉ / *RESIDUAL SOIL – DUMPED*
- (3) ENROCHEMENT TOUT-VENANT – DÉVERSÉ / *RANDOM ROCKFILL – DUMPED*
- (3A) ENROCHEMENT MAX. 300 mm – COMPACTÉ / *ROCKFILL MAX. 300 mm – COMPACTED*
- (4) PERRÉ 200–500 mm / *RIP-RAP 200–500 mm*
- GÉOTEXTILE EN POLYPROPYLÈNE / *POLYPROPYLENE GEOTEXTILE*
- GÉOTEXTILE EN POLYESTÈRE / *POLYESTER GEOTEXTILE*
- MORT-TERRAIN / *OVERBURDEN*
- ROC / *ROCK*

NOTES:

1– LE SYSTÈME DE COORDONNÉES UTILISÉ EST LE: UTM WGS 084
THE COORDINATE SYSTEM IS THE: UTM WGB 084

2– COURBES DE NIVEAU GÉNÉRÉES À PARTIR D'UN NUAGE DE POINTS ISSU D'UN LEVÉ LIDAR FOURNI PAR SOUTHERN MAPPING COMPANY (SEPTEMBRE 2009).
TOPOGRAPHY WITH 1 M CONTOUR INTERVAL DERIVED FROM LIDAR POINTS PROVIDED BY SOUTHERN MAPPING COMPANY (SEPTEMBER 2009).

3– UN PARAFOUILLE N'EST PAS REQUIS SOUS LA SURFACE DU ROC
A KEY TRENCH IS NOT REQUIRED BELOW ROCK SURFACE

4– UN D_{50} DE 500 mm EST REQUIS POUR L'AVANCÉE DE LA PREMIÈRE MOITIÉE DU BATARDEAU ET UN D_{50} DE 1000 mm POUR LA DERNIERE MOITIÉE (CONSTRUCTION EN PERIODE D'ÉTIAGE SEULEMENT)
A D_{50} OF 500 mm IS REQUIRED FOR THE FIRST HALF OF THE COFFERDAM AND A D_{50} OF 1000 mm FOR THE SECOND HALF (FOR CONSTRUCTION DURING THE DRY SEASON ONLY)

0 20 40 60 60 m
ÉCHELLE 1:2000
SCALE 1:2000

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PROJET / *PROJECT*: PROJET HYDROÉLECTRIQUE RÉGIONAL DES CHUTES RUSUMO / *REGIONAL RUSUMO FALLS HYDROELECTRIC PROJECT*

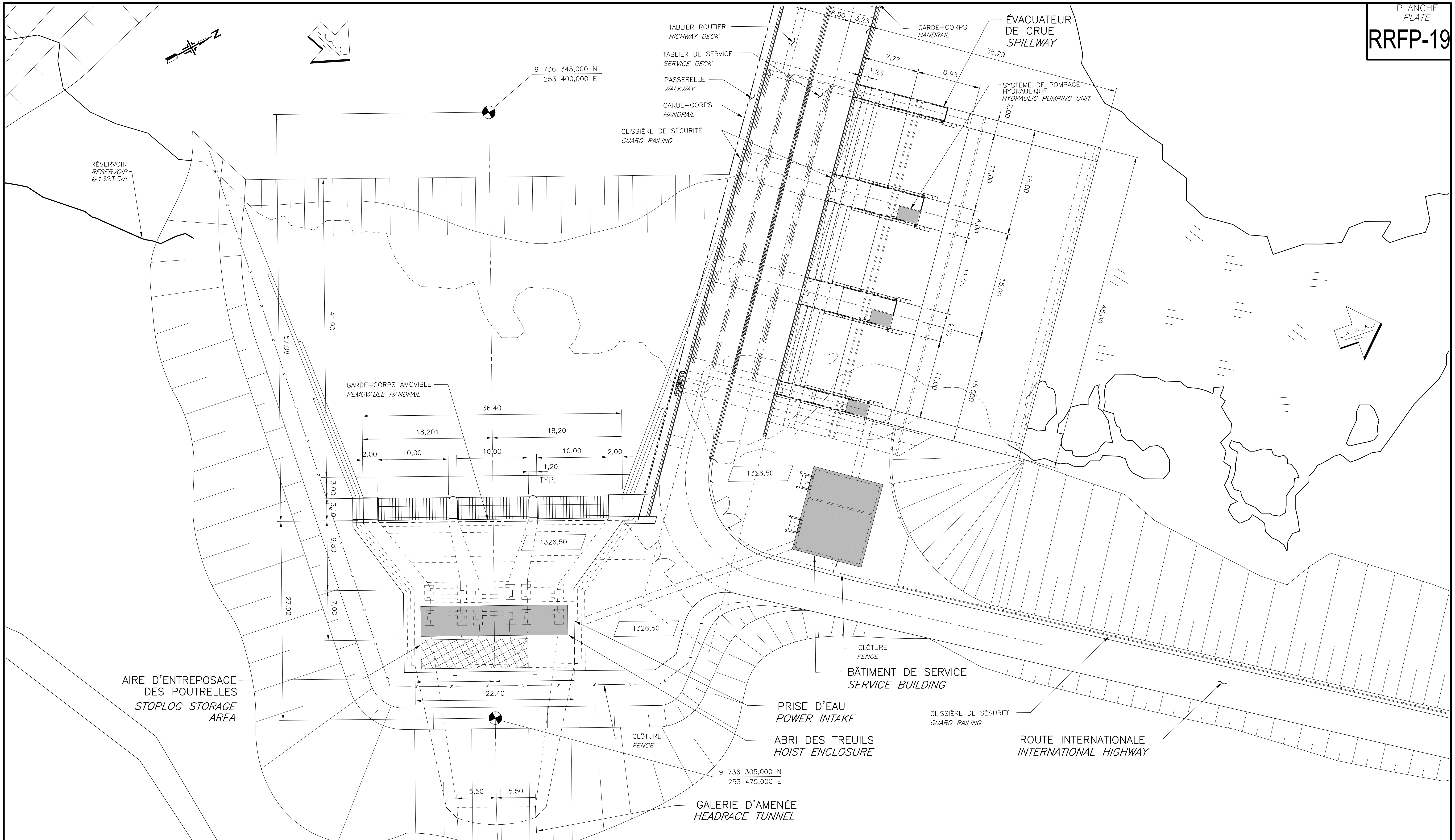
TITRE / *TITLE*: DÉRIVATION PLAN ET COUPES / *DIVERSION PLAN AND SECTIONS*

No DESSIN/*DRAWING No.* 605084–EGTO–40DD–9005.dwg
REV. 00

605084–EGTO–40DD–9005–00.dwg
2012.01.20/1:37pm

PLANCHE
PLATE

RRFP-19



NOTES:

1. LE SYSTÈME DE COORDONNÉES UTILISÉ EST LE "UTM WGS 84"
   THE COORDINATE SYSTEM IS THE "UTM WGS 84".
2. COURBES DE NIVEAU GÉNÉRÉES À PARTIR D'UN NUAGE DE POINTS ISSU D'UN LEVÉ LIDAR FOURNI PAR SOUTHERN MAPPING COMPANY (SEPTEMBRE 2009).
   TOPOGRAPHY WITH 1 M CONTOUR INTERVAL DERIVED FROM LIDAR POINTS PROVIDED BY SOUTHERN MAPPING COMPANY (SEPTEMBER 2009).

0 5 10 15 20 m

RAPPORT 1 : 500
SCALE 1 : 500

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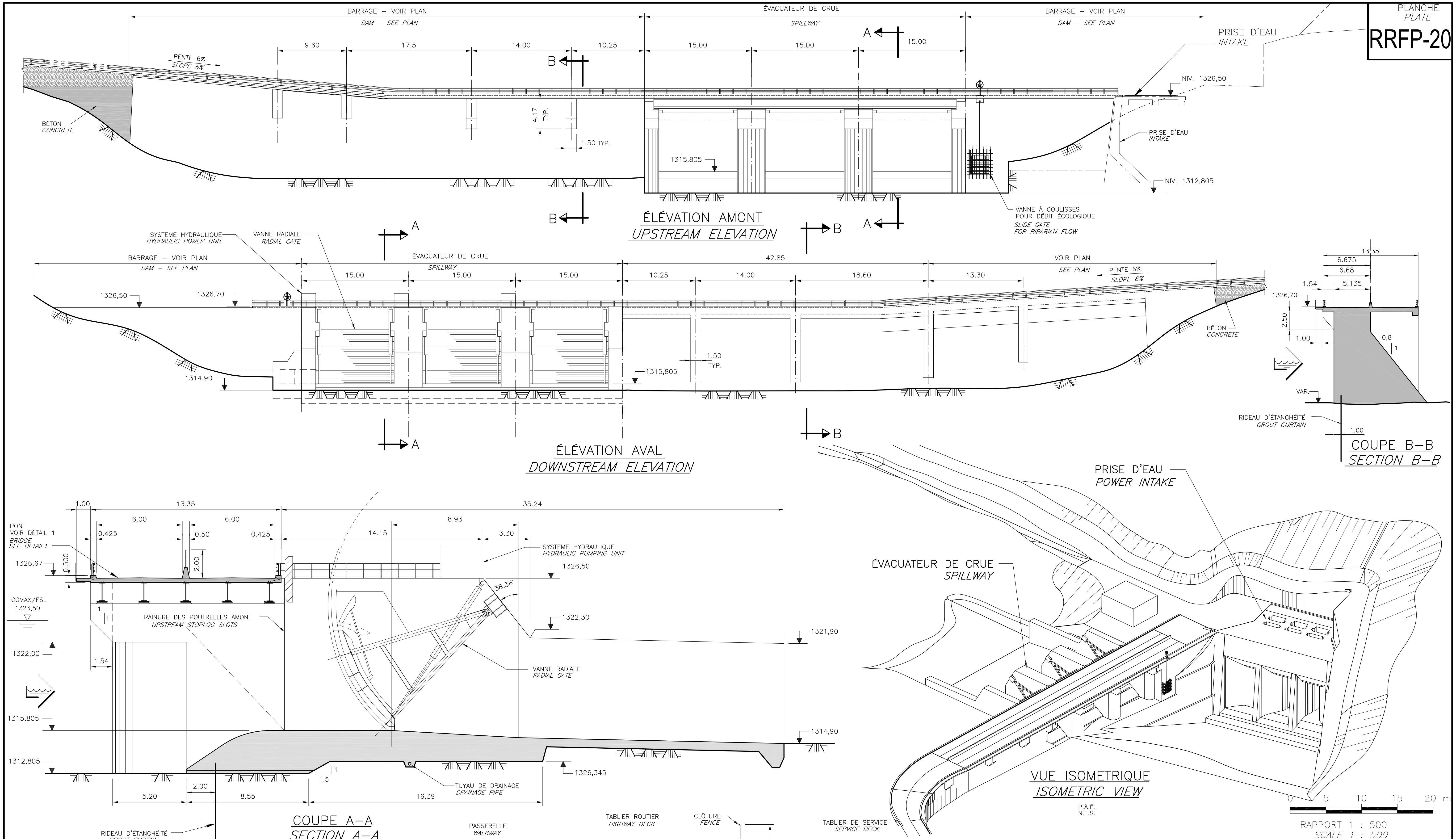
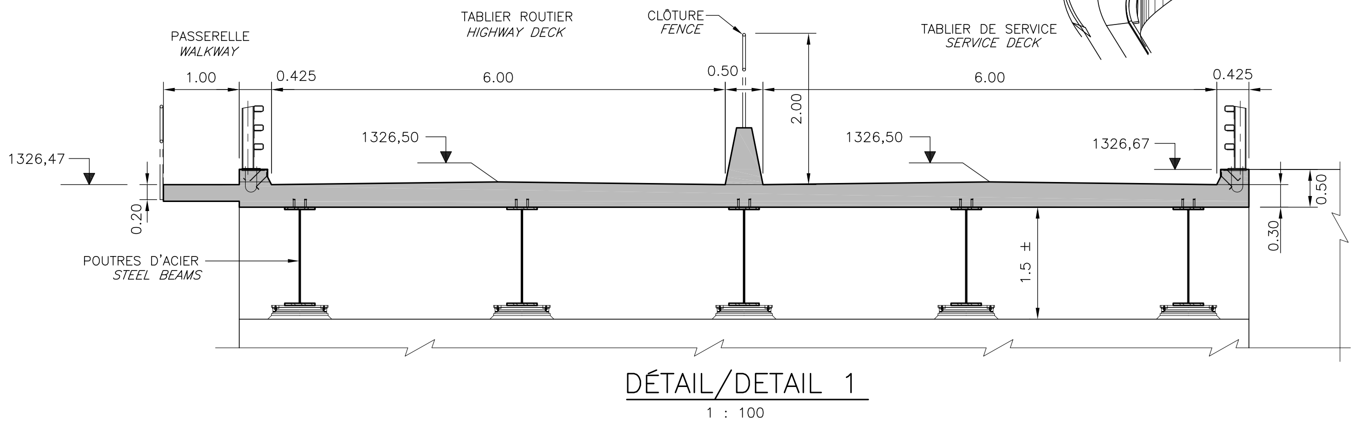
Nile Equatorial Lakes Subsidiary Action Program
(NELSAP)

PROJET *PROJECT*	PROJET HYDROÉLECTRIQUE RÉGIONAL DES CHUTES RUSUMO *REGIONAL RUSUMO FALLS HYDROELECTRIC PROJECT*
TITRE *TITLE*	ÉVACUATEUR DE CRUE ET PRISE D'EAU VUE EN PLAN — *SPILLWAY AND POWER INTAKE PLAN VIEW*
No DESSIN/*DRAWING No.* 605084–EGTO–40DD–9006.dwg	REV. 01

605084–EGTO–40DD–9006–01.dwg

2012.01.20/2:11pm





NOTES:

1. LE SYSTÈME DE COORDONNÉES UTILISÉ EST LE "UTM WGS 84"
   THE COORDINATE SYSTEM IS THE "UTM WGS 84".
2. COURBES DE NIVEAU GÉNÉRÉES À PARTIR D'UN NUAGE DE POINTS ISSU D'UN LEVÉ LIDAR FOURNI PAR SOUTHERN MAPPING COMPANY (SEPTEMBRE 2009).
   TOPOGRAPHY WITH 1 M CONTOUR INTERVAL DERIVED FROM LIDAR POINTS PROVIDED BY SOUTHERN MAPPING COMPANY (SEPTEMBER 2009).

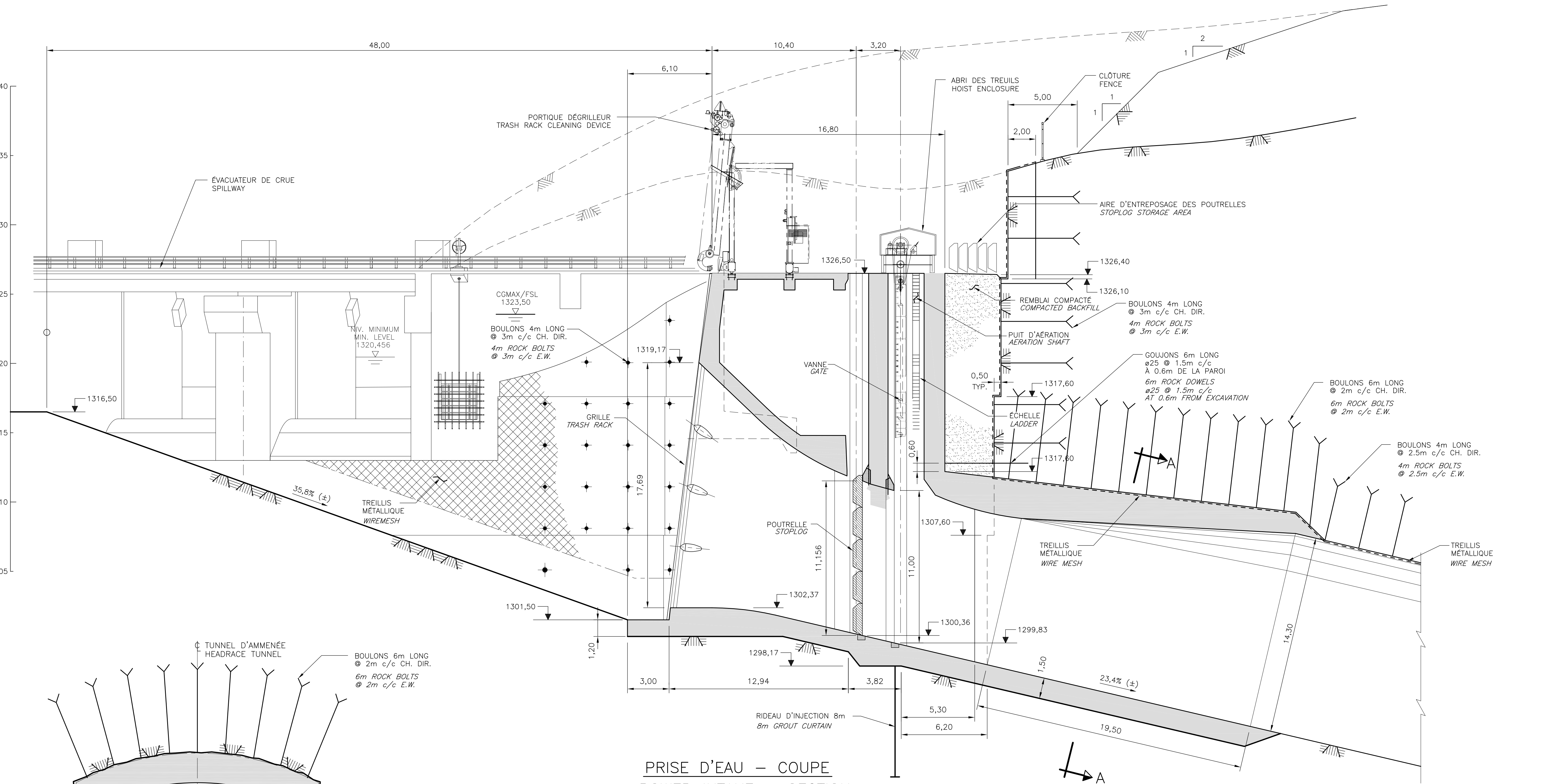
NILE BASIN INITIATIVE
Nile Equatorial Lakes Subsidiary Action Program (NELSAP)

PROJET / *PROJECT*: PROJET HYDROÉLECTRIQUE RÉGIONAL DES CHUTES RUSUMO
REGIONAL RUSUMO FALLS HYDROELECTRIC PROJECT

TITRE / *TITLE*: ÉVACUATEUR DE CRUE ÉLÉVATIONS, COUPES ET VUE ISOMETRIQUE
SPILLWAY ELEVATIONS, SECTIONS AND ISOMETRIC VIEW

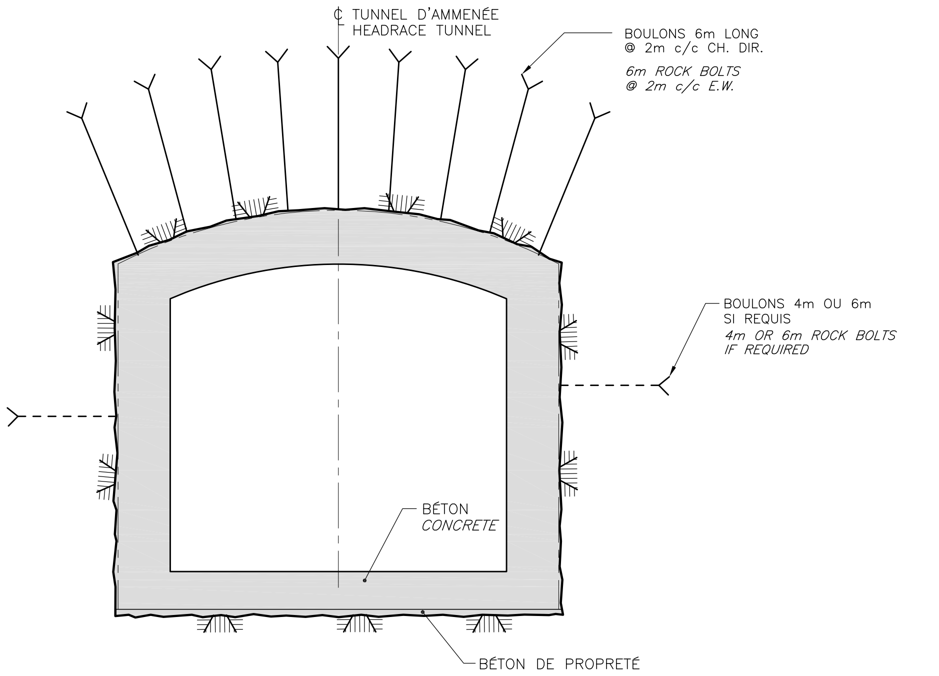
No DESSIN/*DRAWING No.*: 605084–EGTO–40DD–9010.dwg
REV.: 01

PLANCHE
PLATE
RRFP-21



PRISE D'EAU – COUPE

POWER INTAKE – SECTION



COUPE A–A

SECTION A–A

0 3 6 9 12 m

RAPPORT 1 : 300 S.I.C.
SCALE 1 : 300 U.N.O.

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Nile Equatorial Lakes Subsidiary Action Program (NELSAP)

PROJET / PROJECT: PROJET HYDROÉLECTRIQUE RÉGIONAL DES CHUTES RUSUMO / *REGIONAL RUSUMO FALLS HYDROELECTRIC PROJECT*

TITRE / TITLE: PRISE D'EAU PROFIL LONGITUDINAL ET COUPE / *POWER INTAKE LONGITUDINAL PROFILE AND SECTION*

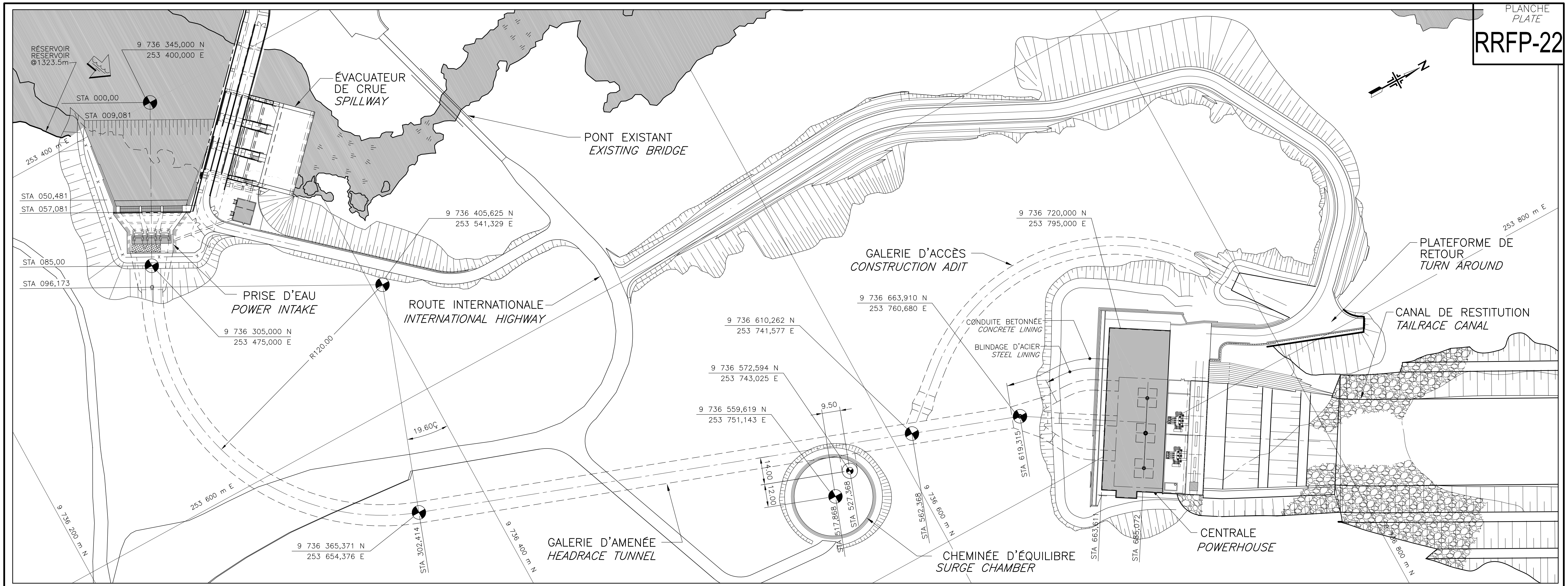
NO. DESSIN/*DRAWING NO.* 605084-EGTO-40DD-9007.dwg

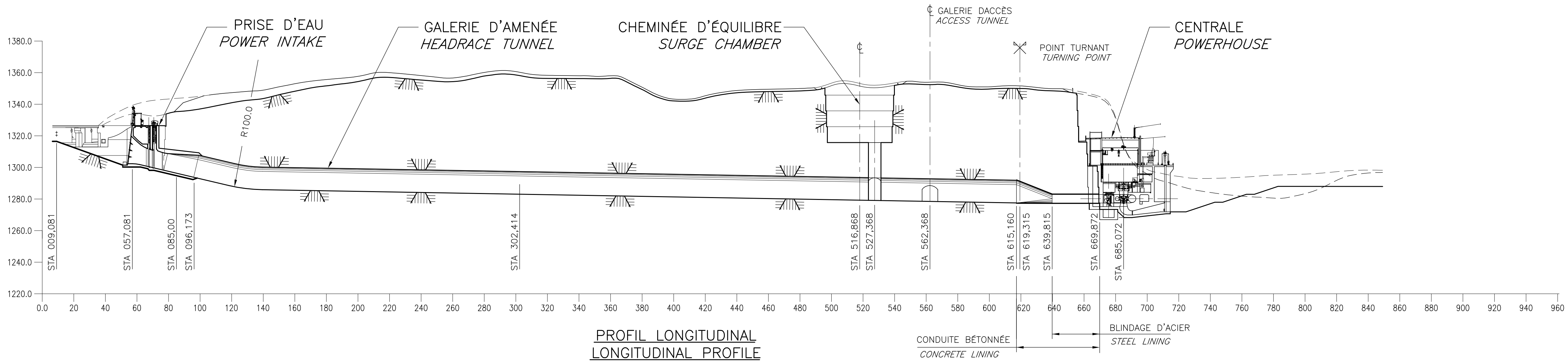
REV. 01

605084-EGTO-40DD-9007-01.dwg

2012.01.20/2:46pm

PLANCHE
PLATE
RRFP-22





PROFIL LONGITUDINAL
LONGITUDINAL PROFILE
1:3000

NOTES:

1. LE SYSTÈME DE COORDONNÉES UTILISÉ EST LE "UTM WGS 84"
THE COORDINATE SYSTEM IS THE "UTM WGS 84".
2. COURBES DE NIVEAU GÉNÉRÉES À PARTIR D'UN NUAGE DE POINTS ISSU D'UN LEVÉ LIDAR FOURNI PAR SOUTHERN MAPPING COMPANY (SEPTEMBRE 2009).
TOPOGRAPHY WITH 1 M CONTOUR INTERVAL DERIVED FROM LIDAR POINTS PROVIDED BY SOUTHERN MAPPING COMPANY (SEPTEMBER 2009).

0 20 40 60 80 m

RAPPORT 1 : 2 000
SCALE 1 : 2,000

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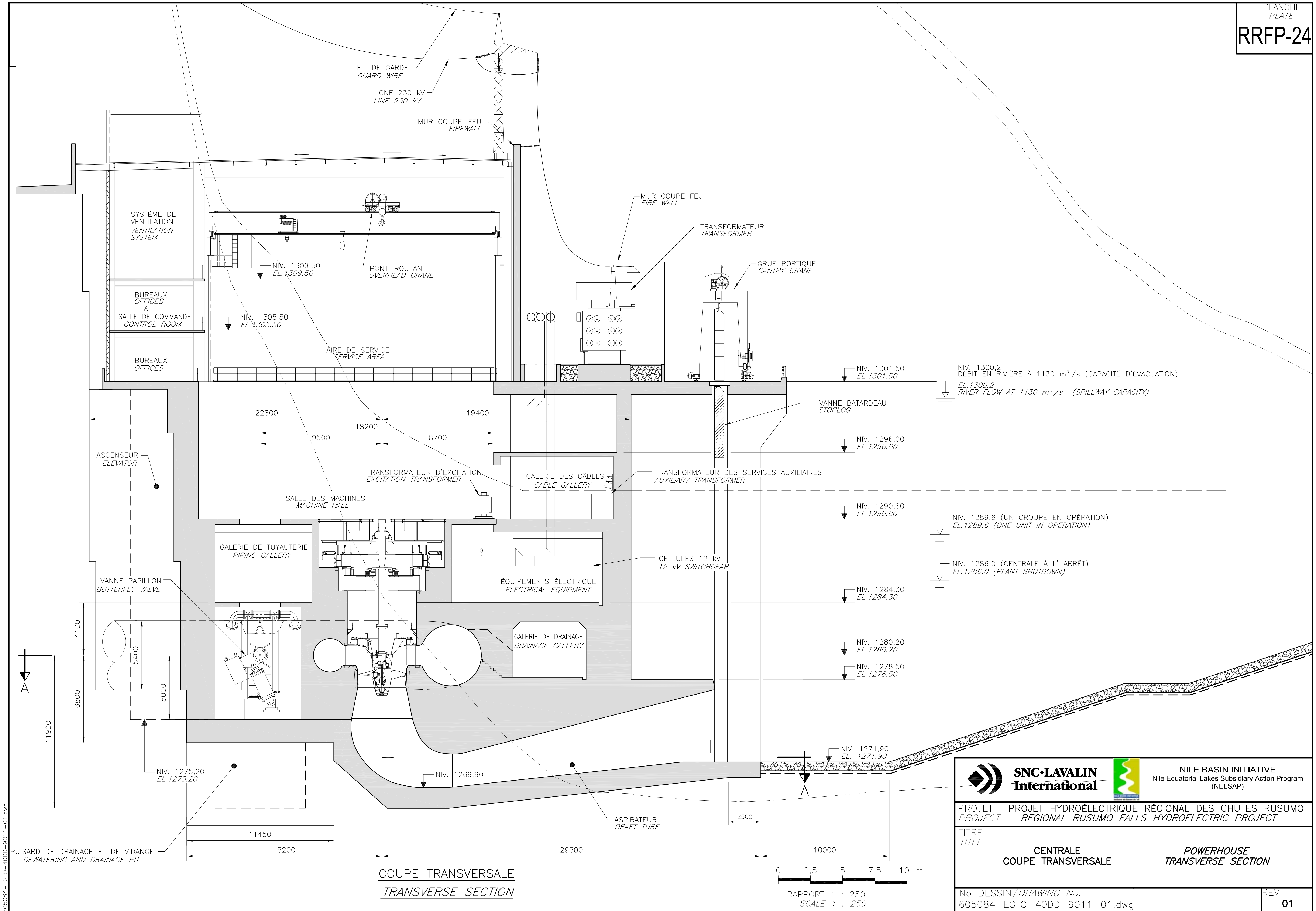
Nile Equatorial Lakes Subsidiary Action Program (NELSAP)

PROJET *PROJECT*	PROJET HYDROÉLECTRIQUE RÉGIONAL DES CHUTES RUSUMO *REGIONAL RUSUMO FALLS HYDROELECTRIC PROJECT*
TITRE *TITLE*	SYSTEME D'ADDUCTION D'EAU PLAN ET PROFIL LONGITUDINAL — *WATER CONVEYANCE SYSTEM PLAN AND LONGITUDINAL SECTION*
No DESSIN/*DRAWING No.* 605084-EGTO-40DD-9008.dwg	REV. 01

605084-EGTO-40DD-9008-01.dwg
2012.01.20/2:49pm



COUPE TRANSVERSALE
TRANSVERSE SECTION

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Nile Equatorial Lakes Subsidiary Action Program
(NELSAP)

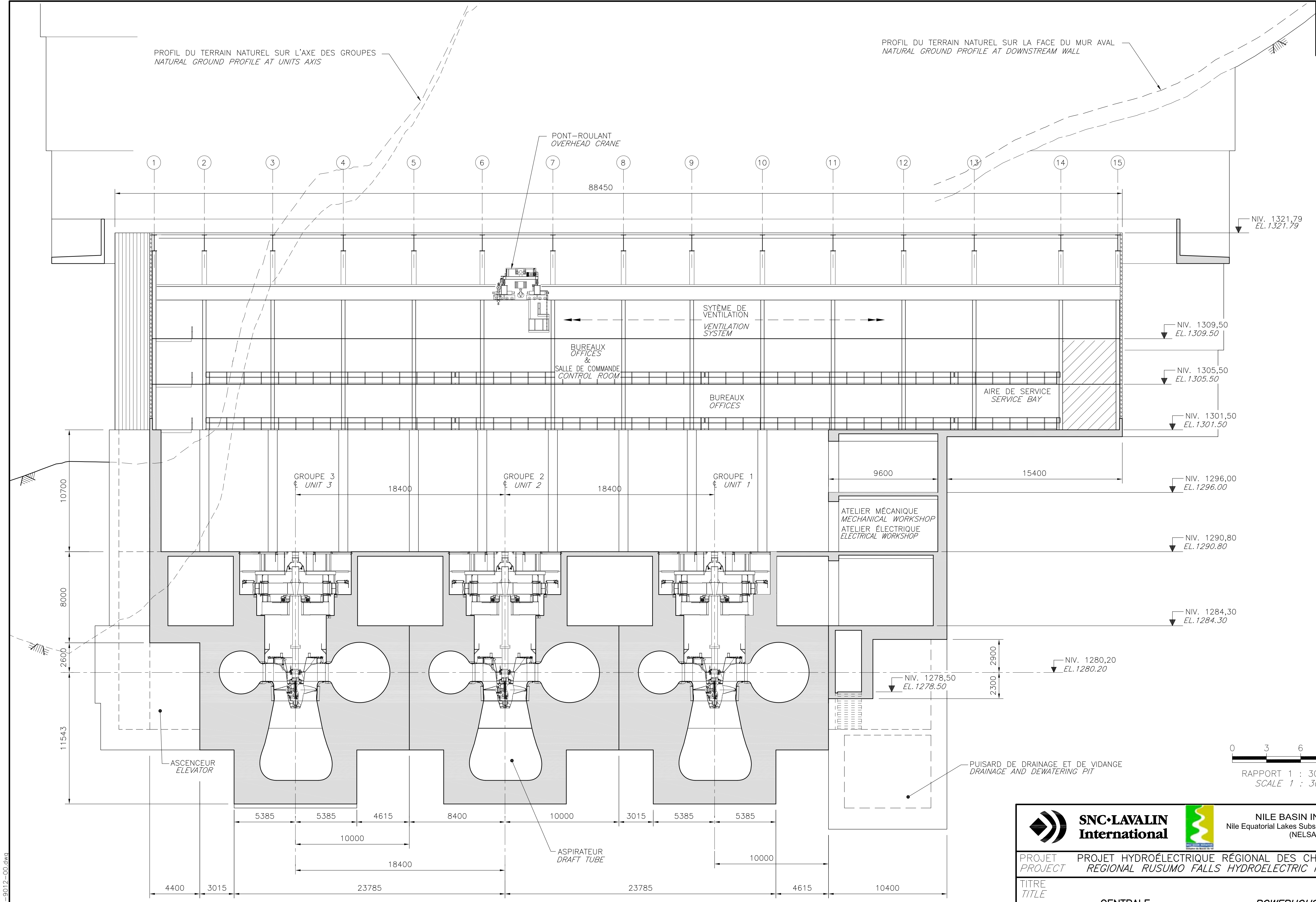
PROJET / *PROJECT*: PROJET HYDROÉLECTRIQUE RÉGIONAL DES CHUTES RUSUMO / *REGIONAL RUSUMO FALLS HYDROELECTRIC PROJECT*

TITRE / *TITLE*: CENTRALE COUPE TRANSVERSALE / *POWERHOUSE TRANSVERSE SECTION*

No DESSIN/*DRAWING No.*: 605084-EGTO-40DD-9011-01.dwg

REV.: 01

PLANCHE
PLATE
RRFP-25



COUPE LONGITUDINALE
LONGITUDINAL SECTION

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Nile Equatorial Lakes Subsidiary Action Program (NELSAP)

PROJET / *PROJECT*: PROJET HYDROÉLECTRIQUE RÉGIONAL DES CHUTES RUSUMO
REGIONAL RUSUMO FALLS HYDROELECTRIC PROJECT

TITRE / *TITLE*:
CENTRALE
COUPE LONGITUDINALE
POWERHOUSE
LONGITUDINAL SECTION

No DESSIN/*DRAWING No.*
605084-EGTO-40DD-9012-00.dwg
REV.
00

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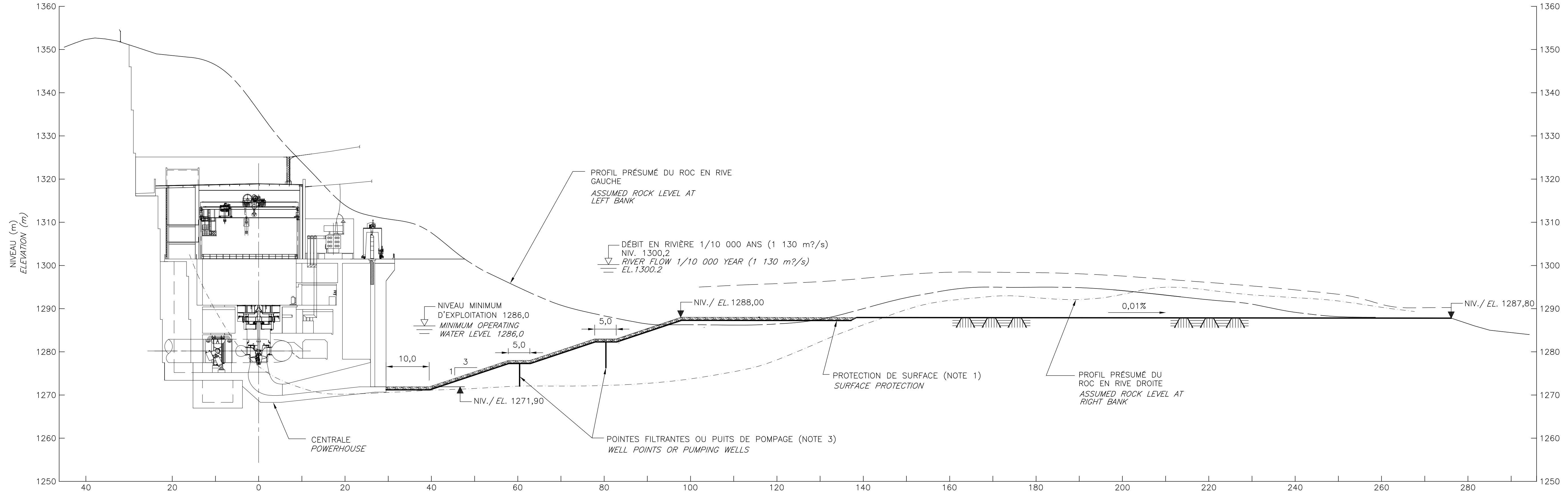
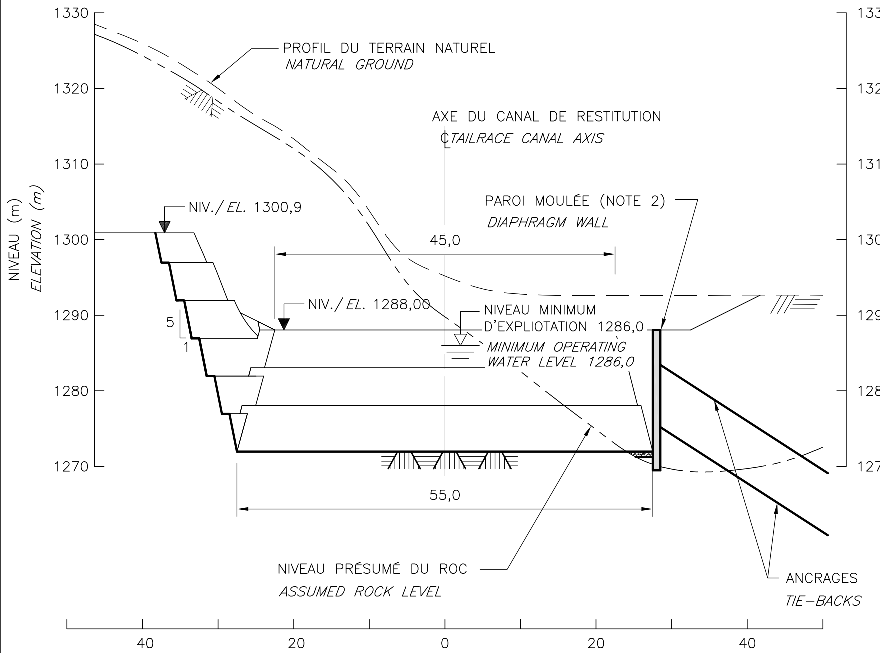
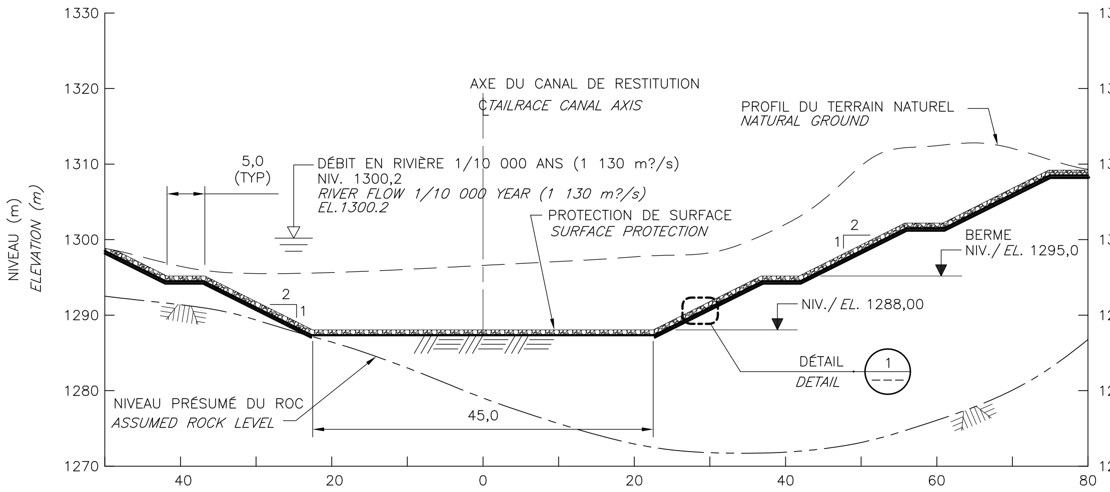
2012.01.20/2:57pm



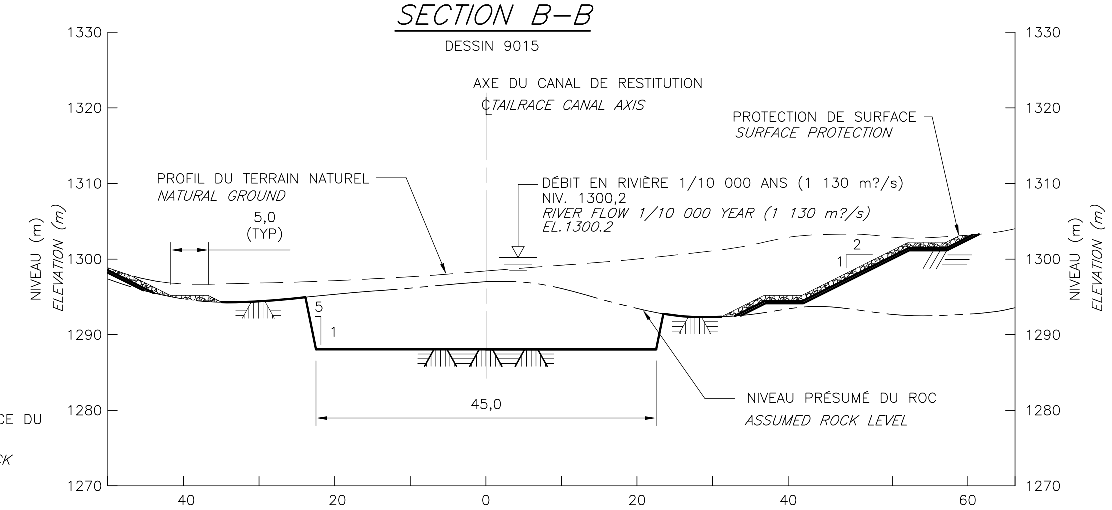
PROFIL LONGITUDINAL
LONGITUDINAL PROFILE



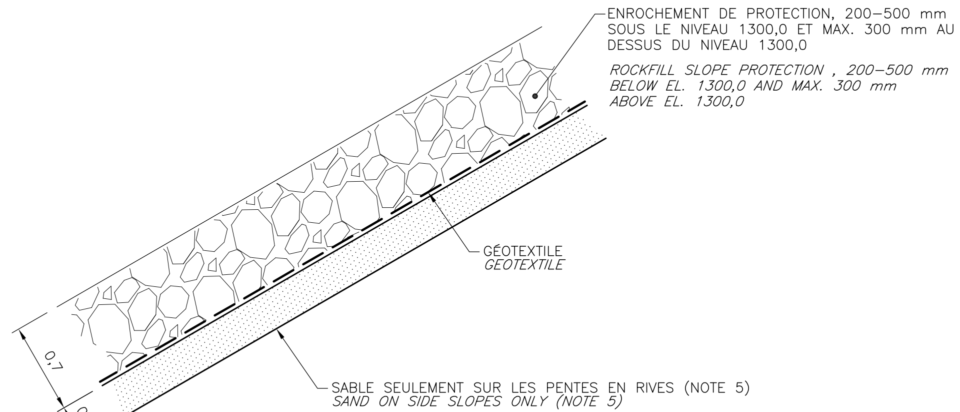
COUPE A–A
SECTION A–A
DESSIN 9015



COUPE B–B
SECTION B–B
DESSIN 9015



COUPE C–C
SECTION C–C
DESSIN 9015



DÉTAIL/ *DETAIL 1*
PROTECTION DE SURFACE
SURFACE PROTECTION

0 10 20 30 40 m
RAPPORT 1 : 1 000
SCALE 1 : 1 000

LÉGEND / *LEGEND*

- MORT–TERRAIN / *OVERBURDEN*
- ROC / *ROCK*

NOTES:

1– LA PROTECTION DE SURFACE EST REQUISE SUR LE MORT–TERRAIN ET LE ROC ALTÉRÉ.
SURFACE PROTECTION IS REQUIRED ON OVERBURDEN AND HIGHLY WEATHERED ROCK.

2– DIMENSIONNEMENT À ÊTRE RÉALISÉ À L'ÉTAPE D'INGÉNIERIE DÉTAILLÉE.
DESIGN TO BE FINALIZED DURING DETAILED ENGINEERING PHASE.

3– LES FORAGES DE 1987 (TRACTEBEL 1987) ONT RÉVÉLÉ LA PRESENCE DE SOLS GRANULAIRES PRÉS DE LA SURFACE DU ROC QUI POURRAIENT NÉCESSITER L'USAGE DE PUITS DE POMPAGE OU DE POINTES FILTRANTES
BOREHOLES CARRIED OUT IN 1987 (TRACTEBEL 1987) REVEALED THE PRESENCE OF GRANULAR SOIL NEAR BEDROCK SURFACE. THE USE OF PUMPING WELLS OR WELL POINTS COULD BE REQUIRED

4– SI LE ROCHER EST PLUS BAS QUE LE RADIER DE L'ASPIRATEUR, COMBLER AVEC DU BÉTON DE REMPLISSAGE.
IN CASE ROCK SURFACE IS BELOW DRAFTUBE INVERT, FILL EMPTY VOLUME WITH LEAN CONCRETE.

5– UNE COUCHE DE SABLE POURRAIT ÊTRE REQUISE AU CONTACT DU MORT TERRAIN SUR LES PENTES LONGITUDINALES EN VERTU DES PARAMÈTRES DE RÉSISTANCE DU MORT TERRAIN QUI SERONT MESURÉS EN LABORATOIRE.
A LAYER OF SAND MAY BE REQUIRED BETWEEN THE OVERBURDEN AND THE GEOTEXTILE DEPENDING ON THE OVERBURDEN STRENGTH PARAMETERS MEASURED IN THE LABORATORY.

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PROJET / *PROJECT*: PROJET HYDROÉLECTRIQUE RÉGIONAL DES CHUTES RUSUMO
REGIONAL RUSUMO FALLS HYDROELECTRIC PROJECT

TITRE / *TITLE*:
CANAL DE RESTITUTION
PROFIL, COUPES ET DÉTAIL

TAILRACE CANAL
PROFILE, SECTIONS AND DETAIL

No DESSIN/*DRAWING No.*: 605084–EGT0–40DD–9016.DWG
REV.: 01

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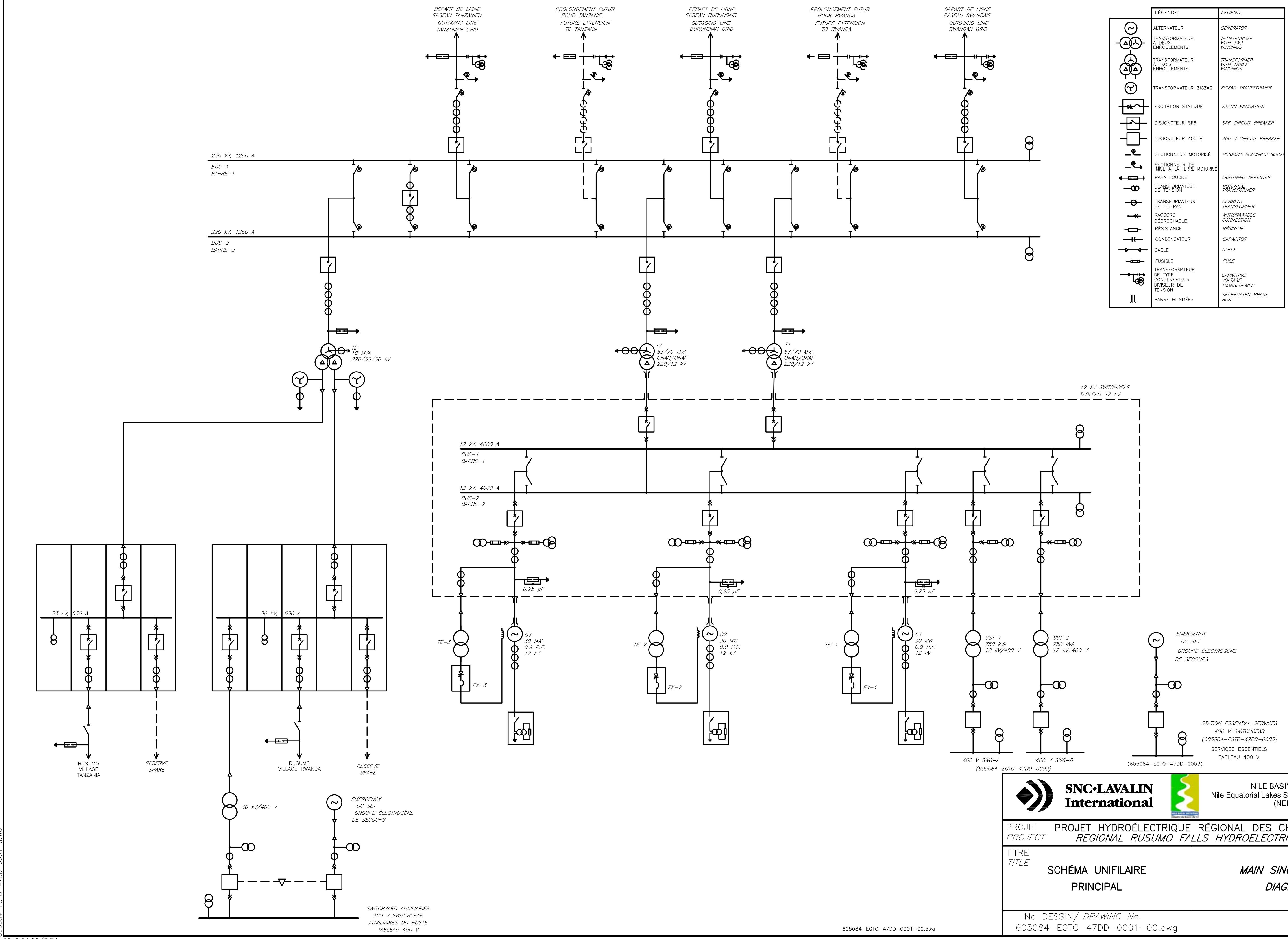
PLANCHE
PLATE
RRFP-33



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Nile Equatorial Lakes Subsidiary Action Program
(NELSAP)

PROJET / *PROJECT*: PROJET HYDROÉLECTRIQUE RÉGIONAL DES CHUTES RUSUMO / *REGIONAL RUSUMO FALLS HYDROELECTRIC PROJECT*

TITRE / *TITLE*: SCHÉMA UNIFILAIRE PRINCIPAL / ***MAIN SINGLE LINE DIAGRAM***

No DESSIN/ *DRAWING No.* 605084-EGTO-47DD-0001-00.dwg

REV. 00

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2010.04.29/9:54am

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