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Greenland Hydropower Project
Site 7e

Prefeasibility report

05-18015

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1 Background and purpose

1.1 Project Overview

1.1.1 Background

The Greenland Power Project (Greenland Project) consists of a greenfield aluminum reduction plant to be developed at a site in or near the town of Maniitsoq in western Greenland and a number of hydro developments to provide electricity for the smelter. The project will involve the development of sufficient hydro power resources among two identified hydro areas in Western Greenland to serve the requirements of the aluminum plant and the development of power transmission facilities between the hydro resources and the aluminum plant. Alcoa will develop the aluminum plant facilities on the plant site, as well as a harbor facility near the plant. The hydro sites will be developed and operated to meet the needs of the aluminum plant. During construction, other infrastructures between population centers, the harbor, the hydro sites and the smelter site will also be developed.

In 2007, during Phase I of the Memorandum of Understanding (MOU), PB Power (PB), with the assistance of outside consultants, completed various field studies and technical analyses as part of an initial feasibility study including: Phase I of the geotechnical and hydrologic investigations; field measurements of flow and sediment; transmission line conceptual design and cost study; office studies of scope and cost of three potential hydro sites (7e, 7d and 6g); and aerial survey and topographic mapping. Based on the results of these field and office studies, conceptual engineering for the project such as dams, tunnels, canals, roads and transmission lines were completed. The power availability at each of the three sites was determined based on the results of a hydrologic investigation as well as the field studies. A conceptual hydro project schedule and cost estimate was also prepared.

Originally, there were five hydropower sites considered as sources of energy for the Greenland Project. Prior to Phase I of the MOU, the three most favorable sites were chosen for further study to provide approximately 600 to 750 MW of power to the aluminum smelter. In MOU Phase I, Site 7d was excluded since the available power at the site could be obtained with an increase water storage capacity at site 7e.

1.1.2 Project status

MOU Phase I concluded on April 20, 2008. Additional investigations for the remainder of Phase I, completed in 2008 by Alcoa, included: refinement of the conceptual quantities; further review of future hydrology; further review of project works required for future hydrology; further review/resolution of transmission line technical/cost data and additional evaluation of mechanical/electrical equipment. These studies further updated the cost/schedule estimate for the project and provided input to the preliminary design and 2007 field study program to be coordinated by PB Power.

During the spring of 2008, Alcoa and the Greenland Homerule Government concluded that it was desirable to continue further evaluation and development of the Project and begin the second phase of investigative activities, MOU Phase II. Phase II continued until Fall 2009.

If, following the conclusion of Phase II activities, Alcoa and the Greenland Homerule Government conclude that it is desirable to pursue further evaluation and development of the Project, they will begin the third phase of activities. The third phase is currently expected to start in 2010 with construction beginning in 2011.

1.1.3 Scope of Work for Phase II Studies

The scope of work is for engineering and construction related services during MOU Phase II to provide preliminary design, cost estimates and planning for the development of the hydro site components to meet the needs of the aluminum plant (650 MW), including the development of preliminary design drawings, construction related services, electrical and mechanical works services. Specifically, this includes the following:

- general layouts;
- design criteria and preliminary design for every major project component;
- firm power capacity of the project (650 MW needed at the smelter);
- preliminary construction cost estimate (+25%, -15%) for each site;
- preliminary construction schedule;
- risk assessment.

In addition to that main scope, a single site scheme has been developed to use the full potential of site 7e. This scheme includes higher dams. The firm power availability doesn't meet the full smelter requirement (533 MW with maximum operating level of 726 m) but reduces the capital cost significantly.

1.2 Hydro sites

1.2.1 Site 7e

1.2.1.1 Description

The 7e hydropower project is located at the western end of Lake Tasersiaq, approximately 100 km south of the town of Kangerlussuaq. This high head scheme's main components and key figures are presented in the project metrics table and include:

- A reservoir which will be created by raising Lake Tasersiaq's present water level (690 m) by 24 m. It's normal operating level will be between 680 m and 714 m, with 4 085 hm^3 of live storage.
- The headworks, including:
  - Two asphalt core rockfill dams, with the larger one being approximately 55 m high;
  - A spillway including a 200 m long ungated concrete weir discharging into a side channel spillway, followed by a rock chute;
  - A temporary diversion tunnel and cofferdams;
  - A headrace channel and intake;
  - A 42 km access road between the harbour and the headworks.
- The conveyance structures and power system, including:
  - A 26.6 km headrace tunnel. At this stage of the study, it is planned to excavate the power tunnel using two TBMs.
  - An air cushion surge chamber;
  - An underground powerhouse equipped with 5 Pelton turbines, a transformer cavern, access and cable galleries;
  - A tailrace tunnel whose outlet discharges at Evighedsfjord;
  - A service building and harbour facility.

Table 1.1 7e project metrics

Design Flood	Permanent civil works - 1:10 000 years flood	2 940 m³/s
	Temporary civil works - 1:20 years flood	1 330 m³/s
Water Levels	***Reservoir***	
	Maximum operating level	714 m
	Minimum operating level	680 m
	Water level with the 1:10 000 years flood	717.3 m
	Downstream - Fjord	
	Maximum tide level	2.6 m
	Minimum tide level	-2.3 m
Production Devices	Number of turbines	5
	Types of turbines	Pelton
	Net head (at max level)	697 m
	Unit discharge	17.4 m³/s
	Maximum unit capacity (Generator output)	126.4 MW
	Voltage Output	13.8 kV
	Maximum generator output - total	595 MW
	Firm power	500 MW
Headrace Canal	Length	2 100 m
	Water velocity	0.65 m/s
Intake	Type of intake	Surface - horizontal
	Number of gates	1
Headrace Tunnel	Length	26.6 km
	Diameter	8 m
	Cross-section shape	Circular (TBM)
	Cross-sectional area	50.3 m²
Powerhouse	Width (upstream - downstream)	16.5 m
	Length	86 m
	Height	28 m
Tailrace Tunnel	Length	3.67 km
	Cross-section shape	Reverse-D
	Cross-sectional area	83.2 m²
Dams	Type	Asphalt core rockfill
	Crest width	6 m
	Dam 1 (Alternate axis)	
	Crest elevation	719 m
	Length	330 m
	Maximum height	55 m
	Dam 2	
	Crest elevation	719.5 m
	Length	995 m
	Maximum height	27 m

Spillway (overflow weir)	Crest length	200 m
	Discharge capacity	2 440 m³/s
Catchment Area	Total area	6 789 km²
Access Road	Total length	41.75 km
Transmission Line	Total length	125 km

1.2.1.2 Hydrology

The total area of the drainage basin at Site 7e is 6 789 km², of which 78% are glacier covered. Most of the inflow comes from glacier melting and occurs between June and October.

Daily flow series have been generated for a 50 year period. Three cases have been considered, producing the following set of data:

- historical series, using past climate data from September 1, 1958 to August 31, 2008;
- projected series 2020, using a climate warming scenario (from DMI) to produce an inflow projection at the year 2020;
- projected series with an horizon set at 2040 using a similar methodology to the 2020 run.

The historical synthetic series comes from an energy balance model and was calibrated on observed data.

Table 1.2 Yearly average flow at site 7e

Case	Yearly average (m³/s)
Historical	83.4
2020	96.1
2040	104.0

1.2.1.3 Power production

The net head is approximately 697 m (~2,287 ft) at full pool.

Based on the 2020 projection (or on the last 20 years), the predicted firm power capacity of Site 7e is approximately 500 MW, providing more than 70% of the planned smelter's total power requirement. The expected firm power for 2040 horizon would reach 536 MW. The powerhouse is equipped with 5 Pelton turbines which can produce a maximum output of 595 MW. The units were selected to provide a minimum of 505 MW over the complete reservoir fluctuation range with one unit shut down for maintenance either at Site 6g or 7e; this was done in order to guarantee the firm power availability.

1.2.1.4 Arctic conditions and permafrost

Since the field investigation results showed the presence of deep permafrost in the vicinity of the intake, a number of measures were taken to prevent freezing problems.

- The headrace canal approach velocity was set in order to ensure that a stable ice cover will rapidly form.
- The intake design includes a 200 m high drop shaft to bring the water below the 0 degree isotherm in the shortest possible distance; this is to avoid ice buildup in the tunnel in case of powerhouse shutdown.

- In order to avoid ice formation in the intake gate shaft, electric heating elements are inserted in tubes embedded in the wall of the gain of the gate over the full height of the gain. A 10.6 kV line along the access road is planned.
- It is planned to unfreeze and grout the dams foundations at the most critical section.
- The tailrace tunnel outlet was relocated downstream of a glacial tongue in the fjord to avoid ice obstruction problems.

1.2.1.5 Construction

The construction schedule spans five years. The critical activities are related to the access road and headworks construction. It takes a little less than 2 years to complete the access road to the dam area and a year is required to impound the reservoir, leaving only 2 years for headworks construction.

Two construction camps are required. The main one (Camp a) will be located near the powerhouse access tunnel entrance. The second one (Camp b) will be located in the dam and intake area. It is expected that construction of Site 7e will require 4.2 million man-hours to complete.

1.2.2 Site 6g

1.2.2.1 Description

The 6g hydropower project (Imarsuup Isua) is located approximately midway between the towns of Nuuk and Maniitsoq in the north-south direction, and approximately 120 km east of them. This high head scheme's main components and key figures are presented in the Site 6g project metrics table and include:

- The main reservoir, which will be created by raising Lake Imarsuaq's (Big lake) present water level (675 m) by 7 m. It's normal operating level will be between 669 m and 682 m with 945.8 hm^3 of live storage;
- The lower reservoir, which will be created by raising Lake Tussapp Tasis' (Lower lake) present water level (653 m) by 14 m. It will be operated at a constant level (667 m);
- The headworks, with the dams, regulating structure and intake include:
  - Four asphalt core rockfill dams, with the largest one being approximately 32 m high;
  - Two concrete spillways, one for each reservoir;
  - Two temporary diversion tunnels and cofferdams;
  - A regulation tunnel connecting the two reservoirs;
  - 2 diversion canals to increase inflow to the Big Lake;
  - 2 canals to avoid ice build-up problems in shallow areas of the Lower lake
  - 46.7 km of access roads between the harbour and the various headworks components;
- The conveyance structure and power system
  - A 10 km headrace tunnel. At this stage of the study,the power tunnel is planned to be excavated by one TBM;
  - An underground powerhouse equipped with 2 Pelton turbines, a transformer cavern, access and cable galleries;
  - A tailrace tunnel whose outlet discharges at Godthabsfjord;
  - A service building and harbour facilities.

Table 1.3 6g project metrics

Design Flood	Permanent civil works BIG LAKE- 1:10 000 years flood	400 m³/s
	Temporary civil works BIG LAKE- 1:20 years flood	245 m³/s
	Permanent civil works LOWER LAKE- 1:10 000 years flood	160 m³/s
	Temporary civil works LOWER LAKE - 1:20 years flood	40 m³/s
Water Levels	***Reservoir-Big Lake***	
	Maximum operating level	682 m
	Minimum operating level	669 m
	Water level with the 1:10 000 years flood	683.8 m
	Reservoir-Lower Lake	
	Operating level (constant)	667 m
	Water level with the 1:10 000 years flood	668.3 m
	Downstream – Fjord	
	Maximum tide level	2.1 m
	Minimum tide level	-3.5 m
Production Devices	Number of turbines	2
	Type of turbines	Pelton
	Net head (at max level)	655.7 m
	Unit discharge	16.6 m³/s
	Maximum unit capacity	97 MW
	Voltage Output	13.8 kV
	Maximum generator output - total	194 MW
	Firm power	185 MW
Headrace Canal	Length	65 m
	Water velocity	0.65 m/s
Intake	Type of intake	Surface - horizontal
	Number of gates	1
Headrace Tunnel	Length	9.99 km
	Diameter	5.1 m
	Cross-section shape	Circular (TBM)
	Cross-sectional area	20.4 m²
Powerhouse	Width (upstream - downstream)	15.3 m
	Height	28 m
	Length	29.5 m
Tailrace Tunnel	Length	1.1 km
	Cross-section shape	Reverse-D
	Cross-sectional area	39.4 m²

Tunnel 1	***Connecting the two reservoirs - regulating structure***	
	Upstream and downstream canal length	170 m
	Tunnel length	1 690 m
	Cross-section shape	Reverse-D (Drill and Blast)
	Cross-sectional area	29.4 m²
	Design discharge	40 m³/s
Dams	Type	Asphalt core rockfill
	Crest width	6 m
	Dam 1	
	Crest elevation	671.5 m
	Length	310 m
	Maximum height	31 m
	Dam 2	
	Crest elevation	671.5 m
	Length	290 m
	Maximum height	18 m
	Dam 3 with geomembrane	
	Crest elevation	685.5 m
	Length	560 m
	Maximum height	13 m
	Dam 4	
	Crest elevation	685.5 m
	Length	175 m
	Maximum height	21 m
	Dam 5	
	Crest elevation	685.5 m
	Length	310 m
	Maximum height	32 m
Canals	***Canal 1***	
	Length	190 m
	Bottom width	3 m
	Design discharge	40 m³/s
	Canal 2	
	Length	180 m
	Bottom width	3 m
	Design discharge	40 m³/s
	Canal 3	
	Length	675 m
	Bottom width	5 m
	Design discharge	28 m³/s
	Canal 4	
	Length	28 m
	Bottom width	10 m
	Design discharge	28 m³/s

Spillways (overflow weir)	***Spillway 1***	
	Crest length	50 m
	Discharge capacity	105 m³/s
	Spillway 2	
	Crest length	72 m
	Discharge capacity	305 m³/s
Catchment Area	Total area	1 375 km²
Access Roads	Total length	46.6 km
Transmission Line	Total length	169 km

1.2.2.2 Hydrology

The total area of the drainage basin at Site 6g is 1 375 km², of which 58% are glacier covered. A large part of the inflow comes from glacier melting and occurs between June and October.

Daily flow series have been generated for a 50 year period. Three cases have been considered, producing the following set of data:

- historical series, using past climate data from September 1, 1958 to August 31, 2008;
- projected series 2020, using a climate warming scenario (from DMI) to produce an inflow projection at the year 2020;
- projected series with an horizon set at 2040 using a similar methodology to the 2020 run.

The historical synthetic series comes from an energy balance model and was calibrated on observed data.

Table 1.4 Yearly average flow at site 6g

Case	Yearly average (m³/s)
Historical	34.0
2020	37.4
2040	39.5

1.2.2.3 Power production

The net head is approximately 655 m (~2,148 ft) at full pool. The powerhouse is equipped with 2 Pelton turbines and the predicted firm power capacity of Site 6g is approximately 185 MW based on the 2020 projection.

1.2.2.4 Arctic conditions and permafrost

The field investigation results did not confirm the presence of permafrost at Site 6g. However, a number of measures were taken to prevent freezing problems.

- The canal’s design water velocities were set in order to ensure that a stable ice cover will rapidly form;
- In order to avoid ice formation in the intake gate shaft, electric heating elements are inserted in tubes embedded in the wall of the gain of the gate over the full height of the gain. A 10.6 kV line along the access road is planned;
- It is planned to unfreeze and grout the dams foundation at the most critical section.

1.2.3 Construction

The construction schedule spans five years. The critical activities are related to the headworks construction. It takes 2 years to construct an access to the Northern dam area and a year is required to impound the reservoir, leaving less than 2 years (only one summer season) for the headworks construction.

Since the headworks of Site 6g are spread over a large territory, four construction camps are required:

- The main one (Camp 1) will be located near the Godthabsfjord and powerhouse access tunnel entrance;
- Camp 2 will be located in the Lower lake dam and intake area;
- Camp 3 will be located in the Southern end of Big lake near the tunnel connecting the two reservoirs;
- Camp 4 will be located in the Northern end of Big Lake, in the vicinity of its present outlet.

It is expected that construction of Site 6g will require 2.3 million man-hours.

1.3 Project Enhancements

During the FEL 2 studies a number of project enhancements were achieved:

Hydrology

- Redefined catchment after inclusion of sub-ice contour and high resolution topographical data;
- Improved modeling approach after calibration of a new temperature model with meteorological measurement taken from stations operating on the Tasersiaq basin glacier margin;
- Flow series projection to consider climate change effect;
- Refined model and projection approach were reviewed and approved by glaciology experts.

Power generation

- Power production evaluation evolved from a 20 years series to a 50 years projected series taking into account all droughts and the natural variability;
- The firm power generator output was increased from 650 MW to 683 MW in order to take into account transmission losses and station service power to provide 650 MW of firm Power at the Smelter itself;
- Added overload capacity to the turbine-generator units to allow for one unit maintenance over the full range of reservoir level, without power reduction at the smelter;
- While the reservoir elevations were maintained to the FEL 1 levels, the potential to increase storage and power production at Site 7e exists and could be developed economically, although it could require extending the construction period to 6 years in order to fill the reservoir;
- Elimination of two diversion tunnels at Site 6g in the base scheme leaves potential for added power at 6g. This added power has a higher marginal cost than Site 7e's potential added power.

Arctic conditions, permafrost, site remoteness

- The design has been adjusted so that the arctic conditions and permafrost do not represent a fatal flaw;
- The Intake concept was adapted to the deep permafrost at Site 7e;
- Electrical lines and heating are planned at every gated intake and tunnel to ensure year-round gate operation;
- Gate redundancy at tunnel 1 (Site 6g) to guarantee continuous operation and room for maintenance of regulating equipment;
- Construction camp were adapted to the sites' remoteness and access conditions;
- Construction schedules now account for seasonal work and daylight periods.

Miscellaneous

- The Site 7e access road alignment in the power tunnel valley was further studied to give access up to the dam area and eliminate a 65 km portion between the second harbour in Sondre Stromfjord and the dam area that was planned in FEL 1.
- The cost of the redundant transmission line was reduced.
- The surge chamber/shaft was eliminated at Site 6g.

1.4 Project risks

The five main risks that were identified for the hydro are:

- Greater than anticipated infrastructure and logistics difficulties could increase costs and delays project start up ;
- Civil works construction difficulties could increase costs and delays (access road, tunnelling, dam construction);
- Unfavorable weather conditions (change in duration of either winters or summers - movement of materials is easier during winter conditions -Fjord ice, fog, movement over snow or ice whereas construction is easier during summer conditions.);
- Difficulties could be encountered along the 300 km transmission lines to be constructed in rough terrain, with long fjord and glacier crossings. Some of them are state-of-the-art
- Environmental issues increase project cost, potentially impact start and completion dates/schedules and reduce available power output (NGO delays, Water releases downstream of dams, Ecosystems or archeological features in flooded areas or T-line corridor, project footprint).

1.5 Potential cost savings

During the FEL 2 studies and design review process, a number of potential alternatives or improvement to the design have been evaluated to reduce the overall project cost but were not actually incorporated in the drawings and base cost estimate. The potential savings (or cost increase) regarding these design modifications are included within the cost summary table for the project and are explained below for both Sites 6g and 7e.

1.5.1 Design modifications and purchasing costs

Headrace canal and intake design (7e): A new location for the intake allowed a reduction in the surface excavation volume by 60%, although slightly extending the headrace tunnel.

Headrace tunnel diameter (6g and 7e): Potential savings included in the cost summary reflect the reduction in headrace tunnel diameter that will likely be adopted after a further optimization study in this area.

Powerhouse location (6g and 7e): Following the results of 2009 field tests, the powerhouse location has to be moved for both sites, to avoid a sub vertical dolerite dyke at Site 7e and an area of low minimum stress level at Site 6g. These changes in the powerhouse location increase the project cost due to slightly longer access tunnels.

Penstocks and manifold optimization (6g and 7e): Potential savings included in the cost summary reflect the reduction in penstock diameter and length that will likely be adopted.

Dam axis (7e): The axis of dam 1 at Site 7e may be moved 200 m downstream to reduce its overall length and volume. At this site, the topography is favorable for the implementation of an ogee weir, unlined chute spillway.

Dam cross-section (6g and 7e): A number of adjustments to the dam cross-sections can be adopted to reduce their construction cost and ease the schedule.

Rock support (6g and 7e): Following the 2009 site investigations, the rock support criteria were reduced compared to those used in the base cost estimate.

Road construction (6g and 7e): The road construction methodology will likely be modified to increase the progression rate, improve the schedule and reduce the number of airlifts. A mobile camp is suggested to follow the road construction during the initial effort, Along with access at both ends of the steep sections, airlifts were proposed. A tunnel could also be excavated during the winter season in one of the section at Site 7e.

Diversion tunnel (6g and 7e): Potential savings included in the cost summary reflect the expected changes in diversion tunnel and cofferdam size after further optimization.

Concrete plugs (6g and 7e): The length and rebar quantities in the concrete plugs can be reduced slightly versus what was included in the base cost estimate.

Cable tunnel (6g and 7e): A new ventilation concept allows elimination of the concrete blocks in the middle of the tunnels, thus reducing the overall cross-section.

Equipment cost: A number of budget prices were received by a Danish supplier for the base cost estimate. Lower prices are expected from a North-American supplier even with addition of freight.

Construction camps: Salvage cost were applied to the construction camps permanent materials and infrastructure as well as temporary construction facilities, which wasn’t done for the base cost estimate.

Fuel cost: was set by Alcoa at 0.66$ USD per liter, which is lower than the 0.72$ USD that was used in the base cost estimate.

All of the above potential savings and modifications were applied to the initial cost estimate to determine the overall saving that could be applied to the project. They’re estimated at 75 M$ for Site 7e and 53 M$ for Site 6g

1.5.2 Working conditions and project contingencies

Additional savings are possible for the project, depending on the working conditions that are assumed, and the contingencies that are applied to the project. Alcoa suggested various criteria to consider in the cost estimate that are different from the parameters used in the base cost estimate, which roughly represent the actual practices in Canada. It is possible that the working conditions could be below the western countries standards if workers from other countries are employed for the project.

The criteria considered in the base cost estimate concerning the workers conditions compared with the new criteria proposed by Alcoa are the followings:

Table 1.5 Working conditions

	Initial cost estimate criteria	Revised criteria proposed by Alcoa
Hourly rate	24$/hr	10$/hr
Workers shift	40 days of work	120 days
Staff shift	40 days of work	60 days of work

Applying the new hourly rate to the cost estimate yields important cost savings on all project items. As for the longer work shifts, it reduced the cost of man power transportation to and from Greenland, as well as the number of overall trips.

The potential savings that can be obtained from the above considerations are:

New hourly rate of 10$/hr: Alcoa suggested the use of a 10$/h rate for Chinese labor. This change represents approximately 75 M$ total for both sites, considering a productivity reduction of 25%

Reduced man-power transportation due to longer working shifts: approximately 40 M$ total for both sites

Finally, Alcoa suggested to apply an overall contingency of 10% to the project total cost instead of the average contingency of 13% which was applied in the base cost estimate (contingencies varied between 10 and 25% depending on the item).

1.6 Opportunities

In addition to the potential savings outlined above, a number of potential opportunities could be further analysed and developed during 2010. They include:

- Construction of tunnel 2 and 3 at Site 6g which are not included in the base scheme and could increase the power output by 8 MW;
- 7F adjacent catchment could be diverted into 7e reservoir to increase the output of a single 7e scheme;
- Use of 2040 hydrology to plan future expansion or increased capacity;
- Staggered development of 7e and 6g to reduce 6g development cost.
- Other potential savings from the base cost estimate could arise with lower unit cost for the main component of the project, which include the equipments costs, the fuel cost, the labor rate and the man-power transportation.

The possibility to develop only Site 7e is one option that was studied in more depth. It is proposed that the maximum operating water level could be raised to 726 m to increase the firm power at the smelter to approximately 530 MW. The cost increase of implementing such a maximum water level would be of approximately 60 M$ at Site 7e. This estimation considers the increase in the overall cost of camp operations, as it would likely require an extra working year relative to the proposed base schedule.

1.7 Project capital cost

The hydro project capital cost is presented in table 1.6. The difference with the cost presented in section 8 comes from the different contingency level.

Table 1.6 Project Costs by Site

Pos.	Item	Site 7e	Site 6g	Cost (M$ USD)	Potential savings Site 7e	Potential Savings Site 6g	Cost with potential savings (M$ USD)
1. CIVIL WORKS							
1.1	DAMS	37.8	29.0	66.9	-6.3	-3.2	57.3
1.2	TUNNELS						
1.2.1	Headrace Tunnel	137.5	43.8	181.3	-11.4	-6.8	163.1
1.2.2	Tailrace Tunnel	16.0	7.4	23.4	-1.6	-0.7	21.0
1.2.3	All other tunnels	4.4	19.0	23.4	-3.7	-3.8	15.9
1.3	CANALS		2.5	2.5		-0.1	2.5
1.4	INTAKE STRUCTURE	59.0	9.2	68.2	-25.1	-0.2	42.9
1.5	UNDERGROUND POWER STATION	34.5	32.4	67.0	-1.4	7.1	72.7
2. MECHANICAL AND ELECTRICAL EQUIPMENT							
2.1	GENERATING EQUIPMENT	121.5	49.9	171.4	-2.2	-1.0	168.2
2.2	AUXILIARY MECHANICAL EQUIPMENTS	11.1	13.5	24.6	-0.2	-0.3	24.2
2.3	ELECTRICAL EQUIPMENT	37.6	30.5	68.1	-0.7	-0.6	66.8
3. INFRASTRUCTURE							
3.1	HARBORS	5.7	8.8	14.5	-0.1	-0.2	14.3
3.2	ROADS	58.0	50.2	108.2	-3.6	-3.5	101.1
3.3	CONSTRUCTION CAMPS						
3.4.1	Construction	56.3	117.4	173.7	-15.7	-37.2	120.8
3.4.2	Operation and maintenance	50.9	35.1	86.0	-0.9	-0.7	84.3
3.5	Construction material transportation	25.1	16.6	41.7	-0.5	-0.3	40.9
DIRECT COSTS TOTAL		**656**	**465**	**1 121**	**-74**	**-51**	**996**
4. INDIRECT COSTS							
4.1	Construction services and temporary facilities	32.7	39.6	72.3	-0.6	-1.1	70.6
4.2	Travel cost	41.0	25.8	66.8	-26.8	-16.4	23.6
4.6	Insurance	25.9	24.9	50.8			50.8
4.8	EPCM (Home office)	12.3	5.8	18.2			18.2
4.9	EPCM (Field office)	54.2	45.8	100.0			100.0
INDIRECT COSTS TOTAL		**166**	**142**	**308**	**-27.4**	**-17.5**	**263**
5.TRANSMISSION LINE							
5.1	Transmission line	93.9	121.0	214.9	-5.0	-5.0	204.9
5.2	Substations	21.6	18.4	40.0			40.0
TRANSMISSION LINE TOTAL		**115**	**139**	**255**	**-5.0**	**-5.0**	**245**
	SUB-TOTAL	**937.0**	**746.6**	**1 684**	**-105.9**	**-73.9**	**1 504**
	TOTAL (with 10% contingency)	**1 031**	**821**	**1 852**			**1 654**
	Hydro Plant Output (MW)	500	185	685			685
	M$/MW	**2.06**	**4.44**	**2.70**			**2.41**

N-1 TRANSMISSION LINE (ADDED COST)							
	Transmission Line	**64.0**	**76.1**	**140.0**			**140.0**
	Substations	**2.7**	**3.3**	**6.0**			**6.0**
	N-1 Transmission Line Total (added cost)	**66.7**	**79.3**	**146.1**			**146.1**
TOTAL (with contingency)		**1 104**	**909**	**2 013**			**1 815**
TOTAL (M$/MW)		**2.21**	**4.91**	**2.94**			**2.65**

The single site 7e option capital cost is presented in Table 1.7.

Table 1.7 Single Site 7e Cost

Pos.	Item	Single Site 7e Cost (M$ USD)
1. Civil works		
1.1	Dams	40.0
1.2	Tunnels	
1.2.1	Headrace Tunnel	137.5
1.2.2	Tailrace Tunnel	14.3
1.2.3	All other tunnels	0.7
1.3	Canals	
1.4	Intake structure	36.9
1.5	Underground power station	33.1
2. Mechanical and electrical equipment		
2.1	Generating equipment	132.5
2.2	Auxiliary mechanical equipments	10.9
2.3	Electrical equipment	36.9
3. Infrastructure		
3.1	Harbors	5.6
3.2	Roads	54.4
3.3	Construction camps	
3.4.1	Construction	40.6
3.4.2	Operation and maintenance	57.5
3.5	Construction material transportation	26.4
Direct costs total		*627*
4. Indirect costs		
4.1	Construction services and temporary facilities	32.1
4.2	Travel cost	15.7
4.6	Insurance	27.8
4.8	EPCM (Home office)	13.2
4.9	EPCM (Field office)	58.1
Indirect costs total		*147*
5.transmission line		
5.1	Transmission line	130.1
5.2	Substations	15.9
	Transmission line total	*146*
	Sub-total	*920*
	TOTAL (with 10% contingency)	*1 012*
	Hydro Plant Output (MW)	535
	M$/MW	*1.89*
N-1 transmission line (added cost)		
	Transmission Line	90.4
	Substations	3.2
	N-1 Transmission Line Total (added cost)	102.9
	Total	**1 115**
	Total (M$/MW)	**2.08**

Table 1.8 shows a summary of the project Capex under two working conditions assumptions.

Table 1.8 Summary of the expected hydro project Capex

Case #	Description	Power capacity (1)	Hydro Only Cost	Million's (2) With Base Case T-Line (N)	With Redundant T-Line (N-1)
1	7e & 6g Total – Base Case (w/Contingencies) ($24/hr labor)	650	1 384	1 654	1 815
2	7e & 6g Total – Base Case (w/Contingencies) ($10/hr labor)	650	1 304	1 574	1 735
3	Site 7e only – Single Hydro (w/Contingencies) ($24/hr labor)	520	851	1 012	1 115
4	Site 7e only – Single Hydro (w/Contingencies) ($10/hr labor)	520	797	958	1 061

Notes:
1) Firm power at the Smelter
2) All cases include 10% contingency
3) Labor based on a 4 month on/2 week off work schedule
4) Single hydro options are based on a 12m increase in dam height relative to the base case
5) Single hydro options extend construction schedule to 6 years due to increased fill time

2 Site description

2.1 Topography

Greenland's topography has a general bowl shape with peripheral mountainous areas surrounding a central basin that extends below the sea level. The Greenland Ice Sheet occupies the central bowl, covers much of the fringing mountains, and in places pushes to the coast where it calves into the sea. Ice-free regions at the fringes of the ice sheet are in most areas mountainous, cut by fjords and contain scattered thin deposits of till and local thick deposits of Quaternary nonglacial sediments of a variety of different ages. The surface elevations of the ice sheet are shown in Figure 2.1.

The general features are a southern and a northern dome with maximum elevations of 2 830 and 3 205 m respectively connected by a long almost horizontal saddle with elevations around 2 500 m.

The main drainage divide runs north-south near the eastern ice margin, leaving large parts of the Inland Ice to flow towards the west, while only smaller sectors drain eastwards. A major drainage outlet from the Inland Ice is located on the west coast in the Disko Bugt area.

The dominant landscape type in West Greenland is hilly up lane composed of rounded knolls of crystalline bedrock at elevations between 300 and 1 500 meters. Site 7e is located in an area between the Sukkertoppen Ice Cap and the Inland Ice. Evighesfjord is a deep (over 1 000 m) fjord that dissects Sukkertappen Ice Cap and leads to the ocean. Evighesfjord is intersected by numerous outlet glaciers.

2.2 General geology and seismicity

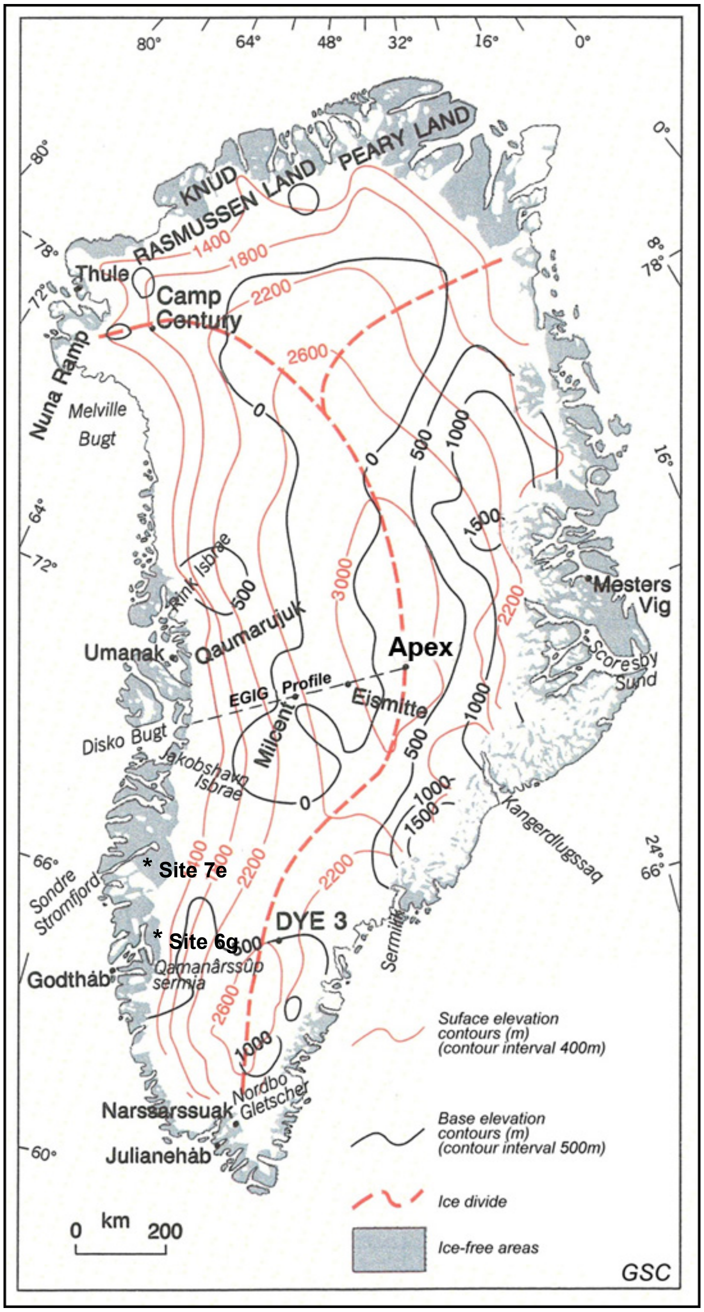
The geological history of Greenland spans more than 3.8 billion years (Vilumsen et al., 2007). The basement consists largely of composite gneisses that were formed more than 1.6 billion years ago. About 60-55 million years ago, there was widespread volcanic activity in Greenland and extensive volcanic provinces developed. The last major event was the Ice Age over the last two million years, when most of Greenland was covered by ice. All of West Greenland – excluding only some high mountains near the coast – was covered by the Inland Ice during the Sisimiut glaciations of Late Wisconsinan age.

According to the geological map (Vilumsen et al., 2007), Site 7e is predominantly underlain by tonalitic to granodioritic gneiss. Structural features are oriented predominantly in the northeast-southwest direction. Geologic mapping during the 2007, 2008, and 2009 field investigations confirmed that the rock is predominantly hard and sound, slightly weathered, and contained medium-sized grains (PB Power, 2009). Occasionally, granitic and mafic dikes were observed and were interpreted to have intruded the main body of rock. Granite occurring in a massive form or as thin dikes was also reported.

In the upstream part of the power tunnel, aerial photographs show some lineaments (topographic feature resulting from a geological structure) nearly parallel to the alignment of the tunnel. Further geological mapping should allow verifying the importance of these features (orientation, dipping, width if the fault or shear zone is narrow, type of filling, etc.) so to ensure that the tunnel is excavated in sound rock while avoid being parallel to major structural discontinuities.

Recent glaciation is marked by erosion rather than sediment accumulation in most areas. Thick Quaternary deposits are of restricted occurrence and are generally confined to major valleys and lowlands along the coasts. The Quaternary geology of West Greenland is described in detail by Fulton (1989). The following figure is a brief summary.

Figure 2.1 Surface and base elevations (m), and main ice divides of the Greenland Ice Sheet



(Reet. N., 1989)

The most widespread glacial deposits are patches of loose gravelly and sandy diamicton and scattered erratic boulders considered to be melt-out till. These materials form a continuous cover in the interior near the Inland Ice margin. Thicker deposits of melt-out till occur in lateral and terminal moraines. Moraines dating from Holocene deglaciation stages occur in all parts of the area, and in their general distribution follow that outlined for till deposits. Moraines generally have developed only along active sectors of the ice margin – lobes and outlet glaciers – while the regionally more extensive passive sectors have created few moraines. The location of moraines along the fjords – at fjord junctions and bends, and at places where the sides change from steep to gentle slopes – suggests that the moraines commonly were formed as an interaction between the glacier and the topography of its bed, rather than in response to climatic change.

Glaciofluvial and fluvial sediments cover the floors of all major valleys, occurring as outwash plains and fluvial terraces deposited from braided rivers. The most extensive plains occur in the valleys between the Inland Ice margin and the heads of fjords. Glaciofluvial sand and gravel also occur as kame terraces along valley sides. Eskers forming from subglacial meltwater are not common.

Marine sediments ranging from coarse littoral gravel to massive or laminated silt are widespread in the coastal areas, occurring up to 140 m above present sea level – the maximum elevation of the Holocene marine limit.

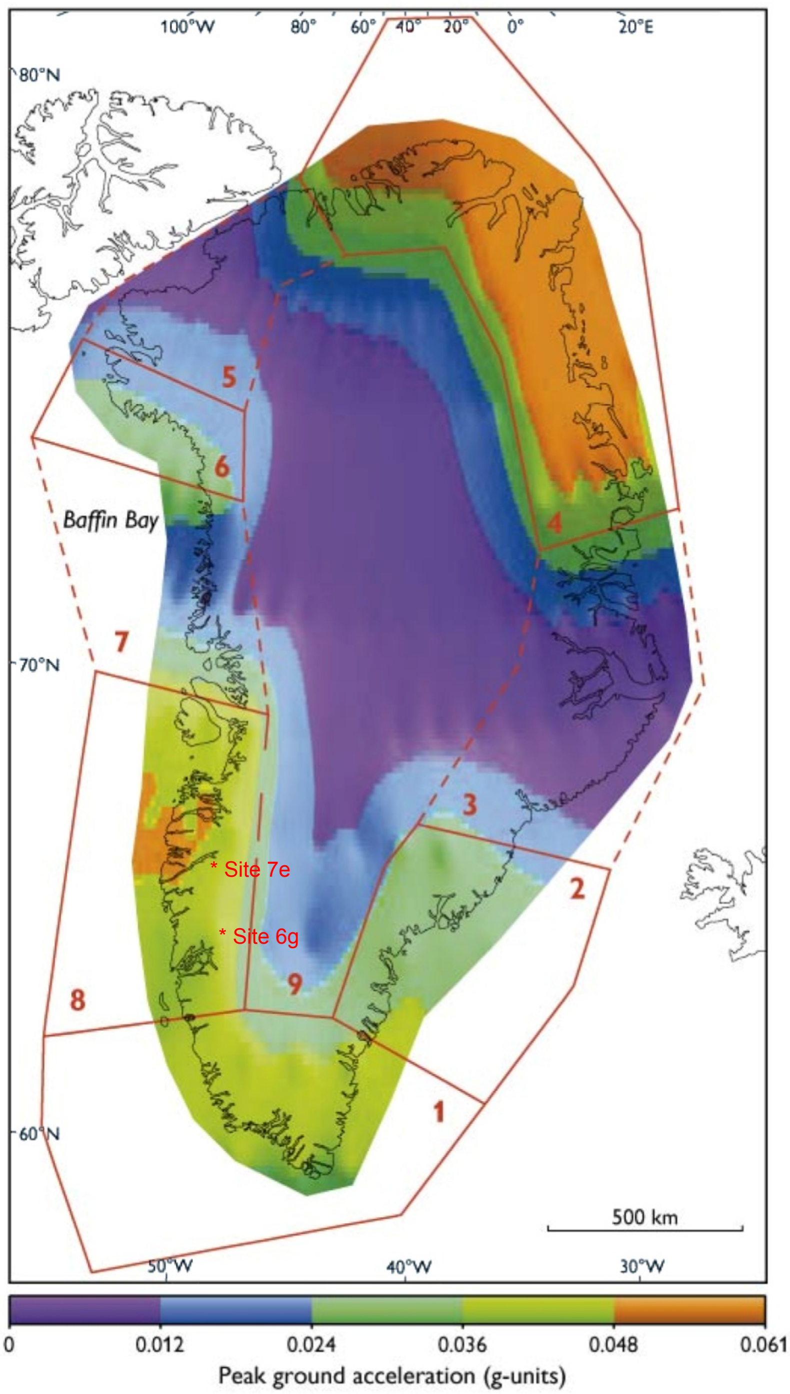
Earthquake activity in Greenland has been registered and mapped since 1907 and thus a long (albeit relatively sparse) record of seismic activity is available for evaluation of seismic hazard and risk.

The seismic hazard assessment of Greenland is computed for a return period of 475 years as shown in Figure 2.2. The maximum hazard is found in seismic source zone 4 at a value of 0.051 g (50.37 cm/s²). From this result, the general seismic hazard in Greenland is considered to be low, following the classification of Jiménez et al. (2003) in which low, moderate and high hazards correspond to peak ground accelerations of 0.0-0.08 g, 0.08-0.24 g and above 0.24 g, respectively, for a 475-year return period (GEUS, 2007 – Geological survey of Denmark and Greenland, bulletin 13, 57-60).

Seismic source zone 4 covering the northern and north-eastern parts of Greenland is the area with the highest seismic hazard; the seismic hazard is below 0.05 g in the other seismic source zones where the highest hazards are encountered in the Disko Bugt – Sisimiut area (seismic source zone 8) followed by southern Greenland (seismic source zone 1).

Site 7e is located in zone 8. Thus, the peak ground acceleration is 0.048 g for a 475-year return period.

Figure 2.2 Seismic hazard in Greenland for a 475-year return period



2.3 Site investigations and local geology

2.3.1 Previous investigations

In 2007, during phase I of the MOU, PB Power completed various field studies and technical analyses as part of an initial feasibility study including Phase I of the geological and hydrological investigations. Specifically, the geotechnical investigations consisted of preliminary geologic mapping of proposed civil works alignments and preliminary borrow source assessments as well as aerial and topographic surveys.

Additional investigations were carried out in 2008. These investigations included geologic mapping in addition to borehole drilling. One borehole was drilled in the former intake area at site 7e (EPT-1), and thermistor strings were installed for permafrost characterization. Two samples of rock core were recovered and tested for a variety of laboratory tests.

Electromagnetic (EM) and seismic refraction surveys were carried out along proposed dam, canal and borrow areas. Only overland profiles were obtained; no profiles were obtained beneath major streams and rivers. The geophysical data were processed and interpreted with calibration to observed rock outcrops, but not against geotechnical boreholes.

A summary of the 2007/2008 geotechnical investigations and the main findings are presented on Table 2.1.

Table 2.1
Site 7e – Existing investigations – Main geological and geotechnical characteristics – Summary

Location	Existing investigations	Rock properties	Soil properties and remarks
Power tunnel (2007/2008 axis) [The new axis (2009 study) follows the former alignment over ± 22 km, inlet is moved north-west (± 7 km), outlet is moved west (± 2 km).]	*Aerial photography* *Topographic maps (2 m contours)* *Geological mapping* *One borehole: EPT-1 located at the former intake area*	*Former intake* • Slightly weathered gray gneiss, foliation striking E/W, dipping steeply N (at least 45°) with few sets of discontinuities[(1)] • 2-3 m wide dykes, slightly weathered, heavily jointed; • RMR classification : average value: 70.3 (Class II, Good); • Geomechanical properties (3 samples): - Uniaxial compressive strength: 151 to 161 MPa - Young's modulus: 28 to 33 GPa - Poisson's ratio: 0.14 to 0.23 - Indirect (Brazilian) tensile strength: 4 to 7.5 MPa - Cerchar abrasivity index: 4.4 to 5.5 - Slake durability: 99.3 to 99.4 % - Petrographic analysis: quartzo-feldspathic gneiss *Along the length* • Massive gneiss with few sets of discontinuities, slightly to moderately weathered, foliation striking NE/SW, dipping steeply SE. Few dykes, heavily jointed, most 1-5 meters wide, some up to 20 m. • RMR Classification: average values between 60.5 and 87.3 (Class II, Good to Class I, Very Good) *Former Outlet* • Massive gneiss with few sets of discontinuities, two dykes 0.75 and 45 meters wide • RMR Classification: average value of 81.4 (Class I, Very Good).	*Former intake:* Thin glacial till cover *Along the length:* Glacial Till End Moraine *Former outlet:* Glacial Till End Moraine Outwash sediments
Dam 1 (2007/2008 axis)	*Aerial photography* *Topographic maps (2 m contours)* *Geological mapping (former axis)* *Seismic survey (former axis) – 8 lines*	• Slightly weathered gneiss with few sets of discontinuities, foliation striking NW/SE, dipping steeply NE • Heavily jointed granitic dike at right abutment, 10 m wide • RMR classification (right and left abutment): average values from 58.5 to 58.8 (Class III, Fair)	*Glacial Till* *Outwash Sediments*
Dam 1 and Spillway (2009 study) [Compared to the former axis, the new axis is located about 2.7 km north-west (downstream)]	*Aerial photography* *Topographic maps (2 m contours)* *Geological mapping (former axis)*	• The new axis is located some 250 m south from alternate axis (Alignment 2). Geological mapping between those two axis show the presence of massive gneiss with foliation striking NW/SE, dipping near verticaly SW (i.e. toward downstream). • Shear zone angling across dam alignment 2 was observed at each abutment. Steep cliffs at right abutment extend toward river. • The rock between the two axis was classified as Fair (Class III) to Good (Class II).	*Glacial till* *End Moraine* *Boulders*
Dam 2 (2007/2008 axis)	*Aerial photography* *Topographic maps (2 m contours)* *Geological mapping (former axis)* *Seismic survey (former axis) – 24 lines*	• Slightly weathered gneiss with few sets of discontinuities, foliation striking NE/SW, dipping steeply SW • Mafic dike heavily jointed, 10 m wide • RMR Classification: average values from 57.2 to 66.2 (Class II, good to Class III, Fair)	*Glacial till* *End Moraine* *Boulders*
Dam 2 and Spillway (2009 study) [Compared to the former axis, the new axis is located about 800 m west (downstream)]	*Aerial photography* *Topographic maps (2 m contours)* *Geological mapping (former axis)*	• The new alignment follows more or less the former alternate axis (Alignment 1) and it is some 200 m south-east from Alignment 2. Massive gneiss of good quality (Class II) is present at right abutment and granitic gneiss, also of good quality (Class II), is present at left abutment.	*Glacial till*

(1) Typically three orthogonal joint sets were found in the rock throughout the site 7e, with one set near horizontal and the other two near vertical. The predominant joint set is aligned with the foliation and tend to be steeply deeping (more than 45°).

2.3.2 2009 Field investigation[1]

An additional geotechnical investigation program was conducted in 2009. The main objective was to gather further data required for the completion of the Phase II engineering study.

Table 2.2 presents the nature and the scope of the 2009 geotechnical investigation. It comprises one deep borehole in the vicinity of the powerhouse, 4 boreholes at Dam 1 (2009 axis) and 4 boreholes at Dam 2 (2009 axis). Apart from gathering information of rock characteristics and conducting in situ testing of the rock, the deep borehole in the vicinity of the powerhouse allowed the installation of a piezometer and thermistor string to determine permeability and permafrost conditions.

The determination of the stress levels in rock formations will allow validation of the powerhouse location and orientation, rock reinforcement and also the length of the penstock steel liner upstream of the powerhouse.

Boreholes at dam areas allow determination of the overburden thickness and the rock characteristics of the foundations. A thermistor string was installed in one of the 3 boreholes at Dam 2 site. These data should allow validation of the decisions made with regard to foundation treatment and typical design cross sections.

2.3.3 Local geology

A summary of the main geotechnical features for each of the civil works as to the layouts studied during MOU Phase I is presented in Table 2.1. Since the beginning of the MOU Phase II engineering study in January 2009, some changes in the previous layouts were made and in some cases the civil works were completely or partially relocated. Therefore, the aim of the 2009 geotechnical investigation was to obtain information at these new sites and to confirm or complete existing data.

2.3.3.1 Powerhouse and power tunnel

While the new power tunnel axis follows more or less the former alignment over ± 22 km between PM 6+000 and 28+400, the water intake was relocated some 7 km north-west and the outlet was relocated some 2 km west (see Figure 2.3 for previous (2007/2008) and current (2009) axis location of the power tunnel and dams). The borehole EPT-1 being located at the former intake area, and therefore a geophysical survey will be required to determine the thickness of the overburden and the rock quality at the new intake (headrace canal). Moreover, a deep borehole (see Table 2.2) was drilled in the vicinity of the powerhouse complex to determine rock quality, stress levels, permeability and permafrost conditions.

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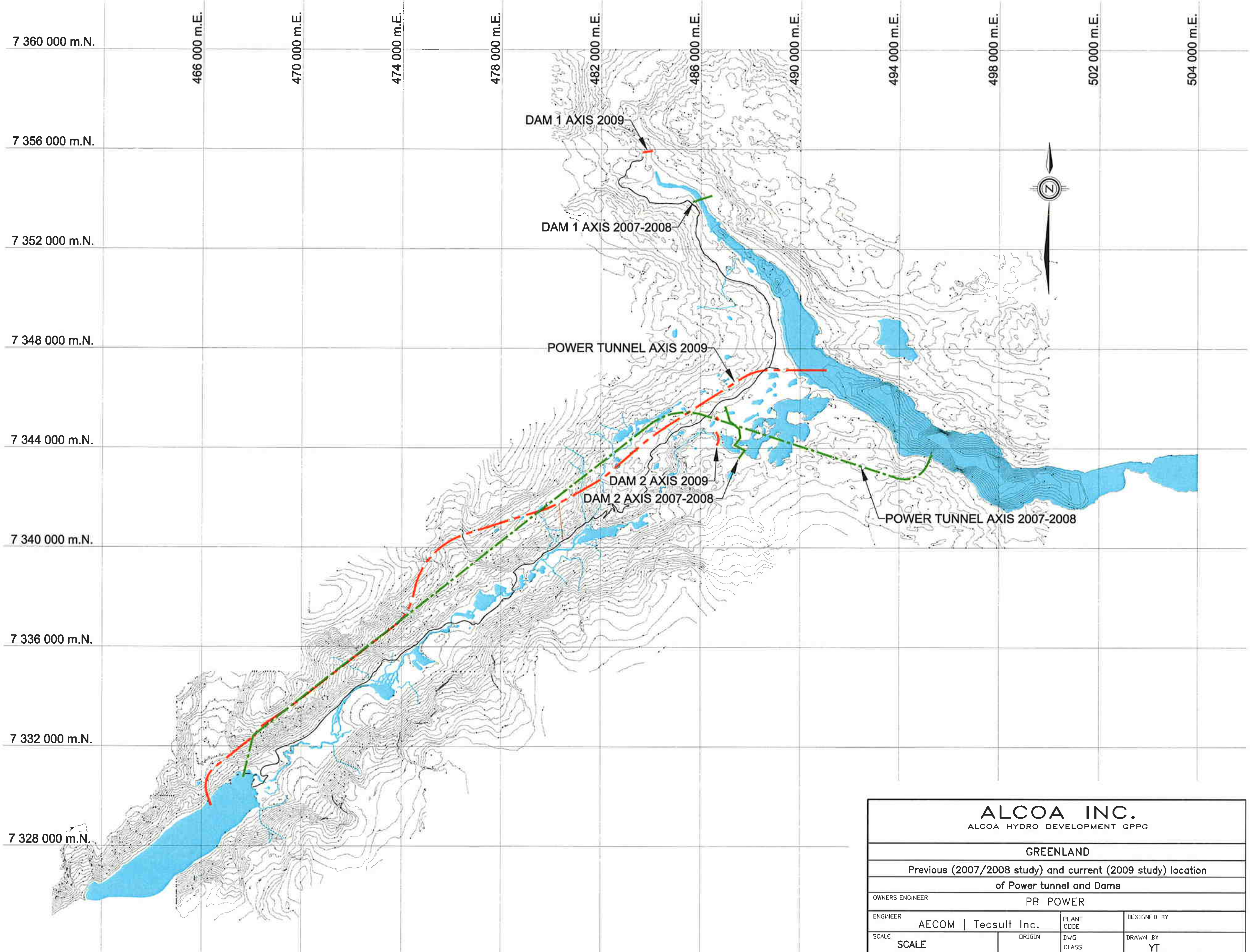
[1] Only partial and preliminary 2009 investigation results were available for the production of this report. Consequently, they are not fully integrated into the report. The main outcome of the 2009 investigations is the displacement of the powerhouse as described in section 12.



ALCOA INC. ALCOA HYDRO DEVELOPMENT GPPG			
GREENLAND			
Previous (2007/2008 study) and current (2009 study) location of Power tunnel and Dams			
OWNERS ENGINEER PB POWER			
ENGINEER AECOM | Tecsult Inc.		PLANT CODE	DESIGNED BY
SCALE SCALE	ORIGIN	DWG CLASS	DRAWN BY YT
Fig 2.3			CHECKED BY SS
			APPROVED BY SS

K:\CAMTL2\Dessins\0518015 GREENLAND\Geo\Working Folder 2009 studies\Site_7e\7e_ figures_rapport_09_2009\0518015-7e-Fig_2_3_09_2009.dwg

Table 2.2 Site 7e – Greenland Hydropower – E2.4arly engineering, Phase II – 2009 Investigation Program

Location	Borehole		Testing			
	Number	Total length (m)[(2)]	Permafrost	Piezometer	Hydrojacking test	Acoustic Survey
Powerhouse	1[(1)]	401	X	X	X	X
Water Intake	---	---	---	---	---	---
Dam 1 and Spillway	4	127.8	X (in 1 hole)	---	---	---
Dam 2	4	81	---	---	---	---
Total	***9***	***609.8***	***2***	***1***	***1***	***1***

(1) Borehole at 30° angle from vertical

Pending the integration of the 2009 investigation results in the present report, available data from geological mapping and borehole EPT-1 show that rock formations consist mainly of gneisses of Good to Very Good quality (Class II, RMR Classification) along the length of the power tunnel and in the former inlet and outlet locations. A few dykes that were heavily jointed, generally 1 to 5 m wide, some up to 20 m wide, were identified along the length of the power tunnel. In these zones, the average RMR value is 60.5 (rock of Good quality Class II). There are few sets of discontinuities along the length of the power tunnel, the main set being parallel to the foliation, striking NE/SW, deeping steeply (more than 45°) SE.

As the inlet and outlet were moved respectively some 7 km north-west and 2 km west from the former locations, these areas have to be investigated.

The geomechanical tests performed during Phase 1 on 3 rock cores from borehole EPI-1 (see Table 2.1) show that rock properties are typical of those of metamorphic (gneissic) and igneous (granitic) rocks. The uniaxial compressive strength varies between 151 and 161 MPa qualifying the rock formations as Very Strong (Class R4). The rock has very high slake durability (>99%).

2.3.3.2 Dam 1, spillway and diversion tunnel

Compared to the former axis, the new dam axis (2009) is located about 2.7 km north-west (downstream).

The area is covered mostly by rock outcrops (both abutments of the dam, diversion tunnel area and along the middle section of the spillway channel area).

In the former axis area, a heavily jointed granitic dike was identified at the right abutment of the dam, 10 m wide, nearly vertical. The overall rock quality (right and left abutments of the dam) was classified as Fair (Class III).

The new axis is located some 250 m from the previously investigated axis, Alternate 2. The rock between those two axis is classified as being of Fair to Good quality. Steep cliffs and the presence of large boulders are characteristic along the right side of the river. A Shear zone was observed angling across Alignment 2 at each abutment.

2.3.3.3 Dam 2

Compared to the former axis, the new axis is located some 800 m west (downstream). Dam2 is in fact constituted of two separated parts, named 2A and 2B. Part 2A is the main part of the dam while part 2B is only a freeboard dike sited 500 m away on the right abutment and wetted only during flooding periods. While in the Dam 2A area, most of the surface is covered by rock outcrops, in the Dam 2B area, glacial till is the predominant formation along the dam axis. Rock outcrops consist of massive gneiss and granitic gneiss of Good quality. Based on borehole 7E-D2-01-09, the thickness of the overburden at Dam 2B reaches 15 m.

2.3.3.4 Construction materials

2.3.3.4.1 Rockfill

Rockfill is the main material needed for the construction of the dams and for the production of aggregates for concrete. Most of the rockfill will come from the planned excavations. Moreover, rock outcrops for quarries are present at all sites and in the vicinity of the dam sites. Preferably, quarries for the dams should be located immediately upstream of each dam, within the future reservoir areas for environmental reasons.

Representative rock samples should be collected and sent to the laboratory for standard testing to ensure that the excavated rock meets the requirements for concrete production. Although concrete out of granitic and gneissic rock usually fulfills the requirements for a good aggregate, some essential tests such as alkali-aggregate reactivity and resistance of unconfined coarse-aggregate to freezing and thawing should be performed.

2.3.3.4.2 Till and other granular material

Potential borrow sources consisting of glacial deposits in the vicinity of the previous dam locations were identified during the 2007/2008 investigations. Although the thickness of the overburden seems rather limited (less than 5-6 m), there are few areas covered with soil along the dam alignments with occasional rock outcrops protruding the surface, and in the power tunnel inlet and outlet areas. Glacial moraines (till) are essentially needed for the construction of the cofferdams. Based on 2007/2008 field observations, these moraines are generally a widely graded material consisting of silt, sand, gravel and stones (cobbles and boulders). The stones are hard and durable and usually sub-angular or sub-rounded. Boulders reach up to 3 meters in diameter and are spaced within the overburden and are generally not nested.

River terrace deposits consisting of granular material such as sand, gravel and cobbles were observed between Dam 1 and Dam 2, as well as in the power tunnel intake area. These river terrace deposits being poorly graded could be suitable for the supply of fine aggregate for concrete and filter production. Areas of interest were identified and investigated by auger sounding during the 2009 investigations. As the information concerning the acceptability of these deposits for the production of filters and fine concrete aggregate is not yet available, it is assumed at this stage these materials will be processed from blasted rock.

Table 2.3 shows the quantities of rockfill (random rockfill, crushed stone and riprap) and till required for the construction of the dams and cofferdams.

Table 2.3 Site 7e – Borrow material – Quantities required for dam construction

Site	Rockfill (m³) Random rockfill	Rockfill (m³) Crushed [(1)] stone (all sizes)	Riprap	Till (m³)	Total (m³)
Dam 1 (including cofferdams)	639 300	127 000	21 500	30 700	*818 500*
Dam 2 (including cofferdam)	194 500[(2)]	100 300	24 500	1 100	*320 400*
Total	*833 800*	*227 300*	*46 000*	*31 800*	*1 138 900*

(1) Including asphaltic concrete core aggregate

(2) Including 3 000 m³ of 0-450 mm selected rockfill

2.4 Climate

Along West Greenland, a 3-4 m thick sea ice (called the west ice) covers most of Baffin Bay during the winter from the Polar Sea to approximately Sisimut. In summer the ice situation in the same waters is influenced by icebergs from the West Greenland Glaciers, mainly the Ilulissat Glacier. Varying quantities of west ice is brought along with the Labrador Sea Current down along the Canadian east coast; only a small proportion of the west ice remains during the summer. The climate in Greenland is an Arctic climate. The climate in Greenland varies considerably, even over short distances. The katabatic wind system of the Greenland Ice Cap results in wind moving from the central portion of the ice cap towards the coast. At the proposed project site, wind is predominantly from the east or southeast.

Along West Greenland, air temperatures vary between the coast and inland. Along the coast, drifting ice or cold water makes the air cold and humid. Further inland, the weather is often warmer and sunny. Differences of up to 5°C have been reported. Temperatures also vary according to altitude. While normally air temperatures decrease with altitude by 6.5°C per kilometer, in the Arctic, the change in temperature is smaller, owing to temperature inversions. One result of such inversions is that spring snow starts melting in the mountains rather than at sea level.

The amount of precipitation is generally higher along the coast than inland. Snow cover is also higher along the coast than inland. Many of the country's long-term meteorological stations operated by the Danish Meteorological Institute (DMI) are situated in Greenland's major population centres, which are mostly located on the coast. In the vicinity of the project area, meteorological stations have been established and maintained by ASIAQ for prior studies. Although the period of record for these stations is generally shorter and frequently with data gaps, these data are useful in better-understanding the climate of the project area. Figure 2.5 shows the locations of the DMI long-term meteorological stations, along with the locations of the nearby ASIAQ stations.

Figure 2.5 Locations of weather stations, West Greenland

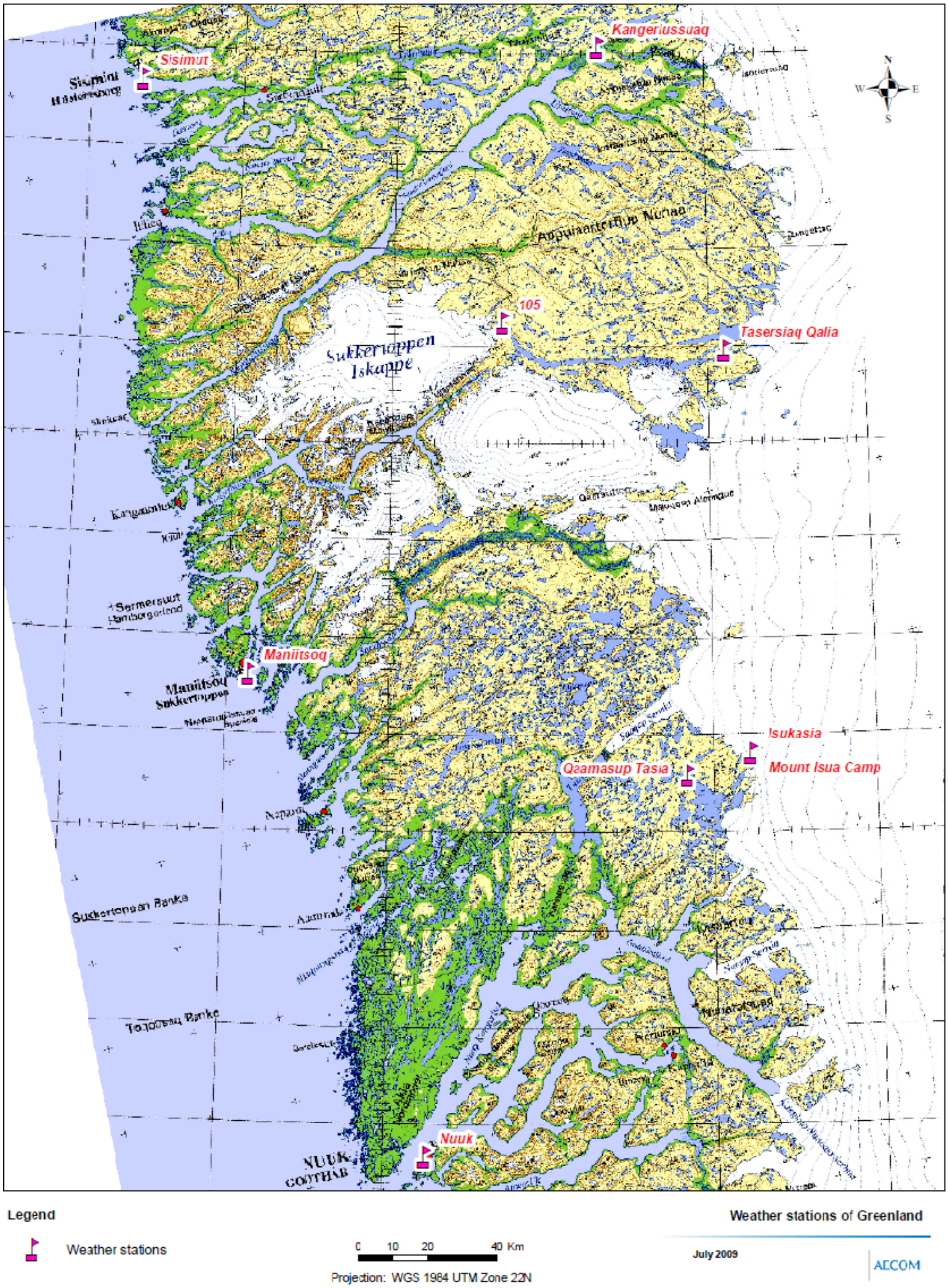


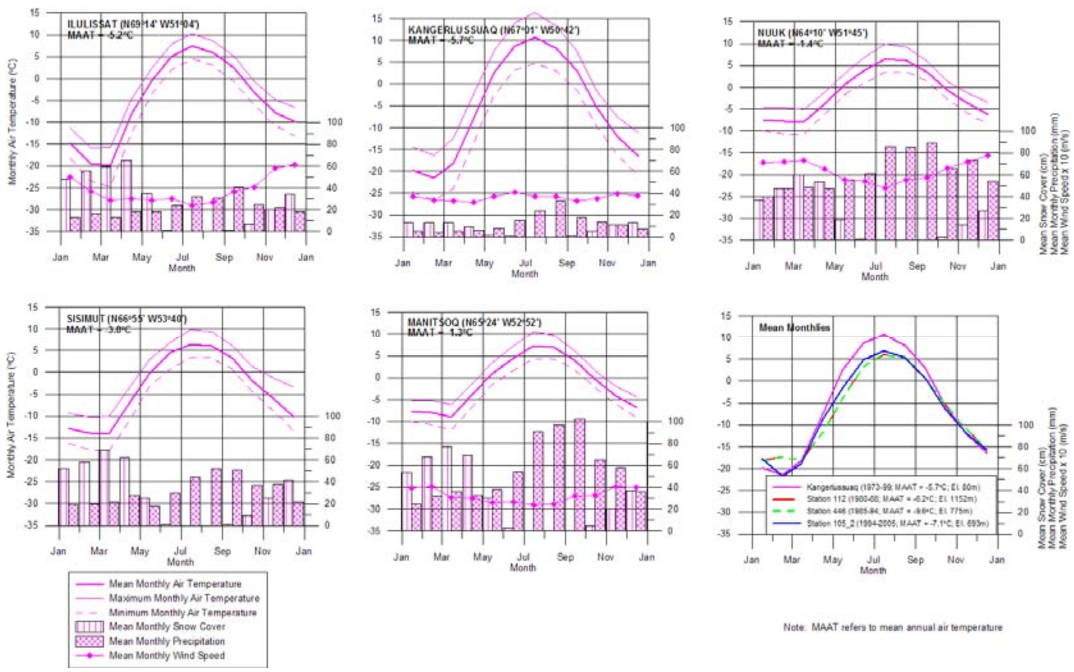
Table 2.4 summarizes the locations, elevations, and period of record for the various stations with air temperature records. Kangerlussuaq is the only DMI station that is located inland; the other DMI stations are located along the western coast.

Table 2.4 List of Meteorological Stations in West Greenland

Station	Name	Period of Record	Operated by	Latitude	Longitude	Elevation (m)
04221	Ilulissat	1961-90	DMI	N 69° 14’	W51° 04’	29
04230	Sisimut	1961-90	DMI	N 66° 55’	W 53° 40’	12
04231	Kangerlussuaq	1973-now	DMI	N67° 01’	W50° 42’	50
04240	Maniitsoq	1961-90	DMI	N65° 24 ‘	W52° 52’	25
04250	Nuuk	1961-90	DMI	N64° 10’	W 51° 45’	80
105	Tasersiaq	1994-04	ASIAQ			~ 750
112	Isukasia	1985-88 (86-87)	ASIAQ	N 65° 12’22”	W49° 45’54”	1152
	Mount Isua Camp	1971-78	ACG-VBB	N65° 12'13"	W49° 46'25"	
114	Tasersiap Qalia	1980-85	ASIAQ	N 66° 14’16”	W49° 53’42”	1000
446	Qaamasup Tasia	1985-94 (87-91)	ASIAQ	N65° 08’48”	W50° 09’47”	775

Figure 2.6 compares the climatic conditions of these stations.

Figure 2.6 Climatic Normals, West Greenland Meteorological Stations



For the DMI stations, monthly air temperatures (mean, maximum, and minimum), precipitation, snow cover and wind speed are presented for the climatic normal period of 1961-90 (Capellan et al., 2001). Figure 2.6 also presents the mean monthly air temperatures for the ASIAQ stations. Figure 2.6 shows that there is no strong relationship between latitude and air temperature. Summers are generally warmer and winters are colder inland (Kangerlussuaq) compared to the coastal stations. Kangerlussuaq also receives much less precipitation and thinner snow cover compared to the coastal stations. By inference, the climate of the project site is also expected to have warmer summers, cooler winters, and less precipitation and snow cover compared to the coastal stations.

The climate at Site 7e is influenced by the rugged topography, the Sukkertoppen ice cap, and the deep fjord. Climate may be variable even over short distances (e.g. from one end of the fjord to the other). The climate at Site 6g is expected to be warmer than at Site 7e because of its location further south, its distance from the ice sheet, and its more flatter and, less-rugged topography.

Table 2.5 lists the mean and extreme maximum/minimum daily air temperatures for the Tasersiaq station. Subfreezing temperatures can be anticipated at any time of year.

Table 2.5 Summary of Monthly Air Temperatures, Tasersiaq Station, 1994-2005

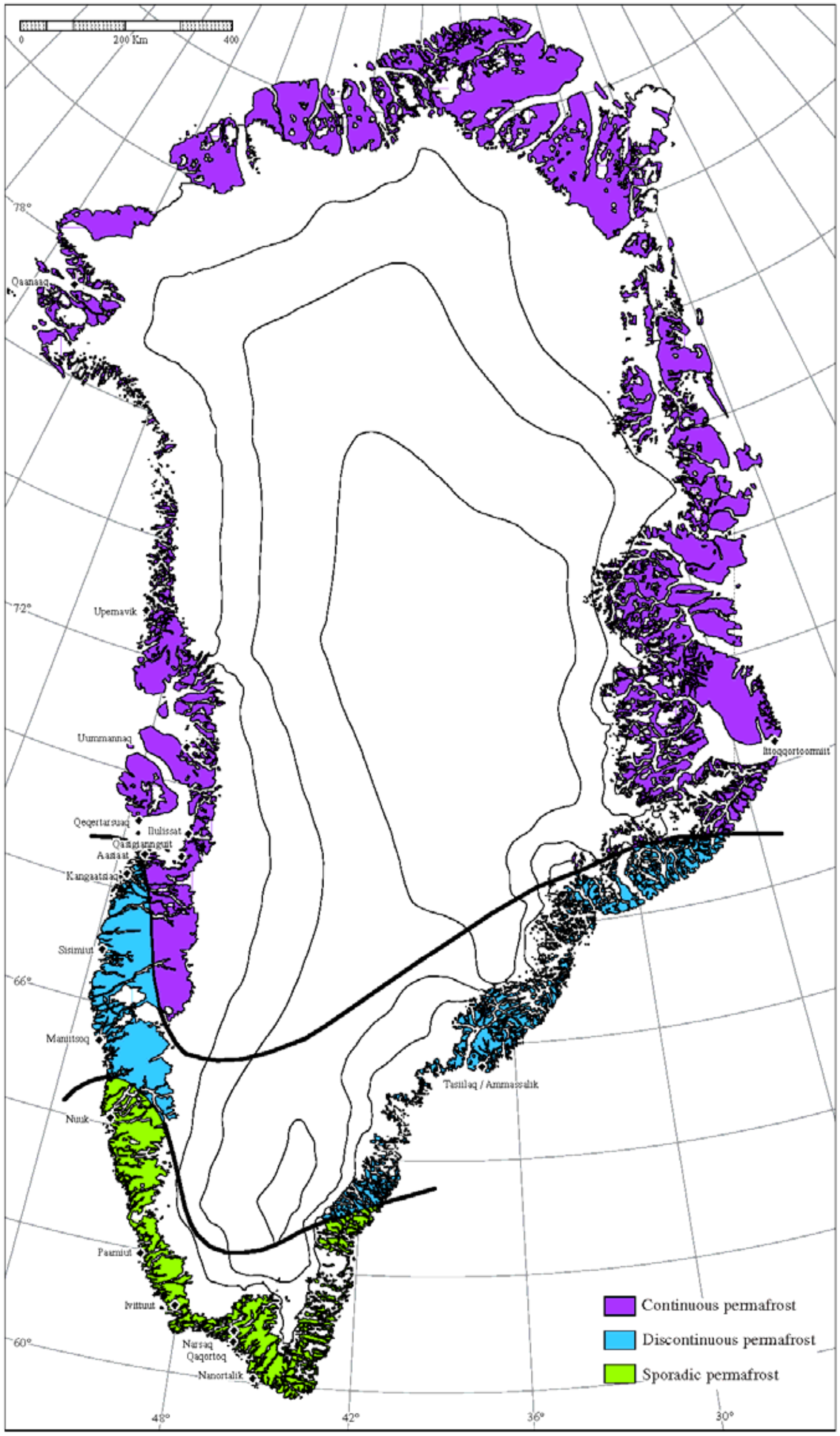
Month	Air Temperature (°C)		
	Mean Monthly	Extreme Minimum Recorded	Extreme Maximum Recorded
January	-17.6	-39.4	6.4
February	-21.8	-41.8	8.2
March	-18.9	-43.6	6.4
April	-8.8	-30.8	6.1
May	-1.5	-23.5	13.9
June	4.8	-5.7	17.9
July	6.9	-2.2	17.5
August	5.3	-3.4	15.2
September	0.7	-13.3	10.4
October	-6.4	-31.0	7.4
November	-11.8	-32.9	8.2
December	-15.6	-41	5.8

The mean annual air temperature at the Site 7e dam areas is expected to be approximately -7°C, based on the monitoring data from the Tasersiaq station. Considering the topographic variations across the site, the climate is expected to be cooler (mean annual air temperature of approximately -9°C) and windier at the top of the fjords near the edge of the ice cap, and warmer (mean annual air temperature approximately -4°C) at the head of Evighedsfjord. At Site 6g, the mean annual air temperature is estimated to range from -5°C to -4°C. Closer to the ice sheet to the east, temperatures are expected to be somewhat cooler.

2.5 Permafrost and ground temperatures

The presence of permafrost, or ground that is perennially frozen for at least two consecutive years, is controlled primarily by climate (air temperature, snow cover, solar radiation), but also by terrain factors such as subsurface conditions, surface cover characteristics, and proximity to water bodies. The project area is within the area of discontinuous permafrost, according to the Greenland permafrost distribution map by Weidick (1968) (see Figure 2.7). The southern limit for continuous permafrost follows approximately the mean annual temperature isotherm of -5°C (Weidick, 1975).

Figure 2.7 Permafrost Distribution Map for Greenland



Permafrost has been categorized into three different types: continuous permafrost, which has continuous regions of permafrost with dispersed frost-free “islands”, discontinuous permafrost, which has more and larger areas without permafrost, and sporadic permafrost, where the permafrost is limited to small areas. The map shows the distribution of permafrost in regions at sea level. After Weidick (1968).

Ground temperature data for west Greenland area are available from the following sources:

- Ilulissat Airport (Ingeman-Nielsen, et al., 2008)
- Kangerlussuaq (van Tatenhove, 1994)
- Buksefjord Hydropower Project (N&R Consult A/S, 1994)
- Paakitsup Akuliarusersua Hydroelectric Power Station (Arctic Consultant Group and LIC Consult, 1985)
- Site 7e Power Tunnel Inlet (PB Power, pers. Communication)
- Sites 6g Power Tunnel Inlet and Outlet (PB Power, pers. Communication).

Figure 2.8 compares the measured ground temperature data. Table 2.6 summarizes the available ground temperature data. Permafrost thickness is not expected to exceed 300 m at the project site. Permafrost is expected to be more discontinuous (i.e., dispersed) at Site 6g than at Site 7e.

Figure 2.8 Ground Temperature Profiles, West Greenland

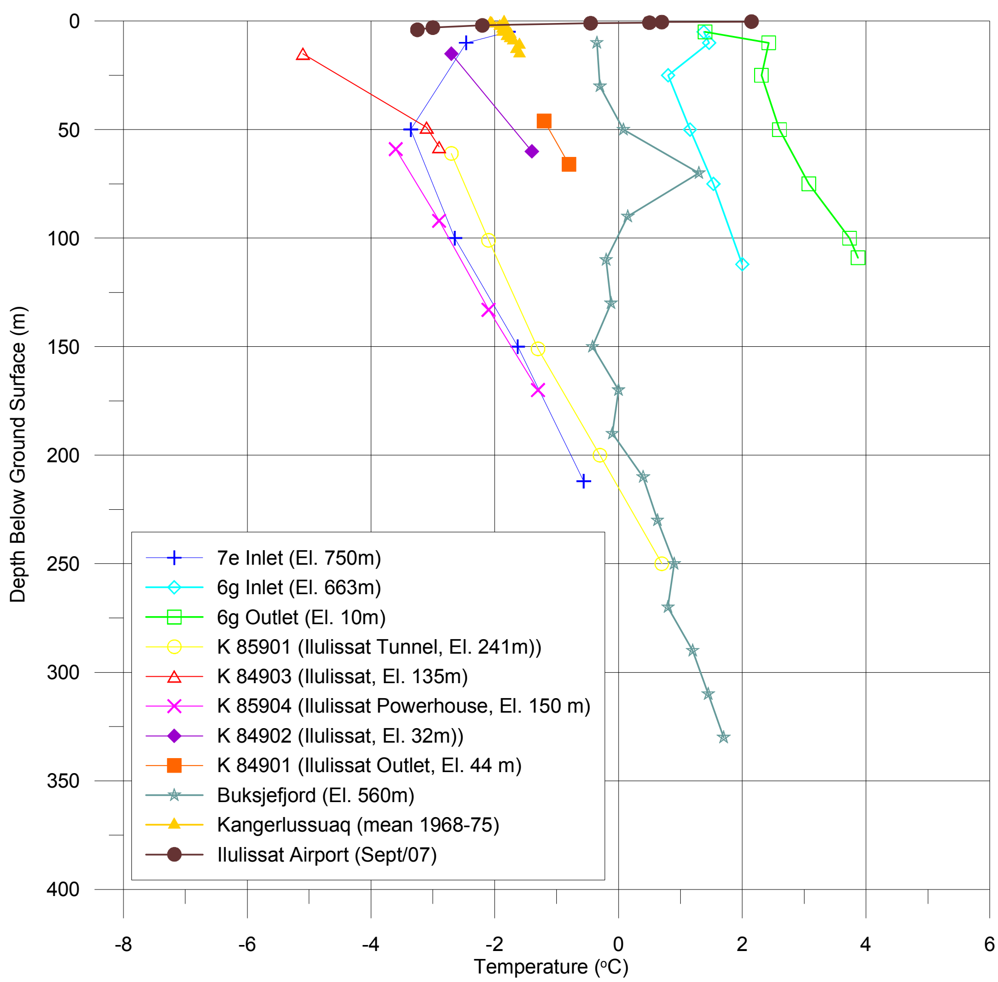


Table 2.6 Summary of Ground Temperature Data, West Greenland

Location	Ground Temperature	Permafrost Thickness	Comments
Ilulissat	-3.25°C at 4 m depth in early September 2007	Indeterminate	Measured ground temperatures up to 5 m depth
Kangerlussuaq	Mean ground surface -1.6°C	Approximately 127 m	Measured ground temperatures up to 15 m depth
Buksefjord stage III	Approximately -0.4°C at ground surface	Up to 170 m depth	Warm (+1.3°C) temperatures at 70 m depth possibly attributed to flowing groundwater
Paakitsup Akuliarusersua	Approximately -5°C to -2°C at ground surface	Up to approximately 240 m; thinner near inlet/outlet of power tunnel because of thermal influence from lake/fjord	5 deep ground temperature profiles, additional shallow temperatures (within 3.5 m depth).
Site 7e	Approximately 4.4°C at ground surface	Approximately 240 m	Measured ground temperatures up to 218 m depth. Located approximately 200 m from lake, only minor thermal influence from lake
Site 6g	Approximately 0.4°C to +1.4°C at ground surface	No permafrost	Holes located within 20 m distance of lake/fjord; thermally influenced by water bodies, Temperature measurements up to 112 m depth

The published ground temperature data summarized in Table 2.6 suggest that ground surface temperatures are between approximately 3 to 4°C warmer than the average annual air temperature; this is consistent with observations from northern Canada.

Ice sheets and glaciers dominate much of the Greenland landscape and impact the project site. It has been postulated by many that the bottom temperature of a continental ice sheet is colder than 0°C (Brown and Pewe, 1973). However, because of the proximity of bottom temperatures to 0°C, permafrost beneath the ice cap or glacier may be thinner than in areas exposed to cold air temperatures.

3 Hydrology

3.1 Previous study

Hydrologic modeling of the study area was carried out by Vatnatskil in 2005, and updated in 2008 and 2009. The modeling work produced long term series (50 years) for the past climate as well as projected series for 2020 and 2040 time horizons.

3.2 Available data

3.2.1 Water levels and tides

3.2.1.1 Water Level of Lake Tasersiaq

Hydrometric observations have been done since 1979, at the outlet of Lake Tasersiaq (station 105) where a calibration curve has been established. The maximum level observed at this location is 691.7 m for a discharge of 1 575 m³/s.

The hydraulic gradient between this station and the proposed intake zone for the headrace tunnel, varies with the discharge. The difference in level may reach about one meter at high discharges.

Water levels at Site 7e were also measured during the bathymetric surveys. At Lake Tasersiaq, the measured values vary from 691.35 to 691.13 m. The relevant values are presented in Table 3.1.

Table 3.1 Measured water level at Site 7e from bathymetric survey

Location	UTM Coordinate		Water level (m)
	Northing	Easting	
Power Tunnel Outlet	7 330 620	467 710	0.00
Tasersiaq	7 342 770	518 690	691.13
Tasersiaq Qalia	7 351 590	550 340	691.05
Tunnel Inlet North	7 345 140	493 330	691.21
Tunnel Inlet South	7 343 840	495 360	691.35

3.2.1.2 Tides

The tidal water at the end of Evighedsfjord was measured for 10 weeks during 2008. It was done by correlating the measured data from Evighedsfjord with tidal record data from Maniitsoq.

Tidal extreme values have been calculated on the basis of the three year tidal record, while mean sea level is calculated on the basis of the one year 10 minute tidal record. The values are presented in Table 3.2 hereafter. No estimation has been made on how the water level will be affected by extreme situations like low pressure systems, wind setup, surge flood, and the effects of the periodic tidal cycle of 18.6 years.

Table 3.2 Tides characteristics

	Height (m)
Highest Astronomical Tide	2.63
Mean High Water of Spring Tide	2.31
Mean Sea Level	0.09
Mean Low Water of spring Tide	-1.90
Lowest Astronomical Tide	-2.32
Delay of the tidal wave, Maniitsoq, mean value	Approx. 3 minutes

3.2.2 Inflows

The average discharge as measured at the outlet of the lake Tasersiaq is 85 m³/s based on a period of record of 1979-2008. The runoff has been modeled by Vatnaskil (2007, 2008, 2009) to produce synthetic discharge series based on the past climate (1958-2008) and projected discharge series which takes into account climate warming.

3.2.2.1 Drainage basins

The drainage basins have been delineated in the hydrologic report prepared by Vatnatskil 2009. The sub-catchments for Site 7e are presented in Figure 3.1. The catchments contributing to the inflows present large parts of glacial areas as indicated in Table 3.3. At Site 7e, the total area of the drainage basin is 9 051 km², from which 81% are glacier covered.

Table 3.3 Repartition of the catchments

	Catchment Area (km²)	Contribution* to the module discharge (m³/s)
Non glacial area	1 528	6
Glacial area	5 281	79
Total catchment	*6 789*	*85*

* Based on ratios from simulation results

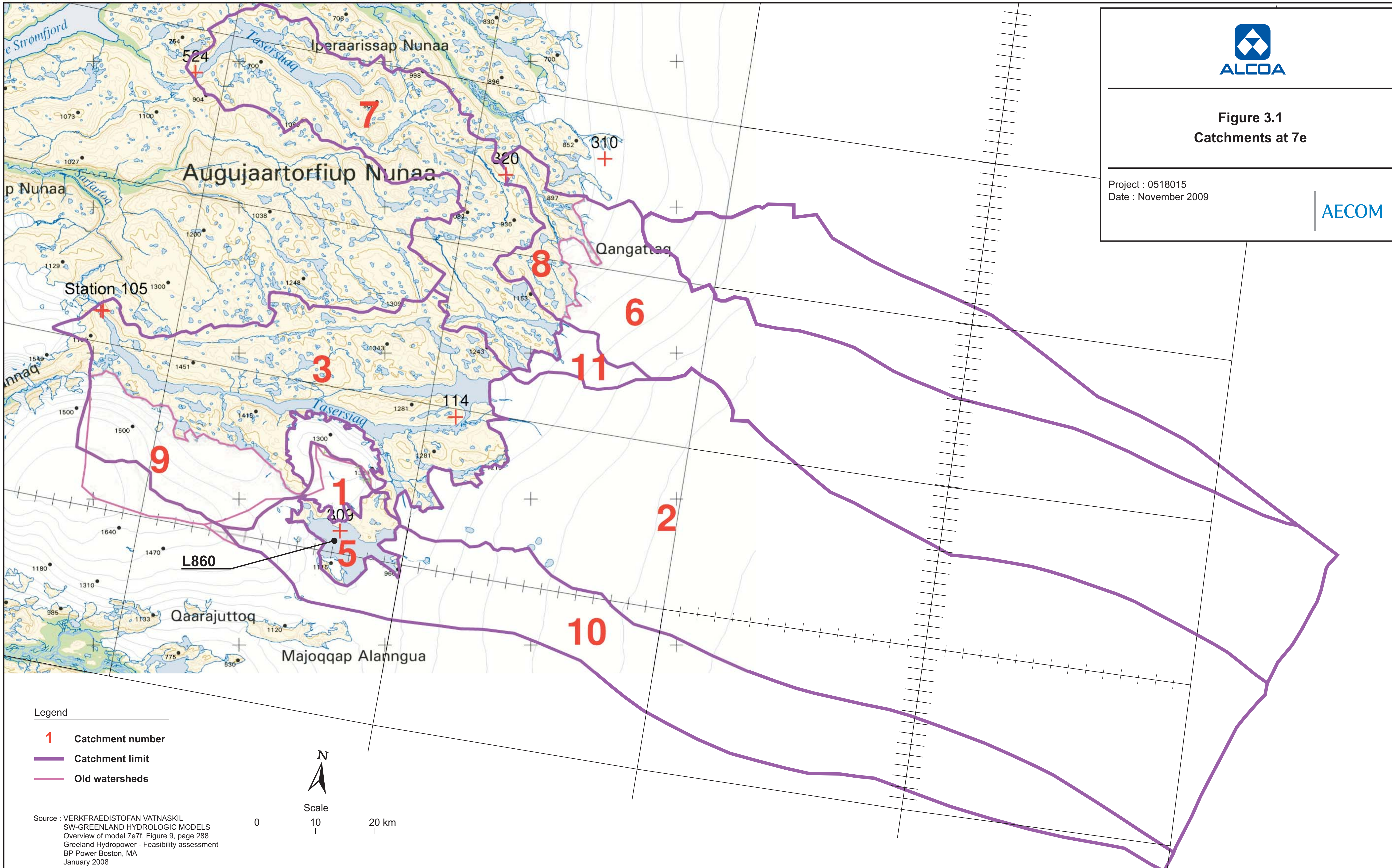


Figure 3.1
Catchments at 7e

3.2.2.2 Gauging stations

A gauging station (station 105) operated by ASIAQ is installed at the outlet of the Lake Tasersiaq. Discharge data is available for this station from August 1979 to August 2008. The average annual discharge for the complete set of data is 85 m³/s.

From the available data, a rating curve was established at station 105. The equation of this curve, giving the discharge in m³/s in function of the water level at the station in meter, is the following:

$$Q = 57.38\,(z - 687.94)^{2.49}$$

3.2.3 Storage curves

Lake Tasersiaq will be used as a storage reservoir for Site 7e. Its layout is presented in Figure 3.4. The storage curve data is based on 2 meters contour topography and 10 meters contour bathymetry. Based on that data, it takes into account:

- shoals at elevation of about 688 m cut the upstream part of Lake Tasersiaq (L690) from the proposed site for the intake structure;
- Lake Tasersiaq connects with Lake Tasersiap Qalia (L694) above the elevation 694 m;
- the thalweg at the outlet of Lake Tasersiaq is approximately at elevation 688 m.

In order to use all of the volume available in the lake below elevation 688 m, dredging of the shoals in the middle of the lake is required to transfer water from the upstream part of the lake to the zone near the intake structure below elevation 688 m.

The storage curves used for Site 7e are presented in Figure 3.2 and Figure 3.3 hereafter.

Due to the shoals in the lake, the stage-surface relationship shows large discrete increases at both elevation 690 m and 694 m.

Figure 3.2 Lake Tasersiaq Stage-Surface Curve

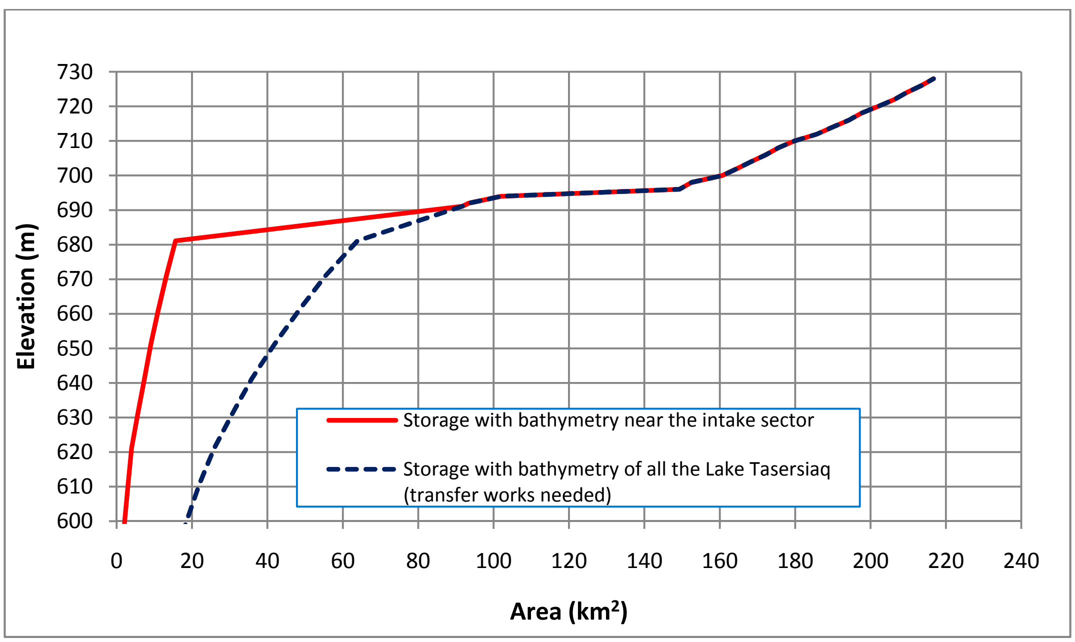
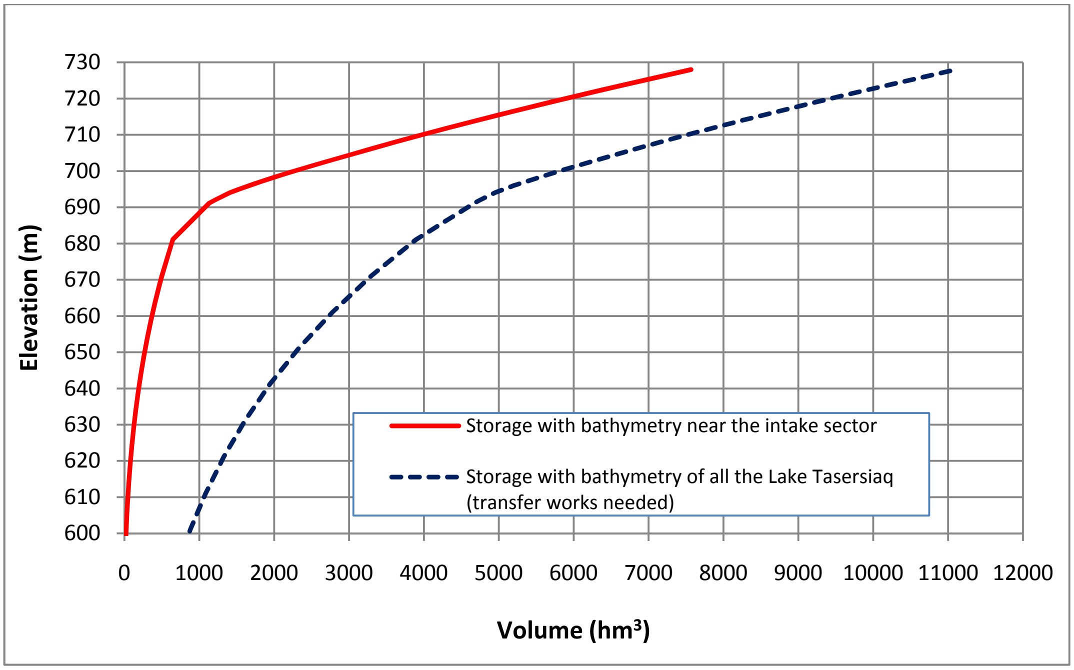


Figure 3.3 Lake Tasersiaq Storage Curve



3.3 Observed data and synthetic series

3.3.1 Observed data

The discharges are measured at the gauging station (Station 105). The average discharges and volume inflows at this station are presented in Table 3.4. The annual average inflows volume is estimated at 2 700 hm³ from the observed data. A large part of these inflows come from glacier melting and are available between June and October: 96% of the annual volume flows in this warmer period.

Table 3.4 Average Inflows at station 105

	Mean Normal temperature at Nuuk (°C)	Average discharge (m³/s)	Inflow Volume (hm³)	Inflow Volume Distribution
January	-7.4	2.4	6.3	0.2%
February	-7.8	1.5	3.8	0.1%
March	-8.0	1.8	4.8	0.2%
April	-3.8	6.1	15.8	0.6%
May	0.6	15.8	42.2	1.6%
June	3.9	72.6	188.3	7.0%
July	6.5	377.8	1 012.0	37.5%
August	6.1	394.2	1 055.8	39.1%
September	3.5	98.5	255.4	9.5%
October	-0.7	29.5	79.1	2.9%
November	-3.7	7.5	19.5	0.7%
December	-6.2	7.0	18.7	0.7%
Annual	***-1.4***	***85***	***2702***	***100.0%***

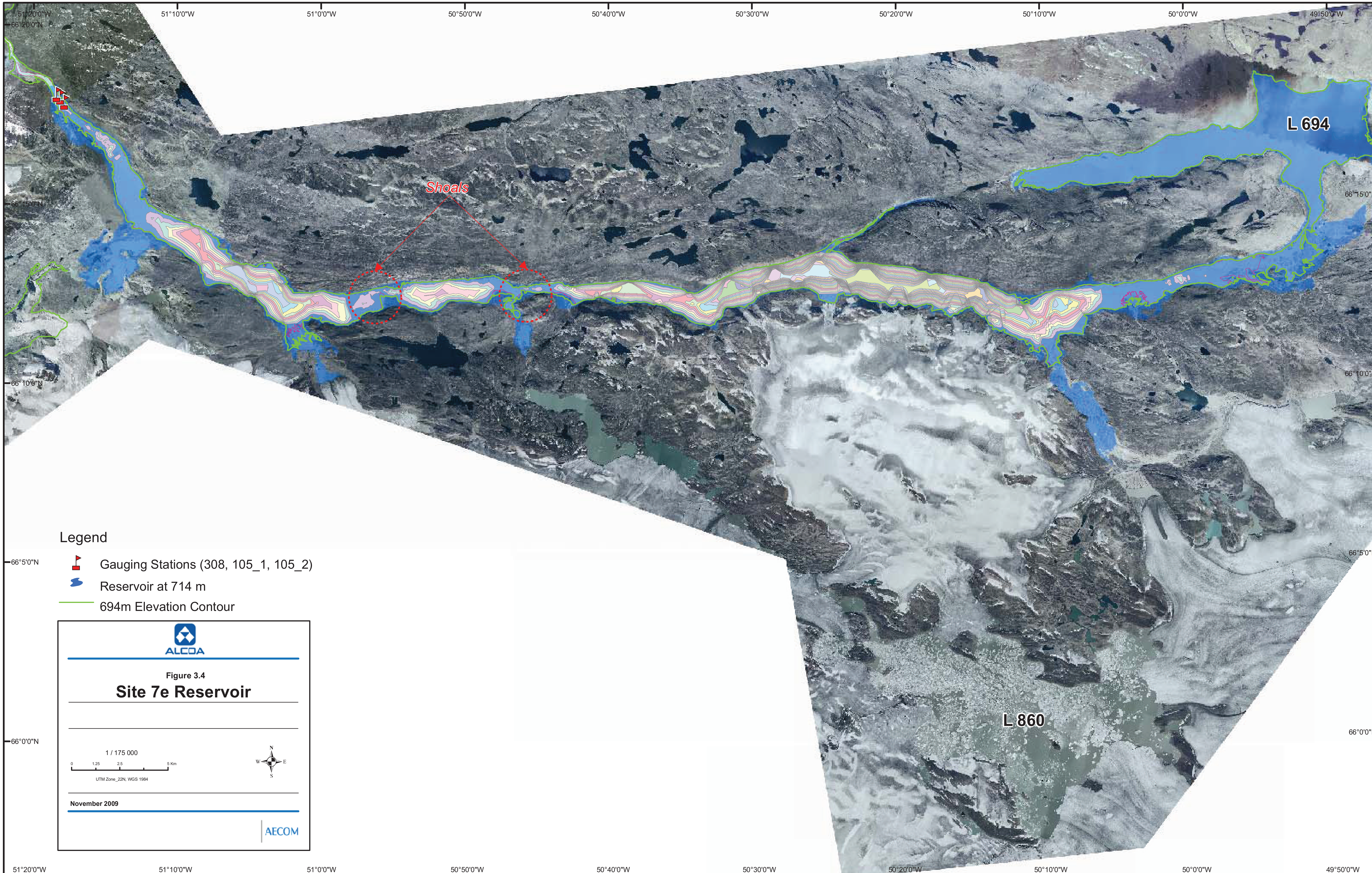


Figure 3.4

Site 7e Reservoir

During the winter months, the inflows are near zero. There is practically no storage from year to year, and it can be assumed that measured annual volume inflows to the lake are equivalent to annual volume outflows. A reverse routing has been applied to the series and gives peak inflow similar to peak outflow with a difference of about 2%.

3.3.2 Synthetic series

3.3.2.1 Hydrological model

Daily flow series have been generated for the period September 1958 to August 2008 by Vatnatskil (2007[2], 2008, and 2009[3]). The discharge data considered in this evaluation are those from the 2009 Vatnaskil report.

The hydrological model uses the energy balance approach, which requires climate parameters including air temperature, precipitation, wind speed, air humidity, surface air pressure and incoming long-wave and short-wave radiation data.

The terrain data come from a high-resolution digital elevation model for the glacier surface and glacier base and a geographical map from GTK[4]. The catchments delineation is based on these terrain data. Where the DEM is available, the catchments were delineated based on the Shreve potential theory, which takes into account an ice load factor. According to this method, it was determined that lake 860 at the site 7e does not drain to the lake Tasersiaq basin. This result may however still be questionable, since the data were sparse in the critical area (Vatnaskil, 2009).

First, the model was calibrated to better fit total water balance, observed average discharge distribution within a year and the measured ablation. It then served to produce historical synthetic discharge series, using past climate data from September 1, 1958 to August 31, 2008.

As a high percentage of the discharges come from glacier melting, the main independent variable is temperature. Figure 3.5 shows a plot of the annual temperatures and discharges.

It was then assumed that future flows can be estimated on the basis of assumption of climate warming projected changes. The simulations have been done for three cases:

- daily historical series, using past climate data from September 1, 1958 to August 31, 2008;
- projected daily discharge series for 2020, using a scenario of climate warming to have a projection of the inflows within the horizon of 2020;
- projected discharge series for 2040, using similar methods to that of 2020.

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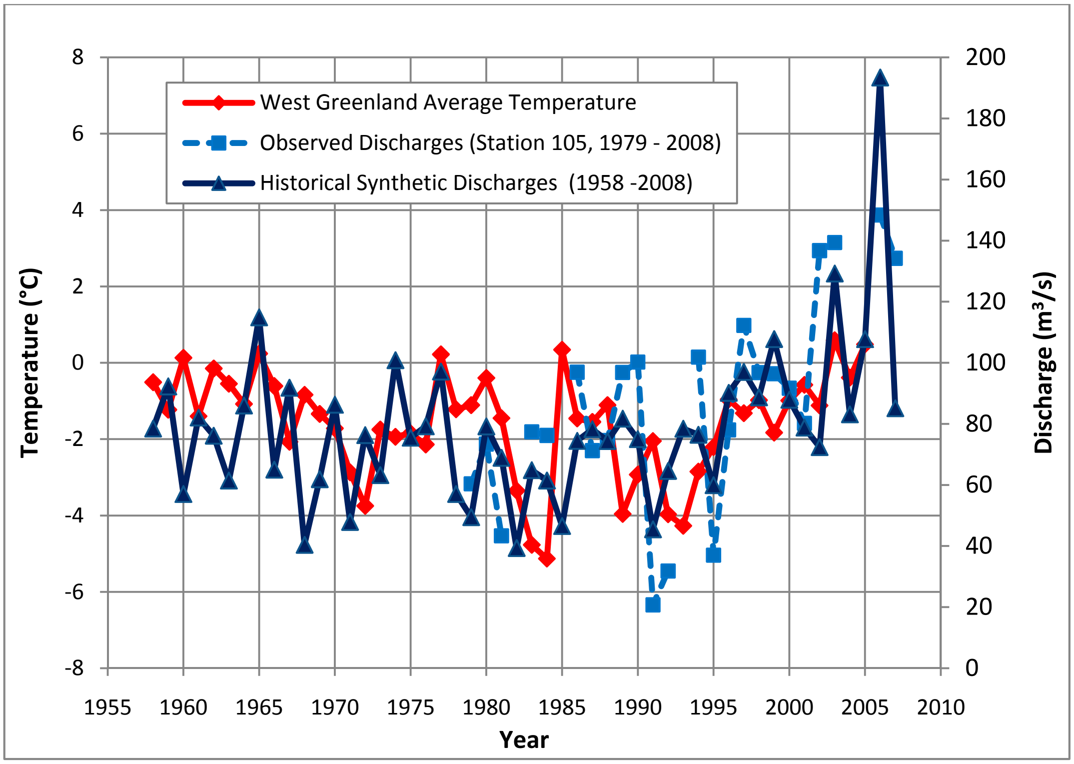
[2] Vatnaskil (2007) Hydrologic modeling in Southwest Greenland, prepared for Alcoa
[3] Vatnaskil (2009) Revised hydrological models in Southwest Greenland and future flows, prepared for Alcoa
[4] Grønlands Topografiske Kortværk (GTK)

Figure 3.5 Temperature and discharges



3.3.2.2 Warming climate effect

The future warming rates have been assessed by several climate model studies, using different scenarios of greenhouse gas emissions. Future melt rates on Greenland ice sheet can be expected to increase on average in the coming decades, due to the anticipated global warming of the atmosphere.

The approach chosen by Vatnaskil was to use monthly average warming rates from a model study, to project historical temperature and longwave radiation fields to the future reference years (2020 and 2040), then running the already calibrated hydrological model using the projected meteorological fields as input. The resulting discharge series can be considered to determine the probability distribution of the discharge for that reference year.

The warming rates used for the projection were extracted from a downscaling of a global climate model run, for Greenland and the surrounding seas (Vatnaskil, 2009). The model used for the downscaling is the regional climate model HIRHAM4. The global climate model data were interpolated to the regional climate model grid (25x25 km) every six hours for the period 1950-2080. The lateral forcing data came from a simulation with the global coupled climate model ECHAM5/MPI-OM1.

The greenhouse gas forcing in the model is from observations up to the year 2000 and follows scenario A1B thereafter. The monthly average warming rates are given in Table 3.5.

Table 3.5 Monthly average warming rates (1960-2040)

Month	Warming rate (°C/Decade)
January	0.28
February	0.50
March	0.48
April	0.52
May	0.30
June	0.21
July	0.13
August	0.05
September	-0.07
October	0.06
November	0.04
December	0.017

The effects of warming of the atmosphere on the melt rates do not emerge only through higher sensible heat flux due to higher temperatures, but also through higher incident longwave radiation. Longwave radiation is actually the thermal radiation of the atmosphere, which basically depends of temperature.

The temperature projection for a given date is performed in the following steps:

a) calculating the number of years from the given date until the reference year;
b) calculating the temperature change as the product of the number of years and the temperature change per year for the specific month;
c) adding the temperature change to the historical temperature.

3.3.2.3 Discharge simulation results

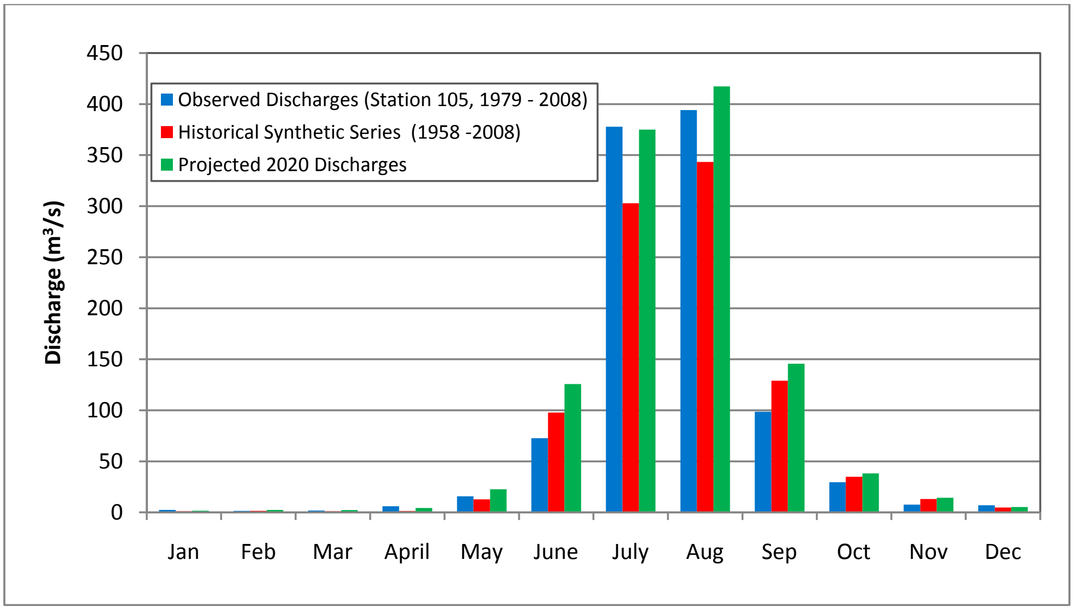
For the historical synthetic series, the annual average discharge is 83 m³/s and for the projected series for the 2020 horizon, the annual average discharge is 96 m³/s. The projected inflow average is 13% higher than the observed module (1979-2008), but is only 2% higher than the observed average of the last 20 years. Table 3.6 summarizes the average and extreme annual discharges of each series, while Figure 3.6 shows the monthly distribution of discharges for each series.

Table 3.6 Module Discharge

	Historic observed discharge / 1979 – 2008 (m³/s)	Historic Synthetic discharge / 1958 – 2008 (m³/s)	Projected 2020 discharge (m³/s)	Projected 2040 discharge (m³/s)
Minimum	19.6	37.7	46.0	51.2
Average	84.8	82.5	95.6	103.6
Maximum	148.4	209.2	215.5	234.3
Standard deviation	34.4	26.9	28.1	30.1

The 2020 projected discharge series is not stationary and shows a general trend. This may indicate that temperature changes are not linear in the time span simulated. Trendless series where obtained from the model by applying a shift in the warming rates towards the end of the series, after 1985. The annual averages obtained this way are 101 m³/s for the projected 2020 trendless series and 108 m³/s for the projected 2040 trendless series.

Figure 3.6 Average Monthly Discharges



The discharged series considered for power availability estimation and design purposes are those estimated for the 2020 horizon.

3.4 Floods

3.4.1 Methodology

The flood estimates were based principally on the 50 years series generated by Vatnatskil (synthetic series). The methodology adopted to determine the flood characteristics considers the following points:

- the time span of observed data is not sufficient to conduct flood frequency analysis. At Site 7e, there is less than 25 complete years of data;
- the annual peak discharges are underestimated in the synthetic series, but the annual volumes are fairly represented;
- the annual flood hydrographs go from June to October, with a peak in July or August.

Two methods have been considered to estimate the floods. The first method is based on the frequency analysis of the annual synthetic maximum discharges and the second is based on the frequency analysis of the annual synthetic volume discharges.

The frequency analysis has been done with HYFRAN (Hydrological Frequency Analysis) a statistic tool developed by INRS-ETE (Institut National de la Recherche Scientifique - Eau Terre et Environnement) of Quebec. It gives a large panel of probability law, applicable to hydro-meteorological series. The retained laws are principally the Generalized Extreme Value (GEV) and Pearson type III.

3.4.1.1 Peak discharge

For this method, the ratio between the observed peak discharges and the synthetic peak discharges are used to adjust 2020 projected synthetic discharge.

For Site 7e, this ratio is determined from the result of flood frequency analysis on synthetic past series and observed past series. The ratio is then applied to the results of the frequency analysis of the projected series. It gives an average increase of about 1.37.

3.4.1.2 Flood volumes

This method is based on the annual volume inflows. It appears that the volume inflows are independent and can be fitted to probability distributions. The results from frequency analysis of these data are used to determine the flood peaks from calculated ratios evaluated between peak discharges and volume inflows of the flood hydrographs.

The relevant characteristic of the hydrographs used is the ratio between peak discharges and the average discharges of the observed hydrographs at station 105.

At Site 7e, the base time of the hydrographs is about five months, from June to October, with the incidence for some years of spikes usually observed in early spring or late autumn: these spikes are probably ice-dam break discharges.

The characteristics of the hydrographs for each year show a ratio of peak discharge to average discharge varying from 2.6 to 5.9. The ratio used is that with an exceeding probability of 33%, which is estimated to value of 4.0. The equivalent ratio of peak discharge to hydrograph volume is 0.3 and is easier to use.

3.4.1.3 Inflow hydrograph

For the temporary structures, the design flood is taken from the results of the observed data. For the permanent structures, the selected design floods are taken as the maximum of the values calculated from the above methods.

The synthetic input hydrographs are based on the observed discharges of 1999 and are deduced by proportional transformation.

3.4.2 Results of flood frequency analysis

The flood frequencies for Site 7e are presented in Table 3.7. The results include the values for the observed, historic synthetic, and projected synthetic series. The hydrograph used are presented in the Figure 3.7

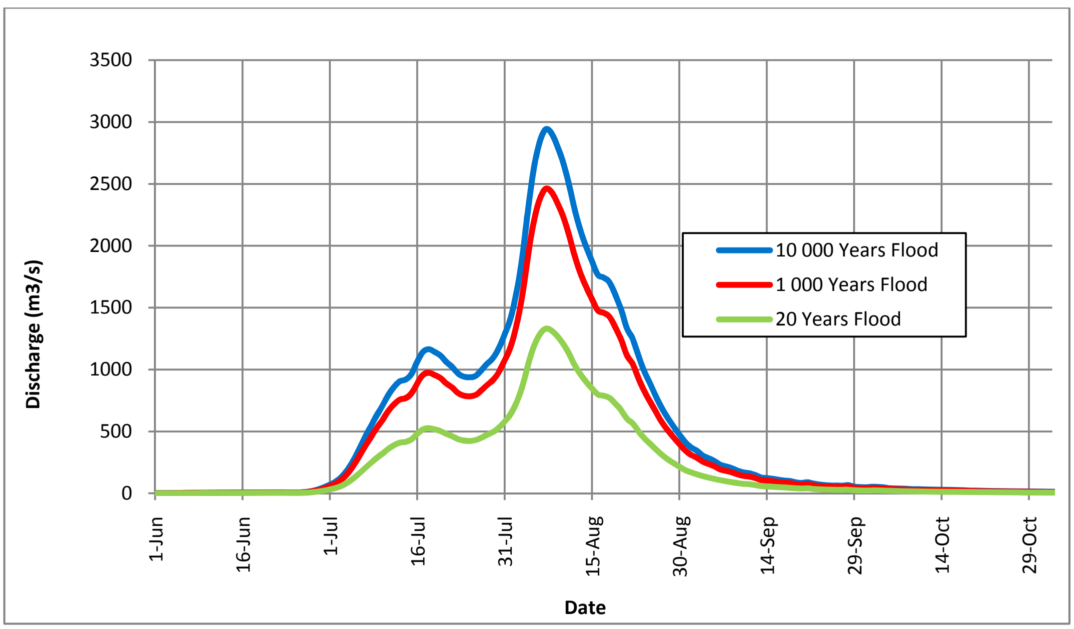
Table 3.7 Flood peaks at Site 7e

Return Period (years)	7e - Observed (station 105) (m^3/s)	7e - Historic synthetic (m^3/s)	7e -Projected 2020 (m^3/s)	7e -Projected 2040 (m^3/s)	7e annual Volume (hm^3)	7e-Projected 2020 reviewed (m^3/s)	7e-Based on volumes (m^3/s)	7e-Projected 2040 reviewed (m^3/s)	Selected floods (m^3/s)
10 000	2 310	1 730	2 160	2 210	**8 020**	2 942	2 416	3 020	**2 940**
2 000	2 084	1 530	1 880	1 940	**6 990**	2 619	2 106	2 690	**2 620**
1 000	1 984	1 450	1 760	1 810	**6 550**	2 470	1 973	2 530	**2 470**
200	1 736	1 250	1 480	1 540	**5 520**	2 125	1 663	2 170	**2 130**
100	1 623	1 160	1 360	1 410	**5 070**	1 969	1 527	2 020	**1 970**

Return Period (years)	7e - Observed (station 105) (m³/s)	7e - Historic synthetic (m³/s)	7e -Projected 2020 (m³/s)	7e -Projected 2040 (m³/s)	7e annual Volume (hm³)	7e-Projected 2020 reviewed (m³/s)	7e-Based on volumes (m³/s)	7e-Projected 2040 reviewed (m³/s)	Selected floods (m³/s)
50	1 503	1 060	1 240	1 290	**4 630**	1 823	1 395	1 870	**1 820**
20	1 333	931	1 080	1 130	**4 030**	1 614	1 214	1 650	**1 610**
10	1 191	826	956	1 010	**3 570**	1 449	1 075	1 480	**1 450**
5	1 030	711	826	880	**3 090**	1 271	931	1 290	**1 270**
3	893	618	723	770	**2 710**	1 121	816	1 140	**1 120**
2	754	527	630	680	**2 360**	978	711	990	**980**

The design criteria for the permanent structures use the flood discharges for the projected 2020 series. Corresponding values for the projected 2040 series are about 2.2% higher.

Figure 3.7 Synthetic hydrographs



3.4.3 Inflow Design Flood

The selected Inflow Design Flood for the 7e structures is the 1:10 000 years flood. It is based on the maximum discharges projected for the 2020 horizon. Its peak discharge is evaluated to 2 940 m³/s.

3.4.4 Inflows during construction

During construction, a risk of exceedance of 5% is accepted for the design of the temporary diversion structures. The selected flood is the 1:20 years flood. It is based on the maximum observed discharges. Its peak discharge is 1 333 m³/s.

The normal conditions during construction can be obtained from the monthly average discharges. The flow-duration values are given in the Table 3.8 hereafter.

Table 3.8 Flow-Duration values with synthetic historic series

Exceedence probability	January	February	March	April	May	June	July	August	September	October	November	December
Minimum	0.1	0.0	0.0	0.0	0.0	0.0	21.8	58.3	8.4	3.1	0.7	0.2
95%	0.1	0.0	0.0	0.0	0.0	12.7	110.6	119.8	33.6	6.3	1.4	0.3
90%	0.1	0.1	0.0	0.0	0.1	23.0	133.2	151.7	42.4	8.2	1.8	0.4
85%	0.2	0.1	0.0	0.0	0.2	30.6	148.8	172.9	49.4	9.9	2.1	0.5
80%	0.2	0.1	0.1	0.0	0.4	38.1	167.4	190.8	55.9	11.7	2.6	0.6
75%	0.2	0.1	0.1	0.1	0.8	45.2	190.8	205.0	62.2	13.7	3.0	0.7
70%	0.2	0.1	0.1	0.1	1.2	51.3	206.0	224.6	69.9	15.6	3.5	0.8
65%	0.3	0.1	0.1	0.1	1.7	57.1	217.4	241.3	76.8	17.6	4.0	0.9
60%	0.3	0.1	0.1	0.1	2.3	64.6	234.3	259.7	84.6	19.8	4.5	1.1
55%	0.3	0.2	0.1	0.1	3.0	71.3	247.3	281.2	92.8	21.9	5.1	1.2
Average	*1.2*	*1.4*	*1.1*	*1.3*	*12.7*	*97.7*	*302.8*	*343.4*	*129.0*	*34.9*	*13.1*	*4.7*
50%	0.4	0.2	0.1	0.1	3.9	78.2	268.0	300.4	100.9	24.5	5.7	1.4
45%	0.5	0.2	0.1	0.1	5.2	87.7	285.9	318.1	110.6	27.2	6.5	1.7
40%	0.6	0.4	0.2	0.2	6.7	95.3	307.2	338.1	120.9	30.1	7.4	2.1
35%	0.7	0.5	0.2	0.2	8.9	105.4	327.3	364.1	132.5	33.6	8.5	2.5
30%	1.0	0.6	0.3	0.3	12.4	117.0	355.3	390.4	145.8	37.4	10.0	3.2
25%	1.4	0.7	0.3	0.7	15.5	135.3	390.7	424.4	162.1	42.2	11.9	4.2
20%	1.8	0.8	0.4	1.1	19.0	150.1	423.9	473.3	183.5	48.5	14.7	5.9
15%	2.4	1.1	0.5	1.9	29.0	169.1	461.0	528.0	212.9	57.0	20.6	8.0
10%	3.1	1.6	1.2	3.4	35.6	190.2	514.2	602.1	249.0	70.1	34.2	12.3
5%	4.3	3.9	7.4	6.0	53.1	236.6	588.6	726.6	304.7	96.4	55.1	20.0
Maximum	16	59	41	45	213	608	1 151	1 131	768	308	189	117

3.5 Reservoir filling time

It is proposed to start the filling of the reservoir at the beginning of the 2015 melting season (5th year of construction), around May 15th. At this stage of construction, the dams will already have reached a 705 m elevation.

The volume inflow needed to fill the reservoir up to the maximum operation level of 714 m is 3 640 hm^3. From frequency analysis, such an inflow volume for a single year corresponds approximately to a recurrence interval of 5 years.

The reservoir filling was simulated with synthetic hydrographs calculated from the observed discharges, corresponding to:

- dry year, based on daily flow with exceedance probability of 80%;
- normal year, based on daily flow average;
- wet year, based on daily flow with exceedance probability of 20%.

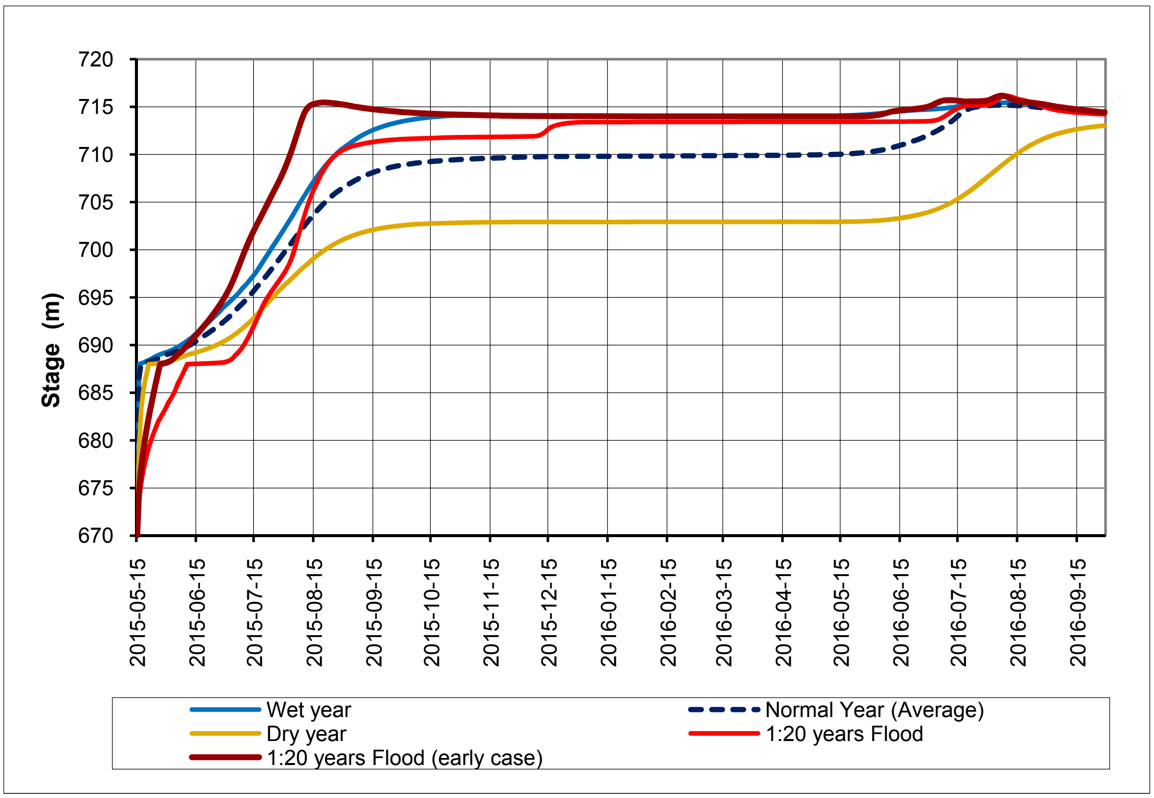
The inflow volumes for these hydrographs are respectively 1 840 hm³, 3 070 hm³ and 3 950 hm³. For a normal year, the inflows do not reach the volume needed to fill the reservoir, and the filling spans over two years. With a wet year, the reservoir can be filled in one hydrological year: such conditions correspond to the average of the last 10 years, and with climate warming, such conditions are expected to continue.

For flood conditions, two 1:20 years hydrograph floods have been considered based on the hydrograph of 1999 beginning in June and 1998 beginning in May.

The filling curves are presented in the Figure 3.8.

With the worst case scenario (inflow volume of 1 840 hm³), the maximum operating level of 714 m is reached during the month of August of the 2nd year (2016).

Figure 3.8 Site 7e Reservoir Filling



3.6 Sediments

The potential for sediment transport in the study area is limited since the surface is composed mostly of bedrock. Sand and gravel will be transported by the floods every year but are likely to be deposited at the bottom of the deep Lake Tasersiaq used as a reservoir. Sediment deposition in the headrace canal and near the intake is discussed in detail in section 6.6.3.

4 Power production and installed capacity

4.1 Smelter requirement

The firm power required at the smelter is 650 MW. This power should be guaranteed to be available at all times over a 50 year time frame of operation.

4.2 Firm yield evaluation

For the Greenland Project, hydropower will be the only energy source available for the smelter. The electric power to be produced is based on the smelter energy requirement of 650 MW to be provided on a constant basis. If considering potential power losses, a total of 685 MW is required at both sites combined (Sites 6g and 7e) to operate the smelter.

To ensure the reliability of the power plant operations, storage of the inflows in a large reservoir is required. The inflow distribution over a year is uneven, with only approximately 3 months of noticeable inflows during the summer, mostly from glacier melting. The variability of the inflows can also be important from year to year due to warmer or colder temperatures.

The hydroelectric firm energy will be based on the energy output over the most adverse sequence of flows in the design inflow series. This adverse sequence of flows is called the critical period.

The evaluation is based upon water resources expected upon the time of operation of the powerhouse: the discharge series used is the projected series for the 2020 horizon.

4.2.1 Drought characteristics

The average discharge for the series is 96 m^3/s. With a mass curve analysis, two main low streamflow periods have been identified:

- one period from 1967 to 1974, with an average discharge of 83 m^3/s and a minimum yearly discharge of 56 m^3/s;
- another longer period from 1977 to 1999 which may be split in two (1977 – 1989, 1990 - 1999) with average discharges of 84 and 86 m^3/s and a minimum yearly discharge of 53 m^3/s.

The minimum storage volume needed to pass these periods and supply a firm power of 500 MW is evaluated to be between 3 100 and 3 370 hm^3. Such a storage volume is available in Lake Tasersiaq between the levels 690 m and 714 m.

4.2.2 Operation range evaluation

4.2.2.1 Net storages

The presence of shoals in Lake Tasersiaq upstream of the intake zone limits the use of the full bathymetry of the reservoir, unless extensive dredging works are done. The natural water elevation of the Lake is around 690 m. During the bathymetric surveys, it has been measured at 691.1 m. The thalweg elevation at the outlet of the lake is estimated at 688 m.

From the storage curve presented in section 4, the reservoir storage has been evaluated for a minimum operation level varying from 690 m to 670 m and maximum operation level varying from 714 m to 726 m.

The net storage volumes are presented in Table 4.1 for alternative scheme of operation levels without and with dredging works.

Table 4.1 Net storage volumes at 7e

Range of elevation (m)	Storage with bathymetry near the intake zone (10^6 m³)	Storage with bathymetry of the entire Lake (10^6 m³)
690 - 714	3 639	3 639
690 - 717	4 219	4 251
690 - 720	4 814	4 847
690 - 723	5 430	5 463
690 - 726	6 062	6 094
680 - 714	4 085	4 425
680 - 717	4 665	5 005
680 - 720	5 260	5 601
680 - 723	5 876	6 217
680 - 726	6 507	6 848
670 - 714	4 226	5 013
670 - 717	4 806	5 593
670 - 720	5 402	6 189
670 - 723	6 018	6 805
670 - 726	6 649	7 436

Between the levels 690 m and 714 m, the volume of the reservoir is 3 639 hm³. It can be seen with Figure 4.1 that the increase in volume when lowering the minimum operating level is less than 15 hm³/m below elevation 680 m, when using only the bathymetry near the intake. With the entire lake volume below elevation 688 m, the gain is less than 60 hm³/m, but necessitates major excavation works which were evaluated to be uneconomical for the power gained.

For elevation over 700 m, the increase in volume is higher than 150 hm³/m. It seems that there is no advantage to go below 680 m for the operation of the powerhouse. It is confirmed by an evaluation of the marginal costs of lowering the minimum operation level, due to increase in the cost of the intake works. These cost are presented in Table 4.2. To go an below 680 m, the cost is up to 19.0 and 20.6 M$/MW, compared to units costs of 0.91 – 1.08 M$/MW for raising the maximum operation level (increase in the cost of dams).

As for dredging the shoals to use the upstream bathymetry of the lake, an evaluation of the marginal costs showed that this option wasn't relative to the base project interesting (marginal cost between 7 and 11 M$/MW).

Figure 4.1 Lake Tasersiaq Storage Variation

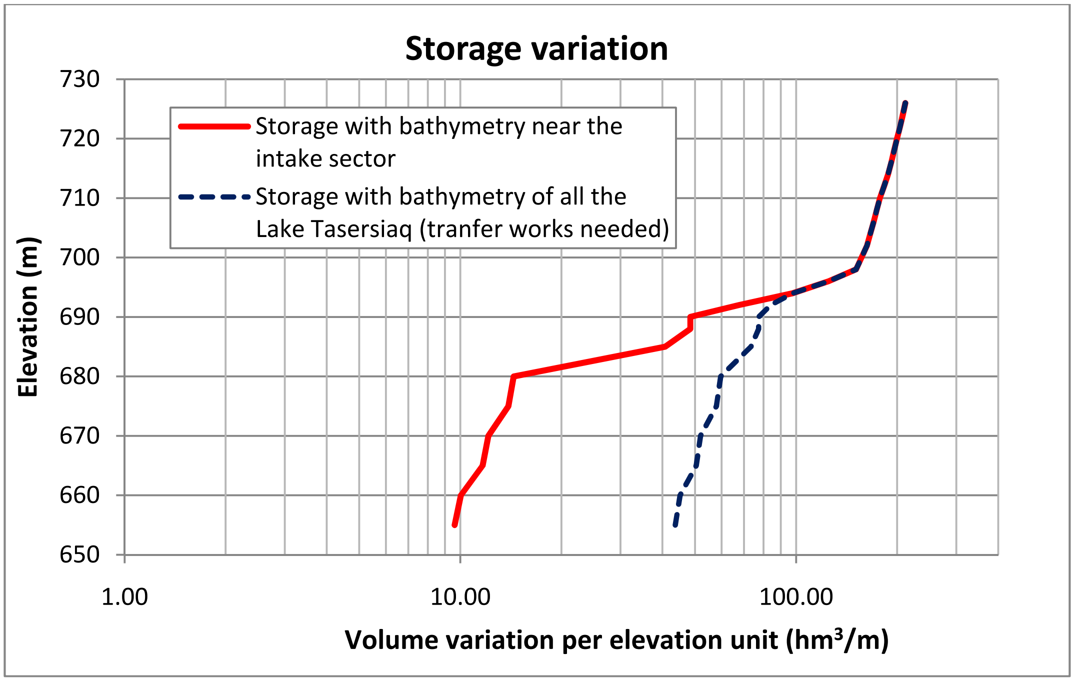


Table 4.2 Effects of operation levels

Gains by rising maximum level			
Operation range (m)	Storage increase (hm³)	Power increase (MW)	Marginal cost (M$/MW)
680 - 714	-	-	-
680 - 717	580	7	1.04
680 - 720	600	8	0.91
680 - 723	620	8	1.08
680 - 726	630	9	0.96

	Lowering minimum level			Adding storage from upstream portion of the lake		
Operation Range	Storage increase (hm³)	Power increase (MW)	Marginal cost (M$/MW)	Storage increase (hm³)	Power (MW)	Marginal cost (M$/MW)
690 - 714	-	-	-		-	-
685 - 714	242	2	3.4	178	4	2.4
680 - 714	204	2	4.9	163	2	10.8
675 - 714	72	0.5	19.0	226	3	7.1
670 - 714	70	0.5	20.6	220	2	11.0

4.2.2.2 Minimum and maximum operation level

Based on the above results, the bathymetry of the upstream part of the lake below 690 m is not taken into account in the net volume and only the storage above the elevation of 680 m will be considered for power generation. For now, it is planned to operate the reservoir between elevation 680 and 714 m.

4.3 Power production study

4.3.1 General methodology

The approach used to determine the energy potential of Site 7e is the sequential streamflow routing method, which is the most viable method for evaluating storage regulated power projects or for multiple purposes such as power.

The method uses the continuity equation to route streamflow through the project, and thus it accounts for the variations in reservoir elevation resulting from water inflow and outflow. The routing is done over the 50 years streamflow series, with a daily step. For a given time period, the water withdrawn is determined in function of generation needs, which are constant in terms of delivered power. Water spills occur when the water level reaches the weir crest.

The level of firm power is determined by trial and error, and is defined as the output that will use the available storage completely once during the period of record.

The firm power is therefore dependant on:

- the drought characteristics;
- the net storage available;
- the net hydraulic head;
- the production device’s efficiency.

4.3.2 Model

The simulations were conducted with version 3.0 of the HEC-ResSim model. This model has been designed and developed by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers to perform Reservoir System Simulations.

The program can be used efficiently for single reservoir or for complete reservoir systems on either critical period or period of record studies. It can handle multi-hourly, daily, weekly, or monthly intervals. It is designed to simultaneously meet flood control criteria and conservation requirements within other operating constraints defined by the user. Conservation requirements can be expressed in terms of seasonal flow requirements or seasonal generation requirements, at specific reservoirs or as seasonal flow requirements at downstream control points. Each demand may be served by one or more upstream reservoirs based upon input data. System operations may be performed for flood control, water supply, and hydropower, where more than one reservoir is operated for a common location.

4.3.3 Net head

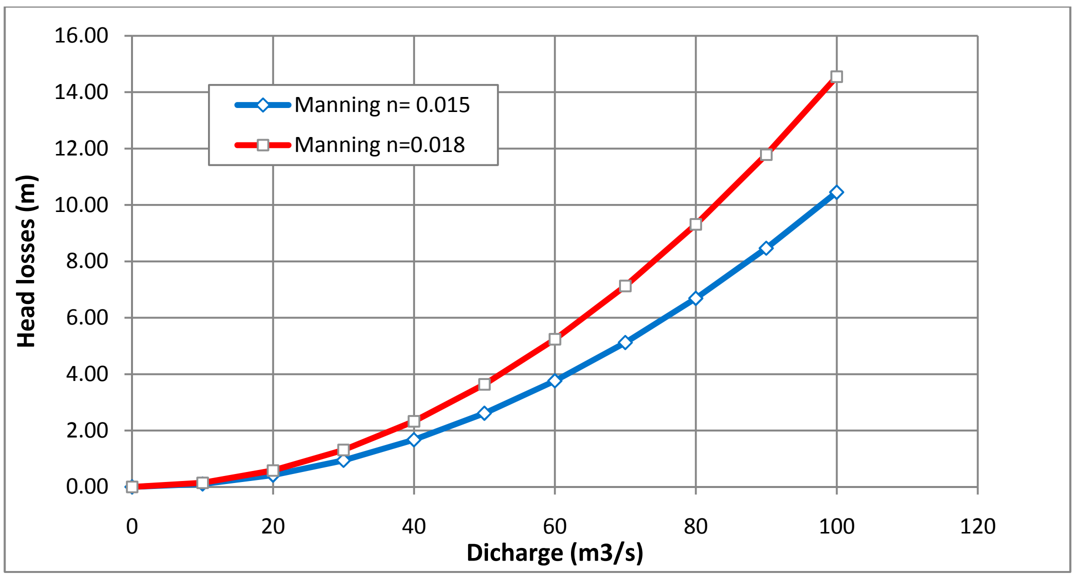
The gross head is taken between the pond surface and the level of the turbines nozzles, set at an elevation of 8 m. Such an elevation is chosen to ensure an appropriate clearance between the maximum tailwater elevation and the level of the flywheel. The clearance is set equal to 1.5 the diameter of the flywheel.

For evaluating the net head, head losses due to the intake structures and the power tunnel are taken into account. The characteristics of the power tunnel are:

- length: 26.6 km
- diameter: 8 m
- cross-section shape: Circular (TBM)
- cross-sectional area : 50.3 m²

Head losses - Discharge relationships are presented in Figure 4.2 below for Manning coefficient n equal to 0.015 and 0.018. However, the base case considered is a Manning's n of 0.015, which is likely for TBM construction.

Figure 4.2 Friction head losses



4.3.4 Production devices efficiency

The following parameters were defined from the proposed turbines:

- turbines: 91.9%
- generator: 98.6%
- high velocity oxygen fuel (HVOF) coating: 0.4%
- global efficiency used: 90.1% to take into account possibility for HVOF coating

4.3.5 Water losses

It is supposed that all of the inflows are reserved for hydropower generation.

Water losses may be of various kinds. In this stage, it is assumed that net evaporation losses are minimal. Preliminary values of head loss resulting from leakage through or around the spillways and the dams are considered, according to the Table 4.3.

Table 4.3 Water Losses

Elevation (m)	Leakage (m³/s)
700	0.35
714	0.50
726	0.65

4.3.6 Power simulation results

Power simulations were run using the available synthetic discharge series previously discussed. The 2020 projected discharge series is retained to determine the firm power available at Site 7e, but simulations were also run with the other synthetic series that are available for comparison purpose. The base scenario that is currently considered, operates the reservoir between elevation 680 and 714 m, without excavating the shoals in the reservoir. Such a scenario yields a firm power of 496 MW with the 2020 projected series and 528 MW with the 2020 projected trendless series, as presented in Table 4.4

Table 4.4 Firm power available according to various inflows series

Discharge series	Average yearly flow (m³/s) 1958-2007	Firm Power (MW)
Historical series	83.4	432
2020 projected series	**96.1**	**496**
2020 projected series (Trendless)	100.8	528
2040 projected series	104.0	536

The 2020 projected series represents the hydraulic conditions expected after the powerhouse is put into service. From the simulation results for Site 7e it can be assessed that the firm power at that horizon is between 496 MW (basic series) and 528 MW (trendless series). For the powerhouse design purpose, the firm power retained is 500 MW, in the lower range of the simulated values for the 2020 projections.

This value can be considered reliable. According to the future flow predictions based on the assumption of climate warming, it is likely that the inflows will increase, giving an increase of 7% of firm power between 2020 and 2040. Furthermore, the historical synthetic series considers a severe drought period in the early 1980's as previously outlined in figure 4.5. With the assumption of climate warming and the increase in discharges, it is conservative to rely on the last 20 years of the historical series (1987-2008), which yield a firm power of 503 MW, which is similar to the firm power retained for design.

Additional simulations were run with the 2020 projected discharge series to quantify the possibility to lower on raise the minimum operating level, and to raise the maximum operating level. It could be possible to increase the firm power at Site 7e by implementing such changes, although it is not possible to achieve a firm power of 650 MW only at Site 7e, which would have allowed to eliminate Site 6g.

The results of those power simulations are presented in Tables 4.5 to 4.7.

Table 4.5 Minimum reservoir level (with zone near the intake only)

Minimum operating level (m)	Maximum operating level (m)	Firm power (MW)	Operating discharge (m³/s)
690	714	486	77-82
685	714	491	78-83
680	714	496	79-84
675	714	497	79-84
670	714	498	80-84

Table 4.6 Minimum reservoir level (with excavation of the shallow waters in the reservoir)

Minimum operating level (m)	Maximum operating level (m)	Firm power (MW)	Operating discharge (m³/s)
690	714	491	78-83
685	714	496	79-84
680	714	498	80-84
675	714	501	81-85
670	714	503	81-85

Table 4.7 Maximum reservoir level

Minimum operating level (m)	Maximum operating level (m)	Firm power (MW)	Operating discharge (m³/s)
680	714	496	80-84
680	717	509	80-85
680	720	517	82-87
680	723	525	84-89
680	726	533	85-90
680	732	548	87-92

All of the results presented in the above tables were simulated for an initial reservoir level of 714 m (maximum operating level). As mentioned in Section 4.6, it is possible that the reservoir couldn't be filled in a single hydrological year if the inflows are not sufficient. In the worst case scenario, it is possible that the powerhouse operations could be started with a reservoir level of only 702 m. Such a scenario wouldn't change the firm power that was found in the simulations for the 2020 projected discharge series, since the volume available below 702 m is sufficient to produce power for the winter following reservoir impoundment start. Afterwards, the inflows would very likely be greater than the operating discharge of the powerhouse for a period of more than 5 years.

The same conclusion applies for the other discharge series and the values that are presented above. The only case where a difference in power production would occur would be if the inflows for the summer following the start of the impounding of the reservoir are lower than the operating discharge required near the minimum operating level for the firm power of 496 MW. Such a scenario is not likely to occur according to the synthetic discharge series used for the power simulations.

4.4 Available firm power at smelter location

The electrical power supply to the smelter will be provided by the two powerhouses of Site 7e and Site 6g.

The operational constraint is that a firm power of 650 MW has to be available anytime at the smelter. The power generated at the generating stations must be sufficient to cover this electricity demand as well as the electricity needs for the powerhouses, the stations service systems, the transmission line and the other different losses.

4.4.1 Station service requirements

Both powerhouses require power to operate, which amounts to a total of 6 MW for both sites. Table 4.8 outlines the needs at the 6g and 7e powerhouses.

Table 4.8 Power station energy requirements

Component	Site 7e (MW)	Site 6g (MW)
Powerhouse	1.6	1.3
Service Station	1.3	1.3
Intake structure	0.25	0.25
Total	***3.15***	***2.85***

4.4.2 Power losses

According to the information supplied by EFLA (transmission line subcontractor), the power losses through the transmission lines are estimated to a total of 22 MW for both sites combined. Finally, a 1% loss in the transformers is considered, which amounts to 7 MW for both sites combined.

4.4.3 Power needed at the generating stations

The power to be generated at Sites 7e and 6g is estimated to 685 MW on a firm basis, as shown in Table 4.9.

Table 4.9 Total power production needs

	Power (MW)
Smelter requirement	650
Station service system	6
Transport losses	22
Generator losses	7
Total	*685*

5 Design criteria and assumptions

5.1 Purpose and Scope

This part of the design criteria defines the general and technical requirements for the following civil works:

- main water intake structures;
- power tunnel;
- powerhouse including service bay;
- transformer cavern;
- cable gallery;
- access galleries;
- spillway;
- surge chamber.

5.2 Stability analysis

Classical stability analysis for the water intake structure, spillways and dams is required.

5.3 Design criteria for tunnels

5.3.1 Geometry of the excavations

The following criterias, with regard to the geometry of the openings, are considered when using drill and blast technique for the excavations:

- tunnel have a D-reverse shape;
- height to width ratio of the cross-sections of the power tunnels is at 1.3;
- the arch depth is equal to 25 to 30% of the width of the tunnel;
- the rock pillar between two galleries and/or the rock cover over a galleries is at least 1.5 times the width of the opening;
- the Manning's friction coefficient considered is n = 0.033 for head loss calculations;
- steel lining is placed in the tunnel near the intake and concrete is poured between the rock and the steel lined section. Elsewhere, the tunnels are unlined.

When a TBM is used for the excavations, the design criteria, with regard to the geometry of the openings, are the following:

- tunnels have a circular cross-section;
- the Manning's friction coefficient considered is n = 0.015 for head loss calculations;

Steel lining is placed in the tunnel near the intake and concrete is poured between the rock and the steel lined section. Elsewhere, the tunnels are unlined.

5.3.2 Excavation methods-Special requirements and restrictions

Well controlled drilling and blasting methods are generally used in all underground excavations to obtain relatively smooth, stable excavated rock faces with minimal overbreak, and requiring minimum scaling and support.

Generally, no excavation sequences or restrictions on methods are imposed that would tend to reduce the contractor's flexibility in planning and add to his costs. However, special requirements are imposed in some considered zones critical to the project and where a greater degree of insurance in the final results of excavation is needed.

In general, the excavation begins with a pilot tunnel on the first 10 meters, followed by slashing to the line within which excavation must be completed. The pilot gallery is excavated so that a layer of rock 2.5 m minimum thick is left in place inside the required excavation line of the walls and the arch of the tunnels. The maximum length of round for the pilot gallery generally does not exceed 2.5 m. Initially, the centre to centre spacing of the perimeter holes for the pilot tunnel is 60 cm. This spacing could be modified depending on the quality of the walls obtained and as to maintain the tolerances which will be specified in the technical specifications.

Pilot tunnel slashing as well as full face heading excavation shall be done using controlled perimeter blasting. Only cartridge type explosive will be used in the perimeter blast holes and in the buffer zone. Benching excavation in tunnel shall have the following specifications:

- maximum height of a bench: 10 m;
- maximum length of a bench: 10 m;
- maximum hole diameter of the perimeter, buffer and production holes: 70 mm;
- initial spacing of the perimeter holes (unless specified otherwise): 0.60 m c/c;
- loading of the perimeter holes: max. 0.65 kg/m² of presplitted surface excluding bottom load;
- bottom load of the perimeter holes: 1.25 kg/hole.

Borehole grid in frozen rocks should be reduced and the explosive ratio increased compared to the same rocks in a thawed state.

5.4 Design Codes and Standards

European standards (EN/ENV) with Norwegian design guidelines shall apply.

Data processing, design and fabrication shall conform to the requirements of European Committee for Standardization (CEN) codes and standards.

Where an applicable EuroNorm (EN) or EuroNorm Vornorm (ENV) is not available, an appropriate ISO standard, ASTM or other internationally recognized standard may be utilized upon prior approval.

The following European standards (EN/ENV) are the principal standards, codes, guidelines and references to be used for the structural design:

The latest edition of a code or standard shall govern.

- EN 2004 Eurocode - Basis of structural design
- ENV2009 Eurocode 1- Actions on structures
- ENV2007 Eurocode 2- Design of concrete structures
- ENV2009 Eurocode 3 - Design of steel structures (both heavy and light gage)
- ENV1996 Eurocode 6 - Design of masonry structures
- ENV2009 Eurocode 8 - Design of structures for earthquake resistance

The following is the list of other codes to be used in the calculations (the latest edition of the following codes or standards shall govern).

- Rules BAEL 91, modified 99
- UK National Annexes to Eurocodes
- BS 8500-1: Concrete - Complementary British Standard to BS EN 206-1
- BS EN 10080: Steel for Reinforcement of Concrete - Weldable reinforcement steel
- BS EN 206-1: Concrete - Specification, performance, production and conformity
- UK National Application Document for Steel Structures
- BS 4449-2005: Specifications of concrete steel bars for reinforcement of concrete
- ONGC 41-GP-35M, type 2 : waterstop in PVC (polyvinylchoride)
- USACE: Conduits, Culverts and Pipes, EM 1110-2-2902, Engineering and Design, March 1998
- USCAE: Shore protection Manual, Waterways Experimental station. Coastal Engineering research Center, 1984. (for tidal waves)
- Byngnings reglement 2006 - Greenland Building Code to be checked by Greenland Engineering Consultant
- Greenland specific Standard for Concrete - to be checked by Greenland Engineering Consultant

5.5 Material Properties

5.5.1 General

• Concrete:		
- Mass		2 500 kg/m³
- Compressive strength at 28 days - cylinder		30 or 40 MPa
- Concrete/rock adherence coefficient, c		300 – 1 000 kPa
- Concrete/concrete friction coefficient		1.0
- Thermal expansion coefficient		$10x10^{-6}$/°C
• Lean concrete:	compressive strength at 28 days - cylinder	15 MPa
• Porous concrete:	compressive strength at 28 days - cylinder	10 MPa
• Reinforcing steel:		
- Mass		7 850 kg/m³
- Yielding strength of regular rebars		500 MPa
• Compacted backfill:		
- Humid density of sand and gravel		2 000 kg/m³
- Humid density of rockfill		2 000 kg/m³
- Saturated density of sand and gravel		2 150 kg/m³
- Saturated density of rockfill		2 200 kg/m³
- Concrete/rockfill coefficient of friction		0.70
- Active coefficient(sand and gravel): K_a		0.33
- At-rest coefficient (sand and gravel): K_0		0.50
• Rock		
- Allowable bearing pressure		1 000 – 4 000 kPa
• Rock/concrete		
- Friction coefficient		0.85

Concrete cover:

- Concrete exposed permanently to soil and water (normal): 60 mm
- Concrete exposed permanently to soil and water (minimum): 50 mm
- Concrete not exposed permanently to soil and water (normal): 40 mm
- Concrete not exposed permanently to soil and water (minimum): 30 mm

5.5.2 Concrete

Greenland standard requirements

The classification of concrete classes is as per EN 206. The following strength classes are to be used:

Table 5.1 Concrete Class

Characteristic Compressive Strength f_{ck} at 28 days (cylinder) [MPa]	Usage
30	Structural concrete
15	Mass concrete, concrete plugs

5.5.3 Reinforcing Steel

Materials and workmanship shall comply with ENV 13670

Reinforcement shall be uncoated grade B500A or B500B, with characteristic yield strength of 500 MPa conforming to ENV 10080, except stirrups and ties, which shall be grade B500C, conforming to NS/Euro Standards.

5.5.4 Steelwork

Greenland standard requirements

The following are additions and modifications from Greenland and Danish standards

The following material properties conforming to European standards are to be used:

Table 5.2 Structural Steel

Mechanical characteristics (t - steel thickness in mm)	Type S.235	S.275	S.335
Elasticity limit f_y (MPa)			
t ≤ 16	235	275	355
16 ≤ t ≤ 40	225	265	345
40 ≤ t ≤ 63	215	255	335
Tensile resistance f_u (MPa)			
t ≤ 3	360/510	430/580	510/680
3 ≤ t ≤ 100	340/470	410/560	490/630
Minimum (average) elongation ε (%)			
t ≤ 3	18	15	15
3 ≤ t ≤ 100	23	19	19

5.5.5 Bolts

Because bolts DIN931 cannot be tensioned on-site and thus are susceptible to stripping of the threads, the bolts that will be used in the steel work are to be A325 or A490. These shall be used for all main site bearing-type and moment connections. Main connections shall include beam to beam, beam to column, column splices, bracings and all beams carrying non-vibrant equipment machines. The minimum size of bolts shall be M20.

5.6 Design loads

The codes and standards to be used in assessing dead and imposed loads are as listed under Section 5.4. Structures shall be designed for the worst-case loading combination.

5.6.1 Dead loads

Dead loads shall be calculated from the unit weights given in NS 3491-1: or from the actual known weights of the materials used. Where there is doubt as to the permanency of dead loads, such loads shall be treated as imposed loads. The self weights of the materials to be used are as follows:

- mass of reinforced concrete: 2 500 kg/m³
- mass of steel: 7 850 kg/m³

5.6.2 Hydrostatic pressure

The hydrostatic pressure is calculated from the upstream water level.

5.6.3 Wind and snow loads

The characteristic windload is independent of the surrounding terrain and height. For Maniitsoq the Annex specifies a windload of 1.2 kN/m². However, a load of 1.6 kN/m² is proposed for the smelter plan due to its exposure to the sea. The same value will be used for the settlement at Kangaamiut, which is also exposed to the ocean.

For snowloads the base values are influenced by the slope of the roof:

- Characteristic load for slopes below 15° is sk = 1.8 kN/m²
- Characteristic load for slopes steeper than 15° is sk = 0.9 kN/m²

5.6.4 Live loads (Imposed Loads)

Imposed loads consist of variable and/or transient load (operating or maintenance conditions, occupancy and/or due to storage of materials imposed on a specified area and/or on structural elements). Imposed load does not include the weight of fixed equipment, piping etc.

The design imposed floor loads shall be shown both in the calculations and on the design drawings. The minimum imposed floor loads shall be:

Table 5.3 Power House Floor loads

Specific using of areas	qk (kN/m²) uniform	Qk (kN) concentrated
Generator floor and machine hall (excl. generators hatch covers)	50	9
Turbine floor	15	9
Bus bars tunnel	24	-
Other transversal tunnels	10	-
Scroll case, access floor and turbine pit	15	-
Penstock	10	
Water intake crest - uniform loading	20	-
Water intake crest - Mobile crane	-	413
Water intake crest - load of a stabilizer	-	860/0.4 m²

Table 5.4 Service Bay Floor Loads

Specific using of areas	qk (kN/m²) uniform	Qk (kN) concentrated
Floor load	15	-
Oil hall - shells	10	196
Battery hall	35	-
Generator floor:		-
floor load	75	
the rotor	-	2 550
the wheel		510
Cone, support, pivot, winnowing circle		196

Table 5.5 Transformer, ventilation area and miscellaneous

Specific using of areas	qk (kN/m²) uniform	Qk (kN) concentrated
Transformers area	15	1 275
Trackway downstream	20	To be determined
Ventilation area	10	-
Stairs, halls and interior pedestrian bridges	5	2.5

5.7 Crane and lifting appliance loads

Crane and monorails shall be designed in accordance with ENV 1993-6:2002 or where information is not available use AISC publication “Report #13”. The crane classification, loads and dynamic effects shall be confirmed by the crane supplier. Crane and other lifting appliance vertical static loads shall be as specified by the manufacturer.

Horizontal loads caused by off-vertical lifting shall not be less than 0.10 times the hoisted load.

Static vertical deflection of cantilever beams shall be evaluated allowing for rotation of the beam at the support.

Fatigue shall be checked in accordance with ENV 1993 and shall be based on the relevant number of cycles applicable to the beam or to the detail being designed and shall take into account the fabrication details of the beam and its components

The increase to be applied to the specified vertical static loads for cranes and other lifting appliances shall be calculated in accordance with code or as recommended by the manufacturer but shall be not less than the following:

Table 5.6 Impact

Loading case	Electric operation	Hand operation
Vertical loads – increase static wheel loads by	25%	10%
Horizontal force transverse to rails taken as percentage of wheel load	10%	5%
Horizontal force along rails taken as percentage of static driving wheel load	10%	5%

5.8 Load Combination factors And Crack width

Partial load safety factors for global analyze:

Table 5.7 Load Combinations

Nb. of variable actions	ELU	ELS
1	$1.35\ G_{max} + G_{min} + 1.5\ Q$	$G + Q$
More than 1	$1.35\ G_{max} + G_{min} + 1.35\ \Sigma Q_i$	$G + 0.9\ \Sigma Q_i$

Partial safety coefficients for materials properties:

Table 5.8 Safety Factor

Combination	Concrete γc	Reinforcing steel γs
Fundamental	1.5	1.15
Accidental (without seismic)	1.35	1.00

For the hydrostatic load the following factors shall be used:

- 1.25 For the max operating level. (MOL).
- 1.15 For the max flood level.

For crack control the following max crack width shall be used:

- 0.40 mm interior exposure.
- 0.33 mm exterior exposure.
- 0.28 mm exposure to water, structure under bending.
- 0.23 mm exposure to water, structure under tension.

5.9 Stability Analysis

Classical stability analysis for the water intake structure, spillway and dams is required.

6 Works description

6.1 General layout

At Site 7e, power will be produced from the underground powerhouse located near sea level at the end of Evighedsfjord. The rapidly rising topography at the end of the fjord made this site a logical choice as a large head is available for power production.

Lake Tasersiaq at an elevation near 700 m will be used as the reservoir to store the inflows from the catchment, mostly coming from glacier melting. Two dams and a spillway will be built on the Lake to close the reservoir. Water will be transferred to the powerhouse through a 27 km long power tunnel, and power will be produced by five Pelton turbines. It is planned to operate the reservoir between elevation 680 and 714 m.

The project will necessitate the construction of approximately 42 km of roads to access the various structures. The main road is the one that will climb the fjord from sea level to reach the intake structure in Lake Tasersiaq.

6.2 Dams

6.2.1 Dams and spillway locations

Dam 1 is located on the river that constitutes the outlet of Tasersiaq Lake. Compared to the previously considered alignment 2.7 km upstream, this location has the advantages to reduce the volume and the cost of the dam and offer a favorable site for the spillway (topography and thinner overburden). In addition, the smaller water depth at the selected downstream site will facilitate cofferdams construction. The length of the Dam 1 crest is 335 m compared to 750 m for the previous location.

The spillway is located on the right abutment of Dam 1. This location is preferred to the Dam 2 area, in order to avoid the flooding of the access road downstream in the valley during operation. The spillway location is set to be as much as possible out of the areas where overburden is present, and the Dam 1 axis has been adjusted accordingly keeping a suitable alignment relative to the river (nearly perpendicular). A minimum distance of 20 m separates the spillway from the crest and the downstream toe of Dam 1.

Since the spillway was switched from Dam 2 to Dam 1 area, the alignment of Dam 2 was moved about 800 m downstream from the previously considered axis, at a location that considerably reduces its length and volume. Another alternative axis, located 300 m downstream and also previously considered, is not selected since it gives a slightly higher dam height and volume with a less favorable higher and steeper right abutment. Dam 2 is sited on the outlet of two lakes located West of Tasersiaq Lake. Those two lakes drain downstream to the major valley along which the access road is set and down to Evighedsfjord afterwards.

Dam 2 is in fact constituted of two separated parts, named 2A and 2B. Part 2A is the main part of the dam while part 2B is only a freeboard dike sited 500 m away on the right abutment and wetted only during flooding periods. The length of the crests of Dam 2A and 2B are respectively 535 and 120 m.

6.2.2 Hydraulic design

6.2.2.1 Spillway capacity

Site 7e spillway is a weir with uncontrolled crest. The discharge over the weir is given by the equation:

$$Q = C_d \times L \times H\sqrt{2gH}$$

Where:

Q = discharge, in m³/s

C_d = variable discharge coefficient

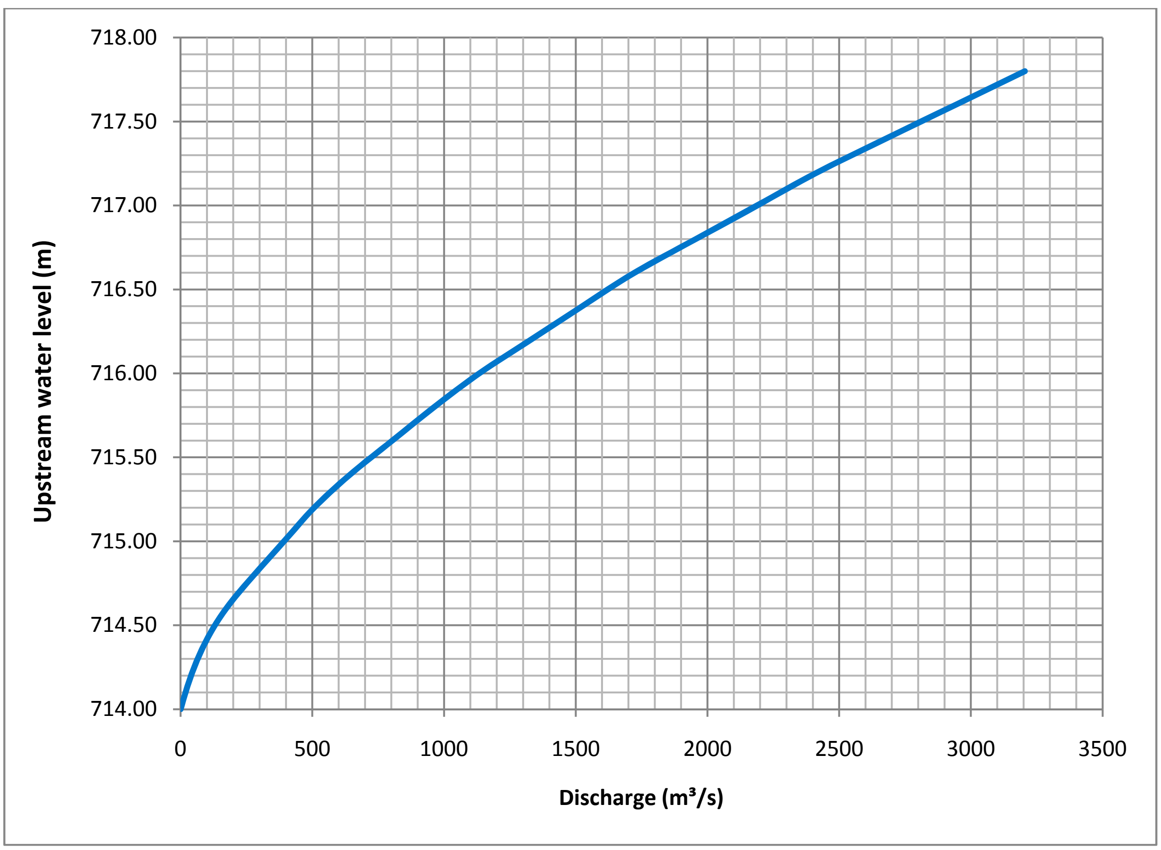
L = effective length of crest, in meters

H = actual head on the crest, in meters

The spillway crest elevation corresponds to the maximum operation level of the reservoir, which is 714 m. The crest length is L = 200 m.

The discharge coefficient, C_d, depends of the type of the weir, the approach height of the weir, and the head on the crest. The type of spillway considered is an ogee crest. For the design flood, corresponding to the 1:10 000 years flood, the discharge coefficient C_d is 0.477. This coefficient varies from 0.39 to 0.52 depending on the hydraulic head. The discharge capacity curve that is considered for the spillway is presented in Figure 6.1 hereafter.

Figure 6.1 Spillway stage-discharge curve



6.2.2.2 Water level during floods

Flood routing has been considered with the hydrographs presented in section 4, for the recurrence intervals 10 000, 1 000, and 100 years. The calculations begin with a full reservoir at the end of the previous water season: water is withdrawn for power generation during the winter, which lowers the level of the reservoir before the occurrence of the flood. When the reservoir is considered full at the arrival of the flood with the powerhouse stopped, the maximum water level increase is less than 0.1 m.

The maximum water levels for the different floods are presented in Table 6.1

Table 6.1 Site 7e reservoir (maximum operating level at 714 m)

Return period	Maximum inflow (m^3/s)	Maximum outflow at the spillway (m^3/s)	Max water level (m)
1 :10 000 years	2 940	2 740	717.4
1 :1 000 years	2 470	2 240	717.0
1:100 years	1 970	1 450	716.3

For the projected 2040 floods, the max water level is only 0.10 m higher.

6.2.2.3 Freeboard and dam crest elevation

The normal freeboard is defined as the difference in elevation between the crest of the dam and the maximum operation level of the reservoir. Minimum freeboard is defined as the difference in elevation between the crest of the dam and the maximum reservoir water elevation that would result from routing the inflow design flood through the reservoir.

Both normal and minimum freeboard requirements should be evaluated to determine the required crest elevation. The freeboard resulting in the higher crest elevation is adopted for design. It is unlikely that maximum winds will occur when the reservoir surface is at its maximum elevation resulting from routing of the maximum design flood. Computations should incorporate the probability of pool level wind and appropriate durations.

The criteria used here to determine the crest elevations are:

- Criteria 1: Minimum Freeboard of 1.5 m above 1:10 000 years flood level;
- Criteria 2: 1:1 000 years flood level and wave run-up of 1:100 years winds;
- Criteria 3: Maximum operation level and wave run-up of 1:1 000 years wind;
- Criteria 4: Level of PMF.

In this stage, PMF has not yet been evaluated. At the moment, the spillway is designed to provide sufficient capacity to pass twice the routed 1:10 000 years flood below the crest of the dams.

The wave heights and freeboard calculations for the dams use the guidelines provided by different references including: Coastal Engineering Research Center of the United States (1984), SEBJ Guide for Rip Rap sizing (1996), Canada Dam Association, USBR Acer and ICOLD - selection of design floods.

The wind data used in the analysis come from the meteorological stations Sisimut (04230) and Manitsok (04240). Available data are maximum wind speeds (10 minutes average), without distinction of the direction. The wind characteristics are presented in Table 6.2.

Table 6.2 Frequency of wind speed

Return period	10 minutes wind speed		Hourly wind speed	
	m/s	km/h	m/s	km/h
1:100 years	37	133	35	127
1:1 000 years	45	162	43	154

Preliminary evaluation of wave heights are done with these winds for maximum fetches.

The wave run-ups, dam crest elevation and freeboards are presented in Table 6.3 below.

Table 6.3 Crest elevation and freeboard of the dams at Site 7e

	7e (Spillway crest el. 714 m, L=200 m)	
	Dam 1	Dam 2
Max Operation Level	714.00	714.00
1:10 000 years flood level	717.50	717.50
1:1 000 years Flood level	717.00	717.00
1:1 000 years wind run-up	1.7	2.9
1:100 years wind run-up	1.4	2.3
Selected crest elevation	719.0	719.5
Minimum Freeboard (1:10 000 years flood)	1.5	1.8
Freeboard for 1:1 000 years flood	2.0	2.5
Normal Freeboard (Maximum operating level)	5.0	5.5

6.2.2.4 Riprap protection

The riprap protecting the embankments resist the impact of waves by their own weight. The minimum and maximum weights are calculated with the following equations.

$$W_{min} = \frac{\rho_r H_s^3}{K(S_r - 1)^3 \cot g\alpha}$$

$$W_{max} = 3\ W_{min}$$

With:

W_{min} : Minimum weight of the riprap, kg
W_{max} : Maximum weight of the riprap, kg
H_s : Wave significative height, in m
ρ_r : Specific mass of the riprap, kg/m³
ρ_w : Specific mass of water, kg/m³
S_r : Riprap density
$cotg(\alpha)$: Embankment slope
K : Stability factor

The parameter K can take the following values:

- K= 3.5 for the 1:1 000 years wave (acceptable damage)
- K= 1.75 for the 1:100 years wave (no damage)

The minimum thickness for the riprap is equal to 2.5 times the minimum diameter.

The preliminary riprap designs for the dams are presented in Table 6.4.

Table 6.4 Riprap size for the dams of Site 7e

		Dam 1	Dam 2
W min	kg	90	330
D min	mm	400	600
D max	mm	600	900
Minimum thickness	mm	1000	1500

6.2.3 Typical dam cross section

The dam type selected for both dams at Site 7e is an asphaltic concrete core rockfill dam (ACRD). Considering the arctic conditions and the scarcity of soils and the short period of time where unfrozen soils maybe found only over small depths makes very difficult the option of building earth dam. The ACRD's have proven to be economical and reliable and show excellent performance in all cases. Furthermore, the asphaltic concrete core construction offers interesting flexibility with respect to weather conditions; it should be interrupted only during heavy rain and can restart as soon as the rain stops. The placement of the asphaltic concrete core can be conducted without problem at temperatures slightly below 0°C. However, under colder temperatures special measures such as asphaltic concrete transportation/storage facilities insulation and aggregate heating are likely to be needed in order to respect the hot temperature criteria (140 to 155°C) required for placement of the asphaltic concrete core.

Dams 1 and 2 are to be founded on bedrock. The only exception if for part of Dam 1 sited over the river where it is judged acceptable to leave in place the overburden (assumed thaw-stable material) present underneath the dam (cofferdams) outside the limits of the 1H:1V slopes from the crest. Assuming an overburden thickness of 2 m at rivers location, the maximum height of Dams 1 and 2 is respectively 54 and 30 m approximately.

For Dam 1, the width of the asphaltic concrete core (zone 5) is set to 0.4 m above level 674.0 m and to 0.5 m below this level in order to be at least 1% of the water head. For Dam 2, the width of the asphaltic concrete core is equal to the standard minimum value of 0.4 m. The asphaltic concrete core is made of crushed stone aggregate with a maximum size of 16 to 18 mm, containing 12% of filler and mixed with about 7% (by weight) of bitumen.

A 4 m wide concrete plinth connects the asphaltic concrete core to the bedrock foundation and serves as a grouting cap. The thickness of the concrete plinth varies according to rock surface topography and an average value of 0.55 m had been considered for cost estimate.

The width of the crest of the dams is fixed at 6 m and the slopes of the upstream and downstream faces are respectively of 1.5H:1V and 1.4H:1V. The crest elevation of Dams 1 and 2 correspond to 719.0 and 719.5 m according to hydraulic design. The top of the impervious asphaltic concrete core is set at level 718.0 m, which is 0.5 m above the extreme maximum level (1:10 000 years).

The asphaltic concrete core (zone 5) and the adjacent support/filter zones (2B) are all placed simultaneously by the specialized paving machine. The total width of these zones consequently depends on the width of the machine, which typically varies from 3.5 to 4.0 m. For both dams, the combined width of the asphaltic concrete core and the support/filter zones has been fixed to 4.0 m. The support/filter material is made of crushed stone, max. diameter 60 mm.

Transitions zones (3E) made of crushed stone, max. diameter 225 mm are placed next to the upstream and downstream support/filter zones. A random rockfill, max diameter 900 mm (zone 3D) completes the body of the dams upstream and downstream of the transition zones. For construction purposes, the width of the transition zones (3E) is set to 3.0 m. For the same reason, the random rockfill zones (3D) are stopped at the level where their width is equal 3.0 m in the upper part of the dams. At these locations, the transition zones (3E) are extended upstream and downstream.

An appropriate riprap (zone 4) is placed on the upstream face of the dams. In the case of Dam 1, the minimum level of the riprap is set 2.0 m (twice the height of the significant wave) below minimum reservoir level (680.0 m) while the riprap covers the whole upstream face of Dam 2 since its lowest point is above the minimum reservoir level.

For Dam 2, an additional zone (3F), made of selected rockfill, max. diameter 450 mm is required to support the upper part of the 600 to 900 mm rockfill riprap (zone 4) where the random rockfill (zone 3D) is not present. For Dam 1, the 400 to 600 mm rockfill riprap (zone 4) is compatible with the transition zone (3E) and there is no need of an additional zone in the upper part of the dam.

For the part B of Dam 2, the same ACRD typical cross-section founded on overburden is considered at this stage of the project for cost estimate. However, a different typical cross section should be later selected for this small freeboard dike. This typical cross section should take into account the characteristics of the overburden.

6.2.4 Foundation treatment

The nature and extent of the foundation treatment of the dams are based on the existing data obtained from the previous field investigations: topography, geological/geotechnical conditions (soil and rock formations) and permafrost characterization. The selection of the typical cross section of asphaltic concrete core rockfill dam (ACRD) reduces the extent of the foundation treatment. In fact, the foundation treatment is essentially concentrated below the concrete plinth which is 4 meters wide. Outside the concrete plinth area, rockfill and crushed stone are placed directly on the rock surface after stripping and removal of all organic materials, without any special treatment. As mentioned previously, these is one exception to that; assuming the presence of thaw-stable material, it is judged acceptable to leave in place the overburden present underneath Dam 1 (cofferdams) outside the limits of the 1H:1V slopes from the crest.

Table 6.5 shows the design criteria selected for the foundation treatment in the concrete plinth area. There are two main types of treatment: rock excavation and vertical curtain grouting. As the grouting cannot be conducted in frozen rock (defrosting required), the excavation of the top layer of rock surface, where rock is generally altered and more fractured, is prioritized. Therefore, the need to proceed with grouting operations, which besides being time consuming and considerably increasing construction costs, is greatly reduced. The choices made offer the advantage to treat the foundation adequately therefore reducing the need for further work after construction. However, in the worst case scenario, should this need arise (important water infiltrations through the foundation after reservoir impoundment), the ACRD offers the possibility to realize grouting after construction.

Table 6.5 Foundation treatment in the concrete plinth area

Water head, Hw (m)	Depth of rock excavation (m)*	Depth of curtain grouting (m)* (Holes 3m c/c)	Length (m)		Total (m)	%
			Dam 1	Dam 2		
Hw < 5	1	0	59	241	300	30%
5 < Hw < 15	2	0	42	282	324	33%
15 < Hw < 25	5	0	47	85	132	13%
Hw > 25 and/or under the river bed (the river bed includes 6m each side of the river)	2	Hw / 3 (min 8m)	185	54	239	24%
		Total	***333***	***662***	***995***	***100%***

Maximum water operation level = 714 m

* For preliminary estimation. To be revised according to further investigations and observations during construction.

This approach is valid with the assumption made that rock is sound and of good quality and it is mainly fractured and altered only in the first few (2-3) meters from the surface. The exact depth of the excavation however will be determined by senior geologist on the site once the overburden is excavated and the rock surface is cleaned by high air pressure.

In order to minimize the formation of additional cracks in the foundation bed, rock excavation in the concrete plinth area should be done using controlled drilling and blasting techniques with reduced charges.

Prior to grouting, the permafrost foundation has to be thawed by injecting warm water (hydro-defrosting) or steam (steam defrosting) in holes drilled at the required depth for grout curtain. Defrosting holes has to be drilled upstream and downstream of the grout curtain line (at less 2 meters) to allow the grout to penetrate the surrounding rock mass. After grouting, all holes must be backfilled from the bottom up with a 0.74:1 water-cement grout by volume. Field tests and ground temperature monitoring are required to verify the effectiveness of both defrosting and grouting methods applied.

The presented criteria and associated quantities are used at this stage mainly for cost estimates. Although the table gives the impression that the decision making depends entirely on the water head of the dams, rock quality will govern the final decisions during construction. Based on the preliminary 2009 investigation results, those criteria and associated quantities should be maintained.

It was determined from the 2007/2008 geological mapping that there are typically three orthogonal sets of joints in the rock throughout Site 7e, one near horizontal and the other two near vertical. The predominant joint set is aligned with the foliation and tends to be steeply deeping (more than 45°). This conclusion is based only on surface geological mapping with no boreholes done in the dam site areas. Therefore, the presence of sub horizontal stress relief joints, result of elastic rebound following glaciations, typical for the northern hemisphere, is somewhat confirmed by 2009 boreholes. Should the subsequent investigations prove otherwise, other types of measures may be considered in order to reduce water losses through the foundation without treatment, such as the addition of an upstream till blanket over the exposed bedrock and a downstream reverse filter consisting of granular material (crushed stone) outside of the steep valleys.

6.2.5 Spillway characteristics

The spillway will be excavated on the right side Dam 1, which is the natural outlet of Lake Tasersiaq. A 200 m long concrete weir will be built on top of the excavation to control the flow passing at the site. The height of the weir is 2 m to minimize the concrete volumes. The weir is built laterally to maximize its length and minimize the rock excavation required.

The excavation will consist of a plateau at elevation 712 m upstream of the weir, and a 40 m wide stepped channel downstream of the weir to dissipate the energy of the flow. The steps will be at each 10 m of elevation, starting at elevation 700 m and emptying downstream of Dam 1 near elevation 660 m (4 steps in total).

The design flood for the spillway is the 1:10 000 years flood as mentioned in section 6.2.2.

6.2.6 Temporary works

In order to build the dams in the dry, cofferdams and diversion works are required. At Dam 1 site, a diversion tunnel is projected at the right abutment. Upstream and downstream cofferdams are both necessary at Dam 1 site. At Dam 2 site, only a drainage ditch combined with a small upstream cofferdam and pumping works are required for flood control during dam construction. A diversion canal has to be excavated to divert the water from the existing lakes upstream of the Dam 2 to Lake Tasersiaq.

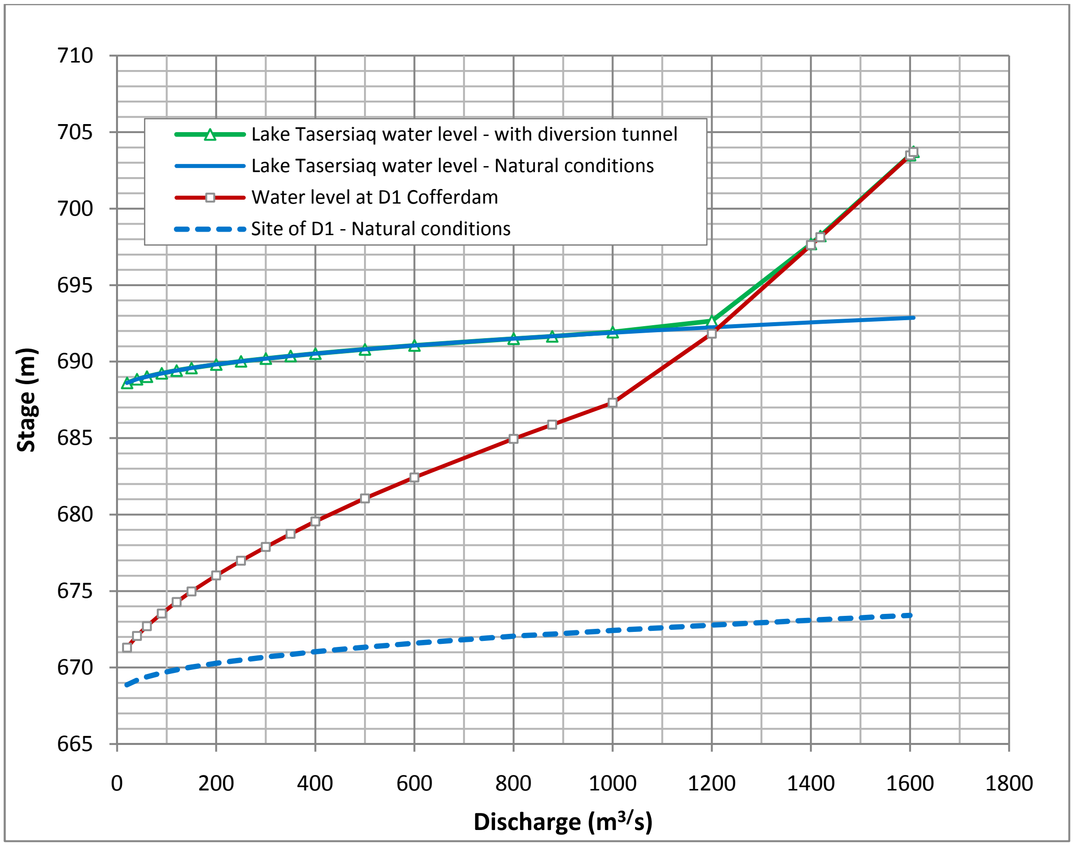
6.2.6.1 Diversion tunnel at Dam 1

The diversion tunnel will have an estimated length of 240 m, with a reverse-D shaped cross-section with a concrete invert. The base width will be 10 m with a maximum height of 12.5 m, for a cross-sectional area of 117 m². Its upstream invert is at the elevation of 670 m and its outlet invert is at the elevation 666 m.

The flow capacity of the tunnel has been calculated with a Manning coefficient of 0.033.

The stage-discharge curves calculated with the diversion tunnel, as well in natural conditions, are presented in the Figure 6.2

Figure 6.2 Stage-Discharge curves during construction



The water levels at Site 7e were estimated during construction. The natural outlet of Lake Tasersiaq is located upstream of the proposed site of Dam 1. In natural conditions, the water levels of the lake are controlled by this outlet, which is at an estimated elevation of 688 m according to the bathymetry measured at the site. During the construction, it is estimated that the natural outlet will control the water levels in the lake up to a discharge of 1 050 m³/s.

The diversion tunnel is designed to pass the 1:20 years flood, corresponding to a discharge of 1 280 m³/s. Routing is considered above the level 688 m (theoretical natural thalweg of the outlet of the reservoir). The maximum water level reached upstream of the diversion tunnel is 688.86 m, for an outflow of 1 140 m³/s at the diversion tunnel exit.

Table 6.6 Site 7e – Water levels at Dam 1 during construction

	Discharge (m³/s)		Water levels in natural conditions (m)		Water levels during construction (m)		
	Inflow	Outflow tunnel	D1 site	Lake	Downstream Tunnel	Upstream Tunnel	Lake
1:20 years flood	1 330	1 140	673.00	692.45	670.60	690.50	692.44
May average	16	16	668.70	688.49	666.17	671.04	688.49
June average	73	73	669.50	689.12	666.49	673.06	689.12
July average	378	378	670.96	690.45	667.73	679.19	690.45
August average	394	394	671.01	690.50	667.79	679.45	690.50

	Discharge (m^3/s)		Water levels in natural conditions (m)		Water levels during construction (m)		
	Inflow	Outflow tunnel	D1 site	Lake	Downstream Tunnel	Upstream Tunnel	Lake
September average	99	99	669.70	689.29	666.60	673.76	689.29
October average	30	30	669.02	688.73	666.27	671.68	688.73
November average	8	8	668.35	688.24	666.08	670.52	688.24

For the cofferdams, a freeboard of 2 m is considered for 1:20 years design flood.

6.2.6.2 Cofferdams at Dam 1

The upstream and downstream cofferdams are positioned to be integrated as much as possible to the body of the dam. However, a minimal margin distance of 10 m is kept between the downstream toe of the upstream cofferdam and the estimated limit of the cut-off trench excavation under the concrete plinth of the dam in order to limit the risk of conflict at this location.

Prior to the construction of the upstream cofferdam, a pre-cofferdam is to be built under low water level conditions. This pre-cofferdam consist in dumped random rockfill, max diameter 900 mm (zone 3) with a low permeability dumped till (zone 1A) upstream of it that reaches the bedrock into a previously excavated cut-off trench. A geotextile filter separates the two fill zones. The crest elevation of the pre-cofferdam is set 1.0 m above the average monthly water level during its construction with the diversion tunnel in operation. The pre-cofferdam allows constructing in the dry, or almost, the relatively large upstream cofferdam that will become a permanent work, being integrated to the dam.

From downstream to upstream, the upstream cofferdam comprises the following zones:

- a random rockfill, max 900 mm (zone 3D) that constitutes the body of the cofferdam;
- a transition zone made of crushed stone, max. 225 mm (zone 3E);
- a geotextile filter;
- a low permeability till core (zone 1) founded on bedrock;
- a random rockfill, max 900 mm (zone 3D) which supports the riprap, protects and confines the lowest part of the till zone;
- a riprap (zone 4) that extends the protection layer of the upstream face of the dam down to the required level.

The top level of the upstream cofferdam till core (cofferdam crest elevation) is set with a 2 m freeboard relative to the maximum water level during construction with a return period of 20 years[5].

The crest elevation of the downstream cofferdam is also set 2 m above the maximum water level during construction with a return period of 20 years.

From upstream to downstream (relative to river flow direction), the downstream cofferdam comprises the following zones placed by dumping:

---

[5] The water levels during construction indicated on the drawings have not been updated according to the latest hydrologic data.

- a random rockfill, max 900 mm (zone 3) that constitutes the body of the cofferdam;
- a transition zone made of crushed stone, max. 225 mm (zone 3A);
- a geotextile filter;
- a low permeability till core (zone 1) founded on bedrock into a previously excavated cut-off trench;
- a random rockfill, max 900 mm (zone 3) which protects the till zone.

6.2.6.3 Dam 2 diversion works

Between the lake and the location of Dam 2, there are two ponds, a larger one at elevation 698 m and a smaller one near the proposed location of the dam at elevation 695 m. Both of those ponds flow towards the natural outlet at the site of Dam 2. It is then proposed to excavate a drainage ditch between the larger pond and Lake Tasersiaq to allow the inflows entering this pond to be diverted towards Lake Tasersiaq. The invert of the drainage ditch will be at an approximate elevation of 696 m, which is sufficient to divert the inflows to the pond.

The inflows to divert at Dam 2 will then come only from the smaller pond. The characteristics of this catchment are:

- area = 2.8 km²;
- average discharge in June = 0.12 m³/s;
- average discharge in July = 0.17 m³/s;
- average discharge in August = 0.07 m³/s;
- maximum discharge (about 1 :20 years) = 0.4 m³/s.

The little pond has an area estimated at 0.225 km², at the level indicated on the maps (694.78 m). If the maximum discharge was flowing during 24 hours, the water level would be raised by about 0.15 m.

Pumping may be considered to divert the inflows to the pond.

6.2.6.4 Dam 2 upstream cofferdam

Due to the small size of the upstream cofferdam required for Dam 2, the inclusion of this cofferdam into the body of the dam is not necessarily prioritized. The upstream cofferdam is rather located apart from Dam 2 at an upstream location that minimizes its volume. This cofferdam consists of dumped random rockfill, max 900 mm (zone 3) with a low permeability dumped till (zone 1A) upstream of it that reaches the bedrock into a previously excavated cut-off trench. A geotextile filter separates the two fill zones. The crest elevation of the upstream cofferdam is set 2 m above the estimated water level of the adjacent small lake.

6.3 Rock excavation and reinforcement

6.3.1 Open cut rock excavation

Well controlled drilling and blasting methods are used in all open-cut excavations to obtain relatively smooth, stable excavation rock faces with a minimum of overbreak and requiring minimum scaling and support.

Generally, no excavation sequences or restrictions on methods are imposed that would tend to reduce the contractor’s flexibility in planning and add to his costs. However, special requirements are imposed in some zones considered critical and where a greater degree of assurance in the final results of excavation is needed.

Consequently, standard clauses covering definitions, special and performance requirements will be included in the technical specifications. The essential of these requirements is given below:

- use of controlled perimeter drilling and blasting, techniques such as presplitting, cushion blasting, smooth blasting and line drilling;
- reduction of presplitting hole spacing (usually 0.60 m c/c) in zones considered critical;
- maximum height of a bench: 10 m. The average slope of the final wall consisting of several benches should be vertical;
- diameter of perimeter, buffer and production holes: 70 to 100 mm max;
- maximum weight of explosive per delay period, including controlled perimeter blasting: 150 kg;
- installation of preset grouted rocks dowels before blasting to reinforce the periphery of some particular areas;
- seismic monitoring.

According to the study done by Bertsov et al. (1980), borehole grid in frozen rocks should be reduced by 13% and the explosive ratio increased by 28% compared to the same rocks in a normal (thawed) state.

In areas where concrete will be placed against the rock surfaces, financial penalties for excessive overbreak will be included in the technical specifications (for example, penalty will be applied when overbreak exceeds 0.15 m on walls and 0.30 m on horizontal surfaces).

Scaling, rock reinforcement and surface protection, if needed, have to be done as soon as access to a freshly blasted face is available and before the subsequent blast.

6.3.2 Underground excavation

6.3.2.1 Powerhouse complex

The excavation of the powerhouse complex including all access tunnels, penstocks, powerhouse cavern, transformer chamber, tailrace gallery, surge chamber and cable tunnel is achieved by using the drill and blast method. These excavations occur during the first 2 years of the construction period. This is achieved by using several access galleries allowing simultaneous advancement over three headings at any time. Indeed, other than the main permanent access tunnel to the powerhouse cavern there are three additional accesses: one to the transformers cavern, a second one to the tailrace tunnel and a third one to the power tunnel.

The excavation of the powerhouse complex begins from the access road at km ±2.5 with the simultaneous open-cut excavation of the two portals: access tunnel to the powerhouse and cable tunnel. Depending on the size of the galleries, once the excavation of the tunnel portals is completed, progress is made by full face heading or pilot tunnel breakthrough followed by slashing and bench excavation.

Once the crown level of the powerhouse cavern reached, the excavation will be done in two phases:

1. excavation of the central section of the arch (approximately 1/3 of the full width) until approximate elevation of 24 m and subsequent lateral slashing on each side of the opening until the final limits of the walls;
2. benching excavation until reaching the button of the powerhouse cavern.

Simultaneously with the deepening of the powerhouse cavern begins the excavation of the tailrace tunnel (two headings from both ends). The rock resulting from the powerhouse lower bench is evacuated through the draft tube galleries and the tailrace tunnel. The excavation of the transformer chamber begins after the excavation of the powerhouse cavern is completed and it is done at the same time as the excavation of the tailrace and cable tunnels continues.

The excavation of the transformer gallery will be equally done by excavating a pilot tunnel to clear the arch, followed by lateral slashing until the final limits of the walls. One bench will complete the excavation of the transformer cavern.

More details on some special requirements and restrictions to be included in the technical specifications are presented in the section “Design criteria for tunnels”.

6.3.2.2 Power tunnel

The excavation of the power tunnel is achieved using two TBM’s (Tunnel Boring Machine) advancing simultaneously allowing conception of the excavation in 26 months, excluding the time of delivery and erection of the TBM’s and the excavation by drill and blast of both adits. The first TBM begins excavation from PM ±28+000 until PM ±12+000, while the second TBM completes the excavation to the headrace canal at PM 1+000.

6.3.3 Rock reinforcement and surface protection

The objective of rock reinforcement and surface protection is to ensure the security of personnel and equipment as well the stability of excavated or natural rock faces. Rock reinforcement consists mainly of grouted rock bolts and preinstalled grouted rock dowels. Shotcrete will be also used in zones of very fractured and altered rock, or fault and shear zones. If necessary, shotcrete with a welded wire mesh will be applied to increase the stability of the rock mass. Steel ribs will only be used if required in rock of very poor quality.

As a general approach to rock support, basic reinforcement is provided firstly by using pattern bolting for critical areas such as tunnel portals, vaults of large permanent underground openings and in enlarged intersections on the access galleries. This pattern bolting and other reinforcement material planned in advance will be shown on the drawings. Supplementary support and surface treatment elsewhere in the excavations will be determined as work advances. The extent of rock support will depend both on local geology and the degree of success of drilling and blasting methods used by the Contractor.

Based on the literature review of case studies of powerhouse projects in cold climates, the rock was found to be stable when frozen but when thawed, could not be maintained safely in an unsupported condition. Thawed rock required temporary lining of the arches.

In order to estimate the quantities of reinforcement material required, consolidation criteria were established depending on the rock quality. Those criteria are shown on Table 6.7 for both methods of excavation, Drill and Blast and TBM. Rock is classified using the Rock Mass Rating (RMR) method developed by Bieniawiski, 1989. As the excavation progressed, the rock formations will be classified accordingly and the type of reinforcement will be determined as to meet the existing geological conditions. Moreover, Wedge analysis using version 3 software will be used to determine the reinforcement required in case of the formation of large wedges of rock.

Surface protection during the excavation will be provided by using flexible chain link mesh. The wire mesh is installed systematically as work progresses, generally after each blast. In open-cut excavations, the wire mesh is installed on all rock walls higher than 3 meters. In underground excavations, the wire mesh is installed on the entire vaults until the face of the excavation.

Table 6.7 Site 7e – Consolidation criterias

Rock class	Distribution %	Drill and blast				TBM			
		Rock bolts	Shotcrete (m³)	Wire mesh (m²)	Steel sets (m)	Rock bolts	Shotcrete (m³)	Wire mesh (m²)	Steel sets (m)
Class 1 RMR : 81-100	75	Occasional (1 rock bolt / linear meter) 2.5 m long	Local application 75mm (15% of the crown)	On crown	---	Occasional (1 rock bolt / linear meter) 2.5 m long	Local application 50 mm (15% of the crown)	Occasional (15% of the crown	---
Class 2 RMR : 61-80	15	Pattern 2.25 m c/c 2.5 m long	Local application 75mm (15% of the crown+ walls down to 3 m from the floor)	On crown	---	Occasional (1 rock bolt / linear meter) 2.5m long	Local application 50 mm (15% of the crown)	Occasional (15% of the crown)	---
Class 3 RMR : 41-60	7	Pattern 2.0 m c/c 3.0 m long	100 mm on 50% of crown + walls down to 3 m from the floor	On crown	---	Pattern 2.5m c/c 2.5m long	50 mm on crown	Occasional (15% of the crown)	---
Class 4 RMR : 21-40	2.5	Pattern 1.5 m c/c 4.0 m long	100 mm on 100% of crown 50 mm on 30% of the walls down to 3 m from the floor	On crown	6'' on crown and walls spaced 1.5 m when required	Pattern 2.0 m c/c 3.0 m long	100 mm on crown and 50 mm on walls	On crown	Light ribs spaced 2 m when required
Class 5 RMR < 20	0.5	Pattern 1 m c/c 5 m long	100 mm on 100% of crown 50 mm on 30% of the walls down to 3 m from the floor	On crown	Heavy ribs spaced 0.75 m	Pattern 1.0 m c/c 4.0 m long	150 mm on crown and walls	On crown and walls	Medium to heavy ribs spaced 1.0 m
Adits + access tunnels		---	Local application 100 mm (15% of the crown+ walls down to 3 m from the floor)	On crown + walls down to 3 m from the floor	---	---	---	---	---

6.4 Excavation slopes in overburden

The slopes required to insure the stability of excavations in overburden greatly depends on the properties of soils and conditions associated to thawing of permafrost soils which may include ice lenses. Considering this later unfavorable condition associated to permafrost (assumed mostly present at 7e), the relative smooth slope of 3H:1V is generally adopted for permanent excavation in overburden. Steeper slopes may be realized for temporary excavation, especially in granular material while smoother slopes might be required for excavation in ice lenses rich soils subject to thawing conditions.

6.5 Conveyance structures concept

6.5.1 General concept

Conveyance structures at Site 7e include the headrace canal (discussed in section 6.6), the intake structure, the power tunnel, the tailrace tunnel and the diversion tunnel.

At this study level, the headrace tunnel is planned to be excavated by a tunnel boring machine. All of the other tunnels are planned to be excavated by drill and blast method.

6.5.2 Permafrost and ice issues

Discontinuous permafrost is expected to depths of approximately 240 m in most of the study area near the reservoir at Site 7e. The design of the conveyance structures has to prevent the risk of freezing of the water passages due to permafrost, and during the winter season (frazil ice issues and ice blocks).

6.5.2.1 Canal

For the headrace canal, a stable cover has to form early in the winter season to reduce frazil ice formation that could eventually block water passages if accumulated in the trashracks and intake structure. The canal is designed for a maximum flow velocity of 0.65 m/s at the reservoir minimum operating level, which allows the formation of a stable ice cover according to Hydro-Quebec standards. When a stable ice cover is formed, water that is constantly flowing underneath will not freeze as it is the case in the headrace canal. Canals with slow moving or stagnant water have to be prohibited as much as possible.

6.5.2.2 Tunnels

Power tunnel

During normal operation, there is no freezing risk in the power tunnel in the permafrost zone. The only potential freezing risk is related to stagnant water and could occur following a complete shutdown or following the first filling.

A numerical study was carried out by BGC Engineering[6] to quantify the risk of ice formation in an 8 m diameter tunnel (diameter of the proposed power tunnel) full of stagnant water in bedrock.

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[6] SETO, Jack and Lukas, ARENSON. (2009). Ice formation in tunnel in permafrost with stagnant water, BGC Engineering.

A two-dimensional analysis was carried out using the commercial software program TEMP/W Geo Slope Inc. The software can model two-dimensional heat transfer for a variety of boundary conditions and heat flow mechanisms. Two models were developed, one with a fine finite element mesh to evaluate the rate of ice formation shortly after water flow stoppage, and the second with a coarser mesh to evaluate ice formation over a much longer period.

The results show that ice will begin to form almost immediately after water flow stops. The rate of ice growth is highest initially but slows down with time because of the relatively warm permafrost temperature (-2.0°C) and because of the large latent heat energy required to change water into ice. Ice at the tunnel wall is predicted to grow to approximately 0.3 m thick fifteen days after water flow stoppage, 0.8 m thick after one hundred days, and 1.1 m thick after two hundred days. Within a one-year period, the 8 m diameter tunnel is not predicted to be completely blocked by ice.

The result of this study shows that ice formation would take a long time before the tunnel could be completely blocked. Although the design plans to avoid such a situation, it if had to occur, a physical intervention could be planned ahead due to the delay available before the situations becomes problematic.

In order to prevent such potential problem, the power tunnel is designed to be below the maximum expected permafrost depth of 250 m, from natural ground level. At the intake structure, a vertical shaft will be excavated downstream from the gates to deepen the entrance of the power tunnel below the expected permafrost level. The vertical shaft will lower the water from elevation 665 m (invert of the intake) to 470 m (entrance of the power tunnel).

In the unlikely event of a long term complete shutdown of the power plant, the intake gate would be closed and the power tunnel drained to the bottom of the shaft. The only zone left at risk against freezing would then be near the intake. Heating of the intake structure will be provided to ensure a reliable operation of the closing gate. Indeed, this gate will be open most of the time so heating is required to eliminate potential ice formation on the steel elements and in the embedded parts if it has to be closed for an emergency (or opened, following maintenance works for example).

Diversion tunnel

The diversion tunnel at Dam 1 will have to be excavated in an area subjected to permafrost and potential ice blocks. The tunnel will most likely flow only during the summer months, from May to September. Ice blocks may accumulate either at the entrance of the tunnel or in the tunnel, but the presence of numerous workers and machinery at the site can allow for a fast intervention in case of a problematic situation.

6.6 Headrace canal and intake

6.6.1 Location and sizing

6.6.1.1 Intake structure

The location of the intake structure was chosen to minimize the excavation quantities of both the intake structure and headrace canal, and the power tunnel. The options that were studied targeted zones were the rock was observed at the surface on the orthophotos for stability purpose of the structure.

The cross-sectional area of the water passage at the intake structure is of the same size as the power tunnel, which is 50 m². The cross-section is set rectangular with a width of 5.75 m and a height of 8.75 m, to minimize the size of the gates.

It is necessary to provide an adequate submergence at the intake structure to eliminate the risk of vortex formation that could reduce the performance of the turbines due to potential air entrainment, and cause debris entrainment towards the thrashracks. The well-known Gordon's law[7] is used to estimate the required submergence. The minimal submergence required is calculated as follow:

$$h = C_a v d^{0.5}$$

Where:

h = minimal submergence (in m)

Ca = coefficient relative to the approach flow conditions (0.54 for symmetric approach and 0.73 for asymmetric)

v = water velocity through the intake structure (in m/s)

d = height of the intake structure (m)

Since a headrace canal will be excavated in the reservoir to ensure adequate flow conditions upstream of the intake, it is assumed that the approach flow conditions will be mostly symmetric. A minimal submergence of 3 m (rounded to the higher integer) was calculated for a height of 10 m at the entrance of intake structure, which is set to make the entrance smoother and reduce head losses. The invert of the intake is then set to elevation 665 m to ensure safe operations at the minimum reservoir level of 680 m, including a 2 m thick layer of ice.

6.6.1.2 Headrace canal

The design criteria for the headrace canal is to have a maximum flow velocity of 0.65 m/s upstream of the intake to ensure the formation of a stable ice cover for the winter season. This criterion is based on the current practice used by Hydro-Quebec in the northern region of James Bay in Quebec. Without a stable ice cover, there is a large risk of clogging of the thrashracks with ice due to constant frazil ice formation.

The cross-sectional area needed for the headrace canal is calculated for the minimum operating level of 680 m. Since the average operating discharge at the site will reach close to 95 m³/s, a 150 m² cross-section allows to meet the design criteria. The section near the intake will be excavated into bedrock at elevation 665 m on a 10 m width. Further upstream, excavation of overburden in the water is required. The invert of the headrace canal is then raised to 675 m on a 15 m width, with side slopes of 3H:1V, which gives a cross-sectional area of 150 m² for a water level of 680 m.

6.6.2 Heating

Heating will be provided at the intake structure, to prevent freezing and to ensure an adequate operation of the gates. The intake will be built into permafrost and the upstream wall of the structure that can be exposed to very low temperatures due to the fluctuations of the water level in the reservoir. A surface electrical line will bring power to the intake.

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[7] Gordon, J. L. (1970). Vortices at intake, Water Power, No. 4.

The proposed scheme is to provide round tubes embedded in the periphery of the concrete walls of the intake shaft. Most of these pipes are located in the upstream wall of the shaft. These pipes will cover the full height of the shaft from the shelter floor down to 2 m below the minimum water level. Electric heating elements with 150 watts/m will be inserted in the pipes.

6.6.3 Sediment transport

6.6.3.1 Available hydrological information

At site 7e, the hydrological modeling was conducted by Vatnaski Consulting Engineering to produce long-term daily flow series (1958-2007). The computed long-term annual mean flow is 76.83 m³/s.

The sediment measurements were carried out by Asiaq Greenland Survey to investigate the sediment input and output of the reservoir. Recent sampling was conducted in 2007. At site 7e, the samplings at the inflow and outlet locations (10 locations total) have provided a concentration of suspended matter varying between 3 and 84 mg/l. The observed grain size ranged from medium silt (18.05 µm) to fine and medium sand (75.16 and 381.46 µm). Since there is no discharge measurement available at the proposed inlet of site 7e, it is not possible to quantify the amount of sediment input as a function of the flow discharge at this site.

However, it should be noted that there exists a significant difference between the amount of suspended matters for the present and the historic data even though samplings were performed roughly in the same period of time in late June of 1977 and 2007, at the same location. The sediment concentration related to the historic data of 1977 is sensitively higher than that the one of the recent data of 2007. This could be explained by the fact that the sediment concentration is in general affected by several hydraulic factors such as the discharge, the current velocity and the stage.

The average concentration of the inflow sediment is 75 mg/l, which is greater than the average concentration at the outlet, i.e. 47 mg/l. It indicates that the sediment may be partially deposited within the site of the inlet.

6.6.3.2 Sediment settling in the headrace canal

The following data was used to quantify the sediment transport volumes at site 7e:

- Maximum reservoir operating level (El_{max}): 714 m
- Turbine discharge (QT): 83 m³/s
- Annual inflow (INF): 2 423 Mm³
- Reservoir storage volume at level 714 m (VR) = 4 715 Mm³
- Headrace canal design for site 7e composed of upstream and downstream reaches:

	Upstream reach - underwater canal	Downstream reach - surface canal
Lenght - L (m)	1 250 (approx.)	650 (approx.)
Mean velocity - V (m/s) for 83 m³/s	Extremely small	0.09

Based upon the above figured, it is expected that the suspended sediment brought into the headrace canal will settle mostly in the upstream reach as its mean velocity is extremely low. It results that the amount of suspended load passing through the intake system is not significant.

6.6.3.2.1 Fall velocity

Based on the concentration of suspended matter measured at the inlet and outlet locations of site 7e, the characteristics of the grain size fractions can be summarized as follows:

- For suspended material: concentration within a range from 3 to 84 mg/l and average particle size of 18.05 µm (medium silt classification)
- For bed material: average grain size within a range from 75.16 to 381.46 µm (from fine to medium sand classification)

The fall velocity ω related to the grain size d is presented in the table below.

Table 6.8 Fall velocities of sediments

Grain size - d (mm)	Fall velocity - ω (cm/s)
0.018	0.02
0.075	0.25
0.381	5.0

6.6.3.2.2 Suspended sediments

As previously stated (see section 6.6.3.1), flow measurements were takenat the inlet and outlet of site 7e during the sediment sampling in 2007. It is then not possible to quantify the sediment inflow to the intake at site 7e. The historical data obtained from the Isua Hydropower Field Investigations (1975) was used to establishthe regression relations between the sediment concentration and the flow discharge. The analytical expression is:

- $C_s = 40.184\ Q^{0.2864}$ in which C_s in mg/l and Q in m^3/s

However, since there is a significant difference between the historic and recent data, the above relation should be used with caution to quantify the amount of sediment input to the reservoir: the computed C_s value has a greater sensivity than the value observed in recently in 2007.

For a given C_s determined from the above equation, the monthly and annual inflows of suspended sediment can be calculated using the following expression:

$$\sum V_{s(i)} = \frac{0.0864 \sum C_{s(i)} x\ Q_{(i)} x\ \Delta t_{(i)}}{\gamma_s}$$

Where:

$V_{s(i)}$ = monthly volume of sediment (m^3)

$Q_{(i)}$ = monthly discharge (m^3/s)

$\Delta t_{(i)}$ = monthly time interval (day)

γ_s = specific weight of sediment under water = 1.6 t/m^3

The sediment transported by suspension into the reservoir is presented in table below.

Table 6.9 Suspended sediments load

Month	Discharge 1958-2006 (m^3/s)	Inflow sediment (m^3)
January	1.34	98
February	1.48	102
March	1.05	72
April	1.80	139
May	5.47	599
June	82.5	19 006
July	304.0	105 142
August	307.7	106 422
September	165.8	4 6649
October	38.64	7 402
November	8.67	1 048
December	3.47	333
Annual	76.83	287 012

The inflow volume of suspended sediment corresponding to a long-term mean flow of 76.83 m³/s, is equal to 0.287 Mm³/yr which corresponds to an average concentration C_s of 189.5 mg/l. As compared with the recent measured C_s-values in 2007 at site 7e (within a range of 3 to 84 mg/l), it indicates that the concentration Cs based on the historic data is much more conservative. By considering C_s-value equal to 84 mg/l, the annual sediment inflow corresponding to the long-term mean flow (76.83 m³/s) is equal to 0.13 Mm³/yr. It indicates that the sediment inflow evaluation based on the historic data is pessimistic compared with the recent data.

6.6.3.2.3 Bed load sediment

The bed load is composed of sand material having a maximum dominating size of 381.5 µm. Based on the criteria for the boundary conditions of the bed load movement in alluvial stream, the characteristical velocities related to the motion of a particle size of 381.5 µm is summarized hereafter:

- Critical velocity: 0.30 m/s
- Average velocity for bed load movement downstream : 0.92 m/s

On the basis of the recorded maximum bed size of 381.5 µm (medium sand) the stream flow velocity is not high enough to exceed the velocities outlined above. It is then expected that the fraction of coarse material such as gravels and cobbles is likely low. The data compiled for the Hungarian, Russian and Chinese streams support that the bed load in alluvial stream is generally not more than 2% of suspended load. However, on the basis of conservative consideration, 2.5% of suspended load can be allowed for the bed load transport. Then, the total sediment load at the reservoir equates to: 1.025 x 0.287 Mm³ = 0.294 Mm³/yr.

The unknown related to bed load fraction is not critical as the bed-load settles in the headwaters of the reservoirs.

6.6.3.2.4 Sediment inflow

The amount of sediments retained in the reservoir can be related to the ratio of the storage volume of the reservoir and annual inflow (after Brune):

VD/VS = f (VR/INF)

Where:

VD = volume of sediment retained in reservoir
VS = inflow sediment into reservoir
VR = reservoir storage volume
INF = mean annual inflow

For VR/INF = 4 715 / 2 423 = 1.95, the ratio VD/VS based on the average curve established by Brune is equal to 0.98. The sediment-retaining potential will be seen to increase, as the ratio VR/INF increases, It means that the inflow sediment will be mostly retained in the reservoir as the storage capacity becomes much more important than the water inflow.

Considering VS = 0.294 Mm³, the sediments retained within reservoir equal:

VD = 0.294 x 0.98 = 0.288 Mm³. Thus, the sediment volume transferred to the outlet through the headrace canal is equal to: VIN = VS - VD = (0.294 - 0.288) 10^6 = 6 000 m³/yr.

For over a 50-yr period, the total volume of sediment expected to pass through the headrace canal is: 6 000 x 50 = 300 000 m³. Such an amount is negligeable compared to the storage volume of the reservoir (4 715 Mm³).

1. Investigation of the sediment settling process in the intake canal

Based on the theory of the ideal settling basin, the required length of the basin L_b and the permissible velocity can be determined by the following relations:

$L_b = hV/ \omega$
(with a water depth in the canal (h) = 714 - 670 = 44 m)

Permissible velocity: $V = a (d)^{½}$
(with a = 51 for d < 0.1 mm and a = 44 for 0.1 mm < d < 1 mm)

The parameters L_b and V determined from the above equations are presented as a function of diameter d in Table 6.10 below.

Table 6.10 Settling conditions of sediments

d (mm)	V (cm/s)	L_b (m)
0.018	6.8	14 960
0.075	14.0	2 464
0.381	27.1	238

From the above figures, the length L_b of the ideal basin corresponding to the diameter d of 0.018 and 0.075 mm is greater than the power canal length 1 900 m. From a theoretical standpoint, it defines that the canal is not long enough to intercept effectively very fine and fine sediments.

Considering the influence of the turbulence on the fall velocity of the particle, the efficiency of a settling basin for removal of sediments was established by the Velikanov equation, stated below:

$L_b = \lambda^2 V^2 [(h)^{1/2} - 0.2]^2 / 7.51\omega^2$

With $\lambda = f(W_s/W_{in})$ (from Velikanov)

Where:

Ws = settled sediment in the settling basin

Win = total sediment entering the canal

The efficiency of removal of sediment defined as a ratio of settling sediment to the total sediment entering to the basin is presented in table below.

Table 6.11 Efficiency of sediment settling

D (mm)	L_b (m)	λ	Settling sediment (%)	Un-settling sediment (%)
0.018	14 960	0.07	52.5	47.5
0.075	2 464	0.38	70	30
0.381	238	1.21	95	5

From the above figures, it indicates that:

- for d = 0.018 mm (silt particle): about 47.5% of un-settling sediment can pass through the intake
- for d = 0.075 mm (very fine sand): about 30% of un-settling sediment can pass through the intake
- for d = 0.381 mm (coarse sand): practically all sediment is settled in the basin

For the case with a headrace canal (1 900 m long), the parameter λ calculated based on the diameter d = 0.381 mm is 3.42. Thus, the efficiency of removal of sediment (% of settling sediments) based on Velikanov graphic's is about 100%; it means that most of the coarse material will settle in the canal within a reach of length 1 900 m. However, even if the canal is found to be very effective to remove the sediment inflow for sediment finer than 0.381 mm, part of sediment inflow may still pass through the intake.

Considering that the total volume of sediment entering the canal is equal to 6 000 m^3/yr, the volume of sediment that can settle in the canal is the following:

Table 6.12 Settling sediments volume

d (mm)	Settling sediments (m^3/yr)	Un-settling sediments (m^3/yr)
0.018	3 000 (150 000)	3 000 (150 000)
0.075	3 600 (180 000)	2 400 (120 000)
0.381	6 000 (300 000)	0 (0)

Note: Values in the parenthesis correspond to the volume of sediment over a period of 50 yrs.

6.6.3.3 Conclusions

Since most of the inflow sediments are retained in the reservoir, the sediment reaching the outlet through the power canal is not very important amounted to about 6 000 m³/yr (or 300 000 m³ over 50 yrs). This value was based on conservative considerations as the compiled data used for calculations correspond to historic sediment sampling.

The upstream reach of the headrace canal (underwater canal) is characterized by an extremely low mean velocity. It can act as a settling basin in which most of the sediment entering the canal will settle down. The downstream reach (surface canal) having a narrower cross section is characterized by a mean velocity of 9 cm/s.

On the basis of the theory of ideal settling basin, all of the total sediment entering the canal can settle in the canal for sediment size greater than 0.381 mm. For $d < 0.381$ mm, part of the sediments entering the canal can pass through the intake: 40% and 50% corresponding respectively to $d = 0.075$ mm and $d = 0.018$ mm.

Considering that the entire total sediment entering the canal will settle down, the sediment depth accumulated annually is: 6 000 m³ / (1 900 m x17 m) = 0.186 m. The value based on rough calculation is highly conservative, as a canal width of 17 m is considered in the calculation. For fine sediment, it is readily observable that, on the basis of the ideal settling basin principle, part of the sediment entering the canal will pass through the intake. In this case, the total sediment amount entering the canal of 6 000 m³ will not totally settle in the canal. Consequently, the real sediment depth accumulated in the canal upstream of the intake is lower than the above calculated value, since part of the total sediment load will be carried further downstream.

As previously stated, it is likely that most of the sediments entering the canal will settle within the upstream reach of the headrace canal as the mean water velocity is extremely low, much less than a permissible velocity (6.8 cm/s) related to a very fine material (grain size 0.018 mm). In such a case, the sediment depth accumulated per year is drastically reduced to less than 2 cm.

6.6.4 Lined section of power tunnel and manifold

This section describes the lined portion of the power tunnel upstream of the powerhouse including the manifold.

The lined portion of the power tunnel represents only a small length of the predominantly unlined power tunnel.

Generally the surrounding rock in the region consists largely of composite gneisses. Preliminary geologic mapping confirmed that the rock is predominantly hard and sound. The permafrost cover in this region is assumed to be 250 m deep, based on the drillings that were conducted at the initial proposed location for the intake structure in the reservoir, which showed permafrost up to such a depth at this location.

The height of the rock cover near 200 m upstream of 7e power station varies from 1 200 m to 900 m.

The hydrostatic head in the tunnel in the case of the 7e power station is about 710 m the rock cover would be adequate assuming a normal distribution of rock stresses.

For final design in-situ testing, hydraulic jacking and door stopper test should be done on the rock in the vicinity of the powerhouse in order to evaluate the ability of the rock to withstand the designed internal pressure.

In order to prevent excessive leakage through the tunnel in the region close to the powerhouse and in absence of three dimensional seepage analyses, ASCE recommends using a length of watertight liner equivalent to 25% of design head for preliminary evaluations.

Part of the designed length of steel lined tunnel can be replaced with reinforced concrete liner, the amount of which will be determined based on actual permeability parameters and detailed seepage analysis through the liner.

For this preliminary analysis about the in-situ rock properties, the value of the concrete liner was chosen conservatively to be 70 m for the power tunnel in 7e power station.

The tunnel diameters were optimized based on an economical analysis with an actualization rate of 4%, however for the final design this actualization rate needs to be reviewed for a more accurate value which can range between 3% up to 6%.

The lined tunnels diameter is calculated to be 4.5 m.

The steel lined portion of the tunnel should be designed to resist internal and external hydrostatic pressure and the liner should also be designed to resist buckling using the Amstutz formula.

In the zone where sound rock is available partial rock participation should be considered in the analysis.

The concrete cover table used around the steel liner and between the liner and the rock excavation is 750 mm.

The manifold is designed to withstand the full internal hydrostatic pressure plus the hydrodynamic pressure.

The diameters of the manifold sections were designed to maintain a constant speed taking into consideration a possible shut down of one unit for maintenance.

Steel liner material should be made out of pressure vessel quality steel with grades corresponding to the European standards (EN/ENV) with accompanying Danish National Annex Documents (NAD) and Danish Building regulation.

The steel liner should be designed to conform to ENV2009 Eurocode 3 - Design of steel structures and based on the latest edition of design codes and standard as listed in section 7.2 of the design criteria. For material properties see section 7.3 of the design criteria.

The elastic limit of the steel (fy) can vary between 235 MPa up to 500 MPa. In addition to steel work specified in section 7.3.4 of the design criteria, high yield strength structural steel (S460Q and the S500Q) can also be utilized but must be certified as pressure vessel quality. The recent trend is towards using a higher strength steel.

6.7 Power tunnel

6.7.1 Tunnel axis and longitudinal profile

The overall length of the tunnel is 26.6 km and has a diameter of 8 m (circular shape). Excluding the inlet and outlet areas, the power tunnel axis follows, for the most part, the previous axis proposed by BP Power in the feasibility assessment study. Only between PM 13 and PM 20, the axis has been moved slightly to the north-west to ensure having sufficient rock cover under the glacier.

However, the inlet was moved north-west for almost 7 km in order to reduce the length of the tunnel. By doing so, it was possible to have the intake on the surface thus facilitating the excavation and the construction of this structure.

The outlet was moved some 2 km downstream to avoid possible long term instability at the previous location, because of the presence of lateral moraines over steep mountainous slopes. The displacement of the outlet allowed also to get away from the toe of the glacier as was the case with the previous location.

6.7.2 Surge Chamber

The surge chamber is located just upstream from the powerhouse (some 500 m). The overall length of the chamber is 102 m, its width is 17 m and it has a height of 13 m. The surge chamber alignment follows the same alignment as the access gallery to the power tunnel thus facilitating the excavation of this structure.

To reduce the air loss during operation, it is decided to completely cover the excavated rock faces (crown and walls) with shotcrete. During the excavation of the chamber, depending of the rock conditions, grouting could be also required to seal the joints, natural and those induced by drilling and blasting operations. The grouting, if necessary, will be done after placing the shotecrete to avoid any loss of grout and to achieve the grouting to refusal at the specified pressure.

When dealing with the transient regime, the role of a surge chamber is threefold:

i) Reduce the water hammer effect in the headrace tunnel during load rejection;
ii) Reduce speed rise influenced by pressure rise variation during load rejection;
iii) Improve the governing stability.

The basic data used for the calculation is presented in the table below. The different cases studied correspond to the proposed design of the turbines, considering different operating levels and number of turbines.

Table 6.13 Studied cases used for the proposed turbine design

Studied cases	L (km)	Q (m^3/s)	H_o (m)	V_o (m/s)
Normal operation with max. level (1)	26.6	81.3	697	1.62
Normal operation with min. level (2)	26.6	85.6	662.2	1.70
1 unit out of service with max. level (3)	26.6	79.1	697	1.57
1 unit out of service with min. level (4)	26.6	83.3	662.1	1.66
1 unit out of service with 95% level (5)	26.6	81.8	674.5	1.63

Where:

L = tunnel length (m)
Q = operating discharge (m^3/s)
H_o = net head (m)
V_o = mean velocity in the headrace tunnel (m/s)

6.7.2.1 Water hammer analysis

Considering that the time of closure of the Pelton needle can be delayed for over 60 seconds to reduce the water hammer effect in the long headrace tunnel within an acceptable limit, the problem of overpressure is not a major concern for the Pelton turbines, as it will be the case for the site 7e powerhouse.

The basic data used for the water hammer is presented hereafter:

- Tunnel length L = 26.6 km
- Mean velocity in the tunnel V_o = 1.70 m/s (case 2) and 1.66 m/s (case 4)
- Net head H_o = 662.1 m for both cases 2 and 4
- Speed of pressure wave in tunnel a = 1400 m/s
- Time of closure assumed T_f = 60 s

Cases 2 and 4 corresponding to unfavorable cases (mean velocity in the tunnel being high), are considered. The maximum pressure rise due to load rejection within 60 s is presented in table below.

Table 6.14 Pressure rise

Time of closure T_f (s)	Water hammer ($\Delta H/H_o$) in % - case 2	Water hammer ($\Delta H/H_o$) in % - case 4
60	23	22

There is no major concern for pressure rise for powerhouse equipped with the Pelton turbine as T_f can be assumed greater than 60 seconds to reduce further water hammer effect. A pressure rise corresponding to a load rejection of 60 seconds is less than 25% of the head H_o. As quoted above, water hammer due to load rejection can be further reduced by increasing the time of closure. Therefore, the water hammer is not a major concern for site 7e without the installation of a surge chamber.

6.7.2.2 Speed rise

Taking into account that a) the deflector device which controls the speed rise, can be activated within a short period of time, generally between 2 to 4 sec and b) the permissible runaway speed is about 1.8 time of the normal speed, such a problem is not a great concern for the Pelton group installation without a surge shaft.

6.7.2.3 Governing stability

At site 7e, the governing stability of the turbines can not be ensured without a surge chamber due to the fact that the head race tunnel is very long (26.6 km) and the water acceleration (T_w) is relatively important with regards to the acceleration time of the flywheel effect (T_m).

The water accelerating time T_w (in sec) and the accelerating time of the flywheel T_m (in sec) can be defined as follows:

- $T_w = \Sigma L\ V_o/g\ H_o$
- $T_m = n^2\ PD^2 / 268\ N$

Where:

L = tunnel length (m)

V_o = mean velocity in the headrace tunnel (m/s)

H_o = net head (m),

n = rotation speed (r.p.m)

PD^2 = inertia of the flywheel (t m^2)

N = power (CV)

In terms of effective power per turbine as well as flywheel inertia, case 4 is the most unfavorable case as compared to case 2.

The parameters T_w and T_m calculated based on the above relations are respectively 6.8s and 8.54s. The ratio of T_m to T_w (T_m/T_w) provides a relatively low value being 1.26.

Based on USBR criteria, it would require $T_m /(T_w)^2 > 2$ or for T_w = 6.8 s, T_m should be greater than 13.6 sec. Results indicate that it would require increasing the flywheel weight in order to improve the acceleration time of the flywheel effect T_m.

The governor stability regulation can be verified with the “Routh-Hurwitz” criterion, stated as follows:

- $x < 2\ K_1/ (3\ K_o\ T_w)$
- $T_m > K_1 \times T_w\ (K_1\ K_o \times T_w) / (K1 - 3/2\ K_o \times T_w)$
- The difficulty of regulation occurs around a relative position of x = 1 (full opening).
- The allowable limit values are: 20% < σ < 50% and 2 < T_r < 10, 11, ….. 15 sec.

As indicated in the table below, it is possible to verify the limit values of T_m and PD^2 in function of the parameters σ and T_r.

Table 6.15 Required inertia of the flywheel for stability

Tr (sec)	11	12	13	14
σ=40%	T_m = 108.8 s PD^2 =24 393 t m^2	T_m= 53.3 s PD^2 =11 950 t m^2	T_m=39.7 s PD^2 =8 901 t m^2	T_m= 33.6 s PD^2 =7 533 t m^2
σ=30%	T_m=145.0 s PD^2 = 32 509 t m^2	T_m= 71.0 s PD^2 =15 918 t m^2	T_m= 52.9 s PD^2 =11 860 t m^2	T_m= 44.8 s PD^2 =10 044 t m^2

Considering the above values, it is however possible to determine the limit values Tm and PD^2 under which the governing stability can not be ensured.

If we consider a favorable scenario characterized by small values of Tm and PD^2, i.e. the scenario corresponding to the dashpot relaxation time (T_r) = 14 s and the statism (σ) = 40%, we obtain PD^2 = 7 533 t m^2. As it has been previously defined for the studied case no.1, the PD^2 namely natural value related to W_e = 125.53 MVA is equal to1 913 t m^2. It results that the increase of the inertia (Δ PD^2) would be: 100 (7 533 – 1 913) / 1 913 = 293.7%, which is about three times the natural inertia.

In conclusion, an increase of inertia on the rotor (PD^2) is not economically viable: a much heavier turbine-generator group would be needed and the increase of inertia would increase the price as well as the efficiency loss of the machine.

The governing stability can be solved by providing a surge shaft at the downstream end of the headrace tunnel.

6.7.2.4 Sizing of the surge chamber

6.7.2.4.1 Conventional surge chamber

The minimum horizontal cross section of a cylindrical shaft can be determined by the classical Thomas formula. Its analytical expression is as follow:

$$F_{th} = \frac{\left(\frac{V_o{}^2}{2\ x\ g}\right) x\ (L\ x\ A)}{\left(h_f\ x\ H_o\right)}$$

Where:

V_o = velocity in the tunnel (1.66 m/s)
L = tunnel length (26 600 m)
A = tunnel cross section (50.3 m^2)
h_f = friction loss (8 m)
H_o = net head (662 m)

The minimum section determined by the Thomas relation (F_{th}) is equal to 35.5 m^2 and corresponds to a shaft diameter (D_{th}) of 6.72 m.

Considering a time of closure of 60 seconds, the maximum up-surge in such a surge chamber is in the order of 30 m above the dynamic water level.

Generally, it may be necessary to consider the shaft horizontal cross section F_s equal to about 1.5 x F_{th} in order to improve the damping effect of mass oscillations.

6.7.2.4.2 Air cushion surge chamber

The main concern of a conventional vertical surge shaft for high head installation is related to an economical problem of access to the top of the pressure shaft in steep rugged terrain. An air cushion surge shaft could be an interesting alternative because it can provide: i) substantial freedom in the choice of the longitudinal profile of the headrace tunnel, b) no longer is it necessary to maintain a shallow, nearly horizontal headrace tunnel for an economic surge shaft. According to the above remarks, the air cushion surge chamber is recommended as an economical alternative to improve the governing stability.

Based on the preliminary calculation with a headrace tunnel length of 26.6 km and a cross section of 50.3 m^2 and with a static head of 662 m, the characteristics of the cushion surge chamber can be summarized as follows:

- Volume of cavern of air cushion : 22 540 m^3
- Air volume: 16 900 m^3, about 75% of the cavern volume
- Dimensions of the air cushion surge chamber: height: 13 m , width: 17 m, length: 102 m
- Air pressure (max. absolute pressure): 5.5 MPa

6.7.3 Penstocks and manifold

The geometry and the sizing of the penstocks and the manifold were based on the general criteria presented in section “Design criteria for tunnels”. The manifold has a circular final shape with the following dimensions: length of 67.5 m with variable diameter from 4.5 to 2.5 m. The penstocks (5) all have the same final circular shape (inside diameter of 1.8 m) with an overall length varying from 27.88 to 29.55 m.

6.8 Turbine-generator units

6.8.1 Pelton turbine selection

6.8.1.1 General criteria for turbine type selection

Before selecting Pelton rather than Francis units, both being theoretically feasible, the main issues which were considered included:

- efficiency at full load;
- facility to deal with silt erosion and long term performance preservation;
- turbine stability;
- manufacturing difficulties of extreme high head Francis runners and precision;
- availability of competent suppliers and repair capability at site;
- cost and schedule;
- sensitivity to tailwater level variations;
- cold region operation;
- space requirements;
- consequences on transients;
- high speed generator reliability.

The very large majority of high head hydroelectric projects are equipped with Pelton turbines. The Pelton turbine has no real limitation in head, size, operating constraints and hydraulic design of the conveying system.

On the borderline, the Francis turbine design favors a higher specific speed which results in a more economical rotational speed with cost and space reductions on both the generator and turbine at the border between both designs.

Around 300 m head, large Francis turbines become more efficient in addition to the proportionally more important headloss difference between the nozzle and tailwater elevation. The selection is generally in favor of the Francis unless the power variation justifies a flatter efficiency curve or abrasive silt concentrations that would lead to extreme erosion rates of the Francis as compared to the easy maintenance of the Pelton.

In the 700 m head range, corresponding to the 7e project, the head loss related to nozzle elevation is relatively less important, Francis turbine efficiencies suffer severely from disc losses, from crown to band proximity and from clearance leakages while the Pelton proportions are next to the best (the highest heads being the best).

Cost and space saving advantages of the Francis turbines are less evident in this head range while runner manufacturing becomes critical. This is the reason why other parameters such as silt erosion risks, easier transient, minimum maintenance and reliability become decisive criteria along with the original investment cost and the theoretical efficiency (“theoretical” to insist on the fact that the this advantage will vanish sooner or later with manufacturing difficulties and constant erosion of clearances).

With 700 m of head, even small concentrations of glacier silt can impair the long term behavior of high head Francis unit and lead to long outages unless a complete set of removable components is kept and maintained as spare parts.

On the generator side, whatever the Roebel bar insulation quality and tests, packing improvements, magnetic core technology, partial discharge and air gap monitoring, static exciter quality and protection relays, high rotational speed air cooled units are not 100% immune against major failures. For both the turbine and generator, Pelton units remain safer and much easier to manufacture and maintain in top condition with minimum outages versus their Francis counterparts.

Pelton turbines also fit better with local constraints:

- design load to be guaranteed irrespective of year, season or maintenance requirements;
- unit operation possible up to minimum reservoir draw down (close to existing lake level);
- local network capability negligible in comparison of smelter requirements;
- no local industry with turbine / generator maintenance capability for units of this size;
- non negligible content of fine silt including very abrasive minerals (angular quartz) in existing lake outflow;
- planned outages to be fully compensated by built-in overcapacity during seasons permitting;
- local maintenance and transportation to be kept at a minimum and excluding calendar constraints;
- deflectors minimize transient effects and make possible a very fast load pick-up.

Considering all the constraints and in order to reduce planned outages to a strict minimum, two bearing units could be selected with the generator foundation combined with the Pelton housing. Alignment is made easier and the unit shaft line is less exposed to cavern compression.

6.8.1.2 Pelton efficiency compares well to Francis at rated load, at least on the long term

The efficiency advantage of a new Francis turbine at best load is lost if the smelter forces the operation at a constant rated load significantly above the best load. To take advantage of their peak efficiency, the Francis units should be overdesigned to minimize the efficiency drop off above best load.

Six jets vertical Pelton turbine in the 100 MW range, achieve efficiency equal to their model (with, at best, a negligible step-up).Based on a runner shape of Dp / B ≈ 3.90, this rated efficiency exceeds 91.8% all over the head range, Dp being the Pelton diameter and B the bucket width.

Comparable high head Francis such as Svartisen have a rated load efficiency in the range of 92%.

To compare a Francis solution with the Pelton, we must first apply the IEC 60193 step-up (down)

- Starvisen
  - Head: 585m
  - D=2354mm
  - 333 rpm
  - rated efficiency: 92%

- Greenland 7e or 6g
  - Head: 689/645m
  - D≈1300 mm
  - 600 / 750 rpm
  - rated efficiency: 91.45%

Then, we must take care of net head loss between nozzle elevation and MSL

Average net head loss: (1.5X Dp + High tide + Ocean rise provision) / Hn = 0.97%

Based on this Starvisen optimization, the theoretical efficiency difference at rated load would be minor:

91.45 %-(91.8%-.97%) = 0.62% to the Francis advantage

It would be possible to locate the Francis turbine best efficiency at the nominal load and increase this advantage. A recent paper by Andritz Hydro in Hydropower & Dams issue 1 of 2009 shows a potential advantage of 3% at 75% of rated load. This realistic figure at 400 m head must indubitably be reduced at 700 m, even for brand new, large and perfectly manufactured Francis turbines.

The Francis manufacturing precision is a real challenge for a unit this size:

With a distributor height in the range of 145 mm, it would be extremely difficult:

- to set the blade within the IEC 60193 precision i.e. 1% +3% on vent opening (indeed we ask for 0%+1% on new Francis runners for all major Canadian Utilities);
- to grind the fillets;
- to fit the crown rings, even in three concentric sections and weld them to the blades and together;
- to protect the inner hydraulic passage with HVOF W-C- Co overlay

To the contrary, the 7 ton Pelton runners with an external diameter of 3 100 mm and bucket width of 632 mm are extremely easy to machine integrally out of a solid forged disc of A743 GRADE CA6NM material (same size as Rothenbrunner, smaller than Vishnuprayag, both forged and machined at FRAVIT, Italy).

The HPHVOF hard coating is overlaid by robots on the face and back of the buckets with excellent thickness control. Finally, the efficiency loss because of the coating roughness would be the same for both solutions and the real Francis runner might not achieve, mainly because of welding / grinding access and fitting precision, the same global rated efficiency as the Pelton turbine. The situation would become worst after the labyrinth seal runner clearances and wicket gate / distributor clearances increase with erosion.

6.8.1.3 Advantage of the Pelton efficiency curve flatness in terms of head (speed coefficient) and flow

Except for very dry years, the utilization factor being close to unity, the efficiency advantage is difficult to quantify.

Even for the Pelton design, the bucket strength (low alternate bending stress at attachment) and lip thickness (erosion resistance and reparability) must be preferred to top notch efficiency. However, the efficiency curve shape is important. Using references obtained from reputed manufacturers for non coated runners with a nominal Nq per jet of 0.01509 and a guaranteed 20% overload at design head of 858 m, we note that, whatever the net head, efficiency is above 92% from 55% nominal load to 132% overload. No Francis turbine can match this flexibility. The best efficiency will be obtained at very different loads from the minimum to the maximum net head. On Francis units, extra wicket gate opening means more cavitation and more instability risks up to the saturation when efficiency drop is not compensated by flow increase.

6.8.1.4 Silt erosion resistance and special design requirements

Existing quartz sediments would expose Francis turbines to unacceptable erosion. It has already been measured (samples 7eA) that 36% of 63-200µ particles were angular or sub-angular quartz with another 15% of finer particles being also angular quartz. Concentration will vary with years, final dam design and reservoir draw-down. However, under these high net heads, even small to medium concentrations such as those at Svartisen will damage stainless steel severely. Based on former concentrations measured in Lake Tasersiaq outlet, and description of Starvisen variable concentrations, 7e Site erosion would be worst than Starvisen's if equipped with Francis turbines, not only because of concentration but also because of turbine smaller size and higher net heads. It might be also more severe than in Kárahnjúkar considering that angular quartz is worst than the tephra, pyroxene and even plagioclase found in volcanic sands of Kárahnjúkar.

Pelton turbines are better adapted to high head operation with non negligible quartz concentrations. The runner, nozzle tip and needle replacement for Pelton units is naturally fast and safe and can be repeated indefinitely without mechanical damage. Specifying friction coupling and large bolt clearance and a telescopic tilting servomotor on the dismantling carriage, the runner removal and re-installation time could be reduced to one shift. The total cost of this maintenance could be limited to 100 men-hours.

The runners, needle tips and nozzle tips can be protected by a renewable layer of W-C-Co whose duration will depend on sediment concentration. As long as rock traps are efficient, it is reasonable to expect protective layer duration of two to five years without repairs. Special precautions will however apply to the first tunnel filling and the first unit to be commissioned shall be equipped with a standard (sacrificial) stainless steel runner.

Francis turbines maintenance would be much more expensive. Even with all the facilities associated to the best dismantling from below arrangement, including the use of Superbolts® all over, the replacement of the runner together with the wicket gates, bottom ring and both stationary seals has to take more than 1 000 men-hours since levers and links have to be disconnected and eccentric trunnions re-adjusted.

If the headcover bushings, seals or facing plates are damaged by the erosion as for Starvisen, a situation highly probable on a unit with such a low distributor height, the refurbishment will be longer.

The head cover itself might also be designed to be removed from below, although it is not generally the case, but it would then require a preliminary separation from the shaft seal, bearing, operating ring, piping and instrumentation with adapted tooling to keep all these equipments in place on the shaft. The logical solution is generally to provide more dismantling space between the turbine floor and generator foundations.

As a consequence of the 750 rpm Francis rotational speed (and longer shaft), the critical speed would be too high for a two bearing design. The addition of a third bearing would further complicate maintenance and increase downtimes.

All distributor components would have to be protected with either hard coating or hard+soft coating but some sensitive zones such as wicket gate sand seals are exposed to faster erosion because of swirls. Maintenance should be planned concurrently with the runner replacements.

The labyrinth seals (both on the runner and stationary sides) would also be protected with hard coating to maintain the turbine efficiency at a reasonable level in spite of internal runner erosion.

The runner hydraulic passage could not be protected with hard coating, and runners should be considered out-of-repair every four operating years.

Francis turbines should also be designed cavitation free for the necessary sustained overload corresponding to the output distribution of the biggest unit to be overhauled, since the cumulated overhaul periods are not negligible.

At the end, all these precautions to make Francis turbines maintenance viable have a cost and indeed become unrealistic in such an isolated environment.

A perfect illustration of the comparative maintenance of Pelton versus Francis is given by Machu Picchu #1 powerhouse (Francis turbines) later completed by #2 powerhouse (Pelton turbines). Before the 1998 flooding, EGEMSA was mastering erosion problems on the Pelton turbines using hard alloys and Electroperu HVOF hard coating facilities while they had to periodically replace the distributors and runners of the 345 m net head Francis turbines; at a time bottom rings were being replaced every 6 months. After the flooding, only the three Pelton turbines were up rated to 90 MW and a new 70 MW Pelton turbine is being added to replace the Francis units.

6.8.1.5 Francis turbine instability risks

Small high head Francis turbines with upstream and downstream interconnections and large tailwater level variations are more at risk of instability than any other installation:

- on small units operated at minimum tailwater level, the part load vortex might not have sufficient height from the runner cone to vanish before reaching the invert of the draft tube elbow; this make small units more instable than large units. We note that the Kárahnjúkar draft tube is made purposely deep (about 5D instead of the usual 3D, D being the runner outlet diameter);
- the deep setting of these very high head Francis turbines makes atmospheric air admission through the shaft difficult if not impossible;
- dangerous rotating vortices occur in between the wicket gates and the runner inlet edges which cause blade fatigue at synchronous speed and extreme radial thrust and wicket gate extreme torque fluctuations at runaway;
- instabilities surge only for certain combinations of tailwater level and powerhouse load distribution between units and might remain undetected for a year or so after the first commissioning and become a major burden while the smelter is in operation; When such instabilities occur, remedies are sources of extra maintenance and mechanical risks:
  - possible resonance with penstocks and tailrace tunnel (Bersimis 1, Hydro-Québec);
  - installation of tripodes or co-axial tube in existing draft tube liners with fatigue cracking risk and liner tearing (Bersimis 1 and Chute des Passes, Alcan);
  - compressors for air admission to stabilization devices;
  - eventual runner replacement for a different design (Sainte Marguerite 3, Hydro-Québec).

Each time such phenomena occurs, they result in commissioning delays or sudden outages during the first years of operation, painful investigations because of apparently random occurrence and costly corrections which will eventually affect the performance. High head Francis turbine design (hydraulic pulsations and mechanical fatigue prediction), as well as pump turbine design, has not reached the high degree of achievement of the Pelton design.

6.8.1.6 Hydraulic passage precision and credibility of guarantees

Our comparisons between Francis and Pelton are theoretically based on equivalent manufacturing care. However, Pelton runners are now much easier to manufacture precisely than Francis runners for similar high head applications.

- On one side, the best Pelton turbines this size are now 100% machined from a fully forged CA6NM disk and 100% coated with a robotized W-C-Co hard layer. Thus, their mechanical and hydraulic performances will fully reflect all the advantages of the newest developments all along their operation.
- On the other side the Francis runner that would suit our requirements would be so small that the welded assembly, although made of 100% machined blades, crown and band rings might finally lack the expected precision for cavitation and efficiency performance; even worst, competitive manufacturers might very well elect the old single piece casting technique for second-rate results. As already mentioned, inner HVOF coatings are excluded and Francis runners will wear until the performance and mechanical resistance severe degradation command their replacement.

6.8.1.7 Availability, cost and schedule

All large manufacturers (Alstom, Andritz and Voith Siemens) plus some Eastern Europe (Turboinstitut in Slovenia) and Japanese suppliers theoretically master the high head Francis technology, some of them with half blade intercalary design. We have no evidence of their ability to produce a precise runner of this size.

Francis delivery is logically longer than Pelton by at least 6 months excluding model test. Model test can easily be omitted for the Pelton but is a must for the Francis which has a 10 months minimum duration.

Considering the particular protection for silt erosion, the dismantling from below, the model development and spare parts, the Francis turbine will be as expensive as the well protected Pelton. Then the cost advantage is essentially limited to the 750 rpm generator (estimated to 15% of the turbine generator unit). Fig. 2 in Andritz paper, Hydropower & Dams issue 1 of 2009 even shows a lower cost for the 100 MW 700 m Pelton turbine.

6.8.1.8 Sensitivity to fjord/ocean level variations

As explained initially, efficiency is not a sensitive issue. As long as nozzle setting is conservatively increased to take into account predictable fjord level increase because of world climatic changes or ice formations, the influence on the project economy is hardly detectable.

For much major variations of the fjord level, the Pelton pressurization remains a viable solution that will be considered as an option for both the civil works and turbine technical specifications. It should not be included in the base design since maintenance complexity overrides the little extra productivity related with tidal variations and safety margin on the nozzle setting.

6.8.1.9 Cold region operation

Considering the reduced flexural strength of ice sheets in the 0°C to -2°C temperature range, we expect both the Francis distributor and the Pelton straight nozzles will crush ice at nominal opening. We cannot imagine any other risk associated with eventual local sub-zero temperatures in very high head turbines.

6.8.1.10 Powerhouse cavern size

Francis turbines for Site 7e would have to be designed to deliver 128.9 MW overload capability at 666.55 m net head and 21.48 m³/s to maintain the guaranteed load while one 7e unit is out of service.

Although the ideal speed for such a unit is probably right in between 600 and 750 rpm, we can assume that it would be statistically feasible at about 94% the outer runner size of Kárahnjúkar, with estimated outlet and inlet runner diameters respectively equal to 1.3 and 2.7 m.

Based on the Pelton preliminary arrangement prepared by AECOM Tecsult for Site 7e the Francis solution with smaller generator pit would allow:

- 5 to 10% reduction of the cavern width;
- 5 to 10% reduction of the cavern length;
- and a smaller pressurized downstream tunnel.

However, the powerhouse would require a slightly deeper excavation for the draft tube elbows and a downstream surge chamber.

Comparing with optimized Kárahnjúkar as built arrangement, we note that the auxiliary equipment floor requirement, erection bay and gallery spacing might have more influence on the powerhouse cavern than the generator pit and spiral distributor / spiral casing sizes.

6.8.1.11 Water conduction design, transient behavior, load pickup and load rejection facilities

The Pelton design with the slow closing needle, fast deflectors, low pressure rise and low speed rise is extremely flexible as compared to the Francis units. Savings in surge chambers are to be expected as well as the particular capacity to call maximum load within less than 2s if the Pelton units are already at speed no load with 100% opening under deflector operation. The Kittimat Kemano aluminum smelter in Canada takes advantage of this flexibility.

6.8.1.12 High speed generator reliability

The higher generator speed reduces the initial cost but increases the operating problems:

- higher rotor temperature rise with uneven temperature distribution;
- bearing and thrust bearing oil spill risk at overspeed;
- salient pole design made more critical with heavily loaded wedges and connections.

6.8.2 Pelton turbine final selection and sizing - Overload capability

As a conclusion, the Pelton design reduces most electro-mechanical risks associated with the Francis turbine, with the only inconvenience of requiring some more horizontal space in the powerhouse cavern and, preferably, an open tailrace tunnel.

In the long run, the global efficiency of both solutions is the same, the Francis option becoming much less efficient if maintenance has to be delayed or if homology is not fully respected at manufacturing stage.

Considering that angular quartz concentration is not negligible, Francis turbine maintenance could be up to 10 times more consuming than the Pelton maintenance. Furthermore, high speed generators are propitious to be more troublesome. A larger stock of turbine spare parts would be necessary and their periodic replacement or refurbishment would also affect the maintenance resources. The Pelton unit management will be easier with only short and minor outages and a lot more flexible regarding smelter instant load requirements and overload operation.

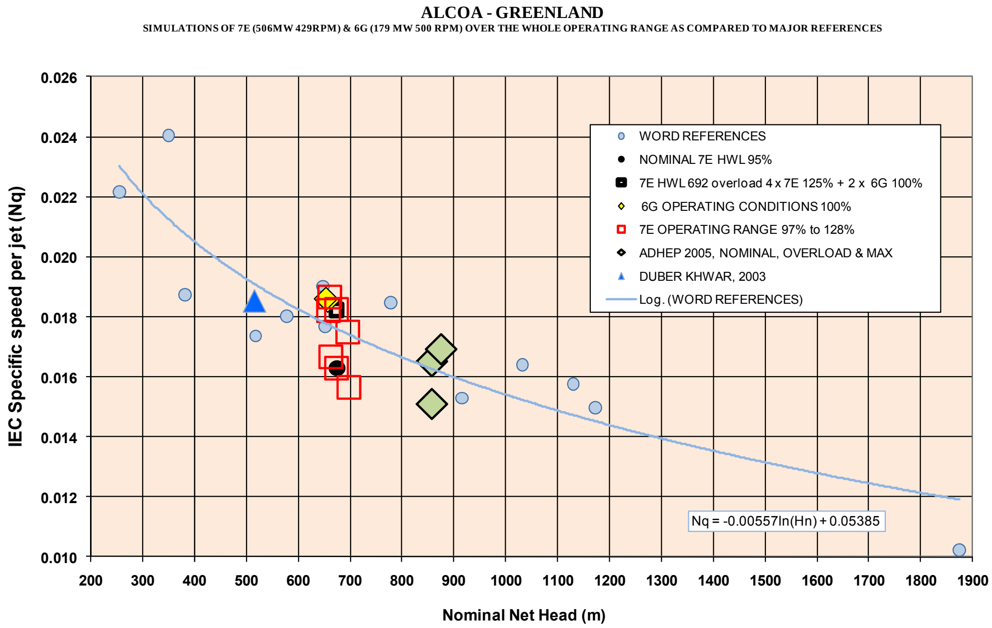
Pelton turbines are then chosen at both sites 6g and 7e, as they were shown to be the most advantageous solution.

With Pelton turbines, in addition to the runner proportion D/B (Pelton diameter / Bucket inner width), the Pelton diameter D and the synchronous rotational speed, we have access to a fourth variable which is the jet number. Equipment in powerhouses 7e and 6g were optimized in order to limit the most severe operating conditions to known characteristics of similar recent units.

Two options deserve to be considered:

- Optimized 6 jets units at 7e (429 rpm) and 6g (500 rpm) of complete different sizes and designs (our drawings.)
- Same 429 rpm generators and same runners (to be confirmed) with a special 5 jet spiral distributor for 6g. This option would reduce spare costs and simplify maintenance for a comparable global cost and improves the operation of turbines at both sites. It becomes competitive if the turbine and generator pit enlargement can fit within original cavern size using both ends to accommodate auxiliaries.

6.8.2.1 500 rpm 6 jet compact design



With this configuration, 6g units operate at a higher specific speed per jet than 7e in normal operation. Then, overload capability is limited to 7e units only.

For 7e units, overload conditions are more or less severe according to the headwater level. Overload capability of 7e units roughly corresponds to the same severity degree accepted for 6g on a constant basis. If unplanned outages of 7e units occur simultaneously with deep draw down after sustained low inflows, the remaining 7e units might have to operate at up to 128% overload, the reason why their nominal operating condition was selected sufficiently below the statistical trend line. This is also the reason why the number of units was fixed to five, the overload percentage for a four unit powerhouse becoming excessive.

The table below lists typical operating conditions at three headwater levels, with or without one unit out of service, either from 6g or 7e, and headlosses corresponding to a smooth headrace tunnel (TBM).

Table 6.16 List of typical operating conditions at three headwater levels

Operating condition	Units	Powerhouse 7e Max HWL one 7e unit – Out of serv.	Max HWL	Min HWL one 7e unit – Out of serv.	Min HWL one 6g unit – Out of serv.	Min HWL	95% HWL one 7e unit – Out of serv.	95% HWL Nominal
Number of units in operation	#	4	5	4	5	5	4	5
HWL	m	714	714	680	680	680	692	692
Powerhouse discharge	m³/s	81.5	81.4	85.8	101.3	85.7	84.2	84.1
Generator output	MW	126.4	101.1	126.4	118.9	101.1	126.4	101.1
Turbine model eff.	%	91.89%	91.93%	91.84%	91.86%	91.91%	91.86%	91.92%

Operating condition	Units	Powerhouse 7e Max HWL one 7e unit – Out of serv.	Max HWL	Min HWL one 7e unit – Out of serv.	Min HWL one 6g unit – Out of serv.	Min HWL	95% HWL one 7e unit – Out of serv.	95% HWL Nominal
% of nominal discharge	%	121%	97%	128%	120%	102%	125%	100%
Turbine discharge	m³/s	20.4	16.3	21.5	20.3	17.1	21.1	16.8
Turbine output	MW	128.2	102.6	128.2	120.6	102.6	128.2	102.6
Turbine net head	m	696.5	697.0	661.6	658.6	662.2	673.9	674.5
D nozzle opening	m	0.244	0.218	0.254	0.247	0.227	0.251	0.224
nq/nq opt		1.159	1.036	1.237	1.206	1.104	1.208	1.079
ns jet	rpm, m, kW	17.51	15.65	18.67	18.21	16.68	18.25	16.30
Nq jet	0.015	0.017	0.016	0.019	0.018	0.017	0.01823	0.016
Unit efficiency	%	90.61%	90.65%	90.56%	90.58%	90.63%	90.58%	90.64%

Unit common characteristics and sizing corresponding to above performances appear at table below:

Table 6.17 Unit characteristics

Output at generator terminals 7e and 6g	7e
Synchronous speed	428.6 rpm
Nozzle level	8.00 m
# jets	6
Pelton diameter Dp	2.449 m
Bucket width B	0.633 m
Dp/B	3.87
Runner weight	9703 kg
Efficiency corr for HVOF coating	-0.4%
“Zero” cavitation ¼ Annexe A IEC 60609	0.25 kg
High tide for full load MSL	2.63 m
Future Ocean rise provision	0.30 m
# Pole pairs	7
Cos Phi	0.9
Generator Eff.	98.60%

6.8.3 Summary of extreme operating conditions

- Maximum generator output: 126.4 MW or 140 MVA at 0.9 power factor *
- Maximum power at 7e generator terminals: 594.5 MW **
- Maximum power at 7e switchyard: 584.7 MW **
- Maximum discharge of 7e powerstation: 101.3 m³/s ***
- Nominal net head 674.5 m
- Maximum static head 705.1 m
- Maximum net head at full load 697 m
- Minimum net head 658.6 m ***

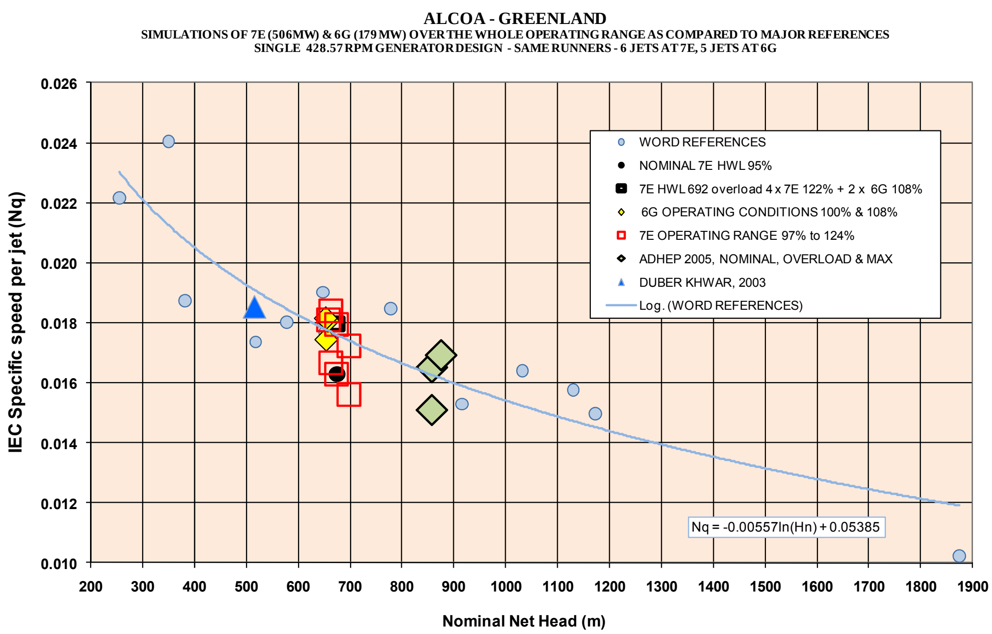
* One 7e unit out of service
** One 6g unit out of service
*** One 6g unit out of service and minimum headwater level at 7e

6.8.3.1 Same generator and runner design for 7e and 6g:

To be able to use the same runners at 6g, with a nominal net head slightly less than the minimum net head of 7e, some compromise will be necessary on the Pelton diameter.

On the graphs below, 6g operating conditions are limited to two yellow lozenges corresponding to the normal headwater level and either normal operation (just below the trend line) or 108% overload (above the trend line) when anyone of the 6g or 7e unit is out of service for inspection or maintenance. We can expect the overload situation to occur at least 6 times in a year, assuming units are inspected yearly, at least during the guarantee period.

Figure 6.3 Specific speed per jet at 7E and 6G as compared to major references



Overload capability was well balanced between 6g and 7e units in order to attain the same severity degree when the 7e reservoir is at its 125% probability of occurrence. If unplanned outages of 7e units occur simultaneously with deep draw down after sustained low inflows, the remaining 7e units might have to operate at up to 124% overload, the reason why their nominal operating condition was selected sufficiently below the statistical trend line. This is also the reason why the number of units was fixed to 5, the overload percentage for a four unit powerhouse becoming excessive.

Table below lists typical operating conditions at three headwater levels, with or without one unit out of service, either from 6g or 7e, and headlosses corresponding to a smooth headrace tunnel (TBM).

Table 6.18 List of typical operating conditions at three headwater levels

Operating condition	Units	Powerhouse 7e Max HWL one 7e unit – Out of serv.	Max HWL	Min HWL one 7e unit – Out of serv.	Min HWL one 6g unit – Out of serv.	Min HWL	95% HWL one 7e unit – Out of serv.	95% HWL Nominal
Number of units in operation	#	4	5	4	5	5	4	5
HWL	m	714	714	680	680	680	692	692
Powerhouse discharge	m³/s	79.1	81.3	83.3	100.0	85.6	81.8	84.1
Generator output	MW	122.9	101.2	122.9	117.5	101.2	122.9	101.2
Turbine model eff.	%	91.93%	91.96%	91.88%	91.90%	91.94%	91.90%	91.95%
% of nominal discharge	%	118%	97%	124%	119%	102%	122%	100%
Turbine discharge	m³/s	19.8	16.3	20.8	20.0	17.1	20.4	16.8
Turbine output	MW	124.7	102.6	124.7	119.2	102.6	124.7	102.6
Turbine net head	m	697.0	697.0	662.1	658.9	662.2	674.5	674.5
D nozzle opening	m	0.241	0.218	0.250	0.246	0.227	0.247	0.224
nq/nq opt		1.142	1.036	1.218	1.198	1.104	1.190	1.079
ns jet	rpm, m, kW	17.25	15.65	18.39	18.09	16.68	17.97	16.30
Nq jet	0.015	0.017	0.016	0.018	0.018	0.017	0.01796	0.016
Unit efficiency	%	90.64%	90.68%	90.60%	90.61%	90.66%	90.62%	90.67%

Unit common characteristics and sizing corresponding to above performances appear at table below:

Table 6.19 Unit characteristics

Output at generator terminals 7e and 6g	7e
Synchronous speed	428.6 rpm
Nozzle level	8.000 m
# jets	6
Pelton diameter Dp	2.449 m
Bucket width B	0.625 m
Dp/B	3.92
Runner weight	9 702 kg
Efficiency corr for HVOF coating	-0.4%
“Zero” cavitation ¼ Annexe A IEC 60609	0.25 kg
High tide for full load MSL	2.63 m
Future Ocean rise provision	0.30 m
# Pole pairs	7
Cos Phi	0.9
Generator Eff.	98.60%

6.8.4 Summary of extreme operating conditions

- Maximum generator output: 122.9 MW or 136.6 MVA at 0.9 power factor*
- Maximum power at 7e generator terminals: 587.5 MW **
- Maximum power at 7e switchyard: 577.7 MW **
- Maximum discharge of 7e powerstation: 100 m³/s ***

- Nominal net head 674.5 m
- Maximum static head 705.1 m
- Maximum net head at full load 697 m
- Minimum net head 658.9 m ***

* One 7e unit out of service
** One 6g unit out of service
*** One 6g unit out of service and minimum headwater level at 7e

6.8.5 Unit configuration: Generator foundation combined with Pelton housing

The arrangement shown on drawing A-403 is for a two bearing compact unit, which combines the advantage of a reduced cavern height and of generator foundations less sensitive to rock relaxation after excavation. Now that most major turbine and generator suppliers are integrated in single companies such as (Voith-Siemens (Riva), Alstom (Neyrpic, ABB), Andritz Hydro (Va Tech EscherWyss Ellyin GE Kvaerner), as well as suppliers from Asia, it is no longer necessary nor commercially valuable to separate the turbine and generator contracts in order to combine the best price and best technology, once a reason for separate foundations.

La Batiaz (Switzerland), San Carlos (Colombia) operate satisfactorily using this arrangement at similar heads as well as a number of high head powerhouses, old or new.

Irrespective of cavern compression sensitivity, the operator also benefits of the two bearing arrangement, which is much easier to commission and maintain than a long shaft three bearing unit.

The only inconvenience is the reduced working space in the deflector and jack/brake zone. These equipments require very little maintenance with the extensive use of stainless steel, self lubricating materials and LVDT feedbacks. Furthermore units attached to a smelter are less exposed to premature wear as compared to Pelton peaking units combined with pump turbines which may start and stop many times a day.

6.8.6 Turbine and valve design and manufacturing

As mentioned previously, these units shall operate with the highest possible availability factor and require the minimum possible maintenance:

a) Runners: However, we are afraid that the first runner to be commissioned cannot be fully protected against impacts, whatever the care given to the tunnel cleaning and the importance of rock traps. It could be of interest to commission the first unit with a non coated smooth runner whose initial performance would be optimal and repair easier. It will serve as a test for erosion rate and hard coating profitability. This first runner will be delivered with a coated spare runner for early replacement in case erosion puts the first runner at risk of irreversible damage. Conservative stress amplitude will be specified.
b) Nozzle tips and needle tips: All nozzles shall be equipped with superfinished Co-W-C hard coated nozzle and needle tips.
c) Cut-in deflectors, nozzle roofs and nozzle heads shall be forged stainless steel for sustained operation with deflected jets.
d) Turbine housing liners, gratings and air admission pipes shall be designed for sustained operation with deflected jets.

e) Spiral distributor shall be delivered in three sections with numerically machined weld preparations for minimum works at site and flange connection to the test head first and spherical valve makeup pipe later. Radiography should be avoided on the site circumferential joints. All spiral construction shall be made of plates and forging.
f) All tooling inside the turbine housing, trolleys, runner coupling, needle attachment and all lifting devices shall be designed for minimum maintenance downtime and skill requirement.
g) Double counterweight, double servomotor spherical valve with service and maintenance seal and seat, fully replaceable using turbine HPU for opening only.

6.8.7 Generator design and manufacturing

Characteristics given for the nominal power factor:

a) Stator winding Class F T. rise 75°K, Max T 115°C at maximum overload and maximum water temperature;
b) Rotor winding Class F T rise 80°K, Max T 120°C at maximum overload and maximum water temperature;
c) Stator core T rise 70°K, Max T 110°C at maximum overload and maximum water temperature, 85 dB max;
d) Accelerated aging test for all series of Roebel bars;
e) Ripple spring radial packing
f) Bolted stator frame with stator core stacked at site;
g) Single piece fans;
h) Hot air drainage capability for powerhouse heating with filtering of air makeup;
i) Partial discharge detectors;
j) Closed loop stainless steel cooling system;
k) Self equilibrated thrust bearing;
l) Stabilization of bearings at maximum overspeed (corresponding to full load rejection);
m) Runaway site test;
n) Short circuit test.

6.8.8 Governor, Excitation system and auxiliaries

The overall responsibility for the T/G unit, main inlet valve, governor, excitation system and associated auxiliaries including control, command and protection, man-machine interface, compressed air for the units, cooling water system shall be the responsibility of the main Contractor and include signal and power cables, batteries, chargers and inverters, and all embedded air and water piping.

6.9 Powerhouse, transformer cavern and annex building outside

6.9.1 General layout

Powerhouse and transformer gallery are located inside of two main caverns.

The overall length of the powerhouse (including the service bay) is 122.50 m at level 14.70 m, its width is 16.50 m and it has a height of 30.80 m. The overall length of the transformer gallery is 134.75 m, its width is 14.0 m and it has a height of 12.7 m at its centerline. The sizing of both caverns was established with accordance with the criteria presented in section “Design criteria for tunnels”. The distance between the powerhouse and the transformer galleries is 1.5 times the width of the powerhouse.

The powerhouse is subdivided in two sections: the first one includes all the energy producing equipments; the second one is located on the left hand side of the main cavern, which is the service bay area. Access to these caverns is possible through two tunnels located at their extreme left.

The dimensions and locations of the energy production areas and the service bay area of the powerhouse are conforming to the requirements of all disciplines. The main level of the Powerhouse, service bay, bus bar galleries, transformer cavern, electro-mechanical tunnel and escape tunnel is 14.7 m.

Service bay includes several locals at different levels including the service building, one assembly area and unloading area with the same level as the main level of the powerhouse namely 14.7 m.

Transformer cavern is located downstream of the powerhouse and parallel to it. The overall length of the transformer cavern is 134.75 m, its width is 14.0 m and it has a height of 12.7 m at its centerline. Its floor level is 14.7 m, same as the principal level the Powerhouse.

Annex building is located outside; it has two floors and a flat roof. The overall dimensions of this building are: 68 m length, 30 m width and 7.5 m height.

6.9.2 Powerhouse layout

The principal floor level of the powerhouse is 14.7 m, the generator floor level is 9.7 m and the turbine floor level is 4.7 m.

The powerhouse is comprised of five bays, one for each turbine-generators unit. The distance between the centerline of each unit is 16.0 m. The unit number 5 is adjacent to the service bay and the unit number 1 is located at the far right of the cavern.

An overhead crane, located at an elevation of 23.5 m, with 265 t capacity, is serving the whole length of the powerhouse and major part of the service bay. This crane covers the whole length of the service bay, up to column line 16, during construction. After construction, the overhead crane serves part of the service bay, up to column line 13.

A suspended ceiling at the elevation 27.50 m is located above the powerhouse and the service bay area.

Table 6.20 Different levels of the powerhouse

Level (m)	Description
2.25	Discharge basin
4.70	The valve floor with valve and servomotor bases
8.00	Centerline of the turbine, distributors and the penstock
9.70	The generator floor with generator housing, oleo pneumatic assembly and turbine wheel hatch
14.70	The powerhouse main floor with turbine wheel hatch, generator cover, electrical control panel. The bus bar galleries, contains the electrical equipments, is at the same level.

6.9.3 Service bay layout

Service bay is located at the extreme left side of the powerhouse.

One elevator and one staircase provide access from level 4.7 m to 27.5 m.

Service bay, at the main floor elevation of 14.7 m, is composed of the assembly area and the unloading area. The five other floors, namely elevations 4.7 m; 9.7 m; 19.2 m; 23.2 m and 27.5 m, are used for different locals.

Table 6.21 Floor description

Level (m)	Description
4.7	Pump room; Hydrocarbon room
9.7	Potable water room; Sanitary waste system room; Oil room; Compressors room; Washrooms
14.7	Accumulator /battery room; Charger (battery) room
19.2	Control room; Computer room; washrooms
23.2	Telecommunication room; Battery Telecom; Substation protection & control center room; Technician office; Engineering office; Lunch room (command room); computer room; Meeting room; Lunch room; washrooms
27.5	Elevator mechanical room (lift well); Mechanical and ventilation room (HVAC)

The overhead crane and suspended ceiling as described above are also located in this area.

6.9.4 Transformer cavern layout

The transformer gallery is located downstream and parallel to the powerhouse in a separate cavern. The overall length of the transformer cavern is 134.75 m, its width is 14.0 m and it has a height of 12.7 m at its centerline. Its floor level is 14.7 m, which is the same as the principal level the Powerhouse. It has two floors at 14.7 m and 23.2 m.

The cable gallery tunnel and access gallery are connected to its extreme right and its extreme left respectively.

Five bus bar galleries, one escape tunnel, one electro-mechanical tunnel at the level 14.7 m, and one ventilation tunnel at the level 28.25 m connect the transformer cavern to the powerhouse cavern. An underground oil separator at 10.7 m level is located at extreme left side of the cavern.

The transformer gallery accommodates five power transformers, two auxiliary transformers and one reserve power transformer. A gantry crane and five draft tube gates are also located in this cavern.

6.9.5 Annex building outside

The annex building is located outside of the caverns. It has two floors and a flat roof. The overall dimensions of this building are 68 m length, 30 m width and 7.5 m height.

This building consists of living spaces, offices, maintenance area, mechanical and electrical rooms.

6.9.5.1 First floor

- Workshop: civil / electrical/ mechanical
- Mechanical warehouse
- Electrical warehouse
- Civil warehouse
- Electrical room
- Wood workshop
- Welding workshop
- Handling maintenance room
- Visitor room office
- Transmission room
- Mechanical and ventilation room

6.9.5.2 Second floor

- Infirmary room
- Technician office
- Powerhouse chef office
- Maintenance chef office
- Administrative office
- Documentation / reproduction office
- Engineering office
- Meeting room
- Lunch room
- Men shower room and bathroom
- Men washroom
- Women shower room and bathroom
- Women washroom

6.9.6 Structure

Concrete floors are mainly used for the Powerhouse, Service bay area, Transformer Cavern and Annex building. The overhead crane in the powerhouse and service bay area is supported by the steel girders. These steel girders are designed as simply supported beams. Steel columns are used to transfer the crane loads to the floor level 14.7 m. Vertical bracings provide stability for the crane supporting steel structures.

The suspended ceiling at the elevation 27.50 m is designed with the light weight steel channels and plates. This ceiling is hanging from the roof by means of cables. These cables are attached to the rock anchors.

6.10 Tailrace tunnel

The overall length of the tailrace tunnel is 3.67 km, its width is 8 m and it has a height of 11 m. It is a free surface flow tunnel with a reversed-D shape. The cross-sectional area is 83.2 m². In order to allow the excavation in the dry, a rock plug is left in place in the extreme end of the tunnel. This rock plug is excavated only after the gates of the draft tubes are installed. There is no gate required at the extreme end of the tailrace tunnel.

A rock groin located upstream of the outlet will prevent the obstruction of the outlet from the glacier and at the same time will be used as a disposal area of the excavated rock.

6.11 Access tunnels

There are several access tunnels available that allow not only the transportation of the construction materials and personnel required for the construction, but also allow the simultaneous excavation of the powerhouse complex on at least tree headings. These access tunnels are: main access tunnel to the powerhouse, access tunnel to the transformer chamber, access tunnel to the power tunnel and access tunnel to the tailrace gallery.

The sizing of the access tunnels shown on the drawings and their sections were established depending of the dimensions of the equipments required for the construction.

The entrance of the access tunnel to the powerhouse is at level 100 m, while 900 m further inside the level is at 10 m, requiring therefore a slope of 10%. The slopes of the three other access tunnels are less than 10%. The layout of all access tunnels was designed as to allow the drainage by gravity.

The crown of all access tunnels will be covered by a wire-mesh so to ensure the safety of the personnel and the equipment.

6.12 Auxiliary services

6.12.1 Electrical

6.12.1.1 Equipment at the Stator voltage (10.3 kV)

6.12.1.1.1 General

The nominal voltage at the generator terminals is 10.3 kV. The equipment between these terminals and the terminals on the LV side of the unit transformers are the following:

6.12.1.1.2 Excitation transformer

The excitation transformer shall be dry type, and shall be able to operate at its nominal rating on a permanent basis

Insulation level shall be class F, resin encapsulated. The transformer shall be encased in an IP 31 (minimum) cubicle, as for the standard IEC 60529 and shall be equipped with bars and all accessories for direct connection to the phase isolated bus bars by tee connection close to the generator terminals.

6.12.1.1.3 Static Excitation

The static excitation system includes mainly:

- the rectifier bridge;
- the field circuit breaker (contactor);
- the field flashing contactor from the battery;
- the field discharge resistor;
- the local / remote control devices;
- the protection relays;
- the power stabilizer.

6.12.1.1.4 Current transformers

The 10.3 kV input at the excitation transformer shall be equipped with a current transformer for the generator differential protection and a second current transformer with a ratio for the excitation transformer overload protection.

6.12.1.1.5 10.3 kV natural air cooled isolated phase bus bar system components and accessories

Isolated phase bus bar

The 10.3 kV isolated phase bus bar shall be the natural air cooled type. The design shall incorporate cubicles and connection points for voltage transformers, excitation transformers, lightning, arrestors, capacitors and cable connections.

Generator voltage transformer cubicles

These cubicles shall be metal clad, air insulated, entirely factory fabricated, and shall contain two voltage transformers with fuse protection on their primaries. The transformers, with their fuses, shall be installed on drawers, withdrawable from the energized 10.3 kV section.

Capacitor and lightning arrestor cubicles

These cubicles shall allow the connection of the capacitors and lightning arrestors to the 10.3 kV main bars.

Generator isolating cubicles

In order to be able to feed the auxiliary services of the power station from the network, an isolating switch is required between each unit transformer and its generator. We can thus isolate each generator from its unit transformer and the 10.3 kV board can be fed from the HV network (refer to the single line diagram). Each switch shall be metal clad, air insulated, with isolating material between the phases.

Generator neutral cubicles

The neutral cubicle for each generator shall include:

- a set of bars, forming the neutral;
- a neutral transformer;
- a neutral resistance, connected to the neutral transformer secondary;
- three protection CTs on each of the three phases.

The neutral cubicle shall be installed close to the generator neutral zone.

Generator phase cubicles

For each generator set, a set of cubicles including, for each phase:

- one CT and one VT for the voltage regulator;
- a two winding VT for:
  - the speed regulation;
  - metering, measuring and protection;
- three CTs for:
  - measuring and metering;
  - over-current and unbalance protection;
- an outgoing section for excitation.

The isolated phase bus bar shall be equipped with provision (connections) so that short circuit tests are possible. One set of bars is foreseen for the five generating sets.

6.12.1.2 Power transformers

6.12.1.2.1 General requirements

The three phase transformers 140 MVA, 10.3 kV – 225 kV. The dimensions can change after the brought modifications to compensate a group in maintenance.

The winding connections are dYn11. The HV windings are star connected with the neutral solidly grounded.

The direct sequence impedance is 12% and the transformers shall be supplied with 2 x ±2.5% off-load tap changers.

Cooling shall be OFWF.

All the transformers shall be equipped with removable wheel sets. The transformers in their bays will be installed on rails via shimming plates. The rails shall be connected to the transformer concrete base.

The 225 kV bushings shall be SF6 type.

Insulated cable at 245 kV shall make the connection between the power transformer and the substation.

At the power transformer SF6 bushing there shall be the SF6 transformer termination module a small section of GIB, gas insulated bus and the GIS cable termination module.

The cable shall terminate at the transformer with it’s GIS sealing end and in the substation with its outdoor sealing end.

The tanks shall be rectangular with a bolted cover.

The material shall be in accordance to the most recent IEC recommendations; the principal recommendations to consider are:

- IEC 60060 High voltage test techniques;
- IEC 60071 insulation coordination;
- IEC 60076 Power transformers;
- IEC 60137 Insulated bushings for ac voltages above 1 000 V;
- IEC 60296 Specifications for new mineral insulating oils for transformers;
- IEC 60076-5 Loading guide for oil-immersed power transformers;
- IEC 60076-10 Noise level determination for transformers and inductances.

Other internationally accepted standards, which are either as or more demanding, such as the American ANSI, IEEE or the German DIN/VDE will also be accepted.

The transformers shall be designed to minimize harmonics and to avoid deforming the sinusoidal wave which may hamper the telecommunications circuits. The neutral points shall be made available and appropriately grounded.

6.12.1.3 Alternating current sources for the 400 V auxiliary services

6.12.1.3.1 10.3 kV switchgear

Two 10.3 kV principal switchgears shall be energized directly from the main bars; they can be fed from one generator or another, the supply source can be switched from one to the other via a circuit breaker.

The section feeding the 400 V auxiliary services shall include the following:

- two 10.3 kV circuit breaker cubicles;
- one transformer feeder;
- one 10.3 kV switchgear feeder (PSG3);
- one measuring cubicle.

The incoming cubicles (10.3 kV circuit breaker) shall also include a 50: 1A current transformer, whose role is to protect the bus bars and the auxiliary service transformer.

The measuring cubicle shall include two voltage transformers, 11 kV / √3: 110 V / √3; the role of one shall be to measure the voltage on one generator and the role of the other shall be to measure the voltage on the adjacent generator.

The 10.3 kV principal switchgear (PSG1) supplied by the groups 1 and 3 constitute the source for Auxiliary Transformer no. S1, and the 10.3 kV principal switchgear (PSG2) supplied by the groups 3 and 5 constitute the source for Auxiliary Transformer no. S2. An appropriate interlock associated with an automatic transfer system will guaranty that there is no inadvertent paralleling of the groups on the 10.3 kV bar. Transformer no. 1 can be energized from either group 1 or group 3; likewise transformer 2 can be fed either from group 3 or group 5. As a single transformer is sized to carry the entire alternating current load from both the power station, it is sufficient to have a single group running for all the auxiliary loads to be fed.

The 10.3 kV/400 transformers S1 and S2 are each rated at 2 000 kVA. They are oil type, air cooled (ONAN). The transformers are fitted with on-load tap changers, with 2 x 2.5%.

The 10.3 kV switchgear (PSG3) supplied by the 10.3 kV principal switchgear (PSG1) and (PSG2) constitute the source for Auxiliary Transformer no. S3 and S4.

The 10.3 kV/400 transformers S3 is rated at 1 500 kVA. They are dry type, natural cooled (ANN). The transformers are fitted with on-load tap changers, with 2 x 2.5%.

The 10.3 kV/400 transformers S4 is rated at 300 kVA. They are dry type, natural cooled (ANN). The transformers are fitted with on-load tap changers, with 2 x 2.5%.

6.12.1.3.2 400 V switchgears

Two main switchgears and ten secondary switchgears are previewed for the auxiliary services of the power house, intakes and services building.

The main switchgears shall be metal clad, self standing cubicles, with withdrawable circuit breakers as well as control and measuring.

The secondary switchgears power the auxiliary services in the areas located in proximity to the switchgears. The motor control centers are integrated in the same switchgear. The incoming breakers are of the withdrawable unit design equipped with automatic switching system, such that if the normal power source is lost, the auxiliary services are not lost.

Two of the ten secondary switchgears have a circuit breaker serving to relieve the non essential loads.

6.12.1.3.3 Auxiliary power sources

The cubicle auxiliary power sources shall be as follows:

- control, interlock and signaling circuits: 125 V d.c.;
- motor cranking circuit: 125 V d.c.;
- heater resistances : 230 V a.c.;
- alternating current for auxiliary electric loads.

400 V Distribution network

The neutral is not distributed, except for the lighting and socket outlet circuits, for which a neutral is created in the 400 V/230 V transformers.

The auxiliary loads are distributed via 400 V panels, as follows:

- power plant:
  - one panel per turbine-generating set, to feed the set's auxiliary loads;
  - one panel for the backed-up (essential) general auxiliary loads (hydraulic set or diesel generating set);
  - one panel for the non backed-up (non essential) auxiliary loads.

The circuit breaker which sheds the loads on the non essential panel can be manually closed, if there is a requirement to feed certain non essential auxiliaries during a prolonged power outage. Care must then be taken to not overload the power source.

6.12.1.4 Emergency Generating Set (EGS)

The EGS constitutes the primary 400 V back-up source for the auxiliary loads.

The EGS, which has an automatic electric starter, has the following main characteristics:

- it is designed for continuous service.

Its principal components are as follows:

- diesel engine and generator on a common chassis, with an elastic coupling between the engine/generator and chassis;
- slave pump on the engine lubricating circuit, forced air cooling the water/oil coolant;
- exhaust circuit;
- diesel tank, and 500 liter day tank in the EGS room;
- preheating;
- electric starting;
- WOODWARD electric speed regulator;
- brushless generator, self-cooled, rotating diode excitation, static voltage regulator;
- high mechanical inertia;
- control and protection panel;

- local room ventilation;
- load resistance, with automatic start and two-step load contactors, all installed on the roof of the EGS room.

6.12.1.5 Direct current feeds

6.12.1.5.1 125 V dc source

The equipment is as follows:

- two sets of battery/chargers, 125 V, each connected to a set of busbars, connected in parallel and each sized to feed all the auxiliary loads;
- one sets of battery/chargers, 125 V, for the generator field flashing

The battery will be composed of 60 lead acid elements.

The chargers will be of the silicon diode type. The chargers will feed the battery to which it is associated in maintenance mode. They are fed from the essential services (backed-up) 400 V panel.

A 125 V dc distribution board, comprising:

- two sets of busbars, each fed from a battery/charger set;
- outgoing circuits, connected in parallel to the 2 sets of busbars, with protective fuses and diodes to eliminate circulating currents between the batteries, and equipped with a two pole circuit breaker.

6.12.1.5.2 48 V dc source

This equipment is used for the telecommunication systems.

It is made up of a 48 V battery/charger and a distribution panel. The battery is a 60 Ah lead-acid type, and is installed in the battery room. The charger has a 25 A rating.

6.12.1.6 Lightning and socket outlets

Plant lighting will be fed from two auxiliary service panels (normal or backed-up) via 400 V/230 V transformers.

Battery pack fixtures will light exit ways until power is restored.

The plant’s socket outlet circuit will be fed from the normal auxiliary service board, via a 400 V/230 V transformer.

6.12.1.7 Telephone

Telecommunications will be via a telephone system with a private PABX internal to the plant. There will be telephones in the various rooms in the plant and connections to the 225 kV substation, to the water intake at the dam and to the workers’ town.

A line from the HF telecommunication system over the 225 kV network is dedicated to the plant.

6.12.1.8 Fire detection

The power plant is equipped with a fire detection system including:

- fire detectors spread out in the various rooms;
- fire alarm panel in the control room.

6.12.2 Mechanical

6.12.2.1 Piping

6.12.2.1.1 General

This chapter describes the piping systems that are not supplied by the units' supplier. The systems are the following one:

- raw water;
- fire protection;
- potable water;
- service water;
- drainage of clear water;
- drainage of waste water;
- drainage of oily water;
- compressed air for general service.

The following systems are supplied by the unit's supplier:

- cooling water;
- filtered water;
- oil handling and storage;
- compressed air for regulation;
- compressed air for breaking;
- units dewatering.

6.12.2.1.2 Raw water

This system supply water to the fire protection system and to the service water system.

The equipment of this system is self cleaning filters and piping networks.

6.12.2.1.3 Fire protection

This system insures the protection of the alternators, the transformers as well as the rooms in the powerhouse that may present a fire hazard.

The system uses water as the extinguishing media.

The water is distributed in a network of pipes to the locations where automatic fire protection is required. For alternators and transformers, deluge valves and dry sprinklers are used. For the rooms, wet sprinklers are used.

There are also sufficient fire hoses and manual extinguishers installed on every floor to complement these systems of automatic protection. The fire hoses are also fed by the same piping network that feed the automatic systems previously described.

Two main pumps are provided to feed the water in the system, taking their water from the raw water system. One pump is able to supply the full flow required. The other is a standby pump in case of failure of the first one. A jockey pump is also provided to maintain the pressure at a suitable value when there is no need for fire protection.

Facilities are also provided to allow for the periodic testing of the pumps and the sprinklers systems.

The fire pumps are located in the service area at level 9.70.

6.12.2.1.4 Potable water

This system insures the supply of potable water suitable for use in lavatories and sinks.

To save on the required flow, the sanitary apparatus like the toilets and the urinals flushes are fed with service water. This system is described hereafter.

Water heaters are provided to supply warm water to the lavatories and sinks.

The water comes from a well (to be confirmed) and is distributed in the powerhouse by a piping network. A storage tank is provided to avoid too frequent starts and stops of the well pump as well as to provide a reserve in case of a pump failure.

The tank and all equipments are located in the service area at level 9.70, except for the well pump which is installed in the well.

6.12.2.1.5 Service water

This system insures the supply of water to the service stations located in the powerhouse and in the transformers gallery as well as to the sanitary apparatus located in the service area.

It takes its water from the raw water system and distributes it, by the means of pumps and a piping network, to the service stations.

The pumps and their control panel are located in the service area at level 9.70.

6.12.2.1.6 Drainage of clear water

This system insures the drainage of clear water from all locations in the powerhouse. All waters that may contain contaminants are drained by dedicated systems like the waste water and oily water described hereafter.

Whenever possible, the water is drained by gravity toward the units' downstream channels.

For locations that are lower than these channels, the water is directed toward a sump where pumps are provided to move the water in the closest unit's channel.

6.12.2.1.7 Drainage of waste water

This system insures the drainage of waste water from all sanitary apparatus.

The wastes are directed to a septic tank whose effluent is transferred to a pumping pit. From there, a pump move the liquids from this pit to a leach field located outside the powerhouse. A second pump acts as a standby for the first.

The septic tank, the pit and the pumps are located in the service area at level 9.70.

6.12.2.1.8 Drainage of oily water

This system insures the drainage of oily water from equipment that may leak oil, namely, the transformer and the units governors and oleo pneumatic systems.

The water is directed to an oil/water separator whose effluent is transferred to the system insuring the drainage of clear water described here above. The oil is confined in the separator from which it can be removed by a vacuum truck or any suitable pumping apparatus.

There is one separator in the service area of the powerhouse in the service area at level 4.70 and another in the transformers gallery at level 14.70.

6.12.2.1.9 Compressed air for general service

This system insures the supply of compressed air to the service stations located in the powerhouse and in the transformers gallery.

The compressors, the storage tank and all accessories are located in the service area at level 9.70.

6.12.2.1.10 Compressed air for the surge chamber

This system is provided to maintain an adequate pressure in the surge chamber by compensating the leaks through rock fractures and also the loss of air due to dissolution in the water.

Two compressors are provided with each one able to supply 100% of the required flow. The required pressure is calculated as 6.9 MPa.

6.12.2.2 HVAC

6.12.2.2.1 Introduction

This section describes conceptual engineering for heating, ventilation and air-conditioning of the hydroelectric power plant.

The HVAC systems have for objective to keep a contaminant free atmosphere for the safety and comfort of personnel. These systems, as per specifications, have the following functions:

- air change;
- evacuation of contaminated air;
- maintain of temperature and relative humidity;
- evacuation of smoke and pressurization of emergency exits in order to facilitate the evacuation of personnel and fire control.

6.12.2.2.2 Principles of ventilation

The principles of ventilation of majors spaces are shown on the drawings.

In normal operation, the outside air required for the ventilation of the complex comes from ventilation units located in a mechanical room near the exit of the cable tunnel. In the mechanical room, the outside air is mixed with inside air from the complex to adjust the supply air temperature in order to cool the powerhouse, the transformer gallery and the cables tunnel. The supply air is delivered to the powerhouse and the transformer gallery through a plenum located in the cables tunnel.

For the needs of ventilation and safety exit, the cables tunnel is divided in two sections by a firewall:

- One section is reserved as a supply air plenum for the undergrounds installation and as emergency exit. This section is divided in two: a lower and an upper part. In normal operation, the lower and upper part are used as a supply air plenum. In case of fire, the upper part is pressurized with outside air for the pressurization of the lower part, which becomes an emergency exit, and for the pressurization of the galleries (see smoke exhaust chapter).
- The other section is used as a return air plenum from the undergrounds installations to the ventilation units and for the passage of the power cables.

A part of the air supplied to the underground is evacuated through the main access tunnel to assure a minimum air change and the evacuation of combustion gas from vehicles.

6.12.2.2.3 Design criteria

Temperature and ventilation

The temperature and ventilation criteria of inside rooms are given in Table 6.22

Table 6.22 Temperature and ventilation criteria

	Heating T.S. °C	Cooling T.S. °C	Outside Air Change*
Powerhouse	16	30	0.25
Transformer gallery	16	30	0.25
Office	21	25	1
Cables gallery	10	35	0.25

* Calculated for a height of 3 600 m

Climate

The outside temperatures used for the preliminary design are presented in the section “Site description”.

Rock temperature

The rock face is an important source of cooling which must be considered in the conception of HVAC systems. To establish the criteria, the heat transfer coefficient presented in the ASHRAE manual (Application Handbook, edition 1999, chapter 26) is used. Two coefficients have been retained for the conception of systems in heating and cooling mode. These coefficients take into account the evolution of the surface rock temperature. The stabilization period is estimated at three years:

- for the sizing of HVAC systems in the cooling mode, the heat transfer coefficient used is 0.57 W/m²°C;
- for the sizing of HVAC systems in the heating mode, the heat transfer coefficient used is 1.2 W/m²°C.

The rock temperature, at the depth of powerhouse, is estimated at 15°C.

Heat loss of production equipments

The permanent heat losses of the production equipments are estimated as follow:

Table 6.23 Major equipments heat loss – Powerhouse

Identification	Heat loss (kW)		
	Quantity	Per unit	Total
Lighting	---	---	50
Auxiliary transformer	5	2	10
Excitation cabinet	5	15	75
Excitation transformer	5	20	100
Bus duct	---	1,3 kW/m/3ph.	208
Total heat loss			***443***

Table 6.24 Major equipments heat losses – Transformers cavern

Identification	Heat loss (kW)		
	Quantity	Per unit	Total
Lighting	---	---	40
Power transformer	5	25	125
Total heat loss			***165***

Table 6.25 Heat loss – Cable Tunnel

Identification	Heat loss (kW)		
	Quantity	Per unit	Total
Lighting	---	---	10
Cables	18 000 m	0.015 kW/m/ph.	270
Total heat loss			***280***

Smoke exhaust

The principles of smoke evacuation are shown on the drawings.

In case of fire detection, the ventilation systems are used for the exhaust of smoke and the pressurization of emergency exits. According to the location of detection, the operation is as follow:

1. Fire in the transformer gallery

In case of fire in the transformer gallery, the emergency exit and the powerhouse are pressurized with outside air.

Following the fire alert, the smoke exhaust system is started to remove the smoke from the transformer gallery. To compensate the air evacuated with smoke, the main access door and the transformer gallery door are opened.

2. Fire in the powerhouse

In case of fire in the powerhouse, the emergency exit and the transformer gallery are pressurized with outside air.

Following the fire alert, the smoke exhaust system is started to remove the smoke from the powerhouse.

To compensate for the air evacuated with the smoke, the main access door and the powerhouse door are opened.

3. Fire in the main access gallery

In case of fire in the main access gallery the emergency exit, the transformer gallery and the powerhouse are pressurized with outside air.

Following the fire alert, the smoke exhaust system is started to remove the smoke from the main gallery.

To compensate for the air evacuated with the smoke, the main access door is opened.

6.12.2.2.4 Heating

The heating of major space and make-up air from outside is principally assured by the heat rejected by the electrical production equipments. Locally, in certain rooms, the heating is completed by the use of forced flow heaters or baseboards.

When required, the heat loss from one generator may also be used.

6.13 Hydro-mechanical equipment

6.13.1 General

This section describes the hydro mechanical equipment that will be provided for Site 7e and gives the summary of the technical characteristics of this equipment.

6.13.2 Intake

6.13.2.1 Gate and hoist

One gate is provided for the water intake.

The gate guides are comprised of one upper light section from elevation 719.00 m down to elevation 680.00 m that serves to guide the gate to the heavy lower section from elevation 680.00 to the sill elevation 665.00 m. This heavy section is comprised of one lintel beam, one sill beam and two heavy side guides that are designed to resist the full load of the wheels of the gate and transfer these loads to the concrete structures. The gate guides are made of carbon steel with a high strength machined wheel rolling path and machined stainless steel sealing surfaces.

The Intake gate is of the fixed wheel type, with wheels mounted on tapper roller bearings. It is fabricated from carbon steel welded construction with upstream skinplate and seals. It is designed to close on its own weight against the full incoming flow to the turbine. The seals are of the elastometer music note type with fluorocarbon cover that reduces friction.

The gate structure is designed and the number and location of wheels selected in order to withstand the full pressure corresponding to the maximum upstream water level of 714 m, the downstream side of the gate being considered empty.

Opening and closing of the gate are made by a cable drum hoist located at the upper end of the gate gain at elevation 719.00 m. The hoist mechanical components are designed to withstand the full maximum motor torque that will be limited to 210% of the motor nominal torque.

The hoist is equipped with an electro-mechanical brake that holds the gate in any position but mainly in the normal open position at 300 mm above the lintel.

Normal opening and closing of the gate are set at 1.20 m/minute but the hoist is also equipped with a fan brake that enables emergency closing of the gate, without electric power and by its own weight at a speed of twice the normal closing speed.

The hoist is protected by a heated shelter.

In order to avoid ice formation mainly on the in inside surface of the upstream wall of the gate gain, electric heating elements are inserted in tubes embedded in the wall of the gain of the gate over the full height of the gain.

6.13.2.2 Trashracks

The trashracks are intended to prevent rocks and debris from entering the intake tunnel and eventually blocking the turbine inlet jets.

The upstream guides are used mainly for the installation of the trashrack but they are also designed to enable the insertion of a set of stoplogs whenever maintenance is required on the intake guides, lintel and sill and the adjacent liners and concrete structure.

6.13.2.3 Stoplogs

One set of stoplogs is provided. The set of stoplogs is kept outside in a storing area provided on the downstream side of the shelter at elevation 719.00 m, The stoplogs are of carbon steel welded construction. They are about 1.50 m high and are all identical and interchangeable except for the upper one that is equipped with a filling valve to fill the space between them and the gate. To prevent any ice problem, the stoplogs will be provided with an upstream skinplate and downstream seal.

The stoplogs are designed to be put in place or removed only under dead water condition.

Handing of the stoplogs is made by a mobile crane and a lifting beam.

6.13.2.4 Summary of the characteristics of intake equipment

The following table gives the general characteristics of intake equipment.

6.13.2.5 Summary of the characteristics of intake equipment

Reference drawings	A 401 A 402
Basic data	
W/L	714.00 m
Sill elevation	665.00 m
Trashracks	
Quantity	1 set
Nominal dimensions	W= 6500mm, h= 10 000 mm, t= 900mm
Number of sections	3
Total mass	60 000 kg
Lifting beam	2 000 kg
Stoplogs	
Quantity	1 set
Type	upstream skin plate downstream seals
Nominal dimensions	W= 6 500 mm, h= 10 000 mm, t= 900 mm
Number of stoplogs	6
Total mass	70 000 kg
Lifting beam	2 000kg (different from that for the trashrack)
Embedded parts *(common for the trashrack and the stoplogs)*	
Quantity	1set
Total mass	30 000 kg
Intake gate	
Quantity	1
Type	Fixed wheel , upstream skinplate and seals
Nominal dimensions	W= 5 750, H= 8 750 mm, t= 900 mm
Total mass	75 000 kg
Embedded parts	35 000 kg
Gate hoist	
Quantity	1
Type	cable drum
Lifting capacity	980 kN
Power	25 kW
Mass	17 000 kg
Concrete	
Intake and shelter	2 700 m^3
Temporary access shaft slab and plug	300 m^3
Intake steel liner	36 000 kg
Gate shaft & shelter heating	195 kW

6.13.3 Diversion tunnel

6.13.3.1 Diversion gate and hoist

The definitive closure of the diversion tunnel will be achieved by means of one diversion gate installed in a concrete structure located at the tunnel entrance.

The diversion gate is of the retractable wheel type, It is fabricated from carbon steel welded construction with downstream skinplate, and seals and a 45° bottom lip. The seals are of the elastomer type with fluorocarbon cover that reduces friction.

The gate is designed to close under its own weight and under the full flow passing through the diversion tunnel when the water levels at elevation 675.00 m.

The number of wheels and their location on the gate structure are selected to withstand the hydrostatic load corresponding to the water level of 675.00 m at time of closing. Above this water level, the wheels will retract and the gate bearing pads will rest against the embedded guides to transfer the load to the concrete structure.

The gate structure itself is designed to withstand the full water load corresponding to the maximum upstream water level of 714.00 m, with the downstream side of the gate being considered empty. This will give all the necessary time to build the tunnel plug.

The gate guides are comprised of one upper light section from elevation 695.00 m down to about elevation 685.00 m that serves to guide the gate to the heavy lower section from elevation 685.00 m to the sill elevation of 670.00 m. This heavy section is comprised of one lintel beam, one sill beam and two heavy side guides that are designed to resist the full load of the wheels and the bearing pads of the gate and transfer these loads to the concrete structures. The gate guides are made of carbon steel with a high strength machined wheel rolling paths and machined stainless steel sealing surfaces.

The gate will be fabricated in sections and its Initial field installation will be made with the help of one or two mobile cranes from a temporary platform at elevation 695.00 m.

Closing of the gate is made by a cable drum hoist temporarily installed at the upper end of the gate guides at elevation 695.00 m and at a speed of 1.20 m/min The hoist structure and mechanical components are designed to withstand the full dead weight of the gate and frictions and the hydrostatics load corresponding to the water level at time of closing.

The hoist is equipped with an electro-mechanical brake that holds the gate in any position but mainly in the normal open position at 300 mm above the lintel.

The hoist is protected by a temporary heated metallic shelter.

Since it is intended to close the gate during the milder season, no permanent heating element is provided for the gate guides although the guides of the embedded parts will be equipped with heating gains as a safety protection.

When the diversion gate is closed, it will be possible to remove the temporary hoist and shelter.

6.13.3.2 Summary of the characteristics of diversion equipment

The following table gives the general characteristics of diversion equipment.

Table 6.26 Summary of the characteristics of diversion equipment

Reference drawing	A 404
Basic data	
Maximum W/L	714,00 m
W/L at time of closing	675.00 m
Sill elevation	670.00 m
Temporary hoist elevation	695.00 m
Diversion gate	
Quantity	1
Type	Retractable wheels, Downstream skinplate and seals
Nominal dimensions	W= 10 000 mm, H= 12 500 mm, t= 1 250 mm
Number of sections	2
Mass of gate	200 000 kg
Mass of embedded parts	60 000 kg
Temporary Gate hoist	
Quantity	1
Type	cable drum
Lifting capacity	2 200 kN
Power	60 kW
Mass	7 500 kg
Concrete	
Total volume	270 m^3
Gate Hoist shelter heating	10 kW

6.13.4 Powerhouse

6.13.4.1 Machine Room Crane

6.13.4.1.1 General description

The machine room of the powerhouse is equipped with one crane which nominal lifting capacity is selected to lift the heaviest load to be handled in the powerhouse that is the alternator rotor.

The crane is a double girder, overhead electric travelling crane. It is equipped with one main hoist and one auxiliary hoist. The auxiliary hoist is overhanging on the side of one of the crane girders and it travels independently from the main hoist and along the bridge main girder.

The crane is operated either using a pendant control station or remote control by the operator standing and walking on the alternator floor at elevation 14.70 m.

6.13.4.1.2 Summary of the technical characteristics

The following table gives the general characteristics of the machine room crane:

Table 6.27 Machine room crane – General Characteristics

Reference Drawing	A 404
Quantity	1
Type	Double girder- Overhead Electric travelling
Lifting capacity	
Main hook	265 metric ton
Auxiliary hook	25 metric ton
Class of service	
Bridge and main hoist	Light duty- infrequent use
Auxiliary hoist	Heavy duty- frequent use
Span	15 600 mm
Overall travelling distance	95 000 mm (approx)
Travelling speed	
Bridge	0-30 m/m
Man hoist trolley	0-25 m/m
Auxiliary hoist trolley	0-25 m/m
Lifting Speed	
Main hook	0-1m/m
Auxiliary hook	0-10 m/m
Lifting Height	
Main hook	18.00 m
Auxiliary hook	18.00 m
Elevation	
Top of rail	23.50 m
Operator's floor	14.70m
Control	Variable speed drives Pendant station moving along bridge girder Remote Radio control
Installed Horsepower	
Bridge	45 kW
Man hoist trolley	15 kW
Auxiliary hoist trolley	4 kW
Main hoist	56 kW
Auxiliary hoist	45 kW

6.13.4.2 Tail race gate

One gate is provided to isolate either one of the turbine discharge tunnels in order to protect the powerhouse and the turbines from the high tide when the portion of the discharge tunnel in the powerhouse has to be emptied for maintenance reasons.

The tailrace gate is a simple bulkhead type. It is fabricated from carbon steel welded construction with upstream skinplate, seals and bearing pads. The seals are of the elastometer music note type.

The gate is designed to be put in place and removed only under dead water condition. It is designed to withstand the hydrostatic load corresponding to the high tide water level, the upstream side of the discharge tunnel being considered empty.

Each gate shaft is provided with one set of embedded guides for each turbine unit. Each set of guides is made of two sections. One light section runs from the floor level of the transformer cavern at elevation 14.70 m and guides the gate down to the heavy lower section from elevation 5.05 m to the sill elevation 1.85 m. This heavy section is comprised of one lintel beam, one sill beam and two heavy side guides. The gate guides are made of carbon steel with a machined bearing path and machined stainless steel sealing surfaces.

The gate is fabricated in two sections and it is handled, transferred from one gate shaft to another, and put in place by means of the gantry crane travelling the length of the transformer cavern at elevation 14.70 m.

The gantry crane hoist is of the fixed position and cable drum type, and is equipped with a lifting beam.

When not used, each section of the tailrace gate can be stored in the upper end of any of the gate guides, under the floor elevation.

6.13.4.3 Summary of the characteristics of tailrace equipment

The following table gives the general characteristics of the tailrace equipment.

Table 6.28 Summary of the characteristics of tailrace equipment

Reference drawing	A 403
Basic data	
W/L	5.05 m
Sill elevation	1.85 m
Tailrace gate	
Quantity	1
Nominal dimensions	W= 3 000mm, H= 3 200 mm, t= 300mm
Number of sections	2
Total mass	2 500 kg
Lifting beam	750 kg
Embedded parts	
Quantity	1 set per turbine unit
Mass	5 000 kg per set
Gate lifting equipment	
Quantity	1
Type	Gantry carne- fixed position, cable drum hoist
Lifting capacity	50 kN
Travelling speed	0-30 m/min
Lifting speed	0-3 m/min
Mass	3 000 kg

6.14 Harbor

6.14.1 Need for Harbor

It is foreseen to have three different phases for the use of harbor facilities at Site 7e:

- Initial Phase: for unloading of initial personnel, preliminary camps and civil works equipment for building of camp(s), harbor structure(s), roads, tunnels etc.
- Construction Phase: for unloading personnel for civil works construction, consumables including arctic diesel, additional civil works equipment.
- Operation Phase: for consumables, personnel, spare parts and equipment necessary during the Operation Phase.

Initial phase

It is assumed that all equipment necessary for the initial civil works will be brought to the sites by large transatlantic ships, which will unloads their cargo onto barges; which will then be beached on the shore, to transfer the equipment to the shore.

This is common practice for civil works of this nature

Construction Phase

During this phase, it is expected that heavy equipment will be beached as above during the entire period. The harbor structure will be built and will be used for personnel and light goods when completed. The heavy civil works equipment will be landed by barges as in the Initial Phase.

Operation Phase

During the Operation Phase it is foreseen that most equipment, personnel and consumables will be unloaded directly to a quay structure. This quay shall be designed for a vessel similar to the Pajuttaat, operated by Royal Arctic Line.

Large type equipment, which is brought to the site(s) by sea-going vessels or which is heavier than the allowable load on the quay, shall be unloaded to the beach by use of barges.

Oil products, like arctic diesel can be brought to the site either in barrels or directly to the quay and pumped to a tank farm.

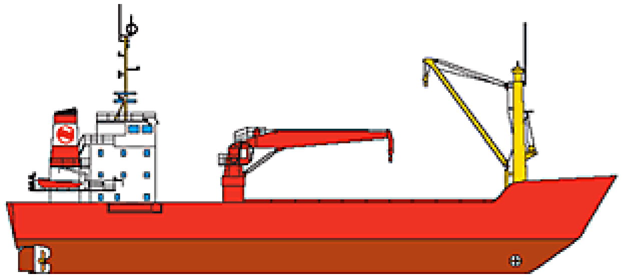
6.14.2 Design ship

During operation of the hydro power facilities equipment, personnel and consumables can be transported by ship to the quay, as mentioned above.

We have been in contact with the operations department of Royal ArcticLine (RAL), which has informed us that RAL is considering modernizing its fleet, serving the smaller towns. The “Design ship” for serving the hydro power facilities in Evighedsfjord and in Godthaabsfjord should be a type similar to the existing Pajuttaat, which can carry a number of 20 ft. containers and other general cargo.

The features for the Pajuttaat are shown on Figure 6.4.

Figure 6.4 Design ship for harbor (Pajuttaat)



Pajuttaat Specs (source: Royal Artic Line)

• Ship type:	General Cargo ship with container capacity
• Length (m):	63
• Beam (m):	12
• Draught (m):	3.71
• Service speed (knots):	13
• Number of containers (TEU+FEU) / Loading capacity (m³):	18+4 / 1349
• Reefer slot / Cold store capacity (m³):	12 / 396
• Loading capacity (ton):	887
• Cranes:	1 x 20 SWL + 1 x 30 SWL
• Year:	1979

6.14.3 Water levels

Information on water levels and tidal variation is taken from reports published in 2008 by Asiaq for both site 7e and 6g. It is presented in Table 6.29.

Table 6.29 Water levels in Evighedsfjord – Site 7e

	Evighedsfjord Site 7e
Highest Astronomical Tide (HAT)	2.63 m
Mean High Water of Spring Tide	2.31 m
Mean Sea Level	0.09 m
Mean Low Water of Spring Tide	-1.90 m
Lowest Astronomical Tide (LAT)	-2.32 m
Delay of the tidal wave, Maniitsoq (mean value)	Approx. 3 minutes

6.14.4 Proposed design basis for the quay structure

The design basis proposed for the conceptual/preliminary design of the quay structures in connection with the hydro power facilities for the Operation Phase is presented in Tables 6.30 and 6.31.

Table 6.30 Water depth at quay at mean sea level

	Site 7e
LAT (from table above)	2.5 m
Extra over for wind setup/low pressure	0.5 m
Maximum draught	4 m
Keel clearance	1 m
Necessary water depth	*8 m*

Table 6.31 Quay height above mean sea level

	Site 7e
LAT (from table above)	2.6 m
Extra over for wind setup	0.5 m
Quay level above high water	1.4 m
Necessary quay depth	*4.5 m*

The quay length is set to 50 m, with bollard of 50 tons. The uniform load on the quay apron is 3 ton/m². The proposed quay plan is shown on drawing no. 104 of the set of drawings.

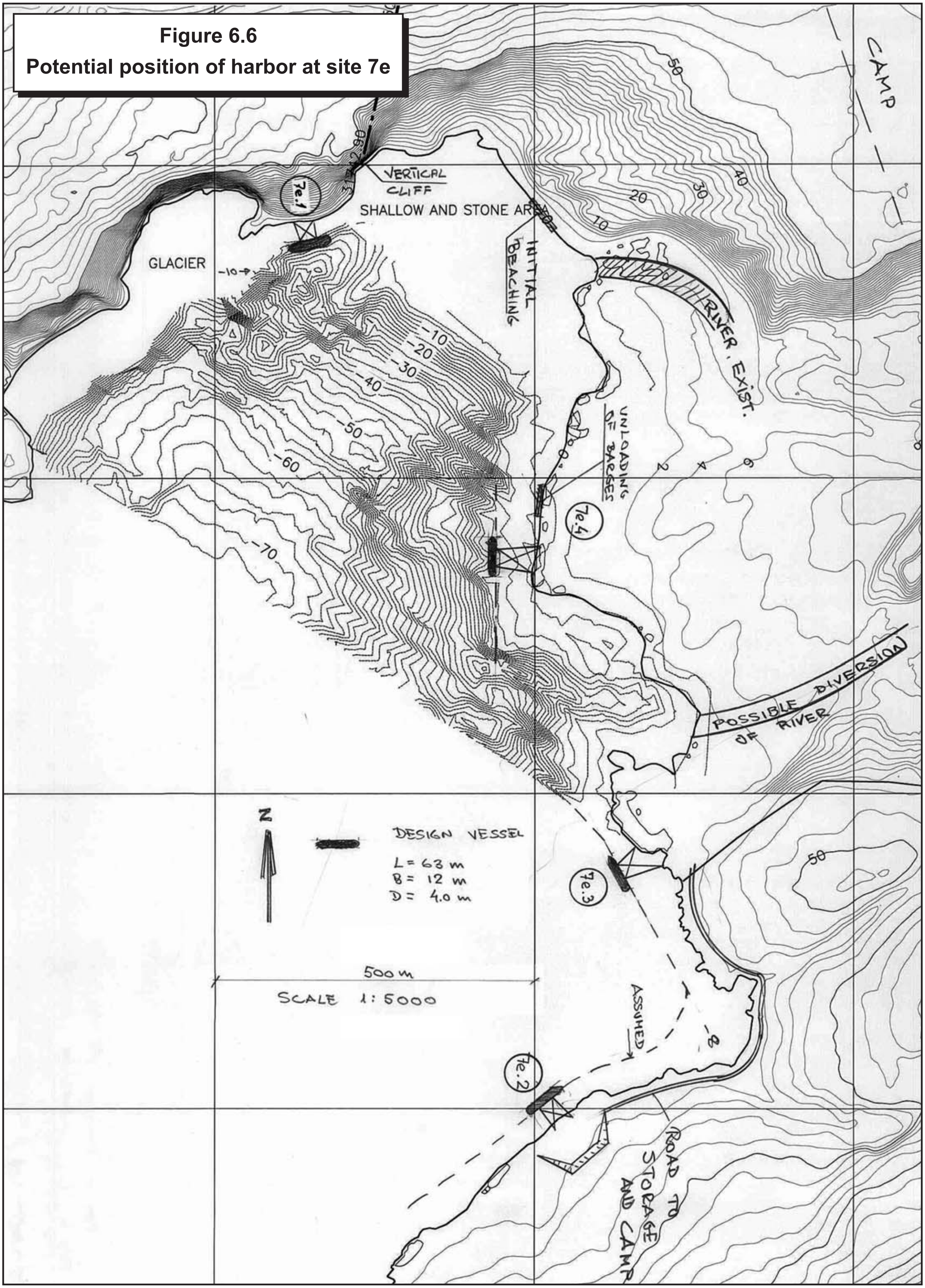
6.14.5 Beaching and harbor facilities

The site environment at Site 7e can be seen on Figure 6.5.

Figure 6.5 Aerial view of proposed location of harbor in Evighedsfjord (Site 7e)

Four possible locations have been considered for the quay structures. Each position has features for and against the location. Two locations have been shown for location of beaching. Figure 6.6 on the following page shows the proposed locations for the quay and for beaching.

Figure 6.6
Potential position of harbor at site 7e



0518015_Figure 6_6_7e.FH11

6.14.5.1 Initial beaching

Initial beaching of barges is envisaged on the beach just northwest of the river mouth for all locations of the quay, as shown on Enclosure 1. The located is, however, labeled as "Shallow and Stone Area" by the field mission. In case it is not suitable to establish the initial beaching here it should be shifted to the position next to harbor location 7e - 4. Initial beaching here will require that initial equipment shall pass the existing river.

6.14.5.2 Barge unloading during construction

Unloading of barges during the construction period is envisaged to be:

- north west of present river mouth for harbor at location 7e - 1, with the same remarks as for the initial beaching mentioned above;
- south east of present river mouth for Harbor at locations 2, 3 and 4 at the flat sandy 'plain' at the bottom of the fjord. This will require a temporary bridge across the river (possibly a Bailey bridge) during the early construction phase for access between the flat sandy plain and the camp site and main roads to tunnel and dam work.

The location for unloading of barges during the construction will be determined based on the most feasible location for the quay structures.

6.14.5.3 Potential location for the quay

The potential locations for the quay are presented in Tables 6.32 to 6.35. For all cases, the quay front is located at 8.0 m water depth. All of the locations are shown on Figure 6.7.

Table 6.32 Position 7e – 1

Position 7e - 1	Pro	Con
Proximity to glacier to the east		Too close
Navigability		Not easy, because of the sea bed contours
Proximity to river	Quay on north side of the river	
Access to camp site and main roads for tunnel and dam work		Possible road from quay to hinterland will be difficult because of steep slopes and removal of "vertical" rock outcrop just east of the quay
Access to storage area on "plain"		Limited storage area near sea level and near quay for storage purpose Difficult access to the flat sandy 'plain' at the bottom of the fjord and south of the river
Hinterland for camp	Acceptable conditions for establishing camp facilities on plateau above harbor and west of river	

As conditions are not favorable, position 7e - 1 is not recommended as suitable for harbor facilities.

Table 6.33 Position 7e - 2

Position 7e - 2	Pro	Con
Proximity to glacier to the east	No problem	
Navigability	Easy access	
Proximity to river		On the south side of the existing river
Access to camp site and main roads for tunnel and dam work		Necessary to have a permanent bridge over river for access to the camp site and main roads for tunnel and dam work Road - as shown in earlier design - from quay to camp and power house will be difficult because it has to pass the foot of the glacier to the East of the river
Access to storage area on “plain”	Easy access to the flat sandy ‘plain’ at the bottom of the fjord and south of the river	Limited hinterland area near sea level and near quay for storage purposes. Small back area for quay can be established near the quay, by blasting a shelf.
Hinterland for camp	Acceptable conditions for establishing camp facilities on plateau above harbor and west of river	Necessary to have a permanent bridgeover river for access to the camp site

As conditions are not favorable, Position 7e.2 is not recommended as suitable for harbor facilities.

Table 6.34 Position 7e - 3

Position 7e - 2	Pro	Con
Proximity to glacier to the east	No problem	
Navigability	Easy access	
Proximity to river		On the south side of the existing river
Access to camp site and main roads for tunnel and dam work		Necessary to have a permanent bridge over river for access to the camp site and main roads for tunnel and dam work

Position 7e - 2	Pro	Con
Access to storage area on "plain"	Easy access to the flat sandy 'plain' at the bottom of the fjord and south of the river	Back area for quay can be established near the quay,
Hinterland for camp	Acceptable conditions for establishing camp facilities on plateau above harbor and west of river	Necessary to have a permanent bridge over river for access to the camp site

Position 7e - 3 may be a possible solution for harbor facilities.

Table 6.35 Position 7e - 4

Position 7e - 2	Pro	Con
Proximity to glacier to the east	No problem	
Navigability	Easy access	
Proximity to river	On the north side of the river, if river the is diverted	On the south side of the river, if river is not diverted
Access to camp site and main roads for tunnel and dam work		Necessary to have a permanent bridge over river for access to the camp site and main roads for tunnel and dam work, unless river is diverted
Access to storage area on "plain"	Easy access to the flat sandy 'plain' at the bottom of the fjord and south of the river Back area for quay can easily be established near the quay	
Hinterland for camp	Acceptable conditions for establishing camp facilities on plateau above harbor and west of river	Necessary to have a permanent bridge over river for access to the camp site, in case the river is not diverted

Position 7e - 4 is considered the best location for the harbor facilities, especially if it is economically feasible to divert the river to the position labeled as "Possible Diversion of River" as shown on Figure 6.7 previously presented.

6.15 Access roads

6.15.1 General design basis

6.15.1.1 Road Types

Two types of roads are considered: primary roads and secondary roads. The primary roads will be used both in the construction phase and later on in the operation phase. All primary roads are shown on the drawings.

The secondary roads will mainly be used in the construction phase and are not shown on the drawings. The design of the secondary roads will be the responsibility of the contractor.

6.15.1.2 Phases

Two different phases for the use of the roads are envisaged:

- **Construction Phase**: The roads will be used for transportation of heavy loads, containers, equipments for civil works construction, fuel for vehicles, generators, materials and consumables for the camps and personnel, from the harbor or landing areas to tunnel adits, camps and dam areas
- **Operation Phase**: The roads will be used for transportation of spare parts and equipment necessary during the operation phase. During the Operation Phase it is foreseen that most equipment, personnel and consumables will be unloaded at the harbor. It is expected that helicopters will be used in both phases for transport of light spare parts and personnel as a supplement to road transport. The helicopters shall operate from approved heliports.

6.15.1.3 Geotechnical conditions

It is recorded that permafrost is present around Lake Tasersiaq at elevation above 700 m for Site 7e. The presence of permafrost in the valley of the Evighedsfjord of Site 7e is anticipated, but further surveys should be carried out. The roads are designed accordingly to the expected permafrost occurrence.

6.15.1.4 Traffic volume

No traffic forecasts are available. The following design criteria have been used.

During the Construction phase

- The primary roads are recommended to be designed for ten passages of heavy vehicles every day or 4 000 passages per year.

During the Operations phase

- The primary road between the harbor and the power station is recommended to be designed for two passages of heavy vehicles everyday or 500 passages per year.
- The primary road beyond the power station is recommended to be designed for two passages of heavy vehicles every week or 100 passages per year.

6.15.1.5 Vehicles and Axle Loads

The roads are expected to be used by ordinary heavy vehicles, and the pavement is planned for 10 ton axle load with two passages per passing vehicle, according to Danish Standards.

The bearing capacity of the roads must be sufficient for a heavy truck like a CAT 740. The empty weight is 33.1 tons, and 72.6 tons when loaded. The truck has 6 wheels. It is expected to carry excavation materials at the construction sites outside the primary roads. The calculated pavement for ordinary heavy vehicle is sufficient for one passage per day with a loaded CAT 740. If the primary roads are used for heavy traffic with the CAT 740 each layer of the pavement and the total thickness has to be increased.

6.15.1.6 Road geometry

The road surfaces will be gravel-paved and shall be carried out with a transverse slope of 4% one-sided or double-sided. According to the literature[8], the maximum longitudinal slope of roads is 10% at a length of 100 m only. As all roads are constructed outside urban areas and mainly as construction roads, the roads may have a maximum longitudinal slope of 10% for longer distances and steeper slope, up to about 15%, for shorter distances.

Primary Roads

Primary roads will have one lane, 4-5 m wide with 0.75 m wide shoulders, for a total of 5.5-6.5 m width. The 5 m wide roads will be used for permanent roads and for roads from the harbor to the main construction sites. The width is increased at narrow bends and in cut-sections to allow for transport of long units and 8 m wide units. Lay-bys are located at maximum distances of 500 m and with free sight. The road width at lay-bys is 8.0 m.

Secondary Roads

Secondary roads run from the primary roads to minor construction sites and borrow areas. They are designed by the contractor.

6.15.1.7 Cross sections

Typical cross sections for the primary roads are shown on drawing no. 103 of the drawings set.

In soil areas where permafrost is expected, the excavation is limited to a minimum to avoid thawing of the frozen soil. In these road sections there will be no balance of cut and fill. Large quantities of NFS material must be brought in from borrow areas, unless the excavated soil is of NFS quality.

A study of the orthophotos has provided an indication of the surface and cross-section to use along the alignment.

In steep sloping areas the roads will have ditches (refer to section 6.15.1.9).

6.15.1.8 Pavement

Based on the traffic volume and axle load mentioned above and a calculation of bearing capacity, the recommended pavement thickness is shown in Table 6.25 below. The material for the wearing course is mechanically stabilized gravel size 0-32 mm. Base course can be the same or screened gravel size 0-50 mm. The sub-base and filter can be selected gravel size 0-80 mm or screened gravel 16-80 mm. The fill below the pavement is selected gravely soil with less clay and silt.

Rock fill is used at steeper rock surfaces. Dents in the surface are filled with minor stones or screened material before the pavement is placed. In areas with heavy traffic with the CAT 740 truck, the total thickness of each layer of the pavement has to be increased.

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[8] Greenland Home Rule, Roads in Greenlandic towns, Directions for design and execution, Oct. 1987 (in Danish only).

6.15.1.9 Water control

Where the surrounding terrain is rising from the road side, water control measures are included with ditches at a short distance from the road embankment. Where the road is located on fill and the surrounding terrain is sloping away from the road side, no water control measures are specified.

Embankment slope shall be 1:2, if possible. Where the roads cross springs, streams, rivers, etc., different kinds of structures are used:

- Bed-level causeways constructed by stones or concrete at a width of 8 m, when the water flow is limited and the water depth can be limited to 0.15 m,
- Vented causeways with culverts and concrete superstructure (Irish bridges) where the stream and water flow are larger than above, and where the water flow over the structure can be limited to 0.15 m,
- Regular bridges or rock-fill embankments with large diameter culverts where the road crosses major streams or rivers.

Culverts and bridges shall be designed for axle and vehicle loads as mentioned in section 6.15.1.5.

6.15.1.10 Maintenance

Autumn maintenance should be carried out just before the winter season. The cross slope at a gradient of 4% and road shoulders are graded even, in order to allow water to flow from road surface into the ditches. The maintenance also includes cleaning out any poorly working ditches and checking culverts for debris etc.

Spring maintenance should be carried out in early spring and consists mainly of de-icing of culverts and ditches filled with ice. During the spring, dust binding may be done using salt ($CaCl2$). When the snow has melted the gravel roads are reshaped using a grader. Bed-level causeways are inspected annually, every spring and maintained when necessary. Other culverts and bridges are inspected regularly and maintained when necessary.

During the construction phase, all roads should be maintained as described above.

During the operation phase, only a minor part of the primary road (from the harbor to the power station) is maintained regularly.

The remaining primary and secondary roads will be maintained only if required for new construction or repair works.

6.15.2 Preliminary Design

The design of the roads is based on the alignment shown on drawing 102 of the drawings set. A 3D-model was prepared for calculation of fill and cut along the planned roads for Site 7e.

Longitudinal sections of each part of the roads are prepared based on the information in the 3D-model and orthophotos, and cut and fill quantities are calculated at Site 7e using the proposed cross-sections (drawing no 103).

The primary road runs from the harbor and staging area at Evighedsfjord to the TBM adit passing the main camp and access tunnel to the power station. This road section has a width of 6.5 m including 1.5 m shoulders. From the TBM adit close to the middle of the headrace tunnel, a 5.5 m wide road leads to the secondary camp between Dam 1 and Dam 2, and onwards to the Dam 1 construction site.

The alignment is divided into three parts, Valley, Uphill and Lake. For each part, longitudinal sections were prepared. The number of water body crossings has been evaluated with orthophotos.

Typical cross sections are shown on Drawing no. 103. The most suitable cross-section was then applied to every stretch of the road, as presented in Table 6.36, along with the cut and fill quantities for every stretch. The number of water body crossings is also presented in Table 6.36.

Table 6.36 Road design at Site 7e (by Niras)

Stations		Length (m)	Road type	Width (m)	Pavement (m)	Soil excavation (m^3)	Fill (m^3)	Rock cut (m^3)	Rock fill (m^3)
Harbor to intake									
0+000	0+800	800	F3	5 (6.5)	0.65	647	4.712		
0+800	1+100	300	F1	5 (6.5)	0.65	416	6.341		
1+100	2+500	1.400	F3	5 (6.5)	0.65	1.132	8.247		
2+500	2+900	400	F2	5 (6.5)	0.65	231	8.455		
			VC	1	nos.				
2+900	6+100	3.200	F1	5 (6.5)	0.65	4.435	67.637		
6+100	7+200	1.100	F2	5 (6.5)	0.65	635	23.250		
7+200	8+000	800	F3	5 (6.5)	0.65	647	4.712		
			VC	2	nos.				
8+000	8+600	600	F2	5 (6.5)	0.65	347	12.682		
			VC	1	nos.				
8+600	9+500	900	F1	5 (6.5)	0.65	1.247	19.023		
			VC	1	nos.				
9+500	9+700	200	C3	5 (6.5)	0.25			11.481	0
			VC	1	nos.				
9+700	11+300	1.600	F2	5 (6.5)	0.65	924	33.818		
11+300	11+730	430	F1	5 (6.5)	0.65	596	9.089		
11+730	11+800	70	Bridge	5 (6.5)					
11+800	14+950	3.150	F1	5 (6.5)	0.65	4.366	66.580		
14+950	15+030	80	Bridge	5 (6.5)					
15+030	15+600	570	F1	5 (6.5)	0.65	790	12.048		
15+600	17+000	1.400	F2	5 (6.5)	0.65	809	29.591		
17+000	18+500	1.500	C3	5 (6.5)	0.25			86.105	0
			VC	2	nos.				
18+500	18+800	300	F2	5 (6.5)	0.65	173	6.341		
18+800	19+200	400	C2	5 (6.5)	0.25			3.188	2.633
19+200	19+900	700	C3	5 (6.5)	0.25			40.182	0
			VC	1	nos.				

Stations		Length (m)	Road type	Width (m)	Pavement (m)	Soil excavation (m³)	Fill (m³)	Rock cut (m³)	Rock fill (m³)
19+900	19+950	50	C2	5 (6.5)	0.25			398	329
19+950	20+000	50	Bridge	5 (6.5)					
20+000	20+100	100	C2	5 (6.5)	0.25			797	658
20+100	20+650	550	C3	5 (6.5)	0.25			31.572	0
			VC	1	nos.				
20+650	20+750	100	F2	5 (6.5)	0.65	58	2.114		
20+750	21+300	550	C3	5 (6.5)	0.25			31.572	0
21+300	21+800	500	C2	5 (6.5)	0.25			3.985	3.292
21+800	21+900	100	C3	5 (6.5)	0.25			5.740	0
21+900	22+000	100	C2	5 (6.5)	0.25			797	658
22+000	22+100	100	C3	5 (6.5)	0.25			5.740	0
			VC	1	nos.				
22+100	22+300	200	F2	5 (6.5)	0.65	116	4.227		
22+300	22+600	300	C3	5 (6.5)	0.25			17.221	0
			VC	1	nos.				
22+600	23+100	500	C2	5 (6.5)	0.25			3.985	3.292
23+100	23+300	200	C1	5 (6.5)	0.25			832	531
23+300	23+800	500	C2	5 (6.5)	0.25			3.985	3.292
23+800	24+000	200	C3	5 (6.5)	0.25			11.481	0
24+000	24+100	100	F2	5 (6.5)	0.65	58	2.114		
24+100	24+800	700	C3	5 (6.5)	0.25			40.182	0
24+800	25+200	400	C2	5 (6.5)	0.25			3.188	2.633
25+200	25+400	200	F3	5 (6.5)	0.65	162	1.178		
25+400	25+500	100	C3	5 (6.5)	0.25			5.740	0
25+500	25+800	300	F3	5 (6.5)	0.65	243	1.767		
25+800	26+000	200	F1	5 (6.5)	0.65	277	4.227		
26+000	28+900	2.900	F3	5 (6.5)	0.65	2.345	17.082		
			VC	2	nos.				
28+900	29+000	100	C2	5 (6.5)	0.25			797	658
29+000	30+000	1.000	F3	5 (6.5)	0.65	809	5.891		
			VC	2	nos.				
30+000	30+300	300	F1	5 (6.5)	0.65	416	6.341		
30+300	32+200	1.900	F3	5 (6.5)	0.65	1.536	11.192		
			VC	1	nos.				
32+200	32+700	500	F1	5 (6.5)	0.65	693	10.568		
32+700	33+249	549	F3	5 (6.5)	0.65	444	3.234		
	Subtotal	*33.249*				*24.552*	*382.461*	*308.968*	*17.976*

Stations		Length (m)	Road type	Width (m)	Pavement (m)	Soil excavation (m^3)	Fill (m^3)	Rock cut (m^3)	Rock fill (m^3)
Intake to Dam 1									
0+000	0+400	400	F3	4 (5.5)	0.45	339	2.226		
0+400	0+600	200	F1	4 (5.5)	0.45	169	3.533		
0+600	1+300	700	F3	4 (5.5)	0.45	593	3.896		
1+300	1+500	200	C1	4 (5.5)	0.25			726	411
1+500	1+900	400	F1	4 (5.5)	0.45	339	7.066		
1+900	4+700	3	C1	4 (5.5)	0.25			10.164	5.760
			VC	1	nos.				
4+700	4+780	80	F3	4 (5.5)	0.45	68	445		
4+780	4+810	30	Bridge	5 (6.5)					
4+810	5+900	1	C2	4 (5.5)	0.25			7.386	5.671
			VC	1	nos.				
5+900	6+400	500	C1	4 (5.5)	0.25			1.815	1.029
			VC	1	nos.				
6+400	10+300	3.900	C2	4 (5.5)	0.25			26.426	20.292
			VC	1	nos.				
10+300	10+500	200	C3	4 (5.5)	0.25			9.583	0
			VC	2	nos.				
10+500	11+700	1.200	C2	4 (5.5)	0.25			8.131	6.244
11+700	12+300	600	F3	4 (5.5)	0.45	508	3.340		
12+300	12+700	400	F2	4 (5.5)	0.45	0	7.066		
			VC	3					
12+700	13+337	637	F1	4 (5.5)	0.45	540	11.253		
	Subtotal	*9.451*				*2.556*	*38.825*	*64.231*	*39.407*
Bed level causeways			***93***	***nos.***					
	Grand total	***42.700***				***27.108***	***421.286***	***373.199***	***57.383***

6.16 Construction Camps

6.16.1 Camp capacity

The projected capacity of the camps is estimated and is listed in Table 6.37. They are planned to be used during all of the construction period. Space for the transmission line workers is included in the projected capacity of the camps.

Table 6.37 Projected capacities of camps

	Camp A	Camp B
Workers	423	274
Staff	100	59
Total	*523*	*333*

The work will be carried out in shift work. The accommodation buildings are based on 100% capacity, while the camp facilities are based on 70% capacity, corresponding to the working day shift. The service buildings must then accommodate respectively 366 and 233 persons at the same time for camps A and B.

The camp shall be self supporting with power and water supply while the sewage treatment plant (STP) and waste disposal is common for the camp and the construction site. The camp will consist of a number of accommodations blocks, service facilities such as kitchen, dining and laundry (KDL), recreation hall (RH), offices, storage facilities and workshops. A helicopter pad is included in the layout.

At the beginning of the first year of construction, a “starter” camp will be constructed at camp A, which shall accommodate 70 people (60 workers and 10 staff).

All buildings and other facilities shall be designed to a Greenlandic standard observing the Greenland Building Code.

6.16.2 Description of camps facilities

6.16.2.1 Camp area layout

At Site 7e, two camps will be constructed:

1. Camp A near the powerhouse and the tailrace tunnel exit at sea level, where workers for the powerhouse and adjacent tunnels will live.
2. Camp B near the intake structure, on the shores of Lake Tasersiaq. Workers for the intake structure, Dam 1 and Dam 2 will live at this camp.

The layouts for the camps are shown on drawing no. 105 and 106 of the drawings set. Both camps are located as close to the construction site as possible. The layouts of the camps consider a minimum of ground leveling. The long accommodation buildings are located along the contours and the larger service buildings are located on flat areas.

The material from rock excavation for the accommodation buildings are used for leveling the ground for the service buildings. If all building should be established on large leveled gravel pad, a considerable amount of blasting and filling must take place.

Each camp consists of four areas:

1. central areal with RH, KDL, offices
2. accommodation area north
3. accommodation area south
4. industrial area with storage, workshops and power station

The distance between the buildings must comply with the distance criteria in the Greenland Building Code. There are shown in Table 6.38.

Table 6.38 Distance criteria for camp buildings

Distance criteria in metres	Wooden facing	Steel facing
Accommodation buildings with more than 10 beds	10	5
Buildings more than 600 m² or with more than 50 persons assembled	10	5
Buildings containing inflammable storage, power stations, fire stations etc.	10	5
Other buildings one storey	5	2.5
Other buildings, more than one storey	5	3.5

For calculating the distance between two buildings the distance criteria for both buildings must be added.

6.16.2.2 Accommodation buildings

The accommodation buildings are constructed of modules in two stories.

Each building comprises:

- sleeping rooms having an area of 9 m²;
- living rooms;
- private bathrooms, toilets and washbasins;
- washing machines and dryers;
- two modules for staircase.

Each building contains at total of 58 modules, each of them 2.9 m × 8.4 m (24.36 m²). The modules are constructed with timber, with a wood facing and insulation for arctic climate. The foundations are steel beams on gravel pads. The beams are tied to anchors in the gravel pad or rock anchors.

The buildings for workers will be equipped with two bed sleeping rooms for workers, while the buildings for the management staff will have single rooms.

The distance between two accommodation buildings is not less than 20 m for fire safety. Each sleeping room must be a fire cell and each wing with 20 rooms is considered a fire section. Each room is equipped with fire alarm system, and a fire hose with water pressure is installed in each corridor

All rooms are heated with electrical radiators. Hot water is produced in water heaters in each module. Water installations are limited to the central common rooms with bath, toilets and laundry facilities.

6.16.2.3 Service buildings

Office for camp administration and infirmary

One two storey building, constructed by the same type of modules as the accommodation buildings, contains offices and rooms for the infirmary. Foundation, heating, fire safety and other installations are as for the accommodation buildings.

Kitchen, dining and laundry (KDL)

The dining hall is designed to accommodate the number of workers during the day shift all at the same time (366 people for camp A and 233 people for camp B). The necessary area is estimated to 1.2 m² per seat. The kitchen area including day storage is estimated to 50% of the dining area. The laundry area is estimated to one module (2.9 x 8.4 m) per 200 people.

The KDL is arranged in one large building constructed by modules like the accommodation buildings or as a steel frame building with insulation and corrugated steel facing. The foundation is steel beams on a gravel pad. A small KDL is established on the "starter" camp.

All of the buildings are heated with electrical heaters.

Recreation hall

The recreation facilities comprise gymnasiums, meeting hall, bar, shops, internet suite, etc. The facilities are included in one or two buildings next to the KDL. The area is estimated to 1.5 m² per person. Construction and heating of the buildings are similar to the KDL.

6.16.2.4 Storage facilities

The supply of goods will take place by ship to the harbor in Evighedsfjord.

The container storage area at the harbor is limited and the containers for the camp must be moved to the camp area shortly after the ship arrival. Between ship arrivals the containers are stripped to the storage buildings or directly to the kitchen storage rooms. The storage facilities in the camp comprises container yards and three storage buildings for cold storage (unheated), heated storage and refrigerated storage respectively.

The storage buildings are constructed by steel frames with corrugated steel facing. The foundation is steel beams on gravel pads and ground anchors may be necessary. The heated storage and refrigerated storage buildings are insulated, and the heating of the buildings is with oil fired unit heaters.

6.16.2.5 Workshop and garage

One building similar to the storage buildings comprise workshops for camp maintenance, mechanical, carpenter etc. The electrical workshop is included in the power station building. A garage for vehicle repair and firefighting equipment is also established in a steel building similar to the storage buildings.

6.16.2.6 Power supply

The design criterion for the power supply is to provide 8 kW of power per person. Diesel generators to meet the required power at each camp are provided. The generators are placed in an insulated steel building which also holds switchboard and operation panel for the power station, electrical workshop and water treatment plant.

6.16.2.7 Water supply

The water supply comprises a reservoir, a raw water pipeline, water treatment plant, storage tank for treated water and water mains to consumers. The water consumption is estimated to 200 liters per person per day.

The reservoir will consist of an insulated storage tank designed for a 1 month capacity of water. The water will run from the reservoir to all the buildings by gravity through a siphon and pipelines. The pipelines are pre-insulated and heat traced, placed on sleepers on the ground. The pipelines will cross the roads in culverts.

At the site of camp A, it is planned to pump water from a small temporary reserve created by damming the small river near camp, while at camp B it is planned to pump water directly from the adjacent lake.

The water treatment plant is located in the same building as the power station. Water quality from the lakes varies over the year. It must be taken into consideration when dimensioning the water treatment that in the snow melting period the level of organic matter will rise (called “Flom”).

The water is treated to obtain a water quality accordingly to Greenlandic standards. The treatment plant will have a capacity of 20 m^3/h.

6.16.2.8 Waste water

All waste water is collected in a sewer system and led to a sewage treatment plant (STP). From the STP the treated water is led to the sea. Sewer mains consist of insulated pipelines from all buildings to the STP. The sewer mains will follow the same alignment as the water mains. The daily volume to be treated corresponds to the projected water consumption of 200 liters per person per day.

6.16.2.9 Waste disposal

The waste from the camp comprises:

- Combustibles material, wood, garbage, waste oil, etc.;
- Metal scrap;
- Hazardous and toxic waste;
- STP sludge.

The production of waste in Greenlandic towns is estimated to 1.5-2 kg per person per day. A value of 2 kg per man is used for the estimation of the waste volume to be produced at each camp. The proposed solution is a containerized incinerator for the full camp capacity.

6.16.2.10 Roads

The roads comprise:

- Primary road between the construction site and the central part of the camp,
- Secondary roads between camp centre and buildings.

The primary road is design for heavy traffic with two lanes, for a total width of 6 m, and 1.5 m shoulders. The pavement is a thickness of 0.65 m of gravel. The distance between the centerline of the roads and buildings shall be not less than 10 m.

All accommodation buildings are connected with the primary road by secondary roads. They are used during construction of the buildings, but shall be maintained for light vehicle traffic for the fire engine and in connection with repair, waste removal etc. The width of the secondary roads is 4 m and 1.5 m shoulders.

Outside entrances to the buildings and level area of gravel fill serves as parking area and turning area at dead end roads.

A gravel area with a diameter of 22.2 m is also established near the camp for the heliport. It is equipped with wind sock and fire extinguishers.

6.16.2.11 Telecommunications

The telecommunication comprises telephone, cellular phone transmission, internet connection, TV signals and radio broadcast.

All telecommunication will be ensured by a link to the existing radio link (TELE-Greenland) via a repeater station. The repeater station must be established on a mountain top at the same standard as a normal TELE Greenland – site. It includes a diesel generator with intermediate operation with solar battery and traditional batteries. The capacity is 8x2 Mbps un-doubled.

A cable from the telecom mast leads to all buildings following the power cable alignment. The cable also carries alarm signals to a central room in the office building.

Stationary telephones are installed in the office building, RH, KDL, garage, workshops and power station. In the accommodation buildings only one stationary telephone is installed. All other telephone connection is by cellular phone to a transmitter on the telecom mast.

TV connections are installed in the RH, and TV rooms in the accommodation buildings. Hotspots are established in all buildings for Wi-Fi internet connection. A number of local and international radio stations will be broadcasted from a transmitter on the telecom link mast, facilitating radio listening all over the area including the construction site.

6.16.2.12 Vehicles

The fleet of vehicles for operation of each of the camp includes:

- double cabin 4WD pick-ups, for managers, maintenance, cleaning, powerhouse, security, etc.;
- trucks with crane for transportation and snow clearing;
- forklift truck for handling containers;
- tractor for waste handling and snow clearing;
- snow clearing equipment for trucks;
- fire engine.

6.16.3 Summary of facilities

The facilities that will be included in camps A and B are presented in Table 6.39, with their respective area.

Table 6.39 Camp facilities at Site 7e

	Camp A		Camp B	
	Nb.	m²	Nb.	m²
Site preparation (including roads)	250 m x 250 m = 62,500 m²		240 m x 240 m = 57,600 m²	
Infrastructures				
• Power station (5.2 MW for A and 3.3. MW for B)	1	600	1	600
• Water supply plan	1		1	
• Sewer plan	1		1	
• Incinerator	1		1	
• Telecommunications	1		1	
Accomodation buildings				
• Workers : 40 modules/building (2 beds/room)	3	4 240	2	2 825
• Staff : 40 modules/building (1 bed/room) (Common rooms included-18 modules/building)	2	2 825	1	1 410
Service buildings				
• Offices	1	365	1	219
• Dining	1	438	1	292
• Kitchen (including day storage)	1	219	1	146
• Laundry	1	73	1	49
• Recreation hall	1	549	1	350
• Infirmary	1	61	1	37
Workshops				
• Mechanical	1	200	1	200
• Electrical	1	200	1	200
• Carpenter	1	200	1	200
Garage & Fire fighting (incl. fire figthting equip.)	1	400	1	400
Storage buildings (2 months + 1 mth reserve)				
• Frozen	1	2 966	1	360
• Cold (refrigerated)	1	2 966	1	360
• Dry (non perishable)	1	6 427	1	780

7 Project schedule

7.1 Introduction

The prefeasibility project schedule yields a 5 year construction program. The project schedule confirms the feasibility of the project as per Alcoa's parameters for site 7e. The project schedule is presented in Appendix of the current report in a summarized high level view. This present section will describe the construction methodology, assumptions, schedule highlights and preliminary critical path.

7.2 Schedule Elements

The attached schedule has been produced in MS Project and is displayed in a Gantt bar chart format with supporting legend. The defined summary activities include activity description, duration and proposed start and finish dates. These activities and summaries represent the high level critical components, including schedule dependencies and constraints.

The project schedule is represented by groups of Work which are the followings:

- Roads
- Powerhouse
- Tunnels
- Headrace
- Intake
- Dams
- Spillways

7.2.1 Schedule Assumptions

7.2.1.1 Daylight/Climatic Conditions

- The summer period has extended daylight, permitting 2 daytime working shifts;
- The limitation of Winter daylight and climatic conditions reduce above ground construction work;
- Some construction, erection, tunnel excavation and turbine installation work is not weather nor daylight dependent allowing for continual activity;
- Weather such as wind, snow and rain are considerations in the present schedule;
- Fjord port is free of ice 12 months of the year;
- Helicopter lifting and travel is limited to daytime operation.

7.2.1.2 Workforce Schedules

- Workcrew 400 hours on and 2 weeks off rotation
- Staff: 1 Month on and 2 weeks off rotation
- 26 working days per month
- 6 day work crew
- 10 hours work shift
- All underground work is calculated on 2 shift per day and is not weather dependent

7.2.1.3 Road Construction Methodology

Many sections of the access road require rock excavation on steep hill side rock terrain. In order to shorten the construction duration of the road, it is proposed to start with a 4 meter wide penetration track permitting a faster progression and access for the equipment required to widen the road to final dimensions at a later date.

7.2.2 Seasonal Work Activities

The main construction activities to be conducted during each season are outlined below.

Summer

- Roads
- Excavation (rock and overburden)
- Backfill

Seasonal Transition Periods (Spring and Fall seasons)

- Tunneling
- Concrete (with outside shelter)

Winter

- Tunneling
- Rock Excavation and blasting (1 daylight shift)
- Concrete (with outside shelter)

The productivities of the major activities are presented in the table below. The estimated durations are a total amount per type of activity. Excavation shifts follow along with anticipated sea shipment volumes.

Table 7.1 Major Activities Productivities

Name	Month	Day	Days per month
TBM’s (Tunnel Boring Machine) excavation (QTY 2) excluding installation and removing)	650	25	26
Drill and Blast excavation (30 to 100 m² – access tunnels)	120	±5	26
Drill and Blast excavation (17.4 m² – cable tunnels)	56	±2	26

- Earth Moving / Rock excavation: 20hours@2 Shifts per day if required (Seasonal daylight restrictions);
- Typical shipment by sea: 10,000 metric tons of materials and 20 000 m³ of equipment or a combination of both.

The total excavation volumes along with the main quantities to be used during construction for the five years of the project are presented in the following table.

Table 7.2 Main Quantities

Name	m^3	Tons	Litres
Tunnels excavated by TBM	1 300 000		
Tunnels excavated by Drill and Blast	850 000		
Open surface excavation Rock	1 500 000		
Open surface excavation Overburden	802,000		
Dam Rockfill Volume	1 122 900		
Asphalt Rockfill Volume	8 500		
Concrete (meters squared)	37000		
Cement (Metric Ton)		13600	
Rebar (Metric Ton)		2300	
Bitumen (Metric Ton)		2 150	
Structural Steel (Metric Ton)		330	
Steel Liner		1 160	
Fuel Requirements			101 600 000

7.2.3 Workers and Staff

The total project man hours requirement is the following:

- Workers = 4,200,000 Man Hours
- Staff = 1,537,200 Man Hours

7.3 Program

7.3.1 Critical Items

The isolated fjord is where the first roll out of the project will begin. The site is accessible year round to establish a pre camp, unloading of ship(s) for supplies and equipment. However it is recommended to set up camp after snow has melted. (March)

After establishment of the pre camp and “beaching of equipment”, the major activity is the road building and excavation inland towards construction sites and camp.

Based on the schedule provided and analysis the primary critical path is identified as follows:

- establishing the initial pre-camp and harbor site;
- primary /access roads and camp installation.

7.3.2 Primary Logistics

The project site is in a remote location which is dependent on well planned and executed logistic support. Both sea and air support are critical to establish and then continually sustain the project site and operations.

7.3.3 Sea Shipments

Including the initial site beach landing and camp set up, 20 sea shipments are planned over 5 years of the project duration. Being 10 equipment shipments of 20,000 m³ and 10 material shipments of 10,000 mt. Temporary floating docks and transport barges will be utilized to move materials to the project camp site from the ships. This will be to provide construction equipment and materials for fabrication of aggregates, concrete, rebar, asphalt, fuel and explosives.

Construction equipment, temporary installations, transportation vehicles and camp modules will also depart by sea shipments.

7.3.4 Air Support

Personnel working on the project will arrive and depart at Kangerlussuaq the Greenland International airport. Shuttling of work crews to the main project work sites will be done via helicopter. This is the existing condition for the entire project including the 2 hydro projects, the transmission lines and the smelter. Weekly incoming Air cargo shipments to the local airport are required in order to deliver such items as perishable food and other required items. The helicopter will then transport these items and personnel to project sites.

Helicopters are needed for the transmission line construction including heavy type craft. An overall logistic operation for the whole project could be foreseen regarding the air support needs. A good coordination between all the construction sites would represent definite cost saving. This is taken into consideration in the pricing of the utilization of helicopters for access road sections not accessible otherwise. In this case, all transportation of workers, construction equipment and materials is done by helicopter.

7.3.5 Major activity start time

The following table indicates the start time of the major activities. The dates are shown in months after receipt of order.

Table 7.3 Estimated start dates for construction activities

Name	Months ARO (Months After Receipt of Order)
Year 1	
Start harbor Site construction	2
Start up Camp	2
Start Main Camp	3
Start Road Work	3
Start Bridge	4
Start Assembly 2 TBM (Tunnel Boring Machine)	10
Start Headrace Excavation	12
Year 2	
Start Power House	12
Start Tailrace excavation	20
Start Cable Tunnel	12

Name	Months ARO (Months After Receipt of Order)
Start TBM Headrace Excavation	12
Establish Camp B	20
Start Intake Construction	24
Start Dam 2	22
Start Road Dam 2 to Dam 1	28
Year 3	
Start Powerhouse E + M works	26
TBM ready to relocate to Intake Structure	34
Start Dam 2 Bitumen impervious core	30
Start Dam 1	35
Start Dam 1 Spillway	35
Year 4	
Start Removal of Headrace TBM	20
Start TBM intake shaft excavation	39
Start Dam 2 Bituminious core	41
Start Dam 1 Bitumen impervious core	42
Year 5	
Start Dam 1 Bituminious core	52
Start diversion tunnel plug	52
Start Powerhouse dry and wet commissioning	50
Commissioning Complete	60

8 Project cost estimation

8.1 Introduction

This present section describes the organization, assumptions and results of the project financial cost estimate of 7e. The detailed cost estimate is included in Appendix 1 while the high level summary is included on the following page. Highlights are the following:

Total direct cost:	$416.9M
Total indirect cost:	$529.0M
Total project cost:	$945.9M

The cost estimate has been prepared using the Alcoa Project WBS with high level activities being the following:

Direct costs

2100 Harbor site preparation
2200 Port facility
2300 Primary road construction
2400 Civil works related to powerhouse, tailrace, tunnels and surge tunnel
2500 Civil works related to power tunnel
2600 Dams and spillways
2700 Electrical works
2800 Mechanical and electrical works
2900 Architectural works

Indirect costs

6100 Temporary construction facilities
6200 Construction services
6300 Construction equipment, tools and supplies
6400 Material transportation
6500 Construction camps
6600 Insurance, taxes, permits and fees
6700 Miscellaneous freight
7000 EPCM home office
8000 EPCM field office
9000 Contingency

For each of these high level items, the following details are provided:

- Man hours;
- Man power cost;
- Consumable material cost;
- Permanent material cost;
- Equipment operation cost;
- Fuel cost; and
- Total cost

The estimate in Appendix 1 includes a breakdown of the high level activities and a further breakdown per second level WBS element.

The estimates provided are all in US dollars. The exchange rates used for other currency conversions are the following:

- Canadian to US dollar = .9
- Euro to the US dollar = .65675

8.2 Cost estimate methodology

The cost estimate uses the contractor methodology which takes into consideration construction methods, with previously witnessed productivities (man hour requirements), adjusted to the particular conditions of this project, being the remoteness, permafrost and temperature, summer and winter daylight conditions and the wind, snow and rain statistics of the area and of course, transportation logistics particularities (sea, air and boat).

8.3 Estimate quantities and unit rates

8.3.1 Direct costs

The estimate quantities for the direct construction elements were provided by the designer teams, based on preliminary drawings, but which have included design optimizations. Permanent equipment prices were based on budgetary quotes received from suppliers and material costs based on present world prices. It should be noted that transportation costs related to these last two items are considered indirect costs and discussed below.

All construction equipment operation and maintenance costs are also considered direct costs. The largest quantity commodity is fuel with a unit price at $0.72/liter, which is the present (August 2009) price in Greenland.

Other major commodity unit prices are the following:

- Cement: $73/mt (from North America)
- Reinforcing steel: $689/mt (from North America)
- Bitumen: $625/mt (from North America)

With approximately 3.3 million direct man hours, man power average base labour rate plays a big role in the overall cost estimate; it is considered to be $24/hour (including premiums, overtime and overhead). This rate was calculated using the following assumptions:

- Base labour hourly rate: $14.70 (in Greenland)
- Shift work hourly premium: $ 1.20
- Overtime premium (%): 50%
- Overhead (%): 26.36% (based on Greenland laws)
- Project work week: 60 hours

8.3.2 Indirect costs

The following section describes details concerning project indirects. Although man hours are required throughout most of the indirect budget elements, it is worth noting that the total indirect man hour count is approximately 0.4 million, with the same all inclusive hourly rate of $24//hour, as described above.

Total indirect costs amount to approximately **$529M**, with 20% of this total amount required for construction, maintenance, catering and operations of the camps.

Below is a brief description of what has been foreseen in each of the principal indirect cost codes and pertinent cost information.

8.3.2.1 Temporary construction facilities (6100)

The estimate preparation for temporary construction facilities involved determining work site requirements. They are as follows:

- Buildings at three construction sites (including an office, garage, trade shop, warehouse, dry house, washroom and foreman office), sized to the peak requirement, including site preparation, installation and dismantling;
- Concrete batch plant for the main site and intake area (installation and dismantling)
- Crushing plant (portable from site to site)
- Asphalt batch plant (at the dam area)
- Explosive depots (at the main camp, dam site and road sites)

The above facilities represent **$3.2M** in project cost.

The above facilities require the support of roads and walkways as well as all utilities totaling **$5.4M**.

8.3.2.2 Construction services (6200)

Construction services include all construction site operational requirements (excluding any camp requirements – which are included in 6500). This includes the following:

- Building maintenance;
- Operational vehicles such as fuel trucks, mechanic's and welding trucks, light vehicles (pick ups, SUVs and ambulance), for all four sites;
- Shop operations;
- Road maintenance;
- Communication (radio and cellular);
- Operation of the water route;
- Final site cleanup;
- Material handling and warehousing (including equipment and man hours, especially fuel depots);
- NDE and QA/QC testing;
- Surveying (excluding man hours);
- Site security;
- Man power transportation (point of origin to appropriate camp); and
- General expenses.

The above site operational costs represent **$65.0M**, of which warehousing and material handling accounts for **$10.7M** and manpower transportation **$41.0M**.

Small tools and supplies have also been included under this budget cost code, not having been included with construction equipment. It should be noted that small tool cost has been evaluated at $0.30/man hour and supplies at $0.10/man hour.

8.3.2.3 Construction equipment, tools and supplies (6300)

The list of construction equipment is included in Appendix 1, describing the type and quantity required for the various construction sites. The equipment cost attributed includes only the depreciated value.

Construction equipment represents a budget of **$74.7M**. The tunnel boring machines account for **$34.6M** of this total, the asphalt batch plant accounts for **$3M** and the crusher, **$1.8M**.

All equipment transportation costs (mobilization and demobilization) have been included in "Miscellaneous freight (6700)".

8.3.2.4 Material transportation (6400)

Material transportation includes freight and insurance costs of all construction bulk materials. This cost element accounts for **$25.1M** of the total project budget.

8.3.2.5 Construction camps (6500)

Twenty percent of the indirect cost are attributed to the construction and operation of the construction camps. Site 7e includes 3 camp sites, accommodating a total of 856 workers and staff (including Transmission Line construction requirements)   Camp capacities were established using peak requirements at each of the work sites.

Construction and removal of the camps amount to **$56.3M**, while operation amounts to **$51.4M**, representing approximately $80 per man day, half of this amount to cover food, catering and camp maintenance and the other half for utility requirements (principally fuel for generators).

This project cost item is worth a total of **$107.7M**.

8.3.2.6 Insurance, taxes, permits and fees (6600)

Project insurance has been evaluated at **$25.9M**, including responsibility insurance, calculated at 2.02% of $725M and risk, calculated at 0.62% of the project value. The project Execution bond was calculated at $0.0069/$ value.

Equipment insurance was calculated at 0.5% of the total equipment value, evaluated at $146M.

It should be noted that it was assumed that the project would be exempt of taxes, duties and port fees.

8.3.2.7 Miscellaneous freight (6700)

Miscellaneous freight includes all mobilization and demobilization costs for project equipment, camp modules and camps utility equipment. Also included in this item is the freight cost inbound of all the permanent equipment such as Turbine/Generator groups, Electro-Mechanical and Mechanical components.

Equipment freight, including insurance, was evaluated at **$24.6M** and camp module and utility equipment freight evaluated at **$10.2M**, for a total of **$34.8M**.

8.3.2.8 EPCM – home and field offices (7000 and 8000)

EPCM home office costs have been evaluated by considering the following:

- Contractor home office services are evaluated at 2% of the direct construction costs of $191M, yielding **$8.3M**;
- Contractor home office services for indirects have not been considered;
- General EPCM project management has been evaluated at **$4M**;
- Total EPCM home office estimate is **$12.3M**.

It should be noted that the following other EPCM costs are not considered:

- Engineering FEL2 and FEL3 activities;
- Procurement activities for purchase and contracts;
- Detailed engineering activities during the construction phase; and
- Contractor 10% profit.

EPCM site office costs have been evaluated by estimating the contractor and general management man month requirements. The contractor requirement include site supervisory staff (superintendents) and all higher grades.

Contractor requirements were estimated at approximately 3 000 man months and general management requirements were estimated at 2 300 man months. A common monthly rate of $10 000 was used, yielding a total EPCM site office cost of **$54.1M**.

8.3.2.9 Contingency (9000)

Project contingency has been established by analyzing each project component, as specified in the WBS, and assigned a specific contingency which reflects the confidence level. It should be noted that an average of 15% has been established for all directs and indirects, while 10% was figured for EPCM items.

The total project contingency has been set at $85.1M, subdivided in the following way:

- Direct cost contingency: **$69.9M** (17% of total direct value)
- Indirect cost contingency: **$47.8M** (13% of total indirect value)
- EPCM contingency: **$6.7M** (10%of EPCM value)

Transmission line contingencies are included in the overall cost.

8.4 Total project cost including Transmission Line Project

WBS	Description	Site 7e	Site 6g	Total Hydro sites	Men-hours (Both sites)
2100	Harbor site preparation	474 981 $	474 981 $	949 962 $	4 460
2200	Port Facility	4 050 016 $	5 233 722 $	9 283 738 $	2 594
2300	Primary roads construction	45 875 129 $	32 358 790 $	78 233 919 $	431 987
2400	Civil works related to Powerhouse, Tailrace tunnel and Surge tunnel	42 329 062 $	23 233 879 $	65 562 941 $	867 656
2500	Civil works related to Power tunnel	130 717 844 $	25 988 319 $	156 706 163 $	1 635 677
2600	Dams and Spillway	32 288 698 $	27 603 038 $	59 891 736 $	804 730
2700	Electrical Works	35 132 187 $	26 691 494 $	61 823 681 $	344 493
2800	Mechanical + Electrical Works	120 575 844 $	44 085 105 $	164 660 949 $	791 400
2900	Architectural works	5 497 800 $	5 497 800 $	10 995 600 $	0
	Directs costs - Sub-Total	*416 941 561 $*	*191 167 128 $*	*608 108 689 $*	*4 882 996*
6100	Temporary Construction Facilities	8 595 590 $	16 725 950 $	25 321 540 $	81 403
6200	Construction Services	65 047 197 $	48 642 636 $	113 689 833 $	645 277
6300	Construction Equipment, Tools & Supplies	74 738 361 $	58 817 800 $	133 556 161 $	0
6400	Material Transportation	25 105 518 $	16 568 461 $	41 673 979 $	0
6500	Construction Camp	107 729 334 $	148 628 635 $	256 357 969 $	148 666
6600	Insurance, Taxes, Permits, Fees	25 871 461 $	24 908 494 $	50 779 955 $	0
6700	Miscellaneous	34 785 789 $	46 247 259 $	81 033 048 $	0
7000	EPCM Home Office	12 338 831 $	5 823 343 $	18 162 174 $	0
8000	EPCM Field Office	54 170 000 $	45 840 000 $	100 010 000 $	0
9000	Contingency	120 933 738 $	79 884 241 $	200 817 979 $	0
	Indirects costs - Sub-Total	*529 315 819 $*	*492 086 819 $*	*1 021 402 638 $*	*875 346*
	Miscellaneous non accounted hours				*750 000*
	Total Hydro Costs	***946 257 380 $***	***683 253 947 $***	***1 629 511 327 $***	***6 508 342***
	Transmission line (by Efla)	93 900 000 $	121 000 000 $	214 900 000 $	
	Substation (by Efla)	21 600 000 $	18 400 000 $	40 000 000 $	
	T-line contingencies	11 500 000 $	13 900 000 $	25 400 000 $	
	Total Costs	***1 073 257 380 $***	***836 553 947 $***	***1 909 811 327 $***	
	With N-1 transmission line (by Efla)	64 000 000 $	76 100 000 $	140 000 000 $	
	With N-1 subsation (by Efla)	2 700 000 $	3 300 000 $	6 000 000 $	
	N-1 T-line contingencies	6 700 000 $	7 900 000 $	14 600 000 $	
	Total Costs (with N-1 transmission line)	***1 146 657 380 $***	***923 853 947 $***	***2 070 411 327 $***	

9 Procurement

The tendering and construction strategy that will be put into place has to meet the project requirements for the construction of the large scale infrastructures that are planned in Greenland. Other constraints include the short time requirement, the remoteness of the proposed construction sites and the cold conditions encountered at the construction sites.

The proposed formula is to follow an accelerated regime in which construction is divided into several lots. Construction of the preliminary facilities such as the harbor and the roads is started as soon as the design and tendering has been done for this part of the project. It will allow the construction of the further works to start earlier as the various accesses will have already been put in place. However, construction of the various lots shouldn't be started prior to the end of the final design of that particular lot. Such a procedure, even if it can reduced the overall construction time, is not recommended since it implies high risk regarding cost control and quality of the design.

9.1 Tendering process

Time appears to be of the essence, also as a long duration development period increases the accrued interest during construction as well as overall general expenses and other financial cost. Accordingly, a practical development approach is essential. The safest alternative considered has the following steps:

1. pre-bidding the harbor and road construction;
2. accelerating essential field exploration; aimed at larger risk components;
3. selecting an engineer for the tender design, without bidding process, who masters valued engineering based on construction driven approach;
4. giving the selected engineer a maximum of 8 months to develop a proper tender design and overall specification package;
5. adopting a transparent risk sharing procedure in the tender documents, with bonuses and not only penalties;
6. encouraging the contractor (bidders) to offer alternative solutions, also during construction, with pre-defined shearing of cost-savings;
7. selecting highly qualified experts to review design (a person who understands and masters valued construction driven design) as well as supporting construction (construction management expert(s)).

For the design phase, work should be carried out by a designated small project design team, located at one common project office, preferably away from the head office. Past experience has shown that long design period, with project staff located at multiple offices, results in "end-rush work", poorer design, delays and higher overall development cost. The smaller and the higher caliber the design team is, the lower will the overall project development cost be.

9.2 Division of construction contracts

The following sub-divisions of the construction lots appears beneficial, both to accelerate the project completion (local smaller contractors are likely to be able to mobilize earlier than large joint-venture), as well as to lower cost. It is likely that local smaller contractors are more likely to be able to mobilize earlier than large joint-ventures. It is assumed that this approach will be supported by a small high quality project-design team following the above addressed traditional tendering approach.

1. Pre-bid construction of the harbor and of the preliminary camp.
2. Pre-bid construction of all temporary roads and eventually the “first phase” construction road to the upper project area. The downside of this through might be that the “Dam-contractor” and the Power-Intake contractor might claim if the road to those locations is not finished “on time”. Pre-bidding this work, with clear intent of possible combination of all lots, would be useful.
3. Eventually, pre-bid the excavation of the access tunnel to the power cavern, also used for setting up and excavating the TBM driven tunnels.
4. Bid separately upper-project facilities other than the power intake; including construction of the dams, the canals, the diversion tunnels and other upper project auxiliary structures.
5. Bid separately the construction of the:

   - Headrace tunnel and shaft excavation, stabilization and lining, including cleaning and testing. In that bid package, make it clear that the bidders stand free to excavate the waterways with a tunnel boring machine (TBM) or by drill an blast, and they can increase or decrease the tunnel slope and introduce shafts at will, including ventilation shafts, as long as the head loss in the tunnel will not increase beyond prescribed value (and as long as this will not increase tendered cost).
   - The power and transformer caverns, tailrace tunnel and all waterways and power generating and appurtenant structures, including the power intake and tunnel closure plugs, switchyard and operation building, etc.
   - Include in this package the bifurcation and the penstock steel liner (specialized sub for this task) The reason for not separating this task from the civil works is to reduce claims.

6. Bid electro-mechanical equipment as the 6th lot. The various suppliers will likely joint-venture.
7. Bid construction of the transmission lines separately, as the 7^{th} lot.

While some of those lots would be tendered at a different time, allowing the Engineer and the Owner to start up certain critical parts of the project faster than if all would be bid at the same time, the setup should allow any Joint Venture to bid on one, more or all of the lots. The later would encourage large international consortiums to collaborate with smaller “local” contractors, who could mobilize faster for the pre-construction works and who are familiar working under arctic conditions.

10 Risk analysis

The five main risks that were identified for the hydro are:

- Greater than anticipated infrastructure and logistics difficulties could increase costs and delays project start up ;
- Civil works construction difficulties could increase costs and delays (access road, tunnelling, dam construction);
- Unfavorable weather conditions (change in duration of either winters or summers - movement of materials is easier during winter conditions -Fjord ice, fog, movement over snow or ice whereas construction is easier during summer conditions.);
- Difficulties could be encountered along the 300 km transmission lines to be constructed in rough terrain, with long fjord and glacier crossings. Some of them are state-of-the-art
- Environmental issues increase project cost, potentially impact start and completion dates/schedules and reduce available power output (NGO delays, Water releases downstream of dams, Ecosystems or archeological features in flooded areas or T-line corridor, project footprint).

11 Project optimization

Optimization of the project layout was carried out to obtain the largest firm yield possible at the lowest per MW cost, while meeting the project requirements regarding the smelter energy needs. Additional optimization will need to be done in the next project phase to increase the reliability and the revenues of the project.

11.1 Single site 7e

It is projected to develop two separate hydro sites; site 6g providing 185 MW and site 7e providing of 500 MW, ensuring to meet the defined smelter needs of 685 MW, including the various power losses and consumption.

An alternative to the actual proposed hydro developments could be to develop only site 7e, which has some potential for an increase in the firm power it can provide. Indeed, the topography surrounding lake Tasersiaq is steep, which would allow to increase the reservoir size by raising the maximum operating level of the reservoir. There is also an available potential increase in the reservoir volume by lowering the minimum operating level to take advantage of the volume available in the depths of the lake.

The current proposed design plans to operate the reservoir between 680 and 714 m with a TBM headrace tunnel of 50 m², yielding a firm power of 496 MW.

The range of operating levels of the reservoir at site 7e can be varied to increase the firm power or reduce the costs of the project. The possibility to raise or lower the maximum and minimum operating level was simulated to determine the firm power available for every scenario. The results are presented in section 5 of the current report.

The first option considers the possibility to raise the crest of the dams to increase the maximum operating level. The gains in firm power are noticeable since the live storage increases rapidly with a raising maximum water level. The cost of raising Dam 2 also increases very rapidly since it is very wide above elevation 714 m (over 1 000 m). The closure of the reservoir is ensured with only Dam 1 and 2 even for higher maximum water levels. However, if this option was to be considered, the closure of the reservoir on glacier edges should be further analyzed as this is an issue that wasn't studied for water levels higher than 717 m (level reached by the 1:10 000 years flood) in the current phase of the project. Table 11.1 summarizes the power gain and cost of raising the maximum water level. The incremental costs of raising the maximum water level were estimated considering the increase in the dam's volume, the additional turbo-generator capacity needed and a longer operation period of the camps.

Tableau 11.1 Incremental cost of raising the maximum operating level of the reservoir

Maximum operating level (m)	Gain in firm power (MW)	Differential cost – estimated (M$)	Incremental cost per MW (M$ / MW)
714	Base scenario		
720	21	24	1.1
726	37	52	1.4
732	52	85	1.6
738	71	118	1.7

Secondly, the minimum operating water level has a direct incidence on the costs for the excavation of the headrace canal. Since the natural water level of the lake is near 690 m, minimum operating levels below this level will require increasingly large overburden and rock excavation to ensure an adequate water passage towards the intake. It is still possible to increase the reservoir volume by lowering the minimum operating level.

The cost related to a variation in the minimum operating level compared to the base scenario is estimated. The main cost variation is for the excavation of the headrace canal, which increases rapidly as the minimum water level is lowered. The power gain or loss and differential costs are presented in Table 11.2 hereafter.

Tableau 11.2 Differential cost of raising or lowering the minimum operating level of the reservoir

Minimum operating level (m)	Gain/loss in firm power (MW)	Differential cost – estimated (M$)	Incremental cost per MW (M$ / MW)
670	1	11	11
675	1	9	9
680	Base scenario		
685	(5)	(7)	(1.4)
690	(5)	(4)	(0.8)

The main potential for an increase in the firm power at site 7e could be obtained with an increase in the maximum operating level, as Table 11.2 shows that lowering the minimum operating level below 680 m lead to minimal gains.

11.2 Potential savings

For the next project phase, additional activities and investigations could allow to reduce the overall project cost and optimize the power production at site 7e. The main items that are targeted for potential savings are outlined below.

11.2.1 List of items

Headrace canal and intake design

A new location for the intake structure was recently presented. This new location allows reducing the surface excavation volume of the headrace canal by 60%. On the other hand, the headrace tunnel becomes 600 m longer with this option. However, this change still leads to an important cost reduction overall.

Figure 11.1 shows the new proposed location of the intake structure.

Headrace tunnel diameter

Optimization of the headrace tunnel should be carried in more details in parallel with maximum operating level revision. Also, since the power plant is not connected to a public network, a smaller tunnel would allow cost reductions without reducing the revenues. The firm power available at the site would however be reduced due to an increase in head losses. However, the firm power could be balanced by raising the dams to increase the useful volume of the reservoir. A more detailed analysis on the subject should be carried out.

As an example, a headrace tunnel diameter of 7 m would lead to a 16.9 M$ saving only on direct costs. So far, we have considered a conservative overall potential economy of 10.5 M$ from a reduction in the headrace tunnel diameter.

Powerhouse location

Following the 2009 investigation and the results obtained from the deep borehole including the jacking tests and acoustic survey as well as the geological mapping it was concluded that, strictly in terms of geological structures, the powerhouse has to be moved so to avoid possible stress relief in rock formations due to the presence of an important sub vertical dolerite dyke, 20 m large, sub-parallel to the power tunnel and few faults/lineation that cut across the originally proposed powerhouse location. The powerhouse site is therefore moved approximately 200 m west to avoid this zone, thus slightly increasing the length of the various access galleries and of the tailrace tunnel. This change leads to an increase in the overall cost of the tunnels.

Figure 11.2 presents the new proposed location of the powerhouse.

It is also proposed to slightly reduce the size of the access tunnel to the surge chamber to keep it at a minimum acceptable size for circulation of the machinery.

Penstocks and manifold optimization

The penstocks, manifold and the lined section of the headrace tunnel leading to the turbines can be optimized with further economical analysis. Both the diameter of the excavated cross-section and the concrete and steel thickness should be reviewed in the next project phase to reduce the costs.

Dam axis and cross-section

The axis of Dam 1 may be moved about 200 m downstream in order to reduce its length and the volume of all fill materials including the asphaltic concrete core. According to the available topography, the right abutment will then be steeper than 45°, presented as a design criterion by some authors. The disadvantage of such a steep abutment could be overcome by an inclination of the concrete plinth towards the upstream direction in order to obtain a more favorable stress conditions inside the core.

The left abutment of dam 1 alternative axis offers a favorable topography for the implementation of an ogee weir, unlined chute spillway. This type of spillway may reduce the excavation volume. Further analysis of the flow conditions at the spillway chute will be needed to determine the excavation requirements downstream of the ogee weir in order to ensure the protection of the downstream toe of the dam.

Figure 11.3 presents a preliminary layout of Dam 1 and Spillway 1 at the downstream site.

An alternative dam type that should also be studied in more details in the future is a concrete faced rockfill dam (CFRD). This type of dam can be constructed more easily during the winter season than the asphaltic concrete core rockfill dam (ACRD) and it can be constructed faster. Despite CFRD is more labour intensive and implies the exclusion of the upstream cofferdam from the dam body, it may be a more interesting dam type especially for Dam 1 which is on the critical path of the construction schedule.

If ACRD is maintained, optimization of the typical cross section maybe conducted. For instance, the reduction of the width of filter and transition zones maybe lead to material cost savings. However, the related more restrictive material placement conditions should be carefully studied.

Rock support

The rock support assumptions can be reduced compared to the estimate presented in the report, thus reducing the cost of each proposed tunnel (headrace, tailrace, access and diversion tunnels).

Road construction

The construction methodology and the initial cost estimate for the road construction were prepared without a site visit. A site visit made by an experience road contractor would allow optimizing the proposed methodology, thus refining the cost and likely reducing the overall cost since the level of contingency could be reduced. Actual contingencies on the road construction estimate account for 25% of the cost. The airlift is also a major item in road construction and a site visit would potentially allow reducing this cost.

Diversion tunnel

In the next study phase, the excavation volume of the diversion tunnel with regard to the cofferdam heights can be optimized to reduce costs.

Concrete plugs

The concrete plugs are designed with a thickness of 5 m. This thickness could be reduced following a more detail structural analysis to approximately 2 or 3 m.

Cable tunnel

A new concept in the ventilation of the cable tunnels would allow eliminating the concrete blocks that are planned to split the tunnel cross-section in two sections. The cross-section of the cable tunnel could then be kept at a minimum size.

Construction camps

In the initial cost estimate, the full purchase prices of all camp buildings and facilities are considered. However, those items will have a remaining value following the end of the project. A depreciation of 60% of the initial cost was applied to the initial purchase price to determine the remaining values that represent savings that can be applied to the overall cost of the project.

Temporary construction facilities

As for the construction camps buildings, no remaining value was applied to the temporary construction facilities. Some items like pipes, generators and other can be reuse by the contractors. Therefore, a remaining value of 40% of the initial purchase price is also applied on those items, representing a cost saving for the project.

11.2.2 Uncertainties in purchasing costs

The main items of the projects are the fuel cost, equipment cost and the man power. The estimation of all of those items relies on unit costs. A change in unit cost for one of those items could largely influence both positively or negatively the overall project cost. Therefore, it is important to validate those unit costs in the next study phase. The potential savings currently considered from those items are detailed below.

In the initial cost estimate, a cost of 0.72 US$/L was used for the fuel, which correspond to the price of crude oil in Greenland. However, it would be possible to purchase the fuel from another country and transport it to Greenland, at a lower cost per litre. Fluctuations in the price of the crude oil barrel over time can lead to important cost variations as the cost of fuel is one of the major items of the project. At the moment, it is proposed to reduce the price per litre to 0.66 US$ which corresponds to the international August 2009 price.

Also, the purchasing costs of Caterpillar equipments were initially given by Denmark suppliers, which correspond to the costs considered in the cost estimate. A cost reduction is anticipated if equipments were to be purchased in the United States and transported to Greenland.

Finally, a cost reduction in the transportation of the labor to and from Greenland is also possible with chartered flights. Indeed, the initial cost estimate considered the actual market price for a single flight ticket to or from Greenland with the available airlines servicing Greenland.

The cost reductions were weighted on both site 7e and 6g to consider the amount of fuel, equipment and labor used for each site.

11.2.3 Working conditions

Additional savings are possible for the project, depending on the working conditions that are assumed, and the contingencies that are applied to the project. Alcoa suggested various criteria to consider in the cost estimate that are different from the parameters used in the base cost estimate, which roughly represent the actual practices in Canada. It is possible that the working conditions could be below the western countries standards if workers from other countries are employed for the project.

The criteria considered in the base cost estimate concerning the workers conditions compared with the new criteria proposed by Alcoa are the followings:

Tableau 11.3 Working conditions

	Initial cost estimate criteria	Revised criteria proposed by Alcoa
Hourly rate	24$/hr	10$/hr
Workers shift	40 days of work	120 days
Staff shift	40 days of work	60 days of work

Applying the new hourly rate to the cost estimate yields important cost savings on all project items. As for the longer work shifts, it reduced the cost of man power transportation to and from Greenland, as well as the number of overall trips.

The potential savings that can be obtained from the above considerations are:

New hourly rate of 10$/hr: Alcoa suggested the use of a 10$/h rate for Chinese labor. This change represents approximately 50 M$ at site 7e, considering a productivity reduction of 25%,

Reduced man-power transportation due to longer working shifts: approximately 25 M$ cost reduction at site 7e.

11.2.4 Summary of potential savings and alternatives

The following table summarizes the items for which optimization or elimination could reduce the cost of the projected site 7e, except for the potential savings related with a reduction of the hourly labor rate from $24/hr to $10/hr which are presented in Table 11.5. The cost reductions (or increase as for the powerhouse location) anticipated were estimated for every component previously discussed. Similar efforts were conducted by the transmission line design team to obtain a potential saving of 5 M$ for the site 7e transmission line. The potentials savings are presented in Table 11.4.

Table 11.4 Summary of potential savings at site 7e

Item	Potential savings (M$)
Headrace canal and intake	20.0
Headrace tunnel diameter	10.5
Powerhouse location	-0.5
Penstocks and manifold	1.8
Dam cross-section and axis (and spillway)	3.0
Rock support requirements	3.4
Road construction methodology	2.5
Diversion tunnel	3.5
Concrete plug design	1.0
Cable tunnel	1.6
Construction camps	14.7
Temporary construction facilities	0.6
Fuel cost	6.1
Construction equipment cost	6.0
Labor transportation cost	26.8
Transmission line	5.0
Total	***106***

The cost savings outlined above were distributed in the project cost summary table to match the original subdivisions of the project. The fuel and construction equipment cost reductions do apply to all items of the projects as they are used throughout. As for the potential savings in the labor transportation cost, they include a 2.5 M$ saving using chartered flights and 24.3 M$ with longer working shifts as explained in section 11.2.3.

Potential savings were determined in part with a deeper analysis of some uncertainties that exist in the project. Therefore, the overall contingencies of the project are reduced to 10 % of the total amount of direct and indirect costs.

Table 11.5 in the next page shows the overall cost summary of the site 7e project with the potential savings. The single site 7e scheme outlined in section 11.1 was also estimated based on an installed capacity of 535 MW with a maximum operating level of 726 m. The projected costs with the $10/hr labor rate option are also presented in this table. Potential savings were determined in part with a deeper analysis of some uncertainties that exist in the project. Therefore, the overall contingencies of the project are reduced to 10 % of the total amount of direct and indirect costs.

Table 11.5 Cost impact of workers hourly rate

Pos.	Item	2 sites project - Site 7e (500 MW)		Single Site 7e (550 MW)	
		$24/hour (initial cost estimate)	$10/hour (potential alternative)	$24/hour (initial cost estimate)	$10/hour (potential alternative)
1. Civil works					
1.1	Dams	31.5	28.9	40.0	37.2
1.2	Tunnels	141.1	130.3	152.5	140.6
1.3	Canals and intake	33.9	29.9	36.9	32.5
1.4	Underground power station	33.1	30.7	33.1	31.5
2. Mechanical and electrical equipment		167.1	155.5	180.4	167.6
3. Infrastructure					
3.1	Harbors and roads	60.1	55.7	60.1	55.3
3.2	Construction Camps	90.5	83.2	98.0	90.0
3.3	Construction material transportation	24.6	22.9	26.4	24.7
Direct costs total		***582.0***	***537.0***	***627.4***	***579.1***
4. Indirect costs					
4.1	Construction services and temporary facilities	32.1	29.8	32.1	29.6
4.2	Travel cost	14.2	14.2	15.7	15.7
4.3	Insurance	25.9	25.9	27.8	28.1
4.4	EPCM	66.5	66.5	71.4	72.3
Indirect costs total		***138.6***	***136.4***	***146.9***	***145.8***
5. Transmission line		110.4	110.4	145.9	145.9
	Sub-total	*831.0*	*783.9*	*920.2*	*870.8*
	Total (with contingency)	***914***	***862***	***1 012***	***958***
	Hydro Plant Output (MW)	500	500	535	535
	M$/MW	*1.83*	*1.72*	*1.89*	*1.79*
N-1 Transmission line (added cost)		66.7	66.7	102.9	102.9
	Total (with contingency)	***988***	***936***	***1 115***	***1 061***
	M$/MW	*1.98*	*1.87*	*2.08*	*1.98*

11.3 Scheduling

The entire project was commented by external reviewers, including the cost estimate and the schedule. One comment was made that the initial schedule for road and dam 1 construction was tight and had a very little margin for delays. In order to improve the schedule, the methodology to build the access roads is modified. This change in methodology also leads to a cost saving.

A mobile camp is now considered to follow the road construction, instead of waiting for the main camp to be set up, and camp B for the road to dam 1. The camp is on skid and pulled by dozers. It was also suggested that access is possible at both ends of certain steep section without an airlift. One section will however likely require the construction of an access tunnel which can be excavated during the winter season. The number of airlifts is then reduced to only one (compared to four initially). Devices will also be put in place to allow early crossing of streams and rivers that do require bridges, to continue with the road construction before the bridges are completed. Construction of some cut sections will then be possible at the end of the fall of the first year of construction (in October and November 2011).

These changes will allow constructing the road at a faster pace and leaving some time margin for other components of the project like Dam 1 which had initially little room for delays, since a minimum height is required for the impounding of the reservoir to start. It is proposed to start the construction at dam 1 before the completion of the access road from Dam 2 as an initial track can be rapidly completed.

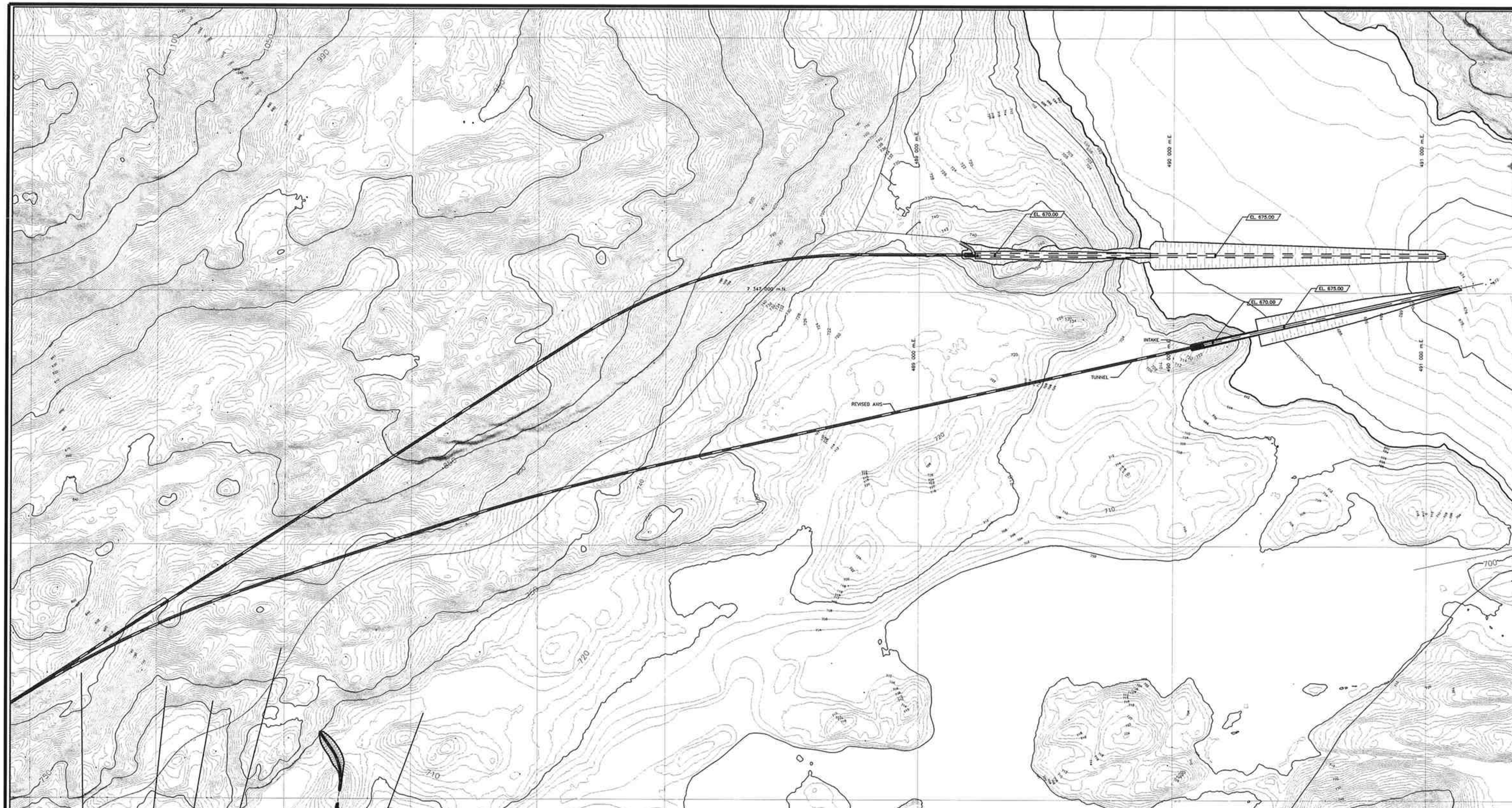
The new proposed schedule considering those changes is presented in Figure 11.4 at the end of the current section.

11.4 Additional opportunities

At site 7e, one main additional opportunity is to raise the maximum operating level to increase the firm power production, as discussed in section 11.1.

Another opportunity that could be implemented at site 7e is the possibility to divert sub-basin 7f into lake Tasersiaq. This sub-basin is located on the northern edge of the eastern side of lake Tasersiaq and is fed mainly by glaciers. There is an important hydrological potential from this sub-basin, but the diversion works required to divert the inflows towards the reservoir of site 7e were thought to be too costly with the limited information available. Additional investigations including the sub-glacial contours in this area would allow to better estimate the cost required to divert this sub-basin and state if there is an economical advantage of doing so.

There is also a possible future opportunity regarding the potential increase in run-off, mainly from the glaciers due the forecasted global warming. 2040 projected discharge series were computed by Vatnaskil but were not used to determine the firm power available at site 7e, since those series consider a steady increase in temperature over the next 40 years. However, there exist a potential that such predictions could occur in the future as global warming is forecasted to continue, along with fast glacier melting. It is then possible that the power production at site 7e could be increased with a future rise in inflows. This additional opportunity should be studied in more depth, either to increase the installed capacity at the site or leave space for a future increase in hydro equipments. Indeed, the projected 2040 series were used in the flood determination to reduce the risk regarding dam and structure safety. The opportunity cost of increasing the power capacity at site 7e would then only include the costs related to the conveyance structures and production devices.



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Tecsult Inc.

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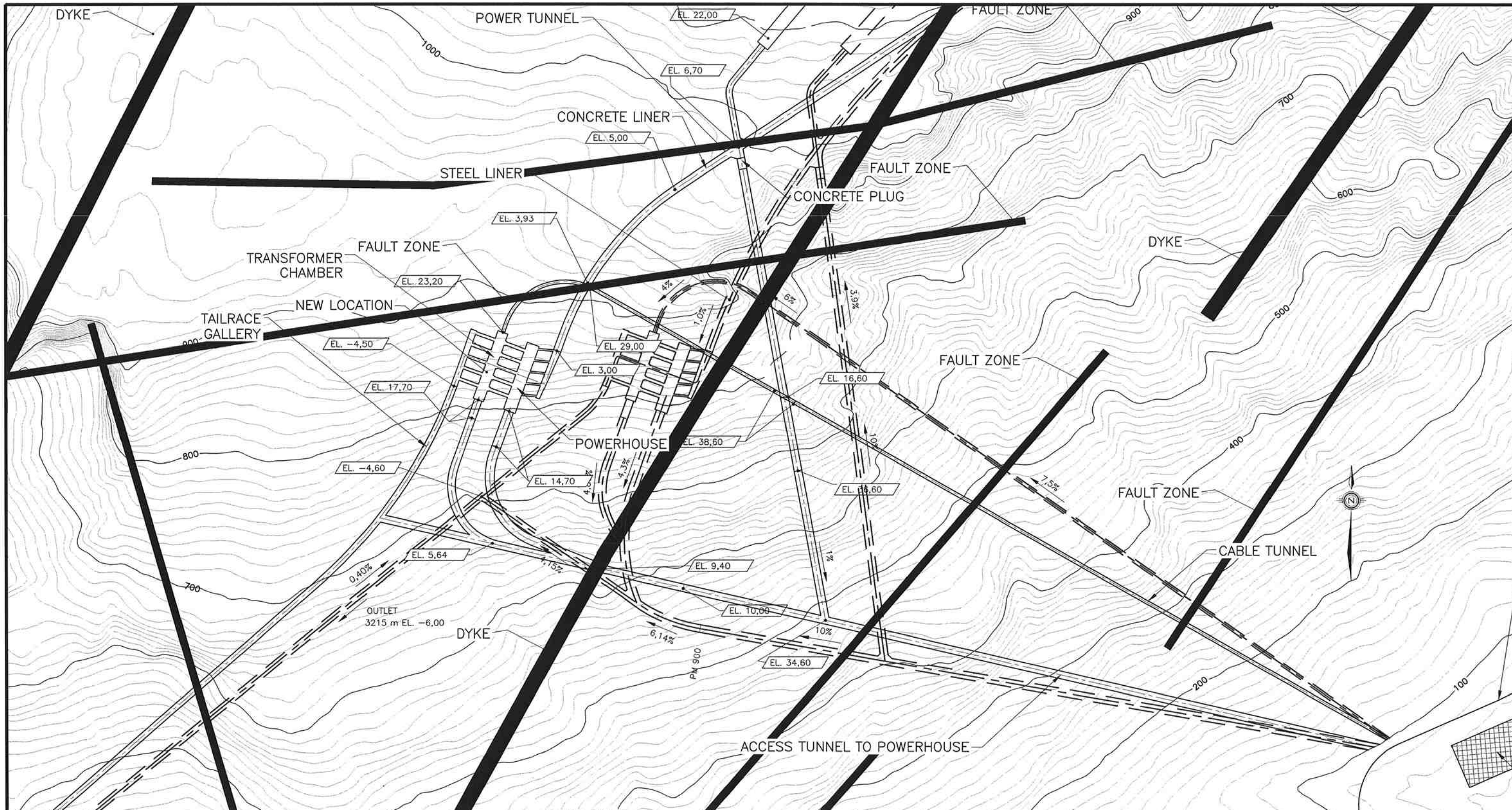
YEAR	MONTH	DAY	NO.	REVISION RECORD	DR.	CK	ZONE

ALCOA INC.

ALCOA HYDRO DEVELOPMENT GPPG

BLDG NO.	GREENLAND
	SITE 7e
	REVISED INTAKE LAYOUT – PLAN VIEW

ENGINEER: TECSULT Inc		PLANT CODE	DESIGNED BY
SCALE: 1:15000	ORIGIN	DWG CLASS	DRAWN BY: Y.T.
FIG. 11.1			CHECKED BY
			APPROVED BY



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YEAR	MONTH	DAY	NO.	REVISION RECORD	DR.	CK	ZONE

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ALCOA INC.
ALCOA HYDRO DEVELOPMENT GPPG

BLDG NO

GREENLAND
SITE 7e
REVISED POWER HOUSE LOCATION

ENGINEER TECSULT Inc
PLANT CODE
DESIGNED BY
SCALE 1:5000
ORIGIN
DWG CLASS
DRAWN BY Y.T.
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FIG. 11.2

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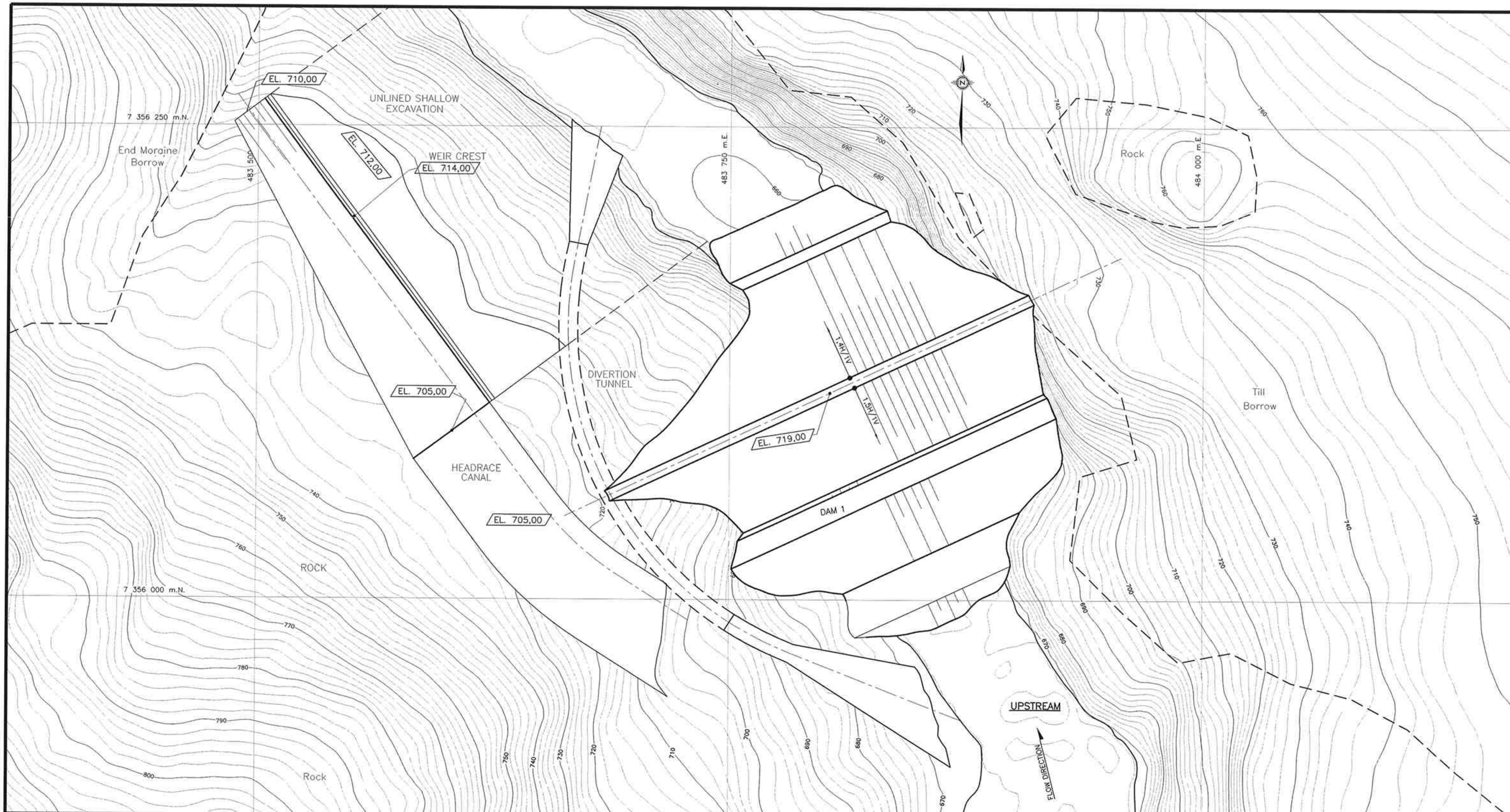

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YEAR	MONTH	DAY	NO.	REVISION RECORD	DR.	CK	ZONE
09	09	18	·	PREFEASABILITY REPORT			

ALCOA INC.

ALCOA HYDRO DEVELOPMENT GPPG

BLDG NO. GREENLAND

SITE 7e

DAM 1 AND SPILLWAY

ENGINEER: TECSULT Inc

PLANT CODE:

DESIGNED BY:

SCALE: 1:2000

ORIGIN:

DWG CLASS:

DRAWN BY: Y.T.

CHECKED BY:

APPROVED BY:

FIG. 11.3

Figure 11.4 Updated schedule for road and dam construction - SITE 7e

N°	Activity
1	Project begins
2	Summer season 2011
3	Harbor site construction
4	Start up camp
5	Main Camp
6	Mobile road camp instalation
7	**Road to dams area**
8	Temporary Road to km 9+500
9	Temporary Road 9+500 to 9+700
10	Temporary Road 9+700 to 17+000
11	Bridge 11+730 to 11+800 - 70 m
12	Bridge 14+950 to 15+030 - 80 m
13	Temporary Road 17+000 to 18+500
14	Temporary Road 18+500 to 19+900
15	Temporary Road 19+900 to 20+750
16	Bridge 19+950 to 20+000 - 50 m
17	Temporary Road 22+600 to 20+750
18	Tunnel 22+600 to 23+800 (400 m)
19	Temporary road 23+800 to 25+400
20	Temporary road 25+400 to 33+249
21	Road Completion
22	
23	Summer season 2011
24	
25	**Powerhouse**
26	Tunnel to get access to crown of cavern (750m)
27	PH cavern excavation
28	PH concrete 1st stage
29	PH E+M works (for 1st unit to wet test)
30	PH E+M works for remaining units
31	Tailrace excavation - 4000 m (2 headings from both ends)
32	Transformer Cavern and Access
33	Surge chamber and Access
34	Cable tunnel
35	Commissioning - Dry & Wet

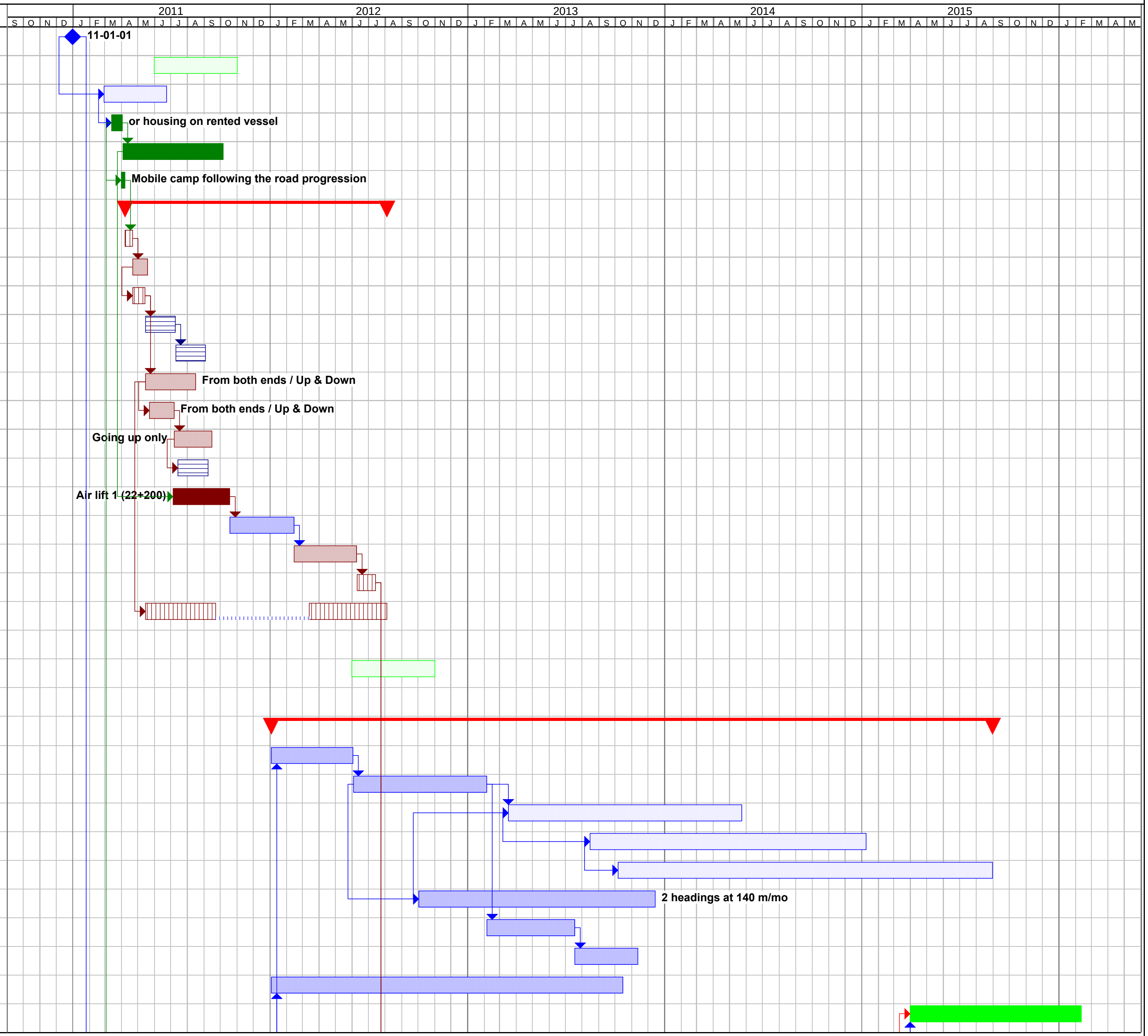


Figure 11.4 Updated schedule for road and dam construction - SITE 7e

N°	Activity
36	**Headrace excavation by TBM**
37	Delivery and transport of 2 TBM units
38	Erection of the 2 TBM
39	Addit to PH (approx 1200 m.+ connect. to headrace u/s of steel lined bifurcations)
40	Excavat.TBM - headrace from u/s of PH, sta 30+000 to approx sta. Km 13+000
41	Addit from road to headrace at approx sta Km. 11+500 first 900m only
42	Excavat.TBM - rest of addit (800 m) and headrace from sta Km. 11+500 to reservoir area (Km 0)
43	Headrace finishing works (and removal of TBM)
44	Camp «B» and facilities
45	**Intake construction**
46	Overburden excavation - Dry
47	Rock excavation - Dry (606 000 m³)
48	Marine Works Mobilization
49	Overburden excavation - Wet (600 000 m³)
50	Intake shaft excavation (673 @ 724)
51	Intake structure
52	TBM arrives to sta.0+000 (200 m. below)
53	Intake shaft excavation (550 @ 673)
54	Close gate
55	Rock excavation - Wet (50 000 m³)
56	**DAM no. 2**
57	Excavation for foundation and cofferdam (±10 000 m³)
58	Upstream Cofferdam
59	Shelter over cut-off trench area
60	Treatment of Foundations (± 2 500 m²)
61	Concrete pad (1 700 m³)
62	Rock Heating and Grouting
63	Rock fill / filters to el 705 (± 150 000 m³)
64	Bitumen impervious core to el 705 (± 2300 m³)
65	Rock fill/filters to el 719 (± 100 000 m³)
66	Bituminous core to el 719 (1500 m³)
67	Summer season 2014
68	**ACCESS ROADS - FROM DAM 2 TO DAM 1**
69	Temporary road 0+000 to 4+780
70	Bridge 4+780 to 4+810 - 80 m

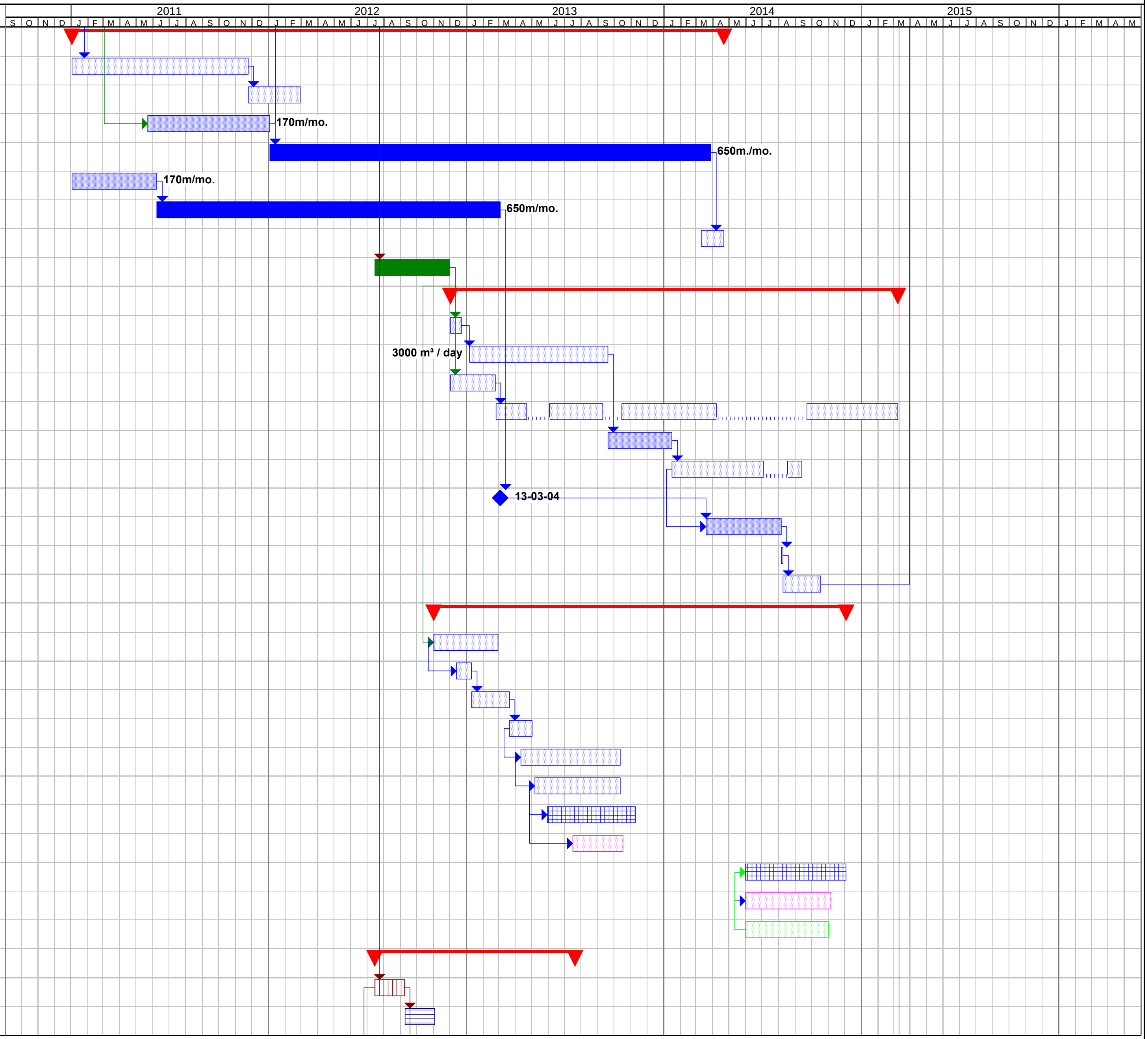
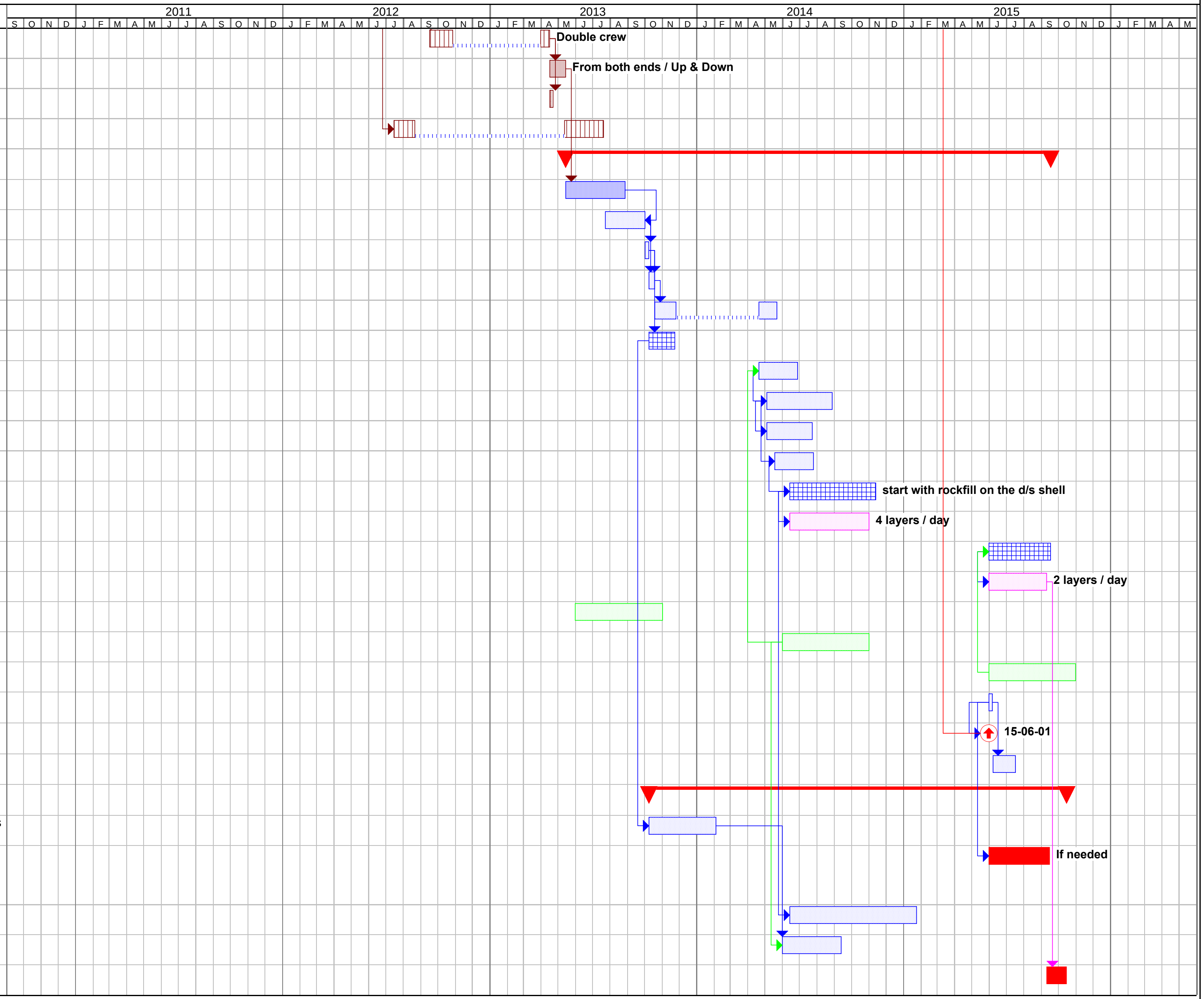


Figure 11.4 Updated schedule for road and dam construction - SITE 7e

N°	Activity
71	Temporary road 4+810 to 10+300
72	Temporary road 10+300 to 11+700
73	Temporary road 11+700 to 13+337
74	Road to Dam 1 Completion
75	**Dam 1**
76	Diversion tunnel (Excavated from both ends)
77	Diversion tunnel portal and finishing works (under shelter if needed)
78	Pre-cofferdam
79	Excavation for foundation of cofferdam (± 6 000 m³) (starts under protection of pre-cofferdam)
80	Excavation for foundations of dam
81	Cofferdams (± 170 200 m³)
82	Treatment of Foundations (± 2 500 m²)
83	Concrete pad (850 m³)
84	Shelter over concrete pad (if needed)
85	Rock Heating and Grouting
86	Rock fill / filters to el 710 (459 900 m³)
87	Bituminous impervious core to el 710 (3 400 m³)
88	Rock fill/filters to 719 (123 300 m³)
89	Bituminous core to 719 (1 490 m³)
90	Summer season 2013
91	Summer season 2014
92	Summer season 2015
93	**Closure of Diversion Tunnel**
94	**Impounding starts**
95	**Diversion Tunnel plug**
96	**SPILLWAY AT DAM D1**
97	Excavation, as quarry for dam D1- lower part and cofferdams (± 200 000 m³)
98	Leave fusible bypass in spillway crest to allow safer impounding, beside the possibilityof discharging via the intake and completed units
99	Excavation, as quarry for dam D1 (± 540 000 m³)
100	Concrete
101	Close fusible bypass



Appendix 1

Cost estimate

Greenland - 7e Cost Estimate

Project Summary

WBS	Description	Man Power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	TOTAL PRICE	Men-hours
2100	Harbor site preparation	53,520 $	364,785 $	- $	34,022 $	22,654 $	474,981 $	2,230
2200	Port Facility	31,128 $	992,500 $	2,725,654 $	23,562 $	5,172 $	4,050,016 $	1,297
2300	Primary roads construction	5,217,436 $	- $	- $	10,667,413 $	17,730 $	45,875,129 $	236,389
2400	Civil works related to Powerhouse, Tailrace tunnel and Surge tunnel	13,432,703 $	10,341,046 $	11,147,157 $	4,872,485 $	2,535,671 $	42,329,062 $	559,963
2500	Civil works related to Power tunnel	31,529,419 $	17,596,212 $	7,439,702 $	39,620,470 $	34,532,041 $	130,717,844 $	1,314,208
2600	Dams and Spillway	9,698,835 $	10,116,326 $	2,094,300 $	5,745,978 $	4,633,259 $	32,288,698 $	410,038
2700	Electrical Works	4,848,289 $	689,265 $	27,312,694 $	2,207,097 $	74,842 $	35,132,187 $	202,002
2800	Mechanical + Electrical Works	19,804,750 $	2,106,937 $	97,422,528 $	1,241,629 $	- $	120,575,844 $	565,850
2900	Architectural works	- $	- $	5,497,800 $	- $	- $	5,497,800 $	0
	Directs costs - Sub-Total	*84,616,080 $*	*42,207,071 $*	*153,639,835 $*	*64,412,656 $*	*41,821,369 $*	*416,941,561 $*	*3,291,977*
6100	Temporary Construction Facilities	665,881 $	3,500,350 $	- $	854,754 $	3,575,625 $	8,595,590 $	27,697
6200	Construction Services	7,858,128 $	46,691,937 $	- $	2,621,530 $	3,875,602 $	65,047,197 $	327,422
6300	Construction Equipment, Tools & Supplies	- $	- $	- $	- $	- $	74,738,361 $	0
6400	Material Transportation	- $	- $	- $	- $	- $	25,105,518 $	0
6500	Construction Camp	1,532,655 $	36,957,045 $	42,402,954 $	2,972,306 $	23,864,374 $	107,729,334 $	63,847
6600	Insurance, Taxes, Permits, Fees	- $	- $	- $	25,871,461 $	- $	25,871,461 $	0
6700	Miscellaneous	- $	- $	- $	- $	- $	34,785,789 $	0
7000	EPCM Home Office	- $	- $	- $	- $	- $	12,338,831 $	0
8000	EPCM Field Office	- $	- $	- $	- $	- $	54,170,000 $	0
9000	Contingency	- $	- $	- $	- $	- $	120,933,738 $	0
	Indirects costs - Sub-Total	*10,056,664 $*	*87,149,332 $*	*42,402,954 $*	*32,320,051 $*	*31,315,601 $*	*529,315,819 $*	*418,966*
							Miscellaneous non accounted hours	*500,000*
	Total Costs	***94,672,744 $***	***129,356,403 $***	***196,042,789 $***	***96,732,707 $***	***73,136,970 $***	***946,257,380 $***	***4,210,943***

Project : 7e Cost Estimate.xlsx

Item : Direct Summary

WBS	Description	Quantity	Un.	Man Power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	TOTAL PRICE	Unit price	Men-hours
2100	**Harbor site preparation**										
2110	Site development	48,000	m²	20,160 $	100,000 $	- $	16,286 $	10,614 $	147,060 $	3 $	840
2120	Fences and Gates			13,200 $	64,785 $	- $	1,450 $	1,426 $	80,861 $		550
2130	Exterior Lighting			**Included in Helocopter Pad**							0
2140	Helicopter pad			20,160 $	200,000 $	- $	16,286 $	10,614 $	247,060 $		840
2200	**Port Facility**										
2210	Wharf			- $	- $	2,475,654 $	- $	- $	2,747,654 $		0
2220	General Material Receiving and Handling	1	ls	- $	- $	250,000 $	- $	- $	250,000 $		0
2230	Storage warehouse			10,968 $	68,500 $	- $	15,000 $	- $	94,468 $		457
2240	Workshop and Miscellaneous			**Included in Architectural Works**							0
2250	Office for custom authorities			**Included in Architectural Works**							0
2260	Fuel depot			20,160 $	924,000 $	- $	8,562 $	5,172 $	957,894 $		840
2300	**Primary roads construction**										
2310	Cross section F1	6,140	m	1,259,631 $					6,365,637 $	1,037 $	57,256
2320	Cross section F2	7,850	m	784,977 $					3,974,777 $	506 $	35,681
2330	Cross section F3	5,800	m	761,616 $					3,805,528 $	656 $	34,619
2340	Cross section C1	4,900	m	205,702 $					1,033,662 $	211 $	9,350
2350	Cross section C2	2,830	m	576,628 $					2,946,920 $	1,041 $	26,210
2360	Cross section C3	3,900	m	1,426,322 $					7,749,902 $	1,987 $	64,833
2370	Bridges	5	un						9,111,000 $	1,822,200 $	
2380	Air Lifts	1	ls	202,560 $	- $	- $	10,667,413 $	17,730 $	10,887,703 $		8,440
2400	**Civil works related to Powerhouse, Tailrace tunnel and Surge tunnel**										
2410	Excavation										
2411	Powerhouse and Access	140,618	m³	1,886,727 $	2,086,754 $	609,452 $	734,877 $	423,382 $	5,741,192 $	41 $	78,716
2412	Transformer Chamber and Access	40,801	m³	505,704 $	595,717 $	158,698 $	172,492 $	109,136 $	1,541,747 $	38 $	21,070
2413	Powerhouse tailrace including Access and Oulet	283,902	m³	4,464,178 $	4,868,126 $	495,647 $	1,439,500 $	581,693 $	11,849,144 $	42 $	186,006
2414	Surge Chamber and Access	28,750	m³	368,020 $	376,687 $	160,728 $	121,181 $	66,641 $	1,093,257 $	38 $	15,334
2415	Cable and Escape Tunnel	20,518	m³	1,697,798 $	533,114 $	347,066 $	637,985 $	319,593 $	3,535,556 $	172 $	70,945
2420	Concrete Works										
2421	Transformer Chamber Concrete	3,170	m³	588,883 $	297,866 $	584,750 $	256,028 $	134,162 $	1,861,689 $	587 $	24,531
2422	Powerhouse - Phase I	7,200	m³	1,370,984 $	614,203 $	1,191,862 $	557,898 $	297,364 $	4,032,311 $	560 $	57,112
2423	Powerhouse - Phase II	3,750	m³	808,899 $	352,371 $	691,796 $	302,796 $	158,652 $	2,314,514 $	617 $	33,698
2424	Cable and Escape Tunnel			305,604 $	15,188 $	584,114 $	49,242 $	23,937 $	978,085 $		12,732
2430	Powerhouse crane installation			25,920 $	1,080 $	- $	7,312 $	4,705 $	39,017 $		1,080
2440	Powerhouse overhead roofing	100	mt	18,000 $	500 $	400,000 $	6,723 $	4,171 $	429,394 $	4,294 $	750
2450	Structural Steel	330	mt	78,720 $	1,640 $	1,245,750 $	21,970 $	13,638 $	1,361,718 $	4,126 $	3,280
2460	Steel lining for Penstocks and Manifold	1,160	mt	389,760 $	13,920 $	3,480,000 $	89,071 $	76,671 $	4,049,422 $	3,491 $	16,240

Project : 7e Cost Estimate.xlsx

Item : Direct Summary

WBS	Description	Quantity	Un.	Man Power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	TOTAL PRICE	Unit price	Men-hours
2470	Concrete Plugs - Tunnels	6,490	m³	923,506 $	583,880 $	1,197,294 $	475,410 $	321,926 $	3,502,016 $	540 $	38,468
2500	**Civil works related to Power tunnel**										
2510	Power tunnel (including Rock Support)	1,337,062	m³	16,090,278 $	3,834,930 $	5,563,263 $	34,140,978 $	30,682,872 $	90,312,321 $	68 $	670,934
2520	Power tunnel Access and addit	279,073	m³	3,234,469 $	4,227,171 $	1,293,755 $	1,093,426 $	1,021,316 $	10,870,137 $	39 $	134,769
2530	Intake excavation										
2531	Soil excavation	802,000	m³	6,581,548 $	2,929,623 $	- $	1,134,703 $	548,784 $	11,194,658 $	14 $	274,231
2532	Rock Excavation	717,200	m³	4,494,344 $	5,925,667 $	- $	2,858,315 $	1,815,178 $	15,093,504 $	21 $	187,246
2533	Intake Tunnel & Shaft Excavation	14,402	m³	355,920 $	329,360 $	80,950 $	152,399 $	91,803 $	1,010,432 $	70 $	14,830
2540	Intake structure	2,720	m³	772,860 $	349,461 $	501,734 $	240,649 $	372,088 $	2,236,792 $	822 $	32,198
2600	**Dams and Spillway**										
2610	Diversion Tunnels (including concrete plug and Portal Structure)										
2,611	Dam 1 - Diversion Tunnel	24,100	m³	516,615 $	666,199 $	328,497 $	344,963 $	499,493 $	2,355,767 $	98 $	21,519
2620	Cofferdams										
2,621	Dam 1 - Cofferdams			775,008 $	534,020 $	77,625 $	185,694 $	350,470 $	1,922,817 $		32,292
2,622	Dam 2 - Cofferdams			231,744 $	497,000 $	5,175 $	17,959 $	118,930 $	870,808 $		9,656
2630	Foundation										
2,631	Dam 1 - Foundation			443,840 $	1,214,754 $	- $	216,236 $	153,839 $	2,028,669 $		18,493
2,632	Dam 2 - Foundation			461,440 $	1,444,150 $	- $	148,693 $	119,875 $	2,174,158 $		19,227
2640	Impervious core										
2,641	Dam 1 - Impervious core			930,765 $	343,522 $	714,361 $	535,372 $	572,004 $	3,096,024 $		42,180
2,642	Dam 2 - Impervious core			828,908 $	370,120 $	751,818 $	498,307 $	366,655 $	2,815,808 $		37,280
2650	Rock fill										
2,651	Dam 1 - Rock fill	581,000	m³	1,049,902 $	54,200 $	- $	850,446 $	544,567 $	2,499,115 $	4 $	43,640
2,652	Dam 2 - Rock fill	275,500	m³	701,263 $	26,350 $	- $	596,751 $	374,713 $	1,699,077 $	6 $	29,123
2660	Spillway										
2,661	Dam 1 - Spillway	645,000	m³	3,759,350 $	4,966,011 $	216,824 $	2,351,557 $	1,532,713 $	12,826,455 $	20 $	156,627
2700	**Electrical Works**										
2710	Supply and Installation of Transformers and Power cables			374,400 $	26,200 $	8,200,000 $	361,000 $	- $	8,961,600 $		15,600
2720	Supply and Installation of High voltage distribution plant			2,751,360 $	131,400 $	10,920,000 $	927,200 $	- $	14,729,960 $		114,640
2730	Permanent camp Utilities Substation										
2731	Water treatment Area Substation			**Included in Underground utilities**							
2732	Administration Building Area Substation			**Included in Underground utilities**							
2733	Sewage Treatment Area Substation			**Included in Underground utilities**							
2734	Fire & Process Water Area Pumping Station Substation			**Included in Underground utilities**							
2735	Maintenance Shop and Warehouse Area Substation			**Included in Underground utilities**							
2736	Port Facility Substation			**Included in 2210 - Warf facilities**							

Item : Direct Summary

WBS	Description	Quantity	Un.	Man Power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	TOTAL PRICE	Unit price	Men-hours
2740	Emergency Generator			2,400 $	1,000 $	165,000 $	1,500 $	- $	169,900 $		100
2750	Plant Communications			156,000 $	25,000 $	700,000 $	100,000 $	- $	981,000 $		6,500
2760	Power plant Command Circuitry			1,200,000 $	300,000 $	2,700,000 $	700,000 $	- $	4,900,000 $		50,000
2770	Switch yard Site	5,400	m²	14,194 $	- $	- $	15,833 $	6,977 $	37,004 $		587
2780	Supply Line to Power Tunnel Intake	33	km	349,935 $	205,665 $	4,627,694 $	101,564 $	67,865 $	5,352,723 $	162,204 $	14,576
2800	**Mechanical + Electrical Works**										
2810	Supply and Installation of Turbine/Generators assemblies			14,175,000 $	1,575,357 $	81,084,078 $	787,679 $	- $	97,622,114 $		405,000
2820	Supply and installation of Power tunnel and Diversion intake Gates			4,333,000 $	350,000 $	7,102,000 $	- $	- $	11,785,000 $		123,800
2830	Supply and installation of Draft tube Gates			297,500 $	- $	470,000 $	- $	- $	767,500 $		8,500
2840	Supply the overhead crane	1	ls			1,575,000 $			1,575,000 $		
2850	Underground Utilities										
2851	Fire water System			87,500 $	10,780 $	404,250 $	26,950 $	- $	529,480 $		2,500
2852	Potable Water System			112,000 $	15,920 $	597,000 $	39,800 $	- $	764,720 $		3,200
2853	Sewage and Sanitary System			241,500 $	47,920 $	1,916,800 $	119,800 $	- $	2,326,020 $		6,900
2854	Compressed Air System			85,750 $	14,160 $	561,400 $	35,400 $	- $	696,710 $		2,450
2855	Process Water System			70,000 $	13,600 $	544,000 $	34,000 $	- $	661,600 $		2,000
2856	CVAC			402,500 $	79,200 $	3,168,000 $	198,000 $	- $	3,847,700 $		11,500
2900	**Architectural works**										
2910	Service building	1	ls	- $	- $	5,497,800 $	- $	- $	5,497,800 $		0
Directs costs - Sub-Total				**84,616,080 $**	**42,207,071 $**	**153,639,835 $**	**64,412,656 $**	**41,821,369 $**	**416,941,561 $**		**3,291,977**

Project : 7e Cost Estimate.xlsx

Item : Indirect Summary

WBS	Description	Quantity	Un.	Man Power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	TOTAL PRICE	Unit price	Men-hours
6100	**Temporary Construction Facilities**										
6110	Work Areas, including Buildings										
6112	Work Areas, including Buildings - Hydro Site 7e			455,593 $	2,538,600 $	- $	109,161 $	65,190 $	3,167,524 $		18,935
6120	Roads , Walkways, Parking Lots										
6122	Roads , Walkways, Parking Lots - Hydro Site 7e			18,720 $	10,000 $	- $	15,122 $	13,689 $	57,531 $		780
6130	Utilities										
6132	Utilities - Hydro Site 7e			191,568 $	951,750 $	- $	730,471 $	3,496,746 $	5,370,535 $		7,982
6140	Weather Protection										
6142	Weather Protection - Hydro Site 7e			**Special weather protection is Included in appropriate items**							
6200	**Construction Services**										
6210	General Site Operation										
6212	General Site Operation - Hydro Site 7e			1,269,168 $	2,919,806 $	- $	509,554 $	2,538,591 $	7,237,119 $		52,882
6220	Final Clean Up										
6222	Final Clean Up - Hydro Site 7e			156,000 $	10,000 $	- $	31,845 $	19,391 $	217,236 $		6,500
6230	Material Handling & Warehousing										
6232	Material Handling & Warehousing - Hydro Site 7e			6,432,960 $	836,000 $	- $	2,080,131 $	1,317,620 $	10,666,711 $		268,040
6240	NDE & QA/QC Testing Services										
6242	NDE & QA/QC Testing Services - Hydro Site 7e			- $	- $	- $	- $	- $	4,000,000 $		0
6250	Surveying										
6252	Surveying - Hydro Site 7e			- $	200,000 $	- $	- $	- $	200,000 $		0
6260	Site Security										
6262	Site Security - Hydro Site 7e			- $	924,332 $	- $	- $	- $	924,332 $		0
6270	Man Power Transportation										
6272	Man Power Transportation - Hydro Site 7e			- $	40,994,799 $	- $	- $	- $	40,994,799 $		0
6280	General Expenses										
6282	General Expenses - Hydro Site 7e			- $	807,000 $	- $	- $	- $	807,000 $		0
6300	**Construction Equipment, Tools & Supplies**										
6302	Construction Equipment, Tools & Supplies - Hydro Site 7e								74,738,361 $		
6400	**Material Transportation**										
6420	Material Transportation - Hydro Site 7e								25,105,518 $		
6500	**Construction Camp**										
6510	Site Preparation										
6512	Site Preparation - Hydro Site 7e	120,100	m²	100,335 $	10,000 $	- $	90,311 $	- $	200,646 $		4,167
6520	Infrastructure										
6522	Infrastructure - Hydro Site 7e			1,296,000 $	5,671,230 $	10,763,850 $	658,710 $	371,499 $	18,761,289 $		54,000
6530	Camps										
6532	Camps - Hydro Site 7e				5,716,804 $	31,632,882 $			37,349,686 $		
6540	Catering										
6542	Catering - Hydro Site 7e				24,988,211 $				24,988,211 $		
6550	Operation										
6552	Operation - Hydro Site 7e			136,320 $	570,800 $	6,222 $	2,223,285 $	23,492,875 $	26,429,502 $		5,680
6600	**Insurance, Taxes, Permits, Fees**										
6620	Insurance, Taxes, Permits, Fees - Hydro Site 7e						25,871,461 $		25,871,461 $		
6700	**Miscellaneous**										
6720	Miscellaneous Freight - Hydro Site 7e								34,785,789 $		
7000	**EPCM Home Office**										
7100	EPCM Home Office - FEL 1 & 2										
7120	EPCM Home Office - FEL 1 & 2 - Hydro Site 7e								12,338,831 $		
8000	**EPCM Field Office**										
8100	EPCM Field Office - FEL 1 & 2										
8120	EPCM Field Office - FEL 1 & 2 - Hydro Site 7e								54,170,000 $		
9000	**Contingency**										
9002	Hydro Site 7e - Contingency								120,933,738 $		
	Indirects costs - Sub-Total			**10,056,664 $**	**87,149,332 $**	**42,402,954 $**	**32,320,051 $**	**31,315,601 $**	**529,315,819 $**		**418,966**
	Directs costs - Sub-Total			**84,616,080 $**	**42,207,071 $**	**153,639,835 $**	**64,412,656 $**	**41,821,369 $**	**416,941,561 $**		**3,291,977**
	Miscellaneous non accounted hours										**500,000**
	Total Costs			**94,672,744 $**	**129,356,403 $**	**196,042,789 $**	**96,732,707 $**	**73,136,970 $**	**946,257,380 $**		**4,210,943**

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			

2100 Harbor site preparation

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2110	**Site development**			**48,000**	**m²**													
	Powerhouse area 30,000 (300 x 100)																	
	Roads 12,000 (3000 x 4)																	
	Parking lot 6,000 42,000 m²																	
	48,000 3,000 m² / sh			14	sh						0	0	0	0	0	0		
	10 h / sh			140	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	840	h	24.00					20,160	0	0	0	0	20,160		840
											0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	126	h				38.25	28.00	0	0	0	4,820	2,540	7,360		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	3	378	h				24.00	20.00	0	0	0	9,072	5,443	14,515		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	126	h				19.00	29.00	0	0	0	2,394	2,631	5,025		
											0	0	0	0	0	0		
	- Miscelaneous (beach landing, etc..)			1	un		100,000				0	100,000	0	0	0	100,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2110	**Site development**			**48,000**	**m²**						**20,160**	**100,000**	**0**	**16,286**	**10,614**	**147,060**	**3.06**	**840**

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2120	**Fences and Gates**			**800**	**m**													
	Fencing and gates										0	0	0	0	0	0		
	Main camp area 800 m										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Gates			1	un		785.00				0	785	0	0	0	785		
	- Chain link			800	m		80.00				0	64,000	0	0	0	64,000		
	75 m / sh			11	sh						0	0	0	0	0	0		
	10 h / sh			110	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	550	h	24.00					13,200	0	0	0	0	13,200		550
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	99	h				13.65	18.00	0	0	0	1,351	1,283	2,634		
	- Fence post auger 1.00 2.00	90%	1	99	h				1.00	2.00	0	0	0	99	143	242		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2120	**Fences and Gates**										**13,200**	**64,785**	**0**	**1,450**	**1,426**	**80,861**		**550**

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2130	**Exterior Lighting**																	
	Included in Helicopter Pad																	
											0	0	0	0	0	0		
											0	0	0	0	0			
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2130	**Exterior Lighting**										**0**	**0**	**0**	**0**	**0**	**0**		**0**
2140	**Helicopter pad**																	
	Helicopter pad										0	0	0	0	0	0		
	Powerhouse area 30,000 (300 x 100) 42,000 m²										0	0	0	0	0	0		
	Roads 12,000 (3000 x 4) 3,000 m² / sh			14	d						0	0	0	0	0	0		
	42,000 10 h / sh			140	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	840	h	24.00					20,160	0	0	0	0	20,160		840
											0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	126	h				38.25	28.00	0	0	0	4,820	2,540	7,360		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	3	378	h				24.00	20.00	0	0	0	9,072	5,443	14,515		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	126	h				19.00	29.00	0	0	0	2,394	2,631	5,025		
											0	0	0	0	0	0		
	- Misc. (Dust control, fuel depot, accessories, etc..)			1	ls		200,000				0	200,000	0	0	0	200,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2140	**Helicopter pad**										**20,160**	**200,000**	**0**	**16,286**	**10,614**	**247,060**		**840**

Item : **2210-2260**

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel $ / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			

2200 Port Facility

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel $ / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2210	**Wharf**																	
	Mobilisation			1	ls						0	0	0	0	0	272 000		
											0	0	0	0	0	0		
	Supply and Install										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Steel Sheet Pile Wall- AZ26			185	mt			3 300			0	0	610 500	0	0	610 500		
											0	0	0	0	0	0		
	- Coping plates 73 m 84.0 kg / m²			6 132	kg			4.33			0	0	26 552	0	0	26 552		
											0	0	0	0	0	0		
	- Waling			9 490	kg			5.83			0	0	55 327	0	0	55 327		
											0	0	0	0	0	0		
	- Waling bolts			2 820	kg			6.67			0	0	18 809	0	0	18 809		
											0	0	0	0	0	0		
	- Tie rods Front Wall			9 370	kg			8.33			0	0	78 083	0	0	78 083		
											0	0	0	0	0	0		
	- Tie rods Side Walls			12 840	kg			6.67			0	0	85 600	0	0	85 600		
											0	0	0	0	0	0		
	- Corrosion Protection (Aluminum anodes)			3 000	kg			6.67			0	0	20 000	0	0	20 000		
											0	0	0	0	0	0		
	- Fender units			3	un			5 000			0	0	15 000	0	0	15 000		
											0	0	0	0	0	0		
	- Bollards 50 t			4	un			3 000			0	0	12 000	0	0	12 000		
											0	0	0	0	0	0		
	- Rescue Ladder			2	un			2 000			0	0	4 000	0	0	4 000		
											0	0	0	0	0	0		
	- Concrete reinforcement-			41.30	m³			2 667			0	0	110 133	0	0	110 133		
											0	0	0	0	0	0		
	- Concrete kerb			59	m³			1 167			0	0	69 300	0	0	69 300		
	- Filter Cloth			270	m²			5.00			0	0	1 350	0	0	1 350		
											0	0	0	0	0	0		
	- Pavement			4 800	m²			30.00			0	0	144 000	0	0	144 000		
											0	0	0	0	0	0		
	- Lighting			1	ls			15 000			0	0	15 000	0	0	15 000		
											0	0	0	0	0	0		
	- Fill			34 000	m³			16.67			0	0	566 667	0	0	566 667		
											0	0	0	0	0	0		
	- Revetments										0	0	0	0	0	0		
	Fill			5 520	m³			16.67			0	0	92 000	0	0	92 000		
	Filter			1 900	m³			53.33			0	0	101 333	0	0	101 333		
	Armour			4 500	m³			100			0	0	450 000	0	0	450 000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2210	**Wharf**										**0**	**0**	**2 475 654**	**0**	**0**	**2 747 654**		**0**

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel $ / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
2220	**General Material Receiving and Handling**			**1**	**ls**													
	- Boom truck 17 tons			1	ls			200 000			0	0	200 000	0	0	200 000		
											0	0	0	0	0	0		
	- Miscelaneous			1	ls			50 000			0	0	50 000	0	0	50 000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2220	**General Material Receiving and Handling**										**0**	**0**	**250 000**	**0**	**0**	**250 000**		**0**
2230	**Storage warehouse**																	
	- Supply 10 x 50			500	m²		137.00				0	68 500	0	0	0	68 500		
	- Install 0.913 h / m²			457	h	24.00					10 968	0	0	0	0	10 968		457
	- Equipment			500	m²				30.00		0	0	0	15 000	0	15 000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2230	**Storage warehouse**										**10 968**	**68 500**	**0**	**15 000**	**0**	**94 468**		**457**
2240	**Workshop and Miscellaneous**																	
	Included in Architectural Works										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2240	**Workshop and Miscellaneous**										**0**	**0**	**0**	**0**	**0**	**0**		**0**
2250	**Office for custom authorities**																	
	Included in Architectural Works										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2250	**Office for custom authorities**										**0**	**0**	**0**	**0**	**0**	**0**		**0**

Project : **7e Cost Estimate.xlsx**

Item : **2210-2260**

WBS	DESCRIPTION	%	n	Qty	Un.	M-P (UNIT PRICES)	Cons. Mat. (UNIT PRICES)	Perm. Mat. (UNIT PRICES)	Equip. Op. (UNIT PRICES)	Fuel $ / h (UNIT PRICES)	Man power (TOTAL COSTS)	Consumable materials (TOTAL COSTS)	Permanent Materials (TOTAL COSTS)	Equipment Operation (TOTAL COSTS)	Fuel Consumption (TOTAL COSTS)	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2260	**Fuel depot**																	
	Total fuel consumption on project Directs 70 000 000										0	0	0	0	0	0		
	Indirects 12 000 000										0	0	0	0	0	0		
	82 000 000 liters										0	0	0	0	0	0		
	Say 100 000 000 total										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Needs kLiters (Constr. / Camps / Total) / Months / kL/ month										0	0	0	0	0	0		
	2 011 / 100 / 19 204 / 19 304 / 10 / 1 930										0	0	0	0	0	0		
	2 012 / 30 000 / 23 045 / 53 045 / 12 / 4 420										0	0	0	0	0	0		
	2 013 / 30 000 / 23 045 / 53 045 / 12 / 4 420										0	0	0	0	0	0		
	2 014 / 30 000 / 23 045 / 53 045 / 12 / 4 420										0	0	0	0	0	0		
	2 015 / 9 900 / 15 364 / 25 264 / 8 / 3 158										0	0	0	0	0	0		
	100 000 / 103 704 / 203 704 / 54										0	0	0	0	0	0		
											0	0	0	0	0	0		
	A 17 490 kL storage tank										0	0	0	0	0	0		
	gives an autonomy of 4 months										0	0	0	0	0	0		
											0	0	0	0	0	0		
	10 000 kL / Shipment 6 Shipments / year										0	0	0	0	0	0		
	60 000 kL / year										0	0	0	0	0	0		
	Supply										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Vertical steel fuel oil tank 17 490 kL			1	un		760 000				0	760 000	0	0	0	760 000		
											0	0	0	0	0	0		
	- Miscelaneous (Storage pond, membrane, piping, etc...)	20%		1	ls		152 000				0	152 000	0	0	0	152 000		
											0	0	0	0	0	0		
	Installation			12	sh						0	0	0	0	0	0		
	10 h / sh			120	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		7	840	h	24.00					20 160	0	0	0	0	20 160		840
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	108	h				13.65	18.00	0	0	0	1 474	1 400	2 874		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	45%	1	54	h				19.00	29.00	0	0	0	1 026	1 128	2 154		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	45%	1	54	h				38.25	28.00	0	0	0	2 066	1 089	3 155		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	108	h				37.00	20.00	0	0	0	3 996	1 555	5 551		
													0	0	0	0		
	- Miscelaneous			120	h		100.00				0	12 000	0	0	0	12 000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2260	**Fuel depot**										**20 160**	**924 000**	**0**	**8 562**	**5 172**	**957 894**		**840**

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	UNIT PRICES Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			

2300 Primary roads construction

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2310	**Cross section F1**			**10,787**	**m**													
	Harbour - Intake **9,550**										0	0	0	0	0	0		
	Intake - Dam 1 **1,237**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Harbour - Intake (5 m lane)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 5.448 h / m			52,028	h	22.00					1,144,625	0	0	0	0	1,144,625		52,028
											0	0	0	0	0	0		
	- Other 486.10 $ / m			9,550	m						0	0	0	0	0	4,642,255		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Intake - Dam 1 (4 m lane)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 4.226 h / m			5,228	h	22.00					115,006	0	0	0	0	115,006		5,228
											0	0	0	0	0	0		
	- Other 374.90 $ / m			1,237	m						0	0	0	0	0	463,751		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2310	**Cross section F1**										**1,259,631**	**0**	**0**	**0**	**0**	**6,365,637**		**57,256**

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2320	**Cross section F2**			**6,200**	**m**													
	Harbour - Intake **5800**										0	0	0	0	0	0		
	Intake - Dam 1 **400**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Harbour - Intake (5 m lane)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 5.844 h / m			33,895	h	22.00					745,694	0	0	0	0	745,694		33,895
											0	0	0	0	0	0		
	- Other 522.60 $ / m			5,800	m						0	0	0	0	0	3,031,080		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Intake - Dam 1 (4 m lane)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 4.464 h / m			1,786	h	22.00					39,283	0	0	0	0	39,283		1,786
											0	0	0	0	0	0		
	- Other 396.80 $ / m			400	m						0	0	0	0	0	158,720		
											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P (UNIT PRICES)	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power (TOTAL COSTS)	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2320	**Cross section F2**										**784,977**	**0**	**0**	**0**	**0**	**3,974,777**		**35,681**
2330	**Cross section F3**			**11,629**	**m**													
	Harbour - Intake 9,849										0	0	0	0	0	0		
	Intake - Dam 1 1,780										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Harbour - Intake (5 m lane)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.072 h / m			30,256	h	22.00					665,635	0	0	0	0	665,635		30,256
											0	0	0	0	0	0		
	- Other 270.40 $ / m			9,849	m						0	0	0	0	0	2,663,170		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Intake - Dam 1 (4 m lane)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 2.451 h / m			4,363	h	22.00					95,981	0	0	0	0	95,981		4,363
											0	0	0	0	0	0		
	- Other 213.90 $ / m			1,780	m						0	0	0	0	0	380,742		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2330	**Cross section F3**										**761,616**	**0**	**0**	**0**	**0**	**3,805,528**		**34,619**
2340	**Cross section C1**			**3,700**	**m**													
	Harbour - Intake 200																	
	Intake - Dam 1 3,500																	
	Harbour - Intake (5 m lane)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 2.598 h / m			520	h	22.00					11,431	0	0	0	0	11,431		520
											0	0	0	0	0	0		
	- Other 247.80 $ / m			200	m						0	0	0	0	0	49,560		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Intake - Dam 1 (4 m lane)										0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P (UNIT PRICES)	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power (TOTAL COSTS)	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
	- M-P 2.523 h / m			8,831	h	22.00					194,271	0	0	0	0	194,271		8,831
											0	0	0	0	0	0		
	- Other 222.40 $ / m			3,500	m						0	0	0	0	0	778,400		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2340	**Cross section C1**										**205,702**	**0**	**0**	**0**	**0**	**1,033,662**		**9,350**
2350	**Cross section C2**			**8,840**	**m**													
	Harbour - Intake **2,650**																	
	Intake - Dam 1 **6,190**																	
	Harbour - Intake (5 m lane)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.049 h / m			8,080	h	22.00					177,757	0	0	0	0	177,757		8,080
											0	0	0	0	0	0		
	- Other 291.10 $ / m			2,650	m						0	0	0	0	0	771,415		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Intake - Dam 1 (4 m lane)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 2.929 h / m			18,131	h	22.00					398,871	0	0	0	0	398,871		18,131
											0	0	0	0	0	0		
	- Other 258.30 $ / m			6,190	m						0	0	0	0	0	1,598,877		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2350	**Cross section C2**										**576,628**	**0**	**0**	**0**	**0**	**2,946,920**		**26,210**
2360	**Cross section C3**			**5,200**	**m**													
	Harbour - Intake **5,000**																	
	Intake - Dam 1 **200**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Harbour - Intake (5 m lane)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 12.475 h / m			62,375	h	22.00					1,372,250	0	0	0	0	1,372,250		62,375
											0	0	0	0	0	0		
	- Other 1,220.30 $ / m			5,000	m						0	0	0	0	0	6,101,500		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Intake - Dam 1 (4 m lane)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 12.289 h / m			2,458	h	22.00					54,072	0	0	0	0	54,072		2,458
											0	0	0	0	0	0		
	- Other 1,110.40 $ / m			200	m						0	0	0	0	0	222,080		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2360	**Cross section C3**										**1,426,322**	**0**	**0**	**0**	**0**	**7,749,902**		**64,833**

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2370	**Bridges**			**230**	**m**													
	Harbour - Intake																	
	11+730 to 11+800 **70** 27,200 $ / m			70	m						0	0	0	0	0	1,904,000		
	14+950 to 15+030 **80** 26,800 $ / m			80	m						0	0	0	0	0	2,144,000		
	19+950 to 20+000 **50** 29,300 $ / m			50	m						0	0	0	0	0	1,465,000		
	Intake - Dam 1																	
	4+780 to 4+810 **30** 32,000 $ / m			30	m						0	0	0	0	0	960,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Bedlevel causeways 6,000 $ / un			93	un						0	0	0	0	0	558,000		
											0	0	0	0	0			
	- Culcerts 80,000 $ / un			26	un						0	0	0	0	0	2,080,000		
											0	0	0	0	0			
											0	0	0	0	0	0		
2370	**Bridges**										**0**	**0**	**0**	**0**	**0**	**9,111,000**		**0**

						UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2380	**Air Lifts**																	
											0	0	0	0	0	0		
	Helicopter capacity Type (kg)										0	0	0	0	0	0		
	(for 1 hour trip) Sikorsky S-61N 3,750										0	0	0	0	0	0		
	AS 350 B3 1,200										0	0	0	0	0	0		
	Bell 214 2,700										0	0	0	0	0	0		
	Boeing 234 12,700										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Cost per hour Mob liter / hour ($ / hour)										0	0	0	0	0	0		
	1.67 $ Fuel Rental										0	0	0	0	0	0		
	S-61N 600 1,002.00 $ 9,667 $										0	0	0	0	0	0		
	AS 350 B3 31,350 $ 200 334.00 $ 2,180 $										0	0	0	0	0	0		
	Bell 214 39,200 $ 600 1,002.00 $ 5,416 $										0	0	0	0	0	0		
	Boeing 234 800,000 $ 1,515 2,530.05 $ 8,130 $										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Air Transportation										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Boeing 234 **12,700**										0	0	0	0	0	0		
	Weight Air lift Qty	Lifts									0	0	0	0	0	0		
	Cat 311C U 11,980 1 1	1									0	0	0	0	0	0		
	2 2	2									0	0	0	0	0	0		
	3 1	1									0	0	0	0	0	0		
											0	0	0	0	0	0		
	Cat 950H Wheel Loader 18,500 2 1	3									0	0	0	0	0	0		
	3 1	3									0	0	0	0	0	0		
											0	0	0	0	0	0		
	Compressor XAHS 237 3,000 1 1	1									0	0	0	0	0	0		
	(500 cfm) 2 3	2									0	0	0	0	0	0		
	3 1	1									0	0	0	0	0	0		
											0	0	0	0	0	0		
	Furukawa HCR9-ES 9,000 1 1	1									0	0	0	0	0	0		
	2 5	5									0	0	0	0	0	0		
	3 5	5									0	0	0	0	0	0		
											0	0	0	0	0	0		
	Miscelaneous	3									0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Equipment air lift	28		28	h				8,130		0	0	0	227,640	0	227,640		
											0	0	0	0	0	0		
	- Mobilisation Shared with catering and transportation	40%		1	ls				320,000		0	0	0	320,000	0	320,000		
											0	0	0	0	0	0		
	Bell 214 **2,700**										0	0	0	0	0	0		
	Air lift 1 2 3										0	0	0	0	0	0		
	Days 137 64 80 281										0	0	0	0	0	0		
	4 Trips / day 548 256 320 1,124										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Men 1,124 trips 1 h / trip			1,124	h				5,416		0	0	0	6,087,584	0	6,087,584		
											0	0	0	0	0	0		
	- Miscelaneous 1 trip / day 1 h / trip 281 days			281	h				5,416		0	0	0	1,521,896	0	1,521,896		
											0	0	0	0	0	0		
	- Mobilisation Shared with catering and transportation	40%		1	ls				15,680		0	0	0	15,680	0	15,680		

Item : 2310-2380

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
	UNIT PRICES / TOTAL COSTS										24.00 $				0.72 $			
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	AS 350 B3 **1,200**										0	0	0	0	0	0		
	Air lift 1 2 3										0	0	0	0	0	0		
	Days 137 64 80 281										0	0	0	0	0	0		
	4 Trips / day 548 256 320 1,124										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Miscelaneous 4 trip / day 1 h / trip 281 days			1,124	h				2,180		0	0	0	2,450,320	0	2,450,320		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Generator 5 kW (Tower light) 672 1 1	1									0	0	0	0	0	0		
	2 3	3									0	0	0	0	0	0		
	3 2	2									0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Equipment air lift	6		6	h				2,180		0	0	0	13,080	0	13,080		
											0	0	0	0	0	0		
	- Mobilisation Shared with catering and transportation	40%		1	ls				12,540		0	0	0	12,540	0	12,540		
											0	0	0	0	0	0		
	Land crew Global Duration 140 days										0	0	0	0	0	0		
	10 h / d			1,400	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	7,000	h	24.00					168,000	0	0	0	0	168,000		7,000
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	1,260	h				13.65	18.00	0	0	0	17,199	16,330	33,529		
											0	0	0	0	0	0		
	Dismantling & Reassembling Equipment			12	sh						0	0	0	0	0	0		
	10 h / sh			120	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-O		12	1,440		24.00					34,560	0	0	0	0	34,560		1,440
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	108	h				13.65	18.00	0	0	0	1,474	1,400	2,874		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2380	**Air Lifts**										**202,560**	**0**	**0**	**10,667,413**	**17,730**	**10,887,703**		**8,440**

2410 Excavation

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2411	**Powerhouse and Access**			**140,618**	**m³**													
	Access to Powerhouse			**49,025**	**m³**						0	0	0	0	0	0		
	Powerhouse										0	0	0	0	0	0		
	Powerhouse cavern 55,783														0			
	Reinforced and lined intake tunnel 20,965														0			
	Manifold 3,502														0			
	Penstocks 2,292														0			
	Bus bar tunnel 5,337														0			
	Draft tubes 3,714 91,593			**91,593**	**m³**										0			
															0			
	Drilling with Rocket Boomer E3C																	
				140,618	**m³**						0	0	0	0	0	0		
	Access **(From TBM access tunnel to Powerhouse)**										0	0	0	0	0	0		
	D Shape **10 x 10** **92.5 m³** **530 m**			**49,025**	**m³**						0	0	0	0	0	0		
	Dia. Area (m²)										0	0	0	0	0	0		
	Arc 11.59 15 17.50										0	0	0	0	0	0		
	Height 10.00										0	0	0	0	0	0		
	Wall 7.50 75.00										0	0	0	0	0	0		
	Width 10.00										0	0	0	0	0	0		
	92.5										0	0	0	0	0	0		
	Excavation										0	0	0	0	0	0		
	Progression 4.66 m										0	0	0	0	0	0		
	Number of rounds 114										0	0	0	0	0	0		
	Number of shifts 160 Prod. Factor 1.4										0	0	0	0	0	0		
	Number of holes (m) (Feet)										0	0	0	0	0	0		
	Production 74 55 mm dia. 42,433 139,181										0	0	0	0	0	0		
	Contour 41 55 mm dia. 23,510 77,114										0	0	0	0	0	0		
	115										0	0	0	0	0	0		
	Cut 3 109 mm dia. 1,720 5,642										0	0	0	0	0	0		
	118										0	0	0	0	0	0		
	Drilling depth 5.03 m 67,664 221,936										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Durations **(hours)** **114 rounds**										0	0	0	0	0	0		
	Drilling 150 m / h 3.96 451 h										0	0	0	0	0	0		
	Blasting 1.15 min / hole 2.26 258 h										0	0	0	0	0	0		
	Scaling & W. mesh 2.00 228 h										0	0	0	0	0	0		
	Mucking 205 m³ / h 2.10 240 h										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling labour										0	0	0	0	0	0		
	Total M-H Bolting W. Mesh Remaining										0	0	0	0	0	0		
	8 12,800 1,792 1,536 9,472										0	0	0	0	0	0		
	14% 12%										0	0	0	0	0	0		
	Drilling 4.00 114 456 h										0	0	0	0	0	0		
	9 h / sh 51 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 4,053 m-h										0	0	0	0	0	0		
	Loading & Blasting 2.26 114 258 h										0	0	0	0	0	0		
	9 h / sh 29 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 2,292 m-h										0	0	0	0	0	0		

Item : (2411)

WBS	DESCRIPTION					%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
															24.00 $				0.72 $			
	Remaining for services				3,127										0	0	0	0	0	0		
															0	0	0	0	0	0		
	Drilling							507	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						8	4,053	h	24.00					97,280	0	0	0	0	97,280		4,053
				114 rounds											0	0	0	0	0	0		
	- Jumbo E 3C		14.00	4.5 h				513	h				14.00		0	0	0	7,182	0	7,182		
	- ›are parts							1	ls		80,722				0	80,722	0	0	0	80,722		
															0	0	0	0	0	0		
		Feet	ft / un												0	0	0	0	0	0		
	- Bits 2"Ø	216,294	1,600					135	un		85.00				0	11,475	0	0	0	11,475		
	- Bits 4"Ø	5,642	1,500					4	un		500.00				0	2,000	0	0	0	2,000		
	- Rod 18'	221,936	7,500					30	un		485.00				0	14,550	0	0	0	14,550		
	- Coupling	221,936	3,700					60	un		50.00				0	3,000	0	0	0	3,000		
	- Shank	221,936	12,500					18	un		300.00				0	5,400	0	0	0	5,400		
	- Misc. Materials	221,936						221,936	ft		0.04				0	8,877	0	0	0	8,877		
															0	0	0	0	0	0		
	Loading & Blasting							286	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						8	2,292	h	24.00					55,004	0	0	0	0	55,004		2,292
															0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)		37.00	20.00		90%	1	258	h				37.00	20.00	0	0	0	9,546	3,715	13,261		
	- Fork lift 10 T		11.00	7.00		90%	1	258	h				11.00	7.00	0	0	0	2,838	1,300	4,138		
	- Explosives Truck		5.00	15.00		90%	1	258	h				5.00	15.00	0	0	0	1,290	2,786	4,076		
															0	0	0	0	0	0		
	5.03 m holes	**114 Rounds**													0	0	0	0	0	0		
		Number	Total	Length (m)											0	0	0	0	0	0		
	Contour holes	41	4,674	23,510											0	0	0	0	0	0		
	Production holes	74	8,436	42,433											0	0	0	0	0	0		
		115	13,110												0	0	0	0	0	0		
															0	0	0	0	0	0		
	- Prima cord	5.5 m			25,707	5%		26,992	m		1.00				0	26,992	0	0	0	26,992		
	- Cap 6m				13,110	13%		14,814	un		3.50				0	51,849	0	0	0	51,849		
	- Dynamite RXL 438	49,025 m³		Powder fact	1.6			78,440	kg		5.60				0	439,264	0	0	0	439,264		
	- XACTEX	4,674 holes			12,854	5%		13,496	kg		7.50				0	101,220	0	0	0	101,220		
		2.75 kg / hole													0	0	0	0	0	0		
															0	0	0	0	0	0		
	Mucking	49,025 m³													0	0	0	0	0	0		
	1.5 Loose »»»»	73,538 m³													0	0	0	0	0	0		
		645 m³ / round													0	0	0	0	0	0		
	Production	140 m³ / h		4.61 h											0	0	0	0	0	0		
		114 rounds		525 h x 10/9 »»				584	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						7	4,085	h	24.00					98,050	0	0	0	0	98,050		4,085
															0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator		19.00	29.00		50%	1	292	h				19.00	29.00	0	0	0	5,548	6,097	11,645		
	- Cat 988H Wheel Loader		39.20	48.00		90%	1	525	h				39.20	48.00	0	0	0	20,580	18,144	38,724		
	- Cat D7R II LGP Track-Type Tractor		38.25	28.00		90%	1	525	h				38.25	28.00	0	0	0	20,081	10,584	30,665		
	- Cat 725 Articulated Dumper 25 T		24.00	20.00		90%	3	1,576	h				24.00	20.00	0	0	0	37,824	22,694	60,518		
															0	0	0	0	0	0		
	Disposal of excavated materials														0	0	0	0	0	0		
		Average hauling distance :		4.00 km											0	0	0	0	0	0		
															0	0	0	0	0	0		
	Loading		8												0	0	0	0	0	0		
	Going		8	30 km / h											0	0	0	0	0	0		
	Unloading		3												0	0	0	0	0	0		

Item : (2411)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Return 8 / 30 km / h										0	0	0	0	0	0		
	27 min.										0	0	0	0	0	0		
	Efficacité : 85% 32 min. / trip										0	0	0	0	0	0		
	0.53 h / trip										0	0	0	0	0	0		
	9.5 h / sh										0	0	0	0	0	0		
	18 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m³										0	0	0	0	0	0		
	216 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **3**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rolling Path Length 530										0	0	0	0	0	0		
	Width 8.00										0	0	0	0	0	0		
	Thickness 0.30										0	0	0	0	0	0		
	Volume 1,272										0	0	0	0	0	0		
	Production 1,200 m³ / sh			1	sh						0	0	0	0	0	0		
	10 h / s			10	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	80	h	24.00					1,920	0	0	0	0	1,920		80
											0	0	0	0	0	0		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	9	h				39.20	48.00	0	0	0	353	311	664		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	9	h				38.25	28.00	0	0	0	344	181	525		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	1	9	h				24.00	20.00	0	0	0	216	130	346		
											0	0	0	0	0	0		
	Portal excavation allready estimated in (2520)																	
	Rock Support										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Horse shoe 10 x 10 92.5 m³ 530 m			**49,025**	**m³**						0	0	0	0	0	0		
	Area (m²)										0	0	0	0	0	0		
	Arc 11.59 17.50										0	0	0	0	0	0		
	Height 10.00										0	0	0	0	0	0		
	Wall 7.50 75.00										0	0	0	0	0	0		
	Width 10.00										0	0	0	0	0	0		
	92.5										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Tunnel										0	0	0	0	0	0		
	Required Length Dia.(m) Arch (m)										0	0	0	0	0	0		
	Class 1 397.5 12.5 11.59	75%									0	0	0	0	0	0		
	Class 2 79.5 12.5 11.59	15%									0	0	0	0	0	0		
	Class 3 37.1 12.5 11.59	7.0%									0	0	0	0	0	0		
	Class 4 13.3 12.5 11.59	2.5%									0	0	0	0	0	0		
	Class 5 2.7 12.5 11.59	0.5%									0	0	0	0	0	0		
	530	100%									0	0	0	0	0	0		
	Class 1 Qty										0	0	0	0	0	0		
	Rock bolts 2,5 m 1 un / m 398 un										0	0	0	0	0	0		
	Shotcrete 50 mm 20.59 m² / m 1,228 m²	15%									0	0	0	0	0	0		
	Wire mesh 20.59 m² / m 6,957 m²	85%									0	0	0	0	0	0		
	Class 2										0	0	0	0	0	0		
	Rock bolts 2,5 m 2.3 un / m 182 un										0	0	0	0	0	0		
	Shotcrete 50 mm 20.59 m² / m 246 m²	15%									0	0	0	0	0	0		
	Wire mesh 20.59 m² / m 1,391 m²	85%									0	0	0	0	0	0		
	Class 3										0	0	0	0	0	0		
	Rock bolts 3 m 2.9 un / m 107 un										0	0	0	0	0	0		
	Shotcrete 50 mm 20.59 m² / m 382 m²	50%									0	0	0	0	0	0		
	Wire mesh 20.59 m² / m 382 m²	50%									0	0	0	0	0	0		
	Class 4										0	0	0	0	0	0		

Item : (2411)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Rock bolts 4 m 5.2 un / m 68 un										0	0	0	0	0	0		
	Shotcrete 50 mm 9.0 m^2 / m 36 m^2	30%									0	0	0	0	0	0		
	Wire mesh 9.0 m^2 / m 83 m^2	70%									0	0	0	0	0	0		
	Shotcrete 100 mm 11.6 m^2 / m 154 m^2	100%									0	0	0	0	0	0		
	Reinf. Mesh 11.6 m^2 / m 154 m^2	100%									0	0	0	0	0	0		
	Steel arch (W 100) 1.5 m c/c 9 un										0	0	0	0	0	0		
	26.6 m / arch 239 m																	
	Class 5										0	0	0	0	0	0		
	Rock bolts 5 m 11.6 un / m 31 un										0	0	0	0	0	0		
	Shotcrete 50 mm 9.0 m^2 / m 7 m^2	30%									0	0	0	0	0	0		
	Wire mesh 9.0 m^2 / m 17 m^2	70%									0	0	0	0	0	0		
	Shotcrete 100 mm 11.6 m^2 / m 31 m^2	100%									0	0	0	0	0	0		
	Reinf. Mesh 11.6 m^2 / m 31 m^2	100%									0	0	0	0	0	0		
	Steel arch (W 150) 0.75 m c/c 4 un										0	0	0	0	0	0		
	26.6 m / arch 106 m										0	0	0	0	0	0		
	Supply Lenght (m)										0	0	0	0	0	0		
-	Rock bolts 2,5 m 580 un 1,493 Losses	3%		597	un			60.00			0	0	35,820	0	0	35,820		
-	Rock bolts 3 m 107 un 330 Losses	3%		110	un			70.00			0	0	7,700	0	0	7,700		
-	Rock bolts 4 m 68 un 280 Losses	3%		70	un			80.00			0	0	5,600	0	0	5,600		
-	Rock bolts 5 m 31 un 160 Losses	3%		32	un			105.00			0	0	3,360	0	0	3,360		
	786 2,263										0	0	0	0	0	0		
-	Injection tubes 150 m roll	3%		16	rolls			110.00			0	0	1,760	0	0	1,760		
-	Oakum 130 bolts / box	3%		7	box			280.00			0	0	1,960	0	0	1,960		
-	Grease 154 bolts / box	3%		5	box			336.00			0	0	1,680	0	0	1,680		
											0	0	0	0	0	0		
-	Wire mesh 8,830 m^2	15%		10,155	m^2			4.60			0	0	46,713	0	0	46,713		
-	Reinf. Mesh 184 m^2	15%		212	m^2			5.60			0	0	1,187	0	0	1,187		
	9,015 m^2										0	0	0	0	0	0		
-	Spikes 1,1 m 1.25 m c/c 7,212 un	3%		7,428	un			4.50			0	0	33,426	0	0	33,426		
-	Wire 0.04 $ / m^2			9,015	m^2			0.04			0	0	361	0	0	361		
	m^2 m^3										0	0	0	0	0	0		
	Shotcrete 50 mm 1,898 0.05 95										0	0	0	0	0	0		
	Shotcrete 100 mm 184 0.1 18										0	0	0	0	0	0		
	113										0	0	0	0	0	0		
-	Cement (40 kg Bags) 0.03 m^3 / bag Losses	7.5%		4,061	bags			10.00			0	0	40,610	0	0	40,610		
	33.33 bags / m^3 3,778 bags										0	0	0	0	0	0		
-	Sand 1.40 mt / m^3 0.08 h / mt			159	mt	1.94	0.00	0.00	2.27	1.58	308	0	0	360	180	848		13
-	Monoset (3% of cement) 151,110 kg	3%		4,533	kg			3.40			0	0	15,412	0	0	15,412		
											0	0	0	0	0	0		
-	Steel arch (W 100) 19.0 kg / m 239 m			4,547	kg			4.00			0	0	18,188	0	0	18,188		
-	Steel arch (W 150) 22.0 kg / m 106 m			2,340	kg			5.00			0	0	11,700	0	0	11,700		
	Rock bolts Installation			**160**	**sh**						0	0	0	0	0	0		
	2,263 m 14 m / sh										0	0	0	0	0	0		
	786 un 5 un / sh																	
	0.5 h / un. including positionning																	
	2.5 h / sh			400	h													
1)	Drilling with Jumbo										0	0	0	0	0	0		
											0	0	0	0	0	0		
-	Jumbo	90%	1	360	h				102.50		0	0	0	36,900	0	36,900		
											0	0	0	0	0	0		
2)	Install with 50t crane with basket										0	0	0	0	0	0		
	786 un 5 un / round										0	0	0	0	0	0		
	0.5 h / un 2.5 h / round including positionning																	
	400 h																	

Item : (2411)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	9.0 h / sh Eff.			45	sh													
	10 h / sh Eff.			450	h													
	- M-P		3	1,350	h	24.00					32,400	0	0	0	0	32,400		1,350
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	405	h				37.00	20.00	0	0	0	14,985	5,832	20,817		
											0	0	0	0	0	0		
	- Impact tool			1	un		300.00				0	300	0	0	0	300		
	- Test rig			1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque rench			1	un		280.00				0	280	0	0	0	280		
											0	0	0	0	0	0		
	3) Injection 40 bolts / sh			20	sh						0	0	0	0	0	0		
	10 h / sh			200	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	800	h	24.00					19,200	0	0	0	0	19,200		800
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	180	h				37.00	20.00	0	0	0	6,660	2,592	9,252		
	- Moyno pump 2.00	75%	1	150	h				2.00		0	0	0	300	0	300		
											0	0	0	0	0	0		
	- Cement (bags) 2,263 m	100%		370	bags			10.00			0	0	3,700	0	0	3,700		
	7,421 ft 0.02269801 sf										0	0	0	0	0	0		
	2 in. Dia hole 168 cu ft										0	0	0	0	0	0		
	0.91 cu ft / bag 185 bags										0	0	0	0	0	0		
	- Intraplast "N" 0.4 kg / bag 74 kg	1%		75	kg			3.00			0	0	225	0	0	225		
	- Miscellaneous			786	un		0.30				0	236	0	0	0	236		
											0	0	0	0	0	0		
	Wire mesh installation										0	0	0	0	0	0		
	Installation by Jumbo team										0	0	0	0	0	0		
	Production of 200 m^2 / sh 9,015 m^2			45	sh						0	0	0	0	0	0		
	10 h / sh			451	h						0	0	0	0	0	0		
	Plus										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	406	h				37.00	20.00	0	0	0	15,022	5,846	20,868		
	- Jack leg 2.00	30%	1	135	h				2.00		0	0	0	270	0	270		
	- Miscellaneous materials Spike drilling 7,933 m			7,933	m		1.00				0	7,933	0	0	0	7,933		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Shotcreting			**113**	**m^3**						0	0	0	0	0	0		
	Production of 0.7 h / m^3 79 h										0	0	0	0	0	0		
	7.5 h / sh Eff.			11	sh						0	0	0	0	0	0		
	10 h / sh			110	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		9	990	h	24.00					23,760	0	0	0	0	23,760		990
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	99	h				37.00	20.00	0	0	0	3,663	1,426	5,089		
	- Shotcrete pump 17.00	60%	1	66	h				17.00		0	0	0	1,122	0	1,122		
	- Hoses	25%	1	28	h		35.00				0	980	0	0	0	980		
	- Nozzle 66 m^3 / un			2	un		275.00				0	550	0	0	0	550		
											0	0	0	0	0	0		
	Arches installation 346 m 27 m / un			**13**	**un**						0	0	0	0	0	0		
	Production of 2 un / sh			7	sh						0	0	0	0	0	0		
	10 h / sh			70	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	350	h	24.00					8,400	0	0	0	0	8,400		350
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	63	h				37.00	20.00	0	0	0	2,331	907	3,238		

Item : (2411)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Miscellaneous materials			13	un		200.00				0	2,600	0	0	0	2,600		
											0	0	0	0	0	0		
	Powerhouse			**55,783**	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Header (m²)										0	0	0	0	0	0		
	Arc 20.50 16.5 57.50										0	0	0	0	0	0		
	Height 9.00										0	0	0	0	0	0		
	Wall 4.00 66.00										0	0	0	0	0	0		
	Width 16.50										0	0	0	0	0	0		
	123.5 118			**14,573**	**m³**						0	0	0	0	0	0		
															0			
	Bench 1 8.8 16.5 145.2 118			17,134	m³						0	0	0	0	0	0		
															0			
	Bench 2 10.8 16.5 178.2 118			21,028	m³						0	0	0	0	0	0		
	2 13.54 27.08 118			3,195	m³						0	0	0	0	0	0		
	205.28			55,930	m³						0	0	0	0	0	0		
											0	0	0	0	0	0		
	474.0 118										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Header Excavation										0	0	0	0	0	0		
	Progression 4.66 m										0	0	0	0	0	0		
	Number of rounds 26										0	0	0	0	0	0		
	Number of shifts 36 Prod. Factor 1.4										0	0	0	0	0	0		
	Number of holes (m) (Feet)										0	0	0	0	0	0		
	Production 99 55 mm dia. 12,947 42,467										0	0	0	0	0	0		
	Contour 44 55 mm dia. 5,754 18,874										0	0	0	0	0	0		
	143										0	0	0	0	0	0		
	Cut 3 109 mm dia. 392 1,287										0	0	0	0	0	0		
	146										0	0	0	0	0	0		
	Drilling depth 5.03 m 62,628										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Durations (hours) 26 rounds										0	0	0	0	0	0		
	Drilling 150 m / h 4.90 127 h										0	0	0	0	0	0		
	Blasting 1.15 min / hole 2.80 73 h										0	0	0	0	0	0		
	Scaling & W. mesh 2.00 52 h										0	0	0	0	0	0		
	Mucking 205 m³ / h 2.81 73 h										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling labour										0	0	0	0	0	0		
	H-H Bolting W. Mesh Remaining										0	0	0	0	0	0		
	8 2,880 403 346 2,131										0	0	0	0	0	0		
	14% 12%										0	0	0	0	0	0		
	Drilling 5.0 26 130 h										0	0	0	0	0	0		
	9 h / sh 14 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 1,156 h-h										0	0	0	0	0	0		
	Loading & Blasting 2.80 26 73 h										0	0	0	0	0	0		
	9 h / sh 8 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 647 h-h										0	0	0	0	0	0		
	Remaining for services 329										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling			144	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	1,156	h	24.00					27,733	0	0	0	0	27,733		1,156
	26 rounds										0	0	0	0	0	0		
	- Jumbo E 3C 14.00 4.5 h			117	h				14.00		0	0	0	1,638	0	1,638		
	- Cat GEP 550 - 400KW 6.50 102.40 12 h			312	h				6.50	102.40	0	0	0	2,028	23,003	25,031		
	Feet ft / un										0	0	0	0	0	0		

Item : (2411)

WBS	DESCRIPTION					%	n	Qty	Un.	M-P	Cons. Mat. (UNIT PRICES)	Perm. Mat. (UNIT PRICES)	Equip. Op. (UNIT PRICES)	Fuel l / h	Man power (TOTAL COSTS)	Consumable materials (TOTAL COSTS)	Permanent Materials (TOTAL COSTS)	Equipment Operation (TOTAL COSTS)	Fuel Consumption (TOTAL COSTS)	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
															24.00 $				0.72 $			
	- Bits 2"Ø	61,341	1,600					38	un		85.00				0	3,230	0	0	0	3,230		
	- Bits 4"Ø	1,287	1,500					1	un		500.00				0	500	0	0	0	500		
	- Rod 18'	62,628	7,500					8	un		485.00				0	3,880	0	0	0	3,880		
	- Coupling	62,628	3,700					17	un		50.00				0	850	0	0	0	850		
	- Shank	62,628	12,500					5	un		300.00				0	1,500	0	0	0	1,500		
	- Misc. Materials	62,628						62,628	ft		0.04				0	2,505	0	0	0	2,505		
															0	0	0	0	0	0		
	Loading & Blasting							81	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						8	647	h	24.00					15,521	0	0	0	0	15,521		647
															0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)		37.00	20.00		90%	1	73	h				37.00	20.00	0	0	0	2,701	1,051	3,752		
	- Fork lift 10 T		11.00	7.00		90%	1	73	h				11.00	7.00	0	0	0	803	368	1,171		
	- Explosives Truck		5.00	15.00		90%	1	73	h				5.00	15.00	0	0	0	365	788	1,153		
															0	0	0	0	0	0		
	5.03 m holes	**26**	**Rounds**												0	0	0	0	0	0		
		Number	Total	Length (m)											0	0	0	0	0	0		
	Contour holes	44	1,144	5,754											0	0	0	0	0	0		
	Production holes	99	2,574	12,947											0	0	0	0	0	0		
		143	3,718												0	0	0	0	0	0		
															0	0	0	0	0	0		
	- Prima cord	5.5	m		6,292	5%		6,607	m		1.00				0	6,607	0	0	0	6,607		
	- Cap 6m				3,718	13%		4,201	un		3.50				0	14,704	0	0	0	14,704		
	- Dynamite RXL 438	14,573	m^3	Powder fact	1.6			23,317	kg		5.60				0	130,574	0	0	0	130,574		
	- XACTEX	1,144	holes		3,146	5%		3,303	kg		7.50				0	24,773	0	0	0	24,773		
		2.75	kg / hole												0	0	0	0	0	0		
															0	0	0	0	0	0		
	Rock Support			**Length**	**118**	**m**														0		
				Area (m^2)																0		
	Arc	20.50	16.5	57.50																0		
	Height	9.00																		0		
	Wall	4.00		66.00																0		
	Width	16.50																		0		
				123.5																0		
																				0		
																				0		
			Header																	0		
	Required	Length	Dia.(m)	Arch (m)																0		
	Class 1	88.5	12.5	11.59		75%														0		
	Class 2	17.7	12.5	11.59		15%														0		
	Class 3	8.3	12.5	11.59		7.0%														0		
	Class 4	3.0	12.5	11.59		2.5%														0		
	Class 5	0.6	12.5	11.59		0.5%														0		
		118				100%														0		
	Class 1			Qty																0		
	Rock bolts 2,5 m	1	un / m	89	un															0		
	Shotcrete 50 mm	13.59	m^2 / m	180	m^2	15%														0		
	Wire mesh	13.59	m^2 / m	1,022	m^2	85%														0		
	Class 2																			0		
	Rock bolts 2,5 m	2.3	un / m	41	un															0		
	Shotcrete 50 mm	13.59	m^2 / m	36	m^2	15%														0		
	Wire mesh	13.59	m^2 / m	204	m^2	85%														0		
	Class 3																			0		
	Rock bolts 3 m	2.9	un / m	24	un															0		
	Shotcrete 50 mm	13.59	m^2 / m	56	m^2	50%														0		
	Wire mesh	13.59	m^2 / m	56	m^2	50%														0		
	Class 4																			0		

Item : (2411)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Rock bolts 4 m 5.2 un / m 15 un														0			
	Shotcrete 50 mm 2.0 m^2 / m 2 m^2	30%													0			
	Wire mesh 2.0 m^2 / m 4 m^2	70%													0			
	Shotcrete 100 mm 11.6 m^2 / m 34 m^2	100%													0			
	Reinf. Mesh 11.6 m^2 / m 34 m^2	100%													0			
	Steel arch (W 100) 1.5 m c/c 2 un														0			
	28.5 m / arch 57 m																	
	Class 5														0			
	Rock bolts 5 m 11.6 un / m 7 un														0			
	Shotcrete 50 mm 2.0 m^2 / m 0 m^2	30%													0			
	Wire mesh 2.0 m^2 / m 1 m^2	70%													0			
	Shotcrete 100 mm 11.6 m^2 / m 7 m^2	100%													0			
	Reinf. Mesh 11.6 m^2 / m 7 m^2	100%													0			
	Steel arch (W 150) 0.75 m c/c 1 un														0			
	28.5 m / arch 29 m														0			
	Supply Lenght (m)														0			
-	Rock bolts 2,5 m 130 un 335 Losses	3%		134	un			60.00							0			
-	Rock bolts 3 m 24 un 75 Losses	3%		25	un			70.00							0			
-	Rock bolts 4 m 15 un 60 Losses	3%		15	un			80.00							0			
-	Rock bolts 5 m 7 un 35 Losses	3%		7	un			105.00							0			
	176 505														0			
-	Injection tubes 150 m roll	3%		3	rolls			110.00							0			
-	Oakum 130 bolts / box	3%		2	box			280.00							0			
-	Grease 154 bolts / box	3%		1	box			336.00							0			
															0			
-	Wire mesh 1,288 m^2	15%		1,481	m^2			4.60							0			
-	Reinf. Mesh 41 m^2	15%		47	m^2			5.60							0			
	1,329 m^2														0			
-	Spikes 1,1 m 1.25 m c/c 1,063 un			1,063	un			4.50							0			
-	Wire 0.04 $ / m^2			1,329	m^2			0.04							0			
	m^2 m^3														0			
	Shotcrete 50 mm 275 0.05 14														0			
	Shotcrete 100 mm 41 0.1 4														0			
	18														0			
-	Cement (40 kg Bags) 0.03 m^3 / bag Losses	7.5%		639	bags			10.00							0			
	33.33 bags / m^3 595 bags														0			
-	Sand 1.40 mt / m^3 0.08 h / mt			25	mt	1.94	0.00	0.00	2.27	1.58	48	0	0	57	28	133		2
											0	0	0	0	0	0		
-	Monoset (3% of cement) 23,786 kg	3%		714	kg			3.40							0			
															0			
-	Steel arch (W 100) 19.0 kg / m 57 m			1,083	kg			4.00							0			
-	Steel arch (W 150) 22.0 kg / m 29 m			627	kg			5.00							0			
	Rock bolts Installation			36	sh						0	0	0	0	0	0		
	505 m 14 m / sh										0	0	0	0	0	0		
	176 un 5 un / sh										0	0	0	0	0	0		
	0.5 h / un. including positionning										0	0	0	0	0	0		
	3 h / sh			108	h													
1)	Drilling with Jumbo																	
											0	0	0	0	0	0		
-	Jumbo	90%	1	97	h	24.00					2,328	0	0	0	0	2,328		97
											0	0	0	0	0	0		
2)	Install with 50t crane with basket										0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		3	324	h	24.00					7,776	0	0	0	0	7,776		324
											0	0	0	0	0	0		

Item : (2411)

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES					TOTAL COSTS					GLOBAL PRICES	UNIT PRICES	MEN-HOURS
								M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption			
													24.00 $				0.72 $			
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	97	h				37.00	20.00	0	0	0	3,589	1,397	4,986		
													0	0	0	0	0	0		
	- Impact tool					1	un		300.00				0	300	0	0	0	300		
	- Test rig					1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque rench					1	un		280.00				0	280	0	0	0	280		
													0	0	0	0	0	0		
	3) Injection	40 bolts / sh	176 un			5	sh						0	0	0	0	0	0		
			10 h / sh			50	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				4	200	h	24.00					4,800	0	0	0	0	4,800		200
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	45	h				37.00	20.00	0	0	0	1,665	648	2,313		
	- Moyno pump	2.00		75%	1	38	h				2.00		0	0	0	76	0	76		
													0	0	0	0	0	0		
	- Cement (bags)	505 m		100%		82	bags			10.00			0	0	820	0	0	820		
		1,656 ft	0.02269801 sf										0	0	0	0	0	0		
		2 in. Dia hole	38 cu ft										0	0	0	0	0	0		
		0.91 cu ft / bag	41 bags										0	0	0	0	0	0		
	- Intraplast "N"	0.4 kg / bag	16 kg	1%		17	kg			3.00			0	0	51	0	0	51		
	- Miscellaneous					176	un		0.30				0	53	0	0	0	53		
																	0			
	Wire mesh installation												0	0	0	0	0	0		
	Installation by Jumbo team												0	0	0	0	0	0		
	Production of	200 m² / sh	1,329 m²			7	sh						0	0	0	0	0	0		
			10 h / sh			66	h						0	0	0	0	0	0		
	Plus												0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	60	h				37.00	20.00	0	0	0	2,220	864	3,084		
	- Jack leg	2.00		30%		20	h				2.00		0	0	0	40	0	40		
	- Miscellaneous materials	Spike drilling	1169.3 m			1,169	m		1.00				0	1,169	0	0	0	1,169		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
	Shotcreting					**18**	**m³**						0	0	0	0	0	0		
	Production of	0.7 h / m³	12 h										0	0	0	0	0	0		
			7.5 h / sh Eff.			2	sh						0	0	0	0	0	0		
			10 h / sh Eff.			20	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				9	180	h	24.00					4,320	0	0	0	0	4,320		180
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	18	h				37.00	20.00	0	0	0	666	259	925		
	- Shotcrete pump	17.00		60%	1	12	h				17.00		0	0	0	204	0	204		
	- Hoses			25%	1	5	h		35.00				0	175	0	0	0	175		
	- Nozzle	66 m³ / un				0	un		275.00				0	0	0	0	0	0		
													0	0	0	0	0	0		
	Arches installation	86 m	29 m / un			**3**	**un**						0	0	0	0	0	0		
	Production of	2 un / sh				2	sh						0	0	0	0	0	0		
			10 h / sh			20	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				5	100	h	24.00					2,400	0	0	0	0	2,400		100
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	18	h				37.00	20.00	0	0	0	666	259	925		
	- Miscellaneous materials					3	un		200.00				0	600	0	0	0	600		
													0	0	0	0	0	0		
	Mucking	14,573 m³											0	0	0	0	0	0		
	1.5 Loose »»»»	21,860 m³											0	0	0	0	0	0		
		841 m³ / round											0	0	0	0	0	0		

Item : (2411)

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Production 140 m³ / h 6.01 h										0	0	0	0	0	0		
	26 rounds 156 h x 10/9 »»			173	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		7	1,214	h	24.00					29,146	0	0	0	0	29,146		1,214
											0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	50%	1	87	h				19.00	29.00	0	0	0	1,653	1,817	3,470		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	156	h				39.20	48.00	0	0	0	6,115	5,391	11,506		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	156	h				38.25	28.00	0	0	0	5,967	3,145	9,112		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	5	781	h				24.00	20.00	0	0	0	18,744	11,246	29,990		
											0	0	0	0	0	0		
	Disposal of excavated materials										0	0	0	0	0	0		
	Average hauling distance : 4.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 8										0	0	0	0	0	0		
	Going 8 30 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 8 30 km / h										0	0	0	0	0	0		
	27 min.										0	0	0	0	0	0		
	Efficacité : 85% 32 min. / trip										0	0	0	0	0	0		
	0.53 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	17 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m³										0	0	0	0	0	0		
	204 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **5**										0	0	0	0	0	0		
	BENCHES																	
	H W (m²) L										0	0	0	0	0	0		
	Bench 1 8.8 16.5 145.2 118			17,134	m³						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Bench 2 10.8 16.5 178.2 118			21,028	m³						0	0	0	0	0	0		
	2 13.54 27.08 118			3,195	m³						0	0	0	0	0	0		
	205.28			**41,357**	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Progression 10 m														0			
	Rounds 12 rounds / bench														0			
	Line drilling 0.6 m c/c														0			
	Damper holes 16 un / round														0			
	Helper holes 16 un / round														0			
	Production holes 39 un / round														0			
															0			
	DRILLING Lentgh Holes Depth Drilling										0	0	0	0	0	0		
	2,5" dia.										0	0	0	0	0	0		
	B1 Line drilling 269 448 9.3 4,166										0	0	0	0	0	0		
	B2 Line drilling 269 448 11.3 5,062										0	0	0	0	0	0		
	B1 Damper 192 9.3 1,786														0			
	B2 Damper 192 11.3 2,170														0			
	3" dia.										0	0	0	0	0	0		
	B1 Helper 192 9.3 1,786										0	0	0	0	0	0		
	B2 Helper 192 11.3 2,170										0	0	0	0	0	0		
	B1 Production 468 9.3 4,352										0	0	0	0	0	0		
	B2 Production 468 11.3 5,288										0	0	0	0	0	0		
	2,600										0	0	0	0	0	0		
	Preshearing area 5,537 m²										0	0	0	0	0	0		
	Durations 250 m / machine / sh										0	0	0	0	0	0		
	(m) (shift)														0			
	Line drilling 9,228 37										0	0	0	0	0	0		

Item : (2411)

						UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Damper 3,956 16										0	0	0	0	0	0		
	Production & Helpers 13,596 54										0	0	0	0	0	0		
	107 3 mach			36	sh						0	0	0	0	0	0		
	10 h / sh			360	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	2,160	h	24.00					51,840	0	0	0	0	51,840		2,160
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	3	972	h				19.40	15.00	0	0	0	18,857	10,498	29,355		
											0	0	0	0	0	0		
	Feet ft / un										0	0	0	0	0	0		
	- Bits 2,5"Ø 43,254 1,500			29	un		160.00				0	4,640	0	0	0	4,640		
	- Bits 3"Ø 44,606 1,500			30	un		200.00				0	6,000	0	0	0	6,000		
	- Rod 18' 87,860 5,000			18	un		500.00				0	9,000	0	0	0	9,000		
	- Coupling 87,860 3,000			29	un		50.00				0	1,450	0	0	0	1,450		
	- Shank 87,860 10,000			9	un		300.00				0	2,700	0	0	0	2,700		
	- Misc. Materials 87,860			87,860	ft		0.05				0	4,393	0	0	0	4,393		
											0	0	0	0	0	0		
	LOADING & BLASTING **41,357** **m³**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Cordex 0.52 m / m³			21,505	m		0.60				0	12,903	0	0	0	12,903		
	- Xactex 0.1 kg m³			4,136	kg		7.50				0	31,017	0	0	0	31,017		
	- Detonators 0.04 un / m³			1,654	un		7.00				0	11,580	0	0	0	11,580		
	- Dynamite 0.96 kg / m³			39,702	kg		6.00				0	238,214	0	0	0	238,214		
											0	0	0	0	0	0		
	Production of 2,600 5 min / hole 217 h																	
	Eff. Factor 0.75			289	h													
	- M-P		4	1,156	h	24.00					27,744	0	0	0	0	27,744		1,156
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	324	h				5.00	15.00	0	0	0	1,620	3,499	5,119		
											0	0	0	0	0	0		
	MUCKING 41,357 m³ (bank)										0	0	0	0	0	0		
	62,035 m³ (loose)										0	0	0	0	0	0		
	2,585 m³ / round										0	0	0	0	0	0		
	Production of 1,250 m³ / sh			50	sh						0	0	0	0	0	0		
	10 h / sh			500	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		10	5,000	h	24.00					120,000	0	0	0	0	120,000		5,000
											0	0	0	0	0	0		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	450	h				39.20	48.00	0	0	0	17,640	15,552	33,192		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	450	h				19.00	29.00	0	0	0	8,550	9,396	17,946		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	5	2,250	h				24.00	20.00	0	0	0	54,000	32,400	86,400		
											0	0	0	0	0	0		
	Disposal of excavated materials										0	0	0	0	0	0		
	Average hauling distance : 4.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 3										0	0	0	0	0	0		
	Going 8 30 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 8 30 km / h										0	0	0	0	0	0		
	22 min.										0	0	0	0	0	0		
	Efficacité : 85% 26 min. / trip										0	0	0	0	0	0		
	0.43 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	21 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m³										0	0	0	0	0	0		

Item : (2411)

WBS	DESCRIPTION	%	n	Qty	Un.	M-P (UNIT PRICES)	Cons. Mat. (UNIT PRICES)	Perm. Mat. (UNIT PRICES)	Equip. Op. (UNIT PRICES)	Fuel l / h	Man power (TOTAL COSTS)	Consumable materials (TOTAL COSTS)	Permanent Materials (TOTAL COSTS)	Equipment Operation (TOTAL COSTS)	Fuel Consumption (TOTAL COSTS)	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	252 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **5**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rock Support L H Area										0	0	0	0	0	0		
	Area 269 19.6 5,272 m²										0	0	0	0	0	0		
	Suppply										0	0	0	0	0	0		
	- Rock bolts 6 m 5 m² / un 1,054 un Losses	3%		1,086	un		110.00				0	119,460	0	0	0	119,460		
	- Wire mesh 4,465 m² Lapping	15%		5,135	m²		4.60				0	23,621	0	0	0	23,621		
	- Spikes 0,7 m 1.56 m² / un 2,862 un	3%		2,948	un		4.50				0	13,266	0	0	0	13,266		
	- Wire			4,465	m²		0.04				0	179	0	0	0	179		
											0	0	0	0	0	0		
	Rock bolts Installation										0	0	0	0	0	0		
	Production of 100 m / sh			64	sh						0	0	0	0	0	0		
	17 un / sh																	
	6 m 6,324 m 10 h / sh			640	h						0	0	0	0	0	0		
	- M-P		6	3,840	h	24.00					92,160	0	0	0	0	92,160		3,840
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	576	h				37.00	20.00	0	0	0	21,312	8,294	29,606		
	- Fork lift 15 T 13.00 9.00	90%	1	576	h				13.00	9.00	0	0	0	7,488	3,732	11,220		
	- Boom truck 17 tons 13.65 18.00	90%	1	576	h				13.65	18.00	0	0	0	7,862	7,465	15,327		
	- Drilling rig (on fork lift)	90%	1	576	h				11.00		0	0	0	6,336	0	6,336		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rock bolts Injection										0	0	0	0	0	0		
	Production of 40 un / sh			27	sh						0	0	0	0	0	0		
	10 h / sh			270	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	1,350		24.00					32,400	0	0	0	0	32,400		1,350
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	243	h				37.00	20.00	0	0	0	8,991	3,499	12,490		
	- Moyno pump 2.00	75%	1	203	h				2.00		0	0	0	406	0	406		
											0	0	0	0	0	0		
	- Cement (bags) 6,324 m	100%		1,034	bags			10.00			0	0	10,340	0	0	10,340		
	20,743 ft 0.02269801 sf										0	0	0	0	0	0		
	2 in. Dia hole 471 cu ft										0	0	0	0	0	0		
	0.91 bag / cu ft 517 bags										0	0	0	0	0	0		
	- Intraplast "N" 0.4 kg / bag 207 kg	1%		209	kg			3.00			0	0	627	0	0	627		
	- Miscellaneous			1,054	un		0.30				0	316	0	0	0	316		
											0	0	0	0	0	0		
	Wire mesh Installation										0	0	0	0	0	0		
	Production of 240 m² / sh			21	sh						0	0	0	0	0	0		
	10 h / sh			210	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	1,050	h	24.00					25,200	0	0	0	0	25,200		1,050
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	189	h				37.00	20.00	0	0	0	6,993	2,722	9,715		
	- Jack leg 2.00	30%		63	h				2.00		0	0	0	126	0	126		
											0	0	0	0	0	0		
	- Misc. Drilling materials 2,862 un 0.7 m			2,003	m		1.00				0	2,003	0	0	0	2,003		
											0	0	0	0	0	0		
	Wire mesh removing (under level 15)										0	0	0	0	0	0		
	L H Area m²										0	0	0	0	0	0		
	269 7 1,883										0	0	0	0	0	0		
	Production of 600 m² / sh			3	sh						0	0	0	0	0	0		
	10 h / sh			30	h						0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
	- M-P		5	150	h	24.00					3,600	0	0	0	0	3,600		150
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	27	h				37.00	20.00	0	0	0	999	389	1,388		
	- Boom truck 17 tons 13.65 18.00	190%	1	57	h				13.65	18.00	0	0	0	778	739	1,517		
											0	0	0	0	0	0		
	83.9 m² 250 m			**20,965**	**m³**						0	0	0	0	0	0		
	Reinforced and lined intake tunnel										0	0	0	0	0	0		
	(based on transformer chamber access)										0	0	0	0	0	0		
	0.39 h / m³			**20,965**	**m³**	**9.31**	**13.94**	**4.19**	**4.86**	**5.00**	195,184	292,252	87,843	101,890	75,474	752,643		**8,176**
											0	0	0	0	0	0		
	Manifold			**3,502**	**m³**						0	0	0	0	0	0		
	Bus bar tunnel			**5,340**	**m³**						0	0	0	0	0	0		
				8,842	**m³**						0	0	0	0	0	0		
	Manifold **49.30 m²** **71 m**			**3,502**	**m³**						0	0	0	0	0	0		
	Bus bar tunnel **± 48.52 m²** **110 m**			**5,337**	**m³**						0	0	0	0	0	0		
				8,839	**m³**						0	0	0	0	0	0		
	D Shape (average tunnels) **49.0 m³** **181 m**			**8,869**	**m³**						0	0	0	0	0	0		
	Area (m²)																	
	Arc 9.27 13.00																	
	Height 6.00																	
	Wall 4.50 36.00																	
	Width 8.00																	
	49.0 181																	
	Excavation																	
	Progression 4.66 m																	
	Number of rounds 39																	
	Number of shifts 55 Prod. Factor 1.4																	
	Number of holes (m) (Feet)																	
	Production 39 55 mm dia. 7,651 25,094																	
	Contour 29 55 mm dia. 5,689 18,660																	
	68																	
	Cut 3 109 mm dia. 589 1,930																	
	71																	
	Drilling depth 5.03 m 13,928 45,684																	
	Durations (hours) 39 rounds																	
	Drilling 150 m / h 2.38 93 h																	
	Blasting 1.15 min / hole 1.36 53 h																	
	Scaling & W. mesh 2.00 78 h																	
	Mucking 205 m³ / h 1.11 43 h																	
	Drilling labour																	
	H-H / Bolting / W. Mesh / Remaining																	
	8 4,400 616 528 3,256																	
	14% 12%										0	0	0	0	0	0		
	Drilling 2.38 39 93 h										0	0	0	0	0	0		
	9 h / sh 10 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 825 h-h										0	0	0	0	0	0		
	Loading & Blasting 1.36 39 53 h										0	0	0	0	0	0		
	9 h / sh 6 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 472 h-h										0	0	0	0	0	0		
	Remaining for services 1,959										0	0	0	0	0	0		
											0	0	0	0	0	0		

Item : (2411)

WBS	DESCRIPTION					%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
															24.00 $				0.72 $			
	Drilling							103	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						8	825	h	24.00					19,809	0	0	0	0	19,809		825
					39 rounds										0	0	0	0	0	0		
	- Jumbo E 3C		14.00		4.5 h			176	h				14.00		0	0	0	2,457	0	2,457		
	- Cat GEP 550 - 400KW		6.50	102.40	12 h			468	h				6.50	102.40	0	0	0	3,042	34,505	37,547		
		Feet	ft / un												0	0	0	0	0	0		
	- Bits 2"Ø	43,754	1,600					27	un		85.00				0	2,295	0	0	0	2,295		
	- Bits 4"Ø	1,930	1,500					1	un		500.00				0	500	0	0	0	500		
	- Rod 18'	45,684	7,500					6	un		485.00				0	2,910	0	0	0	2,910		
	- Coupling	45,684	3,700					12	un		50.00				0	600	0	0	0	600		
	- Shank	45,684	12,500					4	un		300.00				0	1,200	0	0	0	1,200		
	- Misc. Materials	45,684						45,684	ft		0.04				0	1,827	0	0	0	1,827		
															0	0	0	0	0	0		
	Loading & Blasting							59	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						8	472	h	24.00					11,322	0	0	0	0	11,322		472
															0	0	0	0	0	0		
	- Explosives Truck		5.00	15.00		90%	1	53	h				5.00	15.00	0	0	0	265	572	837		
															0	0	0	0	0	0		
	5.03 m holes	**39**	**Rounds**												0	0	0	0	0	0		
		Number	Total	Length (m)											0	0	0	0	0	0		
	Contour holes	29	1,131	5,689											0	0	0	0	0	0		
	Production holes	39	1,521	7,651											0	0	0	0	0	0		
		68	2,652												0	0	0	0	0	0		
															0	0	0	0	0	0		
	- Prima cord	5.5 m			6,221	5%		6,532	m		1.00				0	6,532	0	0	0	6,532		
	- Cap 6m				2,652	13%		2,997	un		3.50				0	10,490	0	0	0	10,490		
	- Dynamite RXL 438	8,869 m³		Powder fact	1.6			14,190	kg		5.60				0	79,466	0	0	0	79,466		
	- XACTEX	1,131 holes			3,110	5%		3,266	kg		7.50				0	24,495	0	0	0	24,495		
		2.75 kg / hole													0	0	0	0	0	0		
															0	0	0	0	0	0		
	Mucking	8,869 m³													0	0	0	0	0	0		
	1.5 Loose »»»»	13,304 m³													0	0	0	0	0	0		
		341 m³ / round													0	0	0	0	0	0		
	Production	140 m³ / h		2.44 h											0	0	0	0	0	0		
		39 rounds		95 h x 10/9 »»				106	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						7	739	h	24.00					17,738	0	0	0	0	17,738		739
															0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator		19.00	29.00		50%	1	53	h				19.00	29.00	0	0	0	1,007	1,107	2,114		
	- Cat 988H Wheel Loader		39.20	48.00		90%	1	95	h				39.20	48.00	0	0	0	3,724	3,283	7,007		
	- Cat D7R II LGP Track-Type Tractor		38.25	28.00		90%	1	95	h				38.25	28.00	0	0	0	3,634	1,915	5,549		
	- Cat 725 Articulated Dumper 25 T		24.00	20.00		90%	2	190	h				24.00	20.00	0	0	0	4,560	2,736	7,296		
															0	0	0	0	0	0		
	Disposal of excavated materials														0	0	0	0	0	0		
	Distance moyenne de transport :			4.00 km											0	0	0	0	0	0		
															0	0	0	0	0	0		
	Loading		8												0	0	0	0	0	0		
	Going		8	30 km / h											0	0	0	0	0	0		
	Unloading		3												0	0	0	0	0	0		
	Return		8	30 km / h											0	0	0	0	0	0		
			27	min.											0	0	0	0	0	0		
	Efficacité :		85%	32 min. / trip											0	0	0	0	0	0		
				0.53 h / trip											0	0	0	0	0	0		
				9 h / sh											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	17 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m³										0	0	0	0	0	0		
	204 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **2**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rock Support										0	0	0	0	0	0		
											0	0	0	0	0	0		
	D Shape (average tunnels) 49.0 m³ 181 m			**8,869**	**m³**						0	0	0	0	0	0		
	Area (m²)										0	0	0	0	0	0		
	Arc 9.27 13.00										0	0	0	0	0	0		
	Height 6.00										0	0	0	0	0	0		
	Wall 4.50 36.00										0	0	0	0	0	0		
	Width 8.00										0	0	0	0	0	0		
	49.0 181										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Tunnel										0	0	0	0	0	0		
	Required Length Dia.(m) Arch (m)										0	0	0	0	0	0		
	Class 1 135.8 12.5 11.59	75%									0	0	0	0	0	0		
	Class 2 27.2 12.5 11.59	15%									0	0	0	0	0	0		
	Class 3 12.7 12.5 11.59	7.0%									0	0	0	0	0	0		
	Class 4 4.5 12.5 11.59	2.5%									0	0	0	0	0	0		
	Class 5 0.9 12.5 11.59	0.5%									0	0	0	0	0	0		
	181	100%									0	0	0	0	0	0		
	Class 1 Qty										0	0	0	0	0	0		
	Rock bolts 2,5 m 1 un / m 136 un										0	0	0	0	0	0		
	Shotcrete 50 mm 14.59 m² / m 297 m²	15%									0	0	0	0	0	0		
	Wire mesh 14.59 m² / m 1,684 m²	85%									0	0	0	0	0	0		
	Class 2										0	0	0	0	0	0		
	Rock bolts 2,5 m 2.3 un / m 62 un										0	0	0	0	0	0		
	Shotcrete 50 mm 14.59 m² / m 59 m²	15%									0	0	0	0	0	0		
	Wire mesh 14.59 m² / m 337 m²	85%									0	0	0	0	0	0		
	Class 3										0	0	0	0	0	0		
	Rock bolts 3 m 2.9 un / m 37 un										0	0	0	0	0	0		
	Shotcrete 50 mm 14.59 m² / m 92 m²	50%									0	0	0	0	0	0		
	Wire mesh 14.59 m² / m 92 m²	50%									0	0	0	0	0	0		
	Class 4										0	0	0	0	0	0		
	Rock bolts 4 m 5.2 un / m 23 un										0	0	0	0	0	0		
	Shotcrete 50 mm 3.0 m² / m 4 m²	30%									0	0	0	0	0	0		
	Wire mesh 3.0 m² / m 10 m²	70%									0	0	0	0	0	0		
	Shotcrete 100 mm 11.6 m² / m 52 m²	100%									0	0	0	0	0	0		
	Reinf. Mesh 11.6 m² / m 52 m²	100%									0	0	0	0	0	0		
	Steel arch (W 100) 1.5 m c/c 3 un										0	0	0	0	0	0		
	18.3 m / arch 55 m																	
	Class 5										0	0	0	0	0	0		
	Rock bolts 5 m 11.6 un / m 10 un										0	0	0	0	0	0		
	Shotcrete 50 mm 3.0 m² / m 1 m²	30%									0	0	0	0	0	0		
	Wire mesh 3.0 m² / m 2 m²	70%									0	0	0	0	0	0		
	Shotcrete 100 mm 11.6 m² / m 10 m²	100%									0	0	0	0	0	0		
	Reinf. Mesh 11.6 m² / m 10 m²	100%									0	0	0	0	0	0		
	Steel arch (W 150) 0.75 m c/c 1 un										0	0	0	0	0	0		
	18.3 m / arch 18 m										0	0	0	0	0	0		
	Supply Lenght (m)										0	0	0	0	0	0		
	- Rock bolts 2,5 m 198 un 510 Losses	3%		204	un			60.00			0	0	12,240	0	0	12,240		
	- Rock bolts 3 m 37 un 114 Losses	3%		38	un			70.00			0	0	2,660	0	0	2,660		
	- Rock bolts 4 m 23 un 96 Losses	3%		24	un			80.00			0	0	1,920	0	0	1,920		
	- Rock bolts 5 m 10 un 50 Losses	3%		10	un			105.00			0	0	1,050	0	0	1,050		

Item : (2411)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	268 770										0	0	0	0	0	0		
	- Injection tubes 150 m roll	3%		5	rolls			110.00			0	0	550	0	0	550		
	- Oakum 130 bolts / box	3%		3	box			280.00			0	0	840	0	0	840		
	- Grease 154 bolts / box	3%		2	box			336.00			0	0	672	0	0	672		
											0	0	0	0	0	0		
	- Wire mesh 2,124 m²	15%		2,443	m²			4.60			0	0	11,238	0	0	11,238		
	- Reinf. Mesh 63 m²	15%		72	m²			5.60			0	0	403	0	0	403		
	2,187 m²										0	0	0	0	0	0		
	- Spikes 1,1 m 1.25 m c/c 1,750 un	3%		1,803	un			4.50			0	0	8,114	0	0	8,114		
	- Wire 0.04 $ / m²			2,187	m²			0.04			0	0	87	0	0	87		
	m² m³										0	0	0	0	0	0		
	Shotcrete 50 mm 454 0.05 23										0	0	0	0	0	0		
	Shotcrete 100 mm 63 0.1 6										0	0	0	0	0	0		
	29										0	0	0	0	0	0		
	- Cement (40 kg Bags) 0.03 m³ / bag Losses	7.5%		1,039	bags			10.00			0	0	10,390	0	0	10,390		
	33.33 bags / m³ 966 bags										0	0	0	0	0	0		
	- Sand 1.40 mt / m³ 0.08 h / mt			41	mt	1.94	0.00	0.00	2.27	1.58	79	0	0	92	46	217		3
											0	0	0	0	0	0		
	- Monoset (3% of cement) 38,646 kg	3%		1,159	kg			3.40			0	0	3,941	0	0	3,941		
											0	0	0	0	0	0		
	- Steel arch (W 100) 19.0 kg / m 1,041 m			19,779	kg			4.00			0	0	79,116	0	0	79,116		
	- Steel arch (W 150) 22.0 kg / m 402 m			8,844	kg			5.00			0	0	44,220	0	0	44,220		
											0	0	0	0	0	0		
	Rock bolts Installation			55	sh						0	0	0	0	0	0		
	770 m 14 m / sh																	
	268 un 5 un / sh																	
	0.5 h / un. including positionning																	
	3 h / sh			165	h													
	1) Drilling with Jumbo										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Jumbo	90%	1	149	h				102.50		0	0	0	15,273	0	15,273		
											0	0	0	0	0	0		
	2) Install with 50t crane with basket										0	0	0	0	0	0		
	- M-P		3	495	h	24.00					11,880	0	0	0	0	11,880		495
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	149	h				37.00	20.00	0	0	0	5,513	2,146	7,659		
											0	0	0	0	0	0		
	- Impact tool			1	un		300.00				0	300	0	0	0	300		
	- Test rig			1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque rench			1	un		280.00				0	280	0	0	0	280		
											0	0	0	0	0	0		
	3) Injection 40 bolts / sh			7	sh						0	0	0	0	0	0		
	10 h /q			70	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	280	h	24.00					6,720	0	0	0	0	6,720		280
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	63	h				37.00	20.00	0	0	0	2,331	907	3,238		
	- Moyno pump 2.00	75%	1	53	h				2.00		0	0	0	106	0	106		
											0	0	0	0	0	0		
	- Cement (bags) 770 m	100%		126	bags			10.00			0	0	1,260	0	0	1,260		
	2,526 ft 0.02269801 sf										0	0	0	0	0	0		
	2 in. Dia hole 57 cu ft										0	0	0	0	0	0		
	0.91 cu ft / bag 63 bags										0	0	0	0	0	0		
	- Intraplast "N" 0.4 kg / bag 25 kg	1%		25	kg			3.00			0	0	75	0	0	75		
	- Miscellaneous			268	un		0.30				0	80	0	0	0	80		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
	Wire mesh installation										0	0	0	0	0	0		
	Installation by Jumbo team										0	0	0	0	0	0		
	Production of 200 m² / sh 2,187 m²			11	sh						0	0	0	0	0	0		
	10 h / sh			109	h						0	0	0	0	0	0		
	Plus										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	98	h				37.00	20.00	0	0	0	3,626	1,411	5,037		
	- Jack leg 2.00	30%		33	h				2.00		0	0	0	66	0	66		
	- Miscellaneous materials Spike drilling 1,925 m			1,925	m		1.00				0	1,925	0	0	0	1,925		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Shotcreting			**29**	**m³**						0	0	0	0	0	0		
	Production of 0.7 h / m³ 20 h										0	0	0	0	0	0		
	7.5 h / sh Eff.			3	sh						0	0	0	0	0	0		
	10 h / sh			30	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		9	270	h	24.00					6,480	0	0	0	0	6,480		270
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	27	h				37.00	20.00	0	0	0	999	389	1,388		
	- Shotcrete pump 17.00	60%	1	18	h				17.00		0	0	0	306	0	306		
	- Hoses	25%	1	8	h		35.00				0	280	0	0	0	280		
	- Nozzle 66 m³ / un			0	un		275.00				0	0	0	0	0	0		
											0	0	0	0	0	0		
	Arches installation 73 m 18 m / un			**4**	**un**						0	0	0	0	0	0		
	Production of 2 un / sh			2	sh						0	0	0	0	0	0		
	10 h / sh			20	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	100	h	24.00					2,400	0	0	0	0	2,400		100
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	18	h				37.00	20.00	0	0	0	666	360	1,026		
	- Miscellaneous materials			4	un		200.00				0	800	0	0	0	800		
											0	0	0	0	0	0		
	Outside services are included in TBM 1 Power tunnel										0	0	0	0	0	0		
	Penstocks **14.8 m²** **155 m**			**2,292**	**m³**						0	0	0	0	0	0		
	Draft tubes ± **14.8 m²** **251 m**			**3,714**	**m³**						0	0	0	0	0	0		
				6,006	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	As per cable tunnel **3.458** h / m³			**6,006**	**m³**	**82.75**	**25.98**	**16.92**	**31.09**	**15.58**	496,977	156,052	101,593	186,750	67,357	1,008,729		**20,767**
											0	0	0	0	0	0		
	Services **Using outside installations for TBM 1**			**900**	**m**													
	Access tunnel 530																	
	Power house 120																	
	Intake tunnel 250																	
	900 m																	
	Ventilation & Heathing										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.0 h / m			2,700	h	24.00					64,800	0	0	0	0	64,800		2,700
											0	0	0	0	0	0		
	- Miscelaneous materials			900	m		10.00				0	9,000	0	0	0	9,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Dewatering										0	0	0	0	0	0		
											0	0	0	0	0	0		

Item : (2411)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- M-P 2.0 h / m			1,800	h	24.00					43,200	0	0	0	0	43,200		1,800
											0	0	0	0	0	0		
	- Miscelaneous materials			900	m		10.00				0	9,000	0	0	0	9,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Industrial Water Supply										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			3,150	h	24.00					75,600	0	0	0	0	75,600		3,150
											0	0	0	0	0	0		
	- Miscelaneous materials			900	m		10.00				0	9,000	0	0	0	9,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Compressed Air										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			3,150	h	24.00					75,600	0	0	0	0	75,600		3,150
											0	0	0	0	0	0		
	- Miscelaneous materials			900	m		24.00				0	21,600	0	0	0	21,600		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Electrical services										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			3,150	h	24.00					75,600	0	0	0	0	75,600		3,150
											0	0	0	0	0	0		
	- Miscelaneous materials			900	m		24.00				0	21,600	0	0	0	21,600		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2411	**Powerhouse and Access**			**140,618**							**1,886,727**	**2,086,754**	**609,452**	**734,877**	**423,382**	**5,741,192**	**40.83**	**78,716**

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			

2410 Excavation

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2412	**Transformer Chamber and Access**			**41,118**	**m^3**													
	(m^2) L																	
	Transformer chamber access 82.5 199			**16,418**	**m^3**						0	0	0	0	0	0		
	Transformer cavern 179.6 134.75			**24,201**	**m^3**						0	0	0	0	0	0		
	Gate shaft 9.5 10.5		5	**499**	**m^3**						0	0	0	0	0	0		
				41,118	**m^3**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Access										0	0	0	0	0	0		
	D Shape **10 x 9** **82.5** **m^3** **199**			**16,418**	**m^3**						0	0	0	0	0	0		
	Area (m^2)										0	0	0	0	0	0		
	Arc 11.59 10 17.50										0	0	0	0	0	0		
	Height 9.00										0	0	0	0	0	0		
	Wall 6.50 65.00										0	0	0	0	0	0		
	Width 10.00										0	0	0	0	0	0		
	82.5										0	0	0	0	0	0		
	Excavation										0	0	0	0	0	0		
	Progression 4.66 m																	
	Number of rounds 43																	
	Number of shifts 60 Prod. Factor 1.4																	
	Number of holes (m) (Feet)																	
	Production 66 55 mm dia. 14,275 46,822																	
	Contour 38 55 mm dia. 8,219 26,958																	
	104																	
	Cut 3 109 mm dia. 649 2,128																	
	107																	
	Drilling depth 5.03 m 23,143 75,909																	
	Durations (hours) 43 rounds																	
	Drilling 150 m / h 3.59 154 h																	
	Blasting 1.15 min / hole 2.05 88 h																	
	Scaling & W. mesh 2.00 86 h																	
	Mucking 205 m^3 / h 1.88 81 h																	
	Drilling labour																	
	H-H Bolting W. Mesh Remaining																	
	8 4,800 672 576 3,552																	
	14% 12%																	
	Drilling 3.6 43 154 h																	
	9 h / sh 17 sh																	
	8 men / sh 10 h / sh 1,371 m-h																	
	Loading & Blasting 2.05 43 88 h																	
	9 h / sh 10 sh																	
	8 men / sh 10 h / sh 784 m-h																	
	Remaining for services 1,397																	
	Drilling			171	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	1,371	h	24.00					32,915	0	0	0	0	32,915		1,371

Item : (2412)

WBS	DESCRIPTION					%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
															24.00 $				0.72 $			
					43 rounds										0	0	0	0	0	0		
	- Jumbo E 3C		14.00		4.5 h			194	h				14.00		0	0	0	2,709	0	2,709		
		Feet	ft / un												0	0	0	0	0	0		
	- Bits 2"Ø	73,781	1,600					46	un		85.00				0	3,910	0	0	0	3,910		
	- Bits 4"Ø	2,128	1,500					1	un		500.00				0	500	0	0	0	500		
	- Rod 18'	75,909	7,500					10	un		485.00				0	4,850	0	0	0	4,850		
	- Coupling	75,909	3,700					21	un		50.00				0	1,050	0	0	0	1,050		
	- Shank	75,909	12,500					6	un		300.00				0	1,800	0	0	0	1,800		
	- Misc. Materials	75,909						75,909	ft		0.04				0	3,036	0	0	0	3,036		
	Loading & Blasting							98	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						8	784	h	24.00					18,813	0	0	0	0	18,813		784
															0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)		37.00	20.00		90%	1	88	h				37.00	20.00	0	0	0	3,256	1,267	4,523		
	- Fork lift 10 T		11.00	7.00		90%	1	88	h				11.00	7.00	0	0	0	968	444	1,412		
	- Explosives Truck		5.00	15.00		90%	1	88	h				5.00	15.00	0	0	0	440	950	1,390		
															0	0	0	0	0	0		
	5.03 m holes	**43 Rounds**													0	0	0	0	0	0		
		Number	Total	Length (m)											0	0	0	0	0	0		
	Contour holes	38	1,634	8,219											0	0	0	0	0	0		
	Production holes	66	2,838	14,275											0	0	0	0	0	0		
		104	4,472												0	0	0	0	0	0		
															0	0	0	0	0	0		
	- Prima cord	5.5 m			8,987	5%		9,436	m		1.00				0	9,436	0	0	0	9,436		
	- Cap 6m				4,472	13%		5,053	un		3.50				0	17,686	0	0	0	17,686		
	- Dynamite RXL 438	16,418 m³		Powder fact 1.6				26,268	kg		5.60				0	147,101	0	0	0	147,101		
	- XACTEX	1,634 holes			4,494	5%		4,718	kg		7.50				0	35,385	0	0	0	35,385		
		2.75 kg / hole													0	0	0	0	0	0		
															0	0	0	0	0	0		
	Mucking	16,418 m³													0	0	0	0	0	0		
	1.5 Loose »»»»	24,626 m³													0	0	0	0	0	0		
		573 m³ / round													0	0	0	0	0	0		
	Production	140 m³ / h		4.09 h											0	0	0	0	0	0		
		43 rounds		176 h x 10/9 »»				195	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						7	1,368	h	24.00					32,835	0	0	0	0	32,835		1,368
															0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator		19.00	29.00		50%	1	98	h				19.00	29.00	0	0	0	1,862	2,046	3,908		
	- Cat 988H Wheel Loader		39.20	48.00		90%	1	176	h				39.20	48.00	0	0	0	6,899	6,083	12,982		
	- Cat D7R II LGP Track-Type Tractor		38.25	28.00		90%	1	176	h				38.25	28.00	0	0	0	6,732	3,548	10,280		
	- Cat 725 Articulated Dumper 25 T		24.00	20.00		90%	3	528	h				24.00	20.00	0	0	0	12,672	7,603	20,275		
	Disposal of excavated materials														0	0	0	0	0	0		
		Average hauling distance :		4.00 km											0	0	0	0	0	0		
															0	0	0	0	0	0		
	Loading		8												0	0	0	0	0	0		
	Going		8	30 km / h											0	0	0	0	0	0		
	Unloading		3												0	0	0	0	0	0		
	Return		8	30 km / h											0	0	0	0	0	0		
			27	min.											0	0	0	0	0	0		
	Efficacité :		85%	32 min. / trip											0	0	0	0	0	0		
				0.53 h / trip											0	0	0	0	0	0		
				9 h / sh											0	0	0	0	0	0		
				17 trips / day											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Cat 725 Articulated Dumper 25 T 12 m³										0	0	0	0	0	0		
	204 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **3**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rolling Path Length 199										0	0	0	0	0	0		
	Width 8.00										0	0	0	0	0	0		
	Thickness 0.30										0	0	0	0	0	0		
	Volume 478										0	0	0	0	0	0		
	Production 1,200 m³ / sh			1	sh						0	0	0	0	0	0		
	10 h / s			10	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	80	h	24.00					1,920	0	0	0	0	1,920		80
											0	0	0	0	0	0		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	9	h				39.20	48.00	0	0	0	353	311	664		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	9	h				38.25	28.00	0	0	0	344	181	525		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	1	9	h				24.00	20.00	0	0	0	216	130	346		
	Rock Support																	
	Horse shoe **10 x 9** **82.5 m³** **199**			**16,418**	**m³**													
	Area (m²)																	
	Arc 11.59 10 17.50																	
	Height 9.00																	
	Wall 6.50 65.00																	
	Width 10.00																	
	82.5																	
	Tunnel																	
	Required Length Dia.(m) Arch (m)																	
	Class 1 149.3 12.5 11.59	75%																
	Class 2 29.9 12.5 11.59	15%																
	Class 3 13.9 12.5 11.59	7.0%																
	Class 4 5.0 12.5 11.59	2.5%																
	Class 5 1.0 12.5 11.59	0.5%																
	199	100%																
	Class 1 Qty																	
	Rock bolts 2,5 m 1 un / m 149 un																	
	Shotcrete 50 mm 18.59 m² / m 416 m²	15%																
	Wire mesh 18.59 m² / m 2,358 m²	85%																
	Class 2																	
	Rock bolts 2,5 m 2.3 un / m 68 un																	
	Shotcrete 50 mm 18.59 m² / m 83 m²	15%																
	Wire mesh 18.59 m² / m 472 m²	85%																
	Class 3																	
	Rock bolts 3 m 2.9 un / m 40 un																	
	Shotcrete 50 mm 18.59 m² / m 129 m²	50%																
	Wire mesh 18.59 m² / m 129 m²	50%																
	Class 4																	
	Rock bolts 4 m 5.2 un / m 26 un																	
	Shotcrete 50 mm 7.0 m² / m 10 m²	30%																
	Wire mesh 7.0 m² / m 24 m²	70%																
	Shotcrete 100 mm 11.6 m² / m 58 m²	100%																
	Reinf. Mesh 11.6 m² / m 58 m²	100%																
	Steel arch (W 100) 1.5 m c/c 3 un																	
	24.6 m / arch 74 m																	

Item : (2412)

WBS	DESCRIPTION				%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
														24.00 $				0.72 $			
	Class 5																				
	Rock bolts 5 m	11.6 un / m	12 un																		
	Shotcrete 50 mm	7.0 m² / m	2 m²		30%																
	Wire mesh	7.0 m² / m	5 m²		70%																
	Shotcrete 100 mm	11.6 m² / m	12 m²		100%																
	Reinf. Mesh	11.6 m² / m	12 m²		100%																
	Steel arch (W 150)	0.75 m c/c	1 un																		
		24.6 m / arch	25 m																		
	Supply		Lenght (m)											0	0	0	0	0	0		
	- Rock bolts 2,5 m	217 un	560	Losses	3%		224	un			60.00			0	0	13,440	0	0	13,440		
	- Rock bolts 3 m	40 un	123	Losses	3%		41	un			70.00			0	0	2,870	0	0	2,870		
	- Rock bolts 4 m	26 un	108	Losses	3%		27	un			80.00			0	0	2,160	0	0	2,160		
	- Rock bolts 5 m	12 un	60	Losses	3%		12	un			105.00			0	0	1,260	0	0	1,260		
		295	851											0	0	0	0	0	0		
	- Injection tubes	150 m roll			3%		6	rolls			110.00			0	0	660	0	0	660		
	- Oakum	130 bolts / box			3%		3	box			280.00			0	0	840	0	0	840		
	- Grease	154 bolts / box			3%		2	box			336.00			0	0	672	0	0	672		
														0	0	0	0	0	0		
	- Wire mesh	2,989 m²			15%		3,437	m²			4.60			0	0	15,810	0	0	15,810		
	- Reinf. Mesh	69 m²			15%		80	m²			5.60			0	0	448	0	0	448		
		3,058 m²												0	0	0	0	0	0		
	- Spikes 1,1 m	1.25 m c/c	2,446 un		3%		2,519	un			4.50			0	0	11,336	0	0	11,336		
	- Wire		0.04 $ / m²				3,058	m²			0.04			0	0	122	0	0	122		
		m²	m³											0	0	0	0	0	0		
	Shotcrete 50 mm	641 0.05	32											0	0	0	0	0	0		
	Shotcrete 100 mm	69 0.1	7											0	0	0	0	0	0		
			39											0	0	0	0	0	0		
	- Cement (40 kg Bags)	0.03 m³ / bag		Losses	7.5%		1,397	bags			10.00			0	0	13,970	0	0	13,970		
		33.33 bags / m³	1,300 bags											0	0	0	0	0	0		
	- Sand	1.40 mt / m³	0.08 h / mt				55	mt	1.94	0.00	0.00	2.27	1.58	106	0	0	124	62	292		4
	- Monoset (3% of cement)		51,988 kg		3%		1,560	kg			3.40			0	0	5,304	0	0	5,304		
														0	0	0	0	0	0		
	- Steel arch (W 100)	19.0 kg / m	74 m				1,402	kg			4.00			0	0	5,607	0	0	5,607		
	- Steel arch (W 150)	22.0 kg / m	25 m				541	kg			5.00			0	0	2,705	0	0	2,705		
	Rock bolts Installation						60	sh						0	0	0	0	0	0		
		851 m	14 m / sh											0	0	0	0	0	0		
		295 un	5 un / sh											0	0	0	0	0	0		
			0.5 h / un. including positionning																		
			2.5 h / sh				150	h													
	1) Drilling with Jumbo													0	0	0	0	0	0		
														0	0	0	0	0	0		
	- Jumbo				90%	1	135	h				102.50		0	0	0	13,838	0	13,838		
														0	0	0	0	0	0		
	2) Install with 50t crane with basket													0	0	0	0	0	0		
														0	0	0	0	0	0		
	- M-P					3	450	h	24.00					10,800	0	0	0	0	10,800		450
														0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00		90%	1	135	h				37.00	20.00	0	0	0	4,995	1,944	6,939		
														0	0	0	0	0	0		
	- Impact tool						1	un		300.00				0	300	0	0	0	300		
	- Test rig						1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque rench						1	un		280.00				0	280	0	0	0	280		

Item : (2412)

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
													24.00 $				0.72 $			
													0	0	0	0	0	0		
	3) Injection	40 bolts / sh				8	sh						0	0	0	0	0	0		
			10 h / sh			80	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				4	320	h	24.00					7,680	0	0	0	0	7,680		320
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	72	h				37.00	20.00	0	0	0	2,664	1,037	3,701		
	- Moyno pump	2.00		75%	1	60	h				2.00		0	0	0	120	0	120		
													0	0	0	0	0	0		
	- Cement (bags)	851 m		100%		140	bags			10.00			0	0	1,400	0	0	1,400		
		2,791 ft	0.02269801 sf										0	0	0	0	0	0		
		2 in. Dia hole	63 cu ft										0	0	0	0	0	0		
		0.91 bag / cu ft	70 bags										0	0	0	0	0	0		
	- Intraplast "N"	0.4 kg / bag	28 kg	1%		28	kg			3.00			0	0	84	0	0	84		
	- Miscellaneous					295	un		0.30				0	89	0	0	0	89		
	Wire mesh installation												0	0	0	0	0	0		
													0	0	0	0	0	0		
	Production of	200 m^2 / sh	3,058 m^2			15	sh						0	0	0	0	0	0		
			10 h / sh			153	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				6	917	h	24.00					22,017	0	0	0	0	22,017		917
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	138	h				37.00	20.00	0	0	0	5,106	1,987	7,093		
	- Jack leg	2.00		30%	1	46	h				2.00		0	0	0	92	0	92		
	- Miscellaneous materials	Spike drilling	2,691 m			2,691	m		1.00				0	2,691	0	0	0	2,691		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
	Shotcreting					**39**	**m^3**						0	0	0	0	0	0		
	Production of	0.7 h / m^3	27 h										0	0	0	0	0	0		
			7.5 h / sh Eff.			4	sh						0	0	0	0	0	0		
			10 h / sh			40	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				5	200	h	24.00					4,800	0	0	0	0	4,800		200
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	36	h				37.00	20.00	0	0	0	1,332	518	1,850		
	- Shotcrete pump	17.00		60%	1	24	h				17.00		0	0	0	408	0	408		
	- Hoses			25%	1	10	h		35.00				0	350	0	0	0	350		
	- Nozzle	66 m^3 / un				1	un		275.00				0	275	0	0	0	275		
													0	0	0	0	0	0		
	Arches installation	98 m	25 m / un			**4**	**un**						0	0	0	0	0	0		
	Production of	2 un / sh				2	sh						0	0	0	0	0	0		
			10 h / sh			20	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				5	100	h	24.00					2,400	0	0	0	0	2,400		100
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	18	h				37.00	20.00	0	0	0	666	259	925		
	- Miscellaneous materials					4	un		200.00				0	800	0	0	0	800		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES					TOTAL COSTS					GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption			
											24.00 $				0.72 $			
	Transformer cavern										0	0	0	0	0	0		
	14 x 13,2										0	0	0	0	0	0		
	Arc 15.50 60.60										0	0	0	0	0	0		
	Height 13.20										0	0	0	0	0	0		
	Wall 8.50 119.00										0	0	0	0	0	0		
	Width 14.00										0	0	0	0	0	0		
	179.6 134.75			24,201	m³						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Excavation										0	0	0	0	0	0		
	Progression 4.66 m										0	0	0	0	0	0		
	Number of rounds 29										0	0	0	0	0	0		
	Number of shifts 41 Prod. Factor 1.4										0	0	0	0	0	0		
	Number of holes (m) (Feet)										0	0	0	0	0	0		
	Production 144 55 mm dia. 21,005 68,897										0	0	0	0	0	0		
	Contour 50 55 mm dia. 7,294 23,923										0	0	0	0	0	0		
	194										0	0	0	0	0	0		
	Cut 3 109 mm dia. 438 1,435										0	0	0	0	0	0		
	197										0	0	0	0	0	0		
	Drilling depth 5.03 m 28,736 94,255										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Durations (hours) 29 rounds										0	0	0	0	0	0		
	Drilling 4.00 116 h										0	0	0	0	0	0		
	Blasting 3.00 87 h										0	0	0	0	0	0		
	Scaling & W. mesh 2.50 73 h										0	0	0	0	0	0		
	Mucking 2.15 62 h										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling labour										0	0	0	0	0	0		
	H-H Bolting W. Mesh Remaining										0	0	0	0	0	0		
	8 3,280 459 394 2,427										0	0	0	0	0	0		
	14% 12%										0	0	0	0	0	0		
	Drilling 4.0 29 116 h										0	0	0	0	0	0		
	9 h / sh 13 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 1,031 h-h										0	0	0	0	0	0		
	Loading & Blasting 3.00 29 87 h										0	0	0	0	0	0		
	9 h / sh 10 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 773 h-h										0	0	0	0	0	0		
	Remaining for services 623										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling			129	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	1,031	h	24.00					24,747	0	0	0	0	24,747		1,031
	29 rounds										0	0	0	0	0	0		
	- Jumbo E 3C 14.00 4.5 h			131	h				14.00		0	0	0	1,827	0	1,827		
	- Cat GEP 550 - 400KW 6.50 102.40 12 h			348	h				6.50	102.40	0	0	0	2,262	25,657	27,919		
	Feet ft / un										0	0	0	0	0	0		
	- Bits 2"Ø 92,820 1,600			58	un		85.00				0	4,930	0	0	0	4,930		
	- Bits 4"Ø 1,435 1,500			1	un		500.00				0	500	0	0	0	500		
	- Rod 18' 94,255 7,500			13	un		485.00				0	6,305	0	0	0	6,305		
	- Coupling 94,255 3,700			25	un		50.00				0	1,250	0	0	0	1,250		
	- Shank 94,255 12,500			8	un		300.00				0	2,400	0	0	0	2,400		
	- Misc. Materials 94,255			94,255	ft		0.04				0	3,770	0	0	0	3,770		
											0	0	0	0	0	0		

Item : (2412)

											UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION						%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
																24.00 $				0.72 $			
	Loading & Blasting								97	h						0	0	0	0	0	0		
																0	0	0	0	0	0		
	- M-P							8	773	h	24.00					18,560	0	0	0	0	18,560		773
																0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)			37.00	20.00		90%	1	87	h				37.00	20.00	0	0	0	3,219	1,253	4,472		
	- Fork lift 10 T			11.00	7.00		90%	1	87	h				11.00	7.00	0	0	0	957	438	1,395		
	- Explosives Truck			5.00	15.00		90%	1	87	h				5.00	15.00	0	0	0	435	940	1,375		
																0	0	0	0	0	0		
	5.03 m holes	**29**	**Rounds**													0	0	0	0	0	0		
		Number		Total	Length (m)											0	0	0	0	0	0		
	Contour holes	50		1,450	7,294											0	0	0	0	0	0		
	Production holes	144		4,176	21,005											0	0	0	0	0	0		
		194		5,626												0	0	0	0	0	0		
																0	0	0	0	0	0		
	- Prima cord	5.5	m			7,975	5%		8,374	m		1.00				0	8,374	0	0	0	8,374		
	- Cap 6m					5,626	13%		6,357	un		3.50				0	22,250	0	0	0	22,250		
	- Dynamite RXL 438	24,201	m³		Powder fact	1.6			38,722	kg		5.60				0	216,842	0	0	0	216,842		
	- XACTEX	1,450	holes			3,988	5%		4,187	kg		7.50				0	31,403	0	0	0	31,403		
		2.75	kg / hole													0	0	0	0	0	0		
																0	0	0	0	0	0		
	Rock Support				**Length**	**135**	**m**													0			
					Area (m²)															0			
		14 x 13,2																		0			
	Arc	15.50			60.60															0			
	Height	13.20																		0			
	Wall	8.50			119.00															0			
	Width	14.00																		0			
					179.6	134.75			24,201	m³						0	0	0	0	0	0		
																0	0	0	0	0	0		
				Tunnel												0	0	0	0	0	0		
	Required	Length		Dia.(m)	Arch (m)											0	0	0	0	0	0		
	Class 1	101.1		12.5	11.59		75%									0	0	0	0	0	0		
	Class 2	20.2		12.5	11.59		15%									0	0	0	0	0	0		
	Class 3	9.4		12.5	11.59		7.0%									0	0	0	0	0	0		
	Class 4	3.4		12.5	11.59		2.5%									0	0	0	0	0	0		
	Class 5	0.7		12.5	11.59		0.5%									0	0	0	0	0	0		
		135					100%									0	0	0	0	0	0		
	Class 1				Qty											0	0	0	0	0	0		
	Rock bolts 2,5 m	1	un / m		101	un										0	0	0	0	0	0		
	Shotcrete 50 mm	22.59	m² / m		342	m²	15%									0	0	0	0	0	0		
	Wire mesh	22.59	m² / m		1,941	m²	85%									0	0	0	0	0	0		
	Class 2															0	0	0	0	0	0		
	Rock bolts 2,5 m	2.3	un / m		46	un										0	0	0	0	0	0		
	Shotcrete 50 mm	22.59	m² / m		68	m²	15%									0	0	0	0	0	0		
	Wire mesh	22.59	m² / m		388	m²	85%									0	0	0	0	0	0		
	Class 3															0	0	0	0	0	0		
	Rock bolts 3 m	2.9	un / m		27	un										0	0	0	0	0	0		
	Shotcrete 50 mm	22.59	m² / m		107	m²	50%									0	0	0	0	0	0		
	Wire mesh	22.59	m² / m		107	m²	50%									0	0	0	0	0	0		
	Class 4															0	0	0	0	0	0		
	Rock bolts 4 m	5.2	un / m		17	un										0	0	0	0	0	0		
	Shotcrete 50 mm	11.0	m² / m		11	m²	30%									0	0	0	0	0	0		
	Wire mesh	11.0	m² / m		26	m²	70%									0	0	0	0	0	0		
	Shotcrete 100 mm	11.6	m² / m		39	m²	100%									0	0	0	0	0	0		
	Reinf. Mesh	11.6	m² / m		39	m²	100%									0	0	0	0	0	0		

Item : (2412)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Steel arch (W 100) 1.5 m c/c 2 un										0	0	0	0	0	0		
	32.5 m / arch 65 m																	
	Class 5										0	0	0	0	0	0		
	Rock bolts 5 m 11.6 un / m 8 un										0	0	0	0	0	0		
	Shotcrete 50 mm 11.0 m² / m 2 m²	30%									0	0	0	0	0	0		
	Wire mesh 11.0 m² / m 5 m²	70%									0	0	0	0	0	0		
	Shotcrete 100 mm 11.6 m² / m 8 m²	100%									0	0	0	0	0	0		
	Reinf. Mesh 11.6 m² / m 8 m²	100%									0	0	0	0	0	0		
	Steel arch (W 150) 0.75 m c/c 1 un										0	0	0	0	0	0		
	32.5 m / arch 33 m										0	0	0	0	0	0		
	Supply Lenght (m)										0	0	0	0	0	0		
	- Rock bolts 2,5 m 147 un 378 Losses	3%		151	un			60.00			0	0	9,060	0	0	9,060		
	- Rock bolts 3 m 27 un 84 Losses	3%		28	un			70.00			0	0	1,960	0	0	1,960		
	- Rock bolts 4 m 17 un 72 Losses	3%		18	un			80.00			0	0	1,440	0	0	1,440		
	- Rock bolts 5 m 8 un 40 Losses	3%		8	un			105.00			0	0	840	0	0	840		
	199 574										0	0	0	0	0	0		
	- Injection tubes 150 m roll	3%		4	rolls			110.00			0	0	440	0	0	440		
	- Oakum 130 bolts / box	3%		2	box			280.00			0	0	560	0	0	560		
	- Grease 154 bolts / box	3%		2	box			336.00			0	0	672	0	0	672		
											0	0	0	0	0	0		
	- Wire mesh 2,466 m²	15%		2,836	m²			4.60			0	0	13,046	0	0	13,046		
	- Reinf. Mesh 47 m²	15%		54	m²			5.60			0	0	302	0	0	302		
	2,513 m²										0	0	0	0	0	0		
	- Spikes 1,1 m 1.25 m c/c 2,011 un	3%		2,071	un			4.50			0	0	9,320	0	0	9,320		
	- Wire 0.04 $ / m²			2,513	m²			0.04			0	0	101	0	0	101		
	m² m³										0	0	0	0	0	0		
	Shotcrete 50 mm 531 0.05 27										0	0	0	0	0	0		
	Shotcrete 100 mm 47 0.1 5										0	0	0	0	0	0		
	31										0	0	0	0	0	0		
	- Cement (40 kg Bags) 0.03 m³ / bag Losses	7.5%		1,119	bags			10.00			0	0	11,190	0	0	11,190		
	33.33 bags / m³ 1,041 bags										0	0	0	0	0	0		
	- Sand 1.40 mt / m³ 0.08 h / mt			44	mt	1.94	0.00	0.00	2.27	1.58	85	0	0	99	50	234		3
											0	0	0	0	0	0		
	- Monoset (3% of cement) 41,635 kg	3%		1,249	kg			3.40			0	0	4,247	0	0	4,247		
											0	0	0	0	0	0		
	- Steel arch (W 100) 19.0 kg / m 65 m			1,235	kg			4.00			0	0	4,940	0	0	4,940		
	- Steel arch (W 150) 22.0 kg / m 33 m			715	kg			5.00			0	0	3,575	0	0	3,575		
											0	0	0	0	0	0		
	Rock bolts Installation			41	sh						0	0	0	0	0	0		
	574 m 14 m / sh										0	0	0	0	0	0		
	199 un 5 un / sh										0	0	0	0	0	0		
	0.5 h / un. including positionning										0	0	0	0	0	0		
	3.0 h / sh			123	h													
	1) Drilling with Jumbo										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Jumbo	90%	1	111	h				102.50		0	0	0	11,378	0	11,378		
											0	0	0	0	0	0		
	2) Install with 50t crane with basket										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		3	369	h	24.00					8,856	0	0	0	0	8,856		369
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	111	h				37.00	20.00	0	0	0	4,107	1,598	5,705		
											0	0	0	0	0	0		
	- Impact tool			1	un		300.00				0	300	0	0	0	300		
	- Test rig			1	un		1,200.00				0	1,200	0	0	0	1,200		

Item : (2412)

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES					TOTAL COSTS					GLOBAL PRICES	UNIT PRICES	MEN-HOURS
								M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption			
													24.00 $				0.72 $			
	- Torque rench					1	un		280.00				0	280	0	0	0	280		
													0	0	0	0	0	0		
	3) Injection	40 bolts / sh	199 un			5	sh						0	0	0	0	0	0		
			10 h / sh			50	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				4	200	h	24.00					4,800	0	0	0	0	4,800		200
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	45	h				37.00	20.00	0	0	0	1,665	648	2,313		
	- Moyno pump	2.00		75%	1	38	h				2.00		0	0	0	76	0	76		
													0	0	0	0	0	0		
	- Cement (bags)	574 m		100%		94	bags			10.00			0	0	940	0	0	940		
		1,881 ft	0.02269801 sf										0	0	0	0	0	0		
		2 in. Dia hole	43 cu ft										0	0	0	0	0	0		
		0.91 cu ft / bag	47 bags										0	0	0	0	0	0		
	- Intraplast "N"	0.4 kg / bag	19 kg	1%		19	kg			3.00			0	0	57	0	0	57		
	- Miscellaneous					199	un		0.30				0	60	0	0	0	60		
	Wire mesh installation												0	0	0	0	0	0		
	Installation by Jumbo team												0	0	0	0	0	0		
	Production of	200 m² / sh	2,513 m²			13	sh						0	0	0	0	0	0		
			10 h / sh			126	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	113	h				37.00	20.00	0	0	0	4,181	1,627	5,808		
	- Jack leg	2.00		30%		38	h				2.00		0	0	0	76	0	76		
	- Miscellaneous materials	Spike drilling	2212.1 m			2,212	m		1.00				0	2,212	0	0	0	2,212		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
	Shotcreting					**31**	**m³**						0	0	0	0	0	0		
	Production of	0.7 h / m³	22 h										0	0	0	0	0	0		
			7.5 h / sh Eff.			3	sh						0	0	0	0	0	0		
			10 h / sh			30	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				9	270	h	24.00					6,480	0	0	0	0	6,480		270
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	27	h				37.00	20.00	0	0	0	999	389	1,388		
	- Shotcrete pump	17.00		60%	1	18	h				17.00		0	0	0	306	0	306		
	- Hoses			25%	1	8	h		35.00				0	280	0	0	0	280		
	- Nozzle	66 m³ / un				0	un		275.00				0	0	0	0	0	0		
													0	0	0	0	0	0		
	Arches installation	98 m	33 m / un			**3**	**un**						0	0	0	0	0	0		
	Production of	2 un / sh				2	sh						0	0	0	0	0	0		
			10 h / sh			20	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				5	100	h	24.00					2,400	0	0	0	0	2,400		100
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	18	h				37.00	20.00	0	0	0	666	259	925		
	- Miscellaneous materials					3	un		200.00				0	600	0	0	0	600		
													0	0	0	0	0	0		
	Mucking	24,201 m³											0	0	0	0	0	0		
	1.5 Loose »»»»	36,302 m³											0	0	0	0	0	0		
		1,252 m³ / round											0	0	0	0	0	0		
	Production	140 m³ / h	8.94 h										0	0	0	0	0	0		
		29 rounds	259 h x 10/9 »»			288	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				7	2,017	h	24.00					48,402	0	0	0	0	48,402		2,017

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	50%	1	144	h				19.00	29.00	0	0	0	2,736	3,007	5,743		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	259	h				39.20	48.00	0	0	0	10,153	8,951	19,104		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	259	h				38.25	28.00	0	0	0	9,907	5,221	15,128		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	6	1,556	h				24.00	20.00	0	0	0	37,344	22,406	59,750		
											0	0	0	0	0	0		
	Disposal of excavated materials										0	0	0	0	0	0		
	Average hauling distance : 3.50 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 8										0	0	0	0	0	0		
	Going 7 30 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 7 30 km / h										0	0	0	0	0	0		
	25 min.										0	0	0	0	0	0		
	Efficacité : 85% 29 min. / trip										0	0	0	0	0	0		
	0.49 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	19 trips / day										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m³										0	0	0	0	0	0		
	228 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **6**										0	0	0	0	0	0		
											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Gate shaft L W H										0	0	0	0	0	0		
	3.80 2.50 10.50		5	**499**	**m³**						0	0	0	0	0	0		
	9.50 m²										0	0	0	0	0	0		
	Excavation										0	0	0	0	0	0		
	Number of holes (m)										0	0	0	0	0	0		
	Production 12 630										0	0	0	0	0	0		
	Contour 21 1,103										0	0	0	0	0	0		
	33 1,733										0	0	0	0	0	0		
	Cut 3 158										0	0	0	0	0	0		
	36 1,890										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling 20 m / h 95 h										0	0	0	0	0	0		
	9.0 h / sh. Eff.			11	sh						0	0	0	0	0	0		
	10 h /sh			110	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		3	330	h	24.00					7,920	0	0	0	0	7,920		330
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	1	99	h				19.40	15.00	0	0	0	1,921	1,069	2,990		
	- Compressor XAHS 237 (500 cfm) 15.00 29.00	90%	1	99	h				15.00	29.00	0	0	0	1,485	2,067	3,552		
											0	0	0	0	0	0		
	- Drilling materials			1,890	m		1.20				0	2,268	0	0	0	2,268		
											0	0	0	0	0	0		
	Blasting 3.50 m / round 495 holes										0	0	0	0	0	0		
	Loading 10 min / hole			83	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	330	h	24.00					7,920	0	0	0	0	7,920		330
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	74	h				5.00	15.00	0	0	0	370	799	1,169		
	15 rounds										0	0	0	0	0	0		
	- Prima cord Average lentgh 84 m / round 1,260 m	5%		1,323	m		1.00				0	1,323	0	0	0	1,323		
	- Caps 33 holes / round 495 un	13%		559	un		5.00				0	2,795	0	0	0	2,795		
	- Dynamite 499 m³ Powder fact 1.6			798	kg		5.60				0	4,469	0	0	0	4,469		
											0	0	0	0	0	0		
	- Miscelaneous material			1,733	m		2.00				0	3,465	0	0	0	3,465		
											0	0	0	0	0	0		
	Mucking **Included in draft tube**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rock Support L = 53										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Supply										0	0	0	0	0	0		
	- Rock bolts 3 m 3.0 un / m 158 un Losses	3%		162	un			70.00			0	0	11,340	0	0	11,340		
	473 m drilling										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Wire mesh 12.60 m² / m 662 m²	15%		761	m²			4.60			0	0	3,501	0	0	3,501		
	- Spikes ,7 m 1.25 m c/c 529 un	3%		545	un			4.50			0	0	2,453	0	0	2,453		
	- Wire 0.04 $ / m²			662	m²			0.04			0	0	26	0	0	26		
											0	0	0	0	0	0		
	Rock bolts Installation (Operating on platform hooked on a crane)										0	0	0	0	0	0		
	1) Drilling 10 m / h 48 h																	
	7.5 h / sh Eff.			7	sh						0	0	0	0	0	0		
	10 h / sh			70	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		3	210	h	24.00					5,040	0	0	0	0	5,040		210
											0	0	0	0	0	0		
	- Jack leg 2.00	90%	1	63	h				2.00	0.00	0	0	0	126	0	126		

Item : (2412)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	63	h				37.00	20.00	0	0	0	2,331	907	3,238		
	- Compressor XAHS 237 (500 cfm) 15.00 29.00	90%	1	63	h				15.00	29.00	0	0	0	945	1,315	2,260		
	2) Install with platform down the shaft										0	0	0	0	0	0		
	158 un 0.5 h / un										0	0	0	0	0	0		
	78.8 h										0	0	0	0	0	0		
	7.5 h / sh. Eff.			11	sh						0	0	0	0	0	0		
	10 h /sh			110	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	440	h	24.00					10,560	0	0	0	0	10,560		440
											0	0	0	0	0	0		
	- Jack leg 2.00	90%	1	99	h				2.00	0.00	0	0	0	198	0	198		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	99	h				37.00	20.00	0	0	0	3,663	1,426	5,089		
	- Impact tool			1	un		300.00				0	300	0	0	0	300		
	- Test rig			1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque wrench			1	un		280.00				0	280	0	0	0	280		
											0	0	0	0	0	0		
	Wire mesh installation										0	0	0	0	0	0		
	Production of 175 m² / sh			4	sh						0	0	0	0	0	0		
	10 h / sh			40	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	200	h	24.00					4,800	0	0	0	0	4,800		200
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	36	h				37.00		0	0	0	1,332	0	1,332		
	- Jack leg 2.00	30%	1	12	h				2.00		0	0	0	24	0	24		
	- Compressor XAHS 237 (500 cfm) 15.00 29.00	90%	1	36	h				15.00		0	0	0	540	0	540		
	- Miscellaneous materials Spike drilling 370.3 m			370	m		1.00				0	370	0	0	0	370		
											0	0	0	0	0	0		
	Wire mesh removing										0	0	0	0	0	0		
	Production of 200 m² / sh			3	sh						0	0	0	0	0	0		
	10 h / sh			30	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	150	h	24.00					3,600	0	0	0	0	3,600		150
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	27	h				37.00	20.00	0	0	0	999	389	1,388		
	- Boom truck 17 tons 13.65 18.00	90%	1	27	h				13.65	18.00	0	0	0	369	350	719		
											0	0	0	0	0	0		
	Services **Using outside installations for TBM 1**			**584**	**m**													
	Transformer Chamber Access tunnel 199																	
	Transformer Chamber 135																	
	Intake tunnel 250																	
	584 m																	
	Ventilation & Heathing										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.0 h / m			1,752	h	24.00					42,048	0	0	0	0	42,048		1,752
											0	0	0	0	0	0		
	- Miscelaneous materials			584	m		10.00				0	5,840	0	0	0	5,840		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Dewatering										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 2.0 h / m			1,168	h	24.00					28,032	0	0	0	0	28,032		1,168
											0	0	0	0	0	0		

Item : (2412)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Miscelaneous materials			584	m		10.00				0	5,840	0	0	0	5,840		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Industrial Water Supply										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			2,044	h	24.00					49,056	0	0	0	0	49,056		2,044
											0	0	0	0	0	0		
	- Miscelaneous materials			584	m		10.00				0	5,840	0	0	0	5,840		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Compressed Air										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			2,044	h	24.00					49,056	0	0	0	0	49,056		2,044
											0	0	0	0	0	0		
	- Miscelaneous materials			584	m		24.00				0	14,016	0	0	0	14,016		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Electrical services										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			2,044	h	24.00					49,056	0	0	0	0	49,056		2,044
											0	0	0	0	0	0		
	- Miscelaneous materials			584	m		24.00				0	14,016	0	0	0	14,016		
2412	**Transformer Chamber and Access**										**505,704**	**595,717**	**158,698**	**172,492**	**109,136**	**1,541,747**		**21,070**

Item : (2413)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2410	**Excavation**																	
2413	**Powerhouse tailrace including Access and Oulet**			301,918	m³													
	(m²) L																	
	Tailrace access 67.2 247			**16,598**	**m³**													
	Tailrace tunnel 71.2 3,670			**261,304**	**m³**													
	Collector 71.2 80			**5,696**	**m³**													
	Outlet			**18,320**	**m³**													
				301,918	**m³**													
	(m²) L																	
	Tailrace access 67.2 247			16,598	m³						0	0	0	0	0	0		
											0	0	0	0	0	0		
	As per Surge Chamber Access 0.43 h / m³			16,598	m³	10.22	14.75	6.32	5.01	2.06	169,580	244,765	104,898	83,195	24,626	627,064		7,065
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Tailrace tunnel 71.2 3,670			261,304	m³						0	0	0	0	0	0		
	Collector 71.2 80			5,696	m³						0	0	0	0	0	0		
	3,750			267,000	m³													
	D Shape 8 x 9,5 71.20 m³ 3,750 m			267,000	m³						0	0	0	0	0	0		
	Area (m²)										0	0	0	0	0	0		
	Arc 9.27 11.20										0	0	0	0	0	0		
	Height 9.50										0	0	0	0	0	0		
	Wall 7.50 60.00										0	0	0	0	0	0		
	Width 8.00 60.00										0	0	0	0	0	0		
	71.20										0	0	0	0	0	0		
	Excavation										0	0	0	0	0	0		
	Progression 4.66 m										0	0	0	0	0	0		
	Number of rounds 805										0	0	0	0	0	0		
	Number of shifts 1,127 Prod. Factor 1.4										0	0	0	0	0	0		
	Number of holes (m) (Feet)										0	0	0	0	0	0		
	Production 57 55 mm dia. 230,802 757,029										0	0	0	0	0	0		
	Contour 38 55 mm dia. 153,868 504,686										0	0	0	0	0	0		
	95										0	0	0	0	0	0		
	Cut 3 109 mm dia. 12,147 39,844										0	0	0	0	0	0		
	98										0	0	0	0	0	0		
	Drilling depth 5.03 m 396,817 1,301,559										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Durations (hours) 805 rounds																	
	Drilling 150 m / h 3.29 2,645 h																	
	Blasting 1.15 min / hole 1.88 1,512 h																	
	Scaling & W. mesh 2.00 1,610 h																	
	Mucking 205 m³ / h 1.62 1,303 h																	
	Drilling labour										0	0	0	0	0	0		
	H-H Bolting W. Mesh Remaining										0	0	0	0	0	0		
	8 90,160 12,622 10,819 66,718										0	0	0	0	0	0		
	14% 12%										0	0	0	0	0	0		

Item : (2413)

						UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Drilling 4.0 805 3,220 h										0	0	0	0	0	0		
	9 h / sh 358 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 28,622 m-h										0	0	0	0	0	0		
	Loading & Blasting 1.88 805 1,512 h										0	0	0	0	0	0		
	9 h / sh 168 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 13,441 m-h										0	0	0	0	0	0		
	Remaining for services 24,656										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling			3,578	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	28,622	h	24.00					686,933	0	0	0	0	686,933		28,622
	805 rounds										0	0	0	0	0	0		
	- Jumbo E 3C 14.00 4.5 h			3,623	h				14.00		0	0	0	50,715	0	50,715		
	Feet ft / un										0	0	0	0	0	0		
	- Bits 2"Ø 1,261,715 1,600			789	un		85.00				0	67,065	0	0	0	67,065		
	- Bits 4"Ø 39,844 1,500			27	un		500.00				0	13,500	0	0	0	13,500		
	- Rod 18' 1,301,559 7,500			174	un		485.00				0	84,390	0	0	0	84,390		
	- Coupling 1,301,559 3,700			352	un		50.00				0	17,600	0	0	0	17,600		
	- Shank 1,301,559 12,500			104	un		300.00				0	31,200	0	0	0	31,200		
	- Misc. Materials 1,301,559			1,301,559	ft		0.04				0	52,062	0	0	0	52,062		
											0	0	0	0	0	0		
	Loading & Blasting			1,680	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	13,441	h	24.00					322,572	0	0	0	0	322,572		13,441
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	1,512	h				37.00	20.00	0	0	0	55,944	21,773	77,717		
	- Fork lift 10 T 11.00 7.00	90%	1	1,512	h				11.00	7.00	0	0	0	16,632	7,620	24,252		
	- Explosives Truck 5.00 15.00	90%	1	1,512	h				5.00	15.00	0	0	0	7,560	16,330	23,890		
											0	0	0	0	0	0		
	5.03 m holes **805 Rounds**										0	0	0	0	0	0		
	Number Total Length (m)										0	0	0	0	0	0		
	Contour holes 38 30,590 153,868										0	0	0	0	0	0		
	Production holes 57 45,885 230,802										0	0	0	0	0	0		
	95 76,475										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Prima cord 5.5 m 168,245	5%		176,657	m		1.00				0	176,657	0	0	0	176,657		
	- Cap 6m 76,475	13%		86,417	un		3.50				0	302,460	0	0	0	302,460		
	- Dynamite RXL 438 267,000 m³ Powder fact 1.6			427,200	kg		5.60				0	2,392,320	0	0	0	2,392,320		
	- XACTEX 30,590 holes 84,123	5%		88,329	kg		7.50				0	662,468	0	0	0	662,468		
	2.75 kg / hole										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Mucking 267,000 m³										0	0	0	0	0	0		
	1.5 Loose »»»» 400,500 m³										0	0	0	0	0	0		
	498 m³ / round										0	0	0	0	0	0		
	Production 140 m³ / h 3.55 h										0	0	0	0	0	0		
	805 rounds 2,861 h x 10/9 »»			3,179	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		7	22,250	h	24.00					534,000	0	0	0	0	534,000		22,250
											0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	50%	1	1,589	h				19.00	29.00	0	0	0	30,191	33,178	63,369		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	2,861	h				39.20	48.00	0	0	0	112,151	98,876	211,027		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	2,861	h				38.25	28.00	0	0	0	109,433	57,678	167,111		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	3	8,582	h				24.00	20.00	0	0	0	205,968	123,581	329,549		
											0	0	0	0	0	0		
	Disposal of excavated materials										0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
	Average hauling distance : 5.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 8										0	0	0	0	0	0		
	Going 10 30 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 10 30 km / h										0	0	0	0	0	0		
	31 min.										0	0	0	0	0	0		
	Efficacité : 85% 36 min. / trip										0	0	0	0	0	0		
	0.61 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	15 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m³										0	0	0	0	0	0		
	180 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **3**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rolling Path Length 3,750										0	0	0	0	0	0		
	Width 8.00										0	0	0	0	0	0		
	Thickness 0.30										0	0	0	0	0	0		
	Volume 9,000										0	0	0	0	0	0		
	Production 1,200 m³ / sh			8	sh						0	0	0	0	0	0		
	10 h / s			80	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	640	h	24.00					15,360	0	0	0	0	15,360		640
											0	0	0	0	0	0		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	72	h				39.20	48.00	0	0	0	2,822	2,488	5,310		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	72	h				38.25	28.00	0	0	0	2,754	1,452	4,206		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	1	72	h				24.00	20.00	0	0	0	1,728	1,037	2,765		
											0	0	0	0	0	0		
	Rock Support										0	0	0	0	0	0		
											0	0	0	0	0	0		
	D Shape 8 x 9,5 71.20 m³ 3,670 m			**261,304**	**m³**						0	0	0	0	0	0		
	Area (m²)										0	0	0	0	0	0		
	Arc 9.27 11.20										0	0	0	0	0	0		
	Height 9.50										0	0	0	0	0	0		
	Wall 7.50 60.00										0	0	0	0	0	0		
	Width 8.00 60.00										0	0	0	0	0	0		
	Crown 8.00 11.20 71.20										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Tunnel										0	0	0	0	0	0		
	Required Length Dia.(m) Arch (m)										0	0	0	0	0	0		
	Class 1 2,752.5 12.5 11.59	75%									0	0	0	0	0	0		
	Class 2 550.5 12.5 11.59	15%									0	0	0	0	0	0		
	Class 3 256.9 12.5 11.59	7.0%									0	0	0	0	0	0		
	Class 4 91.8 12.5 11.59	2.5%									0	0	0	0	0	0		
	Class 5 18.4 12.5 11.59	0.5%									0	0	0	0	0	0		
	3,670	100%									0	0	0	0	0	0		
	Class 1 Qty										0	0	0	0	0	0		
	Rock bolts 2,5 m 1 un / m 2,753 un										0	0	0	0	0	0		
	Shotcrete 50 mm 20.59 m² / m 8,501 m²	15%									0	0	0	0	0	0		
	Wire mesh 20.59 m² / m 48,173 m²	85%									0	0	0	0	0	0		
	Class 2										0	0	0	0	0	0		
	Rock bolts 2,5 m 2.3 un / m 1,260 un										0	0	0	0	0	0		
	Shotcrete 50 mm 20.59 m² / m 1,700 m²	15%									0	0	0	0	0	0		
	Wire mesh 20.59 m² / m 9,635 m²	85%									0	0	0	0	0	0		
	Class 3										0	0	0	0	0	0		

Item : (2413)

											UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION						%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
																24.00 $				0.72 $			
	Rock bolts 3 m	2.9	un / m	744	un											0	0	0	0	0	0		
	Shotcrete 50 mm	20.59	m² / m	2,645	m²		50%									0	0	0	0	0	0		
	Wire mesh	20.59	m² / m	2,645	m²		50%									0	0	0	0	0	0		
	Class 4															0	0	0	0	0	0		
	Rock bolts 4 m	5.2	un / m	473	un											0	0	0	0	0	0		
	Shotcrete 50 mm	9.0	m² / m	248	m²		30%									0	0	0	0	0	0		
	Wire mesh	9.0	m² / m	578	m²		70%									0	0	0	0	0	0		
	Shotcrete 100 mm	11.6	m² / m	1,063	m²		100%									0	0	0	0	0	0		
	Reinf. Mesh	11.6	m² / m	1,063	m²		100%									0	0	0	0	0	0		
	Steel arch (W 100)	1.5	m c/c	61	un											0	0	0	0	0	0		
		24.3	m / arch	1,480	m																		
	Class 5															0	0	0	0	0	0		
	Rock bolts 5 m	11.6	un / m	213	un											0	0	0	0	0	0		
	Shotcrete 50 mm	9.0	m² / m	50	m²		30%									0	0	0	0	0	0		
	Wire mesh	9.0	m² / m	116	m²		70%									0	0	0	0	0	0		
	Shotcrete 100 mm	11.6	m² / m	213	m²		100%									0	0	0	0	0	0		
	Reinf. Mesh	11.6	m² / m	213	m²		100%									0	0	0	0	0	0		
	Steel arch (W 150)	0.75	m c/c	24	un											0	0	0	0	0	0		
		24.3	m / arch	582	m											0	0	0	0	0	0		
	Supply			Lenght (m)												0	0	0	0	0	0		
-	Rock bolts 2,5 m	4,013	un	10,333		Losses	3%		4,133	un			60.00			0	0	247,980	0	0	247,980		
-	Rock bolts 3 m	744	un	2,298		Losses	3%		766	un			70.00			0	0	53,620	0	0	53,620		
-	Rock bolts 4 m	473	un	1,948		Losses	3%		487	un			80.00			0	0	38,960	0	0	38,960		
-	Rock bolts 5 m	213	un	1,095		Losses	3%		219	un			105.00			0	0	22,995	0	0	22,995		
		5,443		15,674												0	0	0	0	0	0		
-	Injection tubes	150	m roll				3%		108	rolls			110.00										
-	Oakum	130	bolts / box				3%		44	box			280.00										
-	Grease	154	bolts / box				3%		36	box			336.00										
-	Wire mesh	61,146	m²				15%		70,318	m²			4.60										
-	Reinf. Mesh	1,276	m²				15%		1,467	m²			5.60										
		62,422	m²																				
-	Spikes 1,1 m	1.25	m c/c	49,938	un		3%		51,436	un			4.50										
-	Wire			0.04	$ / m²				62,422	m²			0.04										
	Shotcrete 50 mm	13,143	0.05	657																			
	Shotcrete 100 mm	1,276	0.1	128																			
				785																			
-	Cement (40 kg Bags)	0.03	m³ / bag			Losses	7.5%		28,121	bags			10.00										
		33.33	bags / m³	26,159	bags																		
-	Sand	1.40 mt / m³		0.08	h / mt				1,099	mt	1.94	0.00	0.00	2.27	1.58	2,131	0	0	2,494	1,250	5,875		88
-	Monoset (3% of cement)			1,046,366	kg		3%		31,391	kg			3.40										
-	Steel arch (W 100)	19.0	kg / m	1,480	m				28,129	kg			4.00										
-	Steel arch (W 150)	22.0	kg / m	582	m				12,815	kg			5.00										
	Rock bolts Installation								**1,127**	**sh**						0	0	0	0	0	0		
	15,674 m			14	m / sh											0	0	0	0	0	0		
	5,443 un			5	un / sh											0	0	0	0	0	0		
				0.5	h / un. including positionning											0	0	0	0	0	0		
				2.5	h / sh				2,818	h													
1)	Drilling with Jumbo															0	0	0	0	0	0		
																0	0	0	0	0	0		

Item : (2413)

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Jumbo	90%	1	2,536	h				102.50		0	0	0	259,940	0	259,940		
											0	0	0	0	0	0		
	2) Install with 50t crane with basket										0	0	0	0	0	0		
	5,443 un 5 un / round										0	0	0	0	0	0		
	0.5 h / un 2.5 h / round including positionning										0	0	0	0	0	0		
	2,818 h										0	0	0	0	0	0		
	9.0 h / sh. Eff.			314	sh						0	0	0	0	0	0		
	10 h /sh			3,140	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		3	9,420	h	24.00					226,080	0	0	0	0	226,080		9,420
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	2,826	h				37.00	20.00	0	0	0	104,562	40,694	145,256		
											0	0	0	0	0	0		
	- Impact tool			1	un		300.00				0	300	0	0	0	300		
	- Test rig			1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque rench			1	un		280.00				0	280	0	0	0	280		
	3) Injection 40 bolts / sh			137	sh						0	0	0	0	0	0		
	10 h / sh			1,370	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	5,480	h	24.00					131,520	0	0	0	0	131,520		5,480
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	1,233	h				37.00	20.00	0	0	0	45,621	17,755	63,376		
	- Moyno pump 2.00	75%	1	1,028	h				2.00		0	0	0	2,056	0	2,056		
											0	0	0	0	0	0		
	- Cement (bags) 15,674 m	100%		2,564	bags			10.00			0	0	25,640	0	0	25,640		
	51,409 ft 0.02269801 sf										0	0	0	0	0	0		
	2 in. Dia hole 1,167 cu ft										0	0	0	0	0	0		
	0.91 cu ft / bag 1,282 bags										0	0	0	0	0	0		
	- Intraplast "N" 0.4 kg / bag 513 kg	1%		518	kg			3.00			0	0	1,554	0	0	1,554		
	- Miscellaneous			5,443	un		0.30				0	1,633	0	0	0	1,633		
	Wire mesh installation										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Production of 200 m^2 / sh 62,422 m^2			312	sh						0	0	0	0	0	0		
	10 h / sh			3,121	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	18,727	h	24.00					449,438	0	0	0	0	449,438		18,727
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	2,809	h				37.00	20.00	0	0	0	103,933	40,450	144,383		
	- Jack leg 2.00	30%	1	936	h				2.00		0	0	0	1,872	0	1,872		
	- Miscellaneous materials Spike drilling 54931.8 m			54,932	m		1.00				0	54,932	0	0	0	54,932		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Shotcreting			**785**	**m^3**						0	0	0	0	0	0		
	Production of 0.7 h / m^3 549 h										0	0	0	0	0	0		
	7.5 h / sh. Eff.			74	sh						0	0	0	0	0	0		
	10 h /sh			740	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	3,700	h	24.00					88,800	0	0	0	0	88,800		3,700
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	666	h				37.00	20.00	0	0	0	24,642	9,590	34,232		
	- Shotcrete pump 17.00	60%	1	444	h				17.00		0	0	0	7,548	0	7,548		
	- Hoses	25%	1	185	h		35.00				0	6,475	0	0	0	6,475		
	- Nozzle 66 m^3 / un			12	un		275.00				0	3,300	0	0	0	3,300		

Item : (2413)

WBS	DESCRIPTION					%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
															24.00 $				0.72 $			
															0	0	0	0	0	0		
	Arches installation	2,063 m		24 m / un				**85**	**un**						0	0	0	0	0	0		
	Production of	2 un / sh						43	sh						0	0	0	0	0	0		
				10 h /q				430	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						5	2,150	h	24.00					51,600	0	0	0	0	51,600		2,150
															0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)		37.00	20.00		90%	1	387	h				37.00	20.00	0	0	0	14,319	5,573	19,892		
	- Miscellaneous materials							85	un		200.00				0	17,000	0	0	0	17,000		
															0	0	0	0	0	0		
	Outlet		**(m³)**					**18,320**	**m³**						0	0	0	0	0	0		
	Rock Excavation (Dry)														0	0	0	0	0	0		
	Ramp to rockfill		**12,650**												0	0	0	0	0	0		
	Tailrace outlet portal and ramp		**3,320**	**15,970**											0	0	0	0	0	0		
															0	0	0	0	0	0		
	Rock Excavation (Wet)														0	0	0	0	0	0		
	Tailrace plug		**2,350**												0	0	0	0	0	0		
	Tailrace channel	**±**	**2,000**												0	0	0	0	0	0		
	Rockfill														0	0	0	0	0	0		
	Outlet protection dyke		**26,250**												0	0	0	0	0	0		
															0	0	0	0	0	0		
	Earthworks														0	0	0	0	0	0		
	Working platform		**28,000**												0	0	0	0	0	0		
															0	0	0	0	0	0		
	Marine Equipment	Duration		6 months in 2012											0	0	0	0	0	0		
		L (ft)	W (ft)	H (ft)	V (cu ft)										0	0	0	0	0	0		
	- Landding barge (Unifloat)	18	8	6	8,640		10	60	mth - un		800				0	48,000	0	0	0	48,000		
	- Noze end		432		2,592		6	36	mth - un		250				0	9,000	0	0	0	9,000		
															0	0	0	0	0	0		
	- Service barge	50	12	7	7,800		2	12	mth - un		4,800				0	57,600	0	0	0	57,600		
															0	0	0	0	0	0		
	- Tug						1	6	mth - un		6,500				0	39,000	0	0	0	39,000		
	- Work boat						1	6	mth - un		3,000				0	18,000	0	0	0	18,000		
	- Miscelaneous (winches, anchors, generators, etc..)							6	mth		6,000				0	36,000	0	0	0	36,000		
				6 mth											0	0	0	0	0	0		
	- Marine crew	26 d / mth		10 h / d			2	3,120	h	24.00					74,880	0	0	0	0	74,880		3,120
	Marine Equipment preparation							60	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						6	360	h	24.00					8,640	0	0	0	0	8,640		360
															0	0	0	0	0	0		
	- Misc. Equipment and materials							60	h		100.00		300.00		0	6,000	0	18,000	0	24,000		
															0	0	0	0	0	0		
	Earthworks							**28,000**	**m³**						0	0	0	0	0	0		
	Production of	2,000 m³ / sh						14	sh						0	0	0	0	0	0		
				10 h / sh				140	h													
	- M-P						5	700	h	24.00					16,800	0	0	0	0	16,800		700
															0	0	0	0	0	0		
	- Cat D8T LGP Track-Type Tractor		47.45	38.60		90%	1	126	h				47.45	38.60	0	0	0	5,979	3,502	9,481		
	- Cat 345 Hydraulic Excavator		40.00	60.00		90%	1	126	h				40.00	60.00	0	0	0	5,040	5,443	10,483		
	- Cat 725 Articulated Dumper 25 T		24.00	20.00		90%	2	252	h				24.00	20.00	0	0	0	6,048	3,629	9,677		
															0	0	0	0	0	0		
	Rock Excavation (Dry)							**15,970**	**m³**						0	0	0	0	0	0		

Item : (2413)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Drilling										0	0	0	0	0	0		
	Drilling grid ,9 x 0.90 1.20 1.08 m²										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling length 14,787 m										0	0	0	0	0	0		
	Production of 200 m / machine / sh			74	sh						0	0	0	0	0	0		
	2 machines			37	sh						0	0	0	0	0	0		
	10 h / s			370	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	1,480	h	24.00					35,520	0	0	0	0	35,520		1,480
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	2	666	h				19.40	15.00	0	0	0	12,920	7,193	20,113		
	- Drilling materials			14,787	m		0.70				0	10,351	0	0	0	10,351		
											0	0	0	0	0	0		
	Blasting										0	0	0	0	0	0		
	Average depth of holes 8 m										0	0	0	0	0	0		
	Number of holes 1,848 un										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Dynamite 1 kg / m³ 15,970 m³ Losses	5%		16,769	kg		5.60				0	93,906	0	0	0	93,906		
	- Caps Losses	5%		1,941	un		4.50				0	8,735	0	0	0	8,735		
											0	0	0	0	0	0		
	- M-P		4	1,480	h	24.00					35,520	0	0	0	0	35,520		1,480
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	333	h				5.00	15.00	0	0	0	1,665	3,596	5,261		
	- Misc. Blasting materials			15,970	m³		0.10				0	1,597	0	0	0	1,597		
											0	0	0	0	0	0		
	Mucking										0	0	0	0	0	0		
	Production of 432 m³ / sh										0	0	0	0	0	0		
	1.5 loose »»»» 647 m³ / sh			37	sh						0	0	0	0	0	0		
	10 h / s			370	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	2,220	h	24.00					53,280	0	0	0	0	53,280		2,220
											0	0	0	0	0	0		
	- Cat D8T LGP Track-Type Tractor 47.45 38.60	90%	1	333	h				47.45	38.60	0	0	0	15,801	9,255	25,056		
	- Cat 345 Hydraulic Excavator 40.00 60.00	90%	1	333	h				40.00	60.00	0	0	0	13,320	14,386	27,706		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	2	666	h				24.00	20.00	0	0	0	15,984	9,590	25,574		
											0	0	0	0	0	0		
	Hauling distance 1.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Trip up 2 25 km / h										0	0	0	0	0	0		
	Unloading 4										0	0	0	0	0	0		
	Back trip 2 35 km / h										0	0	0	0	0	0		
	12 min.										0	0	0	0	0	0		
	Efficiency : 85% 14 min. / trip										0	0	0	0	0	0		
	0.24 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	39 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12.0 m³										0	0	0	0	0	0		
	468 m³/mach/sh										0	0	0	0	0	0		
	Nombre de camions par poste : **2**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rockfill Dumped directly on protection dyke and plug excavation ramp in mucking activity 13,125 m³			**26,250**	**m³**						0	0	0	0	0	0		
	From stock pile 13,125 m³										0	0	0	0	0	0		
											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	UNIT PRICES Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Production of 900 m³ / sh			15	sh						0	0	0	0	0	0		
	10 h / s			150	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		6	900	h	24.00					21,600	0	0	0	0	21,600		900
											0	0	0	0	0	0		
-	Cat D8T LGP Track-Type Tractor 47.45 38.60	90%	1	135	h				47.45	38.60	0	0	0	6,406	3,752	10,158		
-	Cat 345 Hydraulic Excavator 40.00 60.00	90%	1	135	h				40.00	60.00	0	0	0	5,400	5,832	11,232		
-	Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	2	270	h				24.00	20.00	0	0	0	6,480	3,888	10,368		
											0	0	0	0	0	0		
	Hauling distance 1.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Trip up 2 25 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Back trip 2 35 km / h										0	0	0	0	0	0		
	11 min.										0	0	0	0	0	0		
	Efficiency : 85% 13 min. / trip										0	0	0	0	0	0		
	0.22 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	42 trips / day										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12.0 m³										0	0	0	0	0	0		
	504 m³/mach/sh										0	0	0	0	0	0		
	Nombre de camions par poste : **2**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rock Support L H Area										0	0	0	0	0	0		
	10 30 300 m²										0	0	0	0	0	0		
	Suppply										0	0	0	0	0	0		
-	Rock bolts 6 m 5 m² / un 60 un Losses	3%		62	un		110.00				0	6,820	0	0	0	6,820		
-	Wire mesh 270 m² Lapping	15%		311	m²		4.60				0	1,431	0	0	0	1,431		
-	Spikes 0,7 m 1.56 m² / un 173 un	3%		178	un		4.50				0	801	0	0	0	801		
-	Wire			270	m²		0.04				0	11	0	0	0	11		
											0	0	0	0	0	0		
	Rock bolts drilling and Installation										0	0	0	0	0	0		
	Production of 100 m / sh			4	sh						0	0	0	0	0	0		
	6 m bolt 360 m 10 h / sh			40	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		6	240	h	24.00					5,760	0	0	0	0	5,760		240
											0	0	0	0	0	0		
-	Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	36	h				37.00	20.00	0	0	0	1,332	518	1,850		
-	Fork lift 15 T 13.00 9.00	90%	1	36	h				13.00	9.00	0	0	0	468	233	701		
-	Boom truck 17 tons 13.65 18.00	90%	1	36	h				13.65	18.00	0	0	0	491	467	958		
-	Drilling rig (on fork lift)	90%	1	36	h				0.00	0.00	0	0	0	0	0	0		
											0	0	0	0	0	0		
	Wire mesh Installation										0	0	0	0	0	0		
	Production of 100 m² / sh			3	sh						0	0	0	0	0	0		
	10 h / sh			30	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		5	150	h	24.00					3,600	0	0	0	0	3,600		150
											0	0	0	0	0	0		
-	Crane - Rough terrain 50 t (L-Belt) 37.00 20.00		1	30	h				37.00	20.00	0	0	0	1,110	432	1,542		
-	Jack leg 2.00	30%	1	9	h				2.00	0.00	0	0	0	18	0	18		
-	Fork lift 15 T 13.00 9.00		1	30	h				13.00	9.00	0	0	0	390	194	584		
-	Misc. Drilling materials 173 un 0.7 m			121	m		1.00				0	121	0	0	0	121		
											0	0	0	0	0	0		
	Rock Excavation (Wet) (m³)			**2,350**	**m³**						0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Rock plug 2,350										0	0	0	0	0	0		
	Drilling platform 2,350										0	0	0	0	0	0		
	4,700										0	0	0	0	0	0		
	Drilling										0	0	0	0	0	0		
	Drilling grid ,9 x 1,2 0.90 1.20 1.08 m²										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling length 4,352 m										0	0	0	0	0	0		
	Production of 200 m / machine / sh			22	sh						0	0	0	0	0	0		
	2 machines			11	sh						0	0	0	0	0	0		
	10 h / s			110	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	440	h	24.00					10,560	0	0	0	0	10,560		440
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	2	198	h				19.40	15.00	0	0	0	3,841	2,138	5,979		
	- Drilling materials			4,352	m		0.70				0	3,046	0	0	0	3,046		
											0	0	0	0	0	0		
	Blasting										0	0	0	0	0	0		
	Average depth of holes 15 m										0	0	0	0	0	0		
	Number of holes 290 un										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Dynamite 1.5 kg / m³ 3,525 kg Losses	5%		3,701	kg		5.60				0	20,726	0	0	0	20,726		
	- Caps Losses	5%		305	un		4.50				0	1,373	0	0	0	1,373		
											0	0	0	0	0	0		
	Production 6 min / hole 29 h			3	sh						0	0	0	0	0	0		
	10 h / s			30	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	120	h	24.00					2,880	0	0	0	0	2,880		120
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	27	h				5.00	15.00	0	0	0	135	292	427		
	- Misc. Blasting materials			2,350	m³		0.10				0	235	0	0	0	235		
											0	0	0	0	0	0		
	Excavation (Wet)										0	0	0	0	0	0		
	Rock plug 3,525										0	0	0	0	0	0		
	Drilling platform 5,000										0	0	0	0	0	0		
	Tailrace channel 2,000										0	0	0	0	0	0		
	10,525										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Barge mounted clamshell										0	0	0	0	0	0		
	Production of 500 m³ / sh			21	sh						0	0	0	0	0	0		
	10 h / s			210	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	1,260	h	24.00					30,240	0	0	0	0	30,240		1,260
											0	0	0	0	0	0		
	- Barge			2	mth		6,000.00				0	12,000	0	0	0	12,000		
	- Crane 150T - Crawler 50.75 25.00	90%	1	189	h				50.75	25.00	0	0	0	9,592	3,402	12,994		
	- Tug		1	2	mth		6,500.00				0	13,000	0	0	0	13,000		
	- Work boat		1	2	mth		3,000.00				0	6,000	0	0	0	6,000		
	- Scows		2	4	mth - un		3,000.00				0	12,000	0	0	0	12,000		
											0	0	0	0	0	0		
	- Misc. Equipment and materials			210	h		100.00		300.00		0	21,000	0	63,000	0	84,000		
											0	0	0	0	0	0		
	Services **Using outside installations for TBM 1**			**3,997**	**m**													
	Tailrace Access 247																	
	Tailrace Tunnel 3,670																	

Item : (2413)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Collector 80																	
	3,997 m																	
	Ventilation & Heathing										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.0 h / m			11,991	h	24.00					287,784	0	0	0	0	287,784		11,991
											0	0	0	0	0	0		
	- Miscelaneous materials			3,997	m		10.00				0	39,970	0	0	0	39,970		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Dewatering										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 2.0 h / m			7,994	h	24.00					191,856	0	0	0	0	191,856		7,994
											0	0	0	0	0	0		
	- Miscelaneous materials			3,997	m		10.00				0	39,970	0	0	0	39,970		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Industrial Water Supply										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			13,990	h	24.00					335,748	0	0	0	0	335,748		13,990
											0	0	0	0	0	0		
	- Miscelaneous materials			3,997	m		10.00				0	39,970	0	0	0	39,970		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Compressed Air										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			13,990	h	24.00					335,748	0	0	0	0	335,748		13,990
											0	0	0	0	0	0		
	- Miscelaneous materials			3,997	m		24.00				0	95,928	0	0	0	95,928		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Electrical services										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			13,990	h	24.00					335,748	0	0	0	0	335,748		13,990
											0	0	0	0	0	0		
	- Miscelaneous materials			3,997	m		24.00				0	95,928	0	0	0	95,928		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2413	**Powerhouse tailrace including Access and Oulet**			**301,918**	**m³**						**4,464,178**	**4,868,126**	**495,647**	**1,439,500**	**581,693**	**11,849,144**	**39.25**	**186,006**

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
2410	**Excavation**																	
2414	**Surge Chamber and Access**			**27,866**	**m³**													
	Access			**6,854**	**m²**													
	Surge chamber			**21,012**	**m²**													
				27,866	**m³**													
	Access																	
	D Shape **8 x 9** **67.20 m³** **102 m**			**6,854**	**m³**						0	0	0	0	0	0		
	Area (m²)														0			
	Arc 9.27 11.20														0			
	Height 9.00														0			
	Wall 7.00 56.00														0			
	Width 8.00 56.00														0			
	67.20														0			
	Excavation										0	0	0	0	0	0		
	Progression 4.66 m										0	0	0	0	0	0		
	Number of rounds 22										0	0	0	0	0	0		
	Number of shifts 31 Prod. Factor 1.4														0			
	Number of holes (m) (Feet)										0	0	0	0	0	0		
	Production 54 55 mm dia. 5,976 19,600										0	0	0	0	0	0		
	Contour 36 55 mm dia. 3,984 13,067														0			
	Cut 3 109 mm dia. 332 1,089										0	0	0	0	0	0		
	Drilling depth 5.03 m 10,291 33,756										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Durations (h) 22										0	0	0	0	0	0		
	Drilling 3.75 83										0	0	0	0	0	0		
	Blasting 2.00 44										0	0	0	0	0	0		
	Scaling & W. mesh 2.00 44										0	0	0	0	0	0		
	Mucking 2.15 47										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling labour										0	0	0	0	0	0		
	H-H Bolting W. Mesh Remaining										0	0	0	0	0	0		
	8 2,480 347 298 1,835										0	0	0	0	0	0		
	14% 12%										0	0	0	0	0	0		
	Drilling 4.0 22 88 h										0	0	0	0	0	0		
	9 h / sh 10 sh										0	0	0	0	0	0		
	8 men / q 10 h / sh 782 h-h										0	0	0	0	0	0		
	Loading & Blasting 2.5 22 55 h										0	0	0	0	0	0		
	9 h / sh 6 sh										0	0	0	0	0	0		
	8 men / q 10 h / sh 489 h-h										0	0	0	0	0	0		
	Remaining for services 564										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling			98	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	782	h	24.00					18,773	0	0	0	0	18,773		782
											0	0	0	0	0	0		

Item : (2414)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	22 rounds										0	0	0	0	0	0		
	- Jumbo E 3C 14.00 4.5 h / round			99	h				14.00		0	0	0	1,386	0	1,386		
	ft / un										0	0	0	0	0	0		
	- Bits 2"Ø 32,667 1,600			20	un		85.00				0	1,700	0	0	0	1,700		
	- Bits 4"Ø 1,089 1,500			1	un		500.00				0	500	0	0	0	500		
	- Rod 18' 33,756 7,500			5	un		485.00				0	2,425	0	0	0	2,425		
	- Coupling 33,756 3,700			9	un		50.00				0	450	0	0	0	450		
	- Shank 33,756 12,500			3	un		300.00				0	900	0	0	0	900		
	- Misc. Materials 33,756			33,756	ft		0.04				0	1,350	0	0	0	1,350		
											0	0	0	0	0	0		
	Loading & Blasting			61	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	489	h	24.00					11,733	0	0	0	0	11,733		489
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	55	h				37.00	20.00	0	0	0	2,035	792	2,827		
	- Fork lift 10 T 11.00 7.00	90%	1	55	h				11.00	7.00	0	0	0	605	277	882		
	- Explosives Truck 7.60 15.00	90%	1	55	h				7.60	15.00	0	0	0	418	594	1,012		
											0	0	0	0	0	0		
	5.03 m holes **22 Rounds**										0	0	0	0	0	0		
	Number Total Length										0	0	0	0	0	0		
	Contour holes 36 792 3,984										0	0	0	0	0	0		
	Production holes 54 1,188 5,976										0	0	0	0	0	0		
	90 1,980										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Prima cord 5.5 m 4,356	5%		4,574	m		0.55				0	2,516	0	0	0	2,516		
	- Cap 6m 1,980	13%		2,237	un		4.50				0	10,067	0	0	0	10,067		
	- Dynamite RXL 438 6,854 m³ Powder fact 1.6			10,967	kg		5.60				0	61,415	0	0	0	61,415		
	- XACTEX 792 holes 2,178	5%		2,287	kg		7.50				0	17,153	0	0	0	17,153		
	2.75 kg / hole										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Mucking 6,854 m³										0	0	0	0	0	0		
	1.5 Loose »»»» 10,282 m³										0	0	0	0	0	0		
	467 m³ / round										0	0	0	0	0	0		
	Production 140 m³ / h 3.34 h										0	0	0	0	0	0		
	22 rounds 73 h x 10/9 »»			82	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		9	734	h	24.00					17,626	0	0	0	0	17,626		734
											0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	50%	1	41	h				19.00	29.00	0	0	0	779	856	1,635		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	73	h				39.20	48.00	0	0	0	2,862	2,523	5,385		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	73	h				38.25	28.00	0	0	0	2,792	1,472	4,264		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	3	220	h				24.00	20.00	0	0	0	5,280	3,168	8,448		
											0	0	0	0	0	0		
	Disposal of excavated materials																	
	Average hauling distance : 4.00 km																	
	Loading 8																	
	Going 8 30 km / h																	
	Unloading 3																	
	Return 8 30 km / h																	
	27 min.																	
	Efficacité : 85% 32 min. / trip																	
	0.53 h / trip																	

Item : (2414)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	9 h / sh																	
	17 trips / sh																	
	Cat 725 Articulated Dumper 25 T 12 m^3																	
	204 m^3 / truck-sh																	
	Number of trucks : **3**																	
	Rolling Path (m)										0	0	0	0	0	0		
	Gravel from borrow pit Length 102.00										0	0	0	0	0	0		
	Width 8.00										0	0	0	0	0	0		
	Thickness 0.30										0	0	0	0	0	0		
	Volume 245										0	0	0	0	0	0		
	Production 1,200 m^3 / sh			1	sh						0	0	0	0	0	0		
	10 h / s			10	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	80	h	24.00					1,920	0	0	0	0	1,920		80
											0	0	0	0	0	0		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	9	h				39.20	48.00	0	0	0	353	311	664		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	9	h				38.25	28.00	0	0	0	344	181	525		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	1	9	h				24.00	20.00	0	0	0	216	130	346		
											0	0	0	0	0	0		
	Rock Support										0	0	0	0	0	0		
											0	0	0	0	0	0		
	D Shape 8 x 9 67.20 m^3 102 m			**6,854**	**m^3**						0	0	0	0	0	0		
	Area (m^2)										0	0	0	0	0	0		
	Arc 9.27										0	0	0	0	0	0		
	Height 9.00										0	0	0	0	0	0		
	Wall 7.00										0	0	0	0	0	0		
	Width 8.00 56.00										0	0	0	0	0	0		
	Crown 8.00 11.20 67.20										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Tunnel										0	0	0	0	0	0		
	Required Length Dia.(m) Arch (m)										0	0	0	0	0	0		
	Class 1 76.5 12.5 11.59	75%									0	0	0	0	0	0		
	Class 2 15.3 12.5 11.59	15%									0	0	0	0	0	0		
	Class 3 7.1 12.5 11.59	7.0%									0	0	0	0	0	0		
	Class 4 2.6 12.5 11.59	2.5%									0	0	0	0	0	0		
	Class 5 0.5 12.5 11.59	0.5%									0	0	0	0	0	0		
	102	100%									0	0	0	0	0	0		
	Class 1 Qty										0	0	0	0	0	0		
	Rock bolts 2,5 m 1 un / m 77 un										0	0	0	0	0	0		
	Shotcrete 50 mm 19.59 m^2 / m 225 m^2	15%									0	0	0	0	0	0		
	Wire mesh 19.59 m^2 / m 1,274 m^2	85%									0	0	0	0	0	0		
	Class 2										0	0	0	0	0	0		
	Rock bolts 2,5 m 2.3 un / m 35 un										0	0	0	0	0	0		
	Shotcrete 50 mm 19.59 m^2 / m 45 m^2	15%									0	0	0	0	0	0		
	Wire mesh 19.59 m^2 / m 255 m^2	85%									0	0	0	0	0	0		
	Class 3										0	0	0	0	0	0		
	Rock bolts 3 m 2.9 un / m 21 un										0	0	0	0	0	0		
	Shotcrete 50 mm 19.59 m^2 / m 70 m^2	50%									0	0	0	0	0	0		
	Wire mesh 19.59 m^2 / m 70 m^2	50%									0	0	0	0	0	0		
	Class 4										0	0	0	0	0	0		
	Rock bolts 4 m 5.2 un / m 13 un										0	0	0	0	0	0		
	Shotcrete 50 mm 8.0 m^2 / m 6 m^2	30%									0	0	0	0	0	0		

Item : (2414)

WBS	DESCRIPTION						%	n	Qty	Un.	UNIT PRICES					TOTAL COSTS					GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption			
																24.00 $				0.72 $			
	Wire mesh	8.0	m^2 / m	14	m^2		70%									0	0	0	0	0	0		
	Shotcrete 100 mm	11.6	m^2 / m	30	m^2		100%									0	0	0	0	0	0		
	Reinf. Mesh	11.6	m^2 / m	30	m^2		100%									0	0	0	0	0	0		
	Steel arch (W 100)	1.5	m c/c	2	un											0	0	0	0	0	0		
		23.3	m / arch	47	m																		
	Class 5															0	0	0	0	0	0		
	Rock bolts 5 m	11.6	un / m	6	un																		
	Shotcrete 50 mm	8.0	m^2 / m	1	m^2		30%																
	Wire mesh	8.0	m^2 / m	3	m^2		70%																
	Shotcrete 100 mm	11.6	m^2 / m	6	m^2		100%																
	Reinf. Mesh	11.6	m^2 / m	6	m^2		100%																
	Steel arch (W 150)	0.75	m c/c	1	un																		
		23.3	m / arch	23	m																		
	Supply			Lenght (m)												0	0	0	0	0	0		
	- Rock bolts 2,5 m	112	un	288		Losses	3%		115	un			60.00			0	0	6,900	0	0	6,900		
	- Rock bolts 3 m	21	un	66		Losses	3%		22	un			70.00			0	0	1,540	0	0	1,540		
	- Rock bolts 4 m	13	un	52		Losses	3%		13	un			80.00			0	0	1,040	0	0	1,040		
	- Rock bolts 5 m	6	un	30		Losses	3%		6	un			105.00			0	0	630	0	0	630		
		152		436												0	0	0	0	0	0		
	- Injection tubes	150	m roll				3%		3	rolls			110.00			0	0	330	0	0	330		
	- Oakum	130	bolts / box				3%		2	box			280.00			0	0	560	0	0	560		
	- Grease	154	bolts / box				3%		1	box			336.00			0	0	336	0	0	336		
																0	0	0	0	0	0		
	- Wire mesh	1,616	m^2				15%		1,858	m^2			4.60			0	0	8,547	0	0	8,547		
	- Reinf. Mesh	35	m^2				15%		41	m^2			5.60			0	0	230	0	0	230		
		1,651	m^2													0	0	0	0	0	0		
	- Spikes 1,1 m	1.25	m c/c	1,321	un				1,321	un			4.50			0	0	5,945	0	0	5,945		
	- Wire			0.04	$ / m^2				1,651	m^2			0.04			0	0	66	0	0	66		
		m^2		m^3												0	0	0	0	0	0		
	Shotcrete 50 mm	347	0.05	17												0	0	0	0	0	0		
	Shotcrete 100 mm	35	0.1	4												0	0	0	0	0	0		
				21												0	0	0	0	0	0		
	- Cement (40 kg Bags)	0.03	m^3 / bag			Losses	7.5%		749	bags			10.00			0	0	7,490	0	0	7,490		
		33.33	bags / m^3	697	bags											0	0	0	0	0	0		
	- Sand	1.40	mt / m^3	0.08	h / mt				29	mt	1.94	0.00	0.00	2.27	1.58	57	0	0	66	33	156		2
	- Monoset (3% of cement)			27,864	kg		3%		836	kg			3.40			0	0	2,842	0	0	2,842		
																0	0	0	0	0	0		
	- Steel arch (W 100)	19.0	kg / m	47	m				884	kg			4.00			0	0	3,537	0	0	3,537		
	- Steel arch (W 150)	22.0	kg / m	23	m				512	kg			5.00			0	0	2,560	0	0	2,560		
	Rock bolts Installation								**31**	**sh**						0	0	0	0	0	0		
		436	m	14	m / sh											0	0	0	0	0	0		
		152	un	5	un / sh											0	0	0	0	0	0		
				0.5	h / un. including positionning											0	0	0	0	0	0		
				2.5	h / sh				78	h													
	1) Drilling with Jumbo																						
	- Jumbo						90%	1	70	h				102.50		0	0	0	7,175	0	7,175		
																0	0	0	0	0	0		
	2) Install with 50t crane with basket															0	0	0	0	0	0		
		152	un	7	un / round											0	0	0	0	0	0		
		0.5	h / un	3.5	h / round including positionning											0	0	0	0	0	0		

Item : (2414)

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
													24.00 $				0.72 $			
			109 h										0	0	0	0	0	0		
			9.0 h / sh. Eff.			13	sh						0	0	0	0	0	0		
			10 h /sh			130	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				3	390	h	24.00					9,360	0	0	0	0	9,360		390
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	117	h				37.00	20.00	0	0	0	4,329	1,685	6,014		
													0	0	0	0	0	0		
	- Impact tool					1	un		300.00				0	300	0	0	0	300		
	- Test rig					1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque rench					1	un		280.00				0	280	0	0	0	280		
													0	0	0	0	0	0		
	3) Injection	40 bolts / sh				4	sh						0	0	0	0	0	0		
			10 h / sh			40	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				4	160	h	24.00					3,840	0	0	0	0	3,840		160
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	36	h				37.00	20.00	0	0	0	1,332	518	1,850		
	- Moyno pump	2.00		75%	1	30	h				2.00		0	0	0	60	0	60		
													0	0	0	0	0	0		
	- Cement (bags)	436 m		100%		72	bags			10.00			0	0	720	0	0	720		
		1,428 ft	0.02269801 sf										0	0	0	0	0	0		
		2 in. Dia hole	32 cu ft										0	0	0	0	0	0		
		0.91 cu ft / bag	36 bags										0	0	0	0	0	0		
	- Intraplast "N"	0.4 kg / bag	14 kg	1%		15	kg			3.00			0	0	45	0	0	45		
	- Miscellaneous					152	un		0.30				0	46	0	0	0	46		
	Wire mesh installation												0	0	0	0	0	0		
	Installation by Jumbo team												0	0	0	0	0	0		
	Production of	200 m^2 / sh	1,651 m^2			8	sh						0	0	0	0	0	0		
			10 h / sh			83	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	Plus												0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	74	h				37.00	20.00	0	0	0	2,738	1,066	3,804		
	- Jack leg	2.00		30%	1	25	h				2.00		0	0	0	50	0	50		
	- Miscellaneous materials	Spike drilling	1,453 m			1,453	m		1.00											
													0	0	0	0	0	0		
	Shotcreting					**21**	**m^3**						0	0	0	0	0	0		
	Production of	0.7 h / m^3	15 h										0	0	0	0	0	0		
			7.5 h / sh. Eff.			2	sh						0	0	0	0	0	0		
			10 h /sh			20	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				9	180	h	24.00					4,320	0	0	0	0	4,320		180
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	18	h				37.00	20.00	0	0	0	666	259	925		
	- Shotcrete pump	17.00		60%	1	12	h				17.00		0	0	0	204	0	204		
	- Hoses			25%	1	5	h		35.00				0	175	0	0	0	175		
	- Nozzle	66 m^3 / un				0	un		275.00				0	0	0	0	0	0		
													0	0	0	0	0	0		
	Arches installation	70 m	23.3 m / un			**3**	**un**						0	0	0	0	0	0		
	Production of	2 un / sh				2	sh						0	0	0	0	0	0		
			10 h / sh			20	h						0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
	- M-P		5	100	h	24.00					2,400	0	0	0	0	2,400		100
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	18	h				37.00	20.00	0	0	0	666	259	925		
	- Miscellaneous materials			3	un		200.00				0	600	0	0	0	600		
											0	0	0	0	0	0		
	Surge Chamber										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Header (m²)										0	0	0	0	0	0		
	Arc 20.50 16.5 57.50										0	0	0	0	0	0		
	Height 14.00																	
	Wall 4.00 66.00																	
	Width 16.50																	
	123.5 102			12,597	m³													
	As per powerhouse Header 0.27 h / m³			**12,597**	**m³**	**6.46**	**13.24**	**0.06**	**3.38**	**3.45**	**81,316**	**166,744**	**753**	**42,526**	**31,283**	**322,622**		**3,388**
	H W (m²) L										0	0	0	0	0	0		
	Bench 5 16.5 82.5 102			8,415	m³						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Progression 10 m										0	0	0	0	0	0		
	Rounds 10 rounds / bench										0	0	0	0	0	0		
	Line drilling 0.6 m c/c										0	0	0	0	0	0		
	Damper holes 16 un / round										0	0	0	0	0	0		
	Helper holes 16 un / round										0	0	0	0	0	0		
	Production holes 39 un / round										0	0	0	0	0	0		
											0	0	0	0	0	0		
	DRILLING Lentgh Holes Depth Drilling										0	0	0	0	0	0		
	2,5" dia.										0	0	0	0	0	0		
	Line drilling 237 395 5.5 2,173										0	0	0	0	0	0		
	Damper 160 5.5 880										0	0	0	0	0	0		
	3" dia.										0	0	0	0	0	0		
	Helper 160 5.5 880										0	0	0	0	0	0		
	Production 390 5.5 2,145										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Preshearing area 1,304 m²										0	0	0	0	0	0		
	Durations 250 m / machine / sh										0	0	0	0	0	0		
	(m) (shift)													0	0	0		
	Line drilling 2,173 9										0	0	0	0	0	0		
	Damper 880 4										0	0	0	0	0	0		
	Production & Helpers 3,025 12										0	0	0	0	0	0		
	25 2 mach.			13	sh						0	0	0	0	0	0		
	10 h / sh			130	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	650	h	24.00					15,600	0	0	0	0	15,600		650
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	2	234	h				19.40	15.00	0	0	0	4,540	2,527	7,067		
											0	0	0	0	0	0		
	Feet ft / un										0	0	0	0	0	0		
	- Bits 2,5"Ø 10,016 1,500			7	un		160.00				0	1,120	0	0	0	1,120		
	- Bits 3"Ø 9,924 1,500			7	un		200.00				0	1,400	0	0	0	1,400		
	- Rod 18' 19,941 5,000			4	un		500.00				0	2,000	0	0	0	2,000		
	- Coupling 19,941 3,000			7	un		50.00				0	350	0	0	0	350		

Item : (2414)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Shank 19,941 10,000			2	un		300.00				0	600	0	0	0	600		
	- Misc. Materials 19,941			19,941	ft		0.05				0	997	0	0	0	997		
											0	0	0	0	0	0		
	LOADING & BLASTING **8,415** **m^3**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Cordex 0.52 m / m^3			4,376	m		0.60				0	2,625	0	0	0	2,625		
	- Xactex 0.1 kg / m^3			842	kg		7.50				0	6,311	0	0	0	6,311		
	- Detonators 0.04 un / m^3			337	un		7.00				0	2,356	0	0	0	2,356		
	- Dynamite 0.96 kg / m^3			8,078	kg		6.00				0	48,470	0	0	0	48,470		
											0	0	0	0	0	0		
	- M-P		7	910	h	24.00					21,840	0	0	0	0	21,840		910
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	117	h				5.00	15.00	0	0	0	585	1,264	1,849		
											0	0	0	0	0	0		
	MUCKING 8,415 m^3 (bank)										0	0	0	0	0	0		
	12,623 m^3 (loose)										0	0	0	0	0	0		
	1,262 m^3 / round										0	0	0	0	0	0		
	Production of 1,250 m^3 / sh			10	sh						0	0	0	0	0	0		
	10 h / sh			100	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		10	1,000	h	24.00					24,000	0	0	0	0	24,000		1,000
											0	0	0	0	0	0		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	90	h				39.20	48.00	0	0	0	3,528	3,110	6,638		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	90	h				19.00	29.00	0	0	0	1,710	1,879	3,589		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	5	450	h				24.00	20.00	0	0	0	10,800	6,480	17,280		
											0	0	0	0	0	0		
	Disposal of excavated materials										0	0	0	0	0	0		
	Average hauling distance : 4.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 3										0	0	0	0	0	0		
	Going 8 30 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 8 30 km / h										0	0	0	0	0	0		
	22 min.										0	0	0	0	0	0		
	Efficacité : 85% 26 min. / trip										0	0	0	0	0	0		
	0.43 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	21 trips / day										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m^3										0	0	0	0	0	0		
	252 m^3 / truck-sh										0	0	0	0	0	0		
	Number of trucks : **5**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rock Support L H Area										0	0	0	0	0	0		
	Area 237 5 1,185 m^2										0	0	0	0	0	0		
	Suppply										0	0	0	0	0	0		
	- Rock bolts 6 m 5 m^2 / un 237 un Losses	3%		244	un		80.00				0	19,520	0	0	0	19,520		
	- Wire mesh 474 m^2 Lapping	15%		545	m^2		4.60				0	2,507	0	0	0	2,507		
	- Spikes 0,7 m 1.56 m^2 / un 304 un	3%		304	un		4.50				0	1,368	0	0	0	1,368		
	- Wire			474	m^2		0.04				0	19	0	0	0	19		
											0	0	0	0	0	0		
	Rock bolts Installation										0	0	0	0	0	0		
	Production of 100 m / sh			15	sh						0	0	0	0	0	0		
	16 un / sh																	

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	6 m 1,422 m 10 h / sh			150	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	900	h	24.00					21,600	0	0	0	0	21,600		900
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	135	h				37.00	20.00	0	0	0	4,995	1,944	6,939		
	- Fork lift 15 T 13.00 9.00	90%	1	135	h				13.00	9.00	0	0	0	1,755	875	2,630		
	- Boom truck 17 tons 13.65 18.00	90%	1	135	h				13.65	18.00	0	0	0	1,843	1,750	3,593		
	- Drilling rig (on fork lift)	90%	1	135	h				11.00		0	0	0	1,485	0	1,485		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rock bolts Injection										0	0	0	0	0	0		
	Production of 40 un / sh			6	sh						0	0	0	0	0	0		
	10 h / sh			60	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	300		24.00					7,200	0	0	0	0	7,200		300
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	54	h				37.00	20.00	0	0	0	1,998	778	2,776		
	- Moyno pump 2.00	75%	1	45	h				2.00		0	0	0	90	0	90		
											0	0	0	0	0	0		
	- Cement (bags) 1,422 m	100%		232	bags			10.00			0	0	2,320	0	0	2,320		
	4,664 ft 0.02269801 sf										0	0	0	0	0	0		
	2 in. Dia hole 106 cu ft										0	0	0	0	0	0		
	0.91 bag / cu ft 116 bags										0	0	0	0	0	0		
	- Intraplast "N" 0.4 kg / bag 46 kg	1%		47	kg			3.00			0	0	141	0	0	141		
	- Miscellaneous			244	un		0.30				0	73	0	0	0	73		
											0	0	0	0	0	0		
	Wire mesh Installation										0	0	0	0	0	0		
	Production of 240 m^2 / sh			2	sh						0	0	0	0	0	0		
	10 h / sh			20	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	100	h	24.00					2,400	0	0	0	0	2,400		100
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	18	h				37.00	20.00	0	0	0	666	259	925		
	- Jack leg 2.00	30%		6	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Misc. Drilling materials 304 un 0.7 m			213	m		1.00				0	213	0	0	0	213		
											0	0	0	0	0	0		

Item : (2414)

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
	UNIT PRICES / TOTAL COSTS										24.00 $				0.72 $			
	Shotcrete			**210**	**m³**						0	0	0	0	0	0		
	Install										0	0	0	0	0	0		
	Provision for repairs after bench blasting	10%		231	m³						0	0	0	0	0	0		
	Production of 0.7 h / m³ 162 h										0	0	0	0	0	0		
	7.5 h / sh Eff.			22	sh						0	0	0	0	0	0		
	10 h / sh			220	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		9	1,980	h	24.00					47,520	0	0	0	0	47,520		1,980
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	198	h				37.00		0	0	0	7,326	0	7,326		
	- Shotcrete pump 17.00	60%	1	132	h				17.00		0	0	0	2,244	0	2,244		
	- Hoses	25%	1	55	h		35.00				0	1,925	0	0	0	1,925		
	- Nozzle 66 m³ / un			4	un		275.00				0	1,100	0	0	0	1,100		
											0	0	0	0	0	0		
	Supply										0	0	0	0	0	0		
	- Cement (40 kg Bags) 0.03 m³ / bag Losses	7.5%		8,278	bags			10.00			0	0	82,780	0	0	82,780		
	33.33 bags / m³ 7,700 bags										0	0	0	0	0	0		
	- Sand 1.40 mt / m³ 0.08 h / mt			323	mt	1.94	0.00	0.00	2.27	1.58	627	0	0	734	368	1,729		26
											0	0	0	0	0	0		
	- Monoset (3% of cement) 308,000 kg	3%		9,240	kg			3.40			0	0	31,416	0	0	31,416		
											0	0	0	0	0	0		
	Services **Using outside installations for TBM 1**			**204**	**m**													
	Surge Chamber AccessAccess 102																	
	Surge Chamber 102																	
	204 m																	
	Ventilation & Heathing										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.0 h / m			612	h	24.00					14,688	0	0	0	0	14,688		612
											0	0	0	0	0	0		
	- Miscelaneous materials			204	m		10.00				0	2,040	0	0	0	2,040		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Dewatering										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 2.0 h / m			408	h	24.00					9,792	0	0	0	0	9,792		408
											0	0	0	0	0	0		
	- Miscelaneous materials			204	m		10.00				0	2,040	0	0	0	2,040		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Industrial Water Supply										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			714	h	24.00					17,136	0	0	0	0	17,136		714
											0	0	0	0	0	0		
	- Miscelaneous materials			204	m		10.00				0	2,040	0	0	0	2,040		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Compressed Air										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			714	h	24.00					17,136	0	0	0	0	17,136		714
											0	0	0	0	0	0		
	- Miscelaneous materials			204	m		24.00				0	4,896	0	0	0	4,896		
											0	0	0	0	0	0		

Item : (2414)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
	Electrical services										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			714	h	24.00					17,136	0	0	0	0	17,136		714
											0	0	0	0	0	0		
	- Miscelaneous materials			204	m		24.00				0	4,896	0	0	0	4,896		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2414	**Surge Chamber and Access**			**27,866**							**368,020**	**376,687**	**160,728**	**121,181**	**66,641**	**1,093,257**	**39.23**	**15,334**

Item : (2415)

2410 Excavation

WBS	DESCRIPTION	%	n	shty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Eshuip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Eshuipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2415	**Cable and Escape Tunnel**			**20,518**	**m³**													
	Drilling with standard hydraulic drilling machine																	
	From transformer chamber 300 m																	
	From outside 886 m																	
	D Shape **4,5 x 4,2** **17.30 m³** **1,186 m**			**20,518**	**m³**						0	0	0	0	0	0		
	Area (m²)										0	0	0	0	0	0		
	Arc 5.30 3.80										0	0	0	0	0	0		
	Height 4.20										0	0	0	0	0	0		
	Wall 3.00										0	0	0	0	0	0		
	Width 4.50 13.50										0	0	0	0	0	0		
	17.30										0	0	0	0	0	0		
	Excavation										0	0	0	0	0	0		
	Progression 3.00 m										0	0	0	0	0	0		
	Number of rounds 396										0	0	0	0	0	0		
	Number of shifts 554 Prod. Factor 1.4										0	0	0	0	0	0		
	Number of holes (m) (Feet)										0	0	0	0	0	0		
	Production 14 55 mm dia. 18,683 61,281										0	0	0	0	0	0		
	Contour 18 55 mm dia. 24,021 78,790										0	0	0	0	0	0		
	32										0	0	0	0	0	0		
	Cut 3 109 mm dia. 4,004 13,132										0	0	0	0	0	0		
	35										0	0	0	0	0	0		
	Drilling depth 3.37 m 46,708 153,203										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Durations **(hours)** **396 rounds**										0	0	0	0	0	0		
	Drilling 22 m / h 5.36 2,123 h										0	0	0	0	0	0		
	Blasting 5 min / hole 2.92 1,155 h										0	0	0	0	0	0		
	8.28										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling and Blasting			396	sh						0	0	0	0	0	0		
	10 h / sh			3,960	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	15,840	h	24.00					380,160	0	0	0	0	380,160		15,840
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	1	3,564	h				19.40	15.00	0	0	0	69,142	38,491	107,633		
	- Explosives Truck 5.00 15.00	90%	1	3,564	h				5.00	15.00	0	0	0	17,820	38,491	56,311		
											0	0	0	0	0	0		
	3.37 m holes **396 Rounds**										0	0	0	0	0	0		
	Number Total Length (m)										0	0	0	0	0	0		
	Contour holes 18 7,128 24,021										0	0	0	0	0	0		
	Production holes 14 5,544 18,683										0	0	0	0	0	0		
	32 12,672										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Prima cord 3.8 m 27,086	5%		28,441	m		1.00				0	28,441	0	0	0	28,441		
	- Cap 6m 12,672	13%		14,319	un		3.50				0	50,117	0	0	0	50,117		
	- Dynamite RXL 438 20,518 m³ Powder fact 1.6			32,828	kg		5.60				0	183,839	0	0	0	183,839		
	- XACTEX 7,128 holes 19,602	5%		20,582	kg		7.50				0	154,365	0	0	0	154,365		
	2.75 kg / hole										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Feet ft / un										0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	shty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Eshuip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Eshuipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Bits 2,5"Ø 140,071 1,500			93	un		160.00				0	14,880	0	0	0	14,880		
	- Bits 3"Ø 13,132 1,500			9	un		200.00				0	1,800	0	0	0	1,800		
	- Rod 18' 153,203 5,000			31	un		500.00				0	15,500	0	0	0	15,500		
	- Shank 153,203 10,000			15	un		300.00				0	4,500	0	0	0	4,500		
	- Misc. Materials 153,203			153,203	ft		0.05				0	7,660	0	0	0	7,660		
											0	0	0	0	0	0		
	Mucking 20,518 m³										0	0	0	0	0	0		
	1.5 Loose »»»» 30,777 m³										0	0	0	0	0	0		
	78 m³ / round										0	0	0	0	0	0		
	Transformer chamber section **300 m**										0	0	0	0	0	0		
	Scooptram Average hauling distance : 0.15 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 0.5										0	0	0	0	0	0		
	Going 1.0 8.0 km / h										0	0	0	0	0	0		
	Unloading 3.0										0	0	0	0	0	0		
	Return 1.0 8.8 km / h										0	0	0	0	0	0		
	5.5 min.										0	0	0	0	0	0		
	Efficacité : 85% 6.5 min. / trip										0	0	0	0	0	0		
	0.11 h / trip										0	0	0	0	0	0		
	3.00 m³ / trip										0	0	0	0	0	0		
	2.79 h / round										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Left for Rock Support and services = 6.71 h										0	0	0	0	0	0		
	Trucks										0	0	0	0	0	0		
	Average hauling distance : 3.50 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 25.88 3 m³ / trip										0	0	0	0	0	0		
	Going 7 30 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 7 30 km / h										0	0	0	0	0	0		
	43 min.										0	0	0	0	0	0		
	Efficacité : 85% 50 min. / trip										0	0	0	0	0	0		
	0.84 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	11 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m³										0	0	0	0	0	0		
	132 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **2** **(1+1)**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Production 78 m³ / round 3.00 h / round										0	0	0	0	0	0		
	396 rounds 1,188 h x 10/9 »»			1,320	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	6,600	h	24.00					158,400	0	0	0	0	158,400		6,600
											0	0	0	0	0	0		
	- R1300 G - Scooptram 20.35 16.00	90%	1	1,188	h				20.35	16.00	0	0	0	24,176	13,686	37,862		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	1,188	h				38.25	28.00	0	0	0	45,441	23,950	69,391		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	2	2,376	h				24.00	20.00	0	0	0	57,024	34,214	91,238		
											0	0	0	0	0	0		
	Outside section **886 m**										0	0	0	0	0	0		
	Scooptram Average hauling distance : 0.50 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 0.5										0	0	0	0	0	0		
	Going 4.0 8.0 km / h										0	0	0	0	0	0		
	Unloading 3.0										0	0	0	0	0	0		
	Return 3.0 8.8 km / h										0	0	0	0	0	0		

Item : (2415)

WBS	DESCRIPTION	%	n	shty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Eshuip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Eshuipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	10.5 min.										0	0	0	0	0	0		
	Efficiency : 85% 12.4 min. / trip										0	0	0	0	0	0		
	0.21 h / trip										0	0	0	0	0	0		
	3.00 m³ / trip										0	0	0	0	0	0		
	5.33 h / round										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Left for Rock Support and services = 4.17 h										0	0	0	0	0	0		
	Trucks										0	0	0	0	0	0		
	Average hauling distance : 2.50 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 49.41 3 m³ / trip										0	0	0	0	0	0		
	Going 5 30 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 5 30 km / h										0	0	0	0	0	0		
	62 min.										0	0	0	0	0	0		
	Efficacité : 85% 73 min. / trip										0	0	0	0	0	0		
	1.22 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	8 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m³										0	0	0	0	0	0		
	96 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **2** **(1+1)**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Production 78 m³ / round 6.00 h / round										0	0	0	0	0	0		
	396 rounds 2,376 h x 10/9 »»			2,640	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		5	13,200	h	24.00					316,800	0	0	0	0	316,800		13,200
											0	0	0	0	0	0		
-	R1300 G - Scooptram 20.35 16.00	90%	1	2,376	h				20.35	16.00	0	0	0	48,352	27,372	75,724		
-	Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	2,376	h				38.25	28.00	0	0	0	90,882	47,900	138,782		
-	Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	2	4,752	h				24.00	20.00	0	0	0	114,048	68,429	182,477		
											0	0	0	0	0	0		
	Rock Support										0	0	0	0	0	0		
											0	0	0	0	0	0		
	D Shape **4,5 x 4,2** **17.30** **m³** **1,186** **m**										0	0	0	0	0	0		
	Area (m²)										0	0	0	0	0	0		
	Arc 5.30 3.80										0	0	0	0	0	0		
	Height 4.20										0	0	0	0	0	0		
	Wall 3.00 13.50										0	0	0	0	0	0		
	Width 4.50										0	0	0	0	0	0		
	17.30										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Tunnel										0	0	0	0	0	0		
	Reshuired Length Dia.(m) Arch (m)										0	0	0	0	0	0		
	Class 1 889.5 12.5 11.59	75%									0	0	0	0	0	0		
	Class 2 177.9 12.5 11.59	15%									0	0	0	0	0	0		
	Class 3 83.0 12.5 11.59	7.0%									0	0	0	0	0	0		
	Class 4 29.7 12.5 11.59	2.5%									0	0	0	0	0	0		
	Class 5 5.9 12.5 11.59	0.5%									0	0	0	0	0	0		
	1,186	100%									0	0	0	0	0	0		
	Class 1 Qty										0	0	0	0	0	0		
	Rock bolts 2,5 m 1 un / m 890 un										0	0	0	0	0	0		
	Shotcrete 50 mm 11.59 m² / m 1,546 m²	15%									0	0	0	0	0	0		
	Wire mesh 11.59 m² / m 8,763 m²	85%									0	0	0	0	0	0		
	Class 2										0	0	0	0	0	0		

Item : (2415)

WBS	DESCRIPTION	%	n	shty	Un.	M-P	Cons. Mat.	Perm. Mat.	Eshuip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Eshuipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
	Rock bolts 2,5 m 2.3 un / m 407 un										0	0	0	0	0	0		
	Shotcrete 50 mm 11.59 m^2 / m 309 m^2	15%									0	0	0	0	0	0		
	Wire mesh 11.59 m^2 / m 1,753 m^2	85%									0	0	0	0	0	0		
	Class 3										0	0	0	0	0	0		
	Rock bolts 3 m 2.9 un / m 241 un										0	0	0	0	0	0		
	Shotcrete 50 mm 11.59 m^2 / m 481 m^2	50%									0	0	0	0	0	0		
	Wire mesh 11.59 m^2 / m 481 m^2	50%									0	0	0	0	0	0		
	Class 4										0	0	0	0	0	0		
	Rock bolts 4 m 5.2 un / m 153 un										0	0	0	0	0	0		
	Shotcrete 50 mm 0.0 m^2 / m 0 m^2	30%									0	0	0	0	0	0		
	Wire mesh 0.0 m^2 / m 0 m^2	70%									0	0	0	0	0	0		
	Shotcrete 100 mm 11.6 m^2 / m 344 m^2	100%									0	0	0	0	0	0		
	Reinf. Mesh 11.6 m^2 / m 344 m^2	100%									0	0	0	0	0	0		
	Steel arch (W 100) 1.5 m c/c 20 un										0	0	0	0	0	0		
	11.3 m / arch 226 m										0	0	0	0	0	0		
	Class 5										0	0	0	0	0	0		
	Rock bolts 5 m 11.6 un / m 69 un										0	0	0	0	0	0		
	Shotcrete 50 mm 0.0 m^2 / m 0 m^2	30%									0	0	0	0	0	0		
	Wire mesh 0.0 m^2 / m 0 m^2	70%									0	0	0	0	0	0		
	Shotcrete 100 mm 11.6 m^2 / m 69 m^2	100%									0	0	0	0	0	0		
	Reinf. Mesh 11.6 m^2 / m 69 m^2	100%									0	0	0	0	0	0		
	Steel arch (W 150) 0.75 m c/c 8 un										0	0	0	0	0	0		
	11.3 m / arch 90 m										0	0	0	0	0	0		
	Supply Lenght (m)										0	0	0	0	0	0		
	- Rock bolts 2,5 m 1,297 un 3,340 Losses	3%		1,336	un			60.00			0	0	80,160	0	0	80,160		
	- Rock bolts 3 m 241 un 744 Losses	3%		248	un			70.00			0	0	17,360	0	0	17,360		
	- Rock bolts 4 m 153 un 632 Losses	3%		158	un			80.00			0	0	12,640	0	0	12,640		
	- Rock bolts 5 m 69 un 355 Losses	3%		71	un			105.00			0	0	7,455	0	0	7,455		
	1,760 5,071										0	0	0	0	0	0		
	- Injection tubes 150 m roll	3%		35	rolls			110.00			0	0	3,850	0	0	3,850		
	- Oakum 130 bolts / box	3%		14	box			280.00			0	0	3,920	0	0	3,920		
	- Grease 154 bolts / box	3%		12	box			336.00			0	0	4,032	0	0	4,032		
											0	0	0	0	0	0		
	- Wire mesh 10,997 m^2	15%		12,646	m^2			4.60			0	0	58,172	0	0	58,172		
	- Reinf. Mesh 412 m^2	15%		474	m^2			5.60			0	0	2,654	0	0	2,654		
	11,409 m^2										0	0	0	0	0	0		
	- Spikes 1,1 m 1.25 m c/c 9,127 un	3%		9,401	un			4.50			0	0	42,305	0	0	42,305		
	- Wire 0.04 $ / m^2			11,409	m^2			0.04			0	0	456	0	0	456		
	m^2 m^3										0	0	0	0	0	0		
	Shotcrete 50 mm 2,337 0.05 117										0	0	0	0	0	0		
	Shotcrete 100 mm 412 0.1 41										0	0	0	0	0	0		
	158										0	0	0	0	0	0		
	- Cement (40 kg Bags) 0.03 m^3 / bag Losses	7.5%		5,664	bags			10.00			0	0	56,640	0	0	56,640		
	33.33 bags / m^3 5,269 bags										0	0	0	0	0	0		
	- Sand 1.40 mt / m^3 0.08 h / mt			221	mt	1.94	0.00	0.00	2.27	1.58	429	0	0	502	252	1,183		221
											0	0	0	0	0	0		
	- Monoset (3% of cement) 210,768 kg	3%		6,323	kg			3.40			0	0	21,498	0	0	21,498		
											0	0	0	0	0	0		
	- Steel arch (W 100) 19.0 kg / m 226 m			4,294	kg			4.00			0	0	17,176	0	0	17,176		
	- Steel arch (W 150) 22.0 kg / m 90 m			1,989	kg			5.00			0	0	9,944	0	0	9,944		
											0	0	0	0	0	0		
	Rock bolts Installation										0	0	0	0	0	0		
	1,760 un 0.5 h 880 h										0	0	0	0	0	0		
	7.5 h / sh Eff.			118	sh						0	0	0	0	0	0		
	10 h / sh			1,180	h						0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	shty	Un.	UNIT PRICES					TOTAL COSTS					GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						M-P	Cons. Mat.	Perm. Mat.	Eshuip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Eshuipment Operation	Fuel Consumption			
											24.00 $				0.72 $			
	1) Drilling										0	0	0	0	0	0		
	- M-P		4	4,720	h	24.00					113,280	0	0	0	0	113,280		4,720
											0	0	0	0	0	0		
	- Jumbo	90%	1	1,062	h				102.50		0	0	0	108,855	0	108,855		
											0	0	0	0	0	0		
	2) Install with 10 T Fork lift										0	0	0	0	0	0		
	1,760 un 4 un / round										0	0	0	0	0	0		
	0.5 h / un 2.2 h / round including positionning										0	0	0	0	0	0		
	3,911 h										0	0	0	0	0	0		
	9.0 h / sh. Eff.			435	sh						0	0	0	0	0	0		
	10 h /sh			4,350	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		3	13,050	h	24.00					313,200	0	0	0	0	313,200		13,050
											0	0	0	0	0	0		
	- Fork lift 10 T 11.00 7.00	90%	1	3,915	h				11.00	7.00	0	0	0	43,065	19,732	62,797		
											0	0	0	0	0	0		
	- Impact tool			1	un		300.00				0	300	0	0	0	300		
	- Test rig			1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque rench			1	un		280.00				0	280	0	0	0	280		
											0	0	0	0	0	0		
	3) Injection 40 bolts / sh			44	sh						0	0	0	0	0	0		
	10 h /sh			440	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	1,760	h	24.00					42,240	0	0	0	0	42,240		1,760
											0	0	0	0	0	0		
	- Fork lift 10 T 11.00 7.00	90%	1	396	h				11.00	7.00	0	0	0	4,356	1,996	6,352		
	- Moyno pump 2.00	75%	1	330	h				2.00		0	0	0	660	0	660		
											0	0	0	0	0	0		
	- Cement (bags) 5,071 m	100%		830	bags			10.00			0	0	8,300	0	0	8,300		
	16,633 ft 0.02269801 sf										0	0	0	0	0	0		
	2 in. Dia hole 378 cu ft										0	0	0	0	0	0		
	0.91 bag / cu ft 415 bags										0	0	0	0	0	0		
	- Intraplast "N" 0.4 kg / bag 166 kg	1%		168	kg			3.00			0	0	504	0	0	504		
	- Miscellaneous			1,760	un		0.30				0	528	0	0	0	528		
											0	0	0	0	0	0		
	Wire mesh installation										0	0	0	0	0	0		
	Production of 200 m^2 / sh 11,409			57	sh						0	0	0	0	0	0		
	10 h / sh			570	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	3,423	h	24.00					82,145	0	0	0	0	82,145		3,423
											0	0	0	0	0	0		
	- Fork lift 10 T 11.00 7.00	90%	1	513	h				11.00	7.00	0	0	0	5,643	2,586	8,229		
	- Jack leg 2.00	30%	1	171	h				2.00		0	0	0	342	0	342		
	- Miscellaneous materials Spike drilling 10039.7 m			10,040	m		1.00				0	10,040	0	0	0	10,040		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Shotcreting			**158**	**m^3**						0	0	0	0	0	0		
	Production of 0.7 h / m^3 111 h										0	0	0	0	0	0		
	7.5 h / sh. Eff.			15	sh						0	0	0	0	0	0		
	10 h /sh			150	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		9	1,350	h	24.00					32,400	0	0	0	0	32,400		1,350
											0	0	0	0	0	0		
	- Fork lift 10 T 11.00 7.00	90%	1	135	h				11.00	7.00	0	0	0	1,485	680	2,165		
	- Shotcrete pump 17.00	60%	1	90	h				17.00		0	0	0	1,530	0	1,530		

Item : (2415)

WBS	DESCRIPTION	%	n	shty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Eshuip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Eshuipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Hoses	25%	1	38	h		35.00				0	1,330	0	0	0	1,330		
	- Nozzle 66 m³ / un			2	un		275.00				0	550	0	0	0	550		
											0	0	0	0	0	0		
	Arches installation 316 m 11 m / un			**28**	**un**						0	0	0	0	0	0		
	Production of 2 un / sh			14	sh						0	0	0	0	0	0		
	10 h /sh			140	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	700	h	24.00					16,800	0	0	0	0	16,800		700
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	126	h				37.00	20.00	0	0	0	4,662	1,814	6,476		
	- Miscellaneous materials			28	un		200.00				0	5,600	0	0	0	5,600		
	Outside services are included in TBM 1 Power tunnel										0	0	0	0	0	0		
	Dewatering Duration 554 sh (days) 26 d / mth			21	mth						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 1.0 h / m			1,186	h	24.00					28,464	0	0	0	0	28,464		1,186
											0	0	0	0	0	0		
	- Miscelaneous			1,186	m		10.00				0	11,860	0	0	0	11,860		
											0	0	0	0	0	0		
	Industrial Water Supply										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 2.0 h / m			2,372	h	24.00					56,928	0	0	0	0	56,928		2,372
											0	0	0	0	0	0		
	- Miscelaneous materials			1,186	m		10.00				0	11,860	0	0	0	11,860		
	Compressed Air										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 2.0 h / m			2,372	h	24.00					56,928	0	0	0	0	56,928		2,372
											0	0	0	0	0	0		
	- Miscelaneous materials			1,186	m		24.00											
	Ventilation & Heathing										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 1.5 h / m			1,779	h	24.00					42,696	0	0	0	0	42,696		1,779
											0	0	0	0	0	0		
	- Miscelaneous materials			1,186	m		10.00											
	Electrical services										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 2.0 h / m			2,372	h	24.00					56,928	0	0	0	0	56,928		2,372
											0	0	0	0	0	0		
	- Miscelaneous materials			1,186	m		24.00				0	28,464	0	0	0	28,464		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2415	**Cable and Escape Tunnel**			**20,518**	**m³**						**1,697,798**	**533,114**	**347,066**	**637,985**	**319,593**	**3,535,556**	**172.31**	**70,945**

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
	2420 Concrete Works																	
2421	**Transformer Chamber Concrete**			**3,170**	**m^3**													
	Transformer Chamber			**3,170**	**m^2**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Concreting 4.50 h / m^3			14,265	h	24.00					342,360	0	0	0	0	342,360		14,265
	- Construction materials			3,170	m^3		74.00				0	234,580	0	0	0	234,580		
	- Construction equipment			3,170	m^3				48.00	38.00	0	0	0	152,160	86,731	238,891		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Concrete supply 3,170 1.10 h / m^3	2%		3,233	m^2	26.39	13.69	122.47	13.41	4.31	85,334	44,266	395,955	43,339	10,039	578,933		3,550
											0	0	0	0	0	0		
	Reinforcing Steel										0	0	0	0	0	0		
	- Supply and Fabrication 60 kg / m^3 15.00 h / mt			**190**	**mt**	360.00	100.00	992.61	64.16	37.80	68,472	19,020	188,795	12,203	5,177	293,667		2,853
											0	0	0	0	0	0		
	Installation																	
	- M-P 16.00 h / mt			3,043	h	24.00					73,037	0	0	0	0	73,037		3,043
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	20%	1	609	h				37.00	20.00	0	0	0	22,533	8,770	31,303		
	- Boom truck 17 tons 13.65 18.00	50%	1	1,522	h				13.65	18.00	0	0	0	20,775	19,725	40,500		
											0	0	0	0	0	0		
	Concrete transportation from the Batching Plan			**3,233**	**m^3**						0	0	0	0	0	0		
	Average production 80 m^3 / sh			41	sh						0	0	0	0	0	0		
	10 h / sh			410	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		2	820	h	24.00					19,680	0	0	0	0	19,680		820
											0	0	0	0	0	0		
	- Readymix 8 m^3 13.60 14.00	90%	1	369	h				13.60	14.00	0	0	0	5,018	3,720	8,738		
											0	0	0	0	0	0		
	Average hauling distance : 4.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 10										0	0	0	0	0	0		
	Going 8 30 km / h										0	0	0	0	0	0		
	Unloading 15										0	0	0	0	0	0		
	Return 7 35 km / h										0	0	0	0	0	0		
	40 min.										0	0	0	0	0	0		
	Efficacité : 85% 47 min. / trip										0	0	0	0	0	0		
	0.78 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	12 trips / sh										0	0	0	0	0	0		
	Readymix 8 m^3 8 m^3										0	0	0	0	0	0		
	96 m^3 / truck-sh										0	0	0	0	0	0		
	Number of trucks : **1**										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2421	**Transformer Chamber Concrete**										**588,883**	**297,866**	**584,750**	**256,028**	**134,162**	**1,861,689**		**24,531**

Item : (2421-2424)

WBS	DESCRIPTION						%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											UNIT PRICES					TOTAL COSTS							
																24.00 $				0.72 $			
2422	**Powerhouse - Phase I**								**7,200**	**m³**													
	Powerhouse	2,910														0	0	0	0	0	0		
	Penstocks and Manifold	2,290														0	0	0	0	0	0		
	Intake Tunnel	2,000														0	0	0	0	0	0		
		7,200														0	0	0	0	0	0		
																0	0	0	0	0	0		
	Powerhouse								**2,910**	**m²**						0	0	0	0	0	0		
																0	0	0	0	0	0		
	- Concreting	5.00	h / m³						14,550	h	24.00					349,200	0	0	0	0	349,200		14,550
	- Construction materials								2,910	m³		74.00				0	215,340	0	0	0	215,340		
	- Construction equipment								2,910	m³				48.00	38.00	0	0	0	139,680	79,618	219,298		
																0	0	0	0	0	0		
																0	0	0	0	0	0		
	- Concrete supply	2,910		1.10 h / m³			2%		2,968	m²	26.39	13.69	122.47	13.41	4.31	78,339	40,638	363,499	39,786	9,216	531,478		3,259
																0	0	0	0	0	0		
	Reinforcing Steel															0	0	0	0	0	0		
	- Supply and Fabrication	60	kg / m³		15.00	h / mt			**175**	**mt**	360.00	100.00	992.61	64.16	37.80	62,856	17,460	173,310	11,202	4,752	269,580		2,619
																0	0	0	0	0	0		
	Installation																						
	- M-P	16.00	h / mt						2,794	h	24.00					67,046	0	0	0	0	67,046		2,794
																0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)			37.00	20.00		20%	1	559	h				37.00	20.00	0	0	0	20,683	8,050	28,733		
	- Boom truck 17 tons			13.65	18.00		50%	1	1,397	h				13.65	18.00	0	0	0	19,069	18,105	37,174		
																0	0	0	0	0	0		
	Concrete transportation from the Batching Plan								**2,968**	**m³**						0	0	0	0	0	0		
	Average production	50	m³ / sh						60	sh						0	0	0	0	0	0		
					10	h / sh			600	h						0	0	0	0	0	0		
																0	0	0	0	0	0		
	- M-P							2	1,200	h	24.00					28,800	0	0	0	0	28,800		1,200
																0	0	0	0	0	0		
	- Readymix 8 m³			13.60	14.00		90%	1	540	h				13.60	14.00	0	0	0	7,344	5,443	12,787		
																0	0	0	0	0	0		
	Average hauling distance :				4.00	km										0	0	0	0	0	0		
																0	0	0	0	0	0		
	Loading			10												0	0	0	0	0	0		
	Going			8	30	km / h										0	0	0	0	0	0		
	Unloading			15												0	0	0	0	0	0		
	Return			7	35	km / h										0	0	0	0	0	0		
				40	min.											0	0	0	0	0	0		
	Efficacité :			85%	47	min. / trip										0	0	0	0	0	0		
					0.78	h / trip										0	0	0	0	0	0		
					9	h / sh										0	0	0	0	0	0		
					12	trips / sh										0	0	0	0	0	0		
	Readymix 8 m³				8	m³										0	0	0	0	0	0		
					96	m³ / truck-sh										0	0	0	0	0	0		
				Number of trucks :		**1**										0	0	0	0	0	0		

Item : (2421-2424)

WBS	DESCRIPTION				%	n	Qty	Un.	UNIT PRICES					TOTAL COSTS					GLOBAL PRICES	UNIT PRICES	MEN-HOURS
									M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption			
														24.00 $				0.72 $			
														0	0	0	0	0	0		
	Penstocks and Manifold						**2,290**	**m³**						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- Concreting	4.50 h / m³					10,305	h	24.00					247,320	0	0	0	0	247,320		10,305
	- Construction materials						2,290	m³		65.00				0	148,850	0	0	0	148,850		
	- Construction equipment						2,290	m³				52.00	45.00	0	0	0	119,080	74,196	193,276		
														0	0	0	0	0	0		
														0	0	0	0	0	0		
	- Concrete supply	2,290	1.10 h / m³		2%		2,336	m²	26.39	13.69	122.47	13.41	4.31	61,658	31,984	286,096	31,314	7,254	418,306		2,565
														0	0	0	0	0	0		
														0	0	0	0	0	0		
	Concrete transportation from the Batching Plan						**2,336**	**m³**						0	0	0	0	0	0		
	Average production	45 m³ / sh					52	sh						0	0	0	0	0	0		
				10 h / sh			520	h						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- M-P					2	1,040	h	24.00					24,960	0	0	0	0	24,960		1,040
														0	0	0	0	0	0		
	- Readymix 8 m³		13.60	14.00	90%	1	468	h				13.60	14.00	0	0	0	6,365	4,717	11,082		
														0	0	0	0	0	0		
		Average hauling distance :		4.00 km										0	0	0	0	0	0		
														0	0	0	0	0	0		
	Loading		10											0	0	0	0	0	0		
	Going		8	30 km / h										0	0	0	0	0	0		
	Unloading		15											0	0	0	0	0	0		
	Return		7	35 km / h										0	0	0	0	0	0		
			40	min.										0	0	0	0	0	0		
	Efficacité :		85%	47 min. / trip										0	0	0	0	0	0		
				0.78 h / trip										0	0	0	0	0	0		
				9 h / sh										0	0	0	0	0	0		
				12 trips / sh										0	0	0	0	0	0		
	Readymix 8 m³			8 m³										0	0	0	0	0	0		
				96 m³ / truck-sh										0	0	0	0	0	0		
			Number of trucks :	**1**										0	0	0	0	0	0		
														0	0	0	0	0	0		
	Intake Tunnel						**2,000**	**m³**						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- Concreting	6.00 h / m³					12,000	h	24.00					288,000	0	0	0	0	288,000		12,000
	- Construction materials						2,000	m³		60.00				0	120,000	0	0	0	120,000		
	- Construction equipment						2,000	m³				48.00	38.00	0	0	0	96,000	54,720	150,720		
														0	0	0	0	0	0		
														0	0	0	0	0	0		
	- Concrete supply	2,000	1.10 h / m³		2%		2,040	m²	26.39	13.69	122.47	13.41	4.31	53,845	27,931	249,844	27,346	6,335	365,301		2,240
														0	0	0	0	0	0		
	Reinforcing Steel													0	0	0	0	0	0		
	- Supply and Fabrication	60 kg / m³	15.00	h / mt			**120**	**mt**	360.00	100.00	992.61	64.16	37.80	43,200	12,000	119,113	7,699	3,266	185,278		1,800
														0	0	0	0	0	0		
	Installation																				
	- M-P	16.00 h / mt					1,920	h	24.00					46,080	0	0	0	0	46,080		1,920
														0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)		37.00	20.00	20%	1	384	h				37.00	20.00	0	0	0	14,208	5,530	19,738		
	- Boom truck 17 tons		13.65	18.00	50%	1	960	h				13.65	18.00	0	0	0	13,104	12,442	25,546		

Item : (2421-2424)

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
											0	0	0	0	0	0		
	Concrete transportation from the Batching Plan			**2,040**	**m³**						0	0	0	0	0	0		
	Average production 50 m³ / sh			41	sh						0	0	0	0	0	0		
	10 h / sh			410	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		2	820	h	24.00					19,680	0	0	0	0	19,680		820
											0	0	0	0	0	0		
	- Readymix 8 m³ 13.60 14.00	90%	1	369	h				13.60	14.00	0	0	0	5,018	3,720	8,738		
											0	0	0	0	0	0		
	Average hauling distance : 4.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 10										0	0	0	0	0	0		
	Going 8 30 km / h										0	0	0	0	0	0		
	Unloading 15										0	0	0	0	0	0		
	Return 7 35 km / h										0	0	0	0	0	0		
	40 min.										0	0	0	0	0	0		
	Efficacité : 85% 47 min. / trip										0	0	0	0	0	0		
	0.78 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	12 trips / sh										0	0	0	0	0	0		
	Readymix 8 m³ 8 m³										0	0	0	0	0	0		
	96 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **1**										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2422	**Powerhouse - Phase I**										**1,370,984**	**614,203**	**1,191,862**	**557,898**	**297,364**	**4,032,311**		**57,112**

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2423	**Powerhouse - Phase II**			**3,750**	**m³**													
	Powerhouse			**3,750**	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Concreting 5.75 h / m³			21,563	h	24.00					517,500	0	0	0	0	517,500		21,563
	- Construction materials			3,750	m³		74.00				0	277,500	0	0	0	277,500		
	- Construction equipment			3,750	m³				48.00	38.00	0	0	0	180,000	102,600	282,600		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Concrete supply 3,750 1.10 h / m³	2%		3,825	m²	26.39	13.69	122.47	13.41	4.31	100,959	52,371	468,458	51,275	11,877	684,940		4,200
											0	0	0	0	0	0		
	Reinforcing Steel										0	0	0	0	0	0		
	- Supply and Fabrication 60 kg / m³ 15.00 h / mt			**225**	**mt**	360.00	100.00	992.61	64.16	37.80	81,000	22,500	223,338	14,436	6,124	347,398		3,375
											0	0	0	0	0	0		
	Installation																	
	- M-P 16.00 h / mt			3,600	h	24.00					86,400	0	0	0	0	86,400		3,600
											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	20%	1	720	h				37.00	20.00	0	0	0	26,640	10,368	37,008		
	- Boom truck 17 tons 13.65 18.00	50%	1	1,800	h				13.65	18.00	0	0	0	24,570	23,328	47,898		
											0	0	0	0	0	0		
	Concrete transportation from the Batching Plan			**3,825**	**m³**						0	0	0	0	0	0		
	Average production 80 m³ / sh			48	sh						0	0	0	0	0	0		
	10 h / sh			480	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		2	960	h	24.00					23,040	0	0	0	0	23,040		960
											0	0	0	0	0	0		
	- Readymix 8 m³ 13.60 14.00	90%	1	432	h				13.60	14.00	0	0	0	5,875	4,355	10,230		
											0	0	0	0	0	0		
	Average hauling distance : 4.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 10										0	0	0	0	0	0		
	Going 8 30 km / h										0	0	0	0	0	0		
	Unloading 15										0	0	0	0	0	0		
	Return 7 35 km / h										0	0	0	0	0	0		
	40 min.										0	0	0	0	0	0		
	Efficacité : 85% 47 min. / trip										0	0	0	0	0	0		
	0.78 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	12 trips / sh										0	0	0	0	0	0		
	Readymix 8 m³ 8 m³										0	0	0	0	0	0		
	96 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **1**										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2423	**Powerhouse - Phase II**										**808,899**	**352,371**	**691,796**	**302,796**	**158,652**	**2,314,514**		**33,698**
2424	**Cable and Escape Tunnel**																	
	Concrete Blocks			**5,000**	**m²**						0	0	0	0	0	0		
	Supply										0	0	0	0	0	0		
	- Concrete blocks Losses	5%		5,250	m²			110.00			0	0	577,500	0	0	577,500		
											0	0	0	0	0	0		
	Production of 30 m² / sh			175	sh						0	0	0	0	0	0		
	10 h /sh			1,750	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		7	12,250	h	24.00					294,000	0	0	0	0	294,000		12,250
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	1,575	h				13.65	18.00	0	0	0	21,499	20,412	41,911		
											0	0	0	0	0	0		
	- Miscellaneous			1,750	h		6.00		12.00		0	10,500	0	21,000	0	31,500		
											0	0	0	0	0	0		
	Concrete Footing Length 1,186										0	0	0	0	0	0		
	Width 0.30										0	0	0	0	0	0		
	Height 0.150										0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Volume 53 m³			53	m³						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Concreting 5.50 h / m³			294	h	24.00					7,045	0	0	0	0	7,045		294
	- Construction materials			53	m³		74.00				0	3,949	0	0	0	3,949		
	- Construction equipment			53	m³				48.00	38.00	0	0	0	2,562	1,460	4,022		
											0	0	0	0	0	0		
	- Concrete **1.10** h / mt Losses	2%		54	m³	26.39	13.69	122.47	13.41	4.31	1,425	739	6,614	724	168	9,670		59
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Pavement Length 1,186										0	0	0	0	0	0		
	Width 3.50										0	0	0	0	0	0		
	Thickness 0.150										0	0	0	0	0	0		
	Volume 623 m³										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Production 900 m³ / sh			1	sh						0	0	0	0	0	0		
	10 h / s			10	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	40	h	24.00					960	0	0	0	0	960		40
											0	0	0	0	0	0		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	9	h				39.20	48.00	0	0	0	353	311	664		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	9	h				38.25	28.00	0	0	0	344	181	525		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	1	9	h				24.00	20.00	0	0	0	216	130	346		
											0	0	0	0	0	0		
	- Crushed Stone 1.8 mt / m³ **0.08** h / mt			1,121	mt	1.94	0.00	0.00	2.27	1.58	2,174	0	0	2,544	1,275	5,993		90
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2424	**Cable and Escape Tunnel**			**5,000**	**m²**						**305,604**	**15,188**	**584,114**	**49,242**	**23,937**	**978,085**	**195.62**	**12,732**

Item : (2430-2470)

WBS	DESCRIPTION				%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
														24.00 $				0.72 $			
2430	**Powerhouse crane installation**																				
	Including testing																				
							12	sh						0	0	0	0	0	0		
				10 h / sh			120	h						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- M-P					9	1,080	h	24.00					25,920	0	0	0	0	25,920		1,080
														0	0	0	0	0	0		
	- Crane - Rough terrain 120 t (L-Belt)	45.00	23.00		75%	1	90	h				45.00	23.00	0	0	0	4,050	1,490	5,540		
	- Boom truck 17 tons	13.65	18.00		90%	1	108	h				13.65	18.00	0	0	0	1,474	1,400	2,874		
	- Tractor truck & Load Carrier - 65 T	11.50	15.00		60%	1	72	h				11.50	15.00	0	0	0	828	778	1,606		
														0	0	0	0	0	0		
	- Miscellaneous						120	h		9.00		8.00	12.00	0	1,080	0	960	1,037	3,077		
														0	0	0	0	0	0		
														0	0	0	0	0	0		
2430	**Powerhouse crane installation**						**0**	**0**						**25,920**	**1,080**	**0**	**7,312**	**4,705**	**39,017**		**1,080**
2440	**Powerhouse overhead roofing**						**100**	**mt**													
	Overhead Roofing						**100**	**mt**						0	0	0	0	0	0		
	Supply and install													0	0	0	0	0	0		
	- Material						100	mt			4,000			0	0	400,000	0	0	400,000		
														0	0	0	0	0	0		
	Production of	8 mt / sh					13	sh													
				10 h / sh			125	h													
	- M-P					6	750	h	24.00					18,000	0	0	0	0	18,000		750
														0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00		90%	1	113	h				37.00	20.00	0	0	0	4,181	1,627	5,808		
	- Boom truck 17 tons	13.65	18.00		90%	1	113	h				13.65	18.00	0	0	0	1,542	1,464	3,006		
														0	0	0	0	0	0		
	- Miscellaneous						125	h		4.00		8.00	12.00	0	500	0	1,000	1,080	2,580		
														0	0	0	0	0	0		
														0	0	0	0	0	0		
														0	0	0	0	0	0		
2440	**Powerhouse overhead roofing**						**100**	**mt**						**18,000**	**500**	**400,000**	**6,723**	**4,171**	**429,394**		**750**

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
													24.00 $				0.72 $			
2450	**Structural Steel**					**330**	**mt**													
	Steel Structure for service area		80										0	0	0	0	0	0		
	Steel Structure for powerhouse area		250										0	0	0	0	0	0		
			330 mt										0	0	0	0	0	0		
													0	0	0	0	0	0		
	Supply and install					**330**	**mt**						0	0	0	0	0	0		
	- Material					330	mt			3,775			0	0	1,245,750	0	0	1,245,750		
													0	0	0	0	0	0		
	Production of	8.0 mt / sh				41	sh						0	0	0	0	0	0		
			10 h / sh			410	h													
													0	0	0	0	0	0		
	- M-P				8	3,280		24.00					78,720	0	0	0	0	78,720		3,280
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	369	h				37.00	20.00	0	0	0	13,653	5,314	18,967		
	- Boom truck 17 tons	13.65	18.00	90%	1	369	h				13.65	18.00	0	0	0	5,037	4,782	9,819		
													0	0	0	0	0	0		
	- Miscellaneous					410	h		4.00		8.00	12.00	0	1,640	0	3,280	3,542	8,462		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
2450	**Structural Steel**					**330**	**mt**						**78,720**	**1,640**	**1,245,750**	**21,970**	**13,638**	**1,361,718**		**3,280**

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2460	**Steel lining for Penstocks and Manifold**					**1,160**	**mt**													
	Supply and install					**1,160**	**mt**						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Material					1,160	mt			3,000			0	0	3,480,000	0	0	3,480,000		
													0	0	0	0	0	0		
	Production of	10.0 mt / sh				116	sh						0	0	0	0	0	0		
			10 h / sh			1,160	h													
													0	0	0	0	0	0		
	- M-P				14	16,240		24.00					389,760	0	0	0	0	389,760		16,240
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	1,044	h				37.00	20.00	0	0	0	38,628	15,034	53,662		
	- Boom truck 17 tons	13.65	18.00	90%	1	1,044	h				13.65	18.00	0	0	0	14,251	13,530	27,781		
	- Welding Machine - 400 A	2.00	6.00	90%	4	4,176	h				2.00	6.00	0	0	0	8,352	18,040	26,392		
	- Miscellaneous					1,160	h		12.00		24.00	36.00	0	13,920	0	27,840	30,067	71,827		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
2460	**Steel lining for Penstocks and Manifold**					**1,160**	**mt**						**389,760**	**13,920**	**3,480,000**	**89,071**	**76,671**	**4,049,422**	**3,491**	**16,240**

						UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2470	**Concrete Plugs - Tunnels**			**6,490**	**m³**													
	Concrete plugs																	
	Power tunnel - Midway access			**2,500**	**m³**													
	- Concreting 2.75 h / m³			6,875	h	24.00					165,000	0	0	0	0	165,000		6,875
	- Construction materials			2,500	m³		70.00				0	175,000	0	0	0	175,000		
	- Construction equipment			2,500	m³				40.00	48.00	0	0	0	100,000	86,400	186,400		
											0	0	0	0	0	0		
	- Concrete supply 2,500 1.10 h / m³	2%		2,550	m²	26.39	13.69	122.47	13.41	4.31	67,306	34,914	312,306	34,183	7,918	456,627		2,800
	Reinforcing Steel										0	0	0	0	0	0		
	- Supply and Fabrication 60 kg / m³ 15.00 h / mt			**150**	**mt**	360.00	100.00	992.61	64.16	37.80	54,000	15,000	148,892	9,624	4,083	231,599		2,250
											0	0	0	0	0	0		
	Installation																	
	- M-P 16.00 h / mt			2,400	h	24.00					57,600	0	0	0	0	57,600		2,400
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	20%	1	480	h				37.00	20.00	0	0	0	17,760	6,912	24,672		
	- Boom truck 17 tons 13.65 18.00	50%	1	1,200	h				13.65	18.00	0	0	0	16,380	15,552	31,932		
	Concrete transportation from the Batching Plan			**2,500**	**m³**						0	0	0	0	0	0		
	Average production 400 m³ / sh			7	sh						0	0	0	0	0	0		
	10 h / sh			70	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		11	770	h	24.00					18,480	0	0	0	0	18,480		770
											0	0	0	0	0	0		
	- Readymix 8 m³ 13.60 14.00	90%	10	630					13.60	14.00	0	0	0	8,568	6,350	14,918		
											0	0	0	0	0	0		
	Average hauling distance : 21.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 10										0	0	0	0	0	0		
	Going 42 30 km / h										0	0	0	0	0	0		
	Unloading 8										0	0	0	0	0	0		
	Return 36 35 km / h										0	0	0	0	0	0		
	96 min.										0	0	0	0	0	0		
	Efficacité : 85% 113 min. / trip										0	0	0	0	0	0		
	1.88 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	5 trips / sh										0	0	0	0	0	0		
	Readymix 8 m³ 8 m³										0	0	0	0	0	0		
	40 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **10**										0	0	0	0	0	0		
	Power tunnel access Concrete Plug			**2,790**	**m³**													
	- Concreting 2.75 h / m³			7,673	h	24.00					184,140	0	0	0	0	184,140		7,673
	- Construction materials			2,790	m³		70.00				0	195,300	0	0	0	195,300		
	- Construction equipment			2,790	m³				40.00	48.00	0	0	0	111,600	96,422	208,022		
											0	0	0	0	0	0		

Item : (2430-2470)

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
													24.00 $				0.72 $			
	- Concrete supply	2,790	1.10 h / m³	2%		2,846	m²	26.39	13.69	122.47	13.41	4.31	75,119	38,967	348,558	38,151	8,837	509,632		3,125
	Reinforcing Steel												0	0	0	0	0	0		
	- Supply and Fabrication	60 kg / m³	15.00 h / mt			**167**	**mt**	360.00	100.00	992.61	64.16	37.80	60,264	16,740	166,163	10,740	4,556	258,463		2,511
													0	0	0	0	0	0		
	Installation																			
	- M-P	16.00 h / mt				2,678	h	24.00					64,282	0	0	0	0	64,282		2,678
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	20%	1	536	h				37.00	20.00	0	0	0	19,832	7,718	27,550		
	- Boom truck 17 tons	13.65	18.00	50%	1	1,339	h				13.65	18.00	0	0	0	18,277	17,353	35,630		
	Concrete transportation from the Batching Plan					**2,790**	**m³**						0	0	0	0	0	0		
	Average production	400 m³ / sh				7	sh						0	0	0	0	0	0		
			10 h / sh			70	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				5	350	h	24.00					8,400	0	0	0	0	8,400		350
													0	0	0	0	0	0		
	- Readymix 8 m³	13.60	4.00	90%	4	252					13.60	4.00	0	0	0	3,427	726	4,153		
													0	0	0	0	0	0		
	Average hauling distance :		5.00 km										0	0	0	0	0	0		
													0	0	0	0	0	0		
	Loading	10											0	0	0	0	0	0		
	Going	10	30 km / h										0	0	0	0	0	0		
	Unloading	8											0	0	0	0	0	0		
	Return	9	35 km / h										0	0	0	0	0	0		
		37 min.											0	0	0	0	0	0		
	Efficacité :	85%	44 min. / trip										0	0	0	0	0	0		
			0.73 h / trip										0	0	0	0	0	0		
			9 h / sh										0	0	0	0	0	0		
			13 trips / sh										0	0	0	0	0	0		
	Readymix 8 m³		8 m³										0	0	0	0	0	0		
			104 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks :		**4**										0	0	0	0	0	0		
	Tailrace access					**1,200**	**m³**													
	- Concreting	2.75 h / m³				3,300	h	24.00					79,200	0	0	0	0	79,200		3,300
	- Construction materials					1,200	m³		70.00				0	84,000	0	0	0	84,000		
	- Construction equipment					1,200	m³				40.00	48.00	0	0	0	48,000	41,472	89,472		
													0	0	0	0	0	0		
	- Concrete supply	1,200	1.10 h / m³	2%		1,224	m²	26.39	13.69	122.47	13.41	4.31	32,307	16,759	149,907	16,408	3,801	219,182		1,344
	Reinforcing Steel												0	0	0	0	0	0		
	- Supply and Fabrication	60 kg / m³	15.00 h / mt			**72**	**mt**	360.00	100.00	992.61	64.16	37.80	25,920	7,200	71,468	4,619	1,960	111,167		1,080
													0	0	0	0	0	0		

Item : (2430-2470)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Installation																	
	- M-P 16.00 h / mt			1,152	h	24.00					27,648	0	0	0	0	27,648		1,152
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	20%	1	230	h				37.00	20.00	0	0	0	8,510	3,312	11,822		
	- Boom truck 17 tons 13.65 18.00	50%	1	576	h				13.65	18.00	0	0	0	7,862	7,465	15,327		
	Concrete transportation from the Batching Plan			**1,200**	**m³**						0	0	0	0	0	0		
	Average production 300 m³ / sh			4	sh						0	0	0	0	0	0		
	10 h / sh			40	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	160	h	24.00					3,840	0	0	0	0	3,840		160
											0	0	0	0	0	0		
	- Readymix 8 m³ 13.60 14.00	90%	3	108					13.60	14.00	0	0	0	1,469	1,089	2,558		
											0	0	0	0	0	0		
	Average hauling distance : 5.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 10										0	0	0	0	0	0		
	Going 10 30 km / h										0	0	0	0	0	0		
	Unloading 8										0	0	0	0	0	0		
	Return 9 35 km / h										0	0	0	0	0	0		
	37 min.										0	0	0	0	0	0		
	Efficacité : 85% 44 min. / trip										0	0	0	0	0	0		
	0.73 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	13 trips / sh										0	0	0	0	0	0		
	Readymix 8 m³ 8 m³										0	0	0	0	0	0		
	104 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **3**										0	0	0	0	0	0		
											0	0	0	0	0	0		
2470	**Concrete Plugs - Tunnels**			**6,490**	**m³**						**923,506**	**583,880**	**1,197,294**	**475,410**	**321,926**	**3,502,016**	**540**	**38,468**

Item : 2510

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES					TOTAL COSTS					GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption			
											24.00 $				0.72 $			

2500 Civil works related to Power tunnel

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2510	**Power tunnel (including Rock Support)**			**1,337,062**	**m^3**													
	TBM 1 - Operation										0	0	0	0	0	0		
	Dia. Area Lenth Volume										0	0	0	0	0	0		
	8.0 50.27 16,000 804,248			**804,248**	**m^3**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Cutter cost			804,248	m^3				17.75		0	0	0	14,275,402	0	14,275,402		
	Assembling 7 wks 60 h / wk			420	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Foreman		1	420	h	24.00					10,080	0	0	0	0	10,080		420
	- Mechanic		4	1,680	h	24.00					40,320	0	0	0	0	40,320		1,680
	- Electrician		2	840	h	24.00					20,160	0	0	0	0	20,160		840
	- Iron worker		4	1,680	h	24.00					40,320	0	0	0	0	40,320		1,680
	- Miner		1	420	h	24.00					10,080	0	0	0	0	10,080		420
	- Crane op.		1	420	h	24.00					10,080	0	0	0	0	10,080		420
	- Crane op.helper		1	420	h	24.00					10,080	0	0	0	0	10,080		420
	- Truck Driver		3	1,260	h	24.00					30,240	0	0	0	0	30,240		1,260
			17								0	0	0	0	0	0		
	- Crane - Rough terrain 120 t (L-Belt) 45.00 23.00		1	420	h				45.00	23.00	0	0	0	18,900	6,955	25,855		
	- Welding Machine - 400 A 2.00 6.00		1	420	h				2.00	6.00	0	0	0	840	1,814	2,654		
	- Tractor truck & Load Carrier - 65 T 11.50 15.00	100%	1	420	h				11.50	15.00	0	0	0	4,830	4,536	9,366		
	- Boom truck 17 tons 13.65 18.00	100%	2	840	h				13.65	18.00	0	0	0	11,466	10,886	22,352		
											0	0	0	0	0	0		
	Labour										0	0	0	0	0	0		
	Average penetration 1.8 m / h										0	0	0	0	0	0		
	Duration																	
	Distance 16,000 m 8,889 h										0	0	0	0	0	0		
	2 m strokes 8,000 strokes										0	0	0	0	0	0		
	5 min / stroke 667 h										0	0	0	0	0	0		
	1 Conveyer belt splicing per 300 m														0			
	53 splices																	
	15 h / splice 800 h														0			
	10,356										0	0	0	0	0	0		
	Efficiency 85% 12,183 h										0	0	0	0	0	0		
	10 h / sh **1,218 sh**										0	0	0	0	0	0		
	12 sh / week 102 weeks										0	0	0	0	0	0		
	23.6 months										0	0	0	0	0	0		
											0	0	0	0	0	0		
	1) Day shift			609	sh						0	0	0	0	0	0		
	10 h / sh			6,090	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Foreman	100%	1	6,090	h	24.00					146,160	0	0	0	0	146,160		6,090
	- TBM Operator	100%	1	6,090	h	24.00					146,160	0	0	0	0	146,160		6,090
	- Rock Support and support	100%	12	73,080	h	24.00					1,753,920	0	0	0	0	1,753,920		73,080
	- Iron worker	100%	1	6,090	h	24.00					146,160	0	0	0	0	146,160		6,090
	- Electrician	100%	1	6,090	h	24.00					146,160	0	0	0	0	146,160		6,090
			16								0	0	0	0	0	0		
											0	0	0	0	0	0		

Item : 2510

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	2) Night shift			609	sh						0	0	0	0	0	0		
	10 h / sh			6,090	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Foreman	100%	1	6,090	h	24.00					146,160	0	0	0	0	146,160		6,090
	- TBM Operator	100%	1	6,090	h	24.00					146,160	0	0	0	0	146,160		6,090
	- Rock Support and support	100%	12	73,080	h	24.00					1,753,920	0	0	0	0	1,753,920		73,080
	- Iron worker	100%	1	6,090	h	24.00					146,160	0	0	0	0	146,160		6,090
	- Electrician	100%	1	6,090	h	24.00					146,160	0	0	0	0	146,160		6,090
			16								0	0	0	0	0	0		
											0	0	0	0	0	0		
	Equipment										0	0	0	0	0	0		
	- TBM			8,889	h				160.00		0	0	0	1,422,222	0	1,422,222		
	- Conveyers			8,889	h				50.00		0	0	0	444,444	0	444,444		
	- Boom truck 17 tons 13.65 18.00	90%	2	16,000	h				13.65	18.00	0	0	0	218,400	207,360	425,760		
											0	0	0	0	0	0		
	- Container rental 40' 56 un			1,344	c-mts		140.00				0	188,160	0	0	0	188,160		
	24 months 20' 26 un			624	c-mts		100.00				0	62,400	0	0	0	62,400		
											0	0	0	0	0	0		
	Disposal of excavated materials										0	0	0	0	0	0		
	804,248 m³ solid										0	0	0	0	0	0		
	1.6 factor 1,286,797 loose 1,056 m³ / sh										0	0	0	0	0	0		
	118 m³ / h										0	0	0	0	0	0		
	1.97 m³ / min										0	0	0	0	0	0		
	Average hauling distance : 1.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 7.00										0	0	0	0	0	0		
	Going 2.00 35 km / h										0	0	0	0	0	0		
	Unloading 3.00										0	0	0	0	0	0		
	Return 1.00 45 km / h										0	0	0	0	0	0		
	13.00 min.										0	0	0	0	0	0		
	Efficacité : 85% 15 min. / trip										0	0	0	0	0	0		
	0.25 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	36 trips / day										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m³										0	0	0	0	0	0		
	432 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **3**										0	0	0	0	0	0		
				1,218	sh						0	0	0	0	0	0		
	10 h / sh			12,180	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	60,900	h	24.00					1,461,600	0	0	0	0	1,461,600		60,900
											0	0	0	0	0	0		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	3	32,886	h				24.00	20.00	0	0	0	789,264	473,558	1,262,822		
	- Cat D6T LGP Track-Type Tractor 28.40 26.10	90%	1	10,962	h				28.40	26.10	0	0	0	311,321	205,998	517,319		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		

Item : 2510

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
	Dismantling TBM & Conveyers 4 weeks 60 h / w			240	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		16	3,840	h	24.00					92,160	0	0	0	0	92,160		3,840
											0	0	0	0	0	0		
	- Crane - Rough terrain 120 t (L-Belt) 45.00 23.00	90%	1	216	h				45.00	23.00	0	0	0	9,720	3,577	13,297		
	- Tractor truck & Load Carrier - 65 T 11.50 15.00	90%	2	432	h				11.50	15.00	0	0	0	4,968	4,666	9,634		
	- Boom truck 17 tons 13.65 18.00	90%	2	432	h				13.65	18.00	0	0	0	5,897	5,599	11,496		
											0	0	0	0	0	0		
	Dewatering Duration 30 months (26+4)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Purchase of equipment and materials										0	0	0	0	0	0		
	- Pumps			1	ls		20,000				0	20,000	0	0	0	20,000		
	- Miscelaneous			16,000	m		15.00				0	240,000	0	0	0	240,000		
											0	0	0	0	0	0		
	Outside Installation			30	h						0	0	0	0	0	0		
															0			
	- M-P		7	210	h	24.00					5,040	0	0	0	0	5,040		210
											0	0	0	0	0	0		
	- Equipment			30	h				200.00		0	0	0	6,000	0	6,000		
											0	0	0	0	0	0		
	Pumping 130 weeks 6 d / w			780	days						0	0	0	0	0	0		
	20 h / day			15,600	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		1	15,600	h	24.00					374,400	0	0	0	0	374,400		15,600
											0	0	0	0	0	0		
	- Miscelaneous			130	weeks		110.00				0	14,300	0	0	0	14,300		
											0	0	0	0	0	0		
	Industrial Water Supply										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Purchase of equipment and materials										0	0	0	0	0	0		
	- Pumps			2	un		20,000				0	40,000	0	0	0	40,000		
	- Miscelaneous			16,000	m		21.00				0	336,000	0	0	0	336,000		
											0	0	0	0	0	0		
	Enclosed building for Compressors and Generators TBM 1) 13 34 19,50 - 1000										0	0	0	0	0	0		
	(Outside services for TMB 1, Powerhouse, Transformer Chamber, Tailrace tunnel and Cable Tunnel)																	
	Individual containers for generating units																	
	- Supply 10 x 50			500	m²		137.00				0	68,500	0	0	0	68,500		
	- Install 0.913 h / m²			457	h	24.00					10,968	0	0	0	0	10,968		457
	- Equipment			500	m²				30.00		0	0	0	15,000	0	15,000		
											0	0	0	0	0	0		
	- Overhead crane - 15 T			1	ls		75,000				0	75,000	0		0	75,000		
											0	0	0	0	0	0		
	- Door			1	ls		20,000				0	20,000	0	0	0	20,000		
	13 34 19,50 - 1000										0	0	0	0	0	0		
	- Insulation			500	m²		10.70				0	5,350	0	0	0	5,350		
	- M-P 0.075 h / m²			38	h	24.00					912	0	0	0	0	912		38
															0			
	Compressed Air										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Miscelaneous materials			16,000	m		24.00				0	384,000	0	0	0	384,000		
											0	0	0	0	0	0		

Item : 2510

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Outside Installation			120	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		9	1,080	h	24.00					25,920	0	0	0	0	25,920		1,080
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	108	h				13.65	18.00	0	0	0	1,474	1,400	2,874		
											0	0	0	0	0	0		
	Operation 2012 52																	
	2013 52																	
	2014 17																	
	121 weeks 6 days / week			726	days						0	0	0	0	0	0		
	18 h / d			13,068	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		1	13,068	h	24.00					313,632	0	0	0	0	313,632		13,068
											0	0	0	0	0	0		
	- Compressor - 1050 cfm (XRHS1100CD 25.78 50.00		2	26,136	h				25.78	50.00	0	0	0	673,819	940,896	1,614,715		
											0	0	0	0	0	0		
	Ventilation & Heathing Duration (winter) 61 weeks	50%									0	0	0	0	0	0		
	Purchase of equipment and materials										0	0	0	0	0	0		
	- Miscelaneous (fans, Furnace, Ducts, etc.)			16,000	m		20				0	320,000	0	0	0	320,000		
											0	0	0	0	0	0		
	Heathing Operation 7 d / week										0	0	0	0	0	0		
	24 h / day			10,164	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 60 h / week		2	7,260	h	24.00					174,240	0	0	0	0	174,240		7,260
											0	0	0	0	0	0		
	- Furnace - 2 500 000 BTU 2.00 91.00		2	20,328					2.00	91.00	0	0	0	40,656	1,331,891	1,372,547		
											0	0	0	0	0	0		
	Outside Installation and Removing			6	s						0	0	0	0	0	0		
	60 h / s			360	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	2,160	h	24.00					51,840	0	0	0	0	51,840		2,160
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	324	h				13.65	18.00	0	0	0	4,423	4,199	8,622		
											0	0	0	0	0	0		
	Door Operation 61 weeks 6 days / week			366	days						0	0	0	0	0	0		
	18 h / d			6,588	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		1	6,588	h	24.00					158,112	0	0	0	0	158,112		6,588
											0	0	0	0	0	0		
	Electrical supply										0	0	0	0	0	0		
	Needed capacity TBM 3,000 kW										0	0	0	0	0	0		
	Conveyer 2 x 600 1,200 kW										0	0	0	0	0	0		
	Boosters 3 x 600 1,800 kW										0	0	0	0	0	0		
	Powerhouse 600 kW																	
	Transfos 600 kW																	
	Tailrace 1,200 kW																	
	Cable tunnel 600 kW																	
	9,000										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Miscelaneous			16,000	m		22.00				0	352,000	0	0	0	352,000		
											0	0	0	0	0	0		

Item : 2510

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Outside Installation and dismantling			120	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	600	h	24.00					14,400	0	0	0	0	14,400		600
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	108	h				13.65	18.00	0	0	0	1,474	1,400	2,874		
											0	0	0	0	0	0		
	Operation 121 weeks										0	0	0	0	0	0		
	6 days / week										0	0	0	0	0	0		
	18 h / day			13,068	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		2	26,136	h	24.00					627,264	0	0	0	0	627,264		26,136
											0	0	0	0	0	0		
	- Cat GEP 550 - 400KW 400 6.50 102.40 1,600		4	52,272	h				6.50	102.40	0	0	0	339,768	3,853,910	4,193,678		
	- Cat GEP 1250 - 1250kW 1,250 10.50 185.00 7,500		6	78,408	h				10.50	185.00	0	0	0	823,284	10,443,946	11,267,230		
	9,100										0	0	0	0	0	0		
	TBM 2 - Operation										0	0	0	0	0	0		
	Dia. Area Lenth Volume										0	0	0	0	0	0		
	8.0 50.27 10,600 532,814										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Cutter cost			532,814	m³				17.75		0	0	0	9,457,449	0	9,457,449		
	Assembling 7 wks 60 h / wk			420	h							0	0	0	0	0		
											0	0	0	0	0	0		
	- Foreman		1	420	h	24.00					10,080	0	0	0	0	10,080		420
	- Mechanic		4	1,680	h	24.00					40,320	0	0	0	0	40,320		1,680
	- Electrician		2	840	h	24.00					20,160	0	0	0	0	20,160		840
	- Iron worker		4	1,680	h	24.00					40,320	0	0	0	0	40,320		1,680
	- Miner		1	420	h	24.00					10,080	0	0	0	0	10,080		420
	- Crane op.		1	420	h	24.00					10,080	0	0	0	0	10,080		420
	- Crane op.helper		1	420	h	24.00					10,080	0	0	0	0	10,080		420
	- Truck Driver		3	1,260	h	24.00												
			17								0	0	0	0	0	0		
	- Crane - Rough terrain 120 t (L-Belt) 45.00 23.00	90%	1	378	h				45.00	23.00	0	0	0	17,010	6,260	23,270		
	- Welding Machine - 400 A 2.00 6.00	90%	1	378	h				2.00	6.00	0	0	0	756	1,633	2,389		
	- Tractor truck & Load Carrier - 65 T 11.50 15.00	90%	1	378	h				11.50	15.00	0	0	0	4,347	4,082	8,429		
	- Boom truck 17 tons 13.65 18.00	90%	2	756	h				13.65	18.00	0	0	0	10,319	9,798	20,117		
	Labour										0	0	0	0	0	0		
	Average penetration 1.8 m / h										0	0	0	0	0	0		
	Duration Distance 10,600 m 5,889 h										0	0	0	0	0	0		
	2 m strokes 5,300 strokes										0	0	0	0	0	0		
	5 min / stroke 442 h										0	0	0	0	0	0		
	1 Conveyer belt splicing per 300 m														0			
	35 splices														0			
	15 h / splice 530																	
	6,861										0	0	0	0	0	0		
	Efficiency 85% 8,072 h										0	0	0	0	0	0		
	10 h / sh **807 sh**										0	0	0	0	0	0		
	12 sh / week 67 weeks										0	0	0	0	0	0		
	15.5 months										0	0	0	0	0	0		
											0	0	0	0	0	0		
	1) Day shift			404	sh						0	0	0	0	0	0		
	10 h / sh			4,040	h						0	0	0	0	0	0		
											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
-	Foreman	100%	1	4,040	h	24.00					96,960	0	0	0	0	96,960		4,040
-	TBM Operator	100%	1	4,040	h	24.00					96,960	0	0	0	0	96,960		4,040
-	Rock Support and support	100%	12	48,480	h	24.00					1,163,520	0	0	0	0	1,163,520		48,480
-	Iron worker	100%	1	4,040	h	24.00					96,960	0	0	0	0	96,960		4,040
-	Electrician	100%	1	4,040	h	24.00					96,960	0	0	0	0	96,960		4,040
			16								0	0	0	0	0	0		
											0	0	0	0	0	0		
2)	Night shift			404	sh						0	0	0	0	0	0		
	10 h / sh			4,040	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	Foreman	100%	1	4,040	h	24.00					96,960	0	0	0	0	96,960		4,040
-	TBM Operator	100%	1	4,040	h	24.00					96,960	0	0	0	0	96,960		4,040
-	Rock Support and support	100%	12	48,480	h	24.00					1,163,520	0	0	0	0	1,163,520		48,480
-	Iron worker	100%	1	4,040	h	24.00					96,960	0	0	0	0	96,960		4,040
-	Electrician	100%	1	4,040	h	24.00					96,960	0	0	0	0	96,960		4,040
			16								0	0	0	0	0	0		
											0	0	0	0	0	0		
	Equipment										0	0	0	0	0	0		
-	TBM			5,889	h				160.00		0	0	0	942,222	0	942,222		
-	Conveyers			5,889	h				50.00		0	0	0	294,444	0	294,444		
-	Boom truck 17 tons 13.65 18.00	90%	2	10,600	h				13.65	18.00	0	0	0	144,690	137,376	282,066		
											0	0	0	0	0	0		
-	Container rental 40' 56 un			1,344	c-mts		140.00				0	188,160	0	0	0	188,160		
	24 months 20' 40 un			960	c-mts		100.00				0	96,000	0	0	0	96,000		
											0	0	0	0	0	0		
	Disposal of excavated materials										0	0	0	0	0	0		
	532,814 m³ solid										0	0	0	0	0	0		
	1.6 factor 852,502 loose 1,056 m³ / sh										0	0	0	0	0	0		
	118 m³ / h										0	0	0	0	0	0		
	1.97 m³ / min														0			
	Average hauling distance : 1.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 7.00										0	0	0	0	0	0		
	Going 2.00 35 km / h										0	0	0	0	0	0		
	Unloading 3.00										0	0	0	0	0	0		
	Return 1.00 45 km / h										0	0	0	0	0	0		
	13.00 min.										0	0	0	0	0	0		
	Efficacité : 85% 15 min. / trip										0	0	0	0	0	0		
	0.25 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	36 trips / day										0	0	0	0	0	0		
	Cat 725 Arti Cat 725 Articulated Dum 12 m³										0	0	0	0	0	0		
	432 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **3**										0	0	0	0	0	0		
				807	sh						0	0	0	0	0	0		
	10 h / sh			8,070	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		5	40,350	h	24.00					968,400	0	0	0	0	968,400		40,350
											0	0	0	0	0	0		
-	Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	3	21,789	h				24.00	20.00	0	0	0	522,936	313,762	836,698		
-	Cat D6T LGP Track-Type Tractor 28.40 26.10	90%	1	7,263	h				28.40	26.10	0	0	0	206,269	136,486	342,755		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		

Item : 2510

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Dismantling TBM & Conveyers 4 weeks 60 h / w			240	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		16	3,840	h	24.00					92,160	0	0	0	0	92,160		3,840
											0	0	0	0	0	0		
	- Crane - Rough terrain 120 t (L-Belt) 45.00 23.00	90%	1	216	h				45.00	23.00	0	0	0	9,720	3,577	13,297		
	- Tractor truck & Load Carrier - 65 T 11.50 15.00	90%	2	432	h				11.50	15.00	0	0	0	4,968	4,666	9,634		
	- Boom truck 17 tons 13.65 18.00	90%	2	432	h				13.65	18.00	0	0	0	5,897	5,599	11,496		
											0	0	0	0	0	0		
	Dewatering Duration 24 months (17+7)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Purchase of equipment and materials										0	0	0	0	0	0		
	- Pumps			1	ls		20,000				0	20,000	0	0	0	20,000		
	- Miscelaneous			10,600	m		15.00				0	159,000	0	0	0	159,000		
											0	0	0	0	0	0		
	Outside Installation			30	h						0	0	0	0	0	0		
															0			
	- M-P		7	210	h	24.00					5,040	0	0	0	0	5,040		210
											0	0	0	0	0	0		
	- Equipment			30	h				200.00		0	0	0	6,000	0	6,000		
											0	0	0	0	0	0		
	Pumping 104 weeks 6 d / w			624	days						0	0	0	0	0	0		
	20 h / day			12,480	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		1	12,480	h	24.00					299,520	0	0	0	0	299,520		12,480
											0	0	0	0	0	0		
	- Miscelaneous			104	weeks		110.00				0	11,440	0	0	0	11,440		
											0	0	0	0	0	0		
	Industrial Water Supply										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Purchase of equipment and materials										0	0	0	0	0	0		
	- Pumps			2	un		20,000				0	40,000	0	0	0	40,000		
	- Miscelaneous			10,600	m		21.00				0	222,600	0	0	0	222,600		
											0	0	0	0	0	0		
	Enclosed building for Compressors and heating (TBM 2) 13 34 19,50 - 1000										0	0	0	0	0	0		
	Individual containers for generating units																	
	- Supply 10 x 50			500	m^2		137.00				0	68,500	0	0	0	68,500		
	- Install 0.913	h / m^2		457	h	24.00					10,968	0	0	0	0	10,968		457
	- Equipment			500	m^2				30.00		0	0	0	15,000	0	15,000		
											0	0	0	0	0	0		
	- Overhead crane - 15 T			1	ls				75,000		0	0	0	75,000	0	75,000		
											0	0	0	0	0	0		
	- Door			1	ls		20,000				0	20,000	0	0	0	20,000		
	13 34 19,50 - 1000										0	0	0	0	0	0		
	- Insulation			500	m^2		10.70				0	5,350	0	0	0	5,350		
	- M-P 0.075	h / m^2		38	h	24.00					912	0	0	0	0	912		38
															0			
	Compressed Air Duration 24 months										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Miscelaneous materials			10,600	m		24.00				0	254,400	0	0	0	254,400		
											0	0	0	0	0	0		

Item : 2510

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Outside Installation			120	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		9	1,080	h	24.00					25,920	0	0	0	0	25,920		1,080
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	108	h				13.65	18.00	0	0	0	1,474	1,400	2,874		
											0	0	0	0	0	0		
	Operation 2012 44																	
	2013 52																	
	2014 4																	
	100 weeks 6 days / week			600	days													
	18 h / d			10,800	h													
											0	0	0	0	0	0		
	- M-P		1	10,800	h	24.00					259,200	0	0	0	0	259,200		10,800
											0	0	0	0	0	0		
	- Compressor - 1050 cfm (XRHS1100CD 25.78 50.00		4	43,200	h				25.78	50.00	0	0	0	1,113,750	1,555,200	2,668,950		
											0	0	0	0	0	0		
	Ventilation & Heathing Duration (winter) 50 weeks	50%									0	0	0	0	0	0		
	Purchase of equipment and materials										0	0	0	0	0	0		
	- Miscelaneous (fans, Furnace, Ducts, etc.)			10,600	m		20				0	212,000	0	0	0	212,000		
											0	0	0	0	0	0		
	Heathing Operation 7 d / week										0	0	0	0	0	0		
	24 h / day			8,400	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 60 h / week		2	6,000	h	24.00					144,000	0	0	0	0	144,000		6,000
											0	0	0	0	0	0		
	- Furnace - 2 500 000 BTU 2.00 91.00		3	25,200	h				2.00	91.00	0	0	0	50,400	1,651,104	1,701,504		
											0	0	0	0	0	0		
	Outside Installation and Removing			6	s						0	0	0	0	0	0		
	60 h / s			360	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	2,160	h	24.00					51,840	0	0	0	0	51,840		2,160
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	324	h				13.65	18.00	0	0	0	4,423	4,199	8,622		
											0	0	0	0	0	0		
	Door Operation 50 weeks 6 days / week			300	days						0	0	0	0	0	0		
	18 h / d			5,400	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		1	5,400	h	24.00					129,600	0	0	0	0	129,600		5,400
											0	0	0	0	0	0		
	Electrical supply										0	0	0	0	0	0		
	Needed capacity TBM 3,000 kW										0	0	0	0	0	0		
	Conveyer 2 x 600 1,200 kW										0	0	0	0	0	0		
	Boosters 3 x 600 1,800 kW										0	0	0	0	0	0		
	6,000										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Miscelaneous			10,600	m		22.00				0	233,200	0	0	0	233,200		
											0	0	0	0	0	0		
	Outside Installation and dismantling			120	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	600	h	24.00					14,400	0	0	0	0	14,400		600
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00		1	120	h				13.65	18.00	0	0	0	1,638	1,555	3,193		
											0	0	0	0	0	0		

WBS	DESCRIPTION					%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
															24.00 $				0.72 $			
	Operation	100 weeks													0	0	0	0	0	0		
		6 days / week													0	0	0	0	0	0		
		18 h / day						10,800	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						2	21,600	h	24.00					518,400	0	0	0	0	518,400		21,600
	- Cat GEP 550 - 400KW	400	6.50	102.40	1,600		4	43,200	h				6.50	102.40	0	0	0	280,800	3,185,050	3,465,850		
	- Cat GEP 1250 - 1250kW	1,250	10.50	185.00	5,000		4	43,200	h				10.50	185.00	0	0	0	453,600	5,754,240	6,207,840		
					6,600										0	0	0	0	0	0		
	Rock Support (total power tunnel)							**26,600**	**m**						0	0	0	0	0	0		
			Tunnel												0	0	0	0	0	0		
	Required	Length	Dia.(m)	Arch (m)											0	0	0	0	0	0		
	Class 1	19,950.0	8	12.57		75%									0	0	0	0	0	0		
	Class 2	3,990.0	8	12.57		15%									0	0	0	0	0	0		
	Class 3	1,862.0	8	12.57		7.0%									0	0	0	0	0	0		
	Class 4	665.0	8	12.57		2.5%									0	0	0	0	0	0		
	Class 5	133.0	8	12.57		0.5%									0	0	0	0	0	0		
		26,600				100%									0	0	0	0	0	0		
	Class 1			Qty											0	0	0	0	0	0		
	Rock bolts 2,5 m	1 un / m		19,950 un											0	0	0	0	0	0		
	Shotcrete 50 mm	1.88 m² / m		37,605 m²															0			
	Class 2														0	0	0	0	0	0		
	Rock bolts 2,5 m	1.0 un / m		3,990 un											0	0	0	0	0	0		
	Shotcrete 50 mm	1.88 m² / m		7,521 m²															0			
	Wire mesh	1.9 m² / m		7,521 m²											0	0	0	0	0	0		
	Class 3														0	0	0	0	0	0		
	Rock bolts 2,5 m	2.01 un / m		3,744 un											0	0	0	0	0	0		
	Shotcrete 50 mm	12.6 m² / m		23,399 m²											0	0	0	0	0	0		
	Wire mesh	1.9 m² / m		3,510 m²															0			
	Class 4														0	0	0	0	0	0		
	Rock bolts 3 m	3.1 un / m		2,089 un											0	0	0	0	0	0		
	Shotcrete 100 mm	12.6 m² / m		8,357 m²											0	0	0	0	0	0		
	Reinf. Mesh	12.6 m² / m		8,357 m²											0	0	0	0	0	0		
	Steel arch (W 100)	2.00 m c/c		332.50 un											0	0	0	0	0	0		
		20.0 m / arch		6,650 m											0	0	0	0	0	0		
	Class 5														0	0	0	0	0	0		
	Rock bolts 4 m	12.6 un / m		1,671 un											0	0	0	0	0	0		
	Shotcrete 150 mm	12.6 m² / m		1,671 m²											0	0	0	0	0	0		
	Reinf. Mesh	12.6 m² / m		1,671 m²											0	0	0	0	0	0		
	Steel arch (W 150)	1.00 m c/c		133.00 un											0	0	0	0	0	0		
		20.0		2,660 m											0	0	0	0	0	0		
	Supply			Lenght (m)											0	0	0	0	0	0		
	- Rock bolts 2,5 m	27,684 un		69,210	Losses	3%		28,515	un			60.00			0	0	1,710,900	0	0	1,710,900		
	- Rock bolts 3 m	2,089 un		6,267	Losses	3%		2,152	un			70.00			0	0	150,640	0	0	150,640		
	- Rock bolts 4 m	1,671 un		6,884	Losses	3%		1,721	un			80.00			0	0	137,680	0	0	137,680		
		31,444		82,361											0	0	0	0	0	0		
	- Injection tubes	150 m roll				3%		566	rolls			110.00			0	0	62,260	0	0	62,260		
	- Oakum	130 bolts / box				3%		250	box			280.00			0	0	70,000	0	0	70,000		
	- Grease	154 bolts / box				3%		210	box			336.00			0	0	70,560	0	0	70,560		
															0	0	0	0	0	0		
	- Wire mesh	11,031 m²				15%		12,685	m²			4.60			0	0	58,351	0	0	58,351		
	- Reinf. Mesh	10,028 m²				15%		11,532	m²			5.60			0	0	64,579	0	0	64,579		
		21,059 m²													0	0	0	0	0	0		

Item : 2510

						UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Spikes 1.25 m c/c 16,847 un	3%		17,352	un			4.50			0	0	78,084	0	0	78,084		
	- Wire 0.04 $ / m²			21,059	m²			0.04			0	0	842	0	0	842		
	m² Thickness m³										0	0	0	0	0	0		
	Shotcrete 50 mm 68,524 0.05 3,426										0	0	0	0	0	0		
	Shotcrete 100 mm 8,357 0.1 836										0	0	0	0	0	0		
	Shotcrete 150 mm 1,671 0.15 251										0	0	0	0	0	0		
	4,513										0	0	0	0	0	0		
	- Cement (40 kg Bags) 0.03 m³ / bag Losses	7.5%		161,716	bags			10.00			0	0	1,617,160	0	0	1,617,160		
	33.33 bags / m³ 150,433 bags										0	0	0	0	0	0		
	- Sand 1.40 mt / m³ 0.08 h / mt			6,318	mt	1.94	0.00	0.00	2.27	1.58								505
	- Monoset (3% of cement) 6,468,640 kg	3%		194,059	kg			3.40			0	0	659,801	0	0	659,801		
											0	0	0	0	0	0		
	- Steel arch (W 100) 19.0 kg / m 126,350 kg			126,350	kg			4.00			0	0	505,400	0	0	505,400		
	- Steel arch (W 150) 22 kg / m 58,520 kg			58,520	kg			4.00			0	0	234,080	0	0	234,080		
											0	0	0	0	0	0		
	Rock bolts Installation			2,025	sh						0	0	0	0	0	0		
											0	0	0	0	0	0		
	1) Drilling with TBM Crew										0	0	0	0	0	0		
											0	0	0	0	0	0		
	2) Install with 50t crane with basket										0	0	0	0	0	0		
	31,444 un 16 un / sh										0	0	0	0	0	0		
	0.5 h / un incl. Positionning																	
	8 h / sh			15,722	h													
	- M-P		3	47,166	h	24.00					1,131,990	0	0	0	0	1,131,990		47,166
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	14,150	h				37.00	20.00	0	0	0	523,550	203,760	727,310		
											0	0	0	0	0	0		
	- Impact tool			1	un		300.00				0	300	0	0	0	300		
	- Test rig			1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque rench			1	un		280.00				0	280	0	0	0	280		
											0	0	0	0	0	0		
	3) Injection 40 bolts / sh			787	sh						0	0	0	0	0	0		
	10 h / sh			7,870	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	31,480	h	24.00					755,520	0	0	0	0	755,520		31,480
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	7,083	h				37.00	20.00	0	0	0	262,071	101,995	364,066		
	- Moyno pump 2.00	75%	1	5,903	h				2.00		0	0	0	11,806	0	11,806		
											0	0	0	0	0	0		
	- Cement (bags) 82,361 m	100%		13,476	bags			10.00			0	0	134,760	0	0	134,760		
	270,146 ft 0.022698 sf										0	0	0	0	0	0		
	2 in. Dia hole 6,132 cu ft										0	0	0	0	0	0		
	0.91 cu ft / bag 6,738 bags										0	0	0	0	0	0		
	- Intraplast "N" 0.4 kg / bag 2,695 kg	1%		2,722	kg			3.00			0	0	8,166	0	0	8,166		
	- Miscellaneous			31,444	un		0.30				0	9,433	0	0	0	9,433		
											0	0	0	0	0	0		

Item : 2510

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Wire mesh installation Installation by TBM crew										0	0	0	0	0	0		
	Production of 200 m² / sh 21,059 m²			105	sh						0	0	0	0	0	0		
	10 h / sh			1,053	h										0			
	Plus										0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	948	h				37.00	20.00	0	0	0	35,076	13,651	48,727		
	- Jack leg 2.00	30%	1	316	h				2.00		0	0	0	632	0	632		
	- Miscellaneous materials Spike drillin 18531.7 m			18,532	m		1.00				0	18,532	0	0	0	18,532		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Shotcreting **By the TBM crew**			**4,513**	**m³**						0	0	0	0	0	0		
	Production of 0.7 h / m³ 3,159 h														0			
	7.5 h / sh Eff.			422	sh										0			
	10 h / sh			4,220	h						0	0	0	0	0	0		
	Plus										0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	3,798	h				37.00	20.00	0	0	0	140,526	54,691	195,217		
	- Shotcrete pump 17.00	60%	1	2,532	h				17.00		0	0	0	43,044	0	43,044		
	- Hoses	25%	1	1,055	h		35.00				0	36,925	0	0	0	36,925		
	- Nozzle 66 m³ / un			68	un		275.00				0	18,700	0	0	0	18,700		
											0	0	0	0	0	0		
	Arches installation			**466**	**un**						0	0	0	0	0	0		
	Production of 2 un / sh			233	sh						0	0	0	0	0	0		
	10 h / sh			2,330	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	11,650	h	24.00					279,600	0	0	0	0	279,600		11,650
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	2,097	h				37.00	20.00	0	0	0	77,589	30,197	107,786		
	- Miscellaneous materials			466	un		200.00				0	93,200	0	0	0	93,200		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2510	**Power tunnel (including Rock Support)**			**1,337,062**	**m³**						**16,090,278**	**3,834,930**	**5,563,263**	**34,140,978**	**30,682,872**	**90,312,321**	**67.55**	**670,934**

Item : 2520

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2520	**Power tunnel Access and addit**			**279,073**	**m³**													
	KM 16 1,640										0	0	0	0	0	0		
	Powerhouse 1,377										0	0	0	0	0	0		
	D Shape 10 x 10 92.5 m³ 3,017 m			**279,073**	**m³**						0	0	0	0	0	0		
	Area (m²)										0	0	0	0	0	0		
	Arc 11.59 17.50										0	0	0	0	0	0		
	Height 10.00										0	0	0	0	0	0		
	Wall 7.50 75.00										0	0	0	0	0	0		
	Width 10.00										0	0	0	0	0	0		
	92.5										0	0	0	0	0	0		
	Excavation										0	0	0	0	0	0		
	Progression 4.66 m										0	0	0	0	0	0		
	Number of rounds 648										0	0	0	0	0	0		
	Number of shifts 907 Prod. Factor 1.4										0	0	0	0	0	0		
	Number of holes (m) (Feet)										0	0	0	0	0	0		
	Production 74 55 mm dia. 241,199 791,131										0	0	0	0	0	0		
	Contour 41 55 mm dia. 133,637 438,329										0	0	0	0	0	0		
	115										0	0	0	0	0	0		
	Cut 3 109 mm dia. 9,778 32,073										0	0	0	0	0	0		
	118										0	0	0	0	0	0		
	Drilling depth 5.03 m 384,614 1,261,534										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Durations (hours) 648 rounds										0	0	0	0	0	0		
	Drilling 150 m / h 3.96 2,564 h										0	0	0	0	0	0		
	Blasting 1.15 min / hole 2.26 1,466 h										0	0	0	0	0	0		
	Scaling & W. mesh 2.00 1,296 h										0	0	0	0	0	0		
	Mucking 205 m³ / h 2.10 1,363 h										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling labour										0	0	0	0	0	0		
	H-H Bolting W. Mesh Remaining										0	0	0	0	0	0		
	8 72,560 10,158 8,707 53,694										0	0	0	0	0	0		
	14% 12%										0	0	0	0	0	0		
	Drilling 4.0 648 2,592 h										0	0	0	0	0	0		
	9 h / sh 288 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 23,040 h-h										0	0	0	0	0	0		
	Loading & Blasting 2.26 648 1,466 h										0	0	0	0	0	0		
	9 h / sh 163 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 13,040 h-h										0	0	0	0	0	0		
	Remaining for services 17,614										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling			2,880	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	23,040	h	24.00					552,960	0	0	0	0	552,960		23,040
	648 rounds										0	0	0	0	0	0		
	- Jumbo E 3C 14.00 4.5 h			2,916	h				14.00		0	0	0	40,824	0	40,824		
	- Cat GEP 550 - 400KW 6.50 102.40 12 h			7,776	h				6.50	102.40	0	0	0	50,544	573,309	623,853		
	Feet ft / un										0	0	0	0	0	0		
	- Bits 2"Ø 1,229,461 1,600			768	un		85.00				0	65,280	0	0	0	65,280		
	- Bits 4"Ø 32,073 1,500			21	un		500.00				0	10,500	0	0	0	10,500		
	- Rod 18' 1,261,534 7,500			168	un		485.00				0	81,480	0	0	0	81,480		
	- Coupling 1,261,534 3,700			341	un		50.00				0	17,050	0	0	0	17,050		
	- Shank 1,261,534 12,500			101	un		300.00				0	30,300	0	0	0	30,300		
	- Misc. Materials 1,261,534			1,261,534	ft		0.04				0	50,461	0	0	0	50,461		

Item : 2520

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
	Loading & Blasting			1,630	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	13,040	h	24.00					312,960	0	0	0	0	312,960		13,040
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	1,467	h				5.00	15.00	0	0	0	7,335	15,844	23,179		
											0	0	0	0	0	0		
	5.03 m holes 648 Rounds										0	0	0	0	0	0		
	Number Total Length (m)										0	0	0	0	0	0		
	Contour holes 41 26,568 133,637										0	0	0	0	0	0		
	Production holes 74 47,952 241,199										0	0	0	0	0	0		
	115 74,520										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Prima cord 5.5 m 146,124	5%		153,430	m		1.00				0	153,430	0	0	0	153,430		
	- Cap 6m 74,520	13%		84,208	un		3.50				0	294,728	0	0	0	294,728		
	- Dynamite RXL 438 279,073 m^3 Powder fact 1.6			446,516	kg		5.60				0	2,500,490	0	0	0	2,500,490		
	- XACTEX 26,568 holes 73,062	5%		76,715	kg		7.50				0	575,363	0	0	0	575,363		
	2.75 kg / hole										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Mucking 279,073 m^3										0	0	0	0	0	0		
	1.5 Loose »»»» 418,609 m^3										0	0	0	0	0	0		
	646 m^3 / round										0	0	0	0	0	0		
	Production 140 m^3 / h 4.61 h										0	0	0	0	0	0		
	648 rounds 2,990 h x 10/9 »»			3,322	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		7	23,256	h	24.00					558,145	0	0	0	0	558,145		23,256
											0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	50%	1	1,661	h				19.00	29.00	0	0	0	31,559	34,682	66,241		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	2,990	h				39.20	48.00	0	0	0	117,208	103,334	220,542		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	2,990	h				38.25	28.00	0	0	0	114,368	60,278	174,646		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	3	8,970	h				24.00	20.00	0	0	0	215,280	129,168	344,448		
											0	0	0	0	0	0		
	Disposal of excavated materials										0	0	0	0	0	0		
	Average hauling distance : 3.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 8										0	0	0	0	0	0		
	Going 6 30 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 6 30 km / h										0	0	0	0	0	0		
	23 min.										0	0	0	0	0	0		
	Efficacité : 85% 27 min. / trip										0	0	0	0	0	0		
	0.45 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	20 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m^3										0	0	0	0	0	0		
	240 m^3 / truck-sh										0	0	0	0	0	0		
	Number of trucks : **3**										0	0	0	0	0	0		
	Rolling Path Length 3,017										0	0	0	0	0	0		
	Width 8.00										0	0	0	0	0	0		
	Thickness 0.30										0	0	0	0	0	0		
	Volume 7,241										0	0	0	0	0	0		
	Production 1,200 m^3 / sh			7	sh						0	0	0	0	0	0		
	10 h / s			70	h						0	0	0	0	0	0		
											0	0	0	0	0	0		

						UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- M-P		8	560	h	24.00					13,440	0	0	0	0	13,440		560
											0	0	0	0	0	0		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	63	h				39.20	48.00	0	0	0	2,470	2,177	4,647		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	63	h				38.25	28.00	0	0	0	2,410	1,270	3,680		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	1	63	h				24.00	20.00	0	0	0	1,512	907	2,419		
											0	0	0	0	0	0		
	Portals excavation 4,000 m³										0	0	0	0	0	0		
	Drilling										0	0	0	0	0	0		
	Drilling grid ,9 x 1,2 0.90 1.20 1.08 m²										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling length 3,704 m										0	0	0	0	0	0		
	Production of 230 m / machine / sh			16	sh						0	0	0	0	0	0		
	2 machines			8	sh						0	0	0	0	0	0		
	10 h / s			80	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	640	h	24.00					15,360	0	0	0	0	15,360		640
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	2	144	h				19.40	15.00	0	0	0	2,794	1,555	4,349		
	- Drilling materials			3,704	m		0.70				0	2,593	0	0	0	2,593		
											0	0	0	0	0	0		
	Blasting										0	0	0	0	0	0		
	Average depth of holes 8 m										0	0	0	0	0	0		
	Number of holes 463 un										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Dynamite 1 kg / m³ 4,000 Losses	5%		4,200	kg		5.60				0	23,520	0	0	0	23,520		
	- Caps Losses	5%		486	un		4.50				0	2,187	0	0	0	2,187		
											0	0	0	0	0	0		
	- M-P		4	320	h	24.00					7,680	0	0	0	0	7,680		320
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	72	h				5.00	15.00	0	0	0	360	778	1,138		
	- Misc. Blasting mat.			4,000	m3		0.10				0	400	0	0	0	400		
	Mucking										0	0	0	0	0	0		
	Production of 500 m³ / sh										0	0	0	0	0	0		
	1.5 loose »»»» 750 m³ / sh			8	sh						0	0	0	0	0	0		
	10 h / s			80	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Hauling distance 1.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Trip up 2 25 km / h										0	0	0	0	0	0		
	Unloading 4										0	0	0	0	0	0		
	Back trip 2 35 km / h										0	0	0	0	0	0		
	12 min.										0	0	0	0	0	0		
	Efficiency : 85% 14 min. / trip										0	0	0	0	0	0		
	0.24 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	39 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12.0 m³										0	0	0	0	0	0		
	468 m³/mach/sh										0	0	0	0	0	0		
	Nombre de camions par poste : **2**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	480	h	24.00					11,520	0	0	0	0	11,520		480
											0	0	0	0	0	0		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	72	h				39.20	48.00	0	0	0	2,822	2,488	5,310		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	72	h				38.25	28.00	0	0	0	2,754	1,452	4,206		

Item : 2520

WBS	DESCRIPTION					%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
															24.00 $				0.72 $			
	- Cat 725 Articulated Dumper 25 T	24.00	20.00			90%	2	144	h				24.00	20.00	0	0	0	3,456	2,074	5,530		
															0	0	0	0	0	0		
	Rock Support			**KM 16**	**1,640**										0	0	0	0	0	0		
				Powerhouse	**1,377**										0	0	0	0	0	0		
	D Shape	**10 x 10**	**92.5 m³**		**3,017** m			**279,073**	**m³**						0	0	0	0	0	0		
				Area (m²)											0	0	0	0	0	0		
	Arc	11.59		17.50											0	0	0	0	0	0		
	Height	10.00													0	0	0	0	0	0		
	Wall	7.50		75.00											0	0	0	0	0	0		
	Width	10.00													0	0	0	0	0	0		
				92.5											0	0	0	0	0	0		
															0	0	0	0	0	0		
			Tunnel												0	0	0	0	0	0		
	Required	Length	Dia.(m)	Arch (m)											0	0	0	0	0	0		
	Class 1	2,262.8	12.5	11.59		75%									0	0	0	0	0	0		
	Class 2	452.6	12.5	11.59		15%									0	0	0	0	0	0		
	Class 3	211.2	12.5	11.59		7.0%									0	0	0	0	0	0		
	Class 4	75.4	12.5	11.59		2.5%									0	0	0	0	0	0		
	Class 5	15.1	12.5	11.59		0.5%									0	0	0	0	0	0		
		3,017				100%									0	0	0	0	0	0		
	Class 1			Qty											0	0	0	0	0	0		
	Rock bolts 2,5 m	1	un / m	2,263	un										0	0	0	0	0	0		
	Shotcrete 50 mm	20.59	m² / m	6,989	m²	15%									0	0	0	0	0	0		
	Wire mesh	20.59	m² / m	39,602	m²	85%									0	0	0	0	0	0		
	Class 2														0	0	0	0	0	0		
	Rock bolts 2,5 m	2.3	un / m	1,036	un										0	0	0	0	0	0		
	Shotcrete 50 mm	20.59	m² / m	1,398	m²	15%									0	0	0	0	0	0		
	Wire mesh	20.59	m² / m	7,920	m²	85%									0	0	0	0	0	0		
	Class 3														0	0	0	0	0	0		
	Rock bolts 3 m	2.9	un / m	612	un										0	0	0	0	0	0		
	Shotcrete 50 mm	20.59	m² / m	2,174	m²	50%									0	0	0	0	0	0		
	Wire mesh	20.59	m² / m	2,174	m²	50%									0	0	0	0	0	0		
	Class 4														0	0	0	0	0	0		
	Rock bolts 4 m	5.2	un / m	389	un										0	0	0	0	0	0		
	Shotcrete 50 mm	9.0	m² / m	204	m²	30%									0	0	0	0	0	0		
	Wire mesh	9.0	m² / m	475	m²	70%									0	0	0	0	0	0		
	Shotcrete 100 mm	11.6	m² / m	874	m²	100%									0	0	0	0	0	0		
	Reinf. Mesh	11.6	m² / m	874	m²	100%									0	0	0	0	0	0		
	Steel arch (W 100)	1.5	m c/c	50	un										0	0	0	0	0	0		
		26.6	m / arch	1,330	m																	
	Class 5														0	0	0	0	0	0		
	Rock bolts 5 m	11.6	un / m	175	un										0	0	0	0	0	0		
	Shotcrete 50 mm	9.0	m² / m	41	m²	30%									0	0	0	0	0	0		
	Wire mesh	9.0	m² / m	95	m²	70%									0	0	0	0	0	0		
	Shotcrete 100 mm	11.6	m² / m	175	m²	100%									0	0	0	0	0	0		
	Reinf. Mesh	11.6	m² / m	175	m²	100%									0	0	0	0	0	0		
	Steel arch (W 150)	0.75	m c/c	20	un										0	0	0	0	0	0		
		26.6	m / arch	532	m										0	0	0	0	0	0		
	Supply			Lenght (m)											0	0	0	0	0	0		
	- Rock bolts 2,5 m	3,299	un	8,248	Losses	3%		3,398	un			60.00			0	0	203,880	0	0	203,880		
	- Rock bolts 3 m	612	un	1,836	Losses	3%		630	un			70.00			0	0	44,100	0	0	44,100		
	- Rock bolts 4 m	389	un	1,556	Losses	3%		401	un			80.00			0	0	32,080	0	0	32,080		
	- Rock bolts 5 m	175	un	875	Losses	3%		180	un			105.00			0	0	18,900	0	0	18,900		
		4,475		12,515											0	0	0	0	0	0		
	- Injection tubes	150	m roll			3%		86	rolls			110.00			0	0	9,460	0	0	9,460		

Item : 2520

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
	- Oakum 130 bolts / box	3%		36	box			280.00			0	0	10,080	0	0	10,080		
	- Grease 154 bolts / box	3%		30	box			336.00			0	0	10,080	0	0	10,080		
											0	0	0	0	0	0		
	- Wire mesh 50,266 m²	15%		57,806	m²			4.60			0	0	265,908	0	0	265,908		
	- Reinf. Mesh 1,049 m²	15%		1,206	m²			5.60			0	0	6,754	0	0	6,754		
	51,315 m²										0	0	0	0	0	0		
	- Spikes 1,1 m 1.25 m c/c 41,052 un	3%		42,284	un			4.50			0	0	190,278	0	0	190,278		
	- Wire 0.04 $ / m²			51,315	m²			0.04			0	0	2,053	0	0	2,053		
	m² m³										0	0	0	0	0	0		
	Shotcrete 50 mm 10,805 0.05 540										0	0	0	0	0	0		
	Shotcrete 100 mm 1,049 0.1 105										0	0	0	0	0	0		
	645										0	0	0	0	0	0		
	- Cement (40 kg Bags) 0.03 m³ / bag Losses	7.5%		23,118	bags			10.00			0	0	231,180	0	0	231,180		
	33.33 bags / m³ 21,505 bags										0	0	0	0	0	0		
	- Sand 1.40 mt / m³ 0.08 h / mt			903	mt	1.94	0.00	0.00	2.27	1.58	1,752	0	0	2,050	1,027	4,829		72
											0	0	0	0	0	0		
	- Monoset (3% of cement) 860,187 kg	3%		25,806	kg			3.40			0	0	87,740	0	0	87,740		
											0	0	0	0	0	0		
	- Steel arch (W 100) 19.0 kg / m 1,330 m			25,261	kg			4.00			0	0	101,042	0	0	101,042		
	- Steel arch (W 150) 22.0 kg / m 532 m			11,700	kg			5.00			0	0	58,498	0	0	58,498		
	Rock bolts Installation			907	sh						0	0	0	0	0	0		
	12,515 m 14 m / sh																	
	4,475 un 5 un / sh																	
	0.5 h / un. including positionning																	
	3 h / sh			2,721	h													
	1) Drilling with Jumbo										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Jumbo	90%	1	2,449	h				102.50		0	0	0	251,023	0	251,023		
											0	0	0	0	0	0		
	2) Install with 50t crane with basket										0	0	0	0	0	0		
	4,475 un 5 un / sh																	
	0.5 h / un incl. Positionning																	
	2.5 h / sh			2,238	h													
	- M-P		3	6,713	h	24.00					161,100	0	0	0	0	161,100		6,713
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	2,014	h				37.00	20.00	0	0	0	74,518	29,002	103,520		
											0	0	0	0	0	0		
	- Impact tool			1	un		300.00				0	300	0	0	0	300		
	- Test rig			1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque wrench			1	un		280.00				0	280	0	0	0	280		
											0	0	0	0	0	0		
	3) Injection 40 bolts / sh			112	sh						0	0	0	0	0	0		
	10 h / sh			1,120	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	4,480	h	24.00					107,520	0	0	0	0	107,520		4,480
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	1,008	h				37.00	20.00	0	0	0	37,296	14,515	51,811		
	- Moyno pump 2.00	75%	1	840	h				2.00		0	0	0	1,680	0	1,680		
											0	0	0	0	0	0		
	- Cement (bags) 12,515 m	100%		2,048	bags			10.00			0	0	20,480	0	0	20,480		
	41,048 ft 0.02269801 sf										0	0	0	0	0	0		
	2 in. Dia hole 932 cu ft										0	0	0	0	0	0		
	0.91 cu ft / bag 1,024 bags										0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
	- Intraplast "N" 0.4 kg / bag 410 kg	1%		414	kg			3.00			0	0	1,242	0	0	1,242		
	- Miscellaneous			4,475	un		0.30				0	1,343	0	0	0	1,343		
											0	0	0	0	0	0		
	Wire mesh installation										0	0	0	0	0	0		
	Installation by Jumbo team										0	0	0	0	0	0		
	Production of 200 m² / sh 51,315 m²			257	sh						0	0	0	0	0	0		
	10 h / sh			2,566	h						0	0	0	0	0	0		
	Plus										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	2,309	h				37.00	20.00	0	0	0	85,433	33,250	118,683		
	- Jack leg 2.00	30%		770	h				2.00		0	0	0	1,540	0	1,540		
	- Miscellaneous materials Spike drilling 45,157 m			45,157	m		1.00				0	45,157	0	0	0	45,157		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Shotcreting			**645**	**m³**						0	0	0	0	0	0		
	Production of 0.7 h / m³ 452 h										0	0	0	0	0	0		
	7.5 h / sh Eff.			61	sh						0	0	0	0	0	0		
	10 h / sh			610	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		9	5,490	h	24.00					131,760	0	0	0	0	131,760		5,490
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	549	h				37.00	20.00	0	0	0	20,313	7,906	28,219		
	- Shotcrete pump 17.00	60%	1	366	h				17.00		0	0	0	6,222	0	6,222		
	- Hoses	25%	1	153	h		35.00				0	5,355	0	0	0	5,355		
	- Nozzle 66 m³ / un			10	un		275.00				0	2,750	0	0	0	2,750		
											0	0	0	0	0	0		
	Arches installation 1,861 m 27 m / un			**70**	**un**						0	0	0	0	0	0		
	Production of 2 un / sh			35	sh						0	0	0	0	0	0		
	10 h / sh			350	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	1,750	h	24.00					42,000	0	0	0	0	42,000		1,750
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	315	h				37.00	20.00	0	0	0	11,655	6,300	17,955		
	- Miscellaneous materials			70	un		200.00				0	14,000	0	0	0	14,000		
											0	0	0	0	0	0		
	Dewatering Duration 24 months			**3,017**	**m**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Purchase of equipment and materials										0	0	0	0	0	0		
	- Pumps			1	ls		20,000				0	20,000	0	0	0	20,000		
	- Miscelaneous			3,017	m		15.00				0	45,255	0	0	0	45,255		
											0	0	0	0	0	0		
	- M-P 2.0 h / m			6,034	h	24.00					144,816	0	0	0	0	144,816		6,034
											0	0	0	0	0	0		
	Outside Installation			30	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		7	210	h	24.00					5,040	0	0	0	0	5,040		210
											0	0	0	0	0	0		
	- Equipment			30	h				200.00		0	0	0	6,000	0	6,000		
											0	0	0	0	0	0		
	Pumping 104 weeks 6 d / w			624	days						0	0	0	0	0	0		
	20 h / day			12,480	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		1	12,480	h	24.00					299,520	0	0	0	0	299,520		12,480
											0	0	0	0	0	0		
	- Miscelaneous			104	weeks		110.00				0	11,440	0	0	0	11,440		

Item : 2520

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
	Industrial Water Supply										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Purchase of equipment and materials Duration 24 months										0	0	0	0	0	0		
	- Pumps			2	un		20,000				0	40,000	0	0	0	40,000		
	- Miscelaneous			3,017	m		21.00				0	63,357	0	0	0	63,357		
											0	0	0	0	0	0		
	- M-P 2.0 h / m			6,034	h	24.00					144,816	0	0	0	0	144,816		6,034
											0	0	0	0	0	0		
	Compressed Air Duration 24 months										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			10,560	h	24.00					253,428	0	0	0	0	253,428		10,560
											0	0	0	0	0	0		
	- Miscellaneous materials			3,017	m		24.00				0	72,408	0	0	0	72,408		
											0	0	0	0	0	0		
	Ventilation & Heathing										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.0 h / m			9,051	h	24.00					217,224	0	0	0	0	217,224		9,051
											0	0	0	0	0	0		
	- Miscellaneous materials			3,017	m		10.00				0	30,170	0	0	0	30,170		
											0	0	0	0	0	0		
	Electrical services										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3.5 h / m			10,560	h	24.00					253,428	0	0	0	0	253,428		10,560
											0	0	0	0	0	0		
	- Miscellaneous materials			3,017	m		22.00				0	66,374	0	0	0	66,374		
											0	0	0	0	0	0		
	Outside services are included in TBM 1 Power tunnel										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2520	**Power tunnel Access and addit**			**279,073**	**m³**						**3,234,469**	**4,227,171**	**1,293,755**	**1,093,426**	**1,021,316**	**10,870,137**	**38.95**	**134,769**

Item : (2531)

2530 Intake excavation

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2531	**Soil excavation**			**802,000**	**m³**													
	Canal option																	
	Overburden excavation - Dry (Frozen) 162,000 m³										0	0	0	0	0	0		
	Overburden excavation - Wet 640,000 m³										0	0	0	0	0	0		
	802,000 m³										0	0	0	0	0	0		
	Overburden excavation - Wet			640,000	m³						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Marine Works										0	0	0	0	0	0		
	(months) (sh / mth) (shifts)										0	0	0	0	0	0		
	Marine activity 2,013 3 40 120										0	0	0	0	0	0		
	2,014 6 40 240										0	0	0	0	0	0		
	2,015 5 40 200										0	0	0	0	0	0		
	14 560										0	0	0	0	0	0		
	Barge mounted clamshell										0	0	0	0	0	0		
	Production 425 m³ / sh			1,506	sh						0	0	0	0	0	0		
	Available shift 560 un										0	0	0	0	0	0		
	Needed rigs 3 un										0	0	0	0	0	0		
	10 h / sh			15,059	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		16	240,941	h	24.00					5,782,588	0	0	0	0	5,782,588		240,941
											0	0	0	0	0	0		
	- Crane 150T - Crawler 50.75 25.00	90%	1	13,553	h				50.75	25.00	0	0	0	687,815	243,954	931,769		
	- Miscelaneous			15,059	h		10.00				0	150,588	0	0	0	150,588		
											0	0	0	0	0	0		
	Duration 18 month (including mob/demob)																	
	L (ft) W (ft) H (ft) V (cu ft)										0	0	0	0	0	0		
	- Landding barge (Unifloat) 18 8 6 8,640		10	180	mth - un		800				0	144,000	0	0	0	144,000		
	- Noze end 432 2,592		6	108	mth - un		250				0	27,000	0	0	0	27,000		
	- Working barge 50 12 7 23,400		6	108	mth - un		4,800				0	518,400	0	0	0	518,400		
	- Tug		3	54	mth - un		6,500				0	351,000	0	0	0	351,000		
	- Work boat		3	54	mth - un		3,000				0	162,000	0	0	0	162,000		
	- Scows		6	108	mth - un		3,000				0	324,000	0	0	0	324,000		
	- Miscelaneous (winches, anchors, generators, etc..)		34	18	mth		6,000				0	108,000	0	0	0	108,000		
	Marine Equipment preparation and transportation										0	0	0	0	0	0		
	34 trips 1 trip / day			34	sh						0	0	0	0	0	0		
	10 h / s			340	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	2,040	h	24.00					48,960	0	0	0	0	48,960		2,040
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	50%	1	170	h				37.00	20.00	0	0	0	6,290	2,448	8,738		
	- Cat D6T LGP Track-Type Tractor 28.40 26.10	20%	1	68	h				28.40	26.10	0	0	0	1,931	1,278	3,209		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	20%	1	68	h				19.00	29.00	0	0	0	1,292	1,420	2,712		
	- Tractor truck & Load Carrier - 65 T 11.50 15.00	90%	1	306	h				11.50	15.00	0	0	0	3,519	3,305	6,824		
											0	0	0	0	0	0		
	Overburden excavation - Dry **(Frozen soil considered as rock)**			**162,000**	**m³**						0	0	0	0	0	0		
	Drilling										0	0	0	0	0	0		
	Drilling grid ,9 x 1,2 0.90 1.20 1.08 m²										0	0	0	0	0	0		
											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
	Drilling length 150,000 m										0	0	0	0	0	0		
	Production of 200 m / machine / sh			750	sh						0	0	0	0	0	0		
	6 machines			125	sh						0	0	0	0	0	0		
	10 h / s			1,250	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		10	12,500	h	24.00					300,000	0	0	0	0	300,000		12,500
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	6	6,750	h				19.40	15.00	0	0	0	130,950	72,900	203,850		
	- Drilling materials			150,000	m		0.70				0	105,000	0	0	0	105,000		
											0	0	0	0	0	0		
	Blasting										0	0	0	0	0	0		
	Average depth of holes 10 m										0	0	0	0	0	0		
	Number of holes 15,000 un										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Dynamite 1 kg / m³ 162,000 m³ Losses	5%		170,100	kg		5.60				0	952,560	0	0	0	952,560		
	- Caps Losses	5%		15,750	un		4.50				0	70,875	0	0	0	70,875		
											0	0	0	0	0	0		
	- M-P		4	5,000	h	24.00					120,000	0	0	0	0	120,000		5,000
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	1,125	h				5.00	15.00	0	0	0	5,625	12,150	17,775		
	- Misc. Blasting materials			162,000	m³		0.10				0	16,200	0	0	0	16,200		
	Evacuation of excavated materials										0	0	0	0	0	0		
	Production of 1,296 m³ / sh										0	0	0	0	0	0		
	1.5 loose »»»» 1,944 m³ / sh			125	sh						0	0	0	0	0	0		
	10 h / s			1,250	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		11	13,750	h	24.00					330,000	0	0	0	0	330,000		13,750
											0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	1,125	h				38.25	28.00	0	0	0	43,031	22,680	65,711		
	- Cat 345 Hydraulic Excavator 40.00 60.00	90%	1	1,125	h				40.00	60.00	0	0	0	45,000	48,600	93,600		
	- Cat 740 Articulated Dumper 40 T 32.00 27.90	90%	5	5,625	h				32.00	27.90	0	0	0	180,000	112,995	292,995		
	- Generator 5 kW (Tower light) 3.50 2.20	90%	2	2,250	h				3.50	2.20	0	0	0	7,875	3,564	11,439		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	1,125	h				19.00	29.00	0	0	0	21,375	23,490	44,865		
	Hauling distance 2.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Trip up 5 25 km / h										0	0	0	0	0	0		
	Unloading 4										0	0	0	0	0	0		
	Back trip 3 35 km / h										0	0	0	0	0	0		
	16 min.										0	0	0	0	0	0		
	Efficiency : 85% 19 min. / trip										0	0	0	0	0	0		
	0.31 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	29 trips / sh										0	0	0	0	0	0		
	Cat 740 Articulated Dumper 40 T 14.0 m³										0	0	0	0	0	0		
	406 m³/mach/sh										0	0	0	0	0	0		
	Number of trucks per shift **5**										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2531	**Soil excavation**			**802,000**	**m³**						**6,581,548**	**2,929,623**	**0**	**1,134,703**	**548,784**	**11,194,658**	**13.96**	**274,231**

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			

2530 Intake excavation

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2532	**Rock Excavation**			**717,200**	**m³**													
	Invert of channel at elevation 670																	
	Rock Excavation - Dry (Used as rockfill on dams) 710,000 m³										0	0	0	0	0	0		
	Rock Excavation - Wet 7,200 m³										0	0	0	0	0	0		
	717,200										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Construction roads (m) (m² / m) (m³)										0	0	0	0	0	0		
	From intake channel to permanent road 1,000 11 11,000										0	0	0	0	0	0		
	Widenning permanent road 2,000 5 10,000										0	0	0	0	0	0		
	From permanent road to Dam 2 area 1,000 11 11,000										0	0	0	0	0	0		
	4,000 32,000										0	0	0	0	0	0		
	Backfill from excavated materials										0	0	0	0	0	0		
	Foundation			**32,000**	**m³**													
	Production of 1,200 m³ / sh			27	sh						0	0	0	0	0	0		
	10 h / s			270	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	1,080	h	24.00					25,920	0	0	0	0	25,920		1,080
											0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	243	h				38.25	28.00	0	0	0	9,295	4,899	14,194		
	- Cat CS76 XT Vibratory Soil Compactor 14.85 20.00	45%	1	122	h				14.85	20.00	0	0	0	1,812	1,757	3,569		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	25%	1	68	h				19.00	29.00	0	0	0	1,292	1,420	2,712		
	- Miscelaneous (culverts, signalisation, etc...)			4,000	m		2.00				0	8,000	0	0	0	8,000		
	Pavement 0.3 x 10 3 m³ / m			**12,000**	**m³**						0	0	0	0	0	0		
	Production of 1,000 m³ / sh			12	sh						0	0	0	0	0	0		
	10 h / s			120	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		10	1,200	h	24.00					28,800	0	0	0	0	28,800		1,200
											0	0	0	0	0	0		
	- Cat D6T LGP Track-Type Tractor 28.40 26.10	90%	1	108	h				28.40	26.10	0	0	0	3,067	2,030	5,097		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	45%	3	162	h				24.00	20.00	0	0	0	3,888	2,333	6,221		
	- Cat CS76 XT Vibratory Soil Compactor 14.85 20.00	25%	1	30	h				14.85	20.00	0	0	0	446	432	878		
	- Cat 14M Motorgrader 16.65 25.75	90%	1	108	h				16.65	25.75	0	0	0	1,798	2,002	3,800		
	- Cat 980H Wheel Loader 29.00 23.45	90%	1	108	h				29.00	23.45	0	0	0	3,132	1,823	4,955		
											0	0	0	0	0	0		
	Hauling distance from crusher 2.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Trip up 3 35 km / h										0	0	0	0	0	0		
	Unloading 4										0	0	0	0	0	0		
	Back trip 3 35 km / h										0	0	0	0	0	0		
	14 min.										0	0	0	0	0	0		
	Efficiency : 85% 16 min. / trip										0	0	0	0	0	0		
	0.27 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	33 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12.0 m³										0	0	0	0	0	0		
	396 m³/mach/sh										0	0	0	0	0	0		

Item : (2532)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
	Number of trucks per shift 3										0	0	0	0	0	0		
											0	0	0	0	0	0		
-	Pavement material 1.8 mt / m³ 0.08 h / mt			21,600	mt	1.94	0.00	0.00	2.27	1.58	41,904	0	0	49,032	24,572	115,508		1,728
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rock Excavation - Dry			**710,000**	**m³**						0	0	0	0	0	0		
	Drilling										0	0	0	0	0	0		
	Drilling grid ,9 x 1,2 0.90 1.20 1.08 m²										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling length 657,407 m										0	0	0	0	0	0		
	Production of 200 m / machine / sh			3,287	sh						0	0	0	0	0	0		
	6 machines			548	sh						0	0	0	0	0	0		
	10 h / s			5,478	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		10	54,783	h	24.00					1,314,800	0	0	0	0	1,314,800		54,783
											0	0	0	0	0	0		
-	Hydraulic Drilling Machine 19.40 15.00	90%	6	29,583	h				19.40	15.00	0	0	0	573,910	319,496	893,406		
-	Drilling materials			657,407	m		0.70				0	460,185	0	0	0	460,185		
											0	0	0	0	0	0		
	Blasting										0	0	0	0	0	0		
	Average depth of holes 10 m										0	0	0	0	0	0		
	Number of holes 65,741 un										0	0	0	0	0	0		
											0	0	0	0	0	0		
-	Dynamite 1 kg / m³ 710,000 m³ Losses	5%		745,500	kg		5.60				0	4,174,800	0	0	0	4,174,800		
-	Caps Losses	5%		69,028	un		4.50				0	310,626	0	0	0	310,626		
											0	0	0	0	0	0		
-	M-P		4	21,913	h	24.00					525,920	0	0	0	0	525,920		21,913
											0	0	0	0	0	0		
-	Explosives Truck 5.00 15.00	90%	1	4,931	h				5.00	15.00	0	0	0	24,655	53,255	77,910		
-	Misc. Blasting materials			710,000	m³		0.10				0	71,000	0	0	0	71,000		
											0	0	0	0	0	0		
	Mucking										0	0	0	0	0	0		
	Production of 1,296 m³ / sh										0	0	0	0	0	0		
	1.5 loose »»»» 1,944 m³ / sh			548	sh						0	0	0	0	0	0		
	10 h / s			5,478	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		11	60,262	h	24.00					1,446,280	0	0	0	0	1,446,280		60,262
											0	0	0	0	0	0		
-	Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	4,931	h				38.25	28.00	0	0	0	188,611	99,409	288,020		
-	Cat 345 Hydraulic Excavator 40.00 60.00	90%	1	4,931	h				40.00	60.00	0	0	0	197,240	213,019	410,259		
-	Cat 740 Articulated Dumper 40 T 32.00 27.90	90%	8	39,444	h				32.00	27.90	0	0	0	1,262,208	792,351	2,054,559		
-	Generator 5 kW (Tower light) 3.50 2.20	90%	2	9,861	h				3.50	2.20	0	0	0	34,514	15,620	50,134		
-	Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	4,931	h				19.00	29.00	0	0	0	93,689	102,959	196,648		
	Hauling distance 4.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Trip up 10 25 km / h										0	0	0	0	0	0		
	Unloading 4										0	0	0	0	0	0		
	Back trip 7 35 km / h										0	0	0	0	0	0		
	25 min.										0	0	0	0	0	0		
	Efficiency : 85% 29 min. / trip										0	0	0	0	0	0		
	0.49 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	19 trips / sh										0	0	0	0	0	0		
	Cat 740 Articulated Dumper 40 T 14.0 m³										0	0	0	0	0	0		
	266 m³/mach/sh										0	0	0	0	0	0		

Item : (2532)

						UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
	Number of trucks per shift **8**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Consolidation Invert at 670										0	0	0	0	0	0		
	L H Area										0	0	0	0	0	0		
	2 sides 1,040 60 62,400 m²										0	0	0	0	0	0		
	Suppply										0	0	0	0	0	0		
	- Rock bolts 6 m 30 m² / un 2,080 un Losses	3%		2,142	un		110.00				0	235,620	0	0	0	235,620		
	- Wire mesh 62,400 m² Lapping	15%		71,760	m²		4.60				0	330,096	0	0	0	330,096		
	- Spikes 0,7 m 1.56 m² / un 40,000 un	3%		41,200	un		4.50				0	185,400	0	0	0	185,400		
	- Wire			62,400	m²		0.04				0	2,496	0	0	0	2,496		
											0	0	0	0	0	0		
	Rock bolts drilling and Installation										0	0	0	0	0	0		
	Production of 100 m / sh			125	sh						0	0	0	0	0	0		
	6 m bolt 12,480 m 10 h / sh			1,250	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	7,500	h	24.00					180,000	0	0	0	0	180,000		7,500
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	1,125	h				37.00	20.00	0	0	0	41,625	16,200	57,825		
	- Fork lift 15 T 13.00 9.00	90%	1	1,125	h				13.00	9.00	0	0	0	14,625	7,290	21,915		
	- Boom truck 17 tons 13.65 18.00	90%	1	1,125	h				13.65	18.00	0	0	0	15,356	14,580	29,936		
	- Drilling rig (on fork lift)	90%	1	1,125	h				0.00	0.00	0	0	0	0	0	0		
											0	0	0	0	0	0		
	Wire mesh Installation										0	0	0	0	0	0		
	Production of 100 m² / sh			624	sh						0	0	0	0	0	0		
	10 h / sh			6,240	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	31,200	h	24.00					748,800	0	0	0	0	748,800		31,200
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	5,616	h				37.00	20.00	0	0	0	207,792	80,870	288,662		
	- Jack leg 2.00	30%	1	1,872	h				2.00	0.00	0	0	0	3,744	0	3,744		
	- Fork lift 15 T 13.00 9.00	90%	1	5,616	h				13.00	9.00	0	0	0	73,008	36,392	109,400		
	- Misc. Drilling materials 40,000 un 0.7 m			28,000	m		1.00				0	28,000	0	0	0	28,000		
											0	0	0	0	0	0		
	Wire mesh removing (For intake concrete structure)										0	0	0	0	0	0		
	L H Area m²										0	0	0	0	0	0		
	45 60 2,700										0	0	0	0	0	0		
	Production of 600 m² / sh			5	sh						0	0	0	0	0	0		
	10 h / sh			50	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	250	h	24.00					6,000	0	0	0	0	6,000		250
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	45	h				37.00	20.00	0	0	0	1,665	648	2,313		
	- Boom truck 17 tons 13.65 18.00	90%	1	45	h				13.65	18.00	0	0	0	614	583	1,197		
											0	0	0	0	0	0		
	Dewatering Duration 6 months										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Purchase of equipment and materials										0	0	0	0	0	0		
	- Pumps			1	ls		20,000				0	20,000	0	0	0	20,000		
	- Miscelaneous			1,000	m		15.00				0	15,000	0	0	0	15,000		
											0	0	0	0	0	0		
	Installation			30	h						0	0	0	0	0	0		
															0			
	- M-P		7	210	h	24.00					5,040	0	0	0	0	5,040		210
											0	0	0	0	0	0		
	- Equipment			30	h				200.00		0	0	0	6,000	0	6,000		
											0	0	0	0	0	0		
	Pumping 26 weeks 6 d / w			156	days						0	0	0	0	0	0		

Item : (2532)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
	20 h / day			3,120	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		1	3,120	h	24.00					74,880	0	0	0	0	74,880		3,120
											0	0	0	0	0	0		
	- Miscelaneous			26	weeks		110.00				0	2,860	0	0	0	2,860		
	Rock Excavation - Wet			**7,200**	**m³**						0	0	0	0	0	0		
	Rock plug 7,200										0	0	0	0	0	0		
	Drilling platform 10,000										0	0	0	0	0	0		
	17,200										0	0	0	0	0	0		
	Drilling										0	0	0	0	0	0		
	Drilling grid ,9 x 1,2 0.90 1.20 1.08 m²										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling length 15,926 m										0	0	0	0	0	0		
	Production of 200 m / machine / sh			80	sh						0	0	0	0	0	0		
	3 machines			27	sh						0	0	0	0	0	0		
	10 h / s			267	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	1,600	h	24.00					38,400	0	0	0	0	38,400		1,600
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	3	720	h				19.40	15.00	0	0	0	13,968	7,776	21,744		
	- Drilling materials			15,926	m		0.70				0	11,148	0	0	0	11,148		
											0	0	0	0	0	0		
	Blasting										0	0	0	0	0	0		
	Average depth of holes 20 m										0	0	0	0	0	0		
	Number of holes 796 un										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Dynamite 1.5 kg / m³ 10,800 kg Losses	5%		11,340	kg		5.60				0	63,504	0	0	0	63,504		
	- Caps Losses	5%		836	un		4.50				0	3,762	0	0	0	3,762		
											0	0	0	0	0	0		
	Production 8 min / hole 106 h			11	sh						0	0	0	0	0	0		
	10 h / s			110	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	440	h	24.00					10,560	0	0	0	0	10,560		440
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	99	h				5.00	15.00	0	0	0	495	1,069	1,564		
	- Misc. Blasting materials			7,200	m³		0.10				0	720	0	0	0	720		
											0	0	0	0	0	0		
	Mucking Rock plug 7,200										0	0	0	0	0	0		
	1.5 loose »»»» 10,800										0	0	0	0	0	0		
	Drilling platform 10,000										0	0	0	0	0	0		
	20,800 m³										0	0	0	0	0	0		
	With clamshell and casted on each side										0	0	0	0	0	0		
	Production 425 m³ / sh			49	sh						0	0	0	0	0	0		
	10 h / s			490	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	1,960	h	24.00					47,040	0	0	0	0	47,040		1,960
											0	0	0	0	0	0		
	- Crane 150T - Crawler 50.75 25.00	90%	1	441	h				50.75	25.00	0	0	0	22,381	7,938	30,319		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	45%	1	221	h				38.25	28.00	0	0	0	8,453	4,455	12,908		
	- Miscelaneous			490	h		5.00				0	2,450	0	0	0	2,450		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2532	**Rock Excavation**										**4,494,344**	**5,925,667**	**0**	**2,858,315**	**1,815,178**	**15,093,504**		**187,246**

2530 Intake excavation

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2533	**Intake Tunnel & Shaft Excavation**			14,402	m³													
	L Area (m²) Volume																	
	Intake tunnel 16.0 120.0 1,920										0	0	0	0	0	0		
	Shaft from 680 to 719 39.0 78.5 3,062										0	0	0	0	0	0		
	Shaft from 550 to 670 120.0 78.5 9,420										0	0	0	0	0	0		
	14,402										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Intake Tunnel										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Excavation										0	0	0	0	0	0		
	Progression 3.60 m										0	0	0	0	0	0		
	Number of rounds 4										0	0	0	0	0	0		
	Number of holes (m) (Feet)										0	0	0	0	0	0		
	Production 96 55 mm dia. 1,536 5,038										0	0	0	0	0	0		
	Contour 53 55 mm dia. 848 2,781										0	0	0	0	0	0		
	149										0	0	0	0	0	0		
	Cut 3 109 mm dia. 48 157										0	0	0	0	0	0		
	152										0	0	0	0	0	0		
	Drilling depth 4.05 m 2,432 7,977										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling and Blasting										0	0	0	0	0	0		
	Production of 22 m / h 111 h										0	0	0	0	0	0		
	Prod. Factor 1.4			155	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	620	h	24.00					14,880	0	0	0	0	14,880		620
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	1	140	h				19.40	15.00	0	0	0	2,716	1,512	4,228		
	- Compressor - 750 cfm 14.30 27.00	90%	1	140	h				14.30	27.00	0	0	0	2,002	2,722	4,724		
	- Explosives Truck 5.00 15.00	90%	1	140	h				5.00	15.00	0	0	0	700	1,512	2,212		
											0	0	0	0	0	0		
	- Drilling materials			2,432	m		0.96				0	2,335	0	0	0	2,335		
											0	0	0	0	0	0		
	- Explosives			1,920	m³		20.35				0	39,072	0	0	0	39,072		
											0	0	0	0	0	0		
	Mucking 1,920 m³										0	0	0	0	0	0		
	1.5 Loose »»»» 2,880 m³										0	0	0	0	0	0		
	729 m³ / round										0	0	0	0	0	0		
	Average hauling distance : 3.50 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 3										0	0	0	0	0	0		
	Going 6 35 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 6 35 km / h										0	0	0	0	0	0		
	18 min.										0	0	0	0	0	0		
	Efficacité : 85% 21 min. / trip										0	0	0	0	0	0		
	0.35 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	26 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m³										0	0	0	0	0	0		
	312 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **3**										0	0	0	0	0	0		

Item : (2533)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
	1 shift / round			4	sh													
	10 h / sh			40	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	200	h	24.00					4,800	0	0	0	0	4,800		200
											0	0	0	0	0	0		
	- Cat 980H Wheel Loader 29.00 23.45	90%	1	36	h				29.00	23.45	0	0	0	1,044	608	1,652		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	36	h				38.25	28.00	0	0	0	1,377	726	2,103		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	3	108	h				24.00	20.00	0	0	0	2,592	1,555	4,147		
											0	0	0	0	0	0		
	Rock Support L = 6 m										0	0	0	0	0	0		
	Supply																	
	- Rock bolts 3 m 3.0 un / m 18 un Losses	3%		19	un			70.00			0	0	1,330	0	0	1,330		
	54 m drilling																	
	- Wire mesh 28.00 m² / m 168 m²	15%		193	m²			4.60			0	0	888	0	0	888		
	- Spikes ,7 m 1.25 m c/c 134 un	3%		138	un			4.50			0	0	621	0	0	621		
	- Wire 0.04 $ / m²			168	m²			0.04			0	0	7	0	0	7		
											0	0	0	0	0	0		
	Rock bolts Installation										0	0	0	0	0	0		
	1) Drilling 22 m / h 3 h										0	0	0	0	0	0		
	7.5 h / sh Eff.			1	sh													
	10 h / sh			10	h													
	- M-P		2	20	h	24.00					480	0	0	0	0	480		20
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	1	9	h				19.40	15.00	0	0	0	175	97	272		
											0	0	0	0	0	0		
	2) Install with 10 T Fork lift										0	0	0	0	0	0		
	18 un 4.6 un / round										0	0	0	0	0	0		
	0.5 h / un 2.3 h / round including positionning										0	0	0	0	0	0		
	9 h										0	0	0	0	0	0		
	9.0 h / sh. Eff.			1	sh						0	0	0	0	0	0		
	10 h /sh			10	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		3	30	h	24.00					720	0	0	0	0	720		30
											0	0	0	0	0	0		
	- Fork lift 10 T 11.00 7.00	90%	1	9	h				11.00	7.00	0	0	0	99	45	144		
											0	0	0	0	0	0		
	- Impact tool			1	un		300.00				0	300	0	0	0	300		
	- Test rig			1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque wrench			1	un		280.00				0	280	0	0	0	280		
											0	0	0	0	0	0		
	Wire mesh installation										0	0	0	0	0	0		
	Production of 200 m² / sh			1	sh						0	0	0	0	0	0		
	10 h / sh			10	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	60	h	24.00					1,440	0	0	0	0	1,440		60
											0	0	0	0	0	0		
	- Fork lift 10 T 11.00 7.00	90%	1	9	h				11.00	7.00	0	0	0	99	45	144		
	- Jack leg 2.00	30%	1	3	h				2.00		0	0	0	6	0	6		
	- Miscellaneous materials Spike drilling 93.8 m			94	m		1.00				0	94	0	0	0	94		
											0	0	0	0	0	0		
	Shaft from 680 to 719 **Drilling from el.. 719** **39 m**										0	0	0	0	0	0		
	10 m dia. **78.5 m²**			**3,062**	**m³**						0	0	0	0	0	0		
	Excavation										0	0	0	0	0	0		
	Number of holes (m)										0	0	0	0	0	0		
	Production 20 780										0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
	Contour 31 1,209										0	0	0	0	0	0		
	51 1,989										0	0	0	0	0	0		
	Cut 3 117										0	0	0	0	0	0		
	54 2,106										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling 20 m / h 105 h										0	0	0	0	0	0		
	9.0 h / sh. Eff.			12	sh						0	0	0	0	0	0		
	10 h /sh			120	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		3	360	h	24.00					8,640	0	0	0	0	8,640		360
											0	0	0	0	0	0		
-	Hydraulic Drilling Machine 19.40 15.00	90%	1	108	h				19.40	15.00	0	0	0	2,095	1,166	3,261		
-	Compressor XAHS 237 (500 cfm) 15.00 29.00	90%	1	108	h				15.00	29.00	0	0	0	1,620	2,255	3,875		
											0	0	0	0	0	0		
-	Drilling materials			2,106	m		1.20				0	2,527	0	0	0	2,527		
											0	0	0	0	0	0		
	Blasting 3 m / round 13 rounds										0	0	0	0	0	0		
	Loading 15 min / hole 20 h / round			260	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		4	1,040	h	24.00					24,960	0	0	0	0	24,960		1,040
											0	0	0	0	0	0		
-	Explosives Truck 5.00 15.00	90%	1	234	h				5.00	15.00	0	0	0	1,170	2,527	3,697		
											0	0	0	0	0	0		
-	Prima cord Average lentgh 20 m / round 31 holes	5%		8,463	m		1.00				0	8,463	0	0	0	8,463		
-	Caps 51 holes / round	13%		749	un		5.00				0	3,746	0	0	0	3,746		
-	Dynamite 3,062 m³ Powder fact 1.6			4,899	kg		5.60				0	27,436	0	0	0	27,436		
											0	0	0	0	0	0		
-	Miscelaneous material			1,989	m		2.00				0	3,978	0	0	0	3,978		
											0	0	0	0	0	0		
	Mucking 3,062 m³										0	0	0	0	0	0		
	1.5 Loose »»»» 4,593 m³										0	0	0	0	0	0		
	353 m³ / round										0	0	0	0	0	0		
	Average hauling distance : 3.50 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 3										0	0	0	0	0	0		
	Going 6 35 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 6 35 km / h										0	0	0	0	0	0		
	18 min.										0	0	0	0	0	0		
	Efficacité : 85% 21 min. / trip										0	0	0	0	0	0		
	0.35 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	26 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12 m³										0	0	0	0	0	0		
	312 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **2**										0	0	0	0	0	0		
	1 shift / round			13	sh						0	0	0	0	0	0		
	10 h / sh			130	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		5	650	h	24.00					15,600	0	0	0	0	15,600		650
											0	0	0	0	0	0		
-	Cat 980H Wheel Loader 29.00 23.45	90%	1	117	h				29.00	23.45	0	0	0	3,393	1,975	5,368		
-	Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	117	h				38.25	28.00	0	0	0	4,475	2,359	6,834		
-	Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	2	234	h				24.00	20.00	0	0	0	5,616	3,370	8,986		
											0	0	0	0	0	0		
	Rock Support L = 39										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Supply										0	0	0	0	0	0		
-	Rock bolts 3 m 3.0 un / m 117 un Losses	3%		121	un			70.00			0	0	8,470	0	0	8,470		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
	351 m drilling										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Wire mesh 31.42 m² / m 1,225 m²	15%		1,409	m²			4.60			0	0	6,481	0	0	6,481		
	- Spikes ,7 m 1.25 m c/c 980 un	3%		1,009	un			4.50			0	0	4,541	0	0	4,541		
	- Wire 0.04 $ / m²			1,225	m²			0.04			0	0	49	0	0	49		
											0	0	0	0	0	0		
	Rock bolts Installation (Operating on platform hooked on a crane)										0	0	0	0	0	0		
	1) Drilling 7 m / h 51 h																	
	7.5 h / sh Eff.			7	sh						0	0	0	0	0	0		
	10 h / sh			70	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		3	210	h	24.00					5,040	0	0	0	0	5,040		210
											0	0	0	0	0	0		
	- Jack leg 2.00	90%	1	63	h				2.00	0.00	0	0	0	126	0	126		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	63	h				37.00	20.00	0	0	0	2,331	907	3,238		
	- Compressor XAHS 237 (500 cfm) 15.00 29.00	90%	1	63	h				15.00	29.00	0	0	0	945	1,315	2,260		
	2) Install with platform down the shaft										0	0	0	0	0	0		
	117 un 0.5 h / un										0	0	0	0	0	0		
	58.5 h										0	0	0	0	0	0		
	7.5 h / sh. Eff.			8	sh						0	0	0	0	0	0		
	10 h /sh			80	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	320	h	24.00					7,680	0	0	0	0	7,680		320
											0	0	0	0	0	0		
	- Jack leg 2.00	90%	1	72	h				2.00	0.00	0	0	0	144	0	144		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	72	h				37.00	20.00	0	0	0	2,664	1,037	3,701		
	- Impact tool			1	un		300.00				0	300	0	0	0	300		
	- Test rig			1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque wrench			1	un		280.00				0	280	0	0	0	280		
											0	0	0	0	0	0		
	Wire mesh installation										0	0	0	0	0	0		
	Production of 150 m² / sh			8	sh						0	0	0	0	0	0		
	10 h / sh			80	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	400	h	24.00					9,600	0	0	0	0	9,600		400
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	72	h				37.00		0	0	0	2,664	0	2,664		
	- Jack leg 2.00	30%	1	24	h				2.00		0	0	0	48	0	48		
	- Compressor XAHS 237 (500 cfm) 15.00 29.00	90%	1	72	h				15.00		0	0	0	1,080	0	1,080		
	- Miscellaneous materials Spike drilling 686 m			686	m		1.00				0	686	0	0	0	686		
											0	0	0	0	0	0		
	Shaft from 550 to 670 **Drilling from le. 670** **120 m**										0	0	0	0	0	0		
	10 m dia. **78.5 m²**			**9,420**	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Excavation										0	0	0	0	0	0		
	Number of holes (m)										0	0	0	0	0	0		
	Production 20 2,400										0	0	0	0	0	0		
	Contour 31 3,720										0	0	0	0	0	0		
	51 6,120										0	0	0	0	0	0		
	Cut 3 360										0	0	0	0	0	0		
	54 6,480										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling 20 m / h 324 h										0	0	0	0	0	0		
	9.0 h / sh. Eff.			36	sh						0	0	0	0	0	0		
	10 h /sh			360	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		3	1,080	h	24.00					25,920	0	0	0	0	25,920		1,080

Item : (2533)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	1	324	h				19.40	15.00	0	0	0	6,286	3,499	9,785		
	- Compressor XAHS 237 (500 cfm) 15.00 29.00	90%	1	324	h				15.00	29.00	0	0	0	4,860	6,765	11,625		
											0	0	0	0	0	0		
	- Drilling materials			6,480	m		1.20				0	7,776	0	0	0	7,776		
											0	0	0	0	0	0		
	Blasting 3 m / round 40 rounds										0	0	0	0	0	0		
	Loading 30 min / hole 30 h / round			1,200	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	4,800	h	24.00					115,200	0	0	0	0	115,200		4,800
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	1,080	h				5.00	15.00	0	0	0	5,400	11,664	17,064		
											0	0	0	0	0	0		
	- Prima cord Average lentgh 60 m / round 31 holes	5%		78,120	m		1.00				0	78,120	0	0	0	78,120		
	- Caps 51 holes / round	13%		2,305	un		5.00				0	11,526	0	0	0	11,526		
	- Dynamite 9,420 m³ Powder fact 1.6			15,072	kg		5.60				0	84,403	0	0	0	84,403		
											0	0	0	0	0	0		
	- Miscelaneous material			6,120	m		2.00				0	12,240	0	0	0	12,240		
	Mucking With TBM Conveyer																	
	9,420 m³																	
	1.5 Loose »»»» 14,130 m³																	
	471 m³ / round																	
	Average hauling distance : 3.50 km																	
	Loading 15																	
	Going 6 35 km / h																	
	Unloading 3																	
	Return 6 35 km / h																	
	30 min.																	
	Efficacité : 85% 35 min. / trip																	
	0.59 h / trip																	
	9 h / sh																	
	16 trips / sh																	
	Cat 725 Articulated Dumper 25 T 12 m³																	
	192 m³ / truck-sh																	
	Number of trucks : **3**																	
	1 shift / round			40	sh						0	0	0	0	0	0		
	10 h / sh			400	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	2,000	h	24.00					48,000	0	0	0	0	48,000		2,000
											0	0	0	0	0	0		
	- Cat 950H Wheel Loader 18.35 9.05	90%	1	360	h				18.35	9.05	0	0	0	6,606	2,346	8,952		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	360	h				38.25	28.00	0	0	0	13,770	7,258	21,028		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	3	1,080	h				24.00	20.00	0	0	0	25,920	15,552	41,472		
	- Conveyers	90%	1	360	h				50.00		0	0	0	18,000	0	18,000		
											0	0	0	0	0	0		
	Rock Support L = 117										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Supply										0	0	0	0	0	0		
	- Rock bolts 3 m 3.0 un / m 351 un Losses	3%		362	un			70.00			0	0	25,340	0	0	25,340		
	1,053 m drilling										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Wire mesh 31.42 m² / m 3,676 m²	15%		4,227	m²			4.60			0	0	19,444	0	0	19,444		
	- Spikes ,7 m 1.25 m c/c 2,941 un	3%		3,029	un			4.50			0	0	13,632	0	0	13,632		
	- Wire 0.04 $ / m²			3,676	m²			0.04			0	0	147	0	0	147		
											0	0	0	0	0	0		

Item : (2533)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
	Rock bolts Installation **(Operating on platform hooked on a crane)**										0	0	0	0	0	0		
	1) Drilling 7 m / h 151 h																	
	7.5 h / sh Eff.			21	sh						0	0	0	0	0	0		
	10 h / sh			210	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		3	630	h	24.00					15,120	0	0	0	0	15,120		630
											0	0	0	0	0	0		
	- Jack leg 2.00	90%	1	189	h				2.00	0.00	0	0	0	378	0	378		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	189	h				37.00	20.00	0	0	0	6,993	2,722	9,715		
	- Compressor XAHS 237 (500 cfm) 15.00 29.00	90%	1	189	h				15.00	29.00	0	0	0	2,835	3,946	6,781		
	2) Install with platform down the shaft										0	0	0	0	0	0		
	351 un 0.5 h / un										0	0	0	0	0	0		
	175.5 h										0	0	0	0	0	0		
	7.5 h / sh. Eff.			24	sh						0	0	0	0	0	0		
	10 h /sh			240	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	960	h	24.00					23,040	0	0	0	0	23,040		960
											0	0	0	0	0	0		
	- Jack leg 2.00	90%	1	216	h				2.00	0.00	0	0	0	432	0	432		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	216	h				37.00	20.00	0	0	0	7,992	3,110	11,102		
	- Impact tool			1	un		300.00				0	300	0	0	0	300		
	- Test rig			1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque rench			1	un		280.00				0	280	0	0	0	280		
											0	0	0	0	0	0		
	Wire mesh installation										0	0	0	0	0	0		
	Production of 125 m^2 / sh			29	sh						0	0	0	0	0	0		
	10 h / sh			290	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	1,450	h	24.00					34,800	0	0	0	0	34,800		1,450
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	261	h				37.00	20.00	0	0	0	9,657	3,758	13,415		
	- Jack leg 2.00	30%	1	87	h				2.00		0	0	0	174	0	174		
	- Compressor XAHS 237 (500 cfm) 15.00 29.00	90%	1	261	h				15.00	29.00	0	0	0	3,915	5,450	9,365		
	- Miscellaneous materials Spike drilling 2058.7 m			2,059	m		2.00				0	4,118	0	0	0	4,118		
											0	0	0	0	0	0		
	Working platform			75	m^2		500				0	37,500	0	0	0	37,500		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2533	**Intake Tunnel & Shaft Excavation**			**14,402**	**m^2**						**355,920**	**329,360**	**80,950**	**152,399**	**91,803**	**1,010,432**	**70.16**	**14,830**

Item : 2540

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2540	**Intake structure**			**2,720**	**m³**													
	Intake Structure 2,470										0	0	0	0	0	0		
	Plug in the Shaft 250										0	0	0	0	0	0		
	2,720										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Concrete works										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Intake Structure			**2,470**	**m²**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Concreting 3.75 h / m³			9,263	h	24.00					222,300	0	0	0	0	222,300		9,263
	- Construction materials			2,470	m³		78.00				0	192,660	0	0	0	192,660		
	- Construction equipment			2,470	m³				48.00	40.00	0	0	0	118,560	71,136	189,696		
	Winter Protection W H (m²)										0	0	0	0	0	0		
	10 53 530										0	0	0	0	0	0		
	Say			**600**	**m²**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P Installing and removing 0.5 h / m²			300	h	24.00					7,200	0	0	0	0	7,200		300
											0	0	0	0	0	0		
	- Miscelaneous materials			600	m²		10.00		2.00	2.00	0	6,000	0	1,200	864	8,064		
	Duration 9 months										0	0	0	0	0	0		
	30 days / month 24 h / day			6,480	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		2	12,960	h	24.00					311,040	0	0	0	0	311,040		12,960
											0	0	0	0	0	0		
	- Furnace - 1 000 000 BTU 2.00 36.00	75%	2	9,720	h				2.00	36.00	0	0	0	19,440	251,942	271,382		
											0	0	0	0	0	0		
	Plug in the Shaft			**250**	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Concreting 4.00 h / m³			1,000	h	24.00					24,000	0	0	0	0	24,000		1,000
	- Construction materials			250	m³		74.00				0	18,500	0	0	0	18,500		
	- Construction equipment			250	m³				48.00	40.00	0	0	0	12,000	7,200	19,200		
	- Working platform			78	m²		1,000				0	78,000	0	0	0	78,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Concrete supply 2,720 1.10 h / m³	2%		2,774	m²	26.39	13.69	122.47	13.41	4.31	73,219	37,981	339,740	37,186	8,614	496,740		3,046
											0	0	0	0	0	0		
	Reinforcing Steel										0	0	0	0	0	0		
	- Supply and Fabricatior 60 kg / m³ 15.00 h / mt			**163**	**mt**	360.00	100.00	992.61	64.16	37.80	58,752	16,320	161,994	10,471	4,442	251,979		2,448
											0	0	0	0	0	0		
	Installation																	
	- M-P 16.00 h / mt			2,611	h	24.00					62,669	0	0	0	0	62,669		2,611
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	20%	1	522	h				37.00	20.00	0	0	0	19,314	7,517	26,831		

Item : 2540

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
	- Boom truck 17 tons 13.65 18.00	50%	1	1,306	h				13.65	18.00	0	0	0	17,827	16,926	34,753		
	Concrete transportation from the Batching Plan			**2,774**	**m^3**						0	0	0	0	0	0		
	Average production 150 m^3 / sh			19	sh						0	0	0	0	0	0		
	10 h / sh			190	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		3	570	h	24.00					13,680	0	0	0	0	13,680		570
											0	0	0	0	0	0		
	- Readymix 8 m^3 13.60 14.00	90%	2	342	h				13.60	14.00	0	0	0	4,651	3,447	8,098		
											0	0	0	0	0	0		
	Average hauling distance : 1.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 10										0	0	0	0	0	0		
	Going 2 30 km / h										0	0	0	0	0	0		
	Unloading 15										0	0	0	0	0	0		
	Return 2 35 km / h										0	0	0	0	0	0		
	29 min.										0	0	0	0	0	0		
	Efficacité : 85% 34 min. / trip										0	0	0	0	0	0		
	0.57 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	16 trips / sh										0	0	0	0	0	0		
	Readymix 8 m^3 8 m^3										0	0	0	0	0	0		
	128 m^3 / truck-sh										0	0	0	0	0	0		
	Number of trucks : **2**										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2540	**Intake structure**			**2,720**	**m^3**						**772,860**	**349,461**	**501,734**	**240,649**	**372,088**	**2,236,792**		**32,198**

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			

2600 Dams and Spillway

2610 Diversion Tunnels (including concrete plug and Portal Structure)

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2611	**Dam 1 - Diversion Tunnel**			**24,100**	**m³**													
	Excavation Soil Rock Tunnel										0	0	0	0	0	0		
	Upstream Portal 5,700 6,300										0	0	0	0	0	0		
	Downstream Portal 3,500 7,500										0	0	0	0	0	0		
	Tunnel 24,100										0	0	0	0	0	0		
	9,200 13,800 24,100										0	0	0	0	0	0		
	23,000										0	0	0	0	0	0		
	Concrete										0	0	0	0	0	0		
	Gate Structure 270										0	0	0	0	0	0		
	Plug 1,170										0	0	0	0	0	0		
	1,440										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Construction roads (m) (m² / m) (m³)																	
	Between portals 400 8 3,200																	
	From portal to access road 500 11 5,500																	
	Widenning permanent road 1,000 5 5,000																	
	1,900 13,700																	
	Backfill from excavated materials																	
	Foundation			**13,700**	**m³**													
	Production of 1,200 m³ / sh			11	sh						0	0	0	0	0	0		
	10 h / s			110	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	440	h	24.00					10,560	0	0	0	0	10,560		440
											0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	99	h				38.25	28.00	0	0	0	3,787	1,996	5,783		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	25%	1	28	h				19.00	29.00	0	0	0	532	585	1,117		
	Pavement 0.15 x 10 1.5 m³ / m			**2,850**	**m³**						0	0	0	0	0	0		
	Production of 1,000 m³ / sh			3	sh						0	0	0	0	0	0		
	10 h / s			30	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		10	300	h	24.00					7,200	0	0	0	0	7,200		300
											0	0	0	0	0	0		
	- Cat D6T LGP Track-Type Tractor 28.40 26.10	90%	1	27	h				28.40	26.10	0	0	0	767	507	1,274		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	45%	3	41	h				24.00	20.00	0	0	0	984	590	1,574		
	- Cat CS76 XT Vibratory Soil Compactor 14.85 20.00	25%	1	8	h				14.85	20.00	0	0	0	119	115	234		
	- Cat 14M Motorgrader 16.65 25.75	90%	1	27	h				16.65	25.75	0	0	0	450	501	951		
	- Cat 980H Wheel Loader 29.00 23.45	90%	1	27	h				29.00	23.45	0	0	0	783	456	1,239		
											0	0	0	0	0	0		
	Hauling distance from crusher 2.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Trip up 3 35 km / h										0	0	0	0	0	0		
	Unloading 4										0	0	0	0	0	0		
	Back trip 3 35 km / h										0	0	0	0	0	0		
	14 min.										0	0	0	0	0	0		
	Efficiency : 85% 16 min. / trip										0	0	0	0	0	0		
	0.27 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		

Item : (2611)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	33 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12.0 m³										0	0	0	0	0	0		
	396 m³/mach/sh										0	0	0	0	0	0		
	Number of trucks per shift **3**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Pavement material 1.8 mt / m³ 0.08 h / mt			5,130	mt	1.94	0.00	0.00	2.27	1.58	9,952	0	0	11,645	5,836	27,433		410
	Excavation										0	0	0	0	0	0		
	Portals (Overburden considered as rock) Total			**23,000**	**m³**						0	0	0	0	0	0		
															0			
	Drilling										0	0	0	0	0	0		
	Drilling grid ,9 x 1,2 0.90 1.20 1.08 m²										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling length 21,296 m										0	0	0	0	0	0		
	Production of 200 m / machine / sh			106	sh						0	0	0	0	0	0		
	6 machines			18	sh						0	0	0	0	0	0		
	10 h / s			177	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		10	1,767	h	24.00					42,400	0	0	0	0	42,400		1,767
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	6	954	h				19.40	15.00	0	0	0	18,508	10,303	28,811		
	- Drilling materials			21,296	m		0.70				0	14,907	0	0	0	14,907		
											0	0	0	0	0	0		
	Blasting										0	0	0	0	0	0		
	Average depth of holes 10 m										0	0	0	0	0	0		
	Number of holes 2,130 un										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Dynamite 1 kg / m³ 23,000 m³ Losses	5%		24,150	kg		5.60				0	135,240	0	0	0	135,240		
	- Caps Losses	5%		2,236	un		4.50				0	10,062	0	0	0	10,062		
											0	0	0	0	0	0		
	- M-P		4	707	h	24.00					16,960	0	0	0	0	16,960		707
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	159	h				5.00	15.00	0	0	0	795	1,717	2,512		
	- Misc. Blasting materials			23,000	m³		0.10				0	2,300	0	0	0	2,300		
											0	0	0	0	0	0		
	Evacuation of excavated materials										0	0	0	0	0	0		
	Production of 1,302 m³ / sh										0	0	0	0	0	0		
	1.5 loose »»»» 1,953 m³ / sh			18	sh						0	0	0	0	0	0		
	10 h / s			177	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		11	1,943	h	24.00					46,640	0	0	0	0	46,640		1,943
											0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	159	h				38.25	28.00	0	0	0	6,082	3,205	9,287		
	- Cat 345 Hydraulic Excavator 40.00 60.00	90%	1	159	h				40.00	60.00	0	0	0	6,360	6,869	13,229		
	- Cat 740 Articulated Dumper 40 T 32.00 27.90	90%	5	795	h				32.00	27.90	0	0	0	25,440	15,970	41,410		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	159	h				19.00	29.00	0	0	0	3,021	3,320	6,341		
	- Generator 5 kW (Tower light) 3.50 2.20	90%	2	318	h				3.50	2.20	0	0	0	1,113	504	1,617		
											0	0	0	0	0	0		
	Hauling distance 2.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Trip up 3 35 km / h										0	0	0	0	0	0		
	Unloading 4										0	0	0	0	0	0		
	Back trip 3 35 km / h										0	0	0	0	0	0		
	14 min.										0	0	0	0	0	0		
	Efficiency : 85% 16 min. / trip										0	0	0	0	0	0		
	0.27 h / trip										0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	9 h / sh										0	0	0	0	0	0		
	33 trips / sh										0	0	0	0	0	0		
	Cat 740 Articulated Dumper 40 T 14.0 m³										0	0	0	0	0	0		
	462 m³/mach/sh										0	0	0	0	0	0		
	Number of trucks per shift **5**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Consolidation										0	0	0	0	0	0		
	L H Area										0	0	0	0	0	0		
	2 sides 240 10 2,400										0	0	0	0	0	0		
	2 ends 10 23 230										0	0	0	0	0	0		
	2,630 m²																	
	Suppply										0	0	0	0	0	0		
-	Rock bolts 6 m 30 m² / un 88 un Losses	3%		91	un		110.00				0	10,010	0	0	0	10,010		
-	Wire mesh 2,400 m² Lapping	15%		2,760	m²		4.60				0	12,696	0	0	0	12,696		
-	Spikes 0,7 m 1.56 m² / un 1,538 un	3%		1,584	un		4.50				0	7,128	0	0	0	7,128		
-	Wire			2,400	m²		0.04				0	96	0	0	0	96		
											0	0	0	0	0	0		
	Rock bolts drilling and Installation										0	0	0	0	0	0		
	Production of 100 m / sh			6	sh						0	0	0	0	0	0		
	6 m bolt 528 m 10 h / sh			60	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		6	360	h	24.00					8,640	0	0	0	0	8,640		360
											0	0	0	0	0	0		
-	Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	54	h				37.00	20.00	0	0	0	1,998	778	2,776		
-	Fork lift 15 T 13.00 9.00	90%	1	54	h				13.00	9.00	0	0	0	702	350	1,052		
-	Boom truck 17 tons 13.65 18.00	90%	1	54	h				13.65	18.00	0	0	0	737	700	1,437		
-	Drilling rig (on fork lift)	90%	1	54	h				0.00	0.00	0	0	0	0	0	0		
											0	0	0	0	0	0		
	Wire mesh Installation										0	0	0	0	0	0		
	Production of 100 m² / sh			24	sh						0	0	0	0	0	0		
	10 h / sh			240	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		5	1,200	h	24.00					28,800	0	0	0	0	28,800		1,200
											0	0	0	0	0	0		
-	Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	216	h				37.00	20.00	0	0	0	7,992	3,110	11,102		
-	Jack leg 2.00	30%	1	72	h				2.00	0.00	0	0	0	144	0	144		
-	Fork lift 15 T 13.00 9.00	90%	1	216	h				13.00	9.00	0	0	0	2,808	1,400	4,208		
-	Misc. Drilling materials 1,538 un 0.7	m		1,077	m		1.00				0	1,077	0	0	0	1,077		
											0	0	0	0	0	0		
	Diversion tunnel										0	0	0	0	0	0		
	D Shape 10 x 12,5 117.5 m³ 205 m			**24,100**	**m³**						0	0	0	0	0	0		
	Area (m²)										0	0	0	0	0	0		
	Arc 11.59 17.50										0	0	0	0	0	0		
	Height 12.50										0	0	0	0	0	0		
	Wall 10.00 100.00										0	0	0	0	0	0		
	Width 10.00										0	0	0	0	0	0		
	117.5										0	0	0	0	0	0		
	Excavation										0	0	0	0	0	0		
	Progression 4.66 m										0	0	0	0	0	0		
	Number of rounds 44										0	0	0	0	0	0		
	Number of shifts 62 Prod. Factor 1.4										0	0	0	0	0	0		
	Number of holes (m) (Feet)										0	0	0	0	0	0		
	Production 94 55 mm dia. 20,804 68,237										0	0	0	0	0	0		
	Contour 49 55 mm dia. 10,845 35,571										0	0	0	0	0	0		
	143										0	0	0	0	0	0		
	Cut 3 109 mm dia. 664 2,178										0	0	0	0	0	0		
	146										0	0	0	0	0	0		

						UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Drilling depth 5.03 m 32,313 105,986										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Durations (hours) 44 rounds										0	0	0	0	0	0		
	Drilling 150 m / h 4.90 215 h										0	0	0	0	0	0		
	Blasting 1.15 min / hole 2.80 123 h										0	0	0	0	0	0		
	Scaling & W. mesh 2.00 88 h										0	0	0	0	0	0		
	Mucking 205 m³ / h 2.67 118 h										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling labour										0	0	0	0	0	0		
	H-H Bolting W. Mesh Remaining										0	0	0	0	0	0		
	8 4,960 694 595 3,670										0	0	0	0	0	0		
	14% 12%										0	0	0	0	0	0		
	Drilling 5.0 44 220 h										0	0	0	0	0	0		
	9 h / sh 24 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 1,956 h-h										0	0	0	0	0	0		
	Loading & Blasting 2.80 44 123 h										0	0	0	0	0	0		
	9 h / sh 14 sh										0	0	0	0	0	0		
	8 men / sh 10 h / sh 1,120 h-h										0	0	0	0	0	0		
	Remaining for services 595										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling			244	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	1,956	h	24.00					46,933	0	0	0	0	46,933		1,956
	44 rounds										0	0	0	0	0	0		
	- Jumbo E 3C 14.00 4.5 h			198	h				14.00		0	0	0	2,772	0	2,772		
	- Cat GEP 550 - 400KW 6.50 102.40 12 h			528	h				6.50	102.40	0	0	0	3,432	38,928	42,360		
	Feet ft / un										0	0	0	0	0	0		
	- Bits 2"Ø 103,808 1,600			65	un		85.00				0	5,525	0	0	0	5,525		
	- Bits 4"Ø 2,178 1,500			2	un		500.00				0	1,000	0	0	0	1,000		
	- Rod 18' 105,986 7,500			14	un		485.00				0	6,790	0	0	0	6,790		
	- Coupling 105,986 3,700			29	un		50.00				0	1,450	0	0	0	1,450		
	- Shank 105,986 12,500			9	un		300.00				0	2,700	0	0	0	2,700		
	- Misc. Materials 105,986			105,986	ft		0.04				0	4,239	0	0	0	4,239		
											0	0	0	0	0	0		
	Loading & Blasting			140	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	1,120	h	24.00					26,880	0	0	0	0	26,880		1,120
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	126	h				5.00	15.00	0	0	0	630	1,361	1,991		
											0	0	0	0	0	0		
	5.03 m holes 44 Rounds										0	0	0	0	0	0		
	Number Total Length (m)										0	0	0	0	0	0		
	Contour holes 49 2,156 10,845										0	0	0	0	0	0		
	Production holes 94 4,136 20,804										0	0	0	0	0	0		
	143 6,292										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Prima cord 5.5 m 11,858	5%		12,451	m		1.00				0	12,451	0	0	0	12,451		
	- Cap 6m 6,292	13%		7,110	un		3.50				0	24,885	0	0	0	24,885		
	- Dynamite RXL 438 24,100 m³ Powder fact 1.6			38,560	kg		5.60				0	215,936	0	0	0	215,936		
	- XACTEX 2,156 holes 5,929	5%		6,225	kg		7.50				0	46,688	0	0	0	46,688		
	2.75 kg / hole										0	0	0	0	0	0		
	Mucking 24,100 m³										0	0	0	0	0	0		
	1.5 Loose »»»» 36,150 m³										0	0	0	0	0	0		
	822 m³ / round										0	0	0	0	0	0		
	Production 140 m³ / h 5.87 h										0	0	0	0	0	0		
	44 rounds 258 h x 10/9 »»			287	h						0	0	0	0	0	0		

Item : (2611)

WBS	DESCRIPTION				%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
														24.00 $				0.72 $			
														0	0	0	0	0	0		
-	M-P					7	2,008	h	24.00					48,200	0	0	0	0	48,200		2,008
														0	0	0	0	0	0		
-	Cat 329DL Hydraulic Excavator	19.00	29.00		50%	1	143	h				19.00	29.00	0	0	0	2,717	2,986	5,703		
-	Cat 988H Wheel Loader	39.20	48.00		90%	1	258	h				39.20	48.00	0	0	0	10,114	8,916	19,030		
-	Cat D7R II LGP Track-Type Tractor	38.25	28.00		90%	1	258	h				38.25	28.00	0	0	0	9,869	5,201	15,070		
-	Cat 725 Articulated Dumper 25 T	24.00	20.00		90%	4	1,033	h				24.00	20.00	0	0	0	24,792	14,875	39,667		
														0	0	0	0	0	0		
	Disposal of excavated materials													0	0	0	0	0	0		
	Average hauling distance :		3.00 km											0	0	0	0	0	0		
														0	0	0	0	0	0		
	Loading	8												0	0	0	0	0	0		
	Going	6	30 km / h											0	0	0	0	0	0		
	Unloading	3												0	0	0	0	0	0		
	Return	6	30 km / h											0	0	0	0	0	0		
		23	min.											0	0	0	0	0	0		
	Efficacité :	85%	27 min. / trip											0	0	0	0	0	0		
			0.45 h / trip											0	0	0	0	0	0		
			9 h / sh											0	0	0	0	0	0		
			20 trips / sh											0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T		12 m³											0	0	0	0	0	0		
			240 m³ / truck-sh											0	0	0	0	0	0		
	Number of trucks :		4											0	0	0	0	0	0		
	Rolling Path	Length	205											0	0	0	0	0	0		
		Width	8.00											0	0	0	0	0	0		
		Thickness	0.30											0	0	0	0	0	0		
		Volume	492											0	0	0	0	0	0		
	Production	1,200 m³ / sh					1	sh						0	0	0	0	0	0		
			10 h / s				10	h						0	0	0	0	0	0		
														0	0	0	0	0	0		
-	M-P					8	80	h	24.00					1,920	0	0	0	0	1,920		80
														0	0	0	0	0	0		
-	Cat 988H Wheel Loader	39.20	48.00		90%	1	9	h				39.20	48.00	0	0	0	353	311	664		
-	Cat D7R II LGP Track-Type Tractor	38.25	28.00		90%	1	9	h				38.25	28.00	0	0	0	344	181	525		
-	Cat 725 Articulated Dumper 25 T	24.00	20.00		90%	1	9	h				24.00	20.00	0	0	0	216	130	346		
														0	0	0	0	0	0		
	Consolidation													0	0	0	0	0	0		
	Supply	un or m² / m	Qty											0	0	0	0	0	0		
-	Rock bolts 3 m	1	205	615 m	3%		211	un			70.00			0	0	14,770	0	0	14,770		
-	Wire mesh	26	5,330		15%		6,130	m²			4.60			0	0	28,198	0	0	28,198		
														0	0	0	0	0	0		
-	Spikes 0,7 m	1.25 m c/c		4,264 un	3%		4,392	un			4.50			0	0	19,764	0	0	19,764		
-	Wire			0.04 $ / m²			5,330	m²			0.04			0	0	213	0	0	213		
	Rock bolts Installation						62	sh						0	0	0	0	0	0		
	615 m		10 m / sh																		
	205 un		3 un / sh																		
			0.5 h / un. including positionning																		
			2 h / sh				124	h													
1)	Drilling with Jumbo													0	0	0	0	0	0		
														0	0	0	0	0	0		
-	Jumbo				90%	1	112	h				102.50		0	0	0	11,480	0	11,480		
														0	0	0	0	0	0		
2)	Install with 50t crane with basket													0	0	0	0	0	0		
	205 un		3 un / sh																		
			0.5 h / un incl. Positionning																		

Item : (2611)

WBS	DESCRIPTION			%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
								UNIT PRICES					TOTAL COSTS							
													24.00 $				0.72 $			
		1.7 h / sh				103	h													
	- M-P				3	308	h	24.00					7,380	0	0	0	0	7,380		308
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	92	h				37.00	20.00	0	0	0	3,404	1,325	4,729		
													0	0	0	0	0	0		
	- Impact tool					1	un		300.00				0	300	0	0	0	300		
	- Test rig					1	un		1,200.00				0	1,200	0	0	0	1,200		
	- Torque wrench					1	un		280.00				0	280	0	0	0	280		
													0	0	0	0	0	0		
	Wire mesh installation												0	0	0	0	0	0		
	Installation by Jumbo team												0	0	0	0	0	0		
	Production of 200 m² / sh		5,330 m²			27	sh						0	0	0	0	0	0		
			10 h / sh			267	h						0	0	0	0	0	0		
	Plus												0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	240	h				37.00	20.00	0	0	0	8,880	3,456	12,336		
	- Jack leg	2.00		30%		80	h				2.00		0	0	0	160	0	160		
	- Miscellaneous materials	Spike drilling	2,985 m			2,985	m		1.00				0	2,985	0	0	0	2,985		
													0	0	0	0	0	0		
	Compressed Air		Duration	6 months									0	0	0	0	0	0		
	26 days / month	20 h / day				3,120	h													
	- Compressor - 750 cfm	14.30	27.00	50%	2	3,120	h				14.30	27.00	0	0	0	44,616	60,653	105,269		
	- Miscelaneous materials					205	m		24.00				0	4,920	0	0	0	4,920		
													0	0	0	0	0	0		
	Ventilation & Heathing												0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Miscelaneous materials					205	m		10.00				0	2,050	0	0	0	2,050		
													0	0	0	0	0	0		
	Electrical services												0	0	0	0	0	0		
	- Cat GEP 550 - 400KW	6.50	102.40	50%	2	3,120					6.50	102.40	0	0	0	20,280	230,031	250,311		
	- Miscelaneous materials					205	m		22.00				0	4,510	0	0	0	4,510		
													0	0	0	0	0	0		
	Dewatering												0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Miscelaneous materials					205	m		15.00				0	3,075	0	0	0	3,075		
													0	0	0	0	0	0		
	Concrete structure					**270**	**m³**						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Concreting	3.75 h / m³				1,013	h	24.00					24,300	0	0	0	0	24,300		1,013
	- Construction materials					270	m³		78.00				0	21,060	0	0	0	21,060		
	- Construction equipment					270	m³				40.00	48.00	0	0	0	10,800	9,331	20,131		
	- Concrete supply	270	1.10 h / m³	2%		275	m²	26.39	13.69	122.47	13.41	4.31	7,259	3,765	33,680	3,686	854	49,244		302
													0	0	0	0	0	0		
													0	0	0	0	0	0		
	Diversion tunnel Concrete Plug					**1,170**	**m³**						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Concreting	2.75 h / m³				3,218	h	24.00					77,220	0	0	0	0	77,220		3,218
	- Construction materials					1,170	m³		70.00				0	81,900	0	0	0	81,900		
	- Construction equipment					1,170	m³				40.00	48.00	0	0	0	46,800	40,435	87,235		
													0	0	0	0	0	0		
	- Concrete supply	1,170	1.10 h / m³	2%		1,193	m²	26.39	13.69	122.47	13.41	4.31	31,489	16,334	146,110	15,992	3,704	213,629		1,310

Item : (2611)

WBS	DESCRIPTION				%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
														24.00 $				0.72 $			
	Reinforcing Steel													0	0	0	0	0	0		
	- Supply and Fabrication	60 kg / m³	15.00	h / mt			**86**	**mt**	360.00	100.00	992.61	64.16	37.80	31,104	8,640	85,762	5,543	2,352	133,401		1,296
														0	0	0	0	0	0		
	Installation																				
	- M-P	16.00 h / mt					1,382	h	24.00					33,178	0	0	0	0	33,178		1,382
														0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00		20%	1	276	h				37.00	20.00	0	0	0	10,212	3,974	14,186		
	- Boom truck 17 tons	13.65	18.00		50%	1	691	h				13.65	18.00	0	0	0	9,432	8,955	18,387		
	Concrete transportation from the Batching Plan						**1,440**	**m³**						0	0	0	0	0	0		
	Average production	150 m³ / sh					10	sh						0	0	0	0	0	0		
			10	h / sh			100	h						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- M-P					4	400	h	24.00					9,600	0	0	0	0	9,600		400
														0	0	0	0	0	0		
	- Readymix 8 m³	13.60	14.00		90%	3	270					13.60	14.00	0	0	0	3,672	2,722	6,394		
														0	0	0	0	0	0		
	Average hauling distance :		13.00	km										0	0	0	0	0	0		
														0	0	0	0	0	0		
	Loading	10												0	0	0	0	0	0		
	Going	26	30	km / h										0	0	0	0	0	0		
	Unloading	15												0	0	0	0	0	0		
	Return	22	35	km / h										0	0	0	0	0	0		
		73	min.											0	0	0	0	0	0		
	Efficacité :	85%	86	min. / trip										0	0	0	0	0	0		
			1.43	h / trip										0	0	0	0	0	0		
			9	h / sh										0	0	0	0	0	0		
			7	trips / sh										0	0	0	0	0	0		
	Readymix 8 m³		8	m³										0	0	0	0	0	0		
			56	m³ / truck-sh										0	0	0	0	0	0		
		Number of trucks :	**3**											0	0	0	0	0	0		
														0	0	0	0	0	0		
														0	0	0	0	0	0		
2611	**Dam 1 - Diversion Tunnel**													**516,615**	**666,199**	**328,497**	**344,963**	**499,493**	**2,355,767**		**21,519**

WBS	DESCRIPTION			%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
								UNIT PRICES					TOTAL COSTS							
													24.00 $				0.72 $			

2620 Cofferdams

WBS	DESCRIPTION			%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2621	**Dam 1 - Cofferdams**																			
	Dumped material	(m^3)											0	0	0	0	0	0		
	Downstream cofferdam	4,200											0	0	0	0	0	0		
	Upstream cofferdam	5,900											0	0	0	0	0	0		
		10,100											0	0	0	0	0	0		
													0	0	0	0	0	0		
	Compacted material												0	0	0	0	0	0		
	Downstream cofferdam	3,200											0	0	0	0	0	0		
	Upstream cofferdam	167,000											0	0	0	0	0	0		
		170,200											0	0	0	0	0	0		
													0	0	0	0	0	0		
	Dumped material					**10,100**	**m^2**						0	0	0	0	0	0		
	Loading on stockpile at	13	km										0	0	0	0	0	0		
	Production of	1,200	m^3 / sh			8	sh						0	0	0	0	0	0		
			10 h / sh			80	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				15	1,200		24.00					28,800	0	0	0	0	28,800		1,200
													0	0	0	0	0	0		
	- Cat 740 Articulated Dumper 40 T	32.00	27.90	90%	10	720	h				32.00	27.90	0	0	0	23,040	14,463	37,503		
	- Cat 988H Wheel Loader	39.20	48.00	90%	1	72	h				39.20	48.00	0	0	0	2,822	2,488	5,310		
	- Cat 345 Hydraulic Excavator	40.00	60.00	90%	1	72	h				40.00	60.00	0	0	0	2,880	3,110	5,990		
					12								0	0	0	0	0	0		
	Average hauling distance :		13.00 km										0	0	0	0	0	0		
													0	0	0	0	0	0		
	Loading	4											0	0	0	0	0	0		
	Going	26	30 km / h										0	0	0	0	0	0		
	Unloading	3											0	0	0	0	0	0		
	Return	22	35 km / h										0	0	0	0	0	0		
		55 min.											0	0	0	0	0	0		
	Efficacité :	85%	65 min. / trip										0	0	0	0	0	0		
			1.08 h / trip										0	0	0	0	0	0		
			9 h / sh										0	0	0	0	0	0		
			9 trips / sh										0	0	0	0	0	0		
	Cat 740 Articulated Dumper 40 T		14 m^3										0	0	0	0	0	0		
			126 m^3 / truck-sh										0	0	0	0	0	0		
	Number of trucks :		**10**										0	0	0	0	0	0		
													0	0	0	0	0	0		
	Compacted material					**170,200**	**m^3**						0	0	0	0	0	0		
	From stockpile	20,000											0	0	0	0	0	0		
	From excavation of spillway	150,200											0	0	0	0	0	0		
													0	0	0	0	0	0		
	From stock pile Production of	1,000	m^3 / sh			20	sh						0	0	0	0	0	0		
			10 h / sh			200	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				16	3,200		24.00					76,800	0	0	0	0	76,800		3,200

WBS	DESCRIPTION	%	n	Qty	Un.	M-P (UNIT PRICES)	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power (TOTAL COSTS)	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	180	h				19.00	29.00	0	0	0	3,420	3,758	7,178		
	- Cat 740 Articulated Dumper 40 T 32.00 27.90	90%	8	1,440	h				32.00	27.90	0	0	0	46,080	28,927	75,007		
	- Cat D8T LGP Track-Type Tractor 47.45 38.60	90%	1	180	h				47.45	38.60	0	0	0	8,541	5,003	13,544		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	180	h				39.20	48.00	0	0	0	7,056	6,221	13,277		
	- Cat 345 Hydraulic Excavator 40.00 60.00	90%	1	180	h				40.00	60.00	0	0	0	7,200	7,776	14,976		
	- Cat CS76 XT Vibratory Soil Compactor 14.85 20.00	90%	1	180	h				14.85	20.00	0	0	0	2,673	2,592	5,265		
	Average hauling distance : 13.00 km		13								0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Going 26 30 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 22 35 km / h										0	0	0	0	0	0		
	55 min.										0	0	0	0	0	0		
	Efficacité : 85% 65 min. / trip										0	0	0	0	0	0		
	1.08 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	9 trips / sh										0	0	0	0	0	0		
	Cat 740 Articulated Dumper 40 T 14 m^3										0	0	0	0	0	0		
	126 m^3 / truck-sh										0	0	0	0	0	0		
	Number of trucks : **8**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	From excavation of spillway										0	0	0	0	0	0		
	Production of 4,000 m^3 / sh			38	sh						0	0	0	0	0	0		
	10 h / sh			380	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		13	4,940		24.00					118,560	0	0	0	0	118,560		4,940
											0	0	0	0	0	0		
	- Cat D8T LGP Track-Type Tractor 47.45 38.60	90%	2	684	h				47.45	38.60	0	0	0	32,456	19,010	51,466		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	2	684	h				19.00	29.00	0	0	0	12,996	14,282	27,278		
	- Cat CS76 XT Vibratory Soil Compactor 14.85 20.00	90%	2	684	h				14.85	20.00	0	0	0	10,157	9,850	20,007		
			6								0	0	0	0	0	0		
	- Miscelaneous			170,200	m^3		0.10				0	17,020	0	0	0	17,020		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Geotextile			**9,000**	**m^2**						0	0	0	0	0	0		
	Production of 550 m^2 / sh			16	sh						0	0	0	0	0	0		
	10 h / sh			160	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	1,280		24.00					30,720	0	0	0	0	30,720		1,280
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	144	h				13.65	18.00	0	0	0	1,966	1,866	3,832		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	144	h				19.00	29.00	0	0	0	2,736	3,007	5,743		
											0	0	0	0	0	0		
	Supply 9,000 m^2	15%		10,350	m^2			7.50			0	0	77,625	0	0	77,625		
											0	0	0	0	0	0		
	Winter protection of stockpiles of ± 25,000 m^3										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Shelter 350 x 15 x 7 350 15 5,250		1	5,250	m^2		80.00				0	420,000	0	0	0	420,000		
											0	0	0	0	0	0		
	Installation and removing			10	sh						0	0	0	0	0	0		
	10 h / s			100	h						0	0	0	0	0	0		
											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- M-P		6	600	h	24.00					14,400	0	0	0	0	14,400		600
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	90	h				13.65	12.96	0	0	0	1,229	840	2,069		
	- Crane - Rough terrain 30 t (L-Belt) 33.00 18.00	90%	1	90	h				33.00	12.96	0	0	0	2,970	840	3,810		
											0	0	0	0	0	0		
	- Miscelaneous (footing, railing, furnace instalation, etc...)			700	m		110.00				0	77,000	0	0	0	77,000		
											0	0	0	0	0	0		
	Heathing 6 months in 2013-2014										0	0	0	0	0	0		
	6 months in 2014-2015 12 mth										0	0	0	0	0	0		
	52 weeks 168 h / w			8,736	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		2	17,472	h	24.00					419,328	0	0	0	0	419,328		17,472
											0	0	0	0	0	0		
	- Furnace - 1 000 000 BTU 2.00 36.00	100%	1	8,736	h				2.00	36.00	0	0	0	17,472	226,437	243,909		
											0	0	0	0	0	0		
	Pumping 30 weeks 6 d / w			180	days						0	0	0	0	0	0		
	20 h / day			3,600	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		1	3,600	h	24.00					86,400	0	0	0	0	86,400		3,600
											0	0	0	0	0	0		
	- Miscelaneous			1	ls		20,000				0	20,000	0	0	0	20,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2621	**Dam 1 - Cofferdams**										**775,008**	**534,020**	**77,625**	**185,694**	**350,470**	**1,922,817**		**32,292**

2622 Dam 2 - Cofferdams

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
	Dumped material (m³)										0	0	0	0	0	0		
	Upstream cofferdam 2,600										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Dumped material			**2,600**	**m²**						0	0	0	0	0	0		
	Loading on stockpile at 3 km										0	0	0	0	0	0		
	Production of 1,000 m³ / sh			3	sh						0	0	0	0	0	0		
	10 h / sh			30	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	240	h	24.00					5,760	0	0	0	0	5,760		240
											0	0	0	0	0	0		
	- Cat 740 Articulated Dumper 40 T 32.00 27.90	90%	3	81	h				32.00	27.90	0	0	0	2,592	1,627	4,219		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	27	h				39.20	48.00	0	0	0	1,058	933	1,991		
	- Cat 345 Hydraulic Excavator 40.00 60.00	90%	1	27	h				40.00	60.00	0	0	0	1,080	1,166	2,246		
			5								0	0	0	0	0	0		
	Average hauling distance : 3.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Going 6 30 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 5 35 km / h										0	0	0	0	0	0		
	18 min.										0	0	0	0	0	0		
	Efficacité : 85% 21 min. / trip										0	0	0	0	0	0		

Item : (2621-2622)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	0.35 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	26 trips / sh										0	0	0	0	0	0		
	Cat 740 Articulated Dumper 40 T 14 m³										0	0	0	0	0	0		
	364 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **3**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Geotextile			**600**	**m²**						0	0	0	0	0	0		
	Production of 550 m² / sh			1	sh						0	0	0	0	0	0		
	10 h / sh			10	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	80		24.00					1,920	0	0	0	0	1,920		80
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	9	h				13.65	18.00	0	0	0	123	117	240		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	9	h				19.00	29.00	0	0	0	171	188	359		
											0	0	0	0	0	0		
	Supply 600 m²	15%		690	m²			7.50			0	0	5,175	0	0	5,175		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Winter protection of stockpiles of ± 25,000 m³										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Shelter 350 x 15 x 7 350 15 5,250		1	5,250	m²		80.00				0	420,000	0	0	0	420,000		
											0	0	0	0	0	0		
	Installation and removing			10	sh						0	0	0	0	0	0		
	10 h / s			100	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	600	h	24.00					14,400	0	0	0	0	14,400		600
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	90	h				13.65	12.96	0	0	0	1,229	840	2,069		
	- Crane - Rough terrain 30 t (L-Belt) 33.00 18.00	90%	1	90	h				33.00	12.96	0	0	0	2,970	840	3,810		
											0	0	0	0	0	0		
	- Miscelaneous (footing, railing, furnace instalation, etc...)			700	m		110.00				0	77,000	0	0	0	77,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Heathing 6 months in 2013-2014 6 mth										0	0	0	0	0	0		
	26 weeks 168 h / w			4,368	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		2	8,736	h	24.00					209,664	0	0	0	0	209,664		8,736
											0	0	0	0	0	0		
	- Furnace - 1 000 000 BTU 2.00 36.00	100%	1	4,368	h				2.00	36.00	0	0	0	8,736	113,219	121,955		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2622	**Dam 2 - Cofferdams**										**231,744**	**497,000**	**5,175**	**17,959**	**118,930**	**870,808**		**9,656**

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2630	**Foundation**																	
2631	**Dam 1 - Foundation**																	
	Excavation										0	0	0	0	0	0		
	Overburden - Frozen (considered as rock) 50,000										0	0	0	0	0	0		
	Rock 5,134										0	0	0	0	0	0		
	55,134			**55,134**	**m³**						0	0	0	0	0	0		
	Drilling										0	0	0	0	0	0		
	Drilling grid ,9 x 0,9 0.90 0.90 0.81 m²										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling length 68,067 m										0	0	0	0	0	0		
	Production of 200 m / machine / sh			340	sh						0	0	0	0	0	0		
	6 machines			57	sh						0	0	0	0	0	0		
	10 h / s			567	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		11	6,233	h	24.00					149,600	0	0	0	0	149,600		6,233
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	6	3,060	h				19.40	15.00	0	0	0	59,364	33,048	92,412		
	- Drilling materials			68,067	m		0.70				0	47,647	0	0	0	47,647		
											0	0	0	0	0	0		
	Blasting										0	0	0	0	0	0		
	Average depth of holes 3 m										0	0	0	0	0	0		
	Number of holes 22,689 un										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Dynamite 1 kg / m³ 55,134 m³ Losses	5%		57,891	kg		5.60				0	324,190	0	0	0	324,190		
	- Caps Losses	5%		23,823	un		4.50				0	107,204	0	0	0	107,204		
											0	0	0	0	0	0		
	- M-P		4	2,267	h	24.00					54,400	0	0	0	0	54,400		2,267
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	510	h				5.00	15.00	0	0	0	2,550	5,508	8,058		
	- Misc. Blasting materials			55,134	m³		0.10				0	5,513	0	0	0	5,513		
											0	0	0	0	0	0		
	Evacuation of excavated materials										0	0	0	0	0	0		
	Production of 973 m³ / sh										0	0	0	0	0	0		
	1.5 loose »»»» 1,459 m³ / sh			57	sh						0	0	0	0	0	0		
	10 h / s			567	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		11	6,233	h	24.00					149,600	0	0	0	0	149,600		6,233
											0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	510	h				38.25	28.00	0	0	0	19,508	10,282	29,790		
	- Cat 345 Hydraulic Excavator 40.00 60.00	90%	1	510	h				40.00	60.00	0	0	0	20,400	22,032	42,432		
	- Cat 740 Articulated Dumper 40 T 32.00 27.90	90%	5	2,550	h				32.00	27.90	0	0	0	81,600	51,224	132,824		
	- Generator 5 kW (Tower light) 3.50 2.20	90%	2	1,020	h				3.50	2.20	0	0	0	3,570	1,616	5,186		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	510	h				19.00	29.00	0	0	0	9,690	10,649	20,339		
			8															
	Hauling distance 3.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Trip up 7 25 km / h										0	0	0	0	0	0		
	Unloading 4										0	0	0	0	0	0		
	Back trip 5 35 km / h										0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	20 min.										0	0	0	0	0	0		
	Efficiency : 85% 24 min. / trip										0	0	0	0	0	0		
	0.39 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	23 trips / sh										0	0	0	0	0	0		
	Cat 740 Articulated Dumper 40 T 14.0 m^3										0	0	0	0	0	0		
	322 m^3/mach/sh										0	0	0	0	0	0		
	Number of trucks per shift **5**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Foundation preparation			**1,400**	**m^2**						0	0	0	0	0	0		
	Production of 50 m^2 / sh			28	sh						0	0	0	0	0	0		
	10 h / s			280	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		10	2,800	h	24.00					67,200	0	0	0	0	67,200		2,800
											0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	252	h				19.00	29.00	0	0	0	4,788	5,262	10,050		
	- Compressor - 750 cfm 14.30 27.00	90%	1	252	h				14.30	27.00	0	0	0	3,604	4,899	8,503		
	- Compressor XAHS 237 (500 cfm) 15.00 29.00	90%	1	252	h				15.00	29.00	0	0	0	3,780	5,262	9,042		
	- Generator 5 kW (Tower light) 3.50 2.20	90%	2	504	h				3.50	2.20	0	0	0	1,764	798	2,562		
	- Miscelaneous			1,400	m^2		3.00				0	4,200	0	0	0	4,200		
											0	0	0	0	0	0		
	Industrial water supply										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Marerials			1,500	m		200.00				0	300,000	0	0	0	300,000		
											0	0	0	0	0	0		
	Installation and Dismantling			8	sh						0	0	0	0	0	0		
	10 h / s			80	h						0	0	0	0	0	0		
	- M-P		6	480	h	24.00					11,520	0	0	0	0	11,520		480
											0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	45%	1	36	h				19.00	20.88	0	0	0	684	752	1,436		
	- Boom truck 17 tons 13.65 18.00	90%	1	72	h				13.65	12.96	0	0	0	983	933	1,916		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	20%	1	16	h				37.00	14.40	0	0	0	592	230	822		
											0	0	0	0	0	0		
	Shelter 100 x 15 m 300 15 4,500 m^2										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Supply			4,500	m^2		80.00				0	360,000	0	0	0	360,000		
											0	0	0	0	0	0		
	Installation and removing			8	sh						0	0	0	0	0	0		
	10 h / s			80	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	480	h	24.00					11,520	0	0	0	0	11,520		480
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	72	h				13.65	12.96	0	0	0	983	672	1,655		
	- Crane - Rough terrain 30 t (L-Belt) 33.00 18.00	90%	1	72	h				33.00	12.96	0	0	0	2,376	672	3,048		
											0	0	0	0	0	0		
	- Miscelaneous (footing, railing, etc...)			600	m		110.00				0	66,000	0	0	0	66,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2631	**Dam 1 - Foundation**										**443,840**	**1,214,754**	**0**	**216,236**	**153,839**	**2,028,669**		**18,493**

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2632	**Dam 2 - Foundation**																	
	Excavation										0	0	0	0	0	0		
	Overburden - Frozen (considered as rock) 35,000										0	0	0	0	0	0		
	Rock 9,060										0	0	0	0	0	0		
	44,060			**44,060**	**m³**						0	0	0	0	0	0		
	Drilling										0	0	0	0	0	0		
	Drilling grid ,9 x 0,9 0.90 0.90 0.81 m²										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling length 54,395 m										0	0	0	0	0	0		
	Production of 200 m / machine / sh			272	sh						0	0	0	0	0	0		
	6 machines			45	sh						0	0	0	0	0	0		
	10 h / s			453	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		11	4,987	h	24.00					119,680	0	0	0	0	119,680		4,987
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	6	2,448	h						0	0	0	0	0	0		
	- Drilling materials			54,395	m						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Blasting										0	0	0	0	0	0		
	Average depth of holes 3 m										0	0	0	0	0	0		
	Number of holes 18,132 un										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Dynamite 1 kg / m³ 44,060 m³ Losses	5%		46,263	kg		5.60				0	259,073	0	0	0	259,073		
	- Caps Losses	5%		19,038	un		4.50				0	85,671	0	0	0	85,671		
											0	0	0	0	0	0		
	- M-P		4	1,813	h	24.00					43,520	0	0	0	0	43,520		1,813
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	1	408	h				5.00	15.00	0	0	0	2,040	4,406	6,446		
	- Misc. Blasting materials			44,060	m³		0.10				0	4,406	0	0	0	4,406		
											0	0	0	0	0	0		
	Evacuation of excavated materials										0	0	0	0	0	0		
	Production of 972 m³ / sh										0	0	0	0	0	0		
	1.5 loose »»»» 1,458 m³ / sh			45	sh						0	0	0	0	0	0		
	10 h / s			453	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		11	4,987	h	24.00					119,680	0	0	0	0	119,680		4,987
											0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	408	h				38.25	28.00	0	0	0	15,606	8,225	23,831		
	- Cat 345 Hydraulic Excavator 40.00 60.00	90%	1	408	h				40.00	60.00	0	0	0	16,320	17,626	33,946		
	- Cat 740 Articulated Dumper 40 T 32.00 27.90	90%	5	2,040	h				32.00	27.90	0	0	0	65,280	40,980	106,260		
	- Generator 5 kW (Tower light) 3.50 2.20	90%	2	816	h				3.50	2.20	0	0	0	2,856	1,293	4,149		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	408	h				19.00	29.00	0	0	0	7,752	8,519	16,271		
											0	0	0	0	0	0		
	Hauling distance 3.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Trip up 7 25 km / h										0	0	0	0	0	0		
	Unloading 4										0	0	0	0	0	0		
	Back trip 5 35 km / h										0	0	0	0	0	0		
	20 min.										0	0	0	0	0	0		
	Efficiency : 85% 24 min. / trip										0	0	0	0	0	0		
	0.39 h / trip										0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	9 h / sh										0	0	0	0	0	0		
	23 trips / sh										0	0	0	0	0	0		
	Cat 740 Articulated Dumper 40 T 14.0 m³										0	0	0	0	0	0		
	322 m³/mach/sh										0	0	0	0	0	0		
	Number of trucks per shift **5**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Foundation preparation			**3,000**	**m²**						0	0	0	0	0	0		
	Production of 50 m² / sh			60	sh						0	0	0	0	0	0		
	10 h / s			600	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		10	6,000	h	24.00					144,000	0	0	0	0	144,000		6,000
											0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	540	h				19.00	29.00	0	0	0	10,260	11,275	21,535		
	- Compressor - 750 cfm 14.30 27.00	90%	1	540	h				14.30	27.00	0	0	0	7,722	10,498	18,220		
	- Compressor XAHS 237 (500 cfm) 15.00 29.00	90%	1	540	h				15.00	29.00	0	0	0	8,100	11,275	19,375		
	- Generator 5 kW (Tower light) 3.50 2.20	90%	2	1,080	h				3.50	2.20	0	0	0	3,780	1,711	5,491		
											0	0	0	0	0	0		
	- Miscelaneous			3,000	m²		3.00				0	9,000	0	0	0	9,000		
											0	0	0	0	0	0		
	Industrial water supply										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Marerials			1,500	m		200.00				0	300,000	0	0	0	300,000		
											0	0	0	0	0	0		
	Installation and Dismantling			8	sh						0	0	0	0	0	0		
	10 h / s			80	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	480	h	24.00					11,520	0	0	0	0	11,520		480
											0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	45%	1	36	h				19.00	20.88	0	0	0	684	541	1,225		
	- Boom truck 17 tons 13.65 18.00	90%	1	72	h				13.65	12.96	0	0	0	983	672	1,655		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	20%	1	16	h				37.00	14.40	0	0	0	592	166	758		
											0	0	0	0	0	0		
	Shelter 2-100 x 15m 300 15 9,000 m²										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Supply			9,000	m²		80.00				0	720,000	0	0	0	720,000		
											0	0	0	0	0	0		
	Installation and removing			16	sh						0	0	0	0	0	0		
	10 h / s			160	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	960	h	24.00					23,040	0	0	0	0	23,040		960
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	144	h				13.65	12.96	0	0	0	1,966	1,344	3,310		
	- Crane - Rough terrain 30 t (L-Belt) 33.00 18.00	90%	1	144	h				33.00	12.96	0	0	0	4,752	1,344	6,096		
											0	0	0	0	0	0		
	- Miscelaneous (footing, railing, etc...)			600	m		110.00				0	66,000	0	0	0	66,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2632	**Dam 2 - Foundation**										**461,440**	**1,444,150**	**0**	**148,693**	**119,875**	**2,174,158**		**19,227**

Item : (2641-2642)

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
2640	**Impervious core**																	
2641	**Dam 1 - Impervious core**																	
	Under shelter protection																	
	Concrete Plinth			**850**	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rock Heating and Injection																	
	Defrosting holes 1,960																	
	Injection holes 940																	
	2,900 m			**2,900**	**m**													
	Impervious core			**49,700**	**m³**													
	Asphalt core 4,700																	
	2B Crushed stone 45,000																	
	49,700																	
	Concrete Plinth			**850**	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Concreting 3.05 h / m³			2,593	h	24.00					62,220	0	0	0	0	62,220		2,593
	- Construction materials			850	m³		107.00				0	90,950	0	0	0	90,950		
	- Construction equipment			850	m³				35.00	26.00	0	0	0	29,750	15,912	45,662		
	- Miscellaneous			850	m³		1.50				0	1,275	0	0	0	1,275		
											0	0	0	0	0	0		
	- Concrete supply 850 1.10 h / m³	2%		867	m²	26.39	13.69	122.47	13.41	4.31	22,884	11,871	106,184	11,622	2,692	155,253		952
											0	0	0	0	0	0		
	Reinforcing Steel										0	0	0	0	0	0		
	- Supply and Fabrication 60 kg / m³ 15.00 h / mt			**51**	**mt**	360.00	100.00	992.61	64.16	37.80	18,360	5,100	50,623	3,272	1,388	78,743		765
											0	0	0	0	0	0		
	Installation																	
	- M-P 16.00 h / mt			816	h	24.00					19,584	0	0	0	0	19,584		816
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	20%	1	163	h				37.00	20.00	0	0	0	6,031	2,347	8,378		
	- Boom truck 17 tons 13.65 18.00	50%	1	408	h				13.65	18.00	0	0	0	5,569	5,288	10,857		
											0	0	0	0	0	0		
	Concrete transportation from the Batching Plan			**867**	**m³**						0	0	0	0	0	0		
	Average production 50 m³ / sh			18	sh						0	0	0	0	0	0		
	10 h / sh			180	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		3	540	h	24.00					12,960	0	0	0	0	12,960		540
											0	0	0	0	0	0		
	- Ready-mix 8 m³ 13.60 14.00	90%	1	162	h				13.60	14.00	0	0	0	2,203	1,633	3,836		
											0	0	0	0	0	0		
	Average hauling distance : 13.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 10										0	0	0	0	0	0		
	Going 26 30 km / h										0	0	0	0	0	0		
	Unloading 15										0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
	Return 22 35 km / h										0	0	0	0	0	0		
	73 min.										0	0	0	0	0	0		
	Efficacies : 85% 86 min. / trip										0	0	0	0	0	0		
	1.43 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	7 trips / sh										0	0	0	0	0	0		
	Ready-mix 8 m³ 8 m³										0	0	0	0	0	0		
	56 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **1**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rock Heating and Injection										0	0	0	0	0	0		
	Defrosting holes 1,960										0	0	0	0	0	0		
	Injection holes 940										0	0	0	0	0	0		
	2,900 m										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling 225 m / sh-mach			13	sh						0	0	0	0	0	0		
	10 h / sh			130	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		4	520	h	24.00					12,480	0	0	0	0	12,480		520
											0	0	0	0	0	0		
-	Hydraulic Drilling Machine 19.40 15.00	90%	1	117	h				19.40	15.00	0	0	0	2,270	1,264	3,534		
-	Compressor - 750 cfm 14.30 27.00	90%	1	117	h				14.30	27.00	0	0	0	1,673	2,274	3,947		
											0	0	0	0	0	0		
-	Drilling materials			2,900	m		0.70				0	2,030	0	0	0	2,030		
											0	0	0	0	0	0		
	Injection 28 m³										0	0	0	0	0	0		
	Cement 38,916 kg										0	0	0	0	0	0		
-	Cement 40 kg bags 973	100%		1,946	un			10.00			0	0	19,460	0	0	19,460		
	Successfull links 100 kg cement / un **389 un**										0	0	0	0	0	0		
	10 un / sh			39	sh						0	0	0	0	0	0		
	10 h / sh			389	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		8	3,112	h	24.00					74,688	0	0	0	0	74,688		3,112
											0	0	0	0	0	0		
-	Compressor - 750 cfm 14.30 27.00	90%	1	350	h				14.30	27.00	0	0	0	5,005	6,804	11,809		
-	Injection pump 10.00	90%	1	350	h				10.00	0.00	0	0	0	3,500	0	3,500		
											0	0	0	0	0	0		
-	Miscellaneous			389	un		45.00				0	17,505	0	0	0	17,505		
											0	0	0	0	0	0		
	Heathing and defrosting										0	0	0	0	0	0		
	Rock defrosting 42 days	6	w								0	0	0	0	0	0		
	Drilling 13 sh										0	0	0	0	0	0		
	Injection 39 sh										0	0	0	0	0	0		
	52 sh										0	0	0	0	0	0		
	2 sh / day 26 days	4	w								0	0	0	0	0	0		
		10	w															
	10 weeks																	
	Lag time 3 weeks										0	0	0	0	0	0		
	13 weeks 168 h / w			2,184	h						0	0	0	0	0	0		
											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- M-P		2	4,368	h	24.00					104,832	0	0	0	0	104,832		4,368
	- Boiler - 1500 kW 4.00 190.00	100%	1	2,184	h				4.00	190.00	0	0	0	8,736	298,771	307,507		
											0	0	0	0	0	0		
	- Miscellaneous (hoses, pipes, etc...) Holes lentgh proportion :	75%		2,175	m		18.00				0	39,150	0	0	0	39,150		
											0	0	0	0	0	0		
	Impervious core			**49,700**	**m³**						0	0	0	0	0	0		
	Asphalt core 4,700										0	0	0	0	0	0		
	2B Crushed stone 45,000										0	0	0	0	0	0		
	49,700 m³										0	0	0	0	0	0		
	Number of passes										0	0	0	0	0	0		
	Heigth 57 m										0	0	0	0	0	0		
	Thickness 0.225 m 253 layers										0	0	0	0	0	0		
	Asphalt 0.090 m³ / m of layer										0	0	0	0	0	0		
	Total lentgh 52,222 m 206 m / layer										0	0	0	0	0	0		
	Progression 70 m / h 2.94 h / layer										0	0	0	0	0	0		
	10 hours shift 3.40 layers / sh	**OK**									0	0	0	0	0	0		
											0	0	0	0	0	0		
	Mechanical placement 3 layers / sh			84	sh						0	0	0	0	0	0		
	Testing bench 25 m 4 layers			6	sh													
				90	sh													
	10 h / sh			900	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		10	9,000	h	24.00					216,000	0	0	0	0	216,000		9,000
											0	0	0	0	0	0		
	- Paver 50.00 40.00	90%	1	810	h				50.00	40.00	0	0	0	40,500	23,328	63,828		
	- Cat 950H Wheel Loader 18.35 9.05	90%	1	810	h				18.35	9.05	0	0	0	14,864	5,278	20,142		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	810	h				19.00	29.00	0	0	0	15,390	16,913	32,303		
	- 10 Wheeler Truck 24.00 20.00	90%	2	1,620	h				24.00	20.00	0	0	0	38,880	23,328	62,208		
	- Cat CB 225 Compactor 14.85 20.00	90%	2	1,620	h				14.85	20.00	0	0	0	24,057	23,328	47,385		
	- Plate damper 1T 2.00 1.45	90%	1	810	h				2.00	1.45	0	0	0	1,620	846	2,466		
			8								0	0	0	0	0	0		
	- Miscelaneous (propane and accessories, uppers, etc)			52,222	m		3.00				0	156,666	0	0	0	156,666		
											0	0	0	0	0	0		
	Asphalt Transportation from Batch Plan										0	0	0	0	0	0		
	Production 56 m³ / sh										0	0	0	0	0	0		
	Average hauling distance : 13.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 10										0	0	0	0	0	0		
	Going 26 30 km / h										0	0	0	0	0	0		
	Unloading 30										0	0	0	0	0	0		
	Return 22 35 km / h										0	0	0	0	0	0		
	88 min.										0	0	0	0	0	0		
	Efficacies : 85% 104 min. / trip										0	0	0	0	0	0		
	1.73 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	6 trips / sh										0	0	0	0	0	0		
	10 Wheeler Truck 8 m³										0	0	0	0	0	0		
	48 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **2**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Manual placement 2 h / layer 253 layers										0	0	0	0	0	0		
	506 h 9 h / sh eff.			56	sh						0	0	0	0	0	0		

Item : (2641-2642)

						UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	10 h / sh			560	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		9	5,040	h	24.00					120,960	0	0	0	0	120,960		5,040
											0	0	0	0	0	0		
	- Cat 950H Wheel Loader 18.35 9.05	45%	1	252	h				18.35	9.05	0	0	0	4,624	1,642	6,266		
	- Plate damper 1T 2.00 1.45	90%	2	1,008	h				2.00	1.45	0	0	0	2,016	1,052	3,068		
	- Boom truck 17 tons 13.65 18.00	45%	1	252	h				13.65	18.00	0	0	0	3,440	3,266	6,706		
											0	0	0	0	0	0		
	- Miscelaneous materials (formwork, spikes, etc…)			253	lay		75.00				0	18,975	0	0	0	18,975		
											0	0	0	0	0	0		
	Supply (m³) (mt)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Asphalt 4,700 7,050 0.45 h / mt	10%		7,755	mt	10.76	0.00	69.39	6.32	0.06	0	0	538,094	48,981	312	587,387		3,471
	- 2B Crushed stone 45,000 81,000 0.08 h / mt	5%		85,050	mt	1.94	0.00	0.00	2.27	1.58	164,997	0	0	193,064	96,753	454,814		6,804
											0	0	0	0	0	0		
	Filter 2B **Transportation from crusher stockpile**			**45,000**	**m³**						0	0	0	0	0	0		
	Thickness 0.225 m 253 layers																	
	2B 0.810 m³ / m of layer										0	0	0	0	0	0		
	52,222 m 206 m / layer										0	0	0	0	0	0		
	Progression 70 m / h 2.94 h / layer										0	0	0	0	0	0		
	10 hours shift 3.40 layers / sh										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Production 501 m³ / sh										0	0	0	0	0	0		
	Average hauling distance : 3.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 5										0	0	0	0	0	0		
	Going 6 30 km / h										0	0	0	0	0	0		
	Unloading 5										0	0	0	0	0	0		
	Return 5 35 km / h										0	0	0	0	0	0		
	21 min.										0	0	0	0	0	0		
	Efficacies : 85% 25 min. / trip										0	0	0	0	0	0		
	0.41 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	22 trips / sh										0	0	0	0	0	0		
	10 Wheeler Truck 8 m³										0	0	0	0	0	0		
	176 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **3**										0	0	0	0	0	0		
				84	sh						0	0	0	0	0	0		
	10 h / sh			840	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	4,200	h	24.00					100,800	0	0	0	0	100,800		4,200
											0	0	0	0	0	0		
	- Cat 950H Wheel Loader 18.35 9.05	90%	1	756	h				18.35	9.05	0	0	0	13,873	4,926	18,799		
	- 10 Wheeler Truck 24.00 20.00	90%	3	2,268	h				24.00	20.00	0	0	0	54,432	32,659	87,091		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2641	**Dam 1 - Impervious core**										**930,765**	**343,522**	**714,361**	**535,372**	**572,004**	**3,096,024**		**42,180**

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
													24.00 $				0.72 $			
2642	**Dam 2 - Impervious core**																			
	Under shelter protection																			
	Concrete Plinth					**1,700**	**m³**						0	0	0	0	0	0		
													0	0	0	0	0	0		
	Rock Heating and Injection												0	0	0	0	0	0		
	Defrosting holes	320											0	0	0	0	0	0		
	Injection holes	152											0	0	0	0	0	0		
		472	m			**472**	**m**						0	0	0	0	0	0		
													0	0	0	0	0	0		
	Impervious core					**42,300**	**m³**						0	0	0	0	0	0		
	Asphalt core	3,800											0	0	0	0	0	0		
	2B Crushed stone	38,500											0	0	0	0	0	0		
		42,300											0	0	0	0	0	0		
													0	0	0	0	0	0		
	Concrete Plinth					**1,700**	**m³**						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Concreting	3.05	h / m³			5,185	h	24.00					124,440	0	0	0	0	124,440		5,185
	- Construction materials					1,700	m³		107.00				0	181,900	0	0	0	181,900		
	- Construction equipment					1,700	m³				35.00	26.00	0	0	0	59,500	31,824	91,324		
	- Miscellaneous					1,700	m³		1.50				0	2,550	0	0	0	2,550		
													0	0	0	0	0	0		
	- Concrete supply	1,700	1.10 h / m³	2%		1,734	m²	26.39	13.69	122.47	13.41	4.31	45,768	23,742	212,368	23,245	5,384	310,507		1,904
													0	0	0	0	0	0		
													0	0	0	0	0	0		
	Reinforcing Steel												0	0	0	0	0	0		
	- Supply and Fabrication	60 kg / m³	15.00 h / mt			**102**	**mt**	360.00	100.00	992.61	64.16	37.80	36,720	10,200	101,246	6,544	2,776	157,486		1,530
													0	0	0	0	0	0		
	Installation																			
	- M-P	16.00	h / mt			1,632	h	24.00					39,168	0	0	0	0	39,168		1,632
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	20%	1	326	h				37.00	20.00	0	0	0	12,062	4,694	16,756		
	- Boom truck 17 tons	13.65	18.00	50%	1	816	h				13.65	18.00	0	0	0	11,138	10,575	21,713		
													0	0	0	0	0	0		
	Concrete transportation from the Batching Plan					**1,734**	**m³**						0	0	0	0	0	0		
	Average production	50	m³ / sh			35	sh						0	0	0	0	0	0		
		10	h / sh			350	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				3	1,050	h	24.00					25,200	0	0	0	0	25,200		1,050
													0	0	0	0	0	0		
	- Ready-mix 8 m³	13.60	14.00	90%	1	315	h				13.60	14.00	0	0	0	4,284	3,175	7,459		
													0	0	0	0	0	0		
	Average hauling distance :	4.00	km										0	0	0	0	0	0		
													0	0	0	0	0	0		
	Loading	10											0	0	0	0	0	0		
	Going	8	30 km / h										0	0	0	0	0	0		
	Unloading	15											0	0	0	0	0	0		
	Return	7	35 km / h										0	0	0	0	0	0		
		40	min.										0	0	0	0	0	0		
	Efficacies :	85%	47 min. / trip										0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
	0.78 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	12 trips / sh										0	0	0	0	0	0		
	Ready-mix 8 m³ 8 m³										0	0	0	0	0	0		
	96 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **1**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Rock Heating and Injection										0	0	0	0	0	0		
	Defrosting holes 320										0	0	0	0	0	0		
	Injection holes 152										0	0	0	0	0	0		
	472 m										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling 225 m / sh-mach			2	sh						0	0	0	0	0	0		
	10 h / sh			20	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		4	80	h	24.00					1,920	0	0	0	0	1,920		80
											0	0	0	0	0	0		
-	Hydraulic Drilling Machine 19.40 15.00	90%	1	18	h				19.40	15.00	0	0	0	349	194	543		
-	Compressor - 750 cfm 14.30 27.00	90%	1	18	h				14.30	27.00	0	0	0	257	350	607		
											0	0	0	0	0	0		
-	Drilling materials			472	m		0.70				0	330	0	0	0	330		
											0	0	0	0	0	0		
	Injection 4 m³										0	0	0	0	0	0		
	Cement 6,293 kg										0	0	0	0	0	0		
											0	0	0	0	0	0		
-	Cement 40 kg bags 157	100%		315	un			10.00			0	0	3,150	0	0	3,150		
											0	0	0	0	0	0		
	Successfull links 100 kg cement / un **63 un**										0	0	0	0	0	0		
	10 un / sh			6	sh						0	0	0	0	0	0		
	10 h / sh			63	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		8	504	h	24.00					12,096	0	0	0	0	12,096		504
											0	0	0	0	0	0		
-	Compressor - 750 cfm 14.30 27.00	90%	1	57	h				14.30	27.00	0	0	0	815	1,108	1,923		
-	Injection pump 10.00	90%	1	57	h				10.00	0.00	0	0	0	570	0	570		
											0	0	0	0	0	0		
-	Miscellaneous			63	un		45.00				0	2,835	0	0	0	2,835		
											0	0	0	0	0	0		
	Heathing and defrosting										0	0	0	0	0	0		
	Rock defrosting 7 days	1	w								0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling 2 sh										0	0	0	0	0	0		
	Injection 6 sh										0	0	0	0	0	0		
	8 sh										0	0	0	0	0	0		
	2 sh / day 4 days	1	w								0	0	0	0	0	0		
		2	w								0	0	0	0	0	0		
	2 weeks										0	0	0	0	0	0		
	Lag time 3 weeks										0	0	0	0	0	0		
	5 weeks 168 h / w			840	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		2	1,680	h	24.00					40,320	0	0	0	0	40,320		1,680
											0	0	0	0	0	0		
-	Boiler - 1500 kW 4.00 190.00	100%	1	840	h				4.00	190.00	0	0	0	3,360	114,912	118,272		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
-	Miscellaneous (hoses, pipes, etc...) Holes lentgh proportion :	75%		354	m		18.00				0	6,372	0	0	0	6,372		
											0	0	0	0	0	0		
	Impervious core			**42,300**	**m³**						0	0	0	0	0	0		
	Asphalt core 3,800										0	0	0	0	0	0		
	2B Crushed stone 38,500										0	0	0	0	0	0		
	42,300 m³										0	0	0	0	0	0		
	Number of passes										0	0	0	0	0	0		
	Heigth 31 m										0	0	0	0	0	0		
	Thickness 0.225 m 138 layers										0	0	0	0	0	0		
	Asphalt 0.090 m³ / m of layer										0	0	0	0	0	0		
	42,222 m 306 m / layer										0	0	0	0	0	0		
	Progression 70 m / h 4.37 h / layer										0	0	0	0	0	0		
	14 hours shift 3.20 layers / sh	**OK**									0	0	0	0	0	0		
											0	0	0	0	0	0		
	Testing bench (Done in Dam 1)																	
	Mechanical placement 3 layers / sh			46	sh						0	0	0	0	0	0		
	14 h / sh			644	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		12	7,728	h	24.00					185,472	0	0	0	0	185,472		7,728
											0	0	0	0	0	0		
-	Paver 50.00 40.00	90%	1	580	h				50.00	40.00	0	0	0	29,000	16,704	45,704		
-	Cat 950H Wheel Loader 18.35 9.05	90%	1	580	h				18.35	9.05	0	0	0	10,643	3,779	14,422		
-	Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	580	h				19.00	29.00	0	0	0	11,020	12,110	23,130		
-	10 Wheeler Truck 24.00 20.00	90%	2	1,159	h				24.00	20.00	0	0	0	27,816	16,690	44,506		
-	Cat CB 225 Compactor 14.85 20.00	90%	2	1,159	h				14.85	20.00	0	0	0	17,211	16,690	33,901		
-	Plate damper 1T 2.00 1.45	90%	1	580	h				2.00	1.45	0	0	0	1,160	606	1,766		
			8								0	0	0	0	0	0		
-	Miscelaneous (propane and accessories, uppers, etc)			42,222	m		3.00				0	126,666	0	0	0	126,666		
											0	0	0	0	0	0		
	Asphalt Transportation from Batch Plan										0	0	0	0	0	0		
	Production 83 m³ / sh										0	0	0	0	0	0		
	Average hauling distance : 13.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 10										0	0	0	0	0	0		
	Going 26 30 km / h										0	0	0	0	0	0		
	Unloading 30										0	0	0	0	0	0		
	Return 22 35 km / h										0	0	0	0	0	0		
	88 min.										0	0	0	0	0	0		
	Efficacies : 85% 104 min. / trip										0	0	0	0	0	0		
	1.73 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	6 trips / sh										0	0	0	0	0	0		
	10 Wheeler Truck 8 m³										0	0	0	0	0	0		
	48 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **2**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Manual placement 2 h / layer 207 layers (total for 2 depressions)										0	0	0	0	0	0		
	414 h 9 h / sh eff.			46	sh						0	0	0	0	0	0		
	10 h / sh			460	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		9	4,140	h	24.00					99,360	0	0	0	0	99,360		4,140
											0	0	0	0	0	0		

Item : (2641-2642)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Cat 950H Wheel Loader 18.35 9.05	45%	1	207	h				18.35	9.05	0	0	0	3,798	1,349	5,147		
	- Plate damper 1T 2.00 1.45	90%	2	828	h				2.00	1.45	0	0	0	1,656	864	2,520		
	- Boom truck 17 tons 13.65 18.00	45%	1	207	h				13.65	18.00	0	0	0	2,826	2,683	5,509		
											0	0	0	0	0	0		
	- Miscelaneous materials (formwork, spikes, etc…)			207	lay		75.00				0	15,525	0	0	0	15,525		
											0	0	0	0	0	0		
	Supply (m³) (mt)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Asphalt 3,800 5,700 0.4475 h / mt	10%		6,270	mt	10.76	0.00	69.39	6.32	0.06	0	0	435,054	39,601	253	474,908		2,806
	- 2B Crushed stone 38,500 69,300 0.0800 h / mt	5%		72,765	mt	1.94	0.00	0.00	2.27	1.58	141,164	0	0	165,177	82,777	389,118		5,821
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Filter 2B **Transportation from crusher stockpile**			**38,500**	**m³**						0	0	0	0	0	0		
	0.810 m³ / m of layer										0	0	0	0	0	0		
	42,222 m 306 m / layer										0	0	0	0	0	0		
	Progression 70 m / h 4.37 h / layer										0	0	0	0	0	0		
	14 hours shift 3.20 layers / sh										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Production 744 m³ / sh										0	0	0	0	0	0		
	Average hauling distance : 4.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 5										0	0	0	0	0	0		
	Going 8 30 km / h										0	0	0	0	0	0		
	Unloading 5										0	0	0	0	0	0		
	Return 7 35 km / h										0	0	0	0	0	0		
	25 min.										0	0	0	0	0	0		
	Efficacies : 85% 29 min. / trip										0	0	0	0	0	0		
	0.49 h / trip										0	0	0	0	0	0		
	13 h / sh										0	0	0	0	0	0		
	27 trips / sh										0	0	0	0	0	0		
	10 Wheeler Truck 8 m³										0	0	0	0	0	0		
	216 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **4**										0	0	0	0	0	0		
				46	sh						0	0	0	0	0	0		
	14 h / sh			644	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	3,220	h	24.00					77,280	0	0	0	0	77,280		3,220
											0	0	0	0	0	0		
	- Cat 950H Wheel Loader 18.35 9.05	90%	1	580	h				18.35	9.05	0	0	0	10,643	3,779	14,422		
	- 10 Wheeler Truck 24.00 20.00	90%	4	2,318	h				24.00	20.00	0	0	0	55,632	33,379	89,011		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2642	**Dam 2 - Impervious core**										**828,908**	**370,120**	**751,818**	**498,307**	**366,655**	**2,815,808**		**37,280**

Item : (2651-2652)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			

2650 Rock fill

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2651	**Dam 1 - Rock fill**			**581,000**	**m³**													
	3D 0-900 Rockfill 500,000										0	0	0	0	0	0		
	3E 0-225 Rockfill 67,000										0	0	0	0	0	0		
	4 400-600 Riprap 14,000										0	0	0	0	0	0		
											0	0	0	0	0	0		
	3D 0-900 Rockfill			**500,000**	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Transport included in Spillway excavation										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Production of 2,400 m³ / sh			208	sh						0	0	0	0	0	0		
	10 h / s			2,080	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		11	22,880	h	24.00					549,120	0	0	0	0	549,120		22,880
											0	0	0	0	0	0		
	- Generator 5 kW (Tower light) 3.50 2.20	90%	4	7,488	h				3.50	2.20	0	0	0	26,208	11,861	38,069		
	- Cat D8T LGP Track-Type Tractor 47.45 38.60	90%	1	1,872	h				47.45	38.60	0	0	0	88,826	52,027	140,853		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	2	3,744	h				38.25	28.00	0	0	0	143,208	75,479	218,687		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	2	3,744	h				19.00	29.00	0	0	0	71,136	78,175	149,311		
	- Cat CS76 XT Vibratory Soil Compactor 14.85 20.00	90%	2	3,744	h				14.85	20.00	0	0	0	55,598	53,914	109,512		
			7								0	0	0	0	0	0		
	- Miscelaneous			500,000	m³		0.10				0	50,000	0	0	0	50,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	3E 0-225 Rockfill			**67,000**	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Transport from crusher										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Production of 900 m³ / sh			74	sh						0	0	0	0	0	0		
	10 h / s			740	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		12	8,880	h	24.00					213,120	0	0	0	0	213,120		8,880
											0	0	0	0	0	0		
	- Generator 5 kW (Tower light) 3.50 2.20	90%	4	2,664	h				3.50	2.20	0	0	0	9,324	4,220	13,544		
	- Cat 988H Wheel Loader 39.20 48.00	90%	1	666	h				39.20	48.00	0	0	0	26,107	23,017	49,124		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	666	h				38.25	28.00	0	0	0	25,475	13,427	38,902		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	666	h				19.00	29.00	0	0	0	12,654	13,906	26,560		
	- Cat CS76 XT Vibratory Soil Compactor 14.85 20.00	90%	1	666	h				14.85	20.00	0	0	0	9,890	9,590	19,480		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	4	2,664	h				24.00	20.00	0	0	0	63,936	38,362	102,298		
			8								0	0	0	0	0	0		
	Hauling distance 3.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Trip up 7 25 km / h										0	0	0	0	0	0		
	Unloading 4										0	0	0	0	0	0		
	Back trip 5 35 km / h										0	0	0	0	0	0		
	20 min.										0	0	0	0	0	0		
	Efficiency : 85% 24 min. / trip										0	0	0	0	0	0		

Item : (2651-2652)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	0.39 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	23 trips / sh										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 12.0 m³										0	0	0	0	0	0		
	276 m³/mach/sh										0	0	0	0	0	0		
	Number of trucks per shift 4										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Supply From crusher 1.8 0.08 h / mt 120,600	5%		126,630	mt	1.94	0.00	0.00	2.27	1.58	245,662	0	0	287,450	144,054	677,166		10,130
											0	0	0	0	0	0		
	4 400-600 Riprap			**14,000**	**m²**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Selection in spillway excavation										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Production of 400 m³ / sh			35	sh						0	0	0	0	0	0		
	10 h / s			350	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	1,750	h	24.00					42,000	0	0	0	0	42,000		1,750
											0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	315	h				19.00	29.00	0	0	0	5,985	6,577	12,562		
	- Cat 345 Hydraulic Excavator 40.00 60.00	90%	1	315	h				40.00	60.00	0	0	0	12,600	13,608	26,208		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	315	h				38.25	28.00	0	0	0	12,049	6,350	18,399		
											0	0	0	0	0	0		
	- Miscelaneous			14,000	m³		0.30				0	4,200	0	0	0	4,200		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2651	**Dam 1 - Rock fill**			**581,000**							**1,049,902**	**54,200**	**0**	**850,446**	**544,567**	**2,499,115**		**43,640**
2652	**Dam 2 - Rock fill**			**275,500**	**m³**													
	3D 0-900 Rockfill 190,000										0	0	0	0	0	0		
	3E 0-225 Rockfill 58,000										0	0	0	0	0	0		
	3F 0-450 Rockfill 3,000																	
	4 400-600 Riprap 24,500										0	0	0	0	0	0		
											0	0	0	0	0	0		
	3D 0-900 Rockfill			**190,000**	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Transport included in Intake channel excavation										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Production of 2,400 m³ / sh			79	sh						0	0	0	0	0	0		
	10 h / s			790	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		11	8,690	h	24.00					208,560	0	0	0	0	208,560		8,690
											0	0	0	0	0	0		
	- Generator 5 kW (Tower light) 3.50 2.20	90%	4	2,844	h				3.50	2.20	0	0	0	9,954	4,505	14,459		
	- Cat D8T LGP Track-Type Tractor 47.45 38.60	90%	1	711	h				47.45	38.60	0	0	0	33,737	19,760	53,497		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	2	1,422	h				38.25	28.00	0	0	0	54,392	28,668	83,060		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	2	1,422	h				19.00	29.00	0	0	0	27,018	29,691	56,709		
	- Cat CS76 XT Vibratory Soil Compactor 14.85 20.00	90%	2	1,422	h				14.85	20.00	0	0	0	21,117	20,477	41,594		
											0	0	0	0	0	0		

Item : (2651-2652)

WBS	DESCRIPTION				%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
														24.00 $				0.72 $			
	- Miscelaneous						190,000	m³		0.10				0	19,000	0	0	0	19,000		
														0	0	0	0	0	0		
														0	0	0	0	0	0		
	3E 0-225 Rockfill						**61,000**	**m³**						0	0	0	0	0	0		
														0	0	0	0	0	0		
	Transport from crusher													0	0	0	0	0	0		
														0	0	0	0	0	0		
	Production of	900 m³ / sh					68	sh						0	0	0	0	0	0		
			10 h / s				680	h						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- M-P					12	8,160	h	24.00					195,840	0	0	0	0	195,840		8,160
														0	0	0	0	0	0		
	- Generator 5 kW (Tower light)	3.50	2.20		90%	4	2,448	h				3.50	2.20	0	0	0	8,568	3,878	12,446		
	- Cat 988H Wheel Loader	39.20	48.00		90%	1	612	h				39.20	48.00	0	0	0	23,990	21,151	45,141		
	- Cat D7R II LGP Track-Type Tractor	38.25	28.00		90%	1	612	h				38.25	28.00	0	0	0	23,409	12,338	35,747		
	- Cat 329DL Hydraulic Excavator	19.00	29.00		90%	1	612	h				19.00	29.00	0	0	0	11,628	12,779	24,407		
	- Cat CS76 XT Vibratory Soil Compactor	14.85	20.00		90%	1	612	h				14.85	20.00	0	0	0	9,088	8,813	17,901		
	- Cat 725 Articulated Dumper 25 T	24.00	20.00		90%	4	2,448	h				24.00	20.00	0	0	0	58,752	35,251	94,003		
						8								0	0	0	0	0	0		
	Hauling distance		3.00 km											0	0	0	0	0	0		
														0	0	0	0	0	0		
	Loading	4												0	0	0	0	0	0		
	Trip up	7	25 km / h											0	0	0	0	0	0		
	Unloading	4												0	0	0	0	0	0		
	Back trip	5	35 km / h											0	0	0	0	0	0		
		20 min.												0	0	0	0	0	0		
	Efficiency :	85%	24 min. / trip											0	0	0	0	0	0		
			0.39 h / trip											0	0	0	0	0	0		
			9 h / sh											0	0	0	0	0	0		
			23 trips / sh											0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T		12.0 m³											0	0	0	0	0	0		
			276 m³/mach/sh											0	0	0	0	0	0		
		Number of trucks per shift	**4**											0	0	0	0	0	0		
														0	0	0	0	0	0		
	- Supply From crusher	1.8	0.08 h / mt	109,800	5%		115,290		1.94	0.00	0.00	2.27	1.58	223,663	0	0	261,708	131,154	616,525		9,223
														0	0	0	0	0	0		
	4 400-600 Riprap						**24,500**	**m²**						0	0	0	0	0	0		
	Selection in intake channel excavation																				
	Production of	400 m³ / sh					61	sh						0	0	0	0	0	0		
			10 h / s				610	h						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- M-P					5	3,050	h	24.00					73,200	0	0	0	0	73,200		3,050
														0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator	19.00	29.00		90%	1	549	h				19.00	29.00	0	0	0	10,431	11,463	21,894		
	- Cat 345 Hydraulic Excavator	40.00	60.00		90%	1	549	h				40.00	60.00	0	0	0	21,960	23,717	45,677		
	- Cat D7R II LGP Track-Type Tractor	38.25	28.00		90%	1	549	h				38.25	28.00	0	0	0	20,999	11,068	32,067		
														0	0	0	0	0	0		
	- Miscelaneous						24,500	m³		0.30				0	7,350	0	0	0	7,350		
														0	0	0	0	0	0		
2652	**Dam 2 - Rock fill**						**275,500**							**701,263**	**26,350**	**0**	**596,751**	**374,713**	**1,699,077**		**29,123**

Item : (2661)

WBS	DESCRIPTION				%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
														24.00 $				0.72 $			
2660	**Spillway**																				
2661	**Dam 1 - Spillway**						**645,000**	**m^3**													
														0	0	0	0	0	0		
	Construction roads	**(m)**	**(m^2 / m)**	**(m^3)**										0	0	0	0	0	0		
	From spillway to crusher	**1,000**	**11**	**11,000**										0	0	0	0	0	0		
	From spillway to Dam 1	**3,000**	**11**	**33,000**										0	0	0	0	0	0		
	Widenning permanent road	**500**	**5**	**2,500**										0	0	0	0	0	0		
		4,500		**46,500**										0	0	0	0	0	0		
	Backfill from excavated materials													0	0	0	0	0	0		
	Foundation						**46,500**	**m^3**						0	0	0	0	0	0		
	Production of 1,200 m^3 / sh						39	sh						0	0	0	0	0	0		
				10 h / s			390	h						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- M-P					4	1,560	h	24.00					37,440	0	0	0	0	37,440		1,560
														0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor	38.25	28.00		90%	1	351	h				38.25	28.00	0	0	0	13,426	7,076	20,502		
	- Cat CS76 XT Vibratory Soil Compactor	14.85	20.00		45%	1	176	h				14.85	20.00	0	0	0	2,614	2,534	5,148		
	- Cat 329DL Hydraulic Excavator	19.00	29.00		25%	1	98	h				19.00	29.00	0	0	0	1,862	2,046	3,908		
	- Miscelaneous (culverts, signalisation, etc...)						4,500	m		2.00				0	9,000	0	0	0	9,000		
														0	0	0	0	0	0		
	Pavement 0.15 x	10		1.5 m^3 / m			**6,750**	**m^3**						0	0	0	0	0	0		
	Production of 1,000 m^3 / sh						7	sh						0	0	0	0	0	0		
				10 h / s			68	h						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- M-P					10	675	h	24.00					16,200	0	0	0	0	16,200		675
														0	0	0	0	0	0		
	- Cat D6T LGP Track-Type Tractor	28.40	26.10		90%	1	61	h				28.40	26.10	0	0	0	1,732	1,146	2,878		
	- Cat 725 Articulated Dumper 25 T	24.00	20.00		45%	3	91	h				24.00	20.00	0	0	0	2,184	1,310	3,494		
	- Cat CS76 XT Vibratory Soil Compactor	14.85	20.00		25%	1	17	h				14.85	20.00	0	0	0	252	245	497		
	- Cat 14M Motorgrader	16.65	25.75		90%	1	61	h				16.65	25.75	0	0	0	1,016	1,131	2,147		
	- Cat 980H Wheel Loader	29.00	23.45		90%	1	61	h				29.00	23.45	0	0	0	1,769	1,030	2,799		
														0	0	0	0	0	0		
	Hauling distance from crusher		2.00 km											0	0	0	0	0	0		
														0	0	0	0	0	0		
	Loading	4												0	0	0	0	0	0		
	Trip up	3	35 km / h											0	0	0	0	0	0		
	Unloading	4												0	0	0	0	0	0		
	Back trip	3	35 km / h											0	0	0	0	0	0		
		14 min.												0	0	0	0	0	0		
	Efficiency :	85%	16 min. / trip											0	0	0	0	0	0		
			0.27 h / trip											0	0	0	0	0	0		
			9 h / sh											0	0	0	0	0	0		
			33 trips / sh											0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T		12.0 m^3											0	0	0	0	0	0		
			396 m^3/mach/sh											0	0	0	0	0	0		
	Number of trucks per shift		**3**											0	0	0	0	0	0		
														0	0	0	0	0	0		
	- Pavement material	1.8 mt / m^3	0.08 h / mt				12,150	mt	1.94	0.00	0.00	2.27	1.58	23,571	0	0	27,581	13,822	64,974		972
														0	0	0	0	0	0		
	Rock Excavation		(m^3)				**645,000**	**m^3**						0	0	0	0	0	0		
	Frozen Overburden considered as rock		20,000											0	0	0	0	0	0		

Item : (2661)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Rock 625,000										0	0	0	0	0	0		
	645,000										0	0	0	0	0	0		
	Drilling										0	0	0	0	0	0		
	Drilling grid ,9 x 1,2 0.90 1.20 1.08 m²										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Drilling length 597,222 m										0	0	0	0	0	0		
	Production of 200 m / machine / sh			2,986	sh						0	0	0	0	0	0		
	12 machines			249	sh						0	0	0	0	0	0		
	10 h / s			2,488	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		20	49,767	h	24.00					1,194,400	0	0	0	0	1,194,400		49,767
											0	0	0	0	0	0		
	- Hydraulic Drilling Machine 19.40 15.00	90%	12	26,874	h				19.40	15.00	0	0	0	521,356	290,239	811,595		
	- Drilling materials			597,222	m		0.70				0	418,055	0	0	0	418,055		
											0	0	0	0	0	0		
	Blasting										0	0	0	0	0	0		
	Average depth of holes 10 m										0	0	0	0	0	0		
	Number of holes 59,722 un										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Dynamite 1 kg / m³ 645,000 m³ Losses	5%		677,250	kg		5.60				0	3,792,600	0	0	0	3,792,600		
	- Caps Losses	5%		62,708	un		4.50				0	282,186	0	0	0	282,186		
											0	0	0	0	0	0		
	- M-P		8	19,907	h	24.00					477,760	0	0	0	0	477,760		19,907
											0	0	0	0	0	0		
	- Explosives Truck 5.00 15.00	90%	2	4,479	h				5.00	15.00	0	0	0	22,395	48,373	70,768		
	- Misc. Blasting materials			645,000	m³		0.10				0	64,500	0	0	0	64,500		
											0	0	0	0	0	0		
	Mucking										0	0	0	0	0	0		
	Production of 2,592 m³ / sh										0	0	0	0	0	0		
	1.5 loose »»»» 3,888 m³ / sh			249	sh						0	0	0	0	0	0		
	10 h / s			2,488	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		24	59,720	h	24.00					1,433,280	0	0	0	0	1,433,280		59,720
											0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	2	4,479	h				38.25	28.00	0	0	0	171,322	90,297	261,619		
	- Cat 345 Hydraulic Excavator 40.00 60.00	90%	2	4,479	h				40.00	60.00	0	0	0	179,160	193,493	372,653		
	- Cat 740 Articulated Dumper 40 T 32.00 27.90	90%	15	33,593	h				32.00	27.90	0	0	0	1,074,976	674,816	1,749,792		
	- Generator 5 kW (Tower light) 3.50 2.20	90%	4	8,958	h				3.50	2.20	0	0	0	31,353	14,189	45,542		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	2	4,479	h				19.00	29.00	0	0	0	85,101	93,522	178,623		
	Hauling distance 4.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 4										0	0	0	0	0	0		
	Trip up 10 25 km / h										0	0	0	0	0	0		
	Unloading 4										0	0	0	0	0	0		
	Back trip 7 35 km / h										0	0	0	0	0	0		
	25 min.										0	0	0	0	0	0		
	Efficiency : 85% 29 min. / trip										0	0	0	0	0	0		
	0.49 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	19 trips / sh										0	0	0	0	0	0		
	Cat 740 Articulated Dumper 40 T 14.0 m³										0	0	0	0	0	0		
	266 m³/mach/sh										0	0	0	0	0	0		
	Number of trucks per shift **15**										0	0	0	0	0	0		
											0	0	0	0	0	0		

Item : (2661)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Consolidation										0	0	0	0	0	0		
	L H Area										0	0	0	0	0	0		
	2 sides 900 25 22,500 m²										0	0	0	0	0	0		
	Suppply										0	0	0	0	0	0		
	- Rock bolts 6 30 m² / un 750 un Losses	3%		773	un		110.00				0	85,030	0	0	0	85,030		
	- Wire mesh 22,500 m² Lapping	15%		25,875	m²		4.60				0	119,025	0	0	0	119,025		
	- Spikes 0,7 m 1.56 m² / un 14,423 un	3%		14,856	un		4.50				0	66,852	0	0	0	66,852		
	- Wire			22,500	m²		0.04				0	900	0	0	0	900		
											0	0	0	0	0	0		
	Rock bolts drilling and Installation										0	0	0	0	0	0		
	Production of 100 m / sh			45	sh						0	0	0	0	0	0		
	6 m bolt 4,500 m 10 h / sh			450	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	2,700	h	24.00					64,800	0	0	0	0	64,800		2,700
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	405	h				37.00	20.00	0	0	0	14,985	5,832	20,817		
	- Fork lift 15 T 13.00 9.00	90%	1	405	h				13.00	9.00	0	0	0	5,265	2,624	7,889		
	- Boom truck 17 tons 13.65 18.00	90%	1	405	h				13.65	18.00	0	0	0	5,528	5,249	10,777		
	- Drilling rig (on fork lift)	90%	1	405	h				0.00	0.00	0	0	0	0	0	0		
											0	0	0	0	0	0		
	Wire mesh Installation										0	0	0	0	0	0		
	Production of 100 m² / sh			225	sh						0	0	0	0	0	0		
	10 h / sh			2,250	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	11,250	h	24.00					270,000	0	0	0	0	270,000		11,250
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	90%	1	2,025	h				37.00	20.00	0	0	0	74,925	29,160	104,085		
	- Jack leg 2.00	30%	1	675	h				2.00	0.00	0	0	0	1,350	0	1,350		
	- Fork lift 15 T 13.00 9.00	90%	1	2,025	h				13.00	9.00	0	0	0	26,325	13,122	39,447		
	- Misc. Drilling materials 14,423 un 0.7	m		10,096	m		1.00				0	10,096	0	0	0	10,096		
											0	0	0	0	0	0		
	Concrete Weir			**1,175**	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Foundation preparation 600 m²										0	0	0	0	0	0		
	Production of 100 m² / sh			6	sh						0	0	0	0	0	0		
	10 h / sh			60	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	300	h	24.00					7,200	0	0	0	0	7,200		300
											0	0	0	0	0	0		
	- Compressor - 750 cfm 14.30 27.00	90%	1	54	h				14.30	27.00	0	0	0	772	1,050	1,822		
	- Generator 5 kW (Tower light) 3.50 2.20	30%	1	18	h				3.50	2.20	0	0	0	63	29	92		
											0	0	0	0	0	0		
	- Miscelaneous			600	m²		0.50				0	300	0	0	0	300		
											0	0	0	0	0	0		
	Concrete			**1,175**	**m³**						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Concreting 5.00 h / m³			5,875	h	24.00					141,000	0	0	0	0	141,000		5,875
	- Construction materials			1,175	m³		80.00				0	94,000	0	0	0	94,000		
	- Construction equipment			1,175	m³				38.00	26.00	0	0	0	44,650	21,996	66,646		
	- Concrete supply 1,175 1.10 h / m³	2%		1,199	m²	26.39	13.69	122.47	13.41	4.31	31,647	16,417	146,845	16,073	3,723	214,705		1,317
											0	0	0	0	0	0		
	Reinforcing Steel										0	0	0	0	0	0		

Item : (2661)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Supply and Fabrication 60 kg / m³ 15.00 h / mt			**71**	**mt**	360.00	100.00	992.61	64.16	37.80	25,380	7,050	69,979	4,523	1,919	108,851		1,058
											0	0	0	0	0	0		
	Installation																	
	- M-P 16.00 h / mt			1,128	h	24.00					27,072	0	0	0	0	27,072		1,128
											0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	20%	1	226	h				37.00	20.00	0	0	0	8,362	3,254	11,616		
	- Boom truck 17 tons 13.65 18.00	50%	1	564	h				13.65	18.00	0	0	0	7,699	7,309	15,008		
											0	0	0	0	0	0		
	Concrete transportation from the Batching Plan			**1,199**	**m³**						0	0	0	0	0	0		
	Average production 150 m³ / sh			8	sh						0	0	0	0	0	0		
	10 h / sh			80	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	400	h	24.00					9,600	0	0	0	0	9,600		400
											0	0	0	0	0	0		
	- Readymix 8 m³ 13.60 14.00	90%	3	216	h				13.60	14.00	0	0	0	2,938	2,177	5,115		
											0	0	0	0	0	0		
	Average hauling distance : 13.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 10										0	0	0	0	0	0		
	Going 26 30 km / h										0	0	0	0	0	0		
	Unloading 15										0	0	0	0	0	0		
	Return 22 35 km / h										0	0	0	0	0	0		
	73 min.										0	0	0	0	0	0		
	Efficacité : 85% 86 min. / trip										0	0	0	0	0	0		
	1.43 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	7 trips / sh										0	0	0	0	0	0		
	Readymix 8 m³ 8 m³										0	0	0	0	0	0		
	56 m³ / truck-sh										0	0	0	0	0	0		
	Number of trucks : **3**										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2661	**Dam 1 - Spillway**			**645,000**	**m³**						**3,759,350**	**4,966,011**	**216,824**	**2,351,557**	**1,532,713**	**12,826,455**		**156,627**

Item : (2710)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2700	**Electrical Works**																	
2710	**Supply and Installation of Transformers and Power cables**																	
	Power transformers																	
	Purchase																	
	- Power transformer (oil)			5	un			1,500,000			0	0	7,500,000	0	0	7,500,000		
											0	0	0	0	0	0		
	Installation										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 3,000 h / un		5	15,000	h	24.00					360,000	0	0	0	0	360,000		15,000
											0	0	0	0	0	0		
	- Miscelaneous			5	un		5,000.00		70,000.00		0	25,000	0	350,000	0	375,000		
											0	0	0	0	0	0		
	Secondary transformers (oil)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Purchase										0	0	0	0	0	0		
	- S1 & S2			2	un			250,000.00			0	0	500,000	0	0	500,000		
											0	0	0	0	0	0		
	Installation										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 200 h / un		2	400	h	24.00					9,600	0	0	0	0	9,600		400
											0	0	0	0	0	0		
	- Miscelaneous			2	un		500.00		4,500.00		0	1,000	0	9,000	0	10,000		
											0	0	0	0	0	0		
	Secondary transformers (dry)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Purchase and Installation										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- S 3			1	un			200,000.00			0	0	200,000	0	0	200,000		
											0	0	0	0	0	0		
	- M-P 200 h / un		1	200	h	24.00					4,800	0	0	0	0	4,800		200
											0	0	0	0	0	0		
	- Miscelaneous			1	un		200.00		2,000.00		0	200	0	2,000	0	2,200		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2710	**Supply and Installation of Transformers and Power cables**										**374,400**	**26,200**	**8,200,000**	**361,000**	**0**	**8,961,600**		**15,600**

2700 Electrical Works

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2720	**Supply and Installation of High voltage distribution plant**																	
	Purchase and Installation										0	0	0	0	0	0		
	12 kV Distribution center										0	0	0	0	0	0		
	- PSG 1			1	un			275,000.00			0	0	275,000	0	0	275,000		
	- PSG 2			1	un			275,000.00			0	0	275,000	0	0	275,000		
	- PSG 3			1	un			175,000.00			0	0	175,000	0	0	175,000		
											0	0	0	0	0	0		
	- M-P 700 h / un		3	2,100	h	24.00					50,400	0	0	0	0	50,400		2,100
											0	0	0	0	0	0		
	- Miscelaneous			3	un		500.00		2,000.00		0	1,500	0	6,000	0	7,500		
											0	0	0	0	0	0		
	400 V Principal distribution center										0	0	0	0	0	0		
	- SG 1			1	un			155,000.00			0	0	155,000	0	0	155,000		
	- SG 2			1	un			155,000.00			0	0	155,000	0	0	155,000		
											0	0	0	0	0	0		
	- M-P 600 h / un		3	1,800	h	24.00					43,200	0	0	0	0	43,200		1,800
											0	0	0	0	0	0		
	- Miscelaneous			3	un		1,000.00		18,000.00		0	3,000	0	54,000	0	57,000		
											0	0	0	0	0	0		
	400 V Secondary group distribution										0	0	0	0	0	0		
	- SG 11			1	un			75,000.00			0	0	75,000	0	0	75,000		
	- SG 12			1	un			75,000.00			0	0	75,000	0	0	75,000		
	- SG 13			1	un			75,000.00			0	0	75,000	0	0	75,000		
	- SG 14			1	un			75,000.00			0	0	75,000	0	0	75,000		
	- SG 15			1	un			75,000.00			0	0	75,000	0	0	75,000		
											0	0	0	0	0	0		
	- M-P 600 h / un		5	3,000	h	24.00					72,000	0	0	0	0	72,000		3,000
											0	0	0	0	0	0		
	- Miscelaneous			5	un		1,000.00		10,000.00		0	5,000	0	50,000	0	55,000		
															0			
	400 V Secondary distribution center										0	0	0	0	0	0		
	- SG 21			1	un			80,000.00			0	0	80,000	0	0	80,000		
	- SG 22			1	un			80,000.00			0	0	80,000	0	0	80,000		
	- SG 23			1	un			80,000.00			0	0	80,000	0	0	80,000		
	- SG 24			1	un			80,000.00			0	0	80,000	0	0	80,000		
															0			
	- M-P 600 h / un		4	2,400	h	24.00					57,600	0	0	0	0	57,600		2,400
											0	0	0	0	0	0		
	- Miscelaneous			4	un		800.00		10,000.00		0	3,200	0	40,000	0	43,200		
											0	0	0	0	0	0		
	«Barres sous gaine»										0	0	0	0	0	0		
	- BSG 1			1	un			100,000.00			0	0	100,000	0	0	100,000		
	- BSG 2			1	un			100,000.00			0	0	100,000	0	0	100,000		
											0	0	0	0	0	0		
	- M-P 750 h / un		2	1,500	h	24.00					36,000	0	0	0	0	36,000		1,500
											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Miscelaneous			2	un		1,000.00		16,000.00		0	2,000	0	32,000	0	34,000		
											0	0	0	0	0	0		
	Bus Bars										0	0	0	0	0	0		
	- BB 1			1	un						0	0	0	0	0	0		
	- BB 2			1	un						0	0	0	0	0	0		
	- BB 3			1	un						0	0	0	0	0	0		
	- BB 4			1	un						0	0	0	0	0	0		
	- BB 5			1	un						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 8,000 h / un		5	40,000	h	24.00					960,000	0	0	0	0	960,000		40,000
											0	0	0	0	0	0		
	- Miscelaneous			5	un		10,000.00		45,000.00		0	50,000	0	225,000	0	275,000		
											0	0	0	0	0	0		
	Cable 22 to 200 m outside tunnel										0	0	0	0	0	0		
	- C1A			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C1B			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C1C			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C2A			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C2B			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C2C			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C3A			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C3B			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C3C			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C4A			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C4B			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C4C			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C5A			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C5B			1.2	km			350,000			0	0	420,000	0	0	420,000		
	- C5C			1.2	km			350,000			0	0	420,000	0	0	420,000		
											0	0	0	0	0	0		
	- M-P 18.0 km 3000 h / km			54,000.0	h	24.00					1,296,000	0	0	0	0	1,296,000		54,000
											0	0	0	0	0	0		
	- Miscelaneous			18	km		2,000.00		17,000.00		0	36,000	0	306,000	0	342,000		
											0	0	0	0	0	0		
	Cable heads 220 kV - Accessories										0	0	0	0	0	0		
	- TDC			15	un			25,000			0	0	375,000	0	0	375,000		
	- TDCGIS			15	un			50,000			0	0	750,000	0	0	750,000		
	- RSC - Splice cables (600 m)			15	un			35,000			0	0	525,000	0	0	525,000		
	- GIS Between transfo and 200 kV cable			15	un			50,000			0	0	750,000	0	0	750,000		
											0	0	0	0	0	0		
	- M-P 150 h / un		60	9,000.0	h	24.00					216,000	0	0	0	0	216,000		9,000
											0	0	0	0	0	0		
	- Miscelaneous			60	un		500.00		3,500.00		0	30,000	0	210,000	0	240,000		
											0	0	0	0	0	0		
	Battery System										0	0	0	0	0	0		
	- 125 V battery Protect.			2	un			40,000			0	0	80,000	0	0	80,000		
	- 125 V battery Primer			1	un			15,000			0	0	15,000	0	0	15,000		
	- Batery charger 300 A			2	un			65,000			0	0	130,000	0	0	130,000		
	- Batery charger 50 A			1	un			25,000			0	0	25,000	0	0	25,000		
	- 120 V «Onduleur» 10 kVA			1	un			40,000			0	0	40,000	0	0	40,000		
											0	0	0	0	0	0		
	- M-P 120 h / un		7	840.0	h	24.00					20,160	0	0	0	0	20,160		840

Item : (2720)

WBS	DESCRIPTION	%	n	Qty	Un.	M-P (UNIT PRICES)	Cons. Mat. (UNIT PRICES)	Perm. Mat. (UNIT PRICES)	Equip. Op. (UNIT PRICES)	Fuel l / h	Man power (TOTAL COSTS)	Consumable materials (TOTAL COSTS)	Permanent Materials (TOTAL COSTS)	Equipment Operation (TOTAL COSTS)	Fuel Consumption (TOTAL COSTS)	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
	- Miscelaneous			7	un		100.00		600.00		0	700	0	4,200	0	4,900		
											0	0	0	0	0	0		
	Miscelaneous materials										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2720	**Supply and Installation of High voltage distribution plant**										**2,751,360**	**131,400**	**10,920,000**	**927,200**	**0**	**14,729,960**		**114,640**

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			

2730 Permanent camp Utilities Substation

2731 Water treatment Area Substation

Included in Underground utilities

											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2731	**Water treatment Area Substation**										**0**	**0**	**0**	**0**	**0**	**0**		**0**

2732 Administration Building Area Substation

Included in Underground utilities

											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2732	**Administration Building Area Substation**										**0**	**0**	**0**	**0**	**0**	**0**		**0**

2733 Sewage Treatment Area Substation

Included in Underground utilities

											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2733	**Sewage Treatment Area Substation**										**0**	**0**	**0**	**0**	**0**	**0**		**0**

2734 Fire & Process Water Area Pumping Station Substation

Included in Underground utilities

											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		

Item : (2731-2736)

						UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2734	**Fire & Process Water Area Pumping Station Substation**										**0**	**0**	**0**	**0**	**0**	**0**		**0**
2735	**Maintenance Shop and Warehouse Area Substation**																	
	Included in Underground utilities																	
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2735	**Maintenance Shop and Warehouse Area Substation**										**0**	**0**	**0**	**0**	**0**	**0**		**0**
2736	**Port Facility Substation**																	
	Included in 2210 Warf facilities																	
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2736	**Port Facility Substation**										**0**	**0**	**0**	**0**	**0**	**0**		**0**

Item : (2740-2770)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
2740	**Emergency Generator**																	
	Purchase and Installation										0	0	0	0	0	0		
	- Generator and Fuel tank			1	un			165,000.00			0	0	165,000	0	0	165,000		
											0	0	0	0	0	0		
	- M-P		1	100.0	h	24.00					2,400	0	0	0	0	2,400		100
											0	0	0	0	0	0		
	- Miscelaneous			1	un		1,000.00		1,500.00		0	1,000	0	1,500	0	2,500		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2740	**Emergency Generator**										**2,400**	**1,000**	**165,000**	**1,500**	**0**	**169,900**		**100**
2750	**Plant Communications**																	
	Purchase and Installation										0	0	0	0	0	0		
	- Communications			1	ls			200,000.00			0	0	200,000	0	0	200,000		
	- Fire detection			1	ls			500,000.00			0	0	500,000	0	0	500,000		
															0			
															0			
	- M-P		1	6,500	h	24.00					156,000	0	0	0	0	156,000		6,500
											0	0	0	0	0	0		
	- Miscelaneous			1	un		25,000.0		100,000		0	25,000	0	100,000	0	125,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2750	**Plant Communications**										**156,000**	**25,000**	**700,000**	**100,000**	**0**	**981,000**		**6,500**
2760	**Power plant Command Circuitry**																	
	Purchase and Installation										0	0	0	0	0	0		
	- Command cables			1	ls			450,000			0	0	450,000	0	0	450,000		
	- Supply cables			1	ls			750,000			0	0	750,000	0	0	750,000		
	- Cable Trays			1	ls			750,000			0	0	750,000	0	0	750,000		
	- Control pannels			1	ls			750,000			0	0	750,000	0	0	750,000		
											0	0	0	0	0	0		
	- M-P			50,000	h	24.00					1,200,000	0	0	0	0	1,200,000		50,000
											0	0	0	0	0	0		
	- Miscelaneous			1	ls		300,000		700,000		0	300,000	0	700,000	0	1,000,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2760	**Power plant Command Circuitry**										**1,200,000**	**300,000**	**2,700,000**	**700,000**	**0**	**4,900,000**		**50,000**

Item : (2740-2770)

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
													24.00 $				0.72 $			
2770	**Switch yard Site**					**5,400**	**m²**													
	Production of	3,000	m² / sh			2	sh						0	0	0	0	0	0		
		10	h / sh			20	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				6	120	h	24.00					2,880	0	0	0	0	2,880		120
													0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor	38.25	28.00	90%	1	18	h				38.25	28.00	0	0	0	689	20	709		
	- Cat 725 Articulated Dumper 25 T	24.00	20.00	90%	3	54	h				24.00	20.00	0	0	0	1,296	43	1,339		
	- Cat 329DL Hydraulic Excavator	19.00	29.00	90%	1	18	h				19.00	29.00	0	0	0	342	21	363		
	- Cat CS76 XT Vibratory Soil Compactor	14.85	20.00	90%	1	18	h				14.85	20.00	0	0	0	267	259	526		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
	Pavement	600	mm of crushed stone										0	0	0	0	0	0		
		3,240	m³										0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Crushed stone	1.8 mt / m³	0.08 h / mt			5,832	mt	2	0	0.00	2.27	1.58	11,314	0	0	13,239	6,634	31,187		467
													0	0	0	0	0	0		
													0	0	0	0	0	0		
2770	**Switch yard Site**					**5,400**	**m²**						**14,194**	**0**	**0**	**15,833**	**6,977**	**37,004**		**587**
2780	**Supply Line to Power Tunnel Intake**					**33**	**km**													
	Supply					33,000	m			123.15			0	0	4,063,950	0	0	4,063,950		
	- Conductor												0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Concrete cover	0.09 m³ / m	1.0981 h / m³			2,970	m³	26.39	13.69	122.47	13.41	4.31	78,392	40,665	363,744	39,813	9,222	531,836		3,261
													0	0	0	0	0	0		
	- Miscellaneous (transfo, switch, etc.)					1	ls			200,000			0	0	200,000	0	0	200,000		
													0	0	0	0	0	0		
	Install					**33,000**	**m**						0	0	0	0	0	0		
	Produuction of		175 m / sh			189	sh						0	0	0	0	0	0		
	16 m³		10 h / sh			1,886	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				6	11,314		24.00					271,543	0	0	0	0	271,543		11,314
													0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator	19.00	29.00	90%	1	1,697	h				19.00	29.00	0	0	0	32,243	35,433	67,676		
	- Readymix 8 m³	13.60	14.00	90%	1	1,697	h				13.60	14.00	0	0	0	23,079	17,106	40,185		
	- Boom truck 17 tons	13.65	18.00	25%	1	471	h				13.65	18.00	0	0	0	6,429	6,104	12,533		
													0	0	0	0	0	0		
	- Miscelaneous					33,000	m		5.00				0	165,000	0	0	0	165,000		
													0	0	0	0	0	0		

Item : (2740-2770)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Concrete transportation from the Batching Plants			**2,970**	**m^3**						0	0	0	0	0	0		
	Average production 16 m^3 / sh			189	sh						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Average hauling distance : 8.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 10										0	0	0	0	0	0		
	Going 16 30 km / h										0	0	0	0	0	0		
	Unloading 15										0	0	0	0	0	0		
	Return 14 35 km / h										0	0	0	0	0	0		
	55 min.										0	0	0	0	0	0		
	Efficacité : 85% 65 min. / trip										0	0	0	0	0	0		
	1.08 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	9 trips / sh										0	0	0	0	0	0		
	Readymix 8 m^3 8 m^3										0	0	0	0	0	0		
	72 m^3 / truck-sh										0	0	0	0	0	0		
	Number of trucks : **1**										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2780	**Supply Line to Power Tunnel Intake**										**349,935**	**205,665**	**4,627,694**	**101,564**	**67,865**	**5,352,723**		**14,576**

Item : 2810-2856

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
									USD »»	0.90			35.00 $				0.72 $			

2800 Mechanical + Electrical Works

2810 Supply and Installation of Turbine/Generators assemblies

WBS	DESCRIPTION			%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
2810	**Supply and Installation of Turbine/Generators assemblies**																			
	Supply												0	0	0	0	0	0		
	- Turbine	5	Sets			1	ls			18,958,827			0	0	18,958,827	0	0	18,958,827		
	- Governor	5	Sets			1	ls			1,074,246			0	0	1,074,246	0	0	1,074,246		
	- Spherical	5	Sets			1	ls			2,367,517			0	0	2,367,517	0	0	2,367,517		
	- Cooling	Prop	Set			1	ls			1,982,408			0	0	1,982,408	0	0	1,982,408		
	- Compressed	Prop	Sets			1	ls			125,801			0	0	125,801	0	0	125,801		
													0	0	0	0	0	0		
	- Instrumentation	1	set			1	ls			21,029,335			0	0	21,029,335	0	0	21,029,335		
										1,661,757			0	0	0	0	0	0		
	- Generator	5	Sets			1	ls			22,691,092			0	0	22,691,092	0	0	22,691,092		
	- Excitation	5	Sets			1	ls						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- DCS/SCADASystem/MMI	1	Set			1	ls			1,518,175			0	0	1,518,175	0	0	1,518,175		
	- 11kVBusDuct	5	Sets			1	ls			2,048,423			0	0	2,048,423	0	0	2,048,423		
	- FireProtection	Prop	Sets			1	ls			180,982			0	0	180,982	0	0	180,982		
	- ProtectionMetering	Prop	Sets			1	ls			1,028,186			0	0	1,028,186	0	0	1,028,186		
	- UAT's+SST	Prop	Sets			1	ls			430,095			0	0	430,095	0	0	430,095		
	- UAB's+SSB	Prop	Sets			1	ls			533,117			0	0	533,117	0	0	533,117		
	- DCSystem	Prop	Sets			1	ls			860,828			0	0	860,828	0	0	860,828		
	- CablesAccessories	Prop	Sets			1	ls			1,659,882			0	0	1,659,882	0	0	1,659,882		
													0	0	0	0	0	0		
	- Spares (4 runners)	Special	set			1	ls			3,668,566			0	0	3,668,566	0	0	3,668,566		
													0	0	0	0	0	0		
	- FirstFill+Tools	Prop	Set			1	ls			534,781			0	0	534,781	0	0	534,781		
													0	0	0	0	0	0		
	- OptionalModelTesting	1	Set			1	ls			391,817			0	0	391,817	0	0	391,817		
													0	0	0	0	0	0		
	Erection and Commissioning												0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P	81,000	h / gr		5	405,000	h	35.00					14,175,000	0	0	0	0	14,175,000		405,000
													0	0	0	0	0	0		
	- Miscelaneous	15,753,570 $		10%		1	ls		1,575,357		787,679		0	1,575,357	0	787,679	0	2,363,036		
				5%									0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
2810	**Supply and Installation of Turbine/Generators assemblies**												**14,175,000**	**1,575,357**	**81,084,078**	**787,679**	**0**	**97,622,114**		**405,000**

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
							USD »»	0.90			35.00 $				0.72 $			
2820	**Supply and installation of Power tunnel and Diversion intake Gates**																	
	Supply and Installation										0	0	0	0	0	0		
	Intake																	
	(kg)										0	0	0	0	0	0		
	Trash Rack 60,000			60,000	kg			9.00			0	0	540,000	0	0	540,000		
	Stop logs 93,000			93,000	kg			12.00			0	0	1,116,000	0	0	1,116,000		
	Embedded parts 80,000			80,000	kg			9.00			0	0	720,000	0	0	720,000		
	Gates 75,000			75,000	kg			14.00			0	0	1,050,000	0	0	1,050,000		
	Spreader 2,000			2,000	kg			12.00			0	0	24,000	0	0	24,000		
	Winches 20,000			20,000	kg			14.00			0	0	280,000	0	0	280,000		
	Lining 4,000			4,000	kg			8.00			0	0	32,000	0	0	32,000		
	334,000										0	0	0	0	0	0		
	Diversion tunnel										0	0	0	0	0	0		
	Gate 200,000			200,000	kg			14.00			0	0	2,800,000	0	0	2,800,000		
	Embedded parts 60,000			60,000	kg			9.00			0	0	540,000	0	0	540,000		
	Hoist 25,000			25,000	kg		14.00				0	350,000	0	0	0	350,000		
	285,000 619,000 kg										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 0.20 h / kg			123,800	h	35.00					4,333,000	0	0	0	0	4,333,000		123,800
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2820	**Supply and installation of Power tunnel and Diversion intake Gates**										**4,333,000**	**350,000**	**7,102,000**	**0**	**0**	**11,785,000**		**123,800**
2830	**Supply and installation of Draft tube Gates**																	
	Gates 2,500 kg / un 12,500			12,500	kg			14.00			0	0	175,000	0	0	175,000		
	Embedded parts 5,000 kg / un 25,000			25,000	kg			9.00			0	0	225,000	0	0	225,000		
	Gantry crane 5000			5,000	kg			14.00			0	0	70,000	0	0	70,000		
	42,500										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 0.20 h / kg			8,500	h	35.00					297,500	0	0	0	0	297,500		8,500
											0	0	0	0	0	0		
2830	**Supply and installation of Draft tube Gates**										**297,500**	**0**	**470,000**	**0**	**0**	**767,500**		**8,500**
2840	**Supply the overhead crane**			**1**	**ls**													
	Supply										0	0	0	0	0	0		
	- 265 / 25 mt Over head crane 1,750,000 CDN			1	un			1,575,000			0	0	1,575,000	0	0	1,575,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
2840	**Supply the overhead crane**										**0**	**0**	**1,575,000**	**0**	**0**	**1,575,000**		**0**

2850 Underground Utilities

WBS	DESCRIPTION		%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
								USD »»	0.90			35.00 $				0.72 $			
2851	**Fire water System**																		
	Supply and Installation											0	0	0	0	0	0		
												0	0	0	0	0	0		
	Protection incendie	539,000 $	75%		1	ls			404,250			0	0	404,250	0	0	404,250		
												0	0	0	0	0	0		
	- M-P				2,500	h	35.00					87,500	0	0	0	0	87,500		2,500
												0	0	0	0	0	0		
	- Miscelaneous Equipment and Materials		2%		1	ls		10,780		26,950		0	10,780	0	26,950	0	37,730		
			5%									0	0	0	0	0	0		
												0	0	0	0	0	0		
												0	0	0	0	0	0		
2851	**Fire water System**											**87,500**	**10,780**	**404,250**	**26,950**	**0**	**529,480**		**2,500**
2852	**Potable Water System**																		
	Supply and Installation											0	0	0	0	0	0		
												0	0	0	0	0	0		
	Potable Water	796,000 $	75%		1	ls			597,000			0	0	597,000	0	0	597,000		
												0	0	0	0	0	0		
	- M-P				3,200	h	35.00					112,000	0	0	0	0	112,000		3,200
												0	0	0	0	0	0		
	- Miscelaneous Equipment and Materials		2%		1	ls		15,920		39,800		0	15,920	0	39,800	0	55,720		
			5%									0	0	0	0	0	0		
												0	0	0	0	0	0		
2852	**Potable Water System**											**112,000**	**15,920**	**597,000**	**39,800**	**0**	**764,720**		**3,200**
2853	**Sewage and Sanitary System**																		
	Supply and Installation											0	0	0	0	0	0		
												0	0	0	0	0	0		
	Drainage des eaux claires	835,000 $										0	0	0	0	0	0		
	Drainage des eaux usées	730,000 $										0	0	0	0	0	0		
	Drainage des eaux huileuses	361,000 $														0			
	Manutention des huiles	470,000 $														0			
		2,396,000 $	80%		1	ls			1,916,800			0	0	1,916,800	0	0	1,916,800		
												0	0	0	0	0	0		
	- M-P				6,900	h	35.00					241,500	0	0	0	0	241,500		6,900
												0	0	0	0	0	0		
	- Miscelaneous Equipment and Materials		2%		1	ls		47,920		119,800		0	47,920	0	119,800	0	167,720		
			5%									0	0	0	0	0	0		
												0	0	0	0	0	0		
2853	**Sewage and Sanitary System**											**241,500**	**47,920**	**1,916,800**	**119,800**	**0**	**2,326,020**		**6,900**

Item : 2810-2856

WBS	DESCRIPTION		%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
								UNIT PRICES				TOTAL COSTS							
								USD »»	0.90			35.00 $				0.72 $			
2854	**Compressed Air System**																		
	Supply and Installation											0	0	0	0	0	0		
												0	0	0	0	0	0		
	Air comprimé basse pression	608,000 $	80%		1	ls			486,400			0	0	486,400	0	0	486,400		
	(air de service)											0	0	0	0	0	0		
																0			
	- M-P				1,750	h	35.00					61,250	0	0	0	0	61,250		1,750
												0	0	0	0	0	0		
	- Miscelaneous Equipment and Materials		2%		1	ls		12,160		30,400		0	12,160	0	30,400	0	42,560		
			5%									0	0	0	0	0	0		
	Surge Chamber System											0	0	0	0	0	0		
												0	0	0	0	0	0		
	- Compressor and piping	100,000 $	75%		1	ls			75,000			0	0	75,000	0	0	75,000		
												0	0	0	0	0	0		
	- M-P				700	h	35.00					24,500	0	0	0	0	24,500		700
												0	0	0	0	0	0		
	- Miscelaneous Equipment and Materials		2%		1	ls		2,000		5,000		0	2,000	0	5,000	0	7,000		
			5%									0	0	0	0	0	0		
												0	0	0	0	0	0		
2854	**Compressed Air System**											**85,750**	**14,160**	**561,400**	**35,400**	**0**	**696,710**		**2,450**
2855	**Process Water System**																		
	Supply and Installation											0	0	0	0	0	0		
												0	0	0	0	0	0		
	Eau de service	586,000 $														0			
	Limnimètres et piézomètres	94,000 $										0	0	0	0	0	0		
		680,000 $	80%		1	ls			544,000			0	0	544,000	0	0	544,000		
																0			
	- M-P				2,000	h	35.00					70,000	0	0	0	0	70,000		2,000
												0	0	0	0	0	0		
	- Miscelaneous Equipment and Materials		2%		1	ls		13,600		34,000		0	13,600	0	34,000	0	47,600		
			5%									0	0	0	0	0	0		
												0	0	0	0	0	0		
2855	**Process Water System**											**70,000**	**13,600**	**544,000**	**34,000**	**0**	**661,600**		**2,000**

Item : 2810-2856

							UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION		%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
								USD »»	0.90			35.00 $				0.72 $			
2856	**CVAC**																		
	Supply and Installation											0	0	0	0	0	0		
												0	0	0	0	0	0		
	Ventilation des bureaux informatique	200,000 $										0	0	0	0	0	0		
	Ventilation des bureaux	225,000 $										0	0	0	0	0	0		
	Ventilation - Plancher alternateurs	600,000 $										0	0	0	0	0	0		
	Ventilation - Bâches et conduites forcées	300,000 $										0	0	0	0	0	0		
	Ventilation - Salle des compresseurs	10,000 $										0	0	0	0	0	0		
	Ventilation - Salle mécanique	90,000 $										0	0	0	0	0	0		
	Ventilation - Galerie des transformateurs	250,000 $										0	0	0	0	0	0		
	Alimentation d'air extérieur - Centrale	1,000,000 $										0	0	0	0	0	0		
	Ventilation - Salle des batteries	50,000 $										0	0	0	0	0	0		
	Ventilation - Salle des huiles et salle des hydrocarbures	75,000 $										0	0	0	0	0	0		
	Ventilation - Hotte de soudure mobile	70,000 $										0	0	0	0	0	0		
	Ventilation - Hotte de soudure des bâches	125,000 $										0	0	0	0	0	0		
	Ventilation - Galerie d'accès permanent	90,000 $										0	0	0	0	0	0		
	Ventilation et chauffage - Salle de traitement des eaux usées	125,000 $										0	0	0	0	0	0		
	Ventilation - Atelier mécanique	70,000 $										0	0	0	0	0	0		
	Ventilation - Atelier électrique	60,000 $										0	0	0	0	0	0		
	Pressurisation des escaliers	80,000 $										0	0	0	0	0	0		
	Ventilation - Salle de traitement d'eau potable	50,000 $										0	0	0	0	0	0		
	Ventilation - Salle de mécanique de l'ascenseur	20,000 $										0	0	0	0	0	0		
	Ventilation - Salle des pompes	20,000 $										0	0	0	0	0	0		
	Ventilation - Gaz délétères	150,000 $										0	0	0	0	0	0		
	Ventilation et chauffage - Prise d'eau	125,000 $										0	0	0	0	0	0		
	Ventilation - Toilettes	10,000 $										0	0	0	0	0	0		
	Ventilation - Entrepôt des pièces de rechange	25,000 $										0	0	0	0	0	0		
	Ventilation - Salle électrique	60,000 $										0	0	0	0	0	0		
	Système de supervision SCADA	20,000 $										0	0	0	0	0	0		
	Système de supervision SCADA	20,000 $										0	0	0	0	0	0		
	Système de supervision SCADA	20,000 $										0	0	0	0	0	0		
	Système de supervision SCADA	20,000 $										0	0	0	0	0	0		
		3,960,000 $	80%		1	ls			3,168,000			0	0	3,168,000	0	0	3,168,000		
	- M-P				11,500	h	35.00					402,500	0	0	0	0	402,500		11,500
	- Miscelaneous Equipment and Materials		2%		1	ls		79,200		198,000		0	79,200	0	198,000	0	277,200		
			5%									0	0	0	0	0	0		
												0	0	0	0	0	0		
2856	**CVAC**											**402,500**	**79,200**	**3,168,000**	**198,000**	**0**	**3,847,700**		**11,500**

Item : 2910

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES
											24.00 $				0.72 $		
2900	**Architectural works**																
2910	**Service building**			**1**	**ls**												
	Supply and install										0	0	0	0	0	0	
	L W H Volume										0	0	0	0	0	0	
	- Service building 68 30 7 14280			14,280	m³			385.00			0	0	5,497,800	0	0	5,497,800	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
2910	**Service building**										**0**	**0**	**5,497,800**	**0**	**0**	**5,497,800**	

6100 Temporary Construction Facilities

6110 Work Areas, including Buildings

WBS	DESCRIPTION				%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel L /h	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
									UNIT PRICES					TOTAL COSTS							
														24.00 $				0.72 $			
6112	**Work Areas, including Buildings - Hydro Site 7e**																				
	Site preparation																				
	Main camp area	30,000	(300 x 100)											0	0	0	0	0	0		
	Dam site area	20,000	(200 x 100)											0	0	0	0	0	0		
	Roads	12,000	(3000 x 4)															0			
	T-Line area (Main camp)	15,600	(120 x1 30)																		
		77,600 m²		3,000 m² / sh			26	sh						0	0	0	0	0	0		
				10 h / sh			260	h						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- M-P					6	1,560	h	24.00					37,440	0	0	0	0	37,440		1,560
														0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor		38.25	28.00	90%	1	234	h				38.25	28.00	0	0	0	8,951	4,717	13,668		
	- Cat 725 Articulated Dumper 25 T		24.00	20.00	90%	3	702	h				24.00	20.00	0	0	0	16,848	10,109	26,957		
	- Cat 329DL Hydraulic Excavator		19.00	29.00	90%	1	234	h				19.00	29.00	0	0	0	4,446	4,886	9,332		
														0	0	0	0	0	0		
	- Misc. (Dust control, accessories, etc..)						1	ls		10,000				0	10,000	0	0	0	10,000		
														0	0	0	0	0	0		
	Buildings					Cnt			L	W	H	Tansp. Vol.		Months							
	Camp A											(cu-ft)	(m³)								
	- Office					8	2,560	sf	40	8	8	20,480	580	60							
	- Garage	Fold-Away	100	60		14	4,480	sf	32	10	4	17,920	508	60							
	- Trade shop	Fold-Away	80	40		12	2,640	sf	22	10	4	10,560	299	60							
	- Warehouse	Fold-Away	80	40		12	2,640	sf	22	10	4	10,560	299	60							
	- Dry House	Fold-Away	80	40		12	2,640	sf	22	10	4	10,560	299	60							
	- Wash Room					2	480	sf	30	8	8	3,840	109	60							
	- Foremen Office					2	640	sf	40	8	8	5,120	145	60							
	Camp B																				
	- Office					4	1,280	sf	40	8	8	10,240	290	60							
	- Garage	Fold-Away	100	60		14	4,480	sf	32	10	4	17,920	508	60							
	- Trade shop	Fold-Away	80	40		12	2,640	sf	22	10	4	10,560	299	60							
	- Warehouse	Fold-Away	80	40		12	2,640	sf	22	10	4	10,560	299	60							
	- Dry House	Fold-Away	80	40		12	2,640	sf	22	10	4	10,560	299	60							
	- Wash Room					2	480	sf	30	8	8	3,840	109	60							
	- Foremen Office					2	640	sf	40	8	8	5,120	145	60							
	km 19																				
	- Dry House	Fold-Away	80	40		12	2,640	sf	22	10	4	10,560	299	60							
	- Wash Room					1	240	sf	30	8	8	1,920	54	60							
	- Foremen Office					1	320	sf	40	8	8	2,560	73	60							
							34,080	sf													
							3,167	**m²**													
	Purchase																				
	- Office						3,840	sf		95.00				0	364,800	0	0		364,800		
	- Garage						8,960	sf		15.00				0	134,400	0	0		134,400		
	- Trade shop						5,280	sf		15.00				0	79,200	0	0		79,200		
	- Warehouse						5,280	sf		15.00				0	79,200	0	0		79,200		
	- Dry House						7,920	sf		15.00				0	118,800	0	0		118,800		
	- Wash Room						1,200	sf		60.00				0	72,000	0	0		72,000		
	- Foremen Office						1,600	sf		47.00				0	75,200	0	0		75,200		
	- Containers 8' x 20'						20	un		6,400				0	128,000	0	0		128,000		
														0	0	0	0		0		
														0	0	0	0		0		

Item : (6112-6132)

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel L /h	TOTAL COSTS Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
													24.00 $				0.72 $			
	Installation and dismantling					40	sh						0	0	0	0		0		
			10 h / sh			400	h						0	0	0	0		0		
													0	0	0	0		0		
	- M-O				20	8,000	h	24.00					192,000	0	0	0	0	192,000		8,000
													0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	90%	1	360	h				37.00	14.40	0	0	0	13,320	3,732	17,052		
	- Cat 329DL Hydraulic Excavator	19.00	29.00	90%	1	360	h				19.00	20.88	0	0	0	6,840	5,412	12,252		
	- Boom truck 17 tons	13.65	18.00	90%	1	360	h				13.65	12.96	0	0	0	4,914	3,359	8,273		
																	0			
	Materials	Building total #########															0			
	- Wood			20%		1	ls		200,000				0	200,000	0	0	0	200,000		
	- Electrical			10%		1	ls		100,000				0	100,000	0	0	0	100,000		
	- Plumbing			15%		1	ls		150,000				0	150,000	0	0	0	150,000		
	- Dry-House			6%		1	ls		60,000				0	60,000	0	0	0	60,000		
	- Concrete			15%		1	ls		150,000				0	150,000	0	0	0	150,000		
																	0			
	Shops Equipment **Site**	**A**	**B**			1	ls		575,000				0	575,000	0	0	0	575,000		
																	0			
	- Wood shop	75,000	50,000										0	0	0	0	0	0		
	- Garage	50,000	100,000										0	0	0	0	0	0		
	- Electrical	75,000	50,000										0	0	0	0	0	0		
	- Plumbing	75,000	50,000										0	0	0	0	0	0		
	- Miscelaneous	25,000	25,000										0	0	0	0	0	0		
		300,000	275,000										0	0	0	0	0	0		
																	0			
	Concrete Batch Plan (Main camp)												0	0	0	0	0	0		
													0	0	0	0	0	0		
	Installation (Including heating of aggregates)												0	0	0	0	0	0		
	Duration	3 weeks				3	wk						0	0	0	0	0	0		
			60 h / wk			180	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				12	2,160	h	24.00					51,840	0	0	0	0	51,840		2,160
													0	0	0	0	0	0		
	- Cat 950H Wheel Loader	18.35	9.05	75%	1	135	h				18.35	9.05	0	0	0	2,477	880	3,357		
	- Cat D7R II LGP Track-Type Tractor	38.25	28.00	40%	1	72	h				38.25	28.00	0	0	0	2,754	1,452	4,206		
	- Cat 329DL Hydraulic Excavator	19.00	29.00	30%	1	54	h				19.00	29.00	0	0	0	1,026	1,128	2,154		
	- Welding Machine - 400 A	2.00	6.00	60%	1	108	h				2.00	6.00	0	0	0	216	467	683		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	30%	1	54	h				37.00	20.00	0	0	0	1,998	778	2,776		
	- Concrete	50 m³			1	50	m³		200.00				0	10,000	0	0	0	10,000		
													0	0	0	0	0	0		
	- Miscelaneous materials (Electrical, plumbing, mechanical, aggregates shelter, etc)					1	ls		75,000				0	75,000	0	0	0	75,000		
													0	0	0	0	0	0		
	Dismantling	90 h			1	90	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				8	720	h	24.00					17,280	0	0	0	0	17,280		720
													0	0	0	0	0	0		
	- Cat 950H Wheel Loader	18.35	9.05	33%	1	30	h				18.35	9.05	0	0	0	551	195	746		
	- Cat D7R II LGP Track-Type Tractor	38.25	28.00	33%	1	30	h				38.25	28.00	0	0	0	1,148	605	1,753		
													0	0	0	0	0	0		
	Concrete Batch Plan (Intake area)																0			
																	0			
	Installation (Including heating of aggregates)												0	0	0	0	0	0		
	Duration					3	wk						0	0	0	0	0	0		
			60 h / wk			180	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				12	2,160	h	24.00					51,840	0	0	0	0	51,840		2,160
													0	0	0	0	0	0		
	- Cat 950H Wheel Loader	18.35	9.05	75%	1	135	h				18.35	9.05	0	0	0	2,477	880	3,357		
	- Cat D7R II LGP Track-Type Tractor	38.25	28.00	40%	1	72	h				38.25	28.00	0	0	0	2,754	1,452	4,206		
	- Cat 329DL Hydraulic Excavator	19.00	29.00	30%	1	54	h				19.00	29.00	0	0	0	1,026	1,128	2,154		
	- Welding Machine - 400 A	2.00	6.00	60%	1	108	h				2.00	6.00	0	0	0	216	467	683		
													0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	UNIT PRICES Fuel L /h	TOTAL COSTS Man power	TOTAL COSTS Construction materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Concrete 50 m³		1	50	m³		200.00				0	10,000	0	0	0	10,000		
											0	0	0	0	0	0		
	- Miscelaneous materials (Electrical, plumbing, mechanical, aggregates shelter, etc)			1	ls		75,000				0	75,000	0	0	0	75,000		
											0	0	0	0	0	0		
	Dismantling 90 h		1	90	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		8	720	h	24.00					17,280	0	0	0	0	17,280		720
											0	0	0	0	0	0		
	- Cat 950H Wheel Loader 18.35 9.05	33%	1	30	h				18.35	9.05	0	0	0	551	195	746		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	33%	1	30	h				38.25	28.00	0	0	0	1,148	605	1,753		
											0	0	0	0	0	0		
	Crusher Plan System (Portable)										0	0	0	0	0	0		
	(Moved from site to site between Powerhouse area, intake and dam 1)														0			
															0			
	Initial Installation and dismantling 5 sh			5	sh										0			
	- Crusher (300 t / h) (Included in 6300) 10 h / sh			50	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		7	350	h	24.00					8,400	0	0	0	0	8,400		350
											0	0	0	0	0	0		
	- Cat 950H Wheel Loader 18.35 9.05	75%	1	38	h				18.35	9.05	0	0	0	697	248	945		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	40%	1	20	h				38.25	28.00	0	0	0	765	403	1,168		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	30%	1	15	h				19.00	29.00	0	0	0	285	313	598		
											0	0	0	0	0	0		
	Moves 2,012 4 times										0	0	0	0	0	0		
	2,013 4 times										0	0	0	0	0	0		
	2,014 4 times										0	0	0	0	0	0		
	2,015 2 times										0	0	0	0	0	0		
	14 times 2 sh / move			28	sh						0	0	0	0	0	0		
	10 h / sh			280	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		5	1,400		24.00					33,600	0	0	0	0	33,600		1,400
											0	0	0	0	0	0		
	- Boom truck 17 tons 13.65 18.00	90%	1	252	h				13.65	18.00	0	0	0	3,440	3,266	6,706		
	- Tractor truck & Load Carrier - 65 T 11.50 15.00	90%	1	252	h				11.50	15.00	0	0	0	2,898	2,722	5,620		
											0	0	0	0	0	0		
	- Miscelaneous			280	h		5.00				0	1,400	0	0	0	1,400		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Asphalt plan										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Bitumen batching plant "drum mix" (400 t / h) (Included in 6300)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Installation at the dam area			5	sh						0	0	0	0	0	0		
	10 h / sh			50	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		7	350	h	24.00					8,400	0	0	0	0	8,400		350
											0	0	0	0	0	0		
	- Cat 950H Wheel Loader 18.35 9.05	20%	1	10	h				18.35	9.05	0	0	0	184	65	249		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	20%	1	10	h				38.25	28.00	0	0	0	383	202	585		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	20%	1	10	h				19.00	29.00	0	0	0	190	209	399		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	50%	1	25	h				37.00	20.00	0	0	0	925	360	1,285		
											0	0	0	0	0	0		
	- Miscelaneous			50	h		200.00				0	10,000	0	0	0	10,000		
											0	0	0	0	0	0		
	Explosives depots										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Main camp area 10,000 (100 x 100)										0	0	0	0	0	0		
	Dam site area 6,400 (80 x 80)										0	0	0	0	0	0		
	Roads 8,000 (2000 x 4)										0	0	0	0	0	0		
	24,400																	
	Access road and site preparation 24,400 m²										0	0	0	0	0	0		

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel L /h	TOTAL COSTS Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
													24.00 $				0.72 $			
			3,000 m² / sh			8	sh						0	0	0	0	0	0		
			10 h / sh			81	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				6	488	h	24.00					11,712	0	0	0	0	11,712		488
													0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor	38.25	28.00	90%	1	73	h				38.25	28.00	0	0	0	2,792	1,472	4,264		
	- Cat 725 Articulated Dumper 25 T	24.00	20.00	90%	3	220	h				24.00	20.00	0	0	0	5,280	3,168	8,448		
	- Cat 329DL Hydraulic Excavator	19.00	29.00	90%	1	73	h				19.00	29.00	0	0	0	1,387	1,524	2,911		
													0	0	0	0	0	0		
	Pavement	150 mm	3,660 m³										0	0	0	0	0	0		
	- Crushed Stone	1.8 mt / m³	**0.08 h / mt**			6,588	mt	1.94	0.00	0.00	2.27	1.58	12,781	0	0	14,955	7,495	35,231		527
													0	0	0	0	0	0		
	Fencing and gates												0	0	0	0	0	0		
	Main camp area	400 m											0	0	0	0	0	0		
	Dam site area	320 m											0	0	0	0	0	0		
													0	0	0	0	0	0		
	- Gates					2	un		1,500				0	3,000	0	0	0	3,000		
	- Chain link					720	m		80.00				0	57,600	0	0	0	57,600		
			75 m / sh			10	sh						0	0	0	0	0	0		
			10 h / sh			100	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				5	500	h	24.00					12,000	0	0	0	0	12,000		500
																	0			
	- Boom truck 17 tons	13.65	18.00	90%	1	90	h				13.65	18.00	0	0	0	1,229	1,166	2,395		
	- Fence post auger	1.00	2.00	90%	1	90	h				1.00	2.00	0	0	0	90	130	220		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
6112	**Work Areas, including Buildings**												**455,593**	**2,538,600**	**0**	**109,161**	**65,190**	**3,167,524**		**18,935**

6120 Roads , Walkways, Parking Lots

6122 Roads , Walkways, Parking Lots - Hydro Site 7e

WBS	DESCRIPTION			%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel L /h	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
	Main Camp site area	20,000	40,000 m²										0	0	0	0	0	0		
	Intake Camp site area	20,000	3,000 m² / sh			13	sh						0	0	0	0	0	0		
			10 h / sh			130	h						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				6	780	h	24.00					18,720	0	0	0	0	18,720		780
													0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor	38.25	28.00	90%	1	117	h				38.25	28.00	0	0	0	4,475	3,276	7,751		
	- Cat 725 Articulated Dumper 25 T	24.00	20.00	90%	3	351	h				24.00	20.00	0	0	0	8,424	7,020	15,444		
	- Cat 329DL Hydraulic Excavator	19.00	29.00	90%	1	117	h				19.00	29.00	0	0	0	2,223	3,393	5,616		
													0	0	0	0	0	0		
	- Misc. (Dust control, etc..)					1	ls		10,000				0	10,000	0	0	0	10,000		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
6122	**Roads , Walkways, Parking Lots**												**18,720**	**10,000**	**0**	**15,122**	**13,689**	**57,531**		**780**

6130 Utilities

6132 Utilities - Hydro Site 7e

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES					TOTAL COSTS					GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel L /h	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption			
											24.00 $				0.72 $			
	Industrial Water installation										0	0	0	0	0	0		
	A) Camp A										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- High pressure pump 6" 2 un										0	0	0	0	0	0		
	- Support and shelter 1 un														0			
	- 4" isolated pipe 2,000 m														0			
	- Heathing cable 2,000 m										0	0	0	0	0	0		
	- Electrical line Including transfo, switches, etc… 2,000 m										0	0	0	0	0	0		
	- Culvert pipe 36" 20 m										0	0	0	0	0	0		
	- Coupplings 4" 409 un										0	0	0	0	0	0		
	- Fittings 32 un										0	0	0	0	0	0		
	- Valve 4" 6 un										0	0	0	0	0	0		
											0	0	0	0	0	0		
	B) Camp B										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- High pressure pump 6" 2 un										0	0	0	0	0	0		
	- Support and shelter 1 un														0			
	- 4" isolated pipe 1,000 m														0			
	- Heathing cable 1,000 m														0			
	- Electrical line Including transfo, switches, etc… 1,000 m														0			
	- Culvert pipe 36" 20 m														0			
	- Coupplings 4" 207 un														0			
	- Fittings 16 un														0			
	- Valve 4" 4 un														0			
															0			
	Marerials														0			
	- High pressure pump 6"			4	un		6,000				0	24,000	0	0	0	24,000		
	- Support and shelter			2	un		3,000				0	6,000	0	0	0	6,000		
	- 4" isolated pipe			3,000	m		75.00				0	225,000	0	0	0	225,000		
	- Heathing cable			3,000	m		6.00				0	18,000	0	0	0	18,000		
	- 600 v Electrical line Including transfo, switches, etc…			3,000	m		80.00				0	240,000	0	0	0	240,000		
	- Culvert pipe 36"			40	m		110.00				0	4,400	0	0	0	4,400		
	- Coupplings 4"			616	un		30.50				0	18,788	0	0	0	18,788		
	- Fittings			48	un		60.00				0	2,880	0	0	0	2,880		
	- Valve 4"			10	un		275.00				0	2,750	0	0	0	2,750		
	- Pipe supports 5 m c/c			600	un		20.00				0	12,000	0	0	0	12,000		
	- Fire stations			20	un		350				0	7,000	0	0	0	7,000		
	- Pins			1,200	un		5.00				0	6,000	0	0	0	6,000		
	- Misc.			1	ls		15,000				0	15,000	0	0	0	15,000		
											0	0	0	0	0	0		
	Installation & Dismantling Duration										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Camp A 30 sh										0	0	0	0	0	0		
	Camp B 16 sh			46	sh						0	0	0	0	0	0		
	10 h / sh			460	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	2,760	h	24.00					66,240	0	0	0	0	66,240		2,760
											0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	45%	1	207	h				19.00	20.88	0	0	0	3,933	4,322	8,255		
	- Boom truck 17 tons 13.65 18.00	90%	1	414	h				13.65	12.96	0	0	0	5,651	5,365	11,016		
	- Crane - Rough terrain 50 t (L-Belt) 37.00 20.00	20%	1	92	h				37.00	14.40	0	0	0	3,404	1,325	4,729		
											0	0	0	0	0	0		
	Sewage										0	0	0	0	0	0		
	Linked to camp site system										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Miscelaneous materials			1,000	m		170.00				0	170,000	0	0	0	170,000		
											0	0	0	0	0	0		
	Installation & Dismantling 15 sh										0	0	0	0	0	0		
	10 h / sh			150	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		6	900		24.00					21,600	0	0	0	0	21,600		900
											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel L /h	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	- Cat 329DL Hydraulic Excavator 19.00 29.00	25%	1	38	h				19.00	20.88	0	0	0	722	793	1,515		
	- Boom truck 17 tons 13.65 18.00	90%	1	135	h				13.65	12.96	0	0	0	1,843	1,750	3,593		
											0	0	0	0	0	0		
	Electrical supply										0	0	0	0	0	0		
	Supply Camp A Camp B										0	0	0	0	0	0		
	- 600 v Electrical line 1,000 500			1,500	m		80.00				0	120,000	0	0	0	120,000		
	- Misc.			1	ls		75,000				0	75,000	0	0	0	75,000		
	- Enclosed building 6 x 6			36	m²		137.00				0	4,932	0	0	0	4,932		
															0			
	Installation & Dismantling Duration										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Camp A 20 sh										0	0	0	0	0	0		
	Camp B 15 sh			35	sh						0	0	0	0	0	0		
	10 h / sh			350	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		7	2,450	h	24.00					58,800	0	0	0	0	58,800		2,450
											0	0	0	0	0	0		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	45%	1	158	h				19.00	20.88	0	0	0	3,002	3,299	6,301		
	- Boom truck 17 tons 13.65 18.00	90%	2	315	h				13.65	12.96	0	0	0	4,300	4,082	8,382		
											0	0	0	0	0	0		
	Generators Operation										0	0	0	0	0	0		
	Months Years Weeks										0	0	0	0	0	0		
	Camp A 60 5 260 2 un										0	0	0	0	0	0		
	Camp B 48 4 208 2 un										0	0	0	0	0	0		
	108 months **468** **weeks**										0	0	0	0	0	0		
	7 d / w 24 h / day			78,624	h										0			
															0			
	- Cat GEP 150 - 100KW 4.50 30.70		2	157,248	h				4.50	22.10	0	0	0	707,616	3,475,810	4,183,426		
											0	0	0	0	0	0		
	- M-P 2 h / w 936 h		2	1,872	h	24.00					44,928	0	0	0	0	44,928		1,872
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
6132	**Utilities**										**191,568**	**951,750**	**0**	**730,471**	**3,496,746**	**5,370,535**		**7,982**

6140 Weather Protection

6142	**Weather Protection - Hydro Site 7e**																	
	Special weather protection is Included in appropriate items																	
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
6142	**Weather Protection**										**0**	**0**	**0**	**0**	**0**	**0**		**0**

Item : (6212-6222)

WBS	DESCRIPTION					%	n	Qty	Un.	UNIT PRICES					TOTAL COSTS					GLOBAL PRICES	UNIT PRICES	MEN-HOURS
										M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption			
															24.00 $				0.72 $			
6200	**Construction Services**																					
6210	**General Site Operation**																					
6212	**General Site Operation - Hydro Site 7e**																					
	Maintenance of buildings														0	0	0	0	0	0		
															0	0	0	0	0	0		
	Camp A		60 mth																0			
	Camp B		40 mth																0			
			100 mth																0			
																			0			
	- Carpenter				15	h / mth		1,500	h	24.00					36,000	0	0	0	0	36,000		1,500
	- Electrician				20	h / mth		2,000	h	24.00					48,000	0	0	0	0	48,000		2,000
	- Plumber				5	h / mth		500	h	24.00					12,000	0	0	0	0	12,000		500
	- Labourer				15	h / mth		1,500	h	24.00					36,000	0	0	0	0	36,000		1,500
															0	0	0	0	0	0		
	Compressors operation														0	0	0	0	0	0		
	Generators operation		**Included in corresponding TBM and D+B activities**												0	0	0	0	0	0		
	Heathing operation														0	0	0	0	0	0		
															0	0	0	0	0	0		
															0	0	0	0	0	0		
	Vehicules														0	0	0	0	0	0		
	Camp A	60 mth		4 weeks / mth				240	w						0	0	0	0	0	0		
															0	0	0	0	0	0		
	1) Fuel truck		60 h / w					14,400	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						1	14,400	h	24.00					345,600	0	0	0	0	345,600		14,400
	- Fuel Truck	60 h / w		6.40	16.00	90%	1	12,960	h				6.40	11.52	0	0	0	82,944	107,495	190,439		
															0	0	0	0	0	0		
	2) Mechanics truck		30 h / w					7,200	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- Mechanics truck			6.40	12.00	90%	1	6,480	h				6.40	8.64	0	0	0	41,472	40,311	81,783		
															0	0	0	0	0	0		
	3) Welding truck		45 h / w					10,800	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- Welding truck			6.40	12.00	90%	1	9,720	h				6.40	8.64	0	0	0	62,208	60,466	122,674		
															0	0	0	0	0	0		
	4) Light vehicules														0	0	0	0	0	0		
															0	0	0	0	0	0		
	- Pick-up	30 l / day		780 l / mth				1,175	un-mth					780	0	0	0	0	659,880	659,880		
	- Crew cab	40 l / day		1040 l / mth				586	un-mth					1,040	0	0	0	0	438,797	438,797		
	- VUS	28 l / day		728 l / mth				303	un-mth					728	0	0	0	0	158,820	158,820		
	- Ambulance	16 l / day		80 l / mth				60	un-mth					80	0	0	0	0	3,456	3,456		
																			0			
	Camp B	40 mth		4 weeks / mth				160	w						0	0	0	0	0	0		
															0	0	0	0	0	0		
	1) Fuel truck		60 h / w					9,600	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- M-P						1	9,600	h	24.00					230,400	0	0	0	0	230,400		9,600
	- Fuel Truck	60 h / w		6.40	16.00	90%	1	8,640	h				6.40	16.00	0	0	0	55,296	99,533	154,829		
															0	0	0	0	0	0		
	2) Mechanics truck		30 h / w					4,800	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- Mechanics truck			6.40	12.00	90%	2	8,640	h				6.40	12.00	0	0	0	55,296	74,650	129,946		
															0	0	0	0	0	0		
	3) Welding truck		45 h / w					7,200	h						0	0	0	0	0	0		
															0	0	0	0	0	0		
	- Welding truck			6.40	12.00	90%	2	12,960	h				6.40	12.00	0	0	0	82,944	111,974	194,918		
															0	0	0	0	0	0		
	4) Light vehicules														0	0	0	0	0	0		
				26 d / month											0	0	0	0	0	0		
	- Pick-up	30 l / day		780 l / mth				478	un-mth					780	0	0	0	0	268,445	268,445		
	- Crew cab	40 l / day		1040 l / mth				440	un-mth					1,040	0	0	0	0	329,472	329,472		
	- VUS	28 l / day		728 l / mth				86	un-mth					728	0	0	0	0	45,078	45,078		

Item : (6212-6222)

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
	- Ambulance 16 l / day 80 l / mth			40	un-mth					80	0	0	0	0	2,304	2,304		
											0	0	0	0	0	0		
	Shop operation			400	w						0	0	0	0	0	0		
	Directs 3,291,977 m - hours										0	0	0	0	0	0		
	Indirects 413,286 m - hours										0	0	0	0	0	0		
	Miscelaneous 500,000 m - hours														0			
	4,205,263 m - hours										0	0	0	0	0	0		
	- Small tools			4,205,263	h		0.30				0	1,261,579	0	0	0	1,261,579		
											0	0	0	0	0	0		
	- Miscelaneous supplies			4,205,263	h		0.10				0	420,526	0	0	0	420,526		
											0	0	0	0	0	0		
	Roads Maintenance 60 months 260 weeks										0	0	0	0	0	0		
	3 d / w 779 d										0	0	0	0	0	0		
	10 h / d			7,794	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		3	23,382	h	24.00					561,168	0	0	0	0	561,168		23,382
											0	0	0	0	0	0		
	- Cat 14M Motorgrader 16.65 25.75	90%	1	7,015	h				16.65	26	0	0	0	116,800	130,058	246,858		
	- 10W - Truck 13.60 14.00	10%	1	779	h				13.60	14	0	0	0	10,594	7,852	18,446		
	- Cat 950H Wheel Loader 18.35 9.05	10%	1	779	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Miscelaneous			7,794	h		1.50				0	11,691	0	0	0	11,691		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
	Communications Camp A Camp B										0	0	0	0	0	0		
	Port. Radio 3,463 1,470			4,933	un-mth		50.00				0	246,650	0	0	0	246,650		
	Cell. 1,923 1,155			3,078	un-mth		120.00				0	369,360	0	0	0	369,360		
											0	0	0	0	0	0		
	Base		1	100	un-mth		120.00				0	12,000	0	0	0	12,000		
											0	0	0	0	0	0		
	- Repairs			108	mth		5,000				0	540,000	0	0	0	540,000		
											0	0	0	0	0	0		
	- Underground phone			1	ls		6,000				0	6,000	0	0	0	6,000		
											0	0	0	0	0	0		
	- Radio towers 1 un / site			2	un		26,000		1,000		0	52,000	0	2,000	0	54,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
6212	**General Site Operation**										**1,269,168**	**2,919,806**	**0**	**509,554**	**2,538,591**	**7,237,119**		**52,882**

6220 Final Clean Up

WBS	DESCRIPTION				%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	TOTAL COSTS Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
														24.00 $				0.72 $			
6222	**Final Clean Up - Hydro Site 7e**																				
	Final clean up													0	0	0	0	0	0		
	Camp A	300 h												0	0	0	0	0	0		
	Camp B	200 h					500	h						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- M-P					13	6,500	h	24.00					156,000	0	0	0	0	156,000		6,500
														0	0	0	0	0	0		
	- Crane - Rough terrain 50 t (L-Belt)		37.00	20.00	75%	1	375	h				37.00	20.00	0	0	0	13,875	5,400	19,275		
	- Cat 988H Wheel Loader		39.20	48.00	20%	1	100	h				39.20	48.00	0	0	0	3,920	3,456	7,376		
	- Cat 329DL Hydraulic Excavator		19.00	29.00	20%	1	100	h				19.00	29.00	0	0	0	1,900	2,088	3,988		
	- Cat 14M Motorgrader		16.65	25.75	15%	1	75	h				16.65	25.75	0	0	0	1,249	1,391	2,640		
	- Cat D7R II LGP Track-Type Tractor		38.25	28.00	25%	1	125	h				38.25	28.00	0	0	0	4,781	2,520	7,301		
	- 10W - Truck		13.60	14.00	90%	1	450	h				13.60	14.00	0	0	0	6,120	4,536	10,656		
														0	0	0	0	0	0		
	- Miscelaneous						1	ls		10,000				0	10,000	0	0	0	10,000		
														0	0	0	0	0	0		
														0	0	0	0	0	0		
6222	**Final Clean Up**													**156,000**	**10,000**	**0**	**31,845**	**19,391**	**217,236**		**6,500**

Item : (6232)

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
###	**Material Handling & Warehousing**																	
###	**Material Handling & Warehousing - Hydro Site 7e**																	
	Durations																	
	P-House **Intake**																	
	2,011 30 10																	
	2,012 50 50																	
	2,013 50 50																	
	2,014 50 50																	
	2,015 30 30																	
	210 190 400 weeks																	
	General hauling and transportation on project										0	0	0	0	0	0		
											0	0	0	0	0	0		
	1) Boom Truck														0			
	Day 2 un / site										0	0	0	0	0	0		
	400 weeks 60 h / w			24,000	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P	####	2	48,000	h	24.00					1,152,000	0	0	0	0	1,152,000		48,000
	- Boom truck 17 tons 13.65 18.00	90%	2	43,200	h				13.65	12.96	0	0	0	589,680	403,108	992,788		
	Night 1 un / site										0	0	0	0	0	0		
	400 weeks 60 h / w			24,000	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P	####	1	24,000	h	24.00					576,000	0	0	0	0	576,000		24,000
	- Boom truck 17 tons 13.65 18.00	90%	1	21,600	h				13.65	12.96	0	0	0	294,840	201,554	496,394		
											0	0	0	0	0	0		
	2) Tractor & carrier 1 un / site										0	0	0	0	0	0		
	400 weeks 60 h / w			24,000	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Truck driver	####	2	48,000	h	24.00					1,152,000	0	0	0	0	1,152,000		48,000
											0	0	0	0	0	0		
	- Tractor truck & Load Carrier - 65 T 11.50 15.00	70%	1	16,800	h				11.50	10.80	0	0	0	193,200	130,637	323,837		
	- Tractor & Trailer 11.50 15.00	30%	1	7,200	h				11.50	10.80	0	0	0	82,800	55,987	138,787		
											0	0	0	0	0	0		
	Included transportation																	
	Cement 3,500 mt 40 mt / trip																	
	Rebar 600 mt 103 trip																	
	4,100 mt 1 trip / day																	
	10 h / day																	
	1,030 h																	
	3) Bus 2 un / site										0	0	0	0	0	0		
	400 weeks 20 h / w			8,000	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Driver		2	16,000	h	24.00					384,000	0	0	0	0	384,000		16,000
	- Bus 5.30 16.00		2	16,000	h				5.30	11.52	0	0	0	84,800	132,710	217,510		
											0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	TOTAL COSTS Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	4) Service crane										0	0	0	0	0	0		
	Powerhouse and Harbour 1 un 210										0	0	0	0	0	0		
	Intake 1 un 190										0	0	0	0	0	0		
	400 weeks										0	0	0	0	0	0		
	60 h / w			24,000	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		1	24,000	h	24.00					576,000	0	0	0	0	576,000		24,000
											0	0	0	0	0	0		
	- Crane - Rough terrain 30 t (L-Belt) 33.00 18.00	90%	1	21,600	h				33.00	18.00	0	0	0	712,800	279,936	992,736		
											0	0	0	0	0	0		
	4) Receiving and returning goods material			400	w		1,000				0	400,000	0	0	0	400,000		
											0	0	0	0	0	0		
	5) Yard crew 1 un / site														0			
	400 weeks 60 h / w			24,000	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		4	96,000		24.00					2,304,000	0	0	0	0	2,304,000		96,000
											0	0	0	0	0	0		
	- Miscelaneous			24,000	h		5.00				0	120,000	0	0	0	120,000		
											0	0	0	0	0	0		
	6) Fuel tanker 75 kL										0	0	0	0	0	0		
	Needed capacity for camp B										0	0	0	0	0	0		
	Average 5 trips / week 375 kL / week										0	0	0	0	0	0		
	190 weeks 71,250 kL	OK																
	6 days / w 1,140 days																	
	10 h / day			11,400	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		1	11,400	h	24.00					273,600	0	0	0	0	273,600		11,400
											0	0	0	0	0	0		
	- Fuel Tanker 11.50 15.00	90%	1	10,260	h				11.50	15.00	0	0	0	117,990	110,808	228,798		
											0	0	0	0	0	0		
	Fuel depot (Camp B)										0	0	0	0	0	0		
	Total fuel consumption on project Directs 70,000,000										0	0	0	0	0	0		
	Indirects 12,000,000										0	0	0	0	0	0		
	82,000,000 liters										0	0	0	0	0	0		
	Say 100,000,000 total										0	0	0	0	0	0		
	70% for Camp B 70,000,000										0	0	0	0	0	0		
	Needs Liters Months L/ month kL / week										0	0	0	0	0	0		
	2,011 10,000 2 5,000										0	0	0	0	0	0		
	2,012 20,000,000 12 1,666,700 385										0	0	0	0	0	0		
	2,013 20,000,000 12 1,666,700										0	0	0	0	0	0		
	2,014 20,000,000 12 1,666,700										0	0	0	0	0	0		
	2,015 9,990,000 8 1,248,800										0	0	0	0	0	0		
	70,000,000 46										0	0	0	0	0	0		
	Supply 1,667 kL / month										0	0	0	0	0	0		
	Monthly transportation from harbour 1,624 kL																	
	Needed capacity 43 kL																	
	1,667 twice for storage safety																	
	Say 3,333 kL capacity																	
	- Fuel tank 3,817 kL 263,000 $			1	un		263,000				0	263,000	0	0	0	263,000		
											0	0	0	0	0	0		
	- Miscelaneous (Storage pond, membrane, piping, etc...)	20%		1	ls		52,600				0	52,600	0	0	0	52,600		
											0	0	0	0	0	0		

WBS	DESCRIPTION			%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	TOTAL COSTS Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
													24.00 $				0.72 $			
	Installation and removal					8	sh						0	0	0	0	0	0		
		10	h / sh			80	sh						0	0	0	0	0	0		
													0	0	0	0	0	0		
	- M-P				8	640	h	24.00					15,360	0	0	0	0	15,360		640
													0	0	0	0	0	0		
	- Boom truck 17 tons	13.65	18.00	90%	1	72	h				13.65	18.00	0	0	0	983	933	1,916		
	- Cat 329DL Hydraulic Excavator	19.00	29.00	45%	1	36	h				19.00	29.00	0	0	0	684	752	1,436		
	- Cat D6T LGP Track-Type Tractor	28.40	26.10	45%	1	36	h				28.40	26.10	0	0	0	1,022	677	1,699		
	- Crane - Rough terrain 50 t (L-Belt)	37.00	20.00	45%	1	36	h				37.00	20.00	0	0	0	1,332	518	1,850		
													0	0	0	0	0	0		
	- Miscelaneous					80	h		5.00				0	400	0	0	0	400		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
6232	**Material Handling & Warehousing**												**6,432,960**	**836,000**	**0**	**2,080,131**	**1,317,620**	**10,666,711**		**268,040**

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	UNIT PRICES Fuel	TOTAL COSTS Man power	TOTAL COSTS Construction materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
6240	**NDE & QA/QC Testing Services**																	
6242	**NDE & QA/QC Testing Services - Hydro Site 7e**																	
	- General Laboratory Shop and Feild services			1	ls						0	0	0	0	0	4,000,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
6242	**NDE & QA/QC Testing Services**										**0**	**0**	**0**	**0**	**0**	**4,000,000**		**0**
6250	**Surveying**																	
6252	**Surveying - Hydro Site 7e**																	
	Man Power is included in Item 8120																	
	Surveying Equipment										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Instruments Rental			100	mth		1,500.00				0	150,000	0	0	0	150,000		
											0	0	0	0	0	0		
	- Miscelaneous			100	mth		500.00				0	50,000	0	0	0	50,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
6252	**Surveying**										**0**	**200,000**	**0**	**0**	**0**	**200,000**		**0**

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	UNIT PRICES Fuel	TOTAL COSTS Man power	TOTAL COSTS Construction materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			

6260 Site Security

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
6262	**Site Security - Hydro Site 7e**																	
	Man Power is included in Item 8120																	
	Safety Equipment and Materials										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Directs 3,291,977										0	0	0	0	0	0		
	Indirects 413,286										0	0	0	0	0	0		
	Miscelaneous 500,000										0	0	0	0	0	0		
	4,205,263 m - hours 100 months										0	0	0	0	0	0		
											0	0	0	0	0	0		
	1) First Aid										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- First aid material and medic care			########	h		0.048				0	201,853	0	0	0	201,853		
											0	0	0	0	0	0		
	- Security Equipment and Accessories			########	h		0.038				0	159,800	0	0	0	159,800		
											0	0	0	0	0	0		
	- Miscelaneous			########	h		0.091				0	382,679	0	0	0	382,679		
											0	0	0	0	0	0		
	2) Fire Protection			1	ls		160,000				0	160,000	0	0	0	160,000		
											0	0	0	0	0	0		
	3) Signalisation			1	ls		20,000.00				0	20,000	0	0	0	20,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
6262	**Site Security**										**0**	**924,332**	**0**	**0**	**0**	**924,332**		**0**

6270 Man Power Transportation

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
6272	**Man Power Transportation - Hydro Site 7e**																	
	Houly labour																	
	Directs 3,291,977 m - hours										0	0	0	0	0	0		
	Indirects 413,286 m - hours										0	0	0	0	0	0		
	Catering and maintenance 504,632 12% Total m_hours																	
	Miscelaneous 500,000 m - hours										0	0	0	0	0	0		
	4,709,895 m - hours										0	0	0	0	0	0		
	Say a trip at 40 days 400 h										0	0	0	0	0	0		
	11,775 trips										0	0	0	0	0	0		
	Helicopter flight 2 hours 903.00 $ 12 Passengers										0	0	0	0	0	0		
	Air fare 1,200.00 $										0	0	0	0	0	0		
	- Personal transportation 2,103.00 $			11,775	trips		2,103				0	24,762,825	0	0	0	24,762,825		
											0	0	0	0	0	0		
	Staff 6,118 m-month										0	0	0	0	0	0		
	Say a trip at 1 month 6,118 trips										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Helicopter flight 2 hours 903.00 $ 12 Passengers										0	0	0	0	0	0		
	Air fare 1,650.00 $										0	0	0	0	0	0		
	- Staff transportation 2,553.00 $			6,118	trips		2,553.00				0	15,619,254	0	0	0	15,619,254		
											0	0	0	0	0	0		
	- Home office personnal Average 4 trips / mth 60 mth			240	trips		2,553.00				0	612,720	0	0	0	612,720		
											0	0	0	0	0	0		
6272	**Man Power Transportation**										**0**	**40,994,799**	**0**	**0**	**0**	**40,994,799**		**0**

Item : (6282)

WBS	DESCRIPTION	%	n	Qty	Un.	M-P (Unit Prices)	Cons. Mat. (Unit Prices)	Perm. Mat. (Unit Prices)	Equip. Op. (Unit Prices)	Fuel (Unit Prices)	Man power (Total Costs)	Construction materials (Total Costs)	Permanent Materials (Total Costs)	Equipment Operation (Total Costs)	Fuel Consumption (Total Costs)	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
###	**General Expenses**																	
###	**General Expenses - Hydro Site 7e**																	
	Duration										0	0	0	0	0	0		
	Main Camp 60 mth										0	0	0	0	0	0		
	Camp B 40 mth										0	0	0	0	0	0		
	100 mth										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Office Costs										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Furniture			1	ls		50,000				0	50,000	0	0	0	50,000		
	- Equipment			1	ls		60,000				0	60,000	0	0	0	60,000		
											0	0	0	0	0	0		
	- Office supplies			100	mth		1,200				0	120,000	0	0	0	120,000		
	- Telephone and internet costs			100	mth		1,500				0	150,000	0	0	0	150,000		
											0	0	0	0	0	0		
	- Computers										0	0	0	0	0	0		
	Main Car 58 un			86	un		2,000				0	172,000	0	0	0	172,000		
	Camp B 28 un										0	0	0	0	0	0		
	- Software and Repairs			1	ls		125,000				0	125,000	0	0	0	125,000		
											0	0	0	0	0	0		
	- Mail			100	mth		400				0	40,000	0	0	0	40,000		
											0	0	0	0	0	0		
	Engineering										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Drafting equipment and material			1	ls		50,000				0	50,000	0	0	0	50,000		
											0	0	0	0	0	0		
	- Drawing reproduction			10,000	m²		2.50				0	25,000	0	0	0	25,000		
											0	0	0	0	0	0		
	- Photography			100	mth		50				0	5,000	0	0	0	5,000		
											0	0	0	0	0	0		
	- Construction Program			1	ls		10,000				0	10,000	0	0	0	10,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
6282	**General Expenses - Hydro Site 7e**										**0**	**807,000**	**0**	**0**	**0**	**807,000**		**0**

Item : (6302)

WBS	DESCRIPTION					%	n	Qty	Un.	Cons. Mat.	Freight in/out	Depr.	Purchase	Construction materials	Freight	Depreciation	Purchase	GLOBAL PRICES
	275.00 CDN / mt	0.9259 $ CDN / USD									250							
	137.50 CDN / m³										125							
###	**Construction Equipment, Tools & Supplies**																	
###	**Construction Equipment, Tools & Supplies - Hydro Site 7e**																	
	TBM #1 - Purchase													0	0	0	0	0
-	HP TBM 8 m dia with backup			17,000,000										0	0	0	0	0
-	Rock support system			1,400,000										0	0	0	0	0
-	16 km Conveyer			6,300,000										0	0	0	0	0
-	Spare parts			5,000,000														
				29,700,000										0	0	0	0	0
		Depreciation		17,820,000		60%	1						29,700,000.00	0	0	17,820,000	29,700,000	17,820,000
														0	0	0	0	0
	Transportation to site													0	0	0	0	0
-	TBM							2,400	m³		250.00			0	600,000	0	0	0
-	Conveyer		48 cont. 40'	77				3,698	m³		250.00			0	924,431	0	0	0
			1 cont. 20'	38				38	m³		250.00			0	9,622	0	0	0
														0	0	0	0	0
																	0	0
	TBM #2- Purchase																0	0
-	HP TBM 8 m dia with backup			17,000,000													0	0
-	Rock support system			1,400,000													0	0
-	16 km Conveyer			6,300,000													0	0
-	Spare parts			3,300,000													0	0
				28,000,000										0	0	0	0	0
		Depreciation		16,800,000		60%	1						28,000,000.00	0	0	16,800,000	28,000,000	16,800,000
																	0	0
	Transportation to site																0	0
-	TBM							2,400	m³		250.00			0	600,000	0	0	0
-	Conveyer		48 cont. 40'	77				3,698	m³		250.00			0	924,431	0	0	0
			1 cont. 20'	38				38	m³		250.00			0	9,622	0	0	0
																	0	0
																	0	0
-	Crane - Rough terrain 30 t (L-Belt)			100	m³	40%	2	200	m³		250.00		310,000	0	50,000	248,000	620,000	248,000
-	Crane - Rough terrain 75 t (L-Belt)			153	m³	40%	1	153	m³		250.00		425,000	0	38,250	170,000	425,000	170,000
-	Crane - Rough terrain 50 t (L-Belt)			194	m³	40%	4	776	m³		250.00		600,000	0	194,000	960,000	2,400,000	960,000
-	Crane - Rough terrain 120 t (L-Belt)			169	m³	40%	1	169	m³		250.00		890,000	0	42,250	356,000	890,000	356,000
-	Crane 150T - Crawler	10	77	770	m³	40%	3	2,310	m³		250.00		1,300,000	0	577,500	1,560,000	3,900,000	1,560,000
-	Sprinkler truck (3000 USgallon)			110	m³	40%	2	220	m³		250.00		125,000	0	55,000	100,000	250,000	100,000
-	Fuel Truck			110	m³	40%	2	220	m³		250.00		125,000	0	55,000	100,000	250,000	100,000
-	Boom truck 17 tons			110	m³	40%	5	550	m³		250.00		226,600	0	137,500	453,200	1,133,000	453,200
-	Readymix 8 m³			90	m³	40%	7	630	m³		250.00		200,000	0	157,500	560,000	1,400,000	560,000
-	Explosives Truck			60	m³	40%	4	240	m³		250.00		120,000	0	60,000	192,000	480,000	192,000
-	Welding or Mechanic Truck			60	m³	40%	4	240	m³		250.00			0				
-	Asplalt tanker (12 000 USgallon)			110	m³	40%	2	220	m³		250.00		125,000		55,000	100,000	250,000	100,000
-	Concrete pump 45 m on truck			220	m³	40%	4	880	m³		250.00		800,000	0	220,000	1,280,000	3,200,000	1,280,000
-	Cat 950H Wheel Loader			80	m³ / un	40%	3	240	m³		250.00		284,730		60,000	341,676	854,190	341,676
-	Cat 980H Wheel Loader			118	m³ / un	40%	2	236	m³		250.00		501,080		59,000	400,864	1,002,160	400,864
-	Cat 988H Wheel Loader			181	m³ / un	40%	3	543	m³		250.00		806,225		135,750	967,470	2,418,675	967,470
															0	0	0	0

WBS	DESCRIPTION		%	n	Qty	Un.	Cons. Mat.	Freight in/out	Depr.	Purchase	Construction materials	Freight	Depreciation	Purchase	GLOBAL PRICES
	275.00 CDN / mt — 0.9259 $ CDN / USD							250							
	- Cat 329DL Hydraulic Excavator	112 m^3 / un	40%	4	448	m^3		250.00		314,325		112,000	502,920	1,257,300	502,920
	- Cat 345 Hydraulic Excavator	290 m^3 / un	40%	3	870	m^3		250.00		800,000		217,500	960,000	2,400,000	960,000
	- Cat 385CL Hydraulic Excavator	323 m^3 / un	40%	1	323	m^3		250.00		986,860		80,750	394,744	986,860	394,744
	- Cat 311C U	48 m^3 / un	40%	3	144	m^3		250.00		150,000		36,000	180,000	450,000	180,000
	- Cat 14M Motorgrader	93 m^3 / un	40%	2	186	m^3		250.00		537,823		46,500	430,258	1,075,646	430,258
	- Cat D8T LGP Track-Type Tractor	69 m^3 / un	40%	3	207	m^3		250.00		765,404		51,750	918,485	2,296,212	918,485
	- Cat D7R II LGP Track-Type Tractor	68 m^3 / un	40%	6	408	m^3		250.00		370,865		102,000	890,076	2,225,190	890,076
	- Cat D6T LGP Track-Type Tractor	61 m^3 / un	40%	2	122	m^3		250.00		538,844		30,500	431,075	1,077,688	431,075
	- Cat 442E 2WS Backhoe Loader	55 m^3 / un	40%	2	110	m^3		250.00		105,115		27,500	84,092	210,230	84,092
	- Cat 740 Articulated Dumper 40 T	156 m^3 / un	40%	21	3,276	m^3		250.00		561,300		819,000	4,714,920	11,787,300	4,714,920
	- Cat 725 Articulated Dumper 25 T	98 m^3 / un	40%	22	2,156	m^3		250.00		427,450		539,000	3,761,560	9,403,900	3,761,560
	- 10 Wheeler Truck	90 m^3 / un	40%	12	1,080	m^3		250.00		220,125		270,000	1,056,600	2,641,500	1,056,600
	- Cat CS76 XT Vibratory Soil Compactor	45 m^3 / un	40%	4	180	m^3		250.00		155,125		45,000	248,200	620,500	248,200
	- Cat GEP 88 - 50KW	6 m^3 / un	40%	4	24	m^3		250.00		21,635		6,000	34,616	86,540	34,616
	- Cat GEP 550 - 400KW	20 m^3 / un	40%	10	200	m^3		250.00		84,100		50,000	336,400	841,000	336,400
	- Cat GEP 910 - 910kW	24 m^3 / un	40%	4	96	m^3		250.00		339,250		24,000	542,800	1,357,000	542,800
	- Cat GEP 1250 - 1250kW	24 m^3 / un	40%	10	240	m^3		250.00		500,000		60,000	2,000,000	5,000,000	2,000,000
	- Generator 5 kW (Tower light)	5 m^3 / un	40%	21	105	m^3		250.00		5,100		26,250	42,840	107,100	42,840
												0	0	0	0
	- R1300 G - Scooptram	42 m^3 / un	40%	2	84	m^3		250.00		307,850		21,000	246,280	615,700	246,280
												0	0	0	0
	- Pick-up Ford F-150 (4x4)	23 m^3 / un	100%	50	1,150	m^3		250.00		17,345		287,500	867,250	867,250	867,250
	- Crew-cab Ford F-150 (4x4)	26 m^3 / un	100%	44	1,144	m^3		250.00		26,884		286,000	1,182,896	1,182,896	1,182,896
	- Escape (4x4)	16 m^3 / un	100%	8	128	m^3		250.00		16,850		32,000	134,800	134,800	134,800
												0	0	0	0
	- Tractor truck	90 m^3 / un	60%	5	450	m^3		250.00		138,900		112,500	416,700	694,500	416,700
	- Load Carrier - 65 T	60 m^3 / un	60%	2	120			250.00		51,400			61,680	102,800	61,680
	- Trailer	60 m^3 / un	60%	4	240	m^3		250.00		40,000		60,000	96,000	160,000	96,000
	- Fuel Trailor	170 m^3 / un	60%	2	340	m^3		250.00		125,000		85,000	150,000	250,000	150,000
	- Welding Machine - 400 A	3 m^3 / un	60%	8	24	m^3		250.00		15,000		6,000	72,000	120,000	72,000
	- Moyno pump	m^3 / un	60%											0	0
	- Jack leg	m^3 / un	60%	1	77	m^3		250.00				19,250		0	0
	- Injection pump	m^3 / un	60%											0	0
	- Shotcrete pump	m^3 / un	60%											0	0
	- Fork lift 10 T	10 m^3 / un	60%	3	30	m^3		250.00		15,000		7,500	27,000	45,000	27,000
	- Fork lift 15 T	15 m^3 / un	60%	1	15	m^3		250.00		30,000		3,750	18,000	30,000	18,000
	- Furukawa HCR9-ES	25 m^3 / un	60%	5	125	m^3		250.00		75,000		31,250	225,000	375,000	225,000
	- Hydraulic Drilling Machine	35 m^3 / un	60%	27	945	m^3		250.00		100,000		236,250	1,620,000	2,700,000	1,620,000
												0	0	0	0
	- Bus - 48 Passengers	91 m^3 / un	80%	2	182	m^3		250.00		89,810		45,500	143,696	179,620	143,696
	- Bus - 32 Passengers	60 m^3 / un	80%	3	180	m^3		250.00		55,000		45,000	132,000	165,000	132,000
	- Bus - 18 Passengers	34 m^3 / un	80%	3	102	m^3		250.00		35,000		25,500	84,000	105,000	84,000
												0	0	0	0
	- Compressor - 1050 cfm (XRHS1100CD6)	21 m^3 / un	60%	8	168	m^3		250.00		160,175		42,000	768,840	1,281,400	768,840
	- Compressor - 900 cfm	21 m^3 / un	60%	2	42	m^3		250.00		115,750		10,500	138,900	231,500	138,900
	- Compressor - 830 cfm (XRS830CD6)	21 m^3 / un	60%	2	42	m^3		250.00		142,050		10,500	170,460	284,100	170,460
	- Compressor - 750 cfm	21 m^3 / un	60%	4	84	m^3		250.00		111,110		21,000	266,664	444,440	266,664
	- Compressor XAHS 237 (500 cfm)	23 m^3 / un	60%	7	161	m^3		250.00		90,000		40,250	378,000	630,000	378,000
												0	0	0	0
	- Furnace - 2 500 000 BTU	3 m^3 / un	100%	6	18	m^3		250.00		16,000		4,500	96,000	96,000	96,000
	- Furnace - 1 000 000 BTU	3 m^3 / un	100%	4	12	m^3		250.00		12,000		3,000	48,000	48,000	48,000
												0	0	0	0
	- Asphalt Paver	39 m^3 / un	60%	2	78	m^3		250.00		225,000	0	19,500	270,000	450,000	270,000

WBS	DESCRIPTION	%	n	Qty	Un.	Cons. Mat.	Freight in/out	Depr.	Purchase	Construction materials	Freight	Depreciation	Purchase	GLOBAL PRICES
	275.00 CDN / mt 0.9259 $ CDN / USD						250							
	- Bomag Twin Roller 3 m³ / un	60%	5	15	m³		250.00		20,000	0	3,750	60,000	100,000	60,000
	- Plate damper 1 m³ / un	60%	10	10	m³		250.00		6,500	0	2,500	39,000	65,000	39,000
										0	0	0	0	0
	POWER TUNNEL ADDITS									0	0	0	0	0
2520	- **Rocket Boomer E3 C** Base 1,300,000									0	0	0	0	0
2520	Canadian required safety options 7,810										0	0	0	0
2520	Canadian standard options 12,642										0	0	0	0
2520	Software options 168,024									0	0	0	0	0
2520	Miscellaneous options 200,000									0	0	0	0	0
2520	Spare parts 87,182									0	0	0	0	0
2520	1,775,658									0	0	0	0	0
2520	USD 1,644,082									0	0	0	0	0
2520	Depreciation 0									0	0	0	0	0
	1,644,082											0	0	0
	Width Height Length Volume (m³) Weight (kg)													
2520	**KM 16** 118 m³ / un	40%	1	118	m³		250.00		1,644,082	0	29,500	657,633	1,644,082	657,633
2520	**Powerhouse** 118 m³ / un	40%	1	118	m³		250.00		1,644,082	0	29,500	657,633	1,644,082	657,633
	Tairace 118 m³ / un	40%	1	118	m³		250.00		1,644,082	0	29,500	657,633	1,644,082	657,633
													0	
	Generators (Included in TBM)												0	
													0	
										0	0	0	0	0
	Portable concrete batch Plan									0	0	0	0	0
	- Powerhouse area 3 cnt 77 m³ / cnt	60%	1	231	m³		250.00		125,000	0	57,750	75,000	125,000	75,000
	- Intake area 3 cnt	60%	1	231	m³		250.00		125,000	0	57,750	75,000	125,000	75,000
	6 cnt									0	0	0	0	0
										0	0	0	0	0
	- Boiler 77 m³ / un	60%	4	308	m³		250.00		30,000	0	77,000	72,000	120,000	72,000
										0	0	0	0	0
										0	0	0	0	0
	- Building (Plan & Cement storage) 1,140 m² 77 m³ / cnt	60%	8	616	m³		250.00			0	154,000			0
										0	0	0	0	0
										0	0	0	0	0
	- Control module 320 sf 77 m³ / cnt	60%	2	154	m³		250.00		50,000.00	0	38,500	60,000	100,000	60,000
										0	0	0	0	0
										0	0	0	0	0
	- Miscelaneous (cement storage, water tank, etc.)	90%	1	77	m³		250.00		35,000.00	0	19,250	31,500	35,000	31,500
										0	0	0	0	0
											0	0	0	0
	Bitumen batching plant									0	0	0	0	0
	1 unit needed in intake area									0	0	0	0	0
										0	0	0	0	0
	- Bitumen batching plant "drum mix" (400 t / h)	60%	2	600	m³		250.00		2,500,000	0	150,000	3,000,000	5,000,000	3,000,000
										0	0	0	0	0
	Crusher									0	0	0	0	0
										0	0	0	0	0
	- Crusher (300 t / h) 600 m³ / unit	60%	2	1,200	m³		250.00		1,500,000	0	300,000	1,800,000	3,000,000	1,800,000
										0	0	0	0	0
	Electrical components									0	0	0	0	0
	(kg) L W H Vol.										0	0	0	0
	- PSG 1 1,700 1,300 1,340 2,675 5.0		2	10	m³					0	0	0	0	0
	2,550 1,950 1,340 2,675 7.0		3	21	m³						0	0	0	0

WBS	DESCRIPTION						%	n	Qty	Un.	Cons. Mat.	Freight in/out	Depr.	Purchase	Construction materials	Freight	Depreciation	Purchase	GLOBAL PRICES
	275.00 CDN / mt		0.9259 $ CDN / USD									250							
-	PSG 2	1,700	1,300	1,340	2,675	5.0		2	10	m³					0	0	0	0	0
		2,550	1,950	1,340	2,675	7.0		3	21	m³						0	0	0	0
-	PSG 3	2,550	650	1,340	2,675	2.0		3	6	m³					0	0	0	0	0
		2,550	1,950	1,340	2,675	7.0		3	21	m³					0	0	0	0	0
						0.0									0	0	0	0	0
-	SG 1	1,700	1,300	1,778	2,596	6.0		4	24	m³					0	0	0	0	0
-	SG 2	1,700	1,300	1,778	2,596	6.0		4	24	m³					0	0	0	0	0
						0.0									0	0	0	0	0
-	SG 11	1,000	1,524	508	2,300	2.0		2	4	m³					0	0	0	0	0
		1,550	2,032	508	2,300	2.0		4	8	m³						0	0	0	0
-	SG 12	1,000	1,524	508	2,300	2.0		2	4	m³					0	0	0	0	0
		1,550	2,032	508	2,300	2.0		4	8	m³						0	0	0	0
-	SG 13	1,000	1,524	508	2,300	2.0		2	4	m³					0	0	0	0	0
		1,550	2,032	508	2,300	2.0		4	8	m³						0	0	0	0
-	SG 14	1,000	1,524	508	2,300	2.0		2	4	m³					0	0	0	0	0
		1,550	2,032	508	2,300	2.0		4	8	m³						0	0	0	0
-	SG 15	1,000	1,524	508	2,300	2.0		2	4	m³					0	0	0	0	0
		1,550	2,032	508	2,300	2.0		4	8	m³					0	0	0	0	0
															0	0	0	0	0
-	SG 21	1,000	1,524	508	2,300	2.0		2	4	m³					0	0	0	0	0
		1,550	2,032	508	2,300	2.0		4	8	m³						0	0	0	0
		1,200	1,524	508	2,300	2.0		3	6	m³						0	0	0	0
-	SG 22	1,000	1,524	508	2,300	2.0		2	4	m³					0	0	0	0	0
		1,550	2,032	508	2,300	2.0		4	8	m³						0	0	0	0
		1,200	1,524	508	2,300	2.0		3	6	m³						0	0	0	0
-	SG 23	1,500	2,286	508	2,300	3.0		3	9	m³					0	0	0	0	0
		1,200	1,524	508	2,300	2.0		3	6	m³						0	0	0	0
		1,200	1,524	508	2,300	2.0		3	6	m³						0	0	0	0
-	SG 24	1,500	2,286	508	2,300	3.0		3	9	m³					0	0	0	0	0
		1,200	1,524	508	2,300	2.0		3	6	m³					0	0	0	0	0
		1,200	1,524	508	2,300	2.0		3	6	m³					0	0	0	0	0
															0	0	0	0	0
-	T 1	82,000	7,800	3,500	4,300	117.0		1	117	m³					0	0	0	0	0
-	T 2	82,000	7,800	3,500	4,300	117.0		1	117	m³					0	0	0	0	0
-	T 3	82,000	7,800	3,500	4,300	117.0		1	117	m³					0	0	0	0	0
-	T 4	82,000	7,800	3,500	4,300	117.0		1	117	m³					0	0	0	0	0
-	T 1	82,000	7,800	3,500	4,300	117.0		1	117	m³					0	0	0	0	0
															0	0	0	0	0
-	S 1	11,825	3,700	2,500	2,360	22.0		1	22	m³					0	0	0	0	0
-	S 2	11,825	3,700	2,500	2,360	22.0		1	22	m³					0	0	0	0	0
-	S 3	5,000	3,000	2,000	2,800	17.0		1	17	m³					0	0	0	0	0
									921	**m³**		125.00			0	115,125	0	0	0
																0	0	0	0
-	220 kV Cable		18,000 m		10.7 kg / m				193	mt		250.00			0	48,250	0	0	0
															0	0	0	0	0
-	Miscelaneous			5 mt / gr				5	25	mt		250.00			0	6,250	0	0	0
															0	0	0	0	0
	GENERATING UNITS														0	0	0	0	0
		(kg)	L	W	T	Vol.									0	0	0	0	0
-	Runner	10,000	3	3	1	61		6	369	m³		125.00			0	46,125	0	0	0
-	shafts	14,000				0		5	70	mt		250.00			0	17,500	0	0	0
-	Spiral 1/3	28,000	10	4	2	349		5	1,746	m³		125.00			0	218,250	0	0	0
-	spiral 2/3	16,000	10	3	2	233		5	1,164	m³		125.00			0	145,500	0	0	0
-	Spiral 3/3	10,000	8	4	1	189		5	946	m³		125.00			0	118,250	0	0	0

Item : (6302)

WBS	DESCRIPTION						%	n	Qty	Un.	Cons. Mat.	Freight in/out	Depr.	Purchase	Construction materials	Freight	Depreciation	Purchase	GLOBAL PRICES
	275.00 CDN / mt		0.9259 $ CDN / USD									250							
	- Nozzles	4,500	3	2	2	198		31	6,126	m³		125.00			0	765,750	0	0	0
	- Gratings and rails	4,000	5	1	1	63		15	945	m³		125.00			0	118,125	0	0	0
	- Pit walls	9,000	6	2	3	486		15	7,290	m³		125.00			0	911,250	0	0	0
	- Deflector SM	2,500	1	1	1	1		5	6	m³		125.00			0	750	0	0	0
	- Pit c. & G.sole plates	12,000	6	4	2	540		15	8,100	m³		125.00			0	1,012,500	0	0	0
	- Turb. Bearing	2,500	2	2	2	30		5	150	m³		125.00			0	18,750	0	0	0
	- Piping	5,000	6	1	1	30		5	150	m³		125.00			0	18,750	0	0	0
	- Anchors	10,000	6	1	1	30		5	150	m³		125.00			0	18,750	0	0	0
	- Pressure tank	5,000	1	1	3	12		5	61	m³		125.00			0	7,625	0	0	0
	- Sump tank	2,000	2	2	2	23		5	113	m³		125.00			0	14,125	0	0	0
	- Governor	400	2	1	1	15		5	76	m³		125.00			0	9,500	0	0	0
	- Sph. Valve	55,000	2	3	3	86		5	429	m³		125.00			0	53,625	0	0	0
	- Counterweights	22,000	3	2	1	37		10	220	mt		250.00			0	55,000	0	0	0
	- SM, By pass	14,000	6	2	2	94		5	470	m³		125.00			0	58,750	0	0	0
	- Dismantl. Pipe	9,000	2	2	2	36		5	180	m³		125.00			0	22,500	0	0	0
	- Compressed air	4,000	5	3	2	30		1	30	m³		125.00			0	3,750	0	0	0
	- Cooling water syst.	5,000	6	3	2	216		6	1,296	m³		125.00			0	162,000	0	0	0
	- Half stator frames	12,833	7	5	4	1,250		10	12,502	m³		125.00			0	1,562,750	0	0	0
	- stator laminations	3,500	1	1	1	86		###	10,368	m³		125.00			0	1,296,000	0	0	0
	- stator winding	3,000	5	2	2	761		50	38,070	m³		125.00			0	4,758,750	0	0	0
	- Bracket	7,000	8	4	1	403		10	4,034	m³		125.00			0	504,250	0	0	0
	- Rotor laminations	9,000	2	1	1	121		60	540	mt		250.00			0	135,000	0	0	0
	- Poles	4,000	2	1	1	90		70	6,272	m³		125.00			0	784,000	0	0	0
	- Rotor spider & shaft	50,000	7	2	2	185		5	250	mt		250.00			0	62,500	0	0	0
	- Bearing & ThrustB.	5,000	3	3	2	68		5	338	m³		125.00			0	42,250	0	0	0
	- Brakes and segments	10,000	6	2	1	36		3	108	m³		125.00			0	13,500	0	0	0
	- Exciter cubicles	750	2	2	3	150		20	3,000	m³		125.00			0	375,000	0	0	0
	- Exciter cubicles	1,000	1	2	3	19		5	94	m³		125.00			0	11,750	0	0	0
	- Exciter transformer	4,000	3	2	3	47		5	234	m³		125.00			0	29,250	0	0	0
	- Control and protection	1,400	2	2	3	113		15	1,688	m³		125.00			0	211,000	0	0	0
	- Station transformer	9,000	3	3	3	23		1	23	m³		125.00			0	2,875	0	0	0
	- Battery Charger/Inverter	750	2	2	2	6		1	6	m³		125.00			0	750	0	0	0
	- Battery	6,000	2	2	2	12		2	12	mt		250.00			0	3,000	0	0	0
															0	0	0	0	0
	Overhead Crane	100,150 kg							1,002	mt		250.00			0	250,500	0	0	0
															0	0	0	0	0
	Piping								44	mt		250.00			0	11,000	0	0	0
															0	0	0	0	0
	CVAC			77	m³ Cnt			5	385	m³		125.00			0	48,125	0	0	0
															0	0	0	0	0
	Intake	(kg)	L	W	T	Vol.									0	0	0	0	0
	Trash Rack	60,000	6,500	10,000	900	59.0		3	177	m³		125.00			0	22,125	0	0	0
	Stop logs	93,000	6,500	10,000	1,500	98.0		6	588	m³		125.00			0	73,500	0	0	0
	Gains	80,000							80	mt		250.00			0	20,000	0	0	0
	Gates	75,000	5,750	8,750	1,000	50.0			50	m³		125.00			0	6,250	0	0	0
	Winches	20,000							20	mt		250.00			0	5,000	0	0	0
	Lining	40,000							40	mt		250.00			0	10,000	0	0	0
															0	0	0	0	0
															0	0	0	0	0
	MARINE EQUIPMENT														0	0	0	0	0
															0	0	0	0	0
	Tailrace Outlet		L (ft)	W (ft)	H (ft)	V (cu ft)									0	0	0	0	0
	- Landding barge (Unifloat)		18	8	6.0	864		10	245	m³		250.00			0	61,167	0	0	0
	- Noze end					432		6	73	m³		250.00			0	18,350	0	0	0

WBS	DESCRIPTION					%	n	Qty	Un.	Cons. Mat.	Freight in/out	Depr.	Purchase	Construction materials	Freight	Depreciation	Purchase	GLOBAL PRICES
	275.00 CDN / mt	0.9259 $ CDN / USD									250							
														0	0	0	0	0
	- Service barge	50	12	6.5	3,900		2	221	m³		250.00			0	55,220	0	0	0
														0	0	0	0	0
	- Tug	12	6	8.0	576		1	16	m³		250.00			0	4,078	0	0	0
	- Work boat	8	4	6.0	192		1	5	m³		250.00			0	1,359	0	0	0
	- Miscelaneous (winches, anchors, generators, etc..)													0	0	0	0	0
														0	0	0	0	0
	Intake													0	0	0	0	0
	- Landding barge (Unifloat)	18	8	6	864		10	245	m³		250.00			0	61,167	0	0	0
	- Noze end				432		6	73	m³		250.00			0	18,350	0	0	0
	- Working barge	50	12	7	3,900		6	663	m³		250.00			0	165,660	0	0	0
	- Tug	12	6	8	576		3	49	m³		250.00			0	12,233	0	0	0
	- Work boat	8	4	6	192		3	16	m³		250.00			0	4,078	0	0	0
	- Scows	18	10	4	720		6	122	m³		250.00			0	30,583	0	0	0
	- Miscelaneous (winches, anchors, generators, etc..)													0	0	0	0	0
														0	0	0	0	0
														0	0	0	0	0
														0	0	0	0	0
														0	0	0	0	0
6302	**Construction Equipment, Tools & Supplies - Hydro Site 7e**													**0**	**24,550,976**		**145,792,242**	**74,738,361**

Item : (6420)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Freight	UNIT PRICES Equip. Op.	UNIT PRICES Fuel	TOTAL COSTS Man power	TOTAL COSTS Construction materials	TOTAL COSTS Freight	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES
	275.00 CDN / mt 0.9259 $ CDN / USD							250			24.00 $				0.72 $		
	137.50 CDN / m³							125									
###	**Material Transportation**																
###	**Material Transportation - Hydro Site 7e**																
	Freight										0	0	0	0	0	0	
	Construction Materials										0	0	0	0	0	0	
	Full Load 3 Shipments 20,000 m³			60,000	m³			250.00			0	0	15,000,000	0	0	15,000,000	
	Partial load shipments			40,000	m³			250.00			0	0	10,000,000	0	0	10,000,000	
											0	0	0	0	0	0	
	Insurance **Other then Commodities**										0	0	0	0	0		
											0	0	0	0	0		
	Construction Materials 42,207,071 $ 0.25 $ / 100$										0	0	0	0	0	105,518	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
											0	0	0	0	0	0	
6420	**Material Transportation - Hydro Site 7e**										**0**	**0**	**25,000,000**	**0**	**0**	**25,105,518**	

Project : 7e Cost Estimate.xlsx

Item : (6512-6552)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES					TOTAL COSTS					GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption			
											24.00 $				0.72 $			

6500 Construction Camp

6510 Site Preparation

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
6512	**Site Preparation - Hydro Site 7e**			**120,100**	**m²**													
	Camp A 62,500 (250 x 250)										0	0	0	0	0	0		
	Camp B 57,600 (240 x 240)										0	0	0	0	0	0		
	120,100 (including roads)										0	0	0	0	0	0		
	3,000 m² / sh			41	sh						0	0	0	0	0	0		
	10 h / sh			410	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		7	2,870	h	24.00					68,880	0	0	0	0	68,880		2,870
											0	0	0	0	0	0		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	90%	1	369	h				38.25	28.00	0	0	0	14,114	0	14,114		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	90%	3	1,107	h				24.00	20.00	0	0	0	26,568	0	26,568		
	- Cat 329DL Hydraulic Excavator 19.00 29.00	90%	1	369	h				19.00	29.00	0	0	0	7,011	0	7,011		
	- Cat CS76 XT Vibratory Soil Compactor 14.85 20.00	45%	1	185	h				14.85	20.00	0	0	0	2,740	0	2,740		
	- Cat 14M Motor grader 16.65 25.75	45%	1	185	h				16.65	25.75	0	0	0	3,072	0	3,072		
											0	0	0	0	0	0		
	- Misc. (Dust control, accessories, etc..)			1	ls		10,000				0	10,000	0	0	0	10,000		
											0	0	0	0	0	0		
	Pavement (roads, parking lot, etc..)										0	0	0	0	0	0		
	150 mm of crushed stone on 50% of the total area																	
	9,008 m³ 16,214 mt																	
											0	0	0	0	0	0		
	- Crushed stone **0.08 h / mt**			16,214	mt	**1.94**	**0.00**	**0.00**	**2.27**	**1.58**	31,455	0	0	36,806	0	68,261		1,297
											0	0	0	0	0	0		
											0	0	0	0	0	0		
6512	**Site Preparation - Hydro Site 7e**										**100,335**	**10,000**	**0**	**90,311**	**0**	**200,646**		**4,167**

6520 Infrastructure

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
6522	**Infrastructure - Hydro Site 7e**																	
	Power Station (diesel generators)																	
	Camp A										0	0	0	0	0	0		
	Needed 8 kW / p-d (Reserve) Total										0	0	0	0	0	0		
	Workers (Including T-Line) 423 0 423	0%																
	Staff 100 0 100	0%																
	523										0	0	0	0	0	0		
	Needed capacity **5.2 mW** **5 years**										0	0	0	0	0	0		
	60 months																	
	1,830 days 24 h / d			43,920	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Transformers 1.75 un / mW			9	un		3,330	103,330			0	29,970	929,970	0	0	959,940		
	- Building Isolated steel building **600**			600	m²		290	830			0	174,000	498,000	0	0	672,000		
	- Electrical mains			1,700	m		110	480			0	187,000	816,000	0	0	1,003,000		
	- Outdoor lightin On poles			6	un		420	1,830			0	2,520	10,980	0	0	13,500		
	- Reefer hotlines			22	un		300	2,000			0	6,600	44,000	0	0	50,600		
	Camp B																	
	Needed 8 kW / p-d (Reserve) Total																	
	Workers (Including T-Line) 274 0 274	0%																
	Staff 59 0 59	0%																

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	TOTAL COSTS Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	333																	
	Needed capacity 3.3 mW 40 months										0	0	0	0	0	0		
	1,200 days 24 h / d			28,800	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Transformers 1.75 un / mW			6	un		3,330	103,330			0	19,980	619,980	0	0	639,960		
	- Building Isolated steel building 600			600	m²		290	830			0	174,000	498,000	0	0	672,000		
	- Electrical mains			1,700	m		110	480			0	187,000	816,000	0	0	1,003,000		
	- Outdoor lightin On poles			6	un		420	1,830			0	2,520	10,980	0	0	13,500		
	- Reefer hotlines			22	un		300	2,000			0	6,600	44,000	0	0	50,600		
											0	0	0	0	0	0		
	Water Supply Plan										0	0	0	0	0	0		
	Camp A 200 L / p-d 523 persons										0	0	0	0	0	0		
	105 kL / d 732 kL / week										0	0	0	0	0	0		
	3,138 kL / month																	
	- Treatment			1	un		3,000	103,330			0	3,000	103,330	0	0	106,330		
											0	0	0	0	0	0		
	- Storage tank Isolated steel tank 1 month capacity			3,138	kL		390	480			0	1,223,820	1,506,240	0	0	2,730,060		
											0	0	0	0	0	0		
	- Water mains Isolated pipes on ground			1,500	m		50	162			0	75,000	243,000	0	0	318,000		
											0	0	0	0	0	0		
	- Raw water pipeline			1,000	m		50	162			0	50,000	162,000	0	0	212,000		
											0	0	0	0	0	0		
	- Miscellaneous (pumping station, pumps, heating, etc..)			1	ls		75,000				0	75,000	0	0	0	75,000		
											0	0	0	0	0	0		
	Supply **60 months**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 10 h / mth		2	1,200	h	24.00					28,800	0	0	0	0	28,800		1,200
											0	0	0	0	0	0		
	- Filtration unit			1	ls		3,000	25,000			0	3,000	25,000	0	0	28,000		
											0	0	0	0	0	0		
	Camp B 200 L / p-d 333 persons										0	0	0	0	0	0		
	67 kL / d 466 kL / week										0	0	0	0	0	0		
	1,998 kL / month																	
	- Treatment			1	un		3,000	103,330			0	3,000	103,330	0	0	106,330		
											0	0	0	0	0	0		
	- Storage tank Isolated steel tank 1 month capacity			1,998	kL		390	480			0	779,220	959,040	0	0	1,738,260		
											0	0	0	0	0	0		
	- Water mains Isolated pipes on ground			1,500	m		50	162			0	75,000	243,000	0	0	318,000		
											0	0	0	0	0	0		
	- Raw water pipeline			1,000	m		50	162			0	50,000	162,000	0	0	212,000		
											0	0	0	0	0	0		
	- Miscellaneous (pumping station, pumps, heating, etc..)			1	ls		75,000				0	75,000	0	0	0	75,000		
											0	0	0	0	0	0		
	Supply **40 months**										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P 10 h / mth		2	800	h	24.00					19,200	0	0	0	0	19,200		800
											0	0	0	0	0	0		
	- Filtration unit			1	ls		3,000	25,000			0	3,000	25,000	0	0	28,000		
											0	0	0	0	0	0		
	Sewer plan										0	0	0	0	0	0		
	Camp A										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Treatment plan SBR process tank and UV-Disinfect 200 m³ / d			1	un		300,000	500,000			0	300,000	500,000	0	0	800,000		
											0	0	0	0	0	0		
	- Sewer mains			1,500	m		240	478			0	360,000	717,000	0	0	1,077,000		
											0	0	0	0	0	0		
	Camp B										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Treatment plan SBR process tank and UV-Disinfect 200 m³ / d			1	un		300,000	500,000			0	300,000	500,000	0	0	800,000		
											0	0	0	0	0	0		
	- Sewer mains			1,500	m		240	478			0	360,000	717,000	0	0	1,077,000		

WBS	DESCRIPTION				%	n	Qty	Un.	M-P (UNIT PRICES)	Cons. Mat. (UNIT PRICES)	Perm. Mat. (UNIT PRICES)	Equip. Op. (UNIT PRICES)	Fuel (UNIT PRICES)	Man power (TOTAL COSTS)	Construction materials (TOTAL COSTS)	Permanent Materials (TOTAL COSTS)	Equipment Operation (TOTAL COSTS)	Fuel Consumption (TOTAL COSTS)	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
														24.00 $				0.72 $			
														0	0	0	0	0	0		
	Incinerator													0	0	0	0	0	0		
	Camp A	**Duration**	**60 months**											0	0	0	0	0	0		
														0	0	0	0	0	0		
	- Supply and install						1	ls		500,000				0	500,000	0	0	0	500,000		
														0	0	0	0	0	0		
		26 d / mth	1,560 days											0	0	0	0	0	0		
			10 h / d				15,600	h						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- M-P					2	31,200	h	24.00					748,800	0	0	0	0	748,800		31,200
														0	0	0	0	0	0		
	- Garbage truck	13.60	14.00		45%	1	7,020	h				13.60	14.00	0	0	0	95,472	70,762	166,234		
	- Cat 950H Wheel Loader	18.35	9.05		90%	1	14,040	h				18.35	9.05	0	0	0	257,634	91,485	349,119		
	- Incinerator	15.00	20.00		90%	1	14,040	h				3.00	6.00	0	0	0	42,120	60,653	102,773		
														0	0	0	0	0	0		
	Camp B	**Duration**	**40 months**											0	0	0	0	0	0		
														0	0	0	0	0	0		
	- Supply and install						1	ls		500,000				0	500,000	0	0	0	500,000		
														0	0	0	0	0	0		
		26 d / mth	1,040 days											0	0	0	0	0	0		
			10 h / d				10,400	h						0	0	0	0	0	0		
														0	0	0	0	0	0		
	- M-P					2	20,800	h	24.00					499,200	0	0	0	0	499,200		20,800
														0	0	0	0	0	0		
	- Garbage truck	13.60	14.00		45%	1	4,680	h				13.60	14.00	0	0	0	63,648	47,174	110,822		
	- Cat 950H Wheel Loader	18.35	9.05		90%	1	9,360	h				18.35	9.05	0	0	0	171,756	60,990	232,746		
	- Incinerator	15.00	20.00		90%	1	9,360	h				3.00	6.00	0	0	0	28,080	40,435	68,515		
														0	0	0	0	0	0		
	Telecommunications													0	0	0	0	0	0		
	Camp A													0	0	0	0	0	0		
														0	0	0	0	0	0		
	- Communication mast						1	un		13,000	63,000			0	13,000	63,000	0	0	76,000		
														0	0	0	0	0	0		
	- brodcast of Radio and W-Fi	Terminal equipment					1	ls		20,000	108,000			0	20,000	108,000	0	0	128,000		
														0	0	0	0	0	0		
	- Cable for TV and Internet						1,500	m		18	14			0	27,000	21,000	0	0	48,000		
														0	0	0	0	0	0		
	Camp B													0	0	0	0	0	0		
														0	0	0	0	0	0		
	- Communication mast						1	un		13,000	63,000			0	13,000	63,000	0	0	76,000		
														0	0	0	0	0	0		
	- brodcast of Radio and W-Fi	Terminal equipment					1	ls		20,000	108,000			0	20,000	108,000	0	0	128,000		
														0	0	0	0	0	0		
	- Cable for TV and Internet						1,500	m		18	14			0	27,000	21,000	0	0	48,000		
														0	0	0	0	0	0		
	- Repeater Tower mast						2	un		13,000	63,000			0	26,000	126,000	0	0	152,000		
														0	0	0	0	0	0		
														0	0	0	0	0	0		
6522	**Infrastructure - Hydro Site 7e**													**1,296,000**	**5,671,230**	**10,763,850**	**658,710**	**371,499**	**18,761,289**		**54,000**

6530 Camps

6532	**Camps - Hydro Site 7e**																				
	Buildings													0	0	0	0	0	0		
	Camp A																				
	Needed		(Reserve)	Total																	
	Workers (Including T-Line)	423	0	423	0%																
	Staff	100	0	100	0%																

Item : (6512-6552)

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
	Accommodations (including common rooms) 523																	
	men / mod. Living Mod. Common Total Mod										0	0	0	0	0	0		
	Mod. **24.36**	**m² / mod**									0	0	0	0	0	0		
	Workers 4 106 42 148 **3,599**										0	0	0	0	0	0		
	Staff 2 50 20 70 **1,705**										0	0	0	0	0	0		
	218 **5,304**	m²									0	0	0	0	0	0		
	Supply and install										0	0	0	0	0	0		
	- Workers			3,599	m²		240	1,320			0	863,760	4,750,680	0	0	5,614,440		
	- Staff			1,705	m²		270	1,450			0	460,350	2,472,250	0	0	2,932,600		
	Mod **m²**										0	0	0	0	0	0		
	Service building										0	0	0	0	0	0		
	- Offices 0.0284 mod / men 15 **365**			365	m²		270	1,320			0	98,550	481,800	0	0	580,350		
	- Dining 20 seats / mod			438	m²		270	1,470			0	118,260	643,860	0	0	762,120		
	1.2 m² / p										0	0	0	0	0	0		
	366.1 seats 18 **438**										0	0	0	0	0	0		
	- Kitchen (incl. Day storage) 50% of dining 9 **219**			219	m²		590	1,770			0	129,210	387,630	0	0	516,840		
	- Laundry 1 mod / 200 p 3 **73**			73	m²		590	1,770			0	43,070	129,210	0	0	172,280		
	- Recreation Hal 1.5 m² / p (70 %) 549 23 **549**			549	m²		250	1,240			0	137,250	680,760	0	0	818,010		
											0	0	0	0	0	0		
	- Infirmary 100 p / bed			61	m²		680	2,020			0	41,480	123,220	0	0	164,700		
	5 beds										0	0	0	0	0	0		
	2 beds / mod 3 **61**										0	0	0	0	0	0		
	70																	
	288																	
	Workshops										0	0	0	0	0	0		
	- Mechanical Isolated steel building **200**			200	m²		280	1,250			0	56,000	250,000	0	0	306,000		
	- Electrical Isolated steel building **200**			200	m²		280	1,250			0	56,000	250,000	0	0	306,000		
	- Carpenter Isolated steel building **200**			200	m²		280	1,250			0	56,000	250,000	0	0	306,000		
	- Garage and Fire Fighting Isolated steel building **400**			400	m²		290	830			0	116,000	332,000	0	0	448,000		
	- Fire fighting Equipment Isolated steel building			1	ls		330	366,670			0	330	366,670	0	0	367,000		
											0	0	0	0	0	0		
	Storage buildings										0	0	0	0	0	0		
	Needed for Camp A 1.50 m² / p / w																	
	780 m² / week										0	0	0	0	0	0		
	Needed for Camp B 50% 250 m² / week																	
	4,120 m² / month »» 10,712	m³ / mth									0	0	0	0	0	0		
	49,440 m² / year 128,544	m³ / y									0	0	0	0	0	0		
	For 2 months 8,240 m²										0	0	0	0	0	0		
	Reserve 1 month 4,120 m²										0	0	0	0	0	0		
	12,360 m² »»»»»»»» 32,136	m³									0	0	0	0	0	0		
	7 Shipment / year 18,363 m³ / ship.	**OK**									0	0	0	0	0	0		
	Food storage Depot (m²) (m³)										0	0	0	0	0	0		
	- Frozen Isolated steel building 2,966 7,713	24%		2,966	m²		150	920			0	444,960	2,729,088	0	0	3,174,048		
	- Cold (refrigerated) Isolated steel building 2,966 7,713	24%		2,966	m²		120	750			0	355,968	2,224,800	0	0	2,580,768		
	- Dry (non perishable) Isolated steel building 6,427 16,711	52%		6,427	m²		130	870			0	835,536	5,591,664	0	0	6,427,200		
	12,360 32,137	100%									0	0	0	0	0	0		
											0	0	0	0	0	0		
	Camp B										0	0	0	0	0	0		
	Needed (Reserve) Total																	
	Workers (Including T-Line) 274 0 274	0%																
	Staff 59 0 59	0%																
	Accommodations (including common rooms) 333																	
	men / mod. Living Mod. Common Total Mod										0	0	0	0	0	0		
	Mod. **24.36**	**m² / mod**									0	0	0	0	0	0		
	Workers 4 69 27 96 **2,326**										0	0	0	0	0	0		
	Staff 2 30 12 42 **1,011**										0	0	0	0	0	0		
	137 **3,337**	m²									0	0	0	0	0	0		
	Supply and install										0	0	0	0	0	0		
	- Workers			2,326	m²		240	1,320			0	558,240	3,070,320	0	0	3,628,560		

WBS	DESCRIPTION				%	Qty	Un.	M-P	Cons. Mat. (UNIT PRICES)	Perm. Mat. (UNIT PRICES)	Equip. Op. (UNIT PRICES)	Fuel (UNIT PRICES)	Man power (TOTAL COSTS)	Construction materials (TOTAL COSTS)	Permanent Materials (TOTAL COSTS)	Equipment Operation (TOTAL COSTS)	Fuel Consumption (TOTAL COSTS)	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
													24.00 $				0.72 $			
	- Staff					1,011	m²		270	1,450			0	272,970	1,465,950	0	0	1,738,920		
			Mod	**m²**									0	0	0	0	0	0		
	Service building												0	0	0	0	0	0		
	- Offices	0.0284 mod / men	9	**219**		219	m²		270	1,320			0	59,130	289,080	0	0	348,210		
	- Dining	20 seats / mod				292	m²		270	1,470			0	78,840	429,240	0	0	508,080		
		1.2 m² / p											0	0	0	0	0	0		
		233.1 seats	12	**292**									0	0	0	0	0	0		
	- Kitchen (incl. Day storage)	50% of dining	6	**146**		146	m²		590	1,770			0	86,140	258,420	0	0	344,560		
	- Laundry	1 mod / 200 p	2	**49**		49	m²		590	1,770			0	28,910	86,730	0	0	115,640		
	- Recreation Hal	1.5 m² / p (70 %) 350	14	**350**		350	m²		250	1,240			0	87,500	434,000	0	0	521,500		
													0	0	0	0	0	0		
	- Infirmary	100 p / bed				37	m²		680	2,020			0	25,160	74,740	0	0	99,900		
		3 beds											0	0	0	0	0	0		
		2 beds / mod	2	**37**									0	0	0	0	0	0		
			45																	
			182																	
	Workshops												0	0	0	0	0	0		
	- Mechanical	Isolated steel building		**200**		200	m²		280	1,250			0	56,000	250,000	0	0	306,000		
	- Electrical	Isolated steel building		**200**		200	m²		280	1,250			0	56,000	250,000	0	0	306,000		
	- Carpenter	Isolated steel building		**200**		200	m²		280	1,250			0	56,000	250,000	0	0	306,000		
	- Garage and Fire Fighting	Isolated steel building		**400**		400	m²		290	830			0	116,000	332,000	0	0	448,000		
	- Fire fighting Equipment	Isolated steel building				1	ls		330	366,670			0	330	366,670	0	0	367,000		
													0	0	0	0	0	0		
	Storage buildings												0	0	0	0	0	0		
	Needed for Camp B	1.50 m² / p / w																		
		500 m² / week											0	0	0	0	0	0		
		2,000 m² / month »»		5,200 m³ / mth									0	0	0	0	0	0		
		24,000 m² / year											0	0	0	0	0	0		
	For 2 weeks	1,000 m²											0	0	0	0	0	0		
	Reserve 1 weeks	500 m²											0	0	0	0	0	0		
		1,500 m² »»»»»»»»»		3,900	m³								0	0	0	0	0	0		
													0	0	0	0	0	0		
	Food storage Depot		(m²)	(m³)									0	0	0	0	0	0		
	- Frozen	Isolated steel building	360	936	24%	360	m²		150	920			0	54,000	331,200	0	0	385,200		
	- Cold (refrigerated)	Isolated steel building	360	936	24%	360	m²		120	750			0	43,200	270,000	0	0	313,200		
	- Dry (non perishable)	Isolated steel building	780	2,028	52%	780	m²		130	870			0	101,400	678,600	0	0	780,000		
			1,500	3,900	100%								0	0	0	0	0	0		
	Starter Camp																			
	Needed			Total																
	Workers			60																
	Staff			10																
	Accommodations (including common rooms)			70																
		men / mod. Living Mod. Common Mod.	Total Mod	**24.36**	**m² / mod**															
	Workers	4 15 6	21	**512**																
	Staff	2 5 2	7	**171**																
			28	**683**	m²															
	Supply and install												0	0	0	0	0	0		
	- Workers					512	m²		240	1,320			0	122,880	675,840	0	0	798,720		
	- Staff					171	m²		270	1,450			0	46,170	247,950	0	0	294,120		
	- Dining	20 seats / mod				49	m²		270	1,470			0	13,230	72,030	0	0	85,260		
		1.2 m² / p											0	0	0	0	0	0		
		49.0 seats	2	**49**									0	0	0	0	0	0		
	- Kitchen (incl. Day storage)	50% of dining	1	**24**		24	m²		590	1,770			0	14,160	42,480	0	0	56,640		
	- Laundry	1 mod / 200 p	1	**24**		24	m²		590	1,770			0	14,160	42,480	0	0	56,640		
	- Recreation Hal	1.5 m² / p (70 %) 63	1	**22**		22	m²		250	1,240			0	5,500	27,280	0	0	32,780		
													0	0	0	0	0	0		
	- Infirmary	100 p / bed				12	m²		680	2,020			0	8,160	24,240	0	0	32,400		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
	1 beds										0	0	0	0	0	0		
	2 beds / mod 1 12										0	0	0	0	0	0		
	33										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
6532	**Camps - Hydro Site 7e**										**0**	**5,716,804**	**31,632,882**	**0**	**0**	**37,349,686**		**0**

6540 Catering

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
6542	**Catering - Hydro Site 7e**																	
	Total Camp A and B																	
	m-hours p-d p-month																	
	Staff 162,510 5,417																	
	Workers m-h / d»»» 10																	
	Directs 3,291,977 329,198 10,973																	
	Indirects 413,286 41,329 1,378																	
	Catering (including Camp Operation) 21,030 701																	
	Miscellaneou 500,000 50,000 1,667																	
	604,066 20,136																	
	Based on different sources, Total cost is estimated at 80.00 USD / m-d																	
	This is including Catering and Operation of the camps																	
	Catering 38% 51%																	
	Security and infirmary 8%																	
	Maintenance 5%																	
	Operation																	
	Power station 49% 49%																	
	100% 100%										0	0	0	0	0	0		
											0	0	0	0	0	0		
	80.00 USD / m-d																	
	- Catering 2,433.33 USD / m-	51%		20,136	m-mth		1,241.00				0	24,988,211	0	0	0	24,988,211		
											0	0	0	0	0	0		
6542	**Catering - Hydro Site 7e**										**0**	**24,988,211**	**0**	**0**	**0**	**24,988,211**		**0**

6550 Operation

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
6552	**Operation - Hydro Site 7e**																	
	Total Camp A and B																	
	m-hours p-d p-month																	
	Staff 162,510 5,417																	
	Workers m-h / d»»» 10																	
	Directs 3,291,977 329,198 10,973																	
	Indirects 41,329 1,378																	
	Catering (including Camp Operation) 21,030 701																	
	Miscellaneou 500,000 50,000 1,667																	

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES					TOTAL COSTS							
											24.00 $				0.72 $			
	604,076 20,136																	
	Based on different sources, Total cost is estimated at 40.00 USD / m-d																	
	This is including Catering and Operation of the camps																	
	Catering 75% 100%																	
	Security and infirmary 10%																	
	Maintenance 15%																	
	Power Station (diesel generators)																	
	Camp A																	
	Needed 8 kW / p-d (Reserve) Total																	
	Workers (Including T-Line) 423 0 423	0%																
	Staff 100 0 100	0%																
	523										0	0	0	0	0	0		
	Needed capacity **5.2 mW**										0	0	0	0	0	0		
	58 months (First 2 months on pioneer camp)																	
	1,764 days 24 h / d			42,340	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Spare Installed										0	0	0	0	0	0		
6	Cat GEP 910 - 910kW 1 8.50 130.80 4,550	50%	5	105,850	h				8.50	130.80	0	0	0	899,725	9,968,530	10,868,255		
5	Cat GEP 550 - 400KW 1 6.50 102.40 1,600	50%	4	84,680	h				6.50	102.40	0	0	0	550,420	6,243,287	6,793,707		
	6,150.0										0	0	0	0	0	0		
	Fuel Storage										0	0	0	0	0	0		
	Total fuel consumption 22,516 kL										0	0	0	0	0	0		
	388 kL / month										0	0	0	0	0	0		
	Transportation from harbor 75 kL / trip										0	0	0	0	0	0		
	5.2 trips / mth										0	0	0	0	0	0		
	300 trips 5 h / trip			1,500	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
-	M-P		2	3,000	h	24.00					72,000	0	0	0	0	72,000		3,000
											0	0	0	0	0	0		
-	Fuel Tanker 75 kL 11.50 15.00	90%	1	1,350	h				12	15.00	0	0	0	15,525	14,580	30,105		
											0	0	0	0	0	0		
	Fuel Tank										0	0	0	0	0	0		
											0	0	0	0	0	0		
-	Fuel tank 795 kL 154,500 $			1	un		154,500				0	154,500	0	0	0	154,500		
											0	0	0	0	0	0		
-	Miscellaneous (Storage pond, membrane, piping, etc...)	20%		1	ls		30,900				0	30,900	0	0	0	30,900		
	Camp B																	
	Needed 8 kW / p-d (Reserve) Total																	
	Workers (Including T-Line) 274 0 274	0%																
	Staff 59 0 59	0%																
	333																	
	Needed capacity **3.3 mW** **40 months**										0	0	0	0	0	0		
	1,200 days 24 h / d			28,800	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Spare Installed										0	0	0	0	0	0		
4	Cat GEP 910 - 910kW 1 8.50 130.80 2,730	50%	3	43,200	h				8.50	130.80	0	0	0	367,200	4,068,403	4,435,603		
4	Cat GEP 550 - 400KW 1 6.50 102.40 1,200	50%	3	43,200	h				6.50	102.40	0	0	0	280,800	3,185,050	3,465,850		
	3,930										0	0	0	0	0	0		
	Fuel Storage										0	0	0	0	0	0		
	Total fuel consumption 10,074 kL										0	0	0	0	0	0		
	252 kL / month										0	0	0	0	0	0		
	Transportation from harbor 75 kL / trip										0	0	0	0	0	0		
	3.4 trips / mth										0	0	0	0	0	0		
	134 trips 10 h / trip			1,340	h						0	0	0	0	0	0		

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
											0	0	0	0	0	0		
	- M-P		2	2,680	h	24.00					64,320	0	0	0	0	64,320		2,680
											0	0	0	0	0	0		
	- Fuel Tanker 75 kL 11.50 15.00	90%	1	1,206	h				12	15.00	0	0	0	13,869	13,025	26,894		
											0	0	0	0	0	0		
	Fuel Tank										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Fuel tank 795 kL 154,500 $			1	un		154,500				0	154,500	0	0	0	154,500		
											0	0	0	0	0	0		
	- Miscellaneous (Storage pond, membrane, piping, etc...)	20%		1	ls		30,900				0	30,900	0	0	0	30,900		
	Starter Camp										0	0	0	0	0	0		
	Needed 8 kW / p-d Total										0	0	0	0	0	0		
	Workers 60										0	0	0	0	0	0		
	Staff 10										0	0	0	0	0	0		
	70										0	0	0	0	0	0		
	Needed capacity **0.7 mW** **2 months**										0	0	0	0	0	0		
	61 days 24 h / d			1,464	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	Spare Installed										0	0	0	0	0	0		
	2 Cat GEP 910 - 910kW 1 8.50 130.80 910	50%	1	732	h			8.50	130.80		0	0	6,222	95,746	0	101,968		
	910										0	0	0	0	0	0		
	- M-P (Included in Camp Operation)										0	0	0	0	0	0		
											0	0	0	0	0	0		
	- Miscellaneous (fueling, temp. Install., etc)			1	ls		200,000				0	200,000	0	0	0	200,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
6552	**Operation - Hydro Site 7e**										**136,320**	**570,800**	**6,222**	**2,223,285**	**23,492,875**	**26,429,502**		**5,680**

Item : (6620)

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	UNIT PRICES Fuel	TOTAL COSTS Man power	TOTAL COSTS Construction materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											25.60 $				0.72 $			
6600	**Insurance, Taxes, Permits, Fees**																	
6620	**Insurance, Taxes, Permits, Fees - Hydro Site 7e**																	
	Insurances ± 725,000,000 $										0	0	0	0	0	0		
	- Responsibility	2.02%		1	ls				14,645,000		0	0	0	14,645,000	0	14,645,000		
											0	0	0	0	0	0		
	- Risk	0.62%		1	ls				4,495,000		0	0	0	4,495,000	0	4,495,000		
											0	0	0	0	0	0		
	- Execution Bund 0.0069 $			1	ls				5,002,500		0	0	0	5,002,500	0	5,002,500		
											0	0	0	0	0	0		
	- Equipment 145,792,242 $	0.5%		1	ls				728,961		0	0	0	728,961	0	728,961		
											0	0	0	0	0	0		
	- Miscellaneous			1	ls				1,000,000		0	0	0	1,000,000	0	1,000,000		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
6620	**Insurance, Taxes, Permits, Fees - Hydro Site 7e**										**0**	**0**	**0**	**25,871,461**	**0**	**25,871,461**		**0**

Item : (6720)

WBS	DESCRIPTION				n	Qty	Un.		Cons. Mat.	Freight in/out	Equip. M.perm.	Fuel	Man power	Construction materials	Freight	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
										UNIT PRICES			TOTAL COSTS							
	275.00 CDN / mt	0.9259 $ CDN / USD								250			24.00 $				0.72 $			
	137.50 CDN / m³									125										
6700	**Miscellaneous**																			
6720	**Miscellaneous Freight - Hydro Site 7e**																			
	Freight												0	0	0	0	0	0		
	Equipment	24,550,976 $											0	0	0	0	0	24,550,976		
													0	0	0	0	0	0		
	Camps	Modules											0	0	0	0	0	0		
	A	288											0	0	0	0	0	0		
	B	182											0	0	0	0	0	0		
	Starter	28											0	0	0	0	0	0		
		498		24.36 m³ / mod		12,132	m³			250.00			0	0	3,033,000	0	0	3,033,000		
													0	0	0	0	0	0		
	Generators	A	B										0	0	0	0	0	0		
	- Cat GEP 910 - 910kW	6	4	24 m³ / un	10	240	m³			250.00			0	0	60,000	0	0	60,000		
	- Cat GEP 550 - 400KW	5	4	20 m³ / un	9	180	m³			250.00			0	0	45,000	0	0	45,000		
													0	0	0	0	0	0		
	- Building	600	600			1,200	m³			250.00			0	0	300,000	0	0	300,000		
	- Fuel Tank	800	800			1,600	m³			250.00			0	0	400,000	0	0	400,000		
	- Transformers	70	42			112	m³			250.00			0	0	28,000	0	0	28,000		
	- Miscellaneous	600	400			1,000	m³			250.00			0	0	250,000	0	0	250,000		
													0	0	0	0	0	0		
	Workshops	1,000	1,000			2,000	m³			250.00			0	0	500,000	0	0	500,000		
													0	0	0	0	0	0		
	Storage buildings	12,360	1,500			13,860	m³			250.00			0	0	3,465,000	0	0	3,465,000		
													0	0	0	0	0	0		
	Fire Fighter Equipment					20	m³			250.00			0	0	5,000	0	0	5,000		
													0	0	0	0	0	0		
	Water Supply												0	0	0	0	0	0		
	- Storage tank	4,000	2,000			6,000	m³			250.00			0	0	1,500,000	0	0	1,500,000		
	- Mains Lines	1500	1500	0.0225 m³ / m		68	m³			250.00			0	0	17,000	0	0	17,000		
	- Raw water lines	1000	1000	0.0225 m³ / m		45	m³			250.00			0	0	11,250	0	0	11,250		
	- Treatment plan	14	14			28	m³			250.00			0	0	7,000	0	0	7,000		
													0	0	0	0	0	0		
	Sewer Plan												0	0	0	0	0	0		
	- Treatment plan	260	260			520	m³			250.00			0	0	130,000	0	0	130,000		
	- Sewer mains	1500	1500	0.0225 m³ / m		68	m³			250.00			0	0	17,000	0	0	17,000		
													0	0	0	0	0	0		
	Incinerators			16 m³ / un	2	32	m³			250.00			0	0	8,000	0	0	8,000		
													0	0	0	0	0	0		
	Telecommunications	30	30			60	m³			250.00			0	0	15,000	0	0	15,000		
													0	0	0	0	0	0		
	Catering	(Included in 6542)											0	0	0	0	0	0		
	Insurance												0	0	0	0	0	0		
													0	0	0	0	0	0		
	Camps		31,632,882 $	0.25 $ / 100$									0	0	0	0	0	79,082		
	Equipment		145,792,242 $	0.25 $ / 100$									0	0	0	0	0	364,481		
													0	0	0	0	0	0		
													0	0	0	0	0	0		
6720	**Miscellaneous Freight - Hydro Site 7e**												**0**	**0**		**0**	**0**	**34,785,789**		

Item : (7120)

WBS	DESCRIPTION	%	n	Qty	Un.	TOTAL COSTS Man power	65	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						25.60 $				0.72 $			
7000	**EPCM Home Office**												
7100	**EPCM Home Office - FEL 1 & 2**												
7120	**EPCM Home Office - FEL 1 & 2 - Hydro Site 7e**												
	Contractor **Percentage of direct costs** 416,941,561 $	2%									8,338,831		
	General Managing										4,000,000		
7120	**EPCM Home Office - FEL 1 & 2 - Hydro Site 7e**										**12,338,831**		

Item : (8002)

Art.	DESCRIPTION	%	n	Qty	Un.	COÛT UNITAIRE M-P Monthly	COÛT UNITAIRE M-P Hourly	TOTAL COSTS Men Power Monthly	TOTAL COSTS Men Power Hourly	GLOBAL PRICES	Men-hours
8000	**EPCM Field Office**										
8120	**EPCM Field Office - FEL 1 & 2 - Hydro Site 7e**										
	Contractor Staff										
	Camp A 2,237										
	Camp B 876										
	3,113 P-Months										
	General Managing Staff										
	Camp A 1,628										
	Camp B 676										
	2,304 P-Months										
	5,417										
	- Average 10,000 $ / month			5,417		10,000.00		54,170,000		54,170,000	
8120	**EPCM Field Office - FEL 1 & 2 - Hydro Site 7e**									**54,170,000**	

Item : **(9002)**

9000 Contingency

							UNIT PRICES					TOTAL COSTS							
WBS	DESCRIPTION		%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel	Man power	Construction materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
												24.00 $				0.72 $			
9002	**Hydro Site 7e - Contingency**																		
	Direct Costs																		
	Harbor site preparation	**474 981**	15%														71 247		
																	0		
	Port Facility	**4 050 016**	15%														607 502		
																	0		
	Primary roads construction	**45 875 129**	25%														11 468 782		
																	0		
	Civil works related to Powerhouse,																0		
	Tailrace tunnel and Surge tunnel																0		
	Excavation	**23 760 896**	15%														3 564 134		
	Concrete Works	**18 568 166**	15%														2 785 225		
																	0		
	Civil works related to Power tunnel																0		
	Power tunnel (including Rock Support)	**90 312 321**	15%														13 546 848		
	Power tunnel Access and addit	**10 870 137**	15%														1 630 521		
	Intake excavation	**27 298 594**	15%														4 094 789		
	Intake structure	**2 236 792**	15%														335 519		
																	0		
	Dams and Spillway																0		
	Diversion Tunnels (including concrete plug and Portal	**2 355 767**	15%														353 365		
																	0		
	Cofferdams	**2 793 625**	15%														419 044		
	Foundation	**4 202 827**	15%														630 424		
	Impervious core	**5 911 832**	10%														591 183		
	Rock fill	**4 198 192**	15%														629 729		
	Spillway	**12 826 455**	15%														1 923 968		
																	0		
	Supply and Installation of Transformers and Power cables	**8 961 600**	15%														1 344 240		
																	0		
																	0		
	Supply and Installation of High voltage distribution plant	**14 729 960**	15%														2 209 494		
																	0		
																	0		
	Emergency Generator	**169 900**	15%														25 485		
	Plant Communications	**981 000**	15%														147 150		
	Power plant Command Circuitry	**4 900 000**	15%														735 000		
	Switch yard Site	**37 004**	15%														5 551		
	Supply Line to Power Tunnel Intake	**5 352 723**	15%														802 908		
																	0		
	Mechanical + Electrical Works																0		
	Supply and Installation of Turbine/Generators	**97 622 114**	15%														14 643 317		
																	0		
	Supply and installation of Power tunnel and Diversion	**11 785 000**	15%														1 767 750		
																	0		
	Supply and installation of Draft tube Gates	**767 500**	15%														115 125		
	Supply the overhead crane	**1 575 000**	15%														236 250		
																	0		
	Underground Utilities																0		
	Fire water System	**529 480**	15%														79 422		
	Potable Water System	**764 720**	15%														114 708		
	Sewage and Sanitary System	**2 326 020**	15%														348 903		
	Compressed Air System	**696 710**	15%														104 507		
	Process Water System	**661 600**	15%														99 240		
	CVAC	**3 847 700**	15%														577 155		

Project : **7e Cost Estimate.xlsx**

Item : **(9002)**

WBS	DESCRIPTION		%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	UNIT PRICES Fuel	TOTAL COSTS Man power	TOTAL COSTS Construction materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
												24.00 $				0.72 $			
																	0		
	Service building	**5 497 800**	15%														824 670		
																	0		
		416 941 561															0		
																	0		
	Indirect Costs																0		
	Temporary Construction Facilities																0		
	Work Areas, including Buildings	**3 167 524**	10%														316 752		
	Roads , Walkways, Parking Lots	**57 531**	15%														8 630		
	Utilities	**5 370 535**	15%														805 580		
																	0		
	Construction Services																0		
	General Site Operation	**7 237 119**	10%														723 712		
	Final Clean Up	**217 236**	20%														43 447		
	Material Handling & Warehousing	**10 666 711**	15%														1 600 007		
	NDE & QA/QC Testing Services	**4 000 000**	10%														400 000		
	Surveying	**200 000**	20%														40 000		
	Site Security	**924 332**	20%														184 866		
	Man Power Transportation	**40 994 799**	15%														6 149 220		
	General Expenses	**807 000**	15%														121 050		
																	0		
	Construction Equipment, Tools & Supplies	**74 738 361**	15%														11 210 754		
																	0		
	Material Transportation	**25 105 518**	15%														3 765 828		
																	0		
	Construction Camp																0		
	Site Preparation	**200 646**	10%														20 065		
	Infrastructure	**18 761 289**	10%														1 876 129		
	Camps	**37 349 686**	10%														3 734 969		
	Catering	**18 618 667**	10%														1 861 867		
	Operation	**56 807 327**	15%														8 521 099		
																	0		
	Insurance, Taxes, Permits, Fees	**25 871 461**	10%														2 587 146		
																	0		
	Miscellaneous Freight	**34 785 789**	10%														3 478 579		
																	0		
	EPCM Home Office - FEL 1 & 2	**12 338 831**	10%														1 233 883		
																	0		
	EPCM Field Office - FEL 1 & 2	**54 170 000**	10%														5 417 000		
																	0		
																	0		
9002	**Hydro Site 7e - Contingency**											**0**	**0**	**0**	**0**	**0**	**120 933 738**		**0**

Project : 7e Cost Estimate.xlsx

Item : Rebars

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	m - h / un	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
												24.00 $				0.72 $			
	Reinforcing Steel			**2,220**	**mt**														
	Purchase 37,000 m³ concrete																		
	60 kg / m³																		
	- Rebars 2,220 mt Losses	5%		2,331	mt			689				0	0	1,606,059	0	0	1,606,059		
												0	0	0	0	0	0		
	- Freight 0.9259 $ CDN »»» 254.62 USD / mt			2,331	mt			254.62				0	0	593,525	0	0	593,525		
	275.00 $ CDN / mt											0	0	0	0	0	0		
												0	0	0	0	0	0		
	- Insurance 0.25 $ / 100$			2,331	mt			1.7225				0	0	4,015	0	0	4,015		
												0	0	0	0	0	0		
	Fabrication											0	0	0	0	0	0		
	Production 4 mt / sh			555	sh							0	0	0	0	0	0		
	10 h / sh			5,550	h							0	0	0	0	0	0		
												0	0	0	0	0	0		
	- M-P		6	33,300	h	24.00						799,200	0	0	0	0	799,200		33,300
												0	0	0	0	0	0		
	- Crane - Rough terrain 30 t (L-Belt) 33.00 18.00	50%	1	2,775	h				33.00	18.00		0	0	0	91,575	35,964	127,539		
	- Tractor & Trailer 11.50 15.00	50%	1	2,775	h				11.50	15.00		0	0	0	31,913	29,970	61,883		
	- Boom truck 17 tons 13.65 18.00	25%	1	1,388	h				13.65	18.00		0	0	0	18,946	17,988	36,934		
												0	0	0	0	0	0		
	- Miscelaneous			2,220	mt		100.00					0	222,000	0	0	0	222,000		
												0	0	0	0	0	0		
												0	0	0	0	0	0		
												0	0	0	0	0	0		
0	**Reinforcing Steel**			**2,220**	**mt**							**799,200**	**222,000**	**2,203,599**	**142,434**	**83,922**	**3,451,155**	**1,554.57**	**33,300**
	Unit costs											**360.00**	**100.00**	**992.61**	**64.16**	**37.80**	**1554.57**		**15.00**

Item : Asphalt

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	m - h / un	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES						TOTAL COSTS							
												24.00 $				0.72 $			
	Asphalt			**27,419**	**mt**														
	Asphalt Plan (m³) (mt)											0	0	0	0	0	0		
	Mix Needs 1.5 mt / m³											0	0	0	0	0	0		
	Dam 1 7,733 11,600											0	0	0	0	0	0		
	Dam 2 10,546 15,819											0	0	0	0	0	0		
	18,279 27,419											0	0	0	0	0	0		
												0	0	0	0	0	0		
	(mt) months monthly Days											0	0	0	0	0	0		
	2,013 3,500 3 1,167 78											0	0	0	0	0	0		
	2,014 12,000 5 2,400 130											0	0	0	0	0	0		
	2,015 12,000 5 2,400 130											0	0	0	0	0	0		
	27,500 338											0	0	0	0	0	0		
												0	0	0	0	0	0		
	Purchase											0	0	0	0	0	0		
	Bitumen											0	0	0	0	0	0		
	- 7.5% of the mix 2,056 mt Losses	5%		2,159	mt			625.00				0	0	1,349,375	0	0	1,349,375		
												0	0	0	0	0	0		
	- Freight 0.9259 $ CDN »»» 254.62 USD / mt			2,159	mt			254.62				0	0	549,730	0	0	549,730		
	275.00 $ CDN / mt											0	0	0	0	0	0		
												0	0	0	0	0	0		
	- Insurance 0.25 $ / 100$			2,159	mt			1.563				0	0	3,373	0	0	3,373		
												0	0	0	0	0	0		
	- Aggregates 25,363 mt Losses	5%		26,631	mt	1.94	0.00	0.00	2.27	1.58	0.08	51,664	0	0	60,452	1,534	113,650		2,130
												0	0	0	0	0	0		
	Mixing 10 h / d			3,380	h							0	0	0	0	0	0		
												0	0	0	0	0	0		
	- M-P		3	10,140	h	24.00						243,360	0	0	0	0	243,360		10,140
												0	0	0	0	0	0		
	- Cat 950H Wheel Loader 18.35 9.05		1	3,380	h				18.35	9.05		0	0	0	62,023	0	62,023		
	- Bitumen batching plant "drum mix" (400 t / h)		1	3,380	h				15.00			0	0	0	50,700	0	50,700		
												0	0	0	0	0	0		
												0	0	0	0	0	0		
												0	0	0	0	0	0		
												0	0	0	0	0	0		
												0	0	0	0	0	0		
0	**Asphalt**			**27,419**	**mt**							**295,024**	**0**	**1,902,478**	**173,175**	**1,534**	**2,372,211**	**86.52**	**12,270**
	Unit costs											**10.76**	**0.00**	**69.39**	**6.32**	**0.06**	**86.52**		**0.45**

Item : Concrete

WBS	DESCRIPTION	%	n	Qty	Un.	M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	m - h / un	Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
						UNIT PRICES						TOTAL COSTS							
												24.00 $				0.72 $			
	Concrete			**37,000**	**m³**														
	Concrete Batch Plan											0	0	0	0	0	0		
												0	0	0	0	0	0		
	Needs Powerhouse 27,000											0	0	0	0	0	0		
	Dams & Intake 10,000											0	0	0	0	0	0		
												0	0	0	0	0	0		
	Powerhouse area (m³) months monthly Days											0	0	0	0	0	0		
	2,011 700 3 233 78											0	0	0	0	0	0		
	2,012 0											0	0	0	0	0	0		
	2,013 12,500 8 1,563 208											0	0	0	0	0	0		
	2,014 9,500 11.5 826 299											0	0	0	0	0	0		
	2,015 4,300 3 1,433 78											0	0	0	0	0	0		
	27,000 **663**											0	0	0	0	0	0		
	Intake area (m³) months monthly Days											0	0	0	0	0	0		
	2,012 400 2 200 52															0			
	2,013 3,000 6 500 156															0			
	2,014 6,000 8 750 208															0			
	2,015 600 3 200 78															0			
	10,000 **494**															0			
	Purchase											0	0	0	0	0	0		
	- Portable Batch plan - 25 m³ / h (Included in 6300)											0	0	0	0	0	0		
	- Building (Plan & Cement storage) (Included in 6300) 1,140 m²		2	2,280	m²		209					0	476,520	0	0	0	476,520		
	- Control module (Included in 6300) 320 sf		2	640	sf		47.00					0	30,080	0	0	0	30,080		
	- Boiller (Included in 6300)											0	0	0	0	0	0		
	Cement											0	0	0	0	0	0		
	- Purchase 350 kg / m³ 12,950 mt Losses	5%		13,598	mt			73.00				0	0	992,654	0	0	992,654		
	37,000 m³											0	0	0	0	0	0		
																0			
	- Freight 0.9259 $ CDN »»» 254.62 USD / mt			13,598	mt			254.62				0	0	3,462,357	0	0	3,462,357		
	275.00 $ CDN / mt											0	0	0	0	0	0		
																0			
	- Insurance 0.25 $ / 100$			13,598	mt			0.1825				0	0	2,482	0	0	2,482		
												0	0	0	0	0	0		
	Aggregates											0	0	0	0	0	0		
	- 40-20 and 20-05 crushed stone & Sand **2.00** mt / m³			74,000	mt	1.94	0.00	0.00	2.27	1.58	0.08	143,560	0	0	167,980	84,182	395,722		5,920
												0	0	0	0	0	0		
	- Additives			37,000	m³			2.00				0	0	74,000	0	0	74,000		
												0	0	0	0	0	0		

Item : Concrete

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	Cons. Mat.	Perm. Mat.	Equip. Op.	Fuel l / h	m - h / un	TOTAL COSTS Man power	Consumable materials	Permanent Materials	Equipment Operation	Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
												24.00 $				0.72 $			
	Mixing											0	0	0	0	0	0		
	Intake 10 h / d			4,940	h							0	0	0	0	0	0		
												0	0	0	0	0	0		
	- M-P		3	14,820	h	24.00						355,680	0	0	0	0	355,680		14,820
												0	0	0	0	0	0		
	- Cat 950H Wheel Loader 18.35 9.05		1	4,940	h				18.35	9.05		0	0	0	90,649	32,189	122,838		
	- Concrete plan		1	4,940	h				10.00			0	0	0	49,400	0	49,400		
												0	0	0	0	0	0		
	Powerhouse area 10 h / d			6,630	h							0	0	0	0	0	0		
												0	0	0	0	0	0		
	- M-P		3	19,890	h	24.00						477,360	0	0	0	0	477,360		19,890
												0	0	0	0	0	0		
	- Cat 950H Wheel Loader 18.35 9.05		1	6,630	h				18.35	9.05		0	0	0	121,661	43,201	164,862		
	- Concrete plan		1	6,630	h				10.00			0	0	0	66,300	0	66,300		
												0	0	0	0	0	0		
												0	0	0	0	0	0		
												0	0	0	0	0	0		
0	**Concrete**			**37,000**	**m³**							**976,600**	**506,600**	**4,531,493**	**495,990**	**159,572**	**6,670,255**	**180.28**	**40,630**
	Unit costs											**26.39**	**13.69**	**122.47**	**13.41**	**4.31**	**180.28**		**1.10**

Item : Crusher

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Crusher			**433,829**	**mt**													
	Crusher Plan System (Portable)										0	0	0	0	0	0		
	Needs										0	0	0	0	0	0		
	Powerhouse area										0	0	0	0	0	0		
	Concrete 27,000 m³ (mt)										0	0	0	0	0	0		
	40-20 0.530 mt / m³ 14,310														0			
	20-05 0.530 mt / m³ 14,310														0			
	Sand 0.855 mt / m³ 23,085														0			
	Road Pavement (Using TBM excavated material)										0	0	0	0	0	0		
	119,700 m³ 1.8 mt / m³										0	0	0	0	0	0		
	51,705 mt														0			
	Intake area										0	0	0	0	0	0		
	Concrete 10,000 m³ (mt)										0	0	0	0	0	0		
	40-20 0.530 mt / m³ 5,300														0			
	20-05 0.530 mt / m³ 5,300														0			
	Sand 0.855 mt / m³ 8,550														0			
	Road Pavement														0			
	58,373 m³ 1.8 mt / m³ 105,071														0			
	Dam impervious core																	
	18,279 m³ 1.8 mt / m³ 32,902																	
	Dam Filter														0			
	125,000 m³ 1.8 mt / m³ 225,000														0			
	382,124 mt														0			
	433,829														0			
	Operation during summer periods only														0			
	Stockpiling a small amount for next springtime start														0			
	Moving between intake , dams and powerhouse sites														0			
															0			
	Powerhouse area 100 mt / h (eff.)										0	0	0	0	0	0		
	(mt) Operation Moving Installation (total hours)										0	0	0	0	0	0		
	2,011 1,000 10 60 20 90										0	0	0	0	0	0		
	2,012 2,000 20 60 20 100										0	0	0	0	0	0		
	2,013 22,000 220 60 20 300										0	0	0	0	0	0		
	2,014 22,000 220 60 20 300														0			
	2,015 5,000 50 60 20 130										0	0	0	0	0	0		
	52,000 520 300 100 920										0	0	0	0	0	0		
	Intake area										0	0	0	0	0	0		
											0	0	0	0	0	0		
	2,013 170,000 1,700 60 20 1,780										0	0	0	0	0	0		
	2,014 140,000 1,400 60 20 1,480										0	0	0	0	0	0		
	2,015 72,000 720 60 20 800										0	0	0	0	0	0		
	382,000 3,820 180 60 4,060										0	0	0	0	0	0		
	434,000										0	0	0	0	0	0		

Item : Crusher

WBS	DESCRIPTION	%	n	Qty	Un.	UNIT PRICES M-P	UNIT PRICES Cons. Mat.	UNIT PRICES Perm. Mat.	UNIT PRICES Equip. Op.	Fuel l / h	TOTAL COSTS Man power	TOTAL COSTS Consumable materials	TOTAL COSTS Permanent Materials	TOTAL COSTS Equipment Operation	TOTAL COSTS Fuel Consumption	GLOBAL PRICES	UNIT PRICES	MEN-HOURS
											24.00 $				0.72 $			
	Crushing and stockpiling Total Hours 4,980										0	0	0	0	0	0		
	Say			5,000	h						0	0	0	0	0	0		
											0	0	0	0	0	0		
	- M-P		7	35,000	h	24.00					840,000	0	0	0	0	840,000		35,000
											0	0	0	0	0	0		
	- Cat 950H Wheel Loader 18.35 9.05	100%	2	10,000	h				18.35	9.05	0	0	0	183,500	65,160	248,660		
	- Cat D7R II LGP Track-Type Tractor 38.25 28.00	100%	1	5,000	h				38.25	28.00	0	0	0	191,250	100,800	292,050		
	- Cat 725 Articulated Dumper 25 T 24.00 20.00	100%	3	15,000	h				24.00	20.00	0	0	0	360,000	216,000	576,000		
	- Crusher Assembly (300 t / h)	100%	1	5,000	h				50.00	84.00	0	0	0	250,000	302,400	552,400		
	Production of 1,800 mt / day										0	0	0	0	0	0		
	1.8 mt / m^3 1,000 m^3 / d														0			
	Average hauling distance : 2.00 km										0	0	0	0	0	0		
											0	0	0	0	0	0		
	Loading 3										0	0	0	0	0	0		
	Going 4 30 km / h										0	0	0	0	0	0		
	Unloading 3										0	0	0	0	0	0		
	Return 4 30 km / h										0	0	0	0	0	0		
	14 min.										0	0	0	0	0	0		
	Efficiency : 85% 16 min. / trip										0	0	0	0	0	0		
	0.27 h / trip										0	0	0	0	0	0		
	9 h / sh										0	0	0	0	0	0		
	33 trips / day										0	0	0	0	0	0		
	Cat 725 Articulated Dumper 25 T 11 m^3										0	0	0	0	0	0		
	363 m^3 / truck-sh										0	0	0	0	0	0		
	Number of trucks : **3**										0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
											0	0	0	0	0	0		
0	**Crusher**			**433,829**	**mt**						**840,000**	**0**	**0**	**984,750**	**684,360**	**2,509,110**	**5.78**	**35,000**
	Unit costs				**mt**						**1.94**	**0.00**	**0.00**	**2.27**	**1.58**			**0.08**