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2 Project Description

The objective of this section is to provide a general description of the Project, which includes the Hydropower Facility, Electrical Interconnect, and Access Road. The section is intended to provide an overview of the Project design, implementation plan, and operating plan, to establish a context within which to assess the potential Project environmental and social impacts (positive and negative). The Project characteristics may be subject to some change based on final planning and design by the Company the EPC Contractor, and the GoG; however, any such changes are not anticipated to change the results of this ESIA analysis.

The three main components of the Project include (see Figure 2.1.):

1. **Hydropower Facility—**Consisting of a dam at the confluence of the Amaila and Kuribrong Rivers, a reservoir, a water tunnel, a powerhouse, turbine generators, an onsite electric substation and switchyard, local access roads, and other ancillary systems required to collect, control, and efficiently use water to generate electricity, all located approximately 200 km southwest of Georgetown (see Section 2.1 for details). It is designed to be a 165 MW hydroelectric facility using only the natural flows of the Amaila and Kuribrong rivers. The Company has no plans for future expansion of the Hydropower Facility.
2. **Electrical Interconnection—**Consisting of about 270 km of high-voltage, 230-kV transmission line and two remote substations, one at Linden and one at Georgetown, that will deliver power from the Project to the Guyana Power and Light (GPL) electric grid (see Section 2.2 for details).
3. **Access Road—**Consisting of approximately 85 km of new roads to be constructed, and about 122 km of existing roads to be upgraded, to provide sufficient access to the transmission line and the hydropower facility (see Section 2.3 for details).

The Project workforce and schedule are described in Sections 2.4 and 2.5, respectively.

The Company is responsible for construction and operation of the Hydropower Facility and the Electrical Interconnection, and the GoG is responsible for the construction and operation of the Access Road, which includes clearing a portion of the transmission line alignment, from where it crosses the Kuribrong River to the hydropower site.

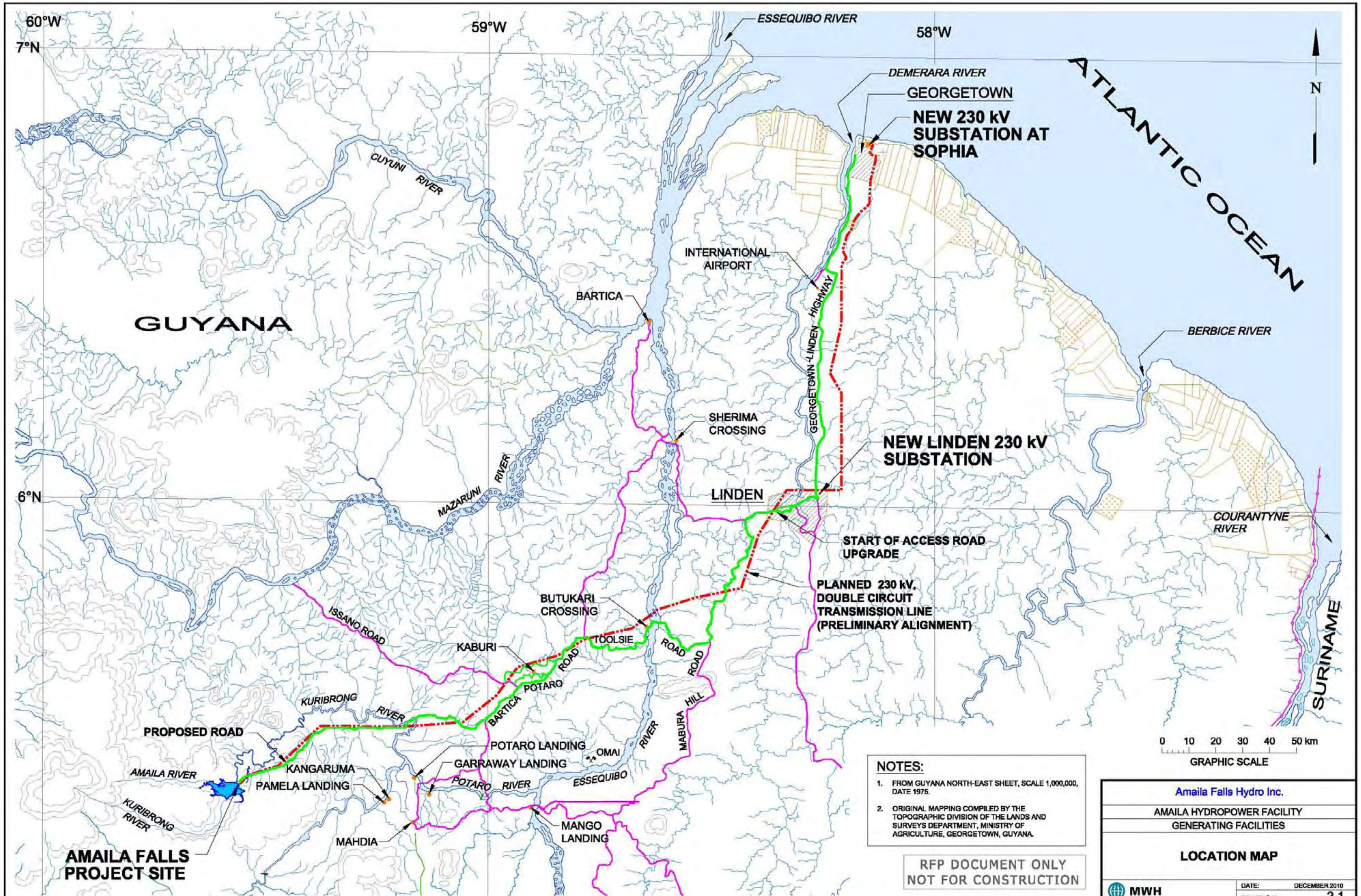


Figure 2.1. Location map

Table 2.1 presents a summary of the major characteristics of the Project as currently designed. Elevations are provided in meters above mean sea level unless otherwise noted. These Project details will be reviewed and updated, if necessary, during final design by the EPC Contractor.

Table 2.1. Summary of Project characteristics[1]

General	
Project Location	The confluence of Amaila and Kuribrong Rivers
Coordinates (at Powerhouse location)	Lat/Long: 5° 23' 42" N 59° 33' 58" W UTM: 21 Northing - 596912 Easting - 219300
Site Elevation	Powerhouse – 77.5 m, above mean sea level (amsl) Reservoir Full Supply Level (FSL) 431.55 m, amsl
Hydrology	
Watershed Area (Drainage Area) upstream of dam	623 km^2
Combined Amaila + Kuribrong River Flows[2]	
Mean Monthly Flow	64 m^3/s
Average Monthly Maximum for a Given Year	151.25 m^3/s
Average Monthly Minimum in a Given Year	14.84 m^3/s
Record Monthly Maximum Flow	210.13 m^3/s
Record Monthly Minimum Flow (for entire 41-year period of record)	4.48 m^3/s
Maximum Flood (Amaila and Kuribrong basins)	
25-yr	1,339 m^3/s
50-yr	1,486 m^3/s
Probable Maximum Flood	
Peak Flow	5,010 m^3/s
Volume	314 mcm
Routed Outflow	2,034 m^3/s
Estimated Annual Sediment Inflow	0.165 mcm
Estimated Annual Net Evaporation	630 mm
Hydropower Facility	
Reservoir	
Minimum operating level (MOL)	425.0 m, amsl
Full supply level (FSL)	431.55 m, amsl
Maximum flood surcharge level	434.35 m, amsl

1 Characteristic Values are approximate, preliminary, and subject to final design reviews.

2 Based on MWH analysis (transposing) of 41-year historical hydrological data in Potaro River.

Reservoir volume at FSL (gross storage)	135.6 mcm
Reservoir perimeter at FSL	59.6 km
Reservoir area at FSL	23.3 km^2
Existing river channel area (already inundated)	1.5 km^2
Net increase in flooded area at FSL	21.8 km^2
Length as measured by Amaila channel	12 km
Length as measured by Kuribrong channel	7 km
Net active storage (FSL – MOL)	101.3 mcm
Average depth	5.8 m
Maximum depth	25.3 m
Filling time to FSL (mean monthly inflow of 64 m^3/s, assuming reservoir is empty at the start)	24 days
Filling time to MOL (mean monthly inflow of 64 m^3/s, assuming reservoir is empty at the start)	6 days
Net Storage Time	
At nominal 50 cms full output (assuming rated flow, no inflow, no evaporation)	80 days
Dams	
Construction Type	Concrete–faced, rock filled
Crest Elevation	435.05 m, amsl
Max Dam Height (above original ground surface)	18.25 m
Dam Crest Width	8 m
Main Dam Centerline Length (Amaila & Kuribrong)	2,460 m
Spillway	
Type	Ungated overflow
Spillway Crest Level	431.55 m, amsl
Spillway Capacity	2,034 m^3/s
Spillway Length	236 m
Intake & Headrace Tunnel	
Construction Type	Concrete for intake, concrete or shotcrete for headrace tunnel depending on rock conditions
Intake Invert - Elevation	418 m, amsl
Length & Height of Intake	11 m width by 8 m high
Effective Face Area	66 m^2
Design Flow at 165 MW at FSL	50.4 m^3/s
Headrace Tunnel Diameter and Length	4.0 or 4.6 m diameter depending on rock conditions, 1,603 m length
Headrace Tunnel Max velocity at 165 MW	3.6 m/s
Surge and Power Shaft	
Lining	Concrete
Inside Diameter	3.4 m
Height	314.4 m
Power Tunnel	
Construction Type	Concrete, steel-lined concrete
Inside Diameter	3.40 m for concrete, 3.10 m for steel-lined concrete
Top Invert (Elevation at Exit from Shaft)	81.25 m, amsl
Bottom Invert (at Entry to Powerhouse)	63.40 m, amsl
Length	1,231 m

Powerhouse (165 MW at FSL)	
Number & Type of Units	4
Gross MW per Unit	41.25 MW
Total Gross Output at Generator Bus Bar	165 MW
Design Flow per Unit	12.6 m^3/s
Tailrace	
Gross Head at FSL	364.4 m
Nominal operating tailrace level (full load) *(typically vary less than 1 m)*	67.2 m, amsl
Minimum downstream tailrace level (at 0 m^3/s assumed flow)	66.4 m, amsl
Extreme maximum operating downstream tailrace level (based on spill flow of 2,034 m^3/s during Probable Maximum Flood)	75.6 m, amsl
Electrical Interconnect	
Substations	Linden, Sophia (Georgetown)
Voltage	230 kV / 69kV
Length	170 km, Amaila to Linden 100 km, Linden to Sophia
Corridor width	Amaila - Linden: 100 m +25m each side selective clearing Linden - Sophia: varies, typically 100 m
Tower construction type	Steel lattice
Number of Circuits	Two (i.e., dual circuits on single tower)
Conductor type	853.7 KCMIL 18/19
Tower height	36 m
Tower arm width	23 m
Conductor minimum height above ground	9 m
Access Roads	
Length of two new roads	85 km (67 km and 18 km)
Length of upgrade roads	122 km
Road Width	5-7 m
Road Corridor width	20−30 m (portions of which will be within the transmission line corridor)
Alignment	As shown on mapping
Design vehicle loading	100 tonnes
Design Speed	50 km/hr
Sight distance	60 m
Preferred max slope	10%
Two (2) Kuribrong Bridges	Steel framed

The hydropower site has been studied over the years, including characterization of the topography for the purpose of preparing drawings showing the physical layout of proposed structures and for evaluation of other factors. Data related to the topographic characterization of the site includes: national 1:50,000 scale printed topographic maps prepared in the 1950s and 1960s; printed topographic surveying and maps contained in screening study reports prepared by Monenco in the mid 1970s; topographic surveying performed by the Sponsor in 2001 as part of feasibility studies; and further topographic surveying performed by the Company in 2009.

The 2001 surveying by the Sponsor was done for feasibility study, and included the area of the dam, waterway and penstock (it did not cover the reservoir). There were no nearby survey benchmarks or control points from which elevations with respect to the national survey datum could be established. Therefore, a local benchmark was established at the powerhouse location, and was assigned an estimated elevation of 100 m above mean sea level. The estimate was based on inspection of available 1:50,000 scale maps in the survey area. All 2001 surveying and elevations at the site were defined with reference to this benchmark.

The most recent 2009 topographic survey covered the reservoir, dam, waterway and powerhouse areas, and was prepared to support the basic design of the project. During the 2009 survey work, the site elevation benchmark reference was confirmed and linked to the national benchmark and mean sea level using high-precision GPS equipment. The 2009 survey determined that the reference benchmark for the 2001 survey was located to be at about elevation 69.5 m amsl, and not 100 m as assumed. The planned site arrangement and features based on 2001 feasibility-level mapping did not change appreciably when overlaid onto the new 2009 topographic model, however revising the benchmark from 100 m AMSL to 69.5m amsl caused the stated elevations of project features as shown on feasibility study drawings and tables to change by approximately 30.5 meters. The site elevation at the powerhouse stated in Table 2.1 is based on the corrected site benchmark elevation.

For clarity it should be noted that drawings and maps produced prior to the August 2009 survey are based on the old assumed site elevation benchmark. Unless revised for other reasons, the old drawings remain valid except for the change in benchmark elevation.

2.1 Hydropower Facility

2.1.1 Hydropower Facility Components

The primary components of the Hydropower Facility are a dam, which creates a water reservoir (or lake), and a powerhouse, which uses the water to create electricity. The reservoir will be created by an earth and rock-filled dam. Water flow from the Amaila and Kuribrong Rivers will fill and replenish the reservoir, while the hydropower plant will draw water from the reservoir to generate electricity for delivery to the GPL grid. Water for power generation will be drawn through a designed intake structure and carried in a tunnel and a penstock to the powerhouse located at the bottom of the escarpment.

The main features of the Hydropower Facility will consist of (see Figure 2.2 and Figure 2.3):

- Dam about 2.5 km long, crossing the Kuribrong River and Amaila River with a ridge dam between
- Reservoir of approximately 23.3 km^2 in area
- Controlled water intake structure (with trash racks)
- Headrace tunnel, power shaft, surge shaft, and power tunnel
- Ungated overflow spillway located in the Amaila section of the dam

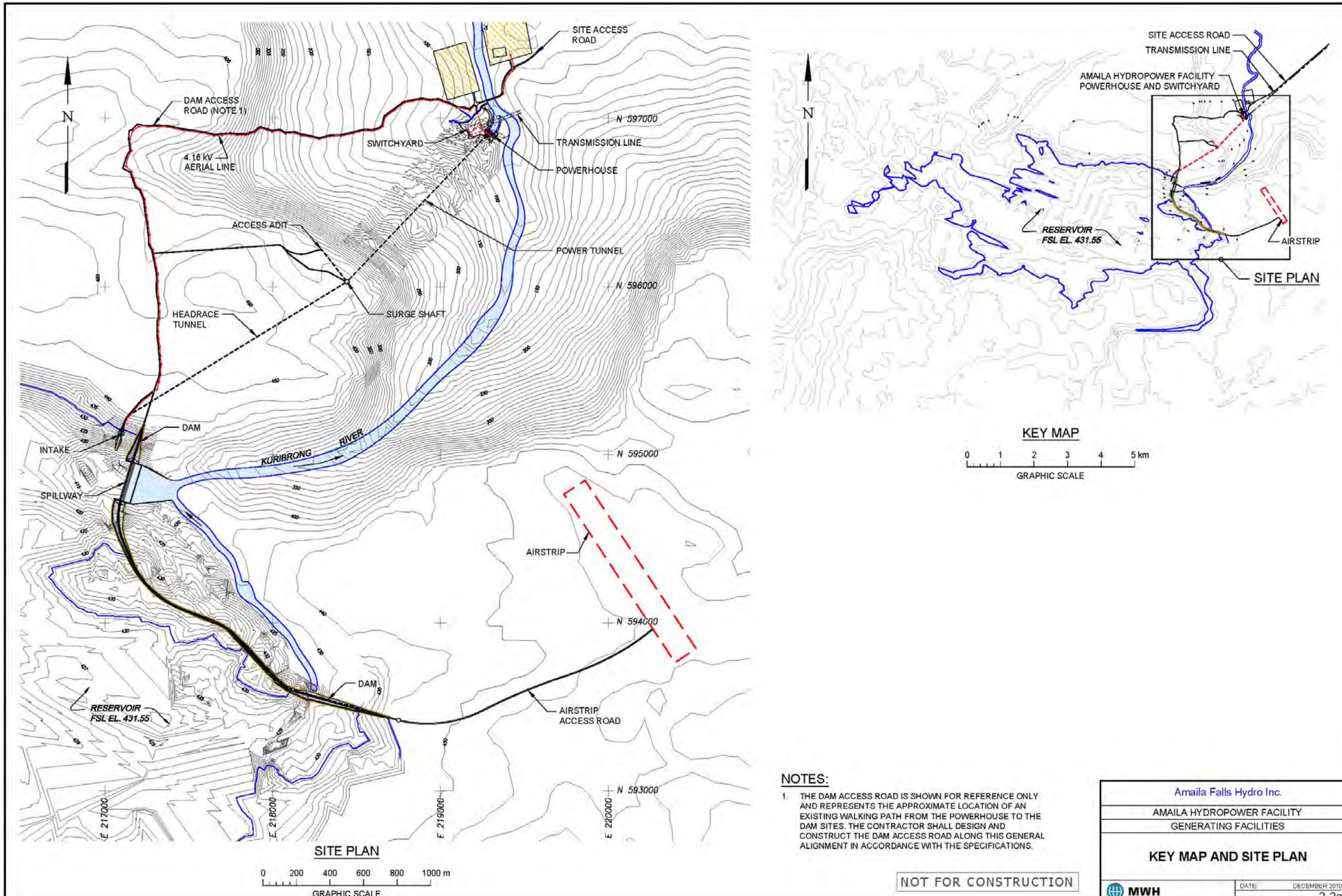


Figure 2.2. Key map and site plan

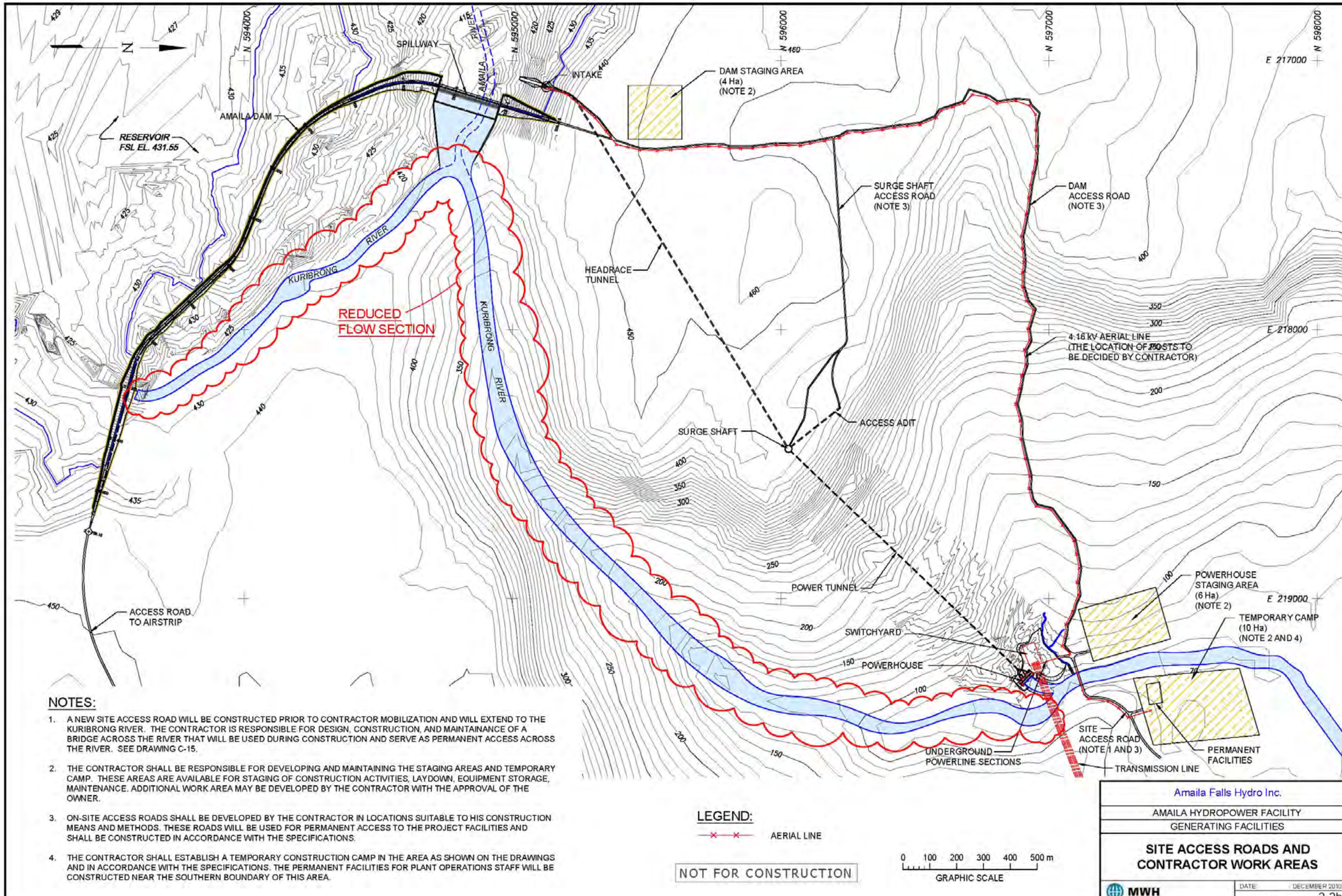


Figure 2.3. Site access roads and contractor work areas

- Gated low-level water outlet
- Powerhouse and turbine generators
- Electrical switchyard and substation located adjacent to the powerhouse
- Emergency diesel generators (about 1 MW) to provide emergency power
- One backup Pelton hydroelectric turbine generator (less than about 1 MW)
- Onsite access roads required for operation and maintenance
- Security and surveillance systems, fencing of selected areas, and site communications
- Ancillary systems and equipment as needed to operate and maintain the hydropower facility
- Offices, maintenance shop, warehouse, staff living quarters, and other onsite facilities.

An estimate of the permanently disturbed areas for the hydropower facility features is presented in Table 2.2.

Table 2.2. Estimated area for permanent features (excluding reservoir)

Area	Hectares
Powerhouse and Switchyard Area	10
Dams	38
Misc (staging, source/disposal, etc.)	10
Airstrip	25
Service Roads	14
Total Permanent Areas	97

2.1.1.1 Dam

The Hydropower Facility includes a main dam to be constructed upstream of the confluence of the Amaila and Kuribrong Rivers. As shown in Figure 2.4., the main dam will span the Kuribrong and Amaila Rivers, as well as an area between the two rivers. The Project will also include a saddle dam located off the left bank of the Amaila River. The dams will be concrete-faced rockfill structures, with grout curtains to ensure water containment in the reservoir. The crest of the dam will be about 8 m wide. A cross-section of the main dam is provided in Figure 2.5.

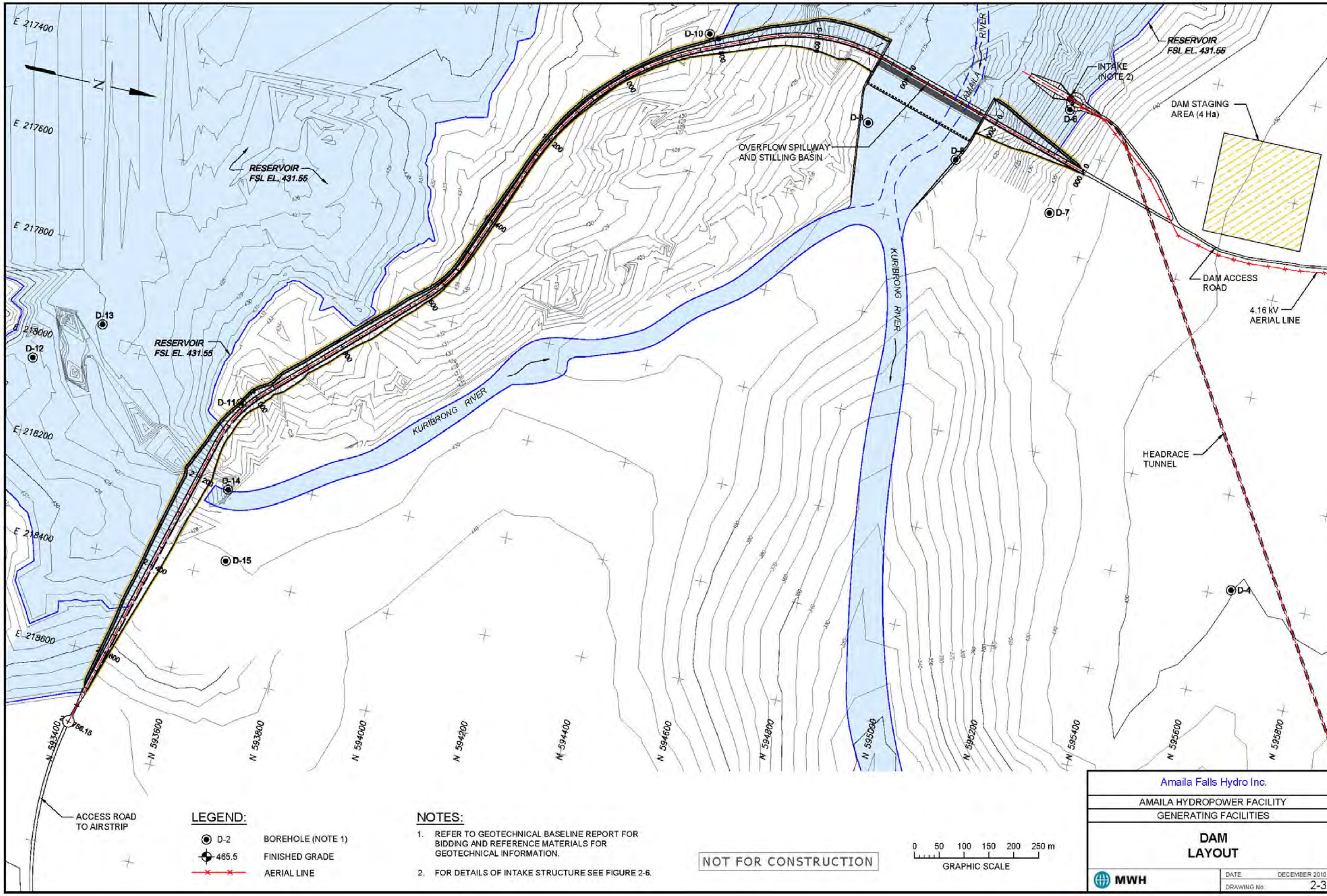


Figure 2.4. Dam layout

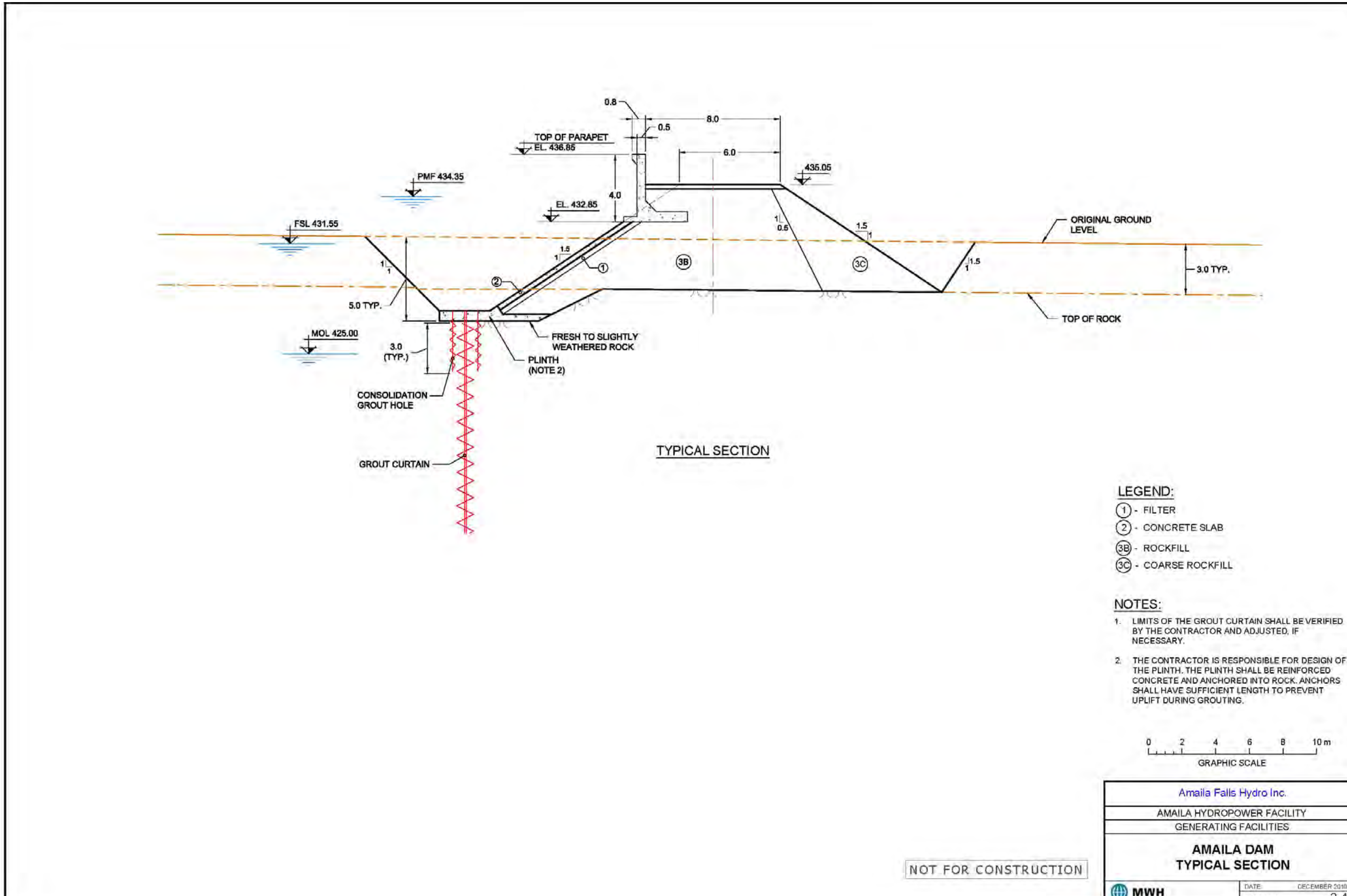


Figure 2.5. Amaila Dam, typical section

The main dam will be constructed of rockfill with an upstream and downstream face slope of about 1V:1.5H (to be verified during detailed design). Foundation treatment will be defined based on further geotechnical studies, but is expected to include a grout curtain cut-off.

A paved vehicular service way with turning areas will be provided over the dam crest. The service way will be unimpaired by operating gantries, instrumentation access points, and all other facilities associated with the operation and maintenance of the Project.

Suitable freeboard values will be adopted in the detailed design phase based on the type of dam construction and considerations of settlement, wave height, wave run up, and extreme flood conditions.

Instrument houses, gallery access points, electrical installations, and all similar operational facilities will be vandal-proof and fully secured against unauthorized access.

Modern, low-maintenance instrumentation systems will be installed to monitor foundation and embankment-fill pore pressures, seepage system outflows, embankment fill and crest deformations, and joint movements.

The design and construction of the Hydropower Facility will be in accordance with internationally recognized standards of practice, including applicable standards of: ASTM (American Society for Testing and Materials), ISO (International Organization for Standardization), DIN (German Code), BS (British Standard), SS (Swedish Standard), EN (European Standard), IEEE (Institute of Electrical and Electronics Engineers), NEMA (Standards, the National Electrical Manufacturers Association), ANSI (American National Standards Institute), or similar recognized standards including accepted Chinese standards as evaluated by the Company during the final engineering phase. These standards and others specified in the construction specifications are intended to ensure (among other things) the safety of the constructed Hydropower Facility, including the dam.

2.1.1.2 Dam Stability

In terms of safety and stability, the dam design will be in accordance with international standards, including stability against sliding on any plane of weakness within the foundation, and against overturning under extreme loading, foundation pressures, flotation, and other design factors as appropriate. The Hydropower Facility design will undergo a rigorous engineering review process by the EPC Contractor and the Company to ensure dam safety. The Company will also establish a Dam Safety Panel to review the design and safety standards of the dam.

The design and construction of the dams will incorporate features to ensure that the dams' stability is maintained under all operating scenarios and environmental conditions. The embankment slopes will be designed to remain stable under all probable conditions of construction and reservoir operation, and seismic loading. The final design and geometry of the dam will consider the prevailing foundation conditions to achieve acceptable safety factors.

Concrete structures will be designed for all loads likely to be encountered during construction and operation. Design assumptions will be based on the applicable provisions of the current international engineering manuals and standards. Loading conditions will be evaluated using appropriate safety factors, and will include normal long-term cyclical and baseload operating loading, as well as exceptional unusual loading.

2.1.1.3 Reservoir

The dam at the confluence of the Amaila and Kuribrong rivers will create a reservoir for storing water to use in generating electricity. A saddle dam or dams may be required to contain the reservoir at possible low spots along its perimeter. Figure 2.2 shows the proposed reservoir. The inundated area will be primarily a contiguous reservoir, with the exception of a few small islands, which may be eliminated depending on the final selection of the onsite quarry areas. The reservoir surface area at FSL will be approximately 23 km^2, and when the reservoir is at MOL (425 amsl) the surface area would be approximately 8.4 km^2.

Based on full output from the powerhouse, the active volume will provide about an average of 23 days storage based on full output assuming zero inflow. This storage will be critical during very dry seasons when river flow into the reservoir is lowest. The main features of the reservoir are described in Table 2.1.

2.1.1.4 Spillway

The spillway will be a concrete ungated spillway incorporated into the structure of the main dam. The spillway will be located on the Amaila section of the dam and will safely discharge overflow water when the reservoir level reaches the maximum elevation of 431.5 amsl (see Figure 2.6). Water flowing over the spillway will continue to the falls and down the reduced-flow segment to join with the powerhouse tailrace, where the Kuribrong River will continue downstream.

The spillway will also incorporate a low-level outlet feature to pass water to the reduced-flow section and down the falls during periods when there is no water otherwise flowing over the spillway. The low-level outlet will likely be in the form of a pipe with a trash screen at its inlet, a discharge valve at its outlet, and a guard valve just upstream of the discharge valve to allow for maintenance of the discharge valve. The low-level outlet will be designed to pass a Minimum Environmental Flow (MEF) of approximately 1 m/s^3. The MEF was established, in part, after the analysis of alternatives, which contemplated the historical hydrological series, the potential impacts on biodiversity downstream of the dam (including both the plant species in the mist zone and the fish species in the reduced-flow segment, according to preliminary identifications during the field campaign), and cost analysis to be borne by rate payers and/or GoG for maintaining a MEF. Further analysis will be performed by the Company to confirm the MEF. Prior to operation of the facility, the Company will develop an operating plan for how the MEF feature will be operated and/or controlled, and under which conditions the MEF should operate.

Suitable prominent warning signs will be provided both upstream and downstream of the spillway. A powerful electric horn may be provided to give an audible warning that spillway discharge is about to commence.

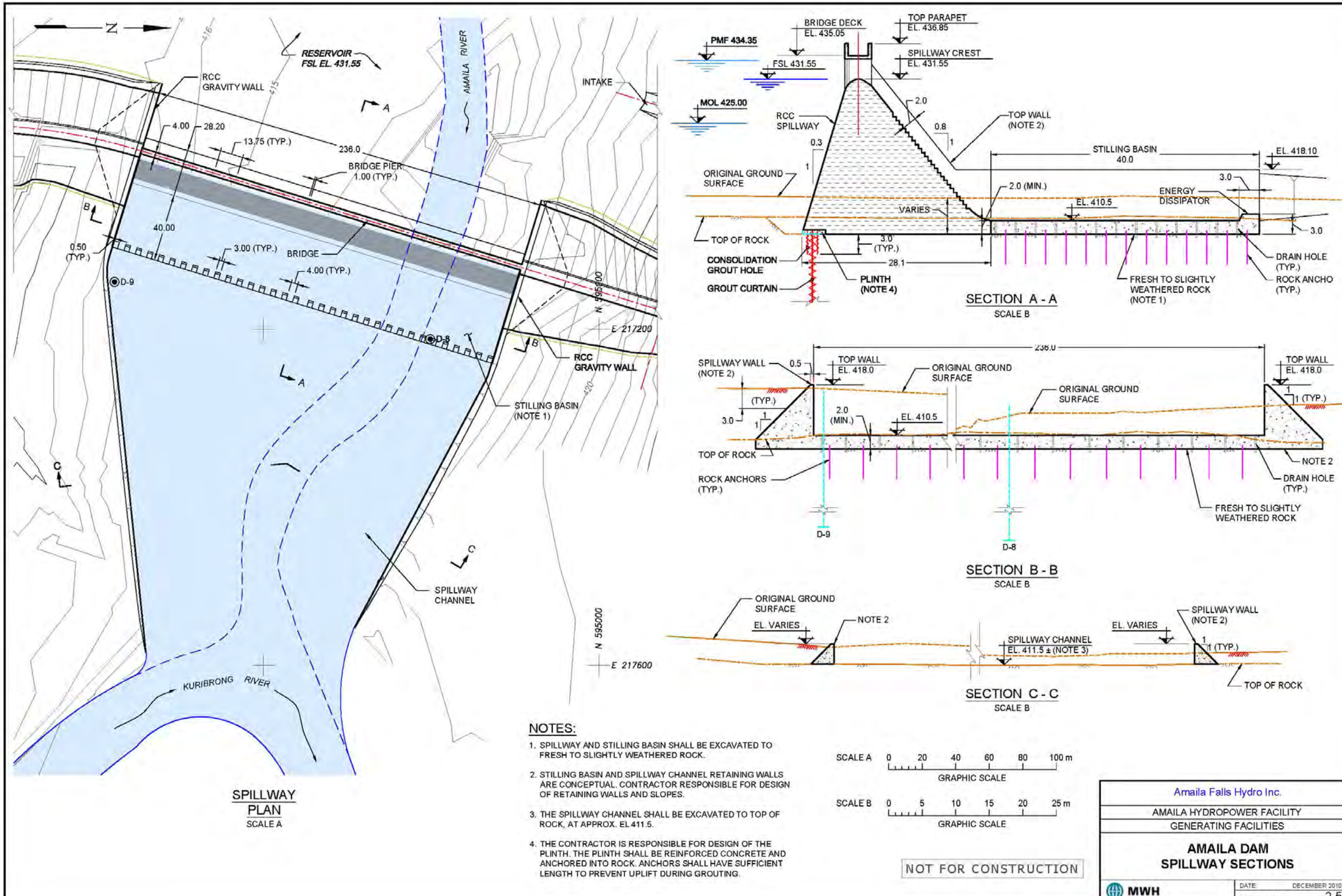


Figure 2.6 Amaila Dam, Spillway sections

2.1.1.5 Reduced-Flow Segment

The main dam and water conduit system will divert water from the reservoir to the powerhouse turbines. After flowing through the turbines, the water will discharge from the powerhouse and into the Kuribrong River via a tailrace channel. The dam and water conduit system will essentially bypass a section of the river and falls area consisting of the area of the Kuribrong and Amaila Rivers above the falls, the falls section itself, and the short area of the Kuribrong River from the bottom of the falls to the powerhouse and tailrace (see Figure 2.3).

The reduced-flow segment will have a total length of approximately 5.7 km. The dam on the Kuribrong River dam will not have a spillway gate and thus no spill water release between the dam and the confluence with the Amaila River. The flow in this segment of approximately 1.6 km will be limited to the contributions from a small tributary on the right margin of the Kuribrong River and direct rainfall runoff into the river. The Amaila River will have a reduced-flow segment of approximately 500 m located between the dam and the confluence with the Kuribrong River just prior to Amaila Falls. The reduced-flow segment on the Kuribrong River from the falls to the powerhouse will be approximately 3.6 km long. The residual flows will vary throughout the year depending on the reservoir-operating regime (see Section 2.1.3.2).

During the wet season after the reservoir fills to the full supply level (FSL), water from the reservoir will spill over the spillway and down the reduced-flow segment. The flow will vary based on the hydrology of the seasons and the reservoir water level.

2.1.1.6 Water Intake and Conduit

Water from the reservoir will be delivered to the turbine generators via a water intake structure and conduit system, consisting of a headrace tunnel, vertical shaft, and power tunnel. The water intake will be located near the left side of the Amaila dam section and spillway. As shown in Figure 2.7, the water intake will be a single submerged, open-faced intake about 11 m wide by 8 m high. The intake will remain submerged and be capable of operating over the full range of reservoir levels and turbine discharges without hydraulic instability or vortex formation. Adequate submergence will be maintained to prevent air being drawn into the water flow or floating trash being drawn against the screens from the water surface. Trash racks will be installed at the water intake. The water intake will include a gate operated by an electrical hydraulic system with backup power supply, and it will also be capable of being fully opened by independent means. It will incorporate provisions for installation of upstream stoplogs for future maintenance.

The water intake will be connected to the headrace tunnel. The underground headrace tunnel will be concrete lined and will slope gently toward the edge of the escarpment to connect to the vertical surge/power shaft. The power shaft will drop about 240 m vertically within the escarpment to deliver water to the power tunnel located under the escarpment. The surge shaft will be located on top of the power shaft, to provide a surge buffer, ensuring smooth operation during changes in operation of the water conduit system. The surge shaft will extend to above ground.

The power tunnel will be a concrete tunnel with a steel lining, extending approximately 1,200 m to the powerhouse. The power tunnel will split its flow into one penstock for each turbine. A small runner pipe will deliver water to the backup power Pelton hydro unit, also located within the powerhouse. The schematic profile of the headrace, surge shaft, and penstock, or power conduit, is shown in Figure 2.8.

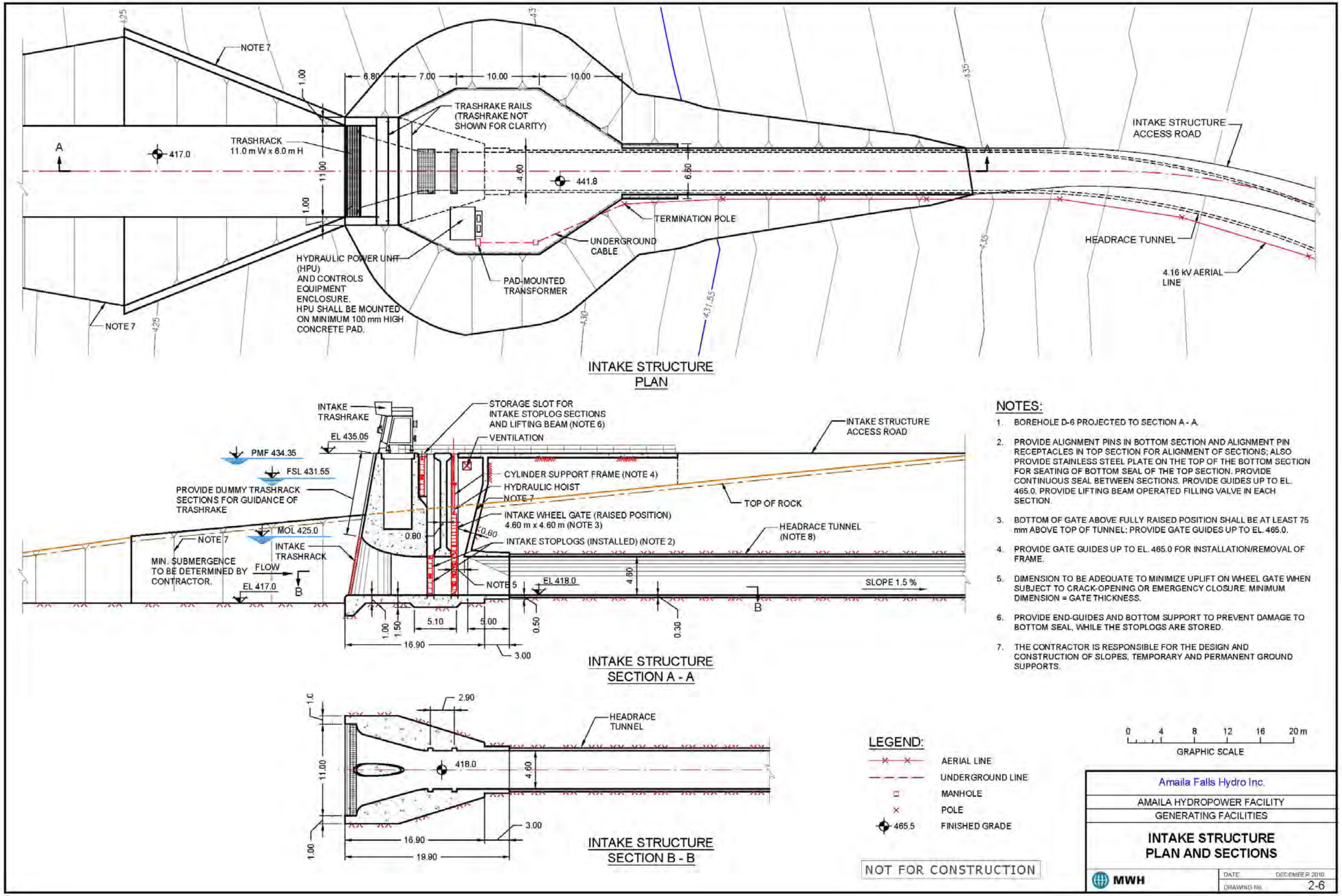


Figure 2.7. Intake structure plan and sections

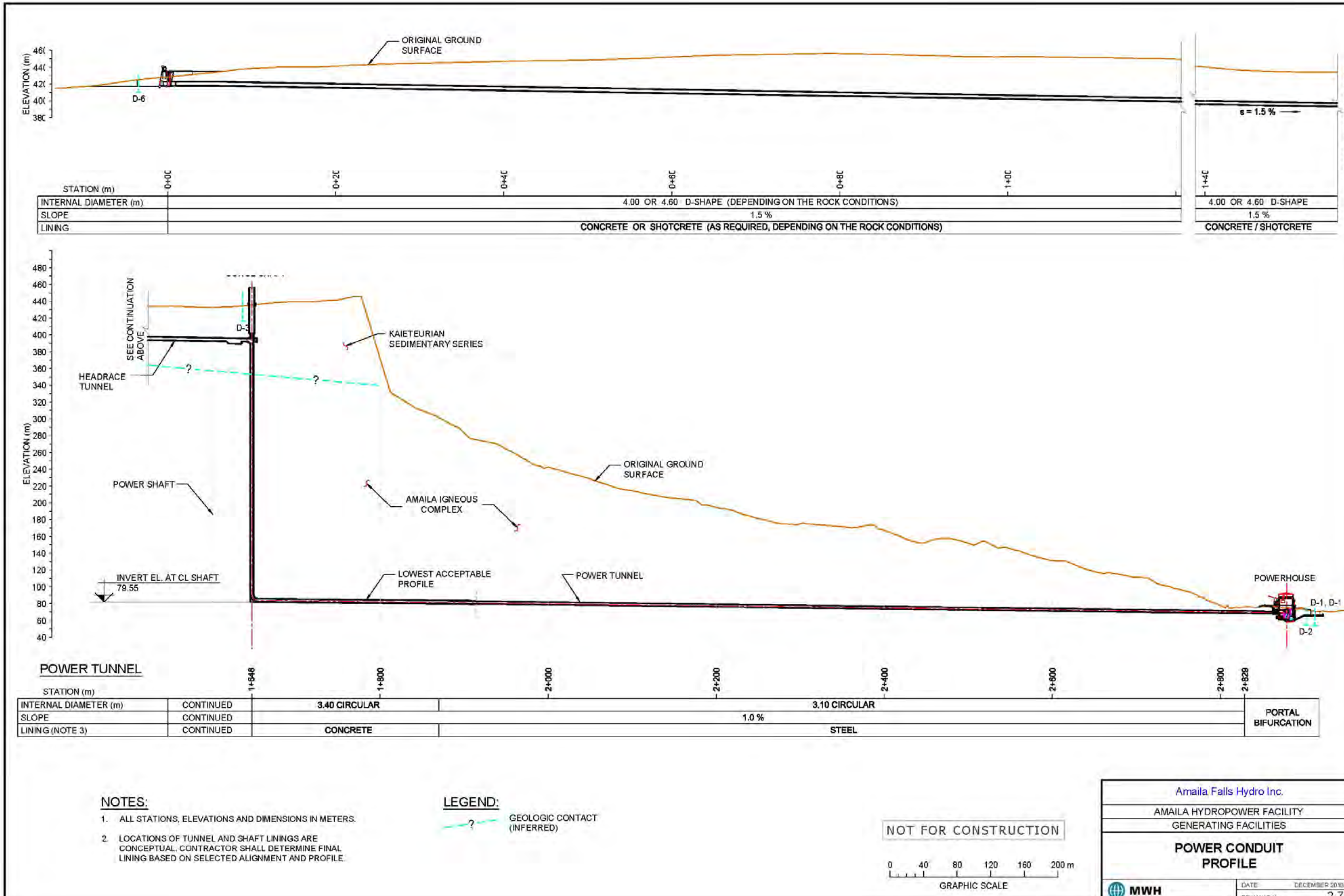


Figure 2.8. Power conduit profile

2.1.1.7 Powerhouse and Tailrace Channel

The powerhouse will house four Francis-type hydro-turbine generators and other ancillary systems required to operate and maintain the facility (see Figure 2.9 and Figure 2.10). The powerhouse will be located at the bottom of the Amaila Falls escarpment, approximately 3 km from the water intake (edge of the reservoir). The main electrical substation and switchyard will be located adjacent to the powerhouse, and the main access road and the transmission line will terminate at the powerhouse. The main access to the site will be from the Access Road, then a site access/service road will be constructed including a bridge across the Kuribrong to the powerhouse.

Each of the turbine generators (air cooled) will have a transformer and then connect to the switchyard bus in groups of two.

Access will be provided for maintenance and repair of the facility, and for all essential services and components that may require frequent attention. A service and unloading bay, with overhead cranes, will be provided and will have sufficient space to permit the laydown, disassembly, and working space for the overhaul and refurbishment of equipment.

The transformers will each be located in a dedicated bay, suitably separated by distance and/or blast walls as needed to prevent the spread of fire. Each transformer will be mounted within a suitable bermed area capable of containing the entire contents of the oil in each unit. All drains from potentially oily areas will be valved and routed through a suitably sized oil separation tank(s).

The powerhouse will include a control room with a digital control system, administration offices, washroom facilities, kitchen and dining areas, electrical rooms including communications equipment, switchgear, motor controls, batteries, protections and relays, etc.

The tailrace channel will be excavated to sound rock, and rip rap of suitable size will be placed to protect the tailrace from erosion. Appropriate signage and site security will be provided to prohibit unauthorized access on site and near the reservoir intake, spillway, and tailrace.

2.1.1.8 Permanent Site Services and Ancillary Areas

Various permanent site services will be established for use during the operational phase of the Hydropower Facility, some of which will be from the construction phase (see Section 2.1.2.4 for Services for Construction). Workshops and stores facilities will be provided with the following features:

- A workshop with open floor areas and overhead traveling crane. The workshop will have a large, secure bay door suitable for truck access.
- A tool shop with adequate open space, storage facilities, and staff work centers/offices as needed.

A secure stores area with an open floor area and necessary shelving units, cabinets, racking units, and storage space for routine operation of the facility.

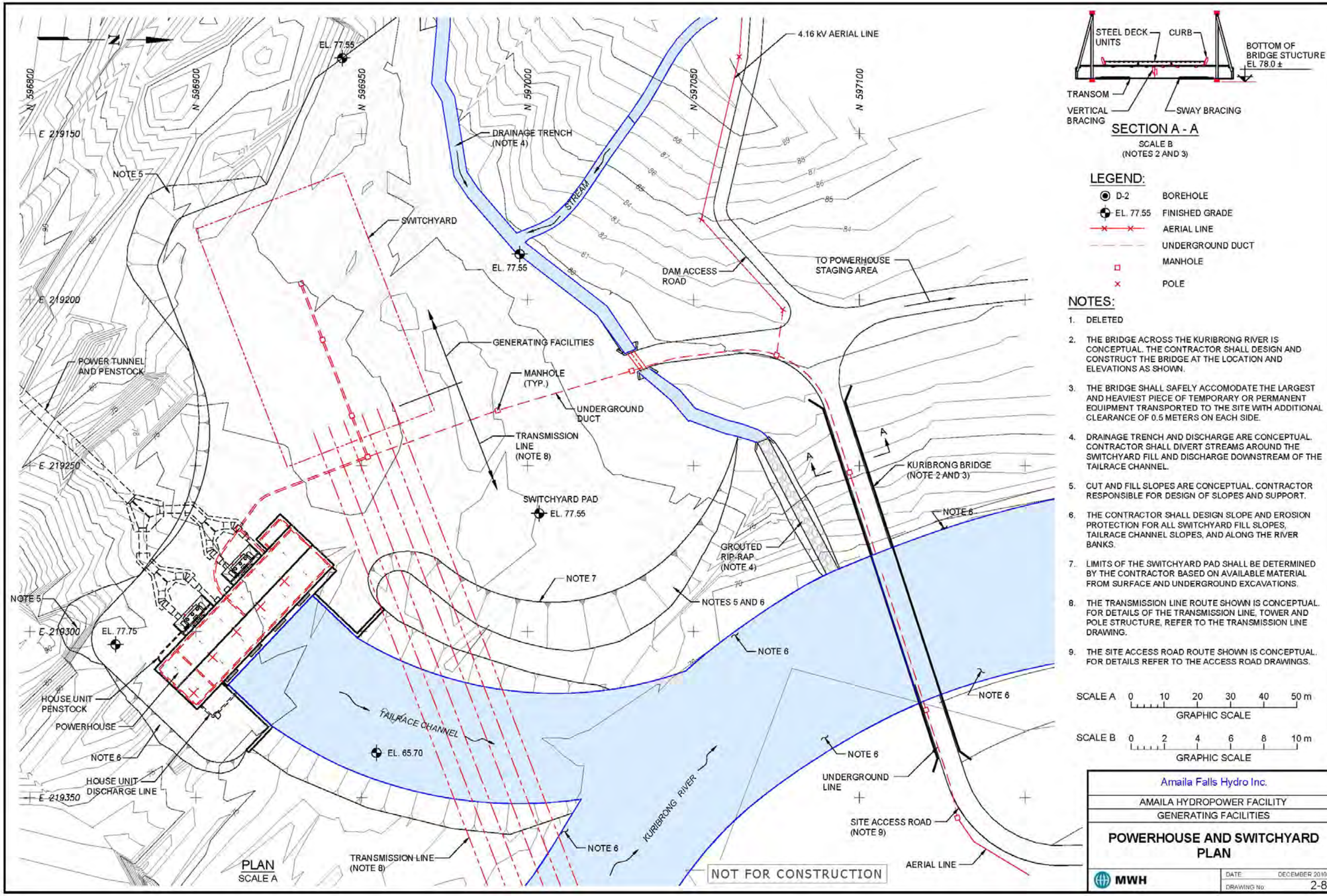


Figure 2.9. Powerhouse and switchyard plan

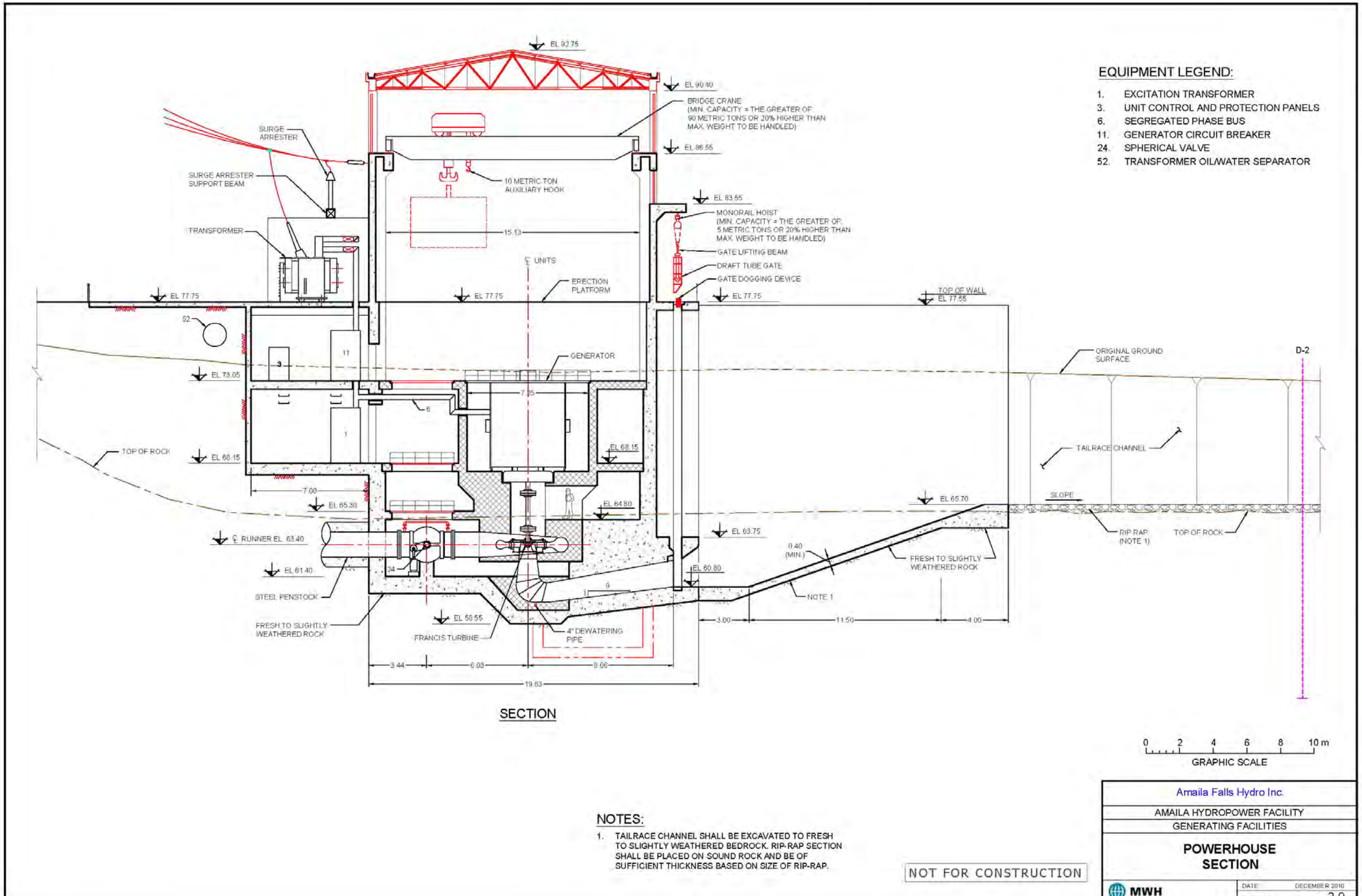


Figure 2.10. Powerhouse section

- A flammable materials stores area for the containment of volatile materials, including paint, acetylene bottles, etc., will be appropriately located away from plant electrical equipment and hazardous areas.
- Showers, toilets, locker room, and mess facilities as needed.

A water treatment plant will provide treated hot and cold water to the living quarters, powerhouse, workshop, and stores washrooms, dining, and kitchen facilities. Potable water will be treated to meet applicable Project environmental standards (see Section 3.6). Service water may be provided to other site services, such as equipment cooling water, heating, ventilating, air conditioning (HVAC), and other powerhouse systems. Water for the main lube oil/water cooling exchangers (about 0.19 m^3/s or 3,000 gpm) will likely be drawn from the discharge of the hydro turbine water circuit and discharged via the tailrace.

A permanent sewage disposal system will be provided to treat all sewage produced by the site installations. The system will be sized and designed to appropriate Guyana regulations and Project environmental standards.

Operation and maintenance work areas will be located within and around the permanent site buildings, primarily near maintenance shops and equipment that requires routine maintenance. Other outside works areas may be located in the following locations where main staging and work activities will occur:

- Left bank of the Amaila River, near the water intake,
- Left bank of the Kuribrong River, near the powerhouse, down from the falls.

Other work areas may be set up depending on the planned operation and maintenance activity.

Lodging for the operation and maintenance crews will be separate from the work areas and located on the right bank of the Kuribrong River, near the future location of a bridge over this river.

The Hydropower Facility, work areas, and lodging areas will rely on the plant auxiliary electrical system to serve the electrical power needs of the general site activities during the operation of the Project. The auxiliary electrical system will normally be supplied by the main hydro turbine generators, but a smaller backup Pelton hydro turbine generator, as well as small diesel gensets, may be used as well, typically during plant outages and black startups.

The powerhouse will have data and voice communication links to the Guyana communications grid for normal voice and data use. The facility control room will also have direct communications links to the GPL Control Center and the remote high-voltage substations at Sophia and Linden. The Hydropower Facility will include an internal onsite communications system to coordinate work throughout the site.

2.1.2 Construction

Construction of the Hydropower Facility will involve establishment of work areas, lodging camps, temporary facilities, plant, and equipment required to complete the works within the scheduled construction period, from receiving a notice to proceed until "substantial completion" of the Hydropower Facility and Electrical Interconnection. Design features are conventional and are not anticipated to require unusual construction methods or complexity.

The Company will continue to work closely with the GoG, local stakeholders, potential Project lenders, and the EPC Contractor in order to advance the planning for Hydropower Facility implementation. Upon finalizing the Project arrangements and securing the necessary funding, Hydropower Facility construction can begin. In the time leading up to the start of construction, The Company and EPC Contractor will begin arranging support services needed for construction, including subcontractors, suppliers, logistic/transport services, and labor recruitment.

The Company and the EPC Contractor will ensure that all requirements of the Project applicable approvals are incorporated into the implementation plans. This will be enforced under the proposed agreement with the EPC Contractor, which requires that all work meet the requirements of all applicable permits, laws, and property owner and lease holder rights.

The design and construction process consists of a number of phases, as follows:

- Detailed design
- Site surveys for design
- Planning, subcontracting, and labor recruitment
- Onsite service/access road construction
- Mobilization and site preparation
- Ongoing engineering, procurement, and transportation
- Works to set up the diversions
- Powerhouse, substation, and tailrace construction
- Dam and spillway construction
- Transmission line clearing and construction
- Remote substation construction
- Reservoir clearing and preparation
- Reservoir inundation
- Project testing and commissioning.

2.1.2.1 Preliminary Works

2.1.2.1.1 Site Surveys

Prior to mobilizing on the hydropower site, the EPC Contractor will conduct additional site surveys that will facilitate the final design.

2.1.2.1.2 Mobilization and Site Preparation

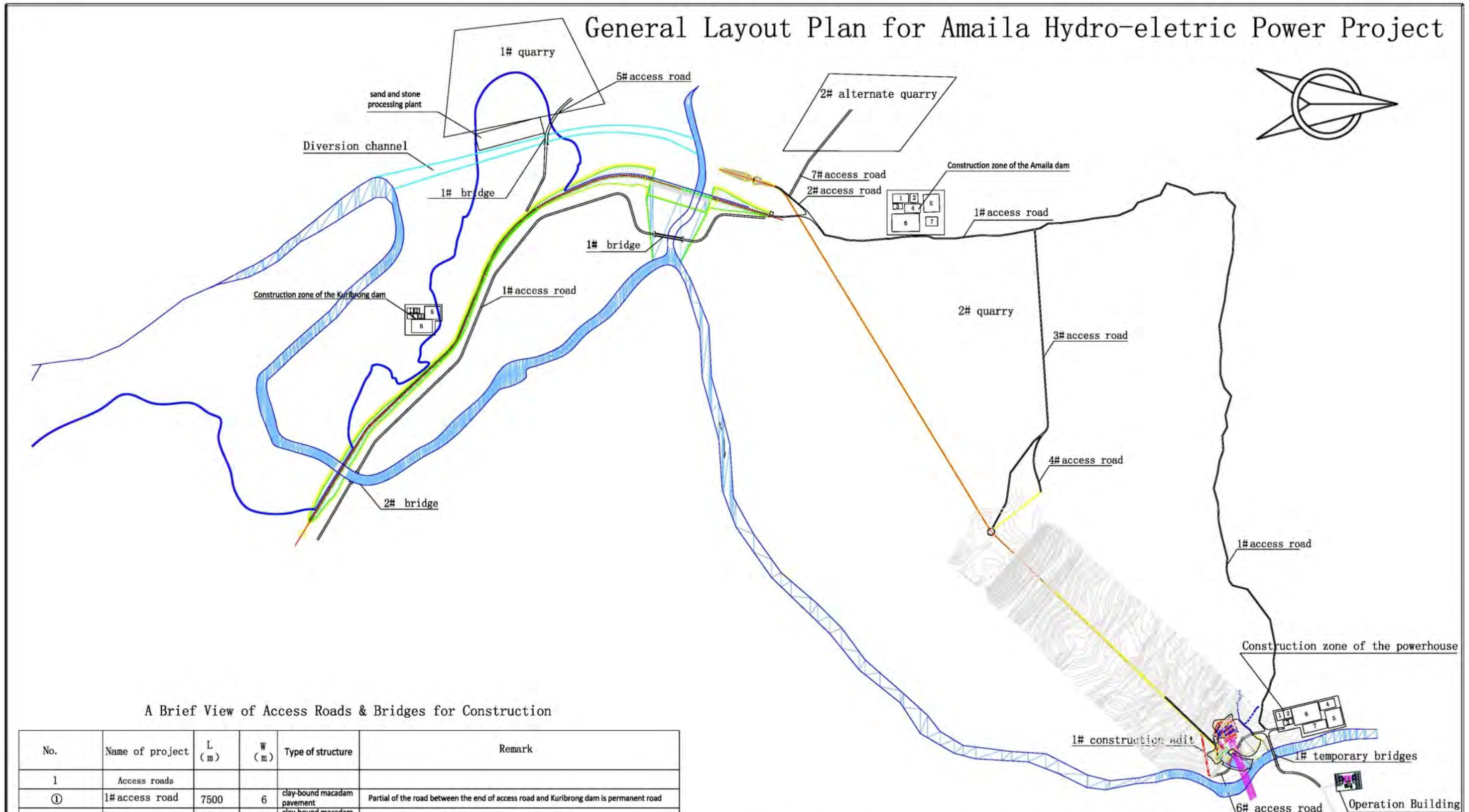
During the mobilization phase, areas of the site to be occupied by temporary works will be cleared and leveled (approximately 115 ha). Figure 2.11 presents a preliminary construction layout plan. An estimate of the area of the temporary construction features is presented in Table 2.3. This process will involve excavation of land above the required level and using the spoil to fill areas below this level. Another site preparation activity will be the installation of a bridge to cross the Kuribrong River at the site, connecting the newly installed Project Access Road to the main work site. Other temporary and permanent service/access roads will be built within the construction site, connecting all necessary works areas. The construction site will be open to pre-authorized visitors but will be closed to the general public.

Table 2.3. Estimated area of temporary construction features

Area	Hectares
Powerhouse work/stage area	19
Amaila Dam work/stage area	18
Kuribrong Dam work/stage area	9
Operation Management	7
Quarries	30
Spoil disposal area	25
Miscellaneous	7
Total Temporary Areas	115

Note: Excludes service roads which are included in the permanent feature areas.

The site preparation works will be preceded by a site grading plan that will identify areas to be re-graded, including stormwater and erosion control measures to be adopted to protect the integrity of the ecosystem (see Section 7 for description of EPC Contractor environmental and social management plan for the construction work).



A Brief View of Access Roads & Bridges for Construction

No.	Name of project	L (m)	W (m)	Type of structure	Remark
1	Access roads				
①	1# access road	7500	6	clay-bound macadam pavement	Partial of the road between the end of access road and Kuribrong dam is permanent road
②	2# access road	200	6	clay-bound macadam pavement	Between 1# access road and the intake is permanent road
③	3# access road	1300	6	clay-bound macadam pavement	Between 1# access road and the surge shaft is permanent road
④	4# access road	260	6	clay-bound macadam pavement	Between 3# access road and the access tunnel of surge shaft is permanent road
⑤	5# access road	2000	6	clay-bound macadam pavement	1# access road to 1# quarry
⑥	6# access road	600	6	clay-bound macadam pavement	Between 1# access road and the 1# adit is permanent road
⑦	7# access road	1000	6	clay-bound macadam pavement	1# access road to 2# quarry
⑧	Other road	1000	6	clay-bound macadam pavement	
	Total	13860			
2	Temporary bridge				
①	1# bridge	60	8		Cross over the Amaila river
②	2# bridge	80	8		Cross over the Kuribrong river
③	3# bridge	50	8		Cross over the diversion open channel

Land Occupation of Construction Auxiliary Facilities

No.	Item	Construction zone of the powerhouse		Construction zone of the Amaila dam		Construction zone of the Kuribrong dam	
		Building area	Occupation area	Building area	Occupation area	Building area	Occupation area
①	Concrete batching system	400	2500	400	3000	200	1000
②	Rebar processing workshop	400	1000	400	1000	200	400
③	Wood processing workshop	400	600	400	600	200	400
④	Equipment parking and maintenance yard	1500	2000	1500	2000	500	800
⑤	warehouse	3000	3500	3000	3500	2000	2500
⑥	Accommodation and office quarter	6000	6500	6000	6500	3000	3500
⑦	Metal processing workshop	2000	2500	1000	1500		
	Total	13700	18600	12700	18100	6100	9100

Note:
1. The dimensions for elevations and stake numbers in this drawing are in meter, the others are in millimeter.
2. All the dimensions for building structures shown herein are based on hydraulic drawings, and for indication only.
3. The 1# adit is 160m long, and will be blocked after the completion of the construction.
4. The gravel processing workshop is located near 1# quarry, occupies 15000m2 of area.

China Railway First Group Co., Ltd			
Amaila Falls HEP		BID	DESIGN
General Layout Plan for Amaila Falls HEP			
Scale	1:10000	Date	2010.07
No.	A—H—C—02		

Figure 2.11. General layout plan for Hydroelectric Facility

2.1.2.2 Construction Support Infrastructure

2.1.2.2.1 Construction Camp

An average of approximately 700 workers are anticipated to work at the Hydropower Facility with a peak of about 1,200 workers. An area will be developed for housing, feeding, and supporting workers during the construction phase. This area is planned for the right side of the Kuribrong River, where a bridge will be constructed. Permanent housing for project operation personnel (approximately 40) will also be established at this location. Only persons working on the site will be allowed access to the lodging areas. The complex will include support facilities, including kitchen, eating area, bathrooms, showers, and recreation area. Communications system (e.g., telephone, etc.) will be provided at the site for workers.

An average of approximately 300 and a peak of about 600 workers are anticipated for the Electrical Interconnection, with these workers being spread along the transmission line route and concentrated at the substations, as the work progresses.

Potable water will be provided by treating water from the Kuribrong or Amaila Rivers, or from underground wells.

2.1.2.2.2 Quarries and Borrow Pits

Quarries and borrow pits will be identified and developed to provide aggregate, rockfill, and sand for construction of the dam embankments, spillway foundation, coffer dams, onsite roads, foundations, and other facilities. An estimated total of about 1,000,000 m^3 of rock fill is needed to construct the dams, for purposes such as concrete production, cofferdams, and onsite access roads. Table 2.4. provides the estimated main quantities for construction.

Table 2.4. Preliminary estimate of excavation and fill

Use	Cubic Meters
Dam Excavation	770,000
Tunnel Excavation	20,000
Fill	1,000,000
Concrete	80,000
RCC	130,000

The rockfill, aggregate, and sand material will be obtained from onsite quarries and borrow pits, the locations of which will be determined by the EPC Contractor during site surveys. Some shallow borrow pits may be located within the reservoir area, preferably near the work sites. To preserve the integrity of the reservoir containment, quarries may be located outside the perimeter of the reservoir, most likely to the left of the Amaila River above the escarpment. Smaller borrow pits and a quarry may also be located below the escarpment to provide material for the powerhouse and substation. Depending on the condition of the excavated rock and material, the spoil material from the tunnel construction may be re-used in the dam areas.

The total area of quarry needed, based on 1 million cubic meters plus 50% contingency and assuming 5 m depth, is about 550 m by 550 m. The area and depth will be determined during construction planning. In order to allow for planning, the area needed for exploring quarry source material may be up to 30 hectares.

Rock will be loosened by drilling and blasting and will then be loaded by front-end loaders into haul trucks for transport to the processing plant. Processing operations will include crushing, screening, and size classification. The feeder or screens will separate large boulders from finer rock that does not require crushing. Jaw, impactor, gyratory crushers, or similar equipment will be used for primary crushing. One or more crusher plants will be required, which will produce aggregates of various grades from the quarries on site. Rock produced from the quarry operations will be stockpiled onsite. The undersized material from the scalping screen on the primary crusher will be fed to a secondary crusher to produce concrete aggregate. Batching plants will also be required for concrete production and for production of filter material for the dam. These facilities will be constructed adjacent to the rock stockpile areas.

Fine sand material will be needed and will be obtained from onsite quarries if available. Fine material may also be generated by the crusher plant. Certain concrete finishes may require importing fine material if onsite material does not meet the specification. The extent of this import will not be known until the concrete mix is tested with aggregates produced on site.

2.1.2.2.3 Disposal of Excavated Material

Material that has to be excavated but is unsuitable for construction purposes will be kept separate from other materials, to prevent contamination of material required for use in the works. Such unwanted material will be disposed of by spreading the material in layers in designated spoil areas, such as the exhausted quarry areas or other areas determined during construction planning. Although some of the excavated material may be reused, it can be assumed for planning purposes that all the excavated material must be spread on spoil areas. Using the values from the table above, adding 50% contingency, and assuming a 5-m height, the total spoils area is estimated to be about 500×500 m.

Permanent spoil areas visible after completion of construction will be shaped to blend with the local topography. Surfaces will be finished and graded to the extent necessary to provide surface drainage, and vegetated to prevent future erosion of the materials.

2.1.2.3 Site Services during Construction

2.1.2.3.1 Electricity

There is no electric power available at the site. The EPC Contractor will install temporary local diesel-powered reciprocating-type generation and site distribution to address the requirements of construction. A peak of up to 3MW of electrical power will be needed during construction. On completion of the construction phase, the EPC Contractor will replace the temporary generators with permanent diesel fuel generators to be used as backup power during operation. The EPC Contractor will assess the possibility of using wood- or biomass-fired generation (i.e., use materials from site clearing).

2.1.2.3.2 Drinking and Service Water

The EPC Contractor will provide all water supplies required during the construction of the plant, including the permanent water supply system. The anticipated water use during construction is as follows:

	Average (m^3/day)	Peak (m^3/day)
Potable use	200	400
Construction use	4,500	6,000

Construction water use may include dust suppression; truck and equipment cleaning; certain equipment cooling; mixing of soil, rock, cement; and other uses. Construction water will likely be drawn from the Kuribrong and/or Amaila Rivers, and potable water will likely be taken from drilled ground water wells. Potable water will be treated through a water treatment system at the site and will be distributed by pipe and pump systems and/or water delivery truck, as appropriate.

2.1.2.3.3 Wastewater and Stormwater

The industrial waste discharge totals are expected to be about 80% of the daily water use, or 3,600 m^3 per day on average. Industrial wastewater will be treated to meet Project environmental standards. Monitoring will be conducted to ensure proper operation and compliance with required standards.

Sanitary wastewater from toilets, kitchen and household sinks, showers, and other sources will be treated through a temporary sanitary wastewater treatment system. Treated wastewater will be discharged via a septic system and leach field, or a treatment lagoon/basin, to the river, in compliance with Guyana regulations and Project environmental standards. Sludge generated in the treatment system will be disposed in a landfill.

Stormwater runoff will be handled via a separate discharge system, designed to handle rain from a storm event as required by the project specifications. In appropriate areas, a first-flush system will be considered. The stormwater collection/handling system will minimize erosion and sedimentation discharges to water courses, streams, rivers, or sensitive ecosystems.

Stormwater collected in bermed hazardous storage areas will be first inspected to confirm acceptable quality to discharge to the stormwater handling system. Unacceptable water will be treated and/or disposed of via truck. Water from oily areas will first be treated thru an oil/water separator prior to discharge/disposal.

2.1.2.3.4 Storage of Hazardous Materials

Fuel for the site generators and site vehicles will be stored in bulk storage tanks (estimated maximum storage quantity of approximately 300 cubic meters). All fuel tank areas will be enclosed by secondary containment capable of storing at least 110% of the capacity of the largest tank for all tanks that are bermed together. Construction vehicles will be refueled by tankers that will collect fuel from a central storage location and distribute it to vehicles around the site. Refueling stations will be located at suitable distances from water bodies or sensitive habitats. Handling of fuels off the hydro site will be managed separately and will include appropriate containment handling and spill response measures.

Other hazardous chemicals like lube oils, paints, sealants, cleaning agents, etc (typically stored in small 55 gallon drums or 2-4 cubic meter tanks) will be stored in appropriate secured covered areas, with secondary containment and proper handling and spill control features. Drains from fuel or hazardous bermed areas will be lock-valved, ensuring only controlled discharge after proper inspection of bermed fluids. All hazardous fluids will be separated from the normal wastewater drainage systems and collected for appropriate recycling or disposal in accordance with Guyanese law and Lender policies. Water from potentially oily areas will first pass through an oil/water separator before being discharged.

Section 7 (ESMP) provides details on hazardous materials management.

The use of explosives will be required to excavate the quarry area, dam foundations, powerhouse foundation, and the water tunnel. There will be a need for explosives use in different capacities for a total of two years. All blasting will be performed using shaped charges and small, controlled blasts. The total quantity of explosive material to be used is estimated to be approximately 300 tonnes. The EPC Contractor will develop an Explosive Material Storage and Use Procedure that will include appropriate measures in compliance with national laws and lender polices. The procedure will include safety and notification procedures to inform people on and off the site.

2.1.2.3.5 Solid Waste Management

Solid waste generated during construction may include packaging materials (e.g., wood, paper, plastic), scrap metal, household and office trash, and oily waste. Other waste material may also include material classified as hazardous waste, such as medical waste, paints, and certain cleaning solutions. Most will be solid waste, although it may also include certain liquids that are unsuitable for discharge through the industrial wastewater system. The estimated solid (and liquid) wastes anticipated to be generated during construction are listed in Table 2.5.

Table 2.5. Estimated waste generated during construction

Type of Waste	Estimated Quantity
Wood, plastics, paper [a]	10 tonnes/month
Scrap metal	5 tonnes/month
Household & office trash	10 tonnes/month
Oily waste [b]	5 tonnes/month
Medical waste	100 kg/month
Liquid waste	5 m3/month

[a] Does not include wood from vegetation clearing nor soil/rock excavations.

[b] Some oily waste may be recycled or reused.

The EPC Contractor will develop a Waste Management Plan (WMP) that describes procedures for handling and disposing of solid waste generated during construction. The WMP may also include a combination of burial and incineration. The EPC Contractor will investigate alternative recycling measures such as recycling centers in Guyana, returning material to suppliers, or recycling material onsite. As appropriate, the WMP will describe waste separation procedures that include recycling. The WMP will also describe measures for handling hazardous waste. See Section 7 for requirements and principal components for waste management.

2.1.2.4 Reservoir Site Preparation

Prior to reservoir filling, the reservoir will need to be cleared of the vegetation within it, which will need to be done according a clearing plan to be developed further by the EPC Contractor. The plan will include temporary road development within the reservoir to access all areas and process the cleared vegetation (see Section 7 for details). Prior to filling of the reservoir, the EPC Contractor will establish a reservoir preparation and filling plan which may include procedures for describing the sequence and stages of filling, identifying the areas that will first flood, procedures for accessing(as needed) required areas of the reservoir, inspecting the reservoir areas to confirm clearance, establishing erosion control measures to avoid unnecessary silting of the main river channels, and other reservoir preparation work. The Company will work closely with rural communities that may periodically access the area to ensure awareness of the changing landscape. During and after inundation, the shoreline of the reservoir will be monitored, and if required, unstable areas will be evaluated to assess if stabilization measures are required. Appropriate signage or other barriers may be considered to warn the public about the area.

2.1.2.5 Engineering, Procurement, and Transportation

Although much of the materials for the civil engineering features of the Hydropower Facility will be generated on site, many mechanical and electrical components will be imported from locations around the world. Cement may also come from sources outside of Guyana to meet the needed quantities (approximately 80,000 cubic meters) and strict specification requirements. The EPC Contractor and the Company will continue to investigate what materials and services can be procured within Guyana.

Equipment and materials that will be procured from outside the immediate region (Brazil, Guyana, etc.) will be shipped to the port of Georgetown and/or transported by barge up the Demerara River to the city of Linden. From there, these supplies will be transported by truck to the site. The Company and EPC Contractor will work closely with the GoG to ensure that material and equipment are processed quickly and cleared through customs, including special customs-clearing areas at Georgetown and Linden dedicated to the Hydropower Facility.

The hydropower site may include an airstrip for landing/takeoff of small passenger and limited cargo planes. The airstrip may be 2500 to 4000 ft long. The preliminary location is on top of the escarpment to right of the Kuribrong River. Construction and operation of the airstrip will be closely coordinated with appropriate GoG ministry procedures.

The construction works will be supported primarily by truck deliveries over the Project Access Roads to the site. Approximately 50–100 vehicle trips may be required per day.

2.1.2.6 Key Construction Procedures

2.1.2.6.1 Vegetation Clearing

Construction-site clearing activities will consist of clearing forested areas to allow access and construction on all temporary and permanent facilities, including along the dam alignment, at locations for diversion structures, at the powerhouse and switchyard, permanent administrative offices and lodging facilities, onsite roads, and temporary construction facilities, quarries, etc. The construction areas will initially be cleared of large trees and underbrush, which will be cleared using conventional methods—chain saws for felling large trees; underbrush cleared by hand cutting; and bulldozers and tractors to remove small trees, tree roots, and stumps, and compile them into appropriate piles for harvesting or controlled burning. Storm water and erosion control procedures will be implemented. See Section 7 for details on vegetation clearing/cutting and storm water and erosion control measures..

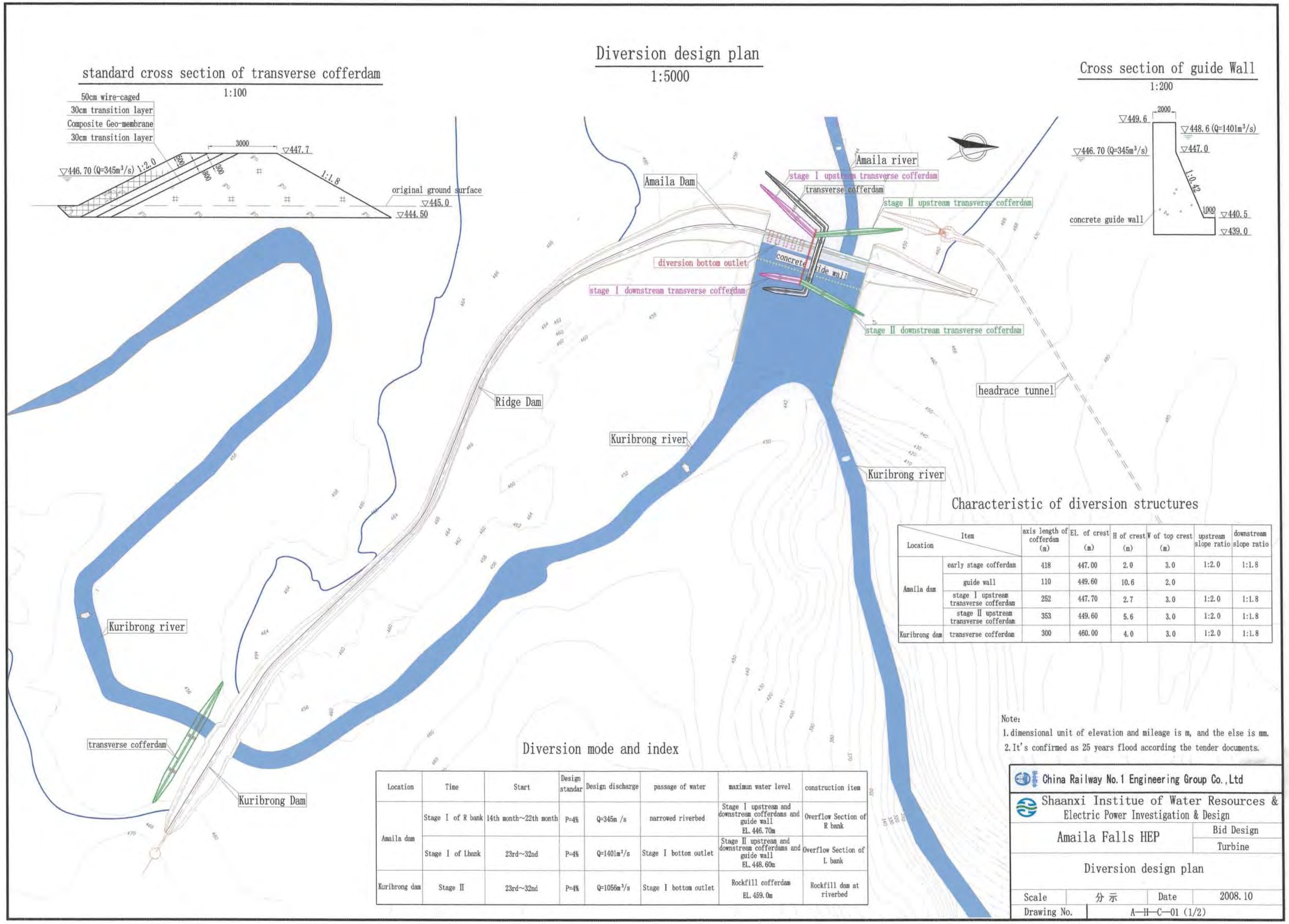
Suitable felled timber will be used for construction purposes on site, including construction of temporary and some permanent facilities, such as living quarters, construction office areas, etc. Other commercial value timber may be harvested for offsite use. Timber and other vegetative material not suitable for use as construction material or commercial use will be stockpiled on site for disposal and burning during construction. Some small brush material may be used for erosion control measures. The majority of the cleared vegetation will be burned in a controlled manner, in accordance with Company-approved procedures. Usable surplus timber will be stockpiled for later use or offsite commercial purposes. The EPC Contractor and Company will explore other uses for the cleared timber, including possible use in villages.

2.1.2.6.2 Diversion Works

The diversion of the Amaila and Kuribrong Rivers will be accomplished by constructing cofferdams at the confluence of the Amaila and Kuribrong Rivers on top of the plateau upstream of the Amaila Falls (see Figure 2.12 and Figure 2.13).

To prevent excess vegetation from being carried downstream, the diversion channel will be cleared prior to construction of each cofferdam. After demarcation of the area, vegetation will be cleared to remove trees and shrubs at ground level. To minimize erosion, digging will be avoided (unless required to provide hydraulic transport within the channel to maintain the root systems and grasses.

The cofferdams will be constructed by placing or tipping boulders and rocks into the river, starting at one river bank and continuing across the river. Large boulders, or if necessary, pre-cast concrete units, will be used to protect against washout as flow velocities progressively increase with the reduction in channel cross-sectional area. After river flow has been controlled, the permeability of the cofferdam may be controlled using an impervious soil blanket and graded material placed on the upstream side to minimize leakage.



Characteristic of diversion structures

Location	Item	axis length of cofferdam (m)	El. of crest (m)	H of crest (m)	W of top crest (m)	upstream slope ratio	downstream slope ratio
Amaila dam	early stage cofferdam	418	447.00	2.0	3.0	1:2.0	1:1.8
	guide wall	110	449.60	10.6	2.0		
	stage Ⅰ upstream transverse cofferdam	252	447.70	2.7	3.0	1:2.0	1:1.8
	stage Ⅱ upstream transverse cofferdam	353	449.60	5.6	3.0	1:2.0	1:1.8
Kuribrong dam	transverse cofferdam	300	460.00	4.0	3.0	1:2.0	1:1.8

Diversion mode and index

Location	Time	Start	Design standar	Design discharge	passage of water	maximun water level	construction item
Amaila dam	Stage Ⅰ of R bank	14th month~22th month	P=4%	Q=345m /s	narrowed riverbed	Stage Ⅰ upstream and downstream cofferdams and guide wall EL.446.70m	Overflow Section of R bank
	Stage Ⅰ of Lbank	23rd~32nd	P=4%	Q=1401m³/s	Stage Ⅰ bottom outlet	Stage Ⅱ upstream and downstream cofferdams and guide wall EL.448.60m	Overflow Section of L bank
Kuribrong dam	Stage Ⅱ	23rd~32nd	P=4%	Q=1056m³/s	Stage Ⅰ bottom outlet	Rockfill cofferdam EL.459.0m	Rockfill dam at riverbed

Figure 2.12. Diversion design plan

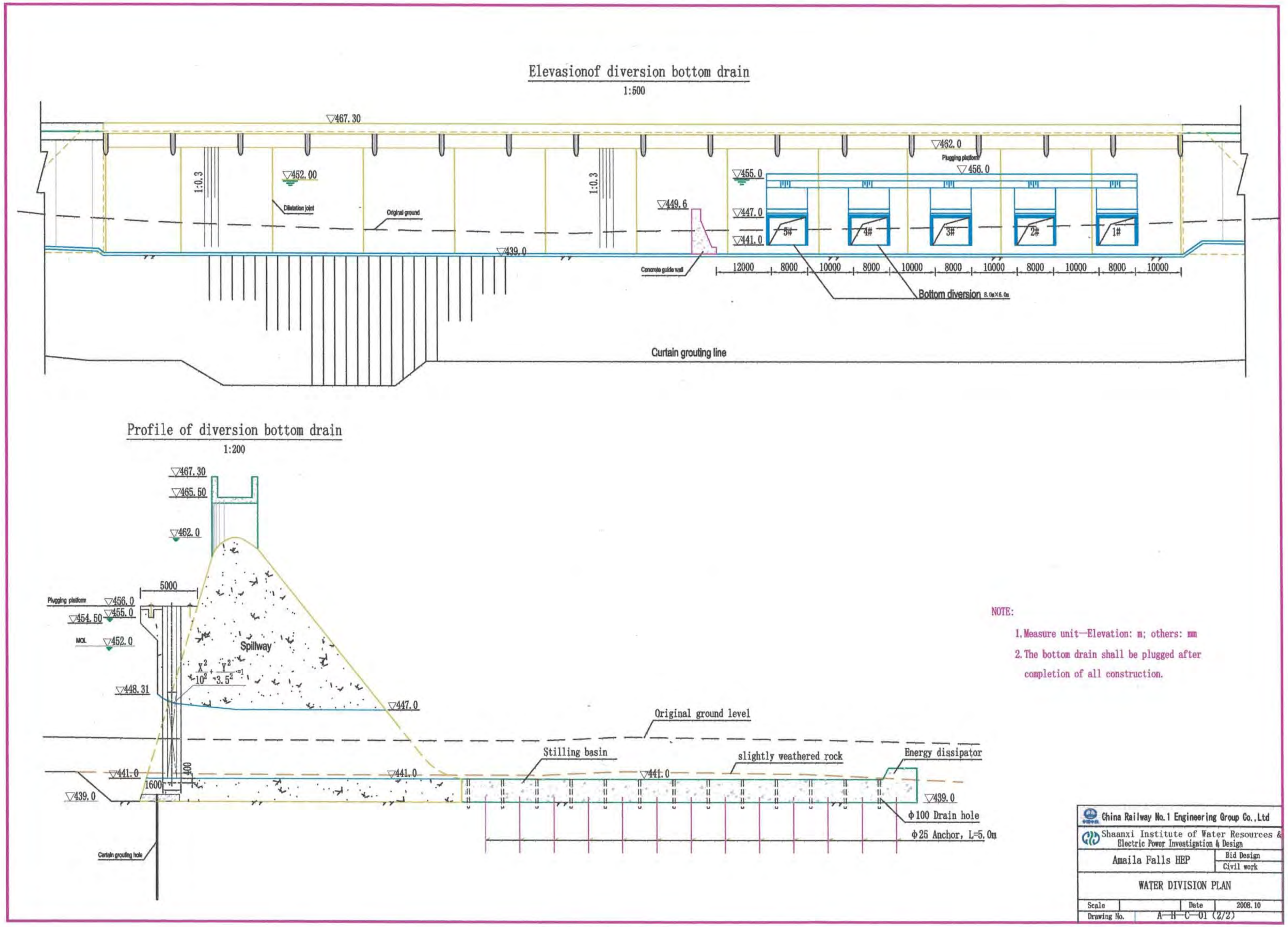


Figure 2.13. Water division plan

Stage I Diversion

The Amaila River will act as the main water channel during the construction period and will be diverted into two phases. The first phase is to build a diversion dam on the right bank of the Amaila River in order to build a portion of the Amaila Dam and spillway. An impermeable geotextile membrane will be placed on the upstream side of the cofferdam, and held in place and protected with riprap. The facility will be capable of diverting the equivalent to the 25-year flood in the Amaila drainage basin at the dam site.

Construction of the dam in the vicinity of the Amaila River would proceed in the protected working area downstream of the cofferdam to the right of the Amaila River. The Amaila spillway foundation excavation and placement of concrete for the slabs, walls, and ogee crest of the spillway would proceed in the protected area. During this first stage, the flood waters will divert down the Amaila channel to the left of the diversion dam. The building of the spillway will require a secondary diversion wall inside the protected area of the initial diversion dam. This will allow the finishing of the spillway and concrete guide wall which separate the right and left portions of the Amaila dam and will form part of the Stage 2 diversion structure later.

Stage II Diversion:

The second stage diversion phase is the interception of all water from both the Amaila and Kuribrong rivers and divert thru the under ports of the spillway built during Stage 1. Second-stage diversion will involve removal of the first-stage cofferdams and placement of new cofferdams on the left of the spillway in order to divert the Amaila river flow through the spillway under ports located on the right side of the Amaila River. With the second-stage cofferdam in place, the zone on the left side of the Amaila river will be protected and the Amaila dam structure can be completed. The second-stage cofferdam will be capable of diverting the 25-year flood event for the Kuribrong and Amaila drainage basins at the dam site.

During this second stage diversion, the Kuribrong River will also be diverted to the Amaila River via a newly constructed 40-50m wide channel between the two rivers. The new channel will connect to the Kuribrong about 1.5km upstream of the dam and to the Amaila river upstream of the stage two diversion dam. The Kuribrong river flow will enter the Amaila river and the combined flow will divert through the five under ports in the Amaila spillway. During the second stage diversion the Kuribrong dam and the left side of the Amaila dam will be completed.

The estimated sequencing schedule for the diversions is:

Work Phase	Months
Amaila Stage I cofferdam located on right bank of Amaila River	14–22
Amaila Stage II cofferdam located on left bank of Amaila River	23–32
Kuribrong cofferdam located on Kuribrong River	23–32

Note: Preliminary, final sequence and timing to be defined after further planning.

Once the other project facilities in the dam are complete and the reservoir is ready for inundation, the bottom under ports will be closed by placement of an upstream bulkhead, and the bottom galleries would be permanently plugged with concrete.

2.1.2.6.3 Dam

Concrete-Face Rock-Filled Dam

A shown in Figure 2.12, the dam works extend across both the Kuribrong and Amaila rivers. The construction of each dam will be undertaken in several distinct phases, which are expected to proceed as follows:

- Foundation excavation and preparation
- Foundation grouting
- Embankment fill placement
- Placement of impervious concrete face.

Foundation Excavation and Preparation

The area within the dam footprint will be excavated down to intact rock. This will entail the removal of all unconsolidated material, boulders, and rock fragments. Unconsolidated soil stripped from the dam foundation will be disposed of in designated spoil areas onsite. Vegetation and organic material will be removed from the footprint area, and weathered material will be removed to a depth necessary to provide a suitable foundation for the rockfill structure. The alignment of the plinth slab will be excavated locally to a deeper depth to reach higher quality rock. Excavation is not expected to be greater than a few meters under most of the structure.

Foundation Grouting

To limit dam and spillway under-seepage, a grout curtain will be installed along an alignment below the upstream toe of the dam. The curtain will extend to a depth suitable for the purpose of minimizing seepage of groundwater under the dam. Grouting pressures will be low enough to avoid fracturing of sound rock. Water was used as the drilling fluid during the subsurface investigation performed for the present study, and it is expected that water will be the drilling fluid used during construction, effectively reducing the likelihood of using chemical drilling fluids.

Embankment Fill Placement

Embankment fill will be placed at approximately 1.5H:1V side slopes on both the upstream and downstream sides of the embankments. The rockfill will consist of rock from the Project quarries. The rockfill will be placed in layers and will be compacted. Any water runoff from the placing and compacting of rockfill will be channeled to a detention basin for recycling. Rockfill placement will be done in such a manner as to result in a uniform face on both embankments. No impervious soils (clay) are known to be present at the dam location in quantities sufficient for constructing an impermeable membrane within the dam. A concrete membrane will therefore be placed over the upstream face of the dam.

2.1.2.6.4 Filling of the Reservoir

Prior to filling the reservoir the EPC Contractor will develop a filling plan outlining the steps leading up to and during the initial filling of the reservoir. The Company will supplement the EPC Contractor planning with stakeholder engagement to inform the public of the planned reservoir filling approach and schedule. After all works are completed as necessary for initial filling of reservoir the bottom diversion ports in the spillway will be plugged and the reservoir will begin filling. The reservoir filling plan will include inspections and monitoring of the area as contingency plans to ensure the reservoir is filled in a safe designed manner.

The construction schedule will strive to plan the filling to take advantage of the wet season, when inflows are higher. Based on an average annual inflow of approximately 64 m/s^3 and a gross reservoir storage volume of about 136 million cubic meters, it will take approximately 25 days to completely fill the reservoir to the FSL. This time will vary depending on the actual rainfall and water inflow from the Kuribrong and Amaila rivers, as well as the starting elevation due to the presence of the stage two cofferdams. The reservoir level will reach the MOL within several days, and at that time, some initial testing may begin. The Contractor and Company will carefully evaluate testing options and incorporate them into the startup plan prior to and during reservoir filling. During reservoir filling, a minimum flow will be directed thru the low level outlet feature to allow flow over the falls and to the lower Kuribrong River. The Company is considering a 30Q10 minimum flow during this reservoir filling.

2.1.2.6.5 Transportation Requirements

It is estimated between 50 and 100 vehicle trips per day on the Project Access Road will occur each way to support the Hydropower Facility construction during peak activity periods. The vehicles will deliver and transport food, supplies, equipment, material, and personnel required for construction. The EPC Contractor anticipates using access to the Demerara River in Linden for loading/unloading material and equipment. After completion of the Project Access Road, the trip from Linden to the hydropower site may be about 4–6 hours. The estimated number of barge crossings on the Essequibo River is approximately 10 to 20 per day during peak periods. The Project plans to install an airstrip on the hydropower site to facilitate faster delivery of certain material and staff.

2.1.2.6.6 Construction Decommissioning

All temporary areas disturbed by construction activities and not intended for permanent use during operation of the Hydropower Facility will be restored to a natural appearance by landscaping, topsoil spreading, for natural revegetation, or seeding with native plants, and planting of trees if needed. Unless otherwise determined by the Company, all temporary facilities used for construction, including batching and crushing plants, crane foundations, workshops, offices, and other buildings will be removed from site on completion of the Hydropower Facility. It is anticipated that some of the EPC Contractor housing area may be left for housing supplemental maintenance staff during maintenance or repair activities. All surfaces will be appropriately regraded and surfaced. If topsoil is generally available, a layer will be placed over the area and revegetated with native plants.

The EPC Contractor will produce a restoration plan for the construction site, including quarries and borrow pits (see Section 7 for details). Measures will be incorporated to minimize erosion or sediment disturbance and consequential impacts on reservoir and downstream river-water quality.

2.1.3 Operation and Maintenance

2.1.3.1 Project Startup and Commissioning

Start-up of the facility will be managed and directed by senior commissioning personnel from the EPC Contractor, and will be closely monitored by the Company. The start-up procedures, as well as planning software, will be developed to manage and direct all testing activities on site in accordance with the start-up program requirements. Before commissioning activities begin, the EPC Contractor will develop commissioning schedules and procedures for the Company review and GPL review as needed. Testing procedures will be developed and agreed upon in accordance with the plant functional specification. All necessary safety and equipment protection systems will be verified prior to any system startup.

The Company will consult with stakeholders as necessary prior to key milestones that may affect offsite conditions, such as the downstream Kuribrong River flow. These events may include filling of the reservoir and other downstream flow controls, and testing or operation of the hydropower units. Stakeholders along the transmission line will also be notified prior to energizing the transmission circuits and substations. The Company and the EPC Contractor will closely coordinate with GPL, Guyana Environmental Protection Agency, and other key Government of Guyana stakeholders during the commissioning phase of the Project.

2.1.3.2 Operating Regime

The Hydropower Facility will be operated and maintained by the Company, and will provide capacity and energy to the GPL grid in accordance with dispatch instructions from GPL. The Project capacity could satisfy the entire current GPL grid demand and forecast demand for several years after project completion. Although the hydropower project could replace the need for GPL to operate existing expensive fossil-fueled generating units, it is anticipated that GPL will maintain these units as backup and for system stability purposes.

The water flow discharged from the powerhouse will roughly follow the energy output of the facility, which can vary from 10 to 100%. It is anticipated that the energy output will be generally baseloaded but will follow the GPL system load. The GPL load does not vary significantly through the seasons, but the GPL system hourly load profile does vary. Therefore, while the output of the facility will be generally constant through each season, the output may vary slightly over the day or through each month. The downstream flows will be more affected by the spill flows due to natural rain events and due to the presence of the buffering reservoir than the variations in generation. The variation in downstream flows due to generation needs will be less than those currently experienced on the Kuribrong River.

There are two wet seasons and two dry seasons in the reservoir area. The reservoir is sized to provide storage of water to facilitate baseload operation during both the wet and dry seasons. The variation of incoming river flows for each season is both above and below the required flow for project generation. During the wet season, the reservoir will be replenished with incoming water. When the reservoir Full Supply Level (FSL) is reached, water will begin to spill over the designed spillway and down the falls section. The FSL should typically be maintained during the wet seasons, and then drawn down during dry seasons when the incoming river water is below the required generation flow.

Under average flow conditions, the reservoir will operate at FSL from May to August. During these months, on average, the contribution of water to the reservoir will be greater than the volume released and thus water would be released from the dam via the spillway. During the remaining months, the reservoir will operate below FSL, and the reduced-flow segment will have a MEF, which is 1 m^3/s. Prior to operations, further analysis will be performed by the Company to confirm the MEF and an operating plan will be developed for how the MEF feature will be operated and/or controlled, and under which conditions the MEF should operate. The total estimated flow in the reduced-flow segment with the addition of spill flows would be approximately 26 m^3/s in May, 90 m^3/s in June, 57 m^3/s in July and 25 m^3/s in August. The simulated spillway flows for low (34.5 m^3/sec), average (61.0 m^3/sec), and high (86.4 m^3/sec) reservoir inflow conditions are shown in Figure 2.14.

In this average water year, due to the quantity of available water in the reservoir, the plant will not be able to operate at full capacity for the complete months of March, October, and November. With regard to the reservoir water level, between August and December the reservoir water level will gradually decrease, going from FSL to at or near MOL. The highest amplitude change is expected between September and October (the driest month of the year), when the reservoir will probably drop about 3 m in 30 days. In order to maximize generation, it is likely that the project will operate at full output until the MOL is reached, at which point it would operate in a run-of-river mode until inflows exceeded approximately 51 cms (maximum plant flow plus MEF) when the reservoir would start to fill. In extreme low flow conditions, the reservoir could also operate in a way to prioritize supply during times of peak demand in which case it may operate for part of a day and not for another part.

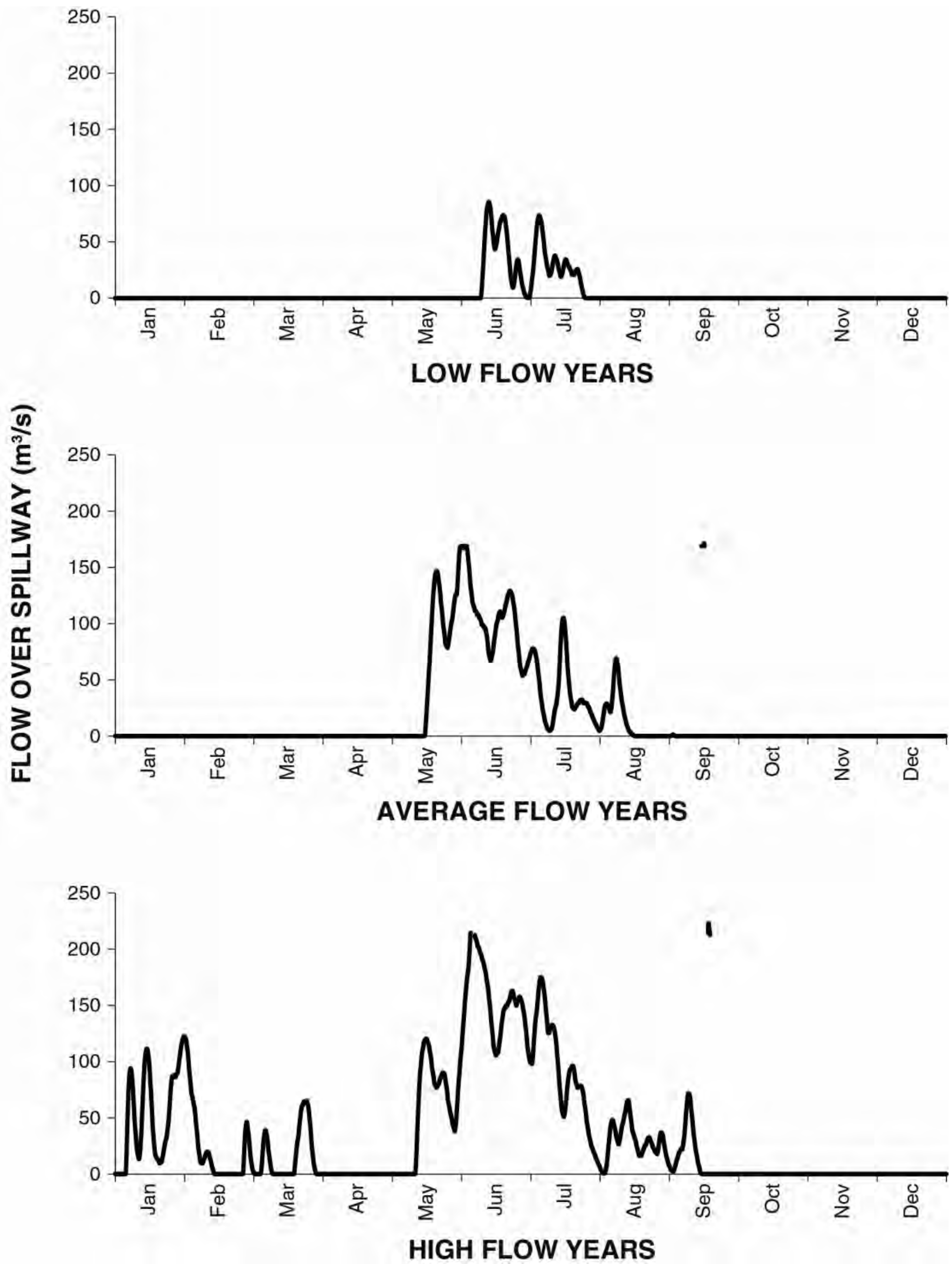


Figure 2.14. Simulated spillway flows for the low, average, and high reservoir inflow conditions.

The Project will operate only when the water level is above the MOL. The water intake is located between 418 amsl and 424 amsl. As shown in the adopted layout (Figure 2.6), the depth of the water intake in relation to the surface will vary depending on the seasonal variations of the reservoir water level. Table 2.6 shows the estimated average depths of the water intake relative to the reservoir water level throughout the year.

Table 2.6. Depth of the water intake relative to the reservoir water level throughout the year

Month	Water Level (amsl)[a]	Depth of Intake[b] (m)
Jan	427.2	6.2
Feb	425.9	4.9
Mar	426.2	5.2
Apr	426.4	5.4
May	431.6	10.6
Jun	431.6	10.6
Jul	431.6	10.6
Aug	431.6	10.6
Set	429.5	8.5
Oct	426.4	5.4
Nov	426.3	5.3
Dec	425.3	4.3
Annual mean	428.3	7.3

[a] Considering the mean monthly flows shown in section 4.1.7.

[b] Considering the elevation 421 amsl as the mean between the intake top (428 amsl) and the intake invert (418 amsl).

2.1.3.3 Maintenance Procedures

An Operation and Maintenance Plan will be developed by the Company and the EPC Contractor. The EPC Construction Contract specifies some of the operation and maintenance programs/procedures and other plant information to be provided by the EPC Contractor. The contract and specifications also include various requirements and standards in the project design that help ensure long-term reliable operation and maintenance, including specific performance and reliability requirements that the project design must meet. This ensures industry-standard requirements are met to ensure the project design and construction will support reliable operation.

The inspection and maintenance program will include a regimented routine of monitoring and inspections of all appropriate equipment and facilities at the hydropower station, transmission lines, and substations. An inspection and monitoring timetable program will be maintained for the major elements of the facilities, including regular daily, weekly, monthly, quarterly, biannually, annually, and multi-year inspections and maintenance activities. A record of inspections and maintenance work will be filed and used for future diagnostics.

The maintenance procedures for each component will incorporate routine planned maintenance work or other work of a less routine nature that may or may not require unit outage. Maintenance procedures will be established for each component of the civil engineering works. The procedures will define the nature and type of routine maintenance work that is envisaged for the component. For the civil works, these typically include such items as clearing drainage structures of trash, vegetation, and sediment; lubricating hinges and bearings; tending to overgrown grass; repairing damaged or flaking paintwork; or repairing road surfaces. The dams will be instrumented for continuous monitoring of pore pressure, deformation, and leakage during operation.

Maintenance procedures for electrical and mechanical equipment will be based on the recommendations of the equipment manufacturers, and typically will include procedures for the repair or replacement of seals, bearings, linkages, and similar serviceable parts. Separate maintenance procedures will be established for maintenance work that is not of a routine nature, such as for components damaged during operation.

2.1.3.4 Maintenance Scheduling

The maintenance program will typically consist of routine and scheduled maintenance. Routine equipment and facility maintenance, including corrective maintenance, is considered regular, preventive, or minor in nature when it is performed periodically, either during operation or during a maintenance outage to maintain the equipment in working order on a day-to-day basis. The work includes, but is not limited to, inspection; lubrication; calibration; adjustment minor leak repair; provision of fluids, greases, and cleaning; and replacement of operational spares, filters, strainers, and cartridges; maintenance or replacement of sensors, fuses, thermocouples, gauges, switches, and light bulbs; and other similar preventive, routine, or minor work. Corrective maintenance is typically performed in response to an equipment failure. While hydroelectric facilities are considered very reliable, unscheduled maintenance outages do occur.

Scheduled maintenance generally includes periodic inspections, testing, repairs, and overhaul or replacement of components on the hydro turbine, generator, and major auxiliaries due to normal wear and tear in accordance with the original equipment manufacturer’s (OEM) recommendations and/or prudent electrical practices. This maintenance typically occurs during a unit outage of predetermined length that is scheduled in advance of its occurrence. There may also be periodic short-term, non-specific maintenance typically scheduled to fit within the overall plant dispatch schedule (e.g., off-peak times).

Some planned and unplanned maintenance is conducted periodically that may require an outage of one or more generating units. In some very rare cases, certain maintenance work, such as within the water intake system and tunnel, may require an outage of the entire facility. All efforts will be made to plan these type of maintenance outages well in advance, so that contingency plans can be made for the GPL electric system, including alternative generation and demand management. In some cases, outages may be scheduled during low-demand periods on the GPL grid. The Company and GPL will coordinate very closely to effectively manage the dispatch and availability of the Hydropower Facility.

2.1.3.5 Dam Safety

The Hydropower Facility will include a network of instrumentation of the type and quantity required in order to monitor the performance and safety of the facility during construction and operation, verify the design assumptions for structures, and monitor deformations, pore pressures, seepage and leakage.

The instrumentation network will include:

- Reservoir inundation
- Surface settlement monuments to monitor surface settlements throughout the facility
- Survey points to monitor vertical and horizontal surface movements
- Standpipe piezometers will be used to monitor pore-pressures in foundations and dam abutments and other project areas
- Vibrating wire piezometers to measure uplift pressures
- Vibrating wire settlement cells for measuring point settlements in the dam fill during construction and operation
- Strong motion measuring system (accelerometers) to measure earthquake acceleration and structural response from earthquakes
- Calibrated seepage measuring weirs to measure and monitor seepage quantities at dam drain outlets and other drainage areas
- Rain gauges and river flow measuring stations.

A method statement describing the instrumentation equipment, installation, data collection and reporting system, and monitoring procedures shall be included with the design. The EPC Contractor will monitor instrumentation upon commencement of construction to provide baseline data. Locations of all instruments shall be tied into the vertical and horizontal survey control system and control points established for the Works.

The operation and maintenance staff will use this monitoring network to establish routine inspection and monitoring procedures to anticipate areas in the Hydropower Facility that require maintenance and more detailed monitoring. The Operation and Maintenance Plan will include routine inspection trips to various locations throughout the facility to verify site conditions and identify focus areas for follow up maintenance.

Prior to filling the reservoir, a dam break study will be performed that will evaluate the final design, assess dam break scenarios and risks, model effects of the spill flows, and establish response procedures in conjunction with appropriate GoG authorities.

2.1.3.6 Water, Wastewater, and Solid Waste During Operation

The water used for operation and maintenance phase will be minor, and will likely be drawn from groundwater. Some water for equipment cooling (e.g., about 700 m3/hr) may be drawn from the power conduit or the Kuribrong River. The facility will use other water for service water (e.g., routine equipment and area cleaning activities), and for potable use (staff household and office), totaling up to about 150 m3/day. The wastewater generated during these periods will be about 80% of the water use. Water for service water may be drawn from groundwater, reservoir, or river, while the potable water will primarily be drawn from groundwater. Wastewater will be discharged through a treatment system designed to comply with applicable regulations. All permanent water supply, sewage and waste disposal works shall conform to the requirements of applicable laws, regulations and permits.

Solid waste generated during normal operation periods will be minor and generally consist of household and office waste, along with small amounts of packaging waste from routine maintenance. During increased activity of outage maintenance, the solid waste will be more. Estimated solid waste generated during operation and maintenance is summarized in Table 2.7.

Table 2.7. Estimated waste generated during operation and maintenance

Type of Waste	Estimated Quantity
Wood, plastics, paper	12 tonnes/year
Scrap metal	4 tonnes/year
Household & office trash	8 tonnes/year
Oily waste	12 tonnes/year
Medical waste	120 kg/year
Liquid waste	12 tonnes/year

2.1.4 Decommissioning

The Hydropower Facility will be operated in accordance with the generating dispatch requirements of GPL or its successor, as detailed in the Power Purchase Agreement (PPA). The term of the PPA is expected to be 20 years, after which time, ownership of the facility will be transferred to the GoG. Typically, the physical life of hydro facilities is on the order of 60 to 100 years.

At this juncture in the life-cycle analysis of the facility, it is difficult to predict the status of the Guyana energy sector over such a long period. Therefore, it is anticipated that the options available to GoG, having acquired an asset after 30–40 years, will be to continue to:

- Operate the facility in line with the future energy strategy
- Put the facility up for sale, and grant another concession to an independent power producer
- Close and/or decommission the facility.

It is expected that the Project will continue to operate past 50 years. However, assuming that closure and decommissioning of the Project is determined to be necessary, then the facilities will be decommissioned to a safe and environmentally acceptable condition. The relatively straightforward procedure will first determine what features need to be removed or modified to make the Hydropower Facility area inherently safe.

The decommissioning plan will need to be designed and evaluated at the time of plant closure. Although the evaluation will determine the final design, it is anticipated that the water intake and tunnel will be plugged, and that all water will be diverted to the falls section via an opening in the dam embankment created during decommissioning. In this case, the reservoir level will be permanently lowered to pre-project conditions, and no downstream water-flow control will be in place. Therefore, an extensive public review process will be needed to ensure that all upstream and downstream areas are not negatively affected.

2.2 Electrical Interconnection

The Electrical Interconnection consists of two main components: about 270 km of high-voltage, 230-kV transmission line, and two substations—one at Linden and one at Georgetown. The transmission line will be constructed in two segments. The first is an approximately 170 km segment from the Hydropower Facility to a new substation to be constructed north of the town of Linden (the Linden Substation). The second segment runs from the Linden Substation to the existing Sophia Substation in Georgetown, a distance of approximately 100 km. The Amaila-Linden-Sophia transmission line will deliver electrical energy generated by the Hydropower Facility to the GPL grid. Figure 2.15 shows a diagrammatic sketch layout of the Electrical Interconnect to the Guyana transmission system.

The transmission line will be a double-circuit configuration supported by double circuit towers with conductors on either side in either an in-line or delta configuration. The double-circuit design provides redundancy in service in case one of the circuits experiences an outage. The typical height of the towers will be about 36 m, and the average span between the towers will be approximately 300–400 m, depending on the topography.

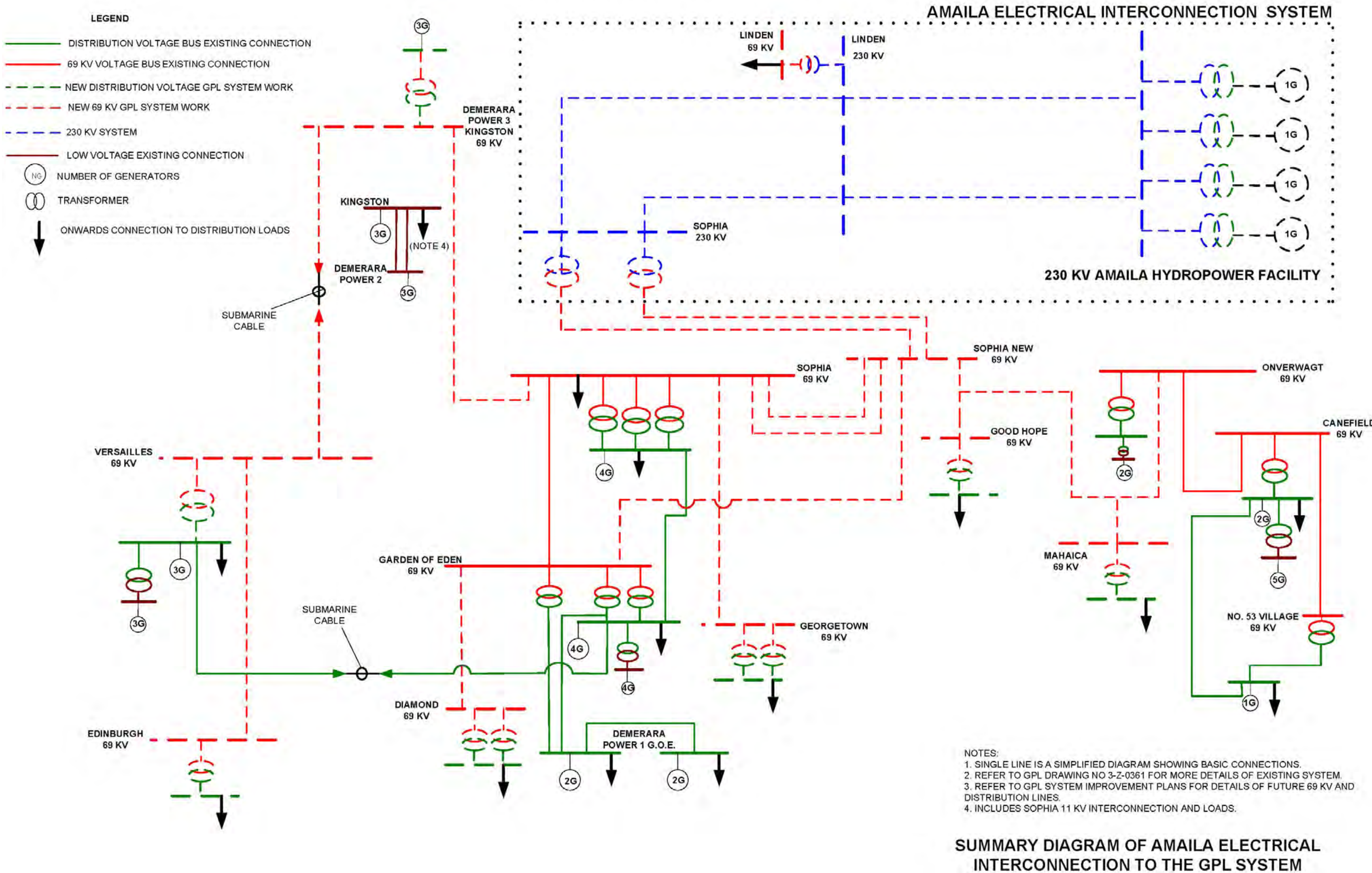


Figure 2.15. One-line diagram of GPL system with proposed Project

2.2.1 Transmission Line

2.2.1.1 Design Standards

The transmission line and substations will be designed and constructed according to applicable electrical design standards (e.g., IEEE, ANSI, ASCE, National Electrical Safety Code, or similar standards). The accessories, connections, and components that conduct currents will be specified with a conduction capacity corresponding to the thermal limits of the conductor in accordance with the climatic conditions of the Project region. The tower foundations will be designed to ensure that all structural forces resulting from each tower will be suitable to the conditions of the soil. Appropriate safety factors will be used to satisfy the failure criteria and will be considered for the structural design. The physical and mechanical soil properties at each location will be determined through soil analysis to understand the precise geo-mechanical characteristics. When these data are collected, the parameters used for the tower foundations will be defined.

All structures, including fences, will have permanent grounding systems. The substations will have a protection system controlled by protection relays for lines, beams, voltage relays, and current relays, all programmed to carry out real-time tests to identify and correct failures due to surges, impulses, or atmospheric conditions.

2.2.1.2 Corridor Alignment

The transmission line corridor must be established to provide adequate space to accommodate construction, operation, and maintenance of the transmission towers and circuits. Figure 2.16 and Figure 2.17 show the proposed transmission line alignment (see Appendix B for detailed alignment maps). The routing attempts to avoid wetland areas and follows relatively straight paths, minimizing the need for sharp angles or bends in the alignment.

An important factor in determining the required width of the corridor is to ensure the reliable, uninterrupted operation of the transmission circuits, minimizing the risk of trees falling on the transmission conductors. The Hydropower Facility and transmission line are in a remote location with respect to the Guyana grid system located in Georgetown and along the coast, and the Guyana electric grid will rely heavily on the Hydropower Facility generation. The remote location also creates challenges in repairing the transmission line in case of outages. Given the remote location and the critical importance of maintaining high reliability of the system, the corridor width was selected to minimize the risk of damage or interruption to the circuits.

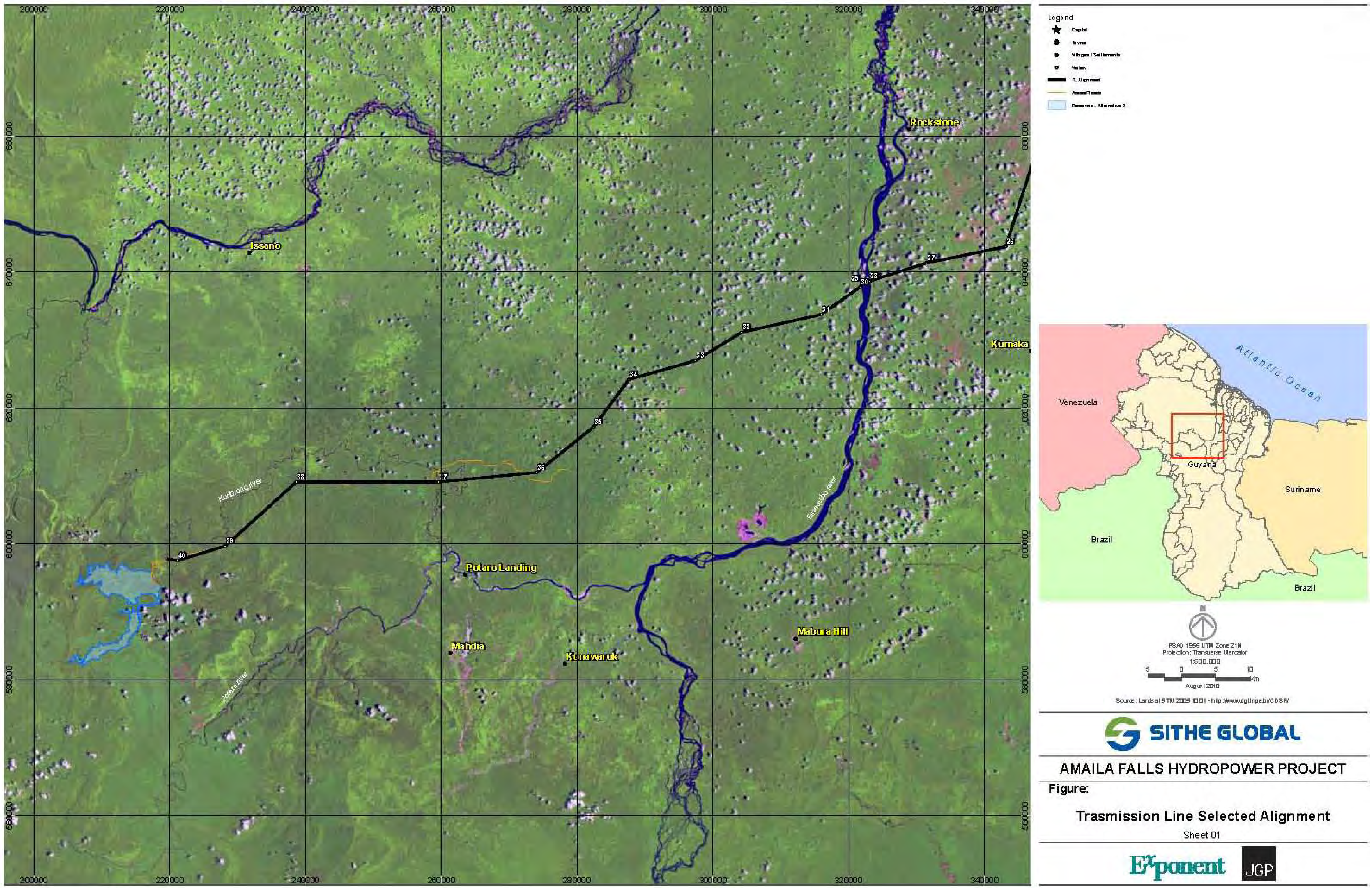


Figure 2.16. Transmission line selected alignment (page 1)

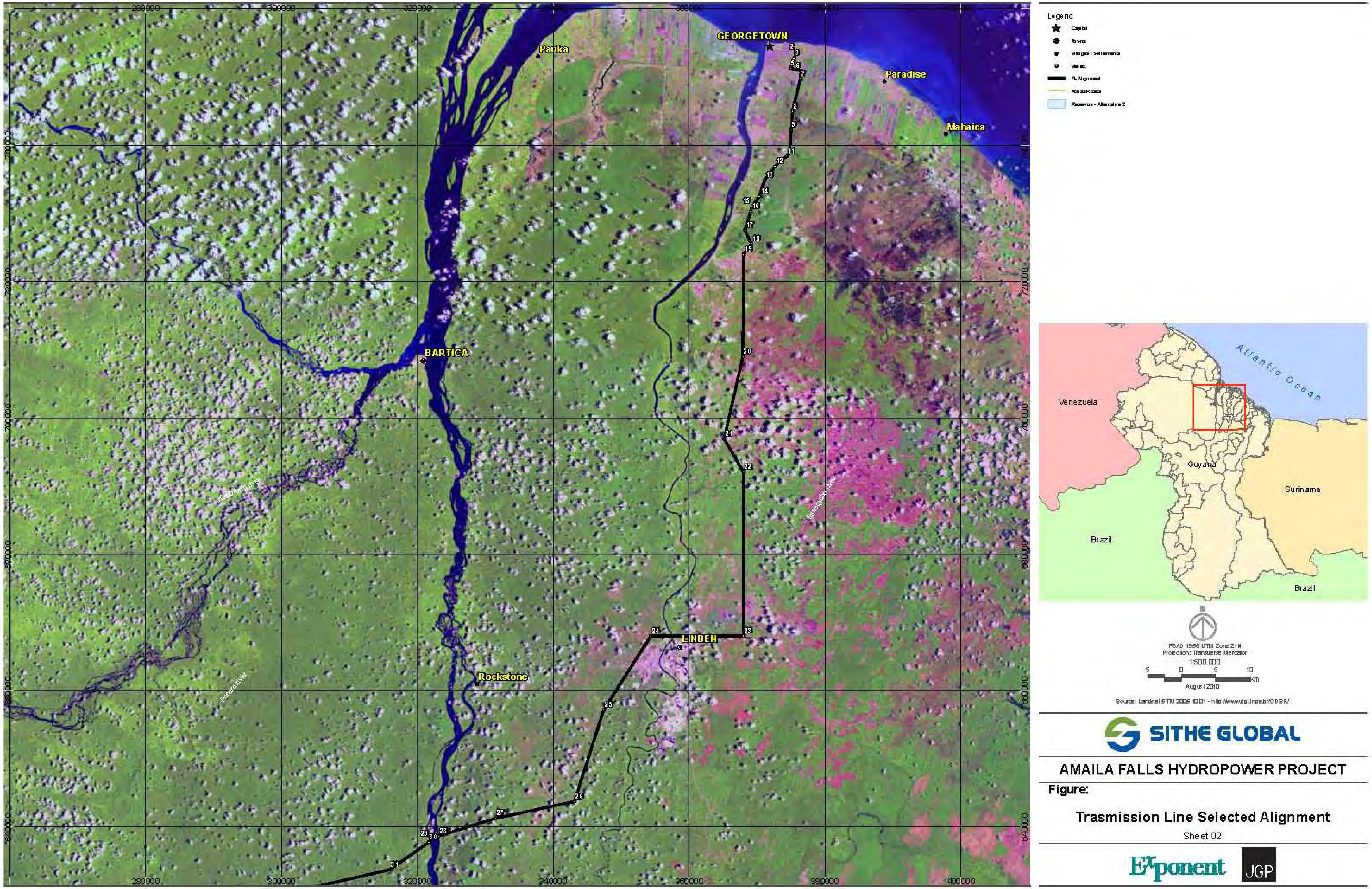


Figure 2.17. Transmission line selected alighment (page 2)

Based on field surveys of the transmission line corridor, the trees typically are approximately 35 m in height but are estimated to be as high 50 m. As shown in Figure 2.18, the farthest distance that the conductor can swing away from the tower centerline (i.e. "blowout distance") is about 22.5 m from the tower centerline. To minimize the risk of trees falling on the conductor (or near enough to cause arcing) during windy conditions and causing an outage to the transmission system, the transmission corridor must be cleared at least 50 m on each side of the centerline, plus an additional 25 m width of selected clearing of trees above 25 m high. This will provide an overall clearance of 75 m on each side from the tower centerline, or 50 m beyond the transmission line "blowout distance", and will protect the system from "danger trees" that might impact the line. Additional forest management will be required outside this distance in a 25 m-wide buffer zone, in order to identify additional danger trees above 50 m in height.

During maintenance of the transmission corridor, the Company will evaluate methods to selectively clear vegetation closer to the blowout distance (perhaps considering selective clearing of trees above 10m high which is below the conductor blowout height). The Company and the EPC Contractor will finalize clearing methods to minimize the impact to the environment, including establishing an exterior buffer zone where selected clearing may be done targeting taller vegetation. Between Linden and Georgetown, the vegetation is lower in height, and therefore, the clearing width within the easement may be less. The clearance requirements will be evaluated on the basis of more detailed field surveys (see Section 7 for vegetation clearing requirements/procedure).

The 100 m width corridor (plus 25 m side buffer) will be maintained from the hydropower site to the substations in Linden and to the outlying areas of Georgetown. Where the corridor enters residential areas of Georgetown, the corridor will be minimized to reduce impacts to homes and businesses along the route. The corridor easement width and clearing requirements are summarized in Table 2.8. (see Section 2.2.3.3 for vegetation clearing).

Table 2.8. Corridor width

Location	Corridor Width (m)
Tall Tree Height Areas (e.g., Linden to Amaila)	100 (plus buffer)
Savannah—Low Tree Height Areas (e.g., Linden to Georgetown)	up to 100
Within Georgetown	30–50

All land required for the corridor from Linden to the hydropower site is State (GoG) land and will be transferred to the Company for purposes of constructing, operating, and maintaining the transmission line. The corridor between Linden and the site is entirely vacant except for some forest concessions (see Section 4.1.13 for details). There is no agricultural use, and no resettlement is required along the corridor between Linden and the hydropower site. A majority of the corridor between Linden and Georgetown is also State owned, but there are some uses (mainly agricultural) by persons who have leased the land from the State. See Section 4.1.9 for details on land use and vegetation within the transmission line corridor.

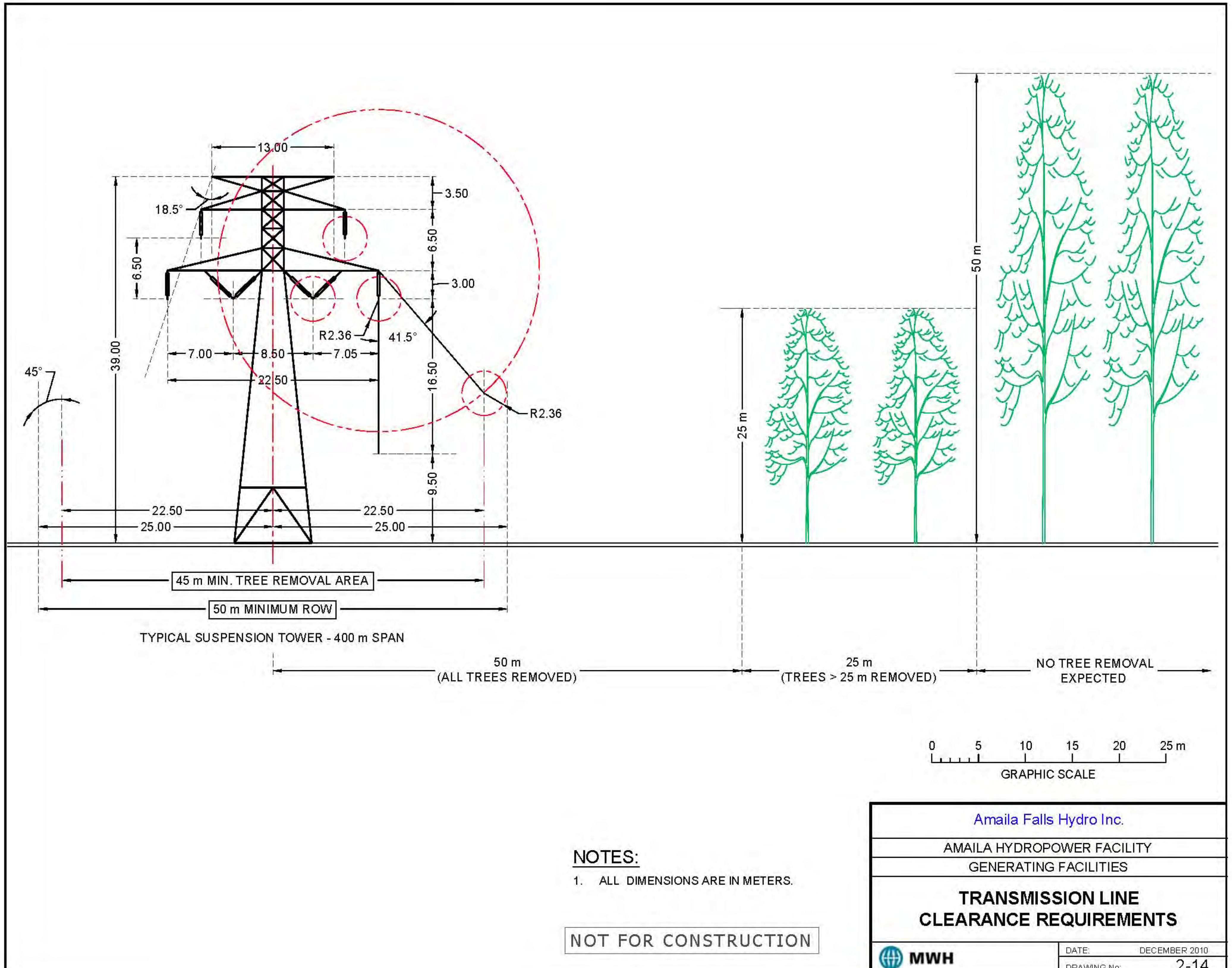


Figure 2.18. Transmission line clearance requirements

2.2.1.3 Safety

Guyana has no transmission lines above 69 kV. Although the proposed 230-kV high-voltage transmission line will be the first within Guyana, such lines are common in other countries (e.g., Brazil, U.S., Europe). The towers and cables are designed to provide adequate safety clearances from the ground, in accordance with electrical safety standards. The minimum conductor sag height between towers is typically about 8 m or more above the ground.

As shown in Figure 2.19, the sag height safely allows for normal pedestrian and vehicle traffic under the conductors; however, vehicles or cranes that have extension arms are prohibited from operating under the transmission lines. At water and road crossings, signs will be installed to warn against use of extra-tall vehicles, booms, or extension arms under the conductors. The towers and conductor sag heights will require special consideration where the lines cross the Essequibo and Demerara Rivers. The Company will consult with the Ministry of Transportation to ensure that the conductor height is adequate.

The towers will incorporate anti-climbing measures and signs as appropriate, to prohibit climbing and/or theft of tower components. Security measures will be incorporated in the construction and operation of the transmission line and substations. The Company anticipates conducting public awareness sessions with communities along the line, to sensitize the public to the safety measures and warnings around the transmission lines and substations.

2.2.1.4 Towers, Foundations, Conductors

The transmission towers will be the steel lattice type commonly used in the United States, Europe, and Brazil. Figure 2.20 and Figure 2.21 show typical designs of the two main types of transmission towers: suspension and angle towers. Angle towers are used at angle points, dead-end points, points where the local topography demands it, and at periodic intervals along the alignment. They are designed to take horizontal and vertical loads; thus, they are heavier than the other type of towers. Suspension towers are. of a lighter construction than tension towers, because they are not required to bear heavy horizontal loads. Suspension towers typically include insulators that are mounted vertically.

The towers will be about 35 to 40 m high, although the specific height of any individual tower will vary. The 230-kV towers will be taller and farther apart than the 69-kV towers that are typically found in Guyana. The distance between towers will vary between 300 and 400 m, and up to approximately 900 steel tower structures will be erected. Depending on the structure type, the total area occupied will be approximately 15×15 m. Climbing guards will be installed on many towers to reduce vandalism and reduce risk to public safety.

Concrete pad, chimney-type, and/or pile-supported foundations are planned for most towers. Foundations for the self-supporting towers will likely use large-diameter bored piles, shallow foundations, or rock-anchored blocks. The choice of foundation type will be based on soil characteristics and access conditions for each individual foundation site.

In certain cases, depending on the available space, the towers may be designed as monopole structures or narrow lattice, to fit within allowed space. This will be decided in conjunction with the EPC Contractor, the Company, and GPL.

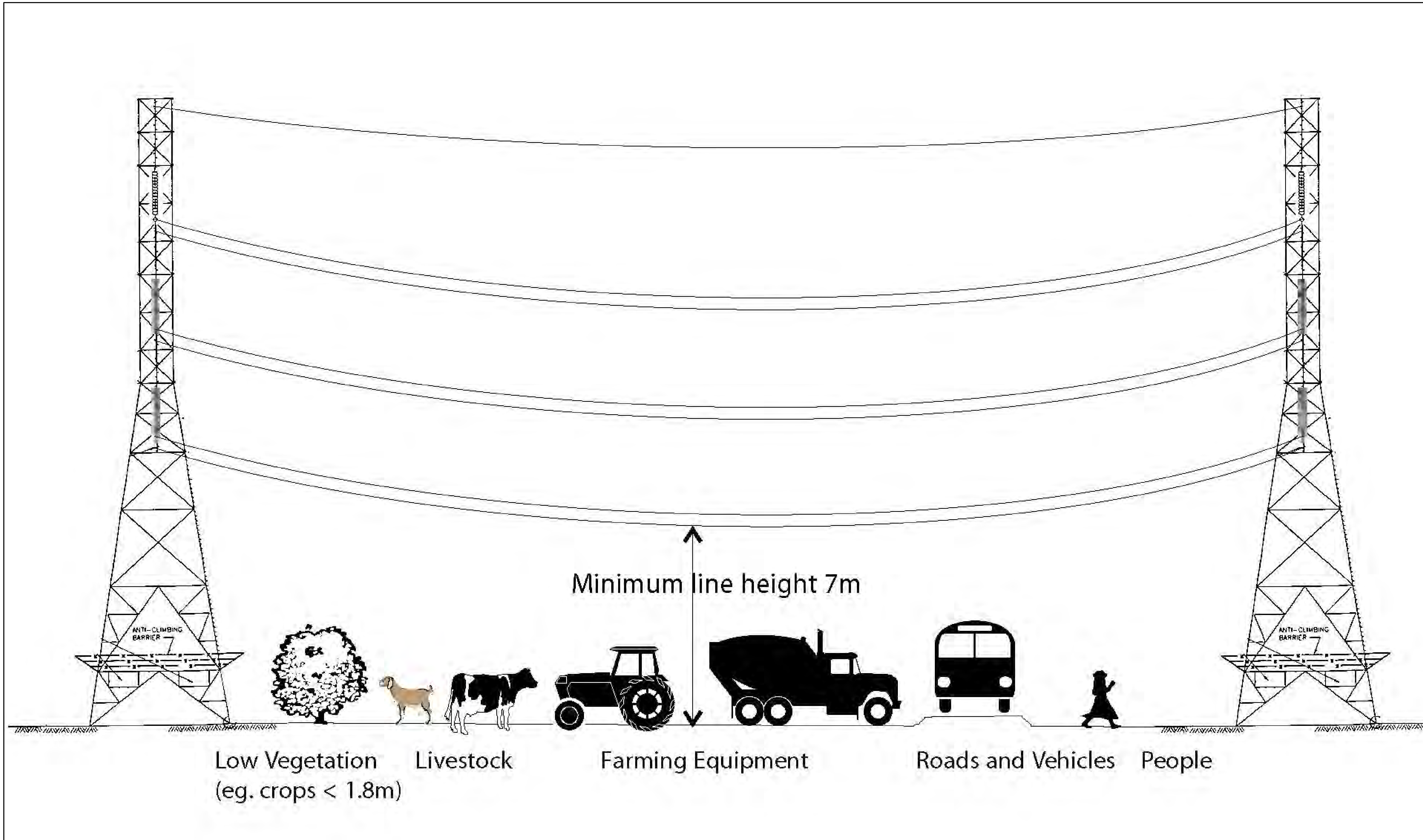
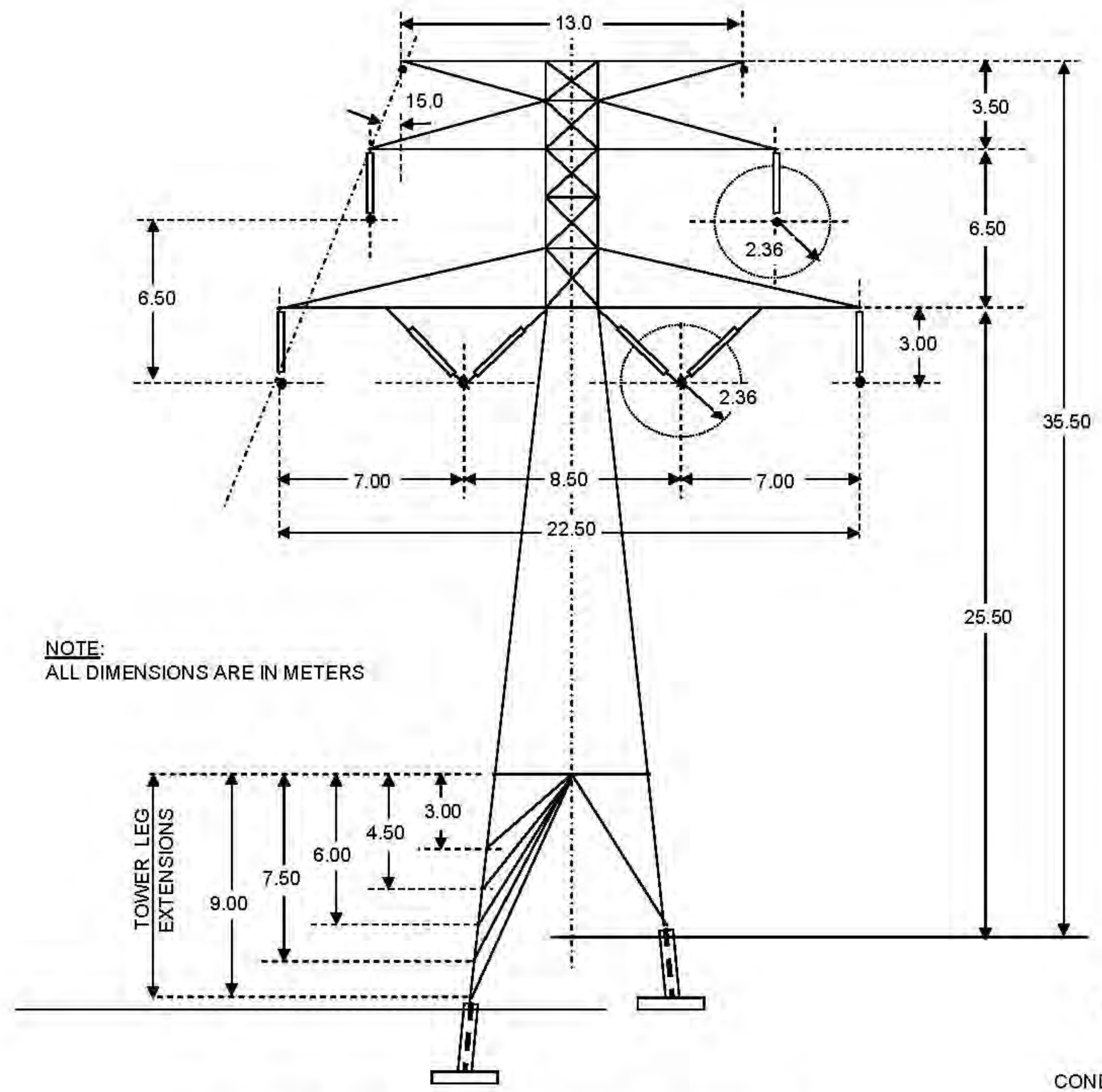


Figure 2.19. Transmission line sag allowance



NOTE:
ALL DIMENSIONS ARE IN METERS

TYPICAL TYPE "S" D/C SUSPENSION TOWER - 365 M SPAN

TRANSMISSION LINE DESIGN DATA

CONDUCTOR: 853.7 KCMIL 18/19
OD: 27.00 mm
WEIGHT: 1.193 kg/m^2
UTS: 9752 kg
MAX TENSION: 2834 kg (INITIAL)

OPGW: ALCOA SAG10 No. GWO835
OD: 13.59 mm
WEIGHT: 0.516 kg/m^2
UTS: 7370 kg
MAX TENSION: 1450 kg (INITIAL)

SHIELD WIRE: 7 No. 8 ALUMOWELD
OD: 9.78 mm
WEIGHT: 0.390 kg/m^2
UTS: 7226 kg
MAX TENSION: 1050 kg (INITIAL)

DESIGN LOADING CONDITIONS
WIND PRESSURE: 50 kg/m^2
TEMPERATURE: 20 ^{o}C
RULING SPAN: 300 m

TOWER DESIGN PARAMETERS
WIND SPAN: 365 m
WEIGHT SPAN: 475 m
LINE ANGLE: 0-2.5 DEG
MIN LEG HEIGHT: 3.0 m
MAX LEG HEIGHT: 9.0 m

WIRE SAG DATA
CONDUCTOR EDS SAG: 11.41 m (FINAL AT EDS TEMPERATURE)
EDS TEMPERATURE: 25 ^{o}C
CONDUCTOR HOT SAG: 12.91 m (FINAL AT MAX OPERATING TEMP)
MAX OPERATING TEMP: 60 ^{o}C

ELECTRICAL DESIGN DATA
MAX SHIELDING ANGLE: 15.0 DEG
INSULATION BIL: 1425 kV
INSULATION STRING LGTH: 3.0 m
IMPULSE AIRGAP CLEARANCE: 2360 mm
MAX SWING ANGLE: 35.0 DEG
LEAKAGE DISTANCE: 6000 mm
CONDUCTOR GROUND CLEARANCE: 8.50 m (PEDESTRIANS AND RURAL ROADS)

No.	REVISIONS	DATE	URS		SITHE GLOBAL AMAILA FALLS PROJECT - Guyana	DWG No.
			DATE:	BY:	230 kV TRANSMISSION LINE TYPICAL TOWER TYPE "S" OUTLINE AND ELECTRICAL CLEARANCES	1
			6/24/2008	AB		

Figure 2.20. 230 kV transmission line, typical tower type "S" outline and electrical clearances

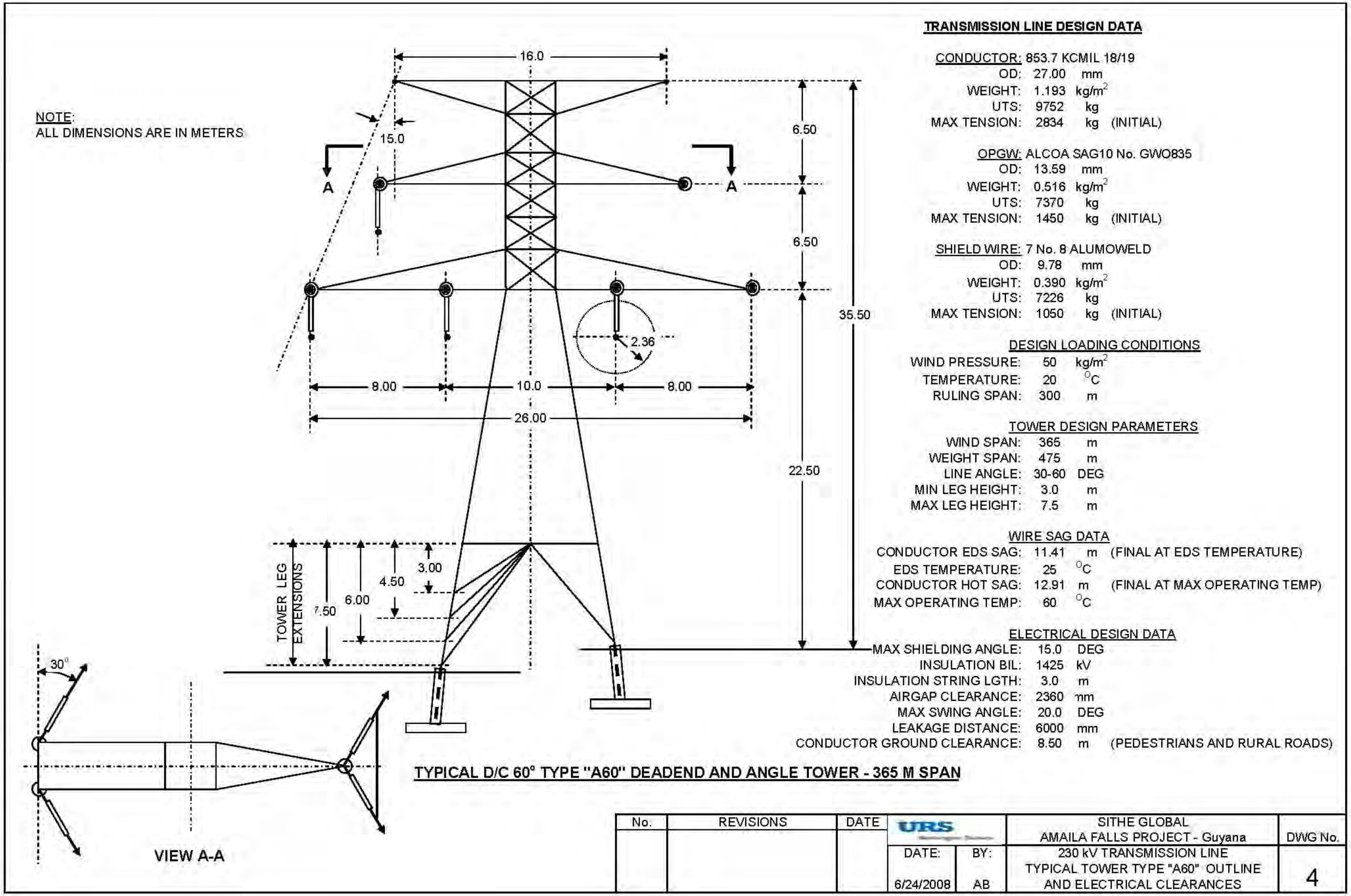


Figure 2.21. 230 kV transmission line, typical tower type “A60” outline and electrical clearances

The estimated excavation volume per foundation may be up to about 2,000 m^3 depending on the type of soil, foundation, and tower. This volume will be significantly less if piling is used. The resulting materials may be used for re-filling and compacting the foundations. Depending on the type of excavation, the remaining material may be spread and graded in the immediate area, respecting natural terrain features and the authorized clearing limits. Excess excavated material may be disposed of in disposal areas that will be pre-established between the EPC Contractor and the Company. If the excavated soil is not suitable for refilling, then material may be acquired from borrow pits to be located prior to construction. A number of borrow pits were identified during the field survey of the road and could be explored for the tower foundations if needed.

The anticipated conductor material is steel-core aluminum cables such as CAAL 853.7 kcmil with an estimated linear weight of 1.193 kgf/m and diameter of 27.00 mm. The conductors will be connected to the towers using electrical insulators specifically selected for the design of the transmission line. Lightning-rod cable will be provided to ensure that the transmission line performs in the face of atmospheric discharges. Extra-high-resistance typical galvanized steel cables will be used. The grounding system will be designed in accordance with applicable electrical safety standards (e.g., national Electrical Safety Code, IEEE, or similar).

2.2.2 Substations

An area adjacent to the powerhouse will be leveled for the onsite Hydropower Facility substation and switchyard, which will contain switching and support equipment for the Hydropower Facility's interconnection with the Project transmission line.

The Electric Interconnection will include construction of two substations, one to be built north of Linden (Linden S/S) and one east of Georgetown on land adjoining the existing GPL Sophia substation (Sophia S/S). The Linden S/S will be built with a 230/13.8-kV (the low voltage still to be finalized) transformation for a distributive function. Sophia S/S will be an expansion of an existing GPL substation, which will be enlarged to accommodate the Project's transmission line and provide transformation of the 230-kV high voltage to the 69-kV voltage that is currently used at Sophia.

The Linden S/S is located within 1 km east of the Georgetown-Linden Highway in an open, undisturbed area, and will have an area of approximately 2 hectares (see Figure 2.22). The location of the Linden S/S may shift slightly to the south to better align with the transmission line corridor. A preliminary layout of the Linden S/S shows that an area of about 100m by 140 m will be required. GPL plans to build short-distance 13.8-kV lines to connect the new high-voltage substation to the existing Linden Power & Light system (which GPL will operate). The new Linden S/S area will be re-graded, leveled, and filled with suitable engineered fill to support the heavy substation equipment. The site is presently State owned. Figure 2.23 presents a plan layout of the Linden substation.

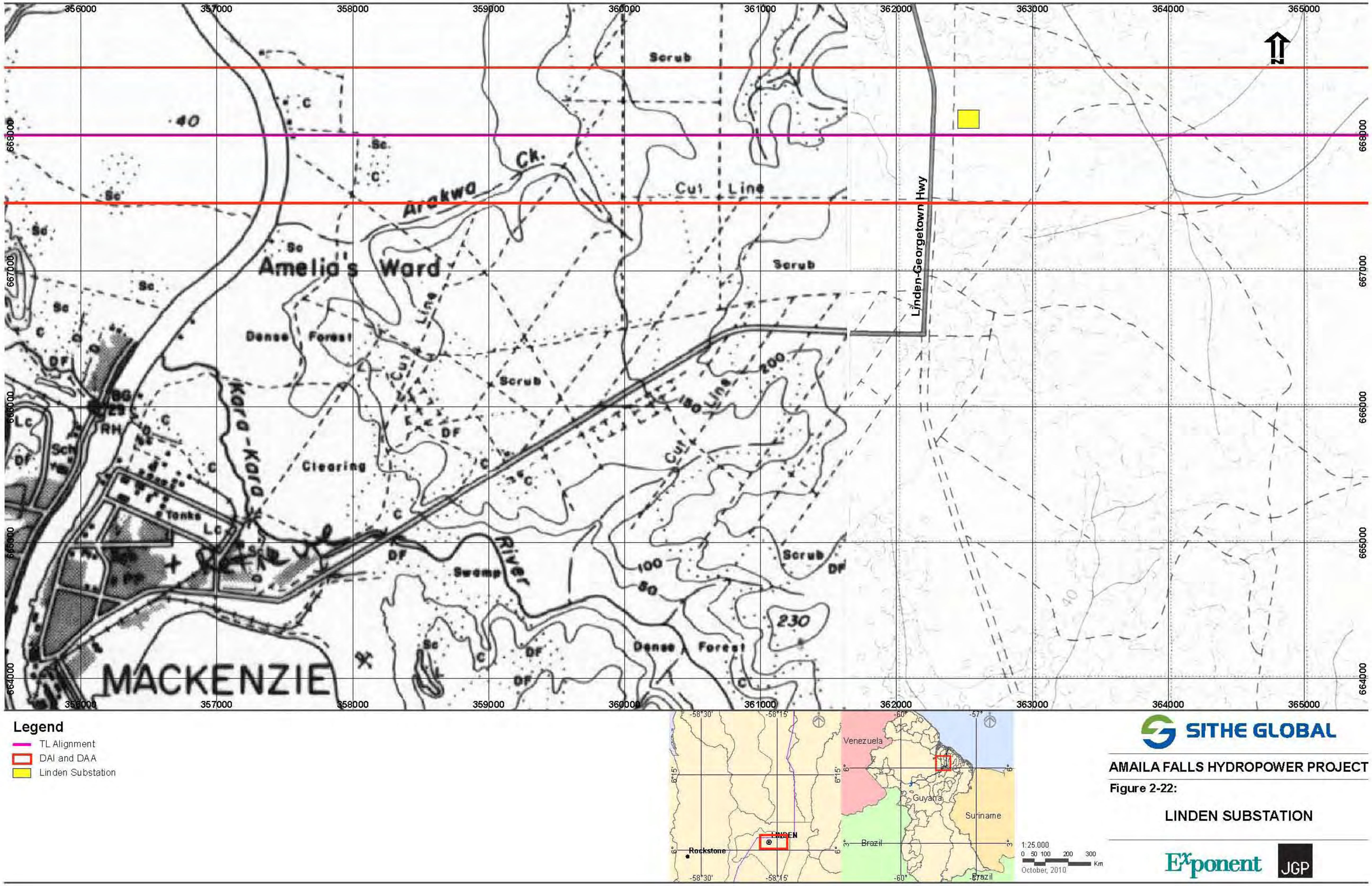


Figure 2.22. Preliminary Linden S/S property

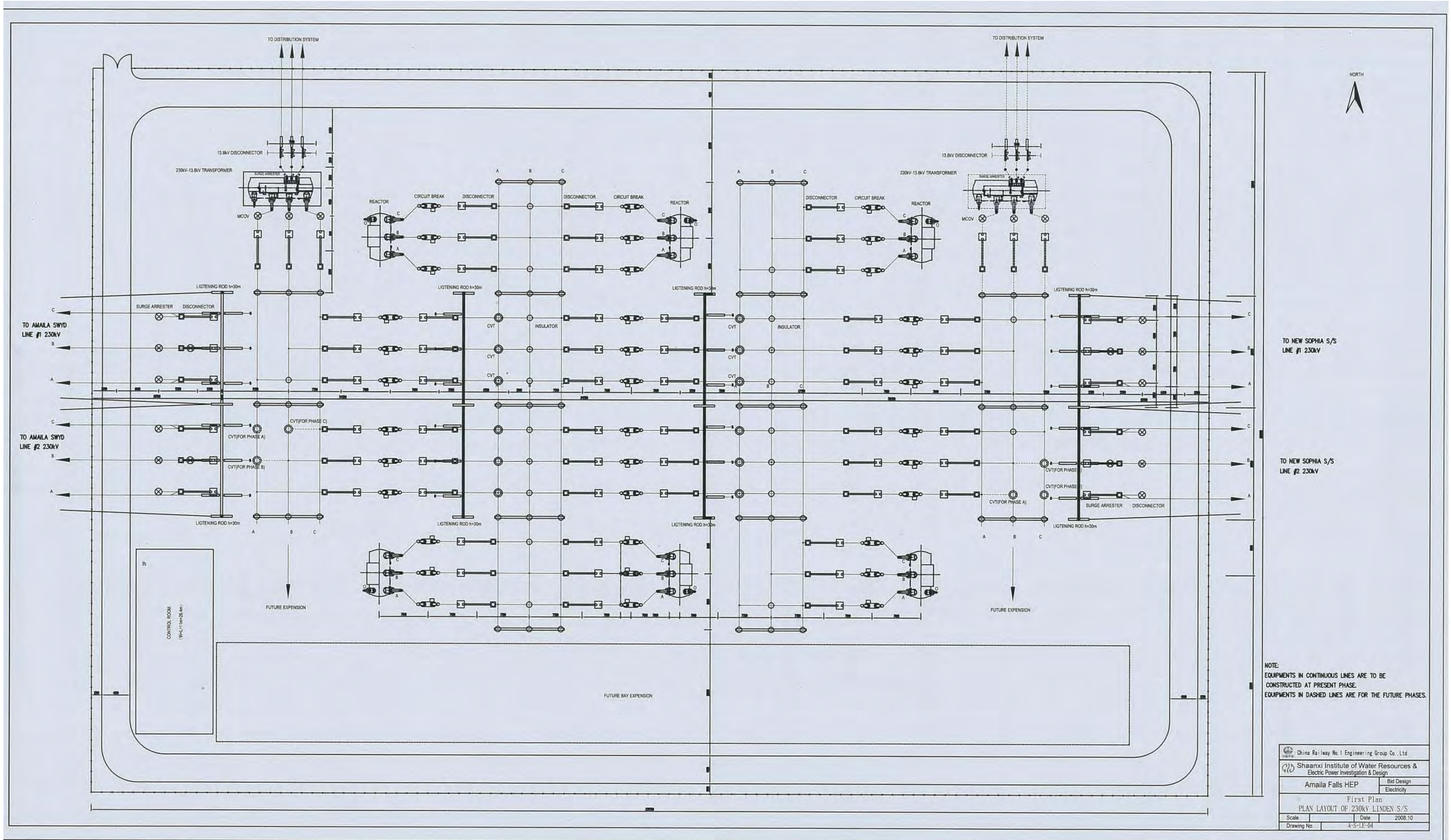


Figure 2.23. Plan layout of 230 KV Linden S/S

The Sophia S/S will be located directly east of the existing Sophia S/S (see Figure 2.24), in an area of approximately 5 hectares. The Sophia 230kV S/S will be located along with other 69kV substations planned in the future by GPL. A preliminary layout of the Sophia S/S shows than an area about 90 m by 140 m will be required. The 230-kV high-voltage line will arrive from the south and connect to the high-voltage bus. Two connections for the 230/69-kV transformers will draw off the high-voltage bus for delivering power to the GPL system. Each of the two 69-kV connections will deliver power to GPL's existing 69-kV substation via two new short-distance 69-kV lines from the new 230-kv substation. The Sophia S/S is located within a flood zone, and therefore, 1–2 m of engineered fill will be added. Figure 2.25 presents an elevation layout of the Sophia substation. Appropriate stormwater and flood control measures will be installed to ensure the substation buildings and equipment are not affected by floods.

Small control and auxiliary buildings and appropriate security measures will be installed at both substations. Equipment in all substations will be grounded to protect both the equipment and personnel working in the substations. All equipment will be fenced to protect the public from contact with the high-voltage equipment. Oil used in transformers will not contain any polychlorinated biphenyls (PCBs), and all equipment containing significant amounts of oil will have secondary containment areas, as well as an integrated means of ensuring that rainfall runoff from the areas passes through an oil/water separator before being discharged to the environment.

The final design and arrangement of the Sophia and Linden substations will be determined through final engineering and in consultation with GPL in order to provide a reliable interconnection with the GPL grid.

2.2.3 Construction/Implementation

The planned construction sequence for the transmission line is described in the following paragraphs, with an emphasis on those activities that have a potential for significant environmental and social impacts. This description covers the standard procedures for transmission line construction and excludes Project site-specific mitigation measures, which are presented in Section 7.

The construction of the transmission line will likely involve multiple work fronts and work teams along the length of the route. The first front will be responsible for identifying and clearing the line route. For the transmission line segment from the Bartica-Potaro Road to the Hydropower Facility, the Access Road Contractor is responsible for clearing this segment. The remaining segments will be cleared by the EPC Contractor or another firm contracted by GoG or the Company. The second front, responsible for the foundations, starts after the completion of an estimated 30% of the services of the first team (opening of the line route). The third team will be responsible for the assembly work. The fourth team will string the cables. In this way, the mobilization plan will have only a small period of time in which the four work fronts will be working together. To achieve this, the main construction camps will be supported by portable installations along the work fronts, in the form of containers, with facilities for housing, meals, water, and waste disposal.

Figure 2.24. Sophia site plan, building, major equipment, and extension layout

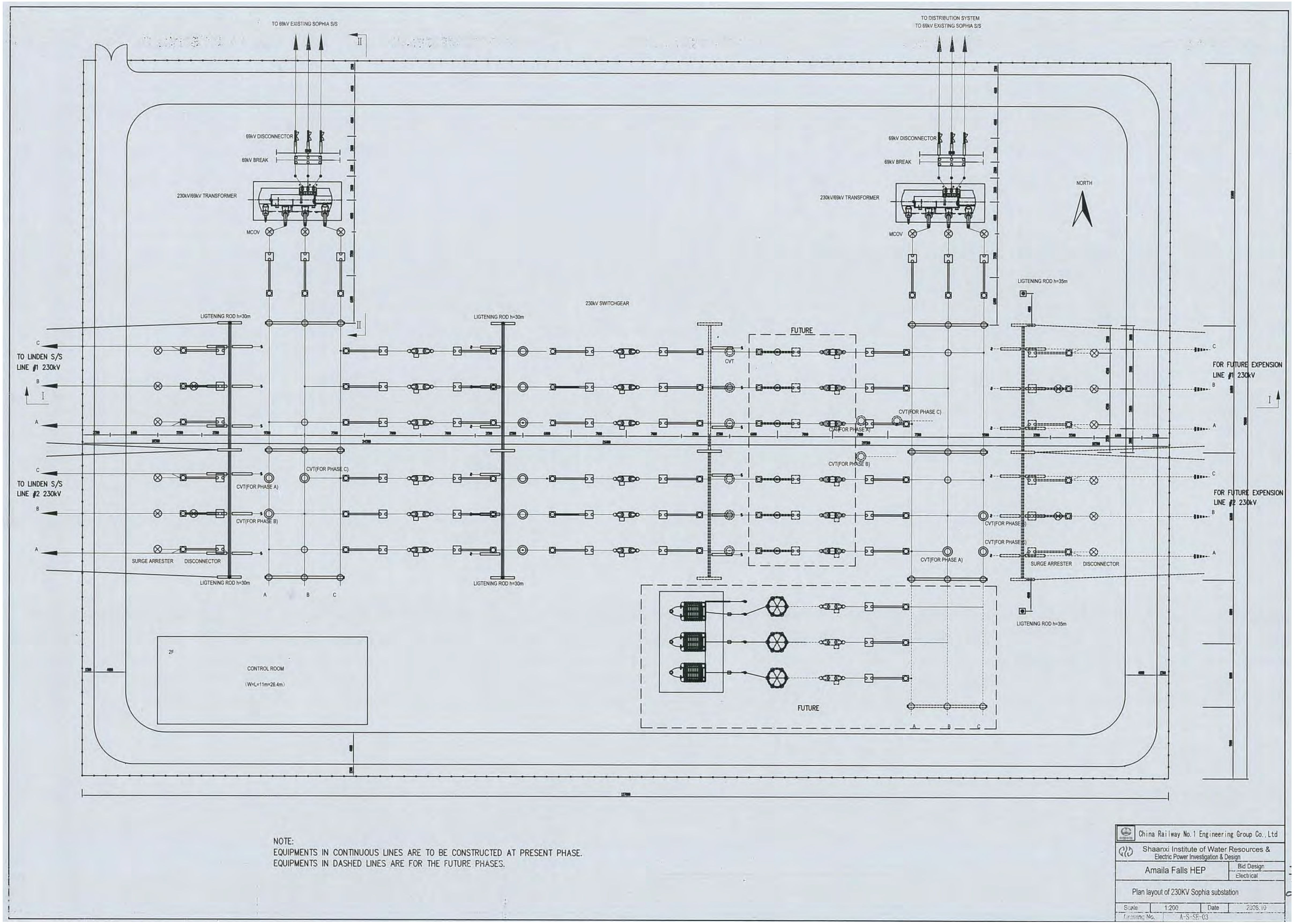


Figure 2.25. Plan layout of 230 kV Sophia substation

Two central management locations for the transmission line will be maintained, one at Linden and the second at the Hydropower Facility, supporting both transmission line work and hydropower efforts. A smaller team will be located in Georgetown. The transmission line work will first proceed in two teams, beginning at Linden and at Sophia. Depending on conditions and status of the resettlement planning of the alignment within Georgetown, the construction/design work may begin outside of Sophia where no resettlement is required (see Section 5.4 for summary of the limited resettlement required and Section 7 for planned resettlement action plan). The two teams will follow the alignment, working toward the center. On completion of the staged work on the Sophia-Linden line, the teams will transfer to the Linden-Amaila line, most likely splitting into three teams, one beginning at Amaila, one beginning at Linden, and one beginning at an intermediate location. While work continues on the transmission line, a substation team will focus on the Sophia and Linden substations.

The transmission line work will likely consist of the following stages, which are further described in the following subsections:

- Mobilization, surveying, planning, and design
- Tower spotting and geotechnical survey
- Vegetation clearing
- Tower foundations
- Tower assembly
- Cable installation
- System checks, testing, and commissioning.

2.2.3.1 Transmission Corridor Access

Access must be provided to every tower for construction, and subsequently, for inspections and maintenance during operations. The main Project Access Road being built and upgraded to access the hydropower site generally follows the path of the transmission line, and in many cases is within the transmission corridor in the segment from Kaburi to the hydropower site (see Section 2.3). Where the Access Road does not fall within the transmission line corridor, other feeder roads must be built to provide access to individual or groups of towers. The feeder roads will likely be the same as used during construction of the transmission line, and may follow within the corridor for some lengths. Because the transmission line may traverse low-lying valleys and streams, the Access Road may not necessarily follow the corridor continuously, but instead may consist of branch feeder roads from the Access Road to reach individual or groups of towers.

The EPC Contractor will establish a procedure to gain access to the construction sites and towers, indicating the roads and route that will be used to reach each tower. Provisory accesses may be structured to accommodate traffic of heavy vehicles and equipment involved in the work during the construction period. The access routes will be planned and implemented according to a construction plan that will maximize the use of the Project Access Road and existing roads or trails and ensure that, if new feeder roads are created, appropriate environmental control procedures will be used to minimize deforestation, control erosion and silting of waterways, and minimize environmental and social impacts. Where soil characteristics do not support equipment and vehicle transit, simple wooden bridges will be constructed using tree trunks produced by the vegetation suppression, the diameter and wood resistance of which are adequate for this use.

The feeder access roads used during construction will be maintained for use during operation and maintenance. The operation and maintenance activities require access for small 4-wheel-drive trucks on a regular basis, but heavy equipment will require access only rarely. Before the transmission line is complete, a plan will be developed regarding the feeder access roads, including how to control access and maintain the erosion control measures.

2.2.3.2 Mobilization, Survey, Planning, and Design

Engineering support and design will continue during the entire construction period; however, a more intensive effort will occur in the early stages prior to the start of construction. The EPC Contractor will initially mobilize for the execution of preliminary services, which will support development of the main design, planning, and procedures. These tasks will consist of the preparation of logistics and accesses to be used in the installation of construction sites and areas for storage of metallic structures, in the hiring of laborers, and for other necessary arrangements.

The initial work will also include final and more detailed topographic surveys of the alignment. Topographic services include all necessary field surveys for the design development, including detailing of the proposed route, positioning of the towers and substation equipment, and planning access and work sequencing. The survey team shall also support the other teams throughout the construction stage. The transmission line alignment has been chosen during the overall project planning and assessment of alternatives (see Section 6). The EPC Contractor will strive to maintain the alignment unchanged; however, as site conditions reveal improved alternatives, the Company will assess these during the engineering phase.

The topography team's work will mainly define the tower locations. The tower spotting effort will consider geologic conditions, topography, stability of the terrain, avoiding whenever possible, flooded or marshy terrains, swamps, and river margins, and locating towers in higher terrain. The survey work will also include gathering site data along the centerline of the corridor and in the adjacent area. These survey data are used to generate a detailed map of the topography along the corridor. In 2008, an initial survey of the transmission line alignment included some plan and profile mapping.

Any landowners or users of the land within the corridor shall be notified prior to the beginning of topographic surveys by the EPC Contractor. Note, as described in Section 4.2 there are basically no land owners or leases along the transmission line route with the exception of the area between Linden and Georgetown and near Kaburi. These surveys shall follow the appropriate procedures to avoid or minimize the impacts of the survey activities.

2.2.3.3 Vegetation Clearing

Clearing of the transmission line corridor will be required to provide access to the tower locations, to conduct tower spotting and the geotechnical survey of the spotted locations. A clear path along the corridor is also required to conduct more detailed line surveys that are used to generate detailed plan and profile mapping.

The clearing of the transmission line corridor for the portion of the alignment between the Kuribrong River and the Hydropower Facility will be done in conjunction with clearing and building of the Access Road (see Section 2.3). Clearing this portion of the corridor during road construction will avoid damage to the road that would have otherwise occurred if the clearing were done after road construction, and will minimize the environmental impacts on fauna from disturbances by construction a second time. Clearing of the remaining transmission line corridor will be done by the EPC Contractor (or other contractor retained by GoG or the Company), and will begin at a later time according to the EPC Contractor schedule.

Section 2.2.1.2 describes the areas, widths, and extent of clearing. Vegetation clearing will consist of cutting and removing trees, shrubs, undergrowth, and brushwood.

The following provides a brief summary of the vegetation clearing; refer to Section 7 and the EPC Contractor ESHSMP and Access Road Contractor ESHSMP for specific details. The transmission line corridor will be cleared to 100 m, with an additional 25-m buffer zone on either side of the 100-m corridor. All trees over 35 m high will be selectively felled. A cleared pathway of 10-30 m will be maintained in the center of the corridor to facilitate construction of the transmission towers and stringing of the lines. In the 25-m outside buffer area, trees will be selectively cut using chainsaws and skilled operators to direct the fallen tree to land in the transmission line corridor.

Vegetation cleared from the alignment will be used to the maximum extent practicable. In portions of the transmission line, the commercial timber is subject to timber sales agreements issued by the Guyana Forestry Commission (GFC) (see Section 4.1.13 for summary). In those areas, the concessionaires will be allowed to remove the commercial timber in a time frame agreed to between the GFC, the Contractor, and the concessionaire. Otherwise, commercial species within the entire transmission line corridor will be cut using chainsaws, dressed to become logs, and stacked to one side for future removal (storage at least 10 m away from clearing edge or sensitive areas). Vegetation cut or cleared that is not commercial-grade timber will be used according to its characteristics. Such uses may include wooden stakes, preliminary protection works, erosion control, camp fences, and other construction uses. In some cases, the cleared vegetation may be used for stormwater erosion controls. Windrows may be built in sloped areas using cleared vegetation. The Company will explore uses for other non-commercial timber that may be cut to appropriate sizes for sale to industries or other establishments for use in boilers or other applications.

In areas of flat terrain, all trees and brush within the corridor will be compiled into burn piles. The spoils will remain horizontal and piled together with the canopy to create burn piles and then set aflame using diesel fuel or other accelerant. In these flat areas, the ground may become grubbed up by the activity. Erosion control measures will be in place to manage stormwater. In sloped areas, the trees and brush will be compiled into windrows and slope breakers to provide erosion protection. In those cases, the vegetation will not be burned. The EPC Contractor or Access Road Contractor (as applicable) will identify areas in which material will burned and not burned, and will review the plan with the Company prior to clearing.

Vegetation clearing and overburden removal activities shall be limited to the strictly necessary areas and shall be conducted to avoid disturbance of vegetation adjacent to the cleared perimeters. To achieve this, clearing of vegetation will always be preceded by a survey crew that will clearly mark the limits of the area to be cleared as established in the engineering documents.

In applicable area, vegetation clearing will be done in a manner to mitigate potential fragmentation impacts. Potential practices to be considered include: maintain a shrub habitat with low vegetation in selected portions of the transmission line corridor to help mitigate the barrier effect for ground dwelling species, establish low vegetation wildlife corridors or crossings at selected locations along the transmission line cleared corridor to help mitigate impacts to larger fauna, avoid or adjust clearing in low valleys and streams in the transmission line corridor where adequate overhead clearance is available above the low canopy vegetation, and consider narrowing the corridor in sensitive habitat areas, especially in areas such as savannahs and wetlands, where the natural vegetation is already below the transmission line overhead clearance requirements. Areas considered environmentally and socially sensitive will be demarcated and signalized for protecting sites or activities that might be potentially affected by the construction, including protected flora sites or individuals, water sources, water holes, fences and pasture lands, vehicle passages and secondary access road crossings, among others. All the areas considered environmentally sensitive and demarcated within the perimeters will be cleared with chainsaws. Use of tractors for clearing will not be allowed within these areas.

2.2.3.4 Tower Foundations

Once tower spotting is confirmed and geotechnical investigation provides adequate information about the subgrade, then final engineering will determine the type of tower foundations. As engineering progresses along the alignment, foundation work can begin. Foundation work will require heavy equipment access to the tower locations. After excavation and forming preparation, then foundation concrete forming is done. This work will continue for each tower location as the team progresses along the alignment in general accordance with the overall work front planning for the Project transmission line.

Access to wet or marshy terrains will demand special care to avoid the necessity of constant maintenance, unnecessary increases in the deforested area, or unnecessary changes to the natural water flows. In some cases, narrow access roads will be built up to access the tower locations. The tower spotting will endeavor to maximize the span lengths in wet areas to avoid extra work in those areas (which typically results in higher construction costs and environmental challenges).

The foundation type for each tower will be chosen based on the geologic conditions in the area of the tower location and the type of tower, loads, etc. Depending on the site conditions, the foundation may be spread concrete footer type, driven pile, or some other type. The overall width required for the tower foundations may be up to 13 m, and the space needed to excavate for the foundations may be up to 20 m, depending on methodology. There is adequate space along nearly the entire length of the transmission alignment; however, a short portion (less than 2 km) of the alignment within the Georgetown area presents a challenge with regard to space for construction of the foundations. This area will be examined in greater detail to determine the best option for tower and foundation type, routing, and temporary construction measures, taking into consideration any impacts on nearby homes and businesses.

The soil material removed during the excavation of tower foundations will be stored in an area close to the work site for later use in backfilling the foundations, or it will be spread in the corridor strip in a controlled manner. In addition, unusable material may be taken to a disposal area authorized by local environmental agencies or reused for eventual repair of feeder roads. It is not anticipated that significant backfill material will be required from borrow pits. If such material is required, the EPC Contractor will identify specific areas and review with the Company prior to use. Other considerations during construction of the tower foundations may include:

- Special care will be used near water courses to avoid alterations or interruptions in the natural drainage system. To avoid sediment transport to the water course, restraining structures will be implanted as necessary.
- The terrain surrounding all foundation works will be restored and protected after the work is concluded, to avoid erosion.
- Excavated material used in the burying of foundations will be packed so as to preserve the surrounding vegetation.
- Depending on the slope and depth of open trenches, the trench walls will be reinforced with wood, steel, or concrete propping.
- After the completion of excavations, any open foundation trenches will be fenced and signalized to prevent accidents involving the local population.

Foundations and/or pile construction will require dewatering of the open trenches. In many cases, pumps will maintain a dry trench, but in some cases, temporary retaining walls may be required. Hoses used to direct drained water to other areas will ensure that it does not affect nearby homes, structures, or sensitive habitat, and may require the use of settling ponds.

If required, depending on the geologic conditions, pre-molded prestressed concrete piles may be used to support tower foundations. Piles are driven into the ground using pile-driving equipment. Piles could be as deep as 30 m. During pile driving, an adequate cushion is used between the headstock and the pile head, to avoid damage to the pile. The pile driving can be noisy, and therefore, any work planned in residential areas will be preceded by public notification.

2.2.3.5 Tower Assembly and Conductor Stringing

On delivery of the steelwork from the storage yard to the tower location, erection of the transmission towers will proceed using a winch and gin pole. Typically, the gin pole will be supported on one leg of the tower while the sections are bolted on. The gin pole will then be lifted to a higher attachment point to repeat the process. Figure 2.26 and Figure 2.27 show a generic assembly method. Extra space around the tower (about 30 m) may be required to guide the lifting of the higher pieces of the tower.

Once the towers are erected, the conductors and shield wires will be strung and tensioned with specialized equipment to achieve the designed sag. Stringing is carried out first by hanging a pilot wire from each tower, connecting the pilot wires together, and then using the pilot wire to draw the conductor along the insulators. This is normally done in sections of 6–7 km at a time.

Guard structures will be used when installing the conductor over highways, main roads, waterways, railroads, or any overhead power or communication lines to ensure that the conductors do not cause a hazard to the public or the construction staff.

Compression dead-ends and splices will be used to secure the conductor to certain towers and join sections of conductor. After the conductors and shield wires are attached to the insulators or clipped to supports, the lines will be sagged to the proper tensions and fitted with vibration dampers. A number of field tests will be undertaken to ensure that the line is installed according to specifications.

Once construction of the transmission line is completed, the soil along the right-of-way will be restored to natural topography to ensure proper drainage and erosion controls.

2.2.3.6 Substation

The construction of the two substations will be done by one team, first working on the Sophia S/S and then Linden S/S. Depending on the timing and sequencing of work, the team may shift from one S/S to the other for certain work. The substation construction will begin with surveying and demarcating the construction area. The Company will ensure affected public or stakeholders are properly notified ahead of time. The EPC Contractor will then mobilize a construction trailer or temporary building on site and install suitable security fencing. The initial work will focus on re-grading the site and building up with engineered fill. The Sophia S/S will require fill to raise the finished level above the flood level.

After the site ground base is prepared, work will begin on excavating trenches and installing required conduits, cabling, grounding grid, stormwater control measures, and other piping. Work will also include excavation and installation of foundations. After the ground work is completed, the substation construction will continue with installation of above ground structures, equipment, and cabling. After installation of required structures, equipment, and cabling a substantial effort will include making final terminations of cabling, and conducting final checks and testing in order to ensure the proper equipment protections and controls are in place.

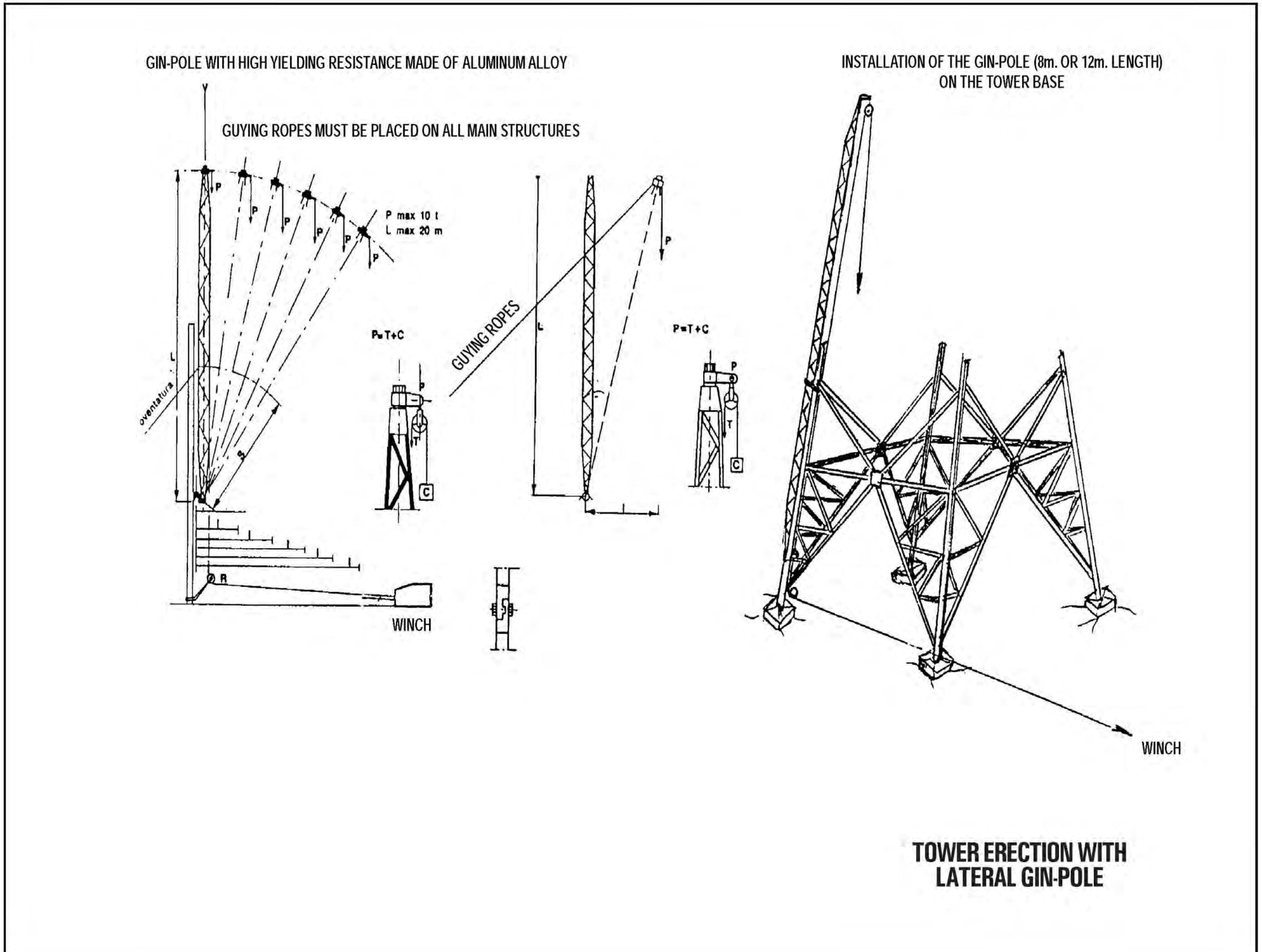


Figure 2.26. Tower erection with lateral gin-pole

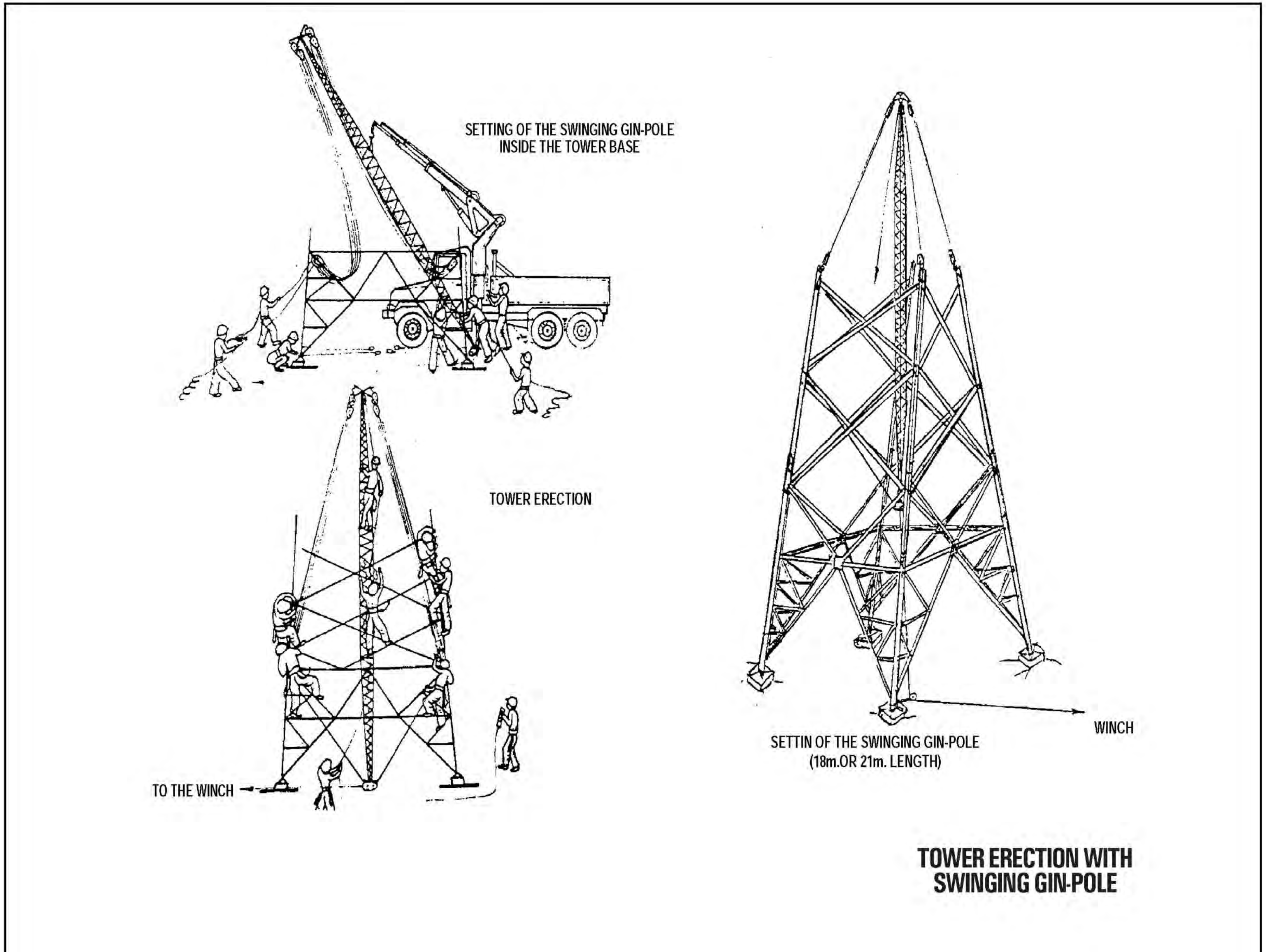


Figure 2.27. Tower erection with swinging gin-pole

2.2.3.7 Transmission Line and Substation Testing and Commissioning

Various equipment tests and checks will be conducted during the manufacture and installation of the Project transmission line and substation equipment. During the final stages of installation, final checks and tests will be conducted to ensure that the interconnection project performs as designed and per contract specifications.

After line installation, all line ground clearances will be confirmed, and the terrain and soil along the corridor will be assessed for stability, compaction, and proper drainage controls. Any problems such as erosion or lack of compaction will prompt necessary corrective actions. Once all circuits have been connected, "dry" testing may begin, consisting of confirmation that all connections have been made according to the wiring diagrams, resistance checks, equipment protection, communication checks, and other tests.

Once all dry tests are complete and verified, and the Company and GPL are satisfied, then live voltage testing of equipment and circuits may occur.

If warranted by concerns of theft or vandalism, the Company and the EPC Contractor, in close coordination with GPL, may evaluate the need to energize individual circuits after cable installation but before full commissioning. This option will be implemented only after a thorough consultation with communities along the corridor.

Final testing and commissioning will be carried out in close coordination with the Company and GPL. GPL will have final authority to make the final interconnection with its GPL electric system.

2.2.3.8 Construction Support Infrastructure

The substations, transmission line, and hydropower facility will be built using relatively independent construction processes, yet they will be carried out at the same time and may depend on similar logistic support coordinated by the Company and EPC Contractor management staff. Before beginning work, the construction teams will establish a procedure to access common areas and how to optimize logistical support for all construction work.

Support facilities for transmission line construction will be present along the transmission line route. These facilities will be located so as to provide the best possible logistical and managing support to the line segments, with the lowest reasonable travel time between the location of the support facilities and the work sites.

Two central management locations for the transmission line will be maintained at Linden and Amaila, supporting both transmission line work and hydropower efforts. A smaller team will be located in Georgetown. Substation construction will require a smaller support office/operation at the Linden and Sophia substation locations. As the transmission line teams move to more remote areas between Linden and Amaila, smaller intermediate logistical support facilities and temporary work camps may be set up along the alignment to support work as it progresses along the route. Different activities (i.e., surveying, geotech studies, tower foundations, erection, and cable stringing) will require different levels of logistical support and therefore will require adjustments in logistical management.

Logistical support facilities may include some of the following features:

- Construction management staff offices
- Lodging for workers (may be separate location) with suitable sleeping quarters, showers, toilets, dining areas, etc.
- Secure storage space (outside yard and indoor space) for equipment, materials, trucks, and other supplies
- Assembly and maintenance areas with open floor areas and overhead crane or gantry
- A tool shop
- A separate hazardous material storage area for fuel, lubricants, acetylene, welding supplies, and other material as needed.

These arrangements will be confirmed further as the project planning progresses.

2.2.4 Operation and Maintenance

The 230-kV transmission line and substations at Linden and Sophia will be owned, operated, and maintained by the Company. The substations will be connected via a high-bandwidth communication system to facilitate system controls, monitoring, and protection. The communication system will also provide needed links between the Hydropower Control Room, the GPL Control Center in Georgetown, and each of the 230-kv substations. There will also be a dedicated voice communication link between the control rooms at the powerhouse and the GPL Control Center.

The Company will work closely with GPL and the GoG to develop a security plan to monitor the substations and transmission line. The Amaila Substation/Switchyard is to be located directly adjacent to the powerhouse, and therefore will be monitored and operated by the hydropower staff. The control room at the powerhouse will be capable of fully controlling the Linden and Sophia Substations remotely. However, AFH will likely initially provide some staff at the substations to establish proper procedures and security.

Operation and maintenance of the transmission lines will include regular visual inspections of the lines by ground access via the Project Access Road, and occasional use of airplanes and/or helicopters. The inspection staff will be a combination of specially trained security/inspection staff for routine inspections, more specialized electrical technicians, and in some cases, third-party engineers as needed. In addition, local personnel may be used for more frequent inspections of vegetation growth, erosion control measures, conditions of the access roads, and general conditions of the towers and foundations. Inspections of the corridor will also include monitoring of encroachment by buildings, crops, or other structures within the right of way.

Periodic and selective forest cutting (about every two years) of overgrown trees (typically greater than 4 m) will take place during operation, to ensure that species do not present a risk to the power lines. The Company will engage a forest expert to assist in developing a forest management/clearing plan during operation and maintenance. Vegetation in the transmission line RoW will be maintained and disposed of according to the Project Environmental and Social Management Plan (see Section 7). No significant use of pesticides or herbicides is contemplated. The operation and maintenance will not generate significant solid or liquid wastes.

2.3 Access Roads

The Project hydropower site currently has no road access. To provide access to the site, the GoG has contracted a construction firm (Access Road Contractor) to upgrade some existing roads and construct new roads from a location west of Linden to the hydropower site. Table 2.9 outlines the Access Road work.

Table 2.9. Project access road

		Distance (km, approximate)	
Section	Description	New	Upgrade
1	Upgrade of existing road from west of Linden along Mabura Hill Road (MHR) to 41 Mile turnoff to Essequibo River.		50
2	New road from MHR to Essequibo River East Landing (most of this utilizes existing logging trails)	18	
3	Upgrade of existing roads from Essequibo River West Landing (Butakari) along existing Toolsie Road and Bartica-Potaro Road (BPR) to just north of Kaburi Community.		36
4	Upgrade of an existing logging road north of Kaburi to Issano Road junction (near Kaburi).		20
5	Upgrade of existing BPR from Issano Road Junction to the Amaila Hydro Road (AHR) Junction (at 82-Mile mark).		16
6	New road from AHR/BPR Junction to west of Kuribrong River bridge until it connects to the transmission line corridor.	24	
7	New road (AHR) from west of Kuribrong River Bridge to just east of the hydropower site.	43	
Total		85	122

The Access Road work includes upgrading existing roads, building new roads, building new river ferry launching facilities at the Essequibo River, building a new bridge over the Kuribrong River, and building or installing small bridges, culverts, railings, drainage facilities, and other features as needed for the access road. The Access Road work also includes building smaller feeder roads to provide access to selected areas of the transmission line.

The Access Road contract includes clearing of a portion of the transmission line corridor between the hydropower site and a location near Portage Falls approximately 43 km east of the hydropower site.

Maintenance of the Access Road is the responsibility of the GoG. The Access Road contract includes an option for the access road Contractor to maintain the access roads for a number of months during construction of the hydropower project.

The Access Road is targeted to be completed prior to the start of construction of the Hydropower Facility.

2.3.1 Description

2.3.1.1 Road Alignment

The Access Road Contractor completed a road alignment survey, which included topography surveys of the road alignment and portions of the transmission line, to determine the final alignment of the road and associated portion of the transmission corridor (i.e., Portage Falls to the hydropower site). This survey work considered not only technical factors, but also environmental factors. A primary consideration was to avoid areas of likely sensitive habitats. The road alignment generally follows higher ridges, for technical reasons, and therefore avoids sensitive habitats that are more likely found in lower stream areas. Figure 2.28 presents the overall map of the new and upgraded roads, and Appendix B shows the detailed road-section alignments. This alignment is generally final, with the exception of some portions approaching the Kuribrong and Essequibo Rivers (within 2 km), where the general corridor has been determined but more in-depth field investigation will confirm the final alignment.

The access road generally parallels the transmission line corridor. Portions of the access road are within the transmission line corridor in the new road section between the Kuribrong River and the hydropower site (approximately 33 km out of 43 km). Where the road and the transmission corridors coincide, the roadway will be offset (e.g., 20 to 30 m) from the centerline of the transmission line clearing, to allow the transmission line to be in the center of the clearing and the road immediately to one side of it. As mentioned earlier, to access the transmission line corridor for construction and maintenance, short branch feeder roads will be installed.

The Access Road Contractor implemented an Initial Works Environmental and Social Management Plan for the road alignment survey. The Company also inspected the road alignment to characterize the natural habitat (see Section 4 for results) and advise on possible changes to the alignment.

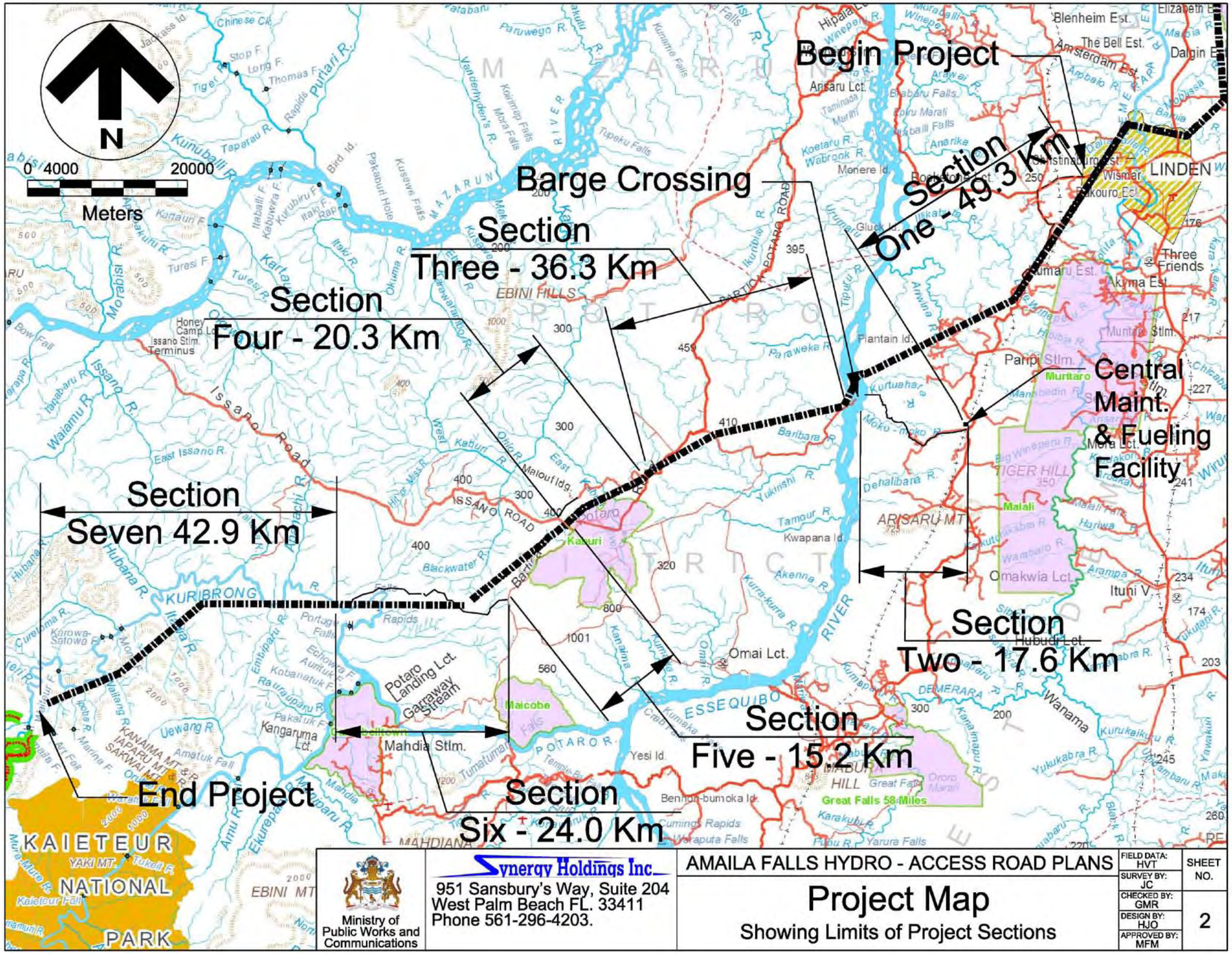


Figure 2.28. Project Access Road sections

2.3.1.2 Design Standards

Both the upgraded and new access roads will be designed to minimize maintenance requirements and handle the construction traffic anticipated for the Hydropower Facility and Electrical Interconnection. The Access Road to the hydropower site must be capable of handling equipment weighing at least 100 tons. The roads will be designed for speeds of at least 50 km/hr, with minimum sight distances and long turning radii. To facilitate large, heavy truck loads to the hydropower site, the main access-road system will provide gentle slopes (e.g., less than 10%). The design and installation of the Access Road will conform to Guyana national safety standards, as well as international specifications defined in the construction specifications.

The Access Road will also include construction of short feeder roads to provide access to the transmission line corridor. These feeder roads are not required to meet the same standards as the main Access Road. The feeder roads will be designed per the specifications of the access road contract.

2.3.1.3 Road Width

The Access Road will require a corridor (RoW) of approximately 20 m. The topography of the adjacent ground may also require some re-contouring of adjacent steep slopes, to make an acceptable transition grade to the road. A typical cross-section of the main access road is shown in Figure 2.29. The new Access Road alignment generally follows within the transmission line corridor, in which case, the cleared area is same as the transmission corridor. As shown in the cross-section figure, the road width generally consists of the main road bed, about 5-7 m wide; another 6–7 m on each side may be required for additional shoulder, drainage ditches, and cleared area beside the road. The width of the transmission line corridor feeder roads will be narrower, normally a maximum of 10 m.

2.3.1.4 Bridges and River Crossings

The Access Road will require two major river crossings: one at the Essequibo River, and one at the Kuribrong River. There is a second crossing of the Kuribrong River directly at the hydropower site, which will be constructed by the EPC Contractor.

The Essequibo River will be crossed using a ferry (or pontoon) landing at the existing site of Butakari, on the west bank of the Essequibo. The details of this landing will be defined during final engineering of the Access Road.

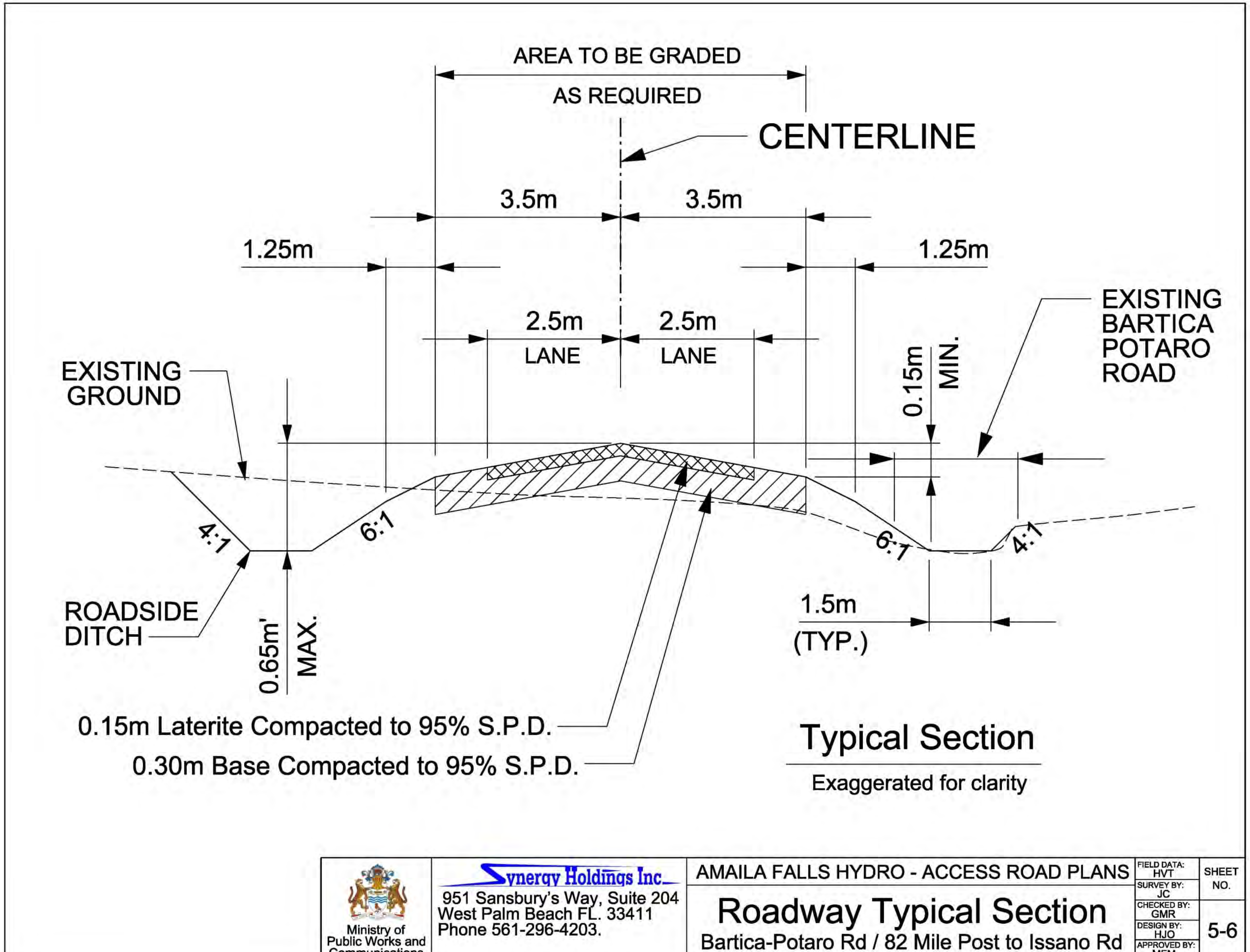


Figure 2.29. Roadway typical section, Amaila Falls to Wisrock/Linden

The Kuribrong River bridge will be located approximately 43 km east of the hydropower site. The Kuribrong River bridge will adhere to conservative design criteria, in accordance with AASHTO LRFD standards. This crossing will be a bridge designed with intermediate columns between the banks of the river. A plan view of the crossing is presented in Figure 2.30. The detailed design will be reviewed during the engineering phase and will consider the river flows, water levels, and topography of the approaches to/from the bridge. A security station will be located at this bridge.

Other smaller rivers and streams will be crossed using bridges, culverts, and similar structures. Based on preliminary engineering, about 12 timber bridges are anticipated, half of which will replace older existing bridges. Figure 2.31 shows a typical design view of the timber bridges. In applicable areas, vegetation clearing for crossings will be done in a manner to mitigate potential fragmentation impacts.

Culverts will be designed for a 50-year event based on historical rainfall data. The timber bridge design will follow the standard design, which provides a conservative load rating. Bridge design and crossings will be evaluated further during the final engineering and construction stages of the Access Road Contract.

2.3.1.5 Drainage

The Access Road drainage system is designed to redirect surface storm water flow to maintain the natural drainage of the terrain without interfering with traffic safety or increasing road maintenance. Proper drainage is a significant factor in the long-term condition and maintenance of the road surface. Features within the drainage system will properly manage the flows to control erosion and manage water discharges to the nearby low areas and waterways. Among the main features of the drainage system are the following:

- Intercept and capture waters coming over the roadway, directing them to a safe outflow
- Regulate the flow of water from one side of the roadway to the other, along all waterways intercepted by the Project, connecting the surface drainage system with natural waterways
- Empty water that infiltrates the platform to prevent deterioration of the road subgrade and surface
- Ensure continuity of the rain drainage system of areas adjacent to the roadway through systems that avoid uncontrolled flows over the roadway
- Provide drainage ditches alongside the new and upgraded roads, with appropriate slopes and slope breaks, and soak-away channels.

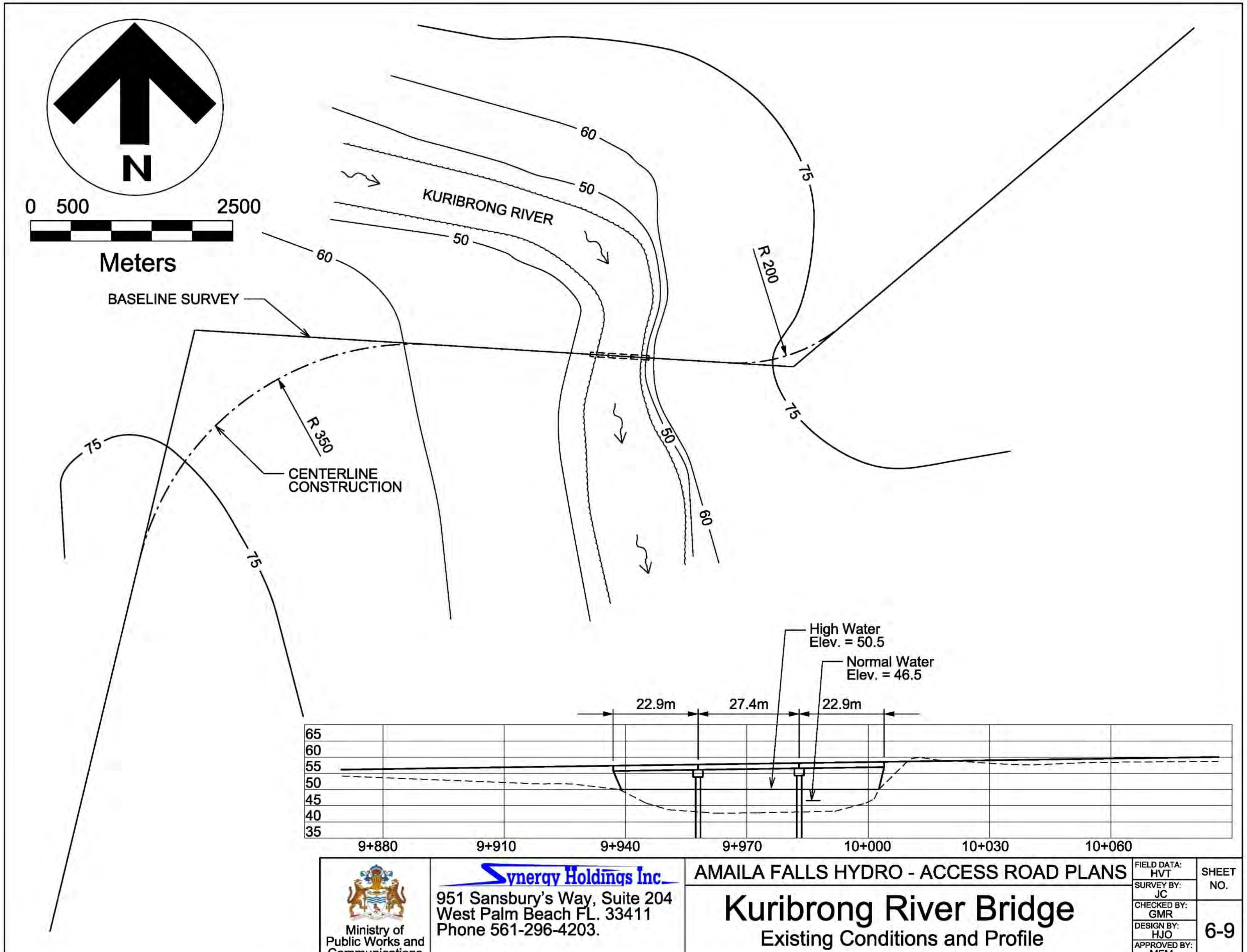


Figure 2.30. Kuribrong River Bridge, existing conditions and profile

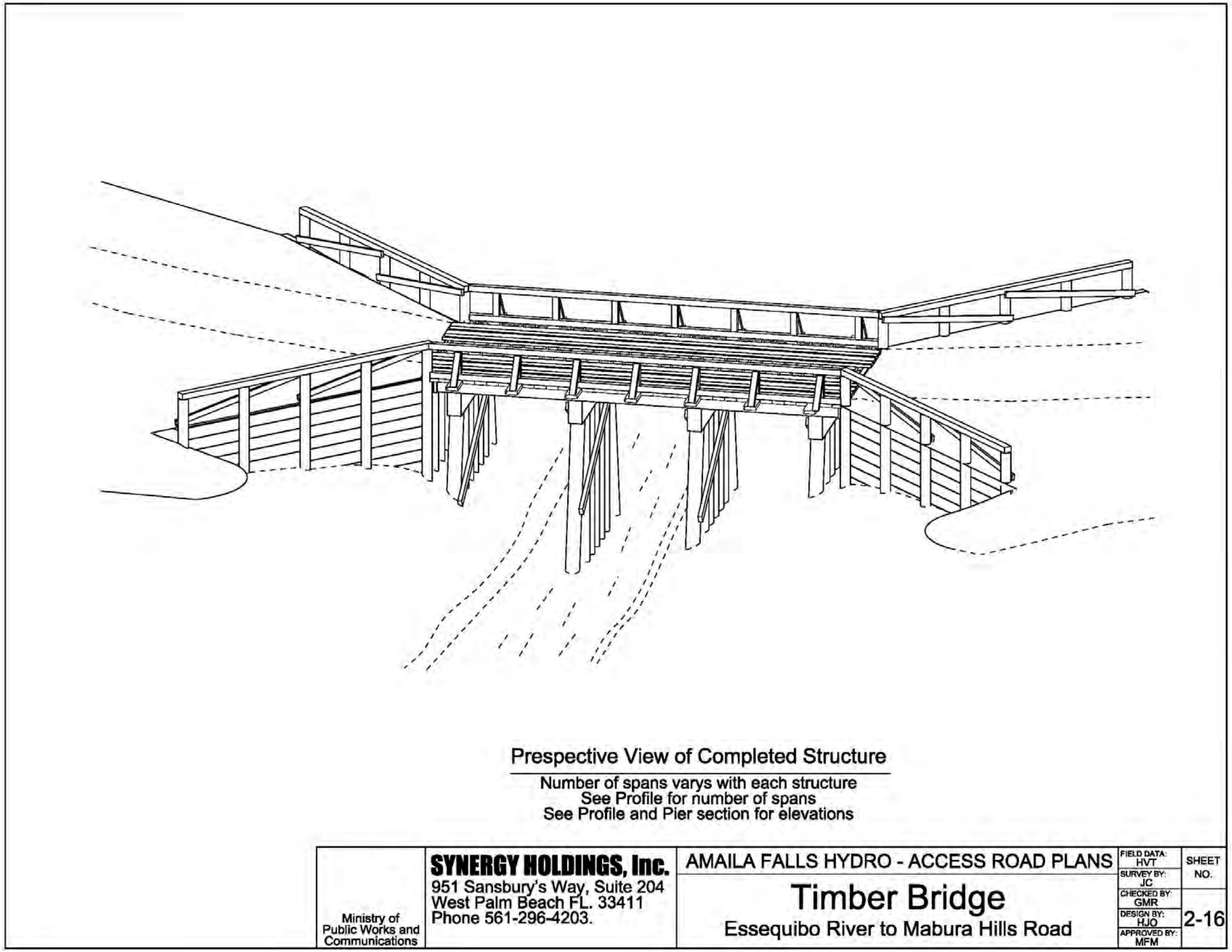


Figure 2.31. Timber Bridge, Essequibo River to Mabura Hills Road

The design of the drainage systems will be defined using available historical meteorological information, 1:5000 topography map, local field survey maps, and hydraulic analyses. The final design basis, assumptions, and methodology for establishing the drainage systems for the road will be approved by the GoG engineer, as well as potential sedimentation and erosion control measures.

The major water crossings will be designed based on estimated 50-year events.

Culvert and pipes may be used for crossing gullies and waterways (if bridges are not used), and for sections of the road with water on both sides. Culverts will be designed appropriately for the maximum expected road loading and estimated water discharges.

Fords/low-level crossings may be installed on some feeder roads that access the transmission line corridor. They are anticipated only for small, shallow (<0.5 m) streams, and if bank approach height is low and gradually sloped, and if the stream bed is stable (gravel or sand).

2.3.2 Construction

2.3.2.1 Work Fronts

After the final road alignment is confirmed and approved by the GoG, the Access Road Contractor will begin work on several fronts. The construction will maximize its use of dry-season weather, and will put in place measures to facilitate wet-season construction later. The work will first focus on the new sections of the road and the clearing of the transmission line alignment.

The first section to be built is the Road Section 2 from Mabura Hill Road (MHR) to the Essequibo River east bank landing. On reaching the river, the west bank landing will be built, along with necessary facilities for the pontoon crossing. The completed Section 2 and Essequibo River crossing facilities will provide an efficient route for the road construction support services to gain access to the remaining work areas.

A second team will simultaneously begin work in Sections 6 and 7 between BPR and the hydropower site. A temporary pontoon crossing will be set up to cross the Kuribrong River to allow the team access to Section 7. A team will be accompanied by a geologist/soil scientist to confirm geotechnical features for road design. The team will also include a forestry expert to tag commercial tree species and maintain a log of these commercial trees that will need to be cut and stacked. Soil elasticity testing will be conducted and logged, and the final specific alignment will be confirmed for construction. Based on current ground-truth survey results, the present proposed road alignment is not expected to change; however, as the clearing teams gain more detailed information, minor adjustments to the alignment may occur with the approval of the Access Road Contractor and GoG.

The general steps in Access Road construction are:

- Vegetation clearing, biomass handling, burning (note: to the extent required—for example, in some areas where the road is upgraded, no vegetation clearing is needed)

- Ground grubbing and bedding for road base
- Installing bridges, culverts, etc.
- Road capping and stormwater drainage.

2.3.2.2 Traffic/Access Control

The Access Road Contractor will, as applicable and necessary, direct public traffic around road construction areas. Public use of the new Access Road section west of the BPR will be prohibited during road construction and restricted to Project traffic thereafter (see road access control measures in Section 7 for details). This includes, during construction, a security point on the new access road between the BPR and the hydropower site to restrict public traffic.

2.3.2.3 Vegetation Clearing

Vegetation clearing will be completed for areas of the new Access Road and a portion of the transmission line corridor from the Kuribrong River to the hydropower site. See Section 2.2.3.3 for a summary of vegetation clearing for the transmission line corridor. For details on the vegetation clearing process and procedures, refer to Section 7 and the Access Road Contractor ESMP.

2.3.2.4 Earthworks and Surface Treatment

The Access Road alignment will cross a variety of soil-type areas, including soft, compressible soil layers. In many areas, the organic top layer is less than 30 cm thick, and the underlying sand may be several meters deep. These conditions will require an engineered approach to excavate to an acceptable depth and replace the soft material with stabilized fill. The surface will require hard capping with appropriate drainage measures to avoid de-stabilizing the underlying material.

Earthwork activities will start after the road corridor is cleared, and will include equipment such as bulldozers, front-end loaders, off-road trucks, and scrapers. Grubbing and bedding earthworks will root rake and remove all organic debris from the corridor. The road and shoulder will be bedded up using good fill from the swales and drainage area and creating a crowned finish typically 30-60 cm higher than the surrounding natural elevation. Should the soils in the area not be of acceptable quality, the off-road trucks will be used to remove the unsuitable soil and replace it with suitable fill acquired from borrow pits. If needed, unsuitable excavated material may be removed to spoil areas or piled outside of the road bed.

The earthwork activities will include excavation of materials in the borrow areas, development of spoil areas, and transport of materials within the corridor. The borrow and spoil areas will be closed and re-graded to natural contours on completion of road construction.

Use of explosives is not anticipated; however, if the excavation encounters shallow stone areas, then use of explosives may be required, along with subsequent removal using heavy equipment. The Access Road Contractor will obtain approval from GoG prior to use of any explosives.

Specific procedures will be developed and necessary permits will be acquired. If the use of explosives is anticipated, the Company or GoG will notify any nearby residents.

Fill areas will be constructed by depositing consecutive layers and compacting those layers over the full width of work sections. This work will involve the use of road graders, disc harrow tractors, water trucks, and various types of roller compactors to ensure the ideal conditions for compaction.

The Access Road construction will require an estimated 150,000 cubic meters of loam, and another 150,000 cubic meters of laterite. Some sections of the road will have an ample supply of loam or laterite made available during the cut-and-fill grading activities. Other areas will not have suitable material within the immediate roadway corridor, and therefore, material will be obtained from nearby existing or newly created borrow pits. During the initial alignment survey, the Access Road Contractor identified a number of potential borrow-pit locations for sources of loam and/or laterite, as shown in Figure 2.32. The Access Road Contractor will endeavor to obtain the material needed for road construction from borrow pits close to the work areas. The Access Road Contractor will confirm with the GoG the actual locations of borrow pits used for sourcing the road fill/surfacing material.

A capping team will be responsible for extracting the laterite and loam from borrow pits, as well as creating the proper soils mix per the design specifications. This team will also lay the bedding and surface material for the road, including compacting the sub-base and capping the surface with laterite or other approved material to provide a finished driving surface. A survey team will ensure that the road is laid out properly, bedded up, and surfaced to the necessary dimensions and grade.

2.3.2.5 Installation of Drainage Systems

The excavation, settlement, grounding, and refilling of storm drainage will involve linear excavation with a bulldozer or excavator in sequential cuts. Appropriate material will be laid to avoid erosion or filling of the drainage ditches. Depending on the stability of the slope, some shoring may be required to stabilize the surrounding ground.

Installation of culvert pipes may require cofferdams before excavation and installation, and backfilling. Particular attention will be given to preventing sedimentation or unnecessary erosion of the banks or bed of the watercourse.

2.3.2.6 Work Camps

Figure 2.33 shows the proposed Access Road temporary work-camp locations. These camps will be occupied as required for the activity in that local area, and will be cleaned properly prior to departing. The camps will be supplied with food rations, portable generators, tools, accommodations, and appropriate waste-handling facilities. The work camps will provide a central location (within the locality of a work area) in which both routine and unplanned

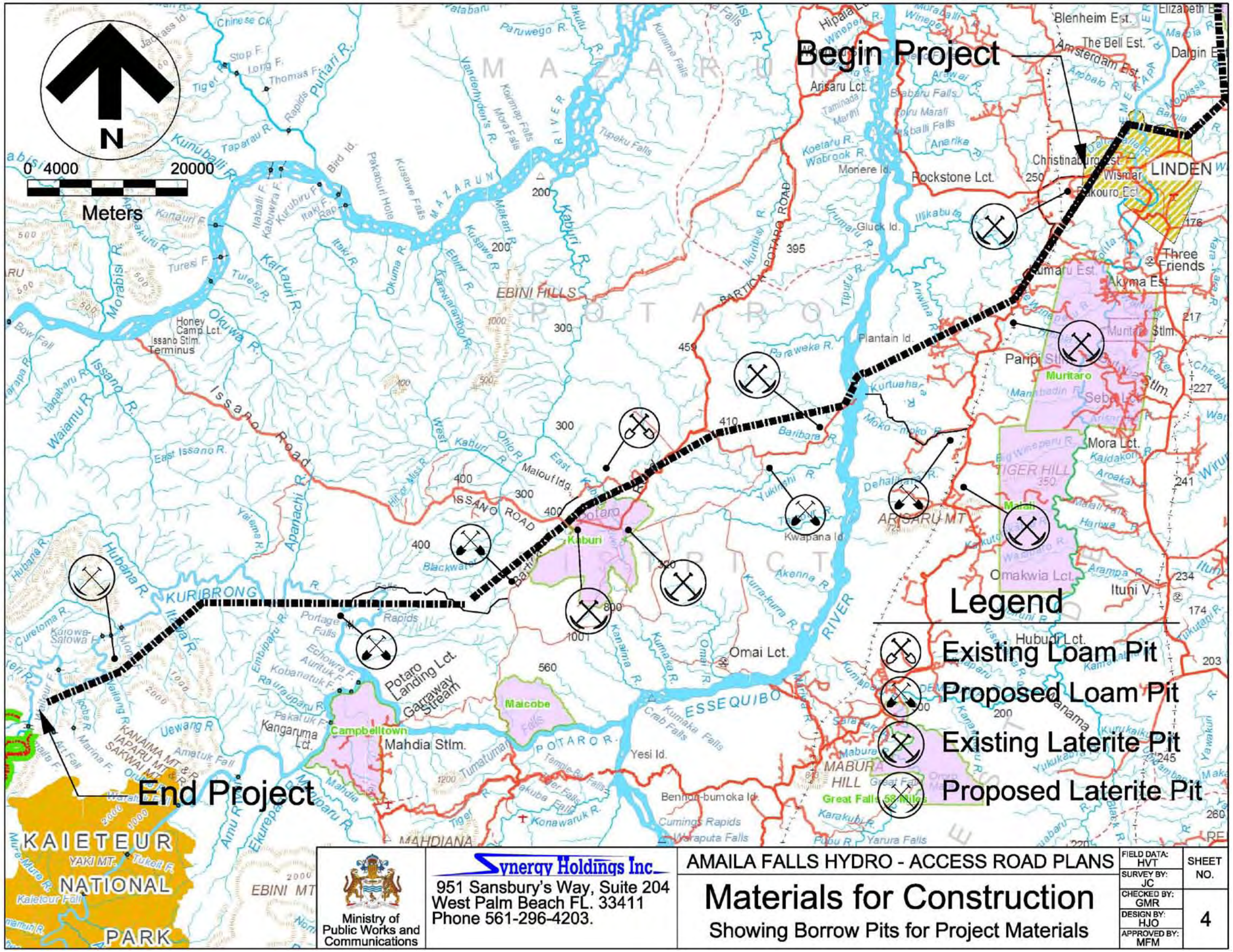


Figure 2.32. Potential construction material burrow pits for Access Road

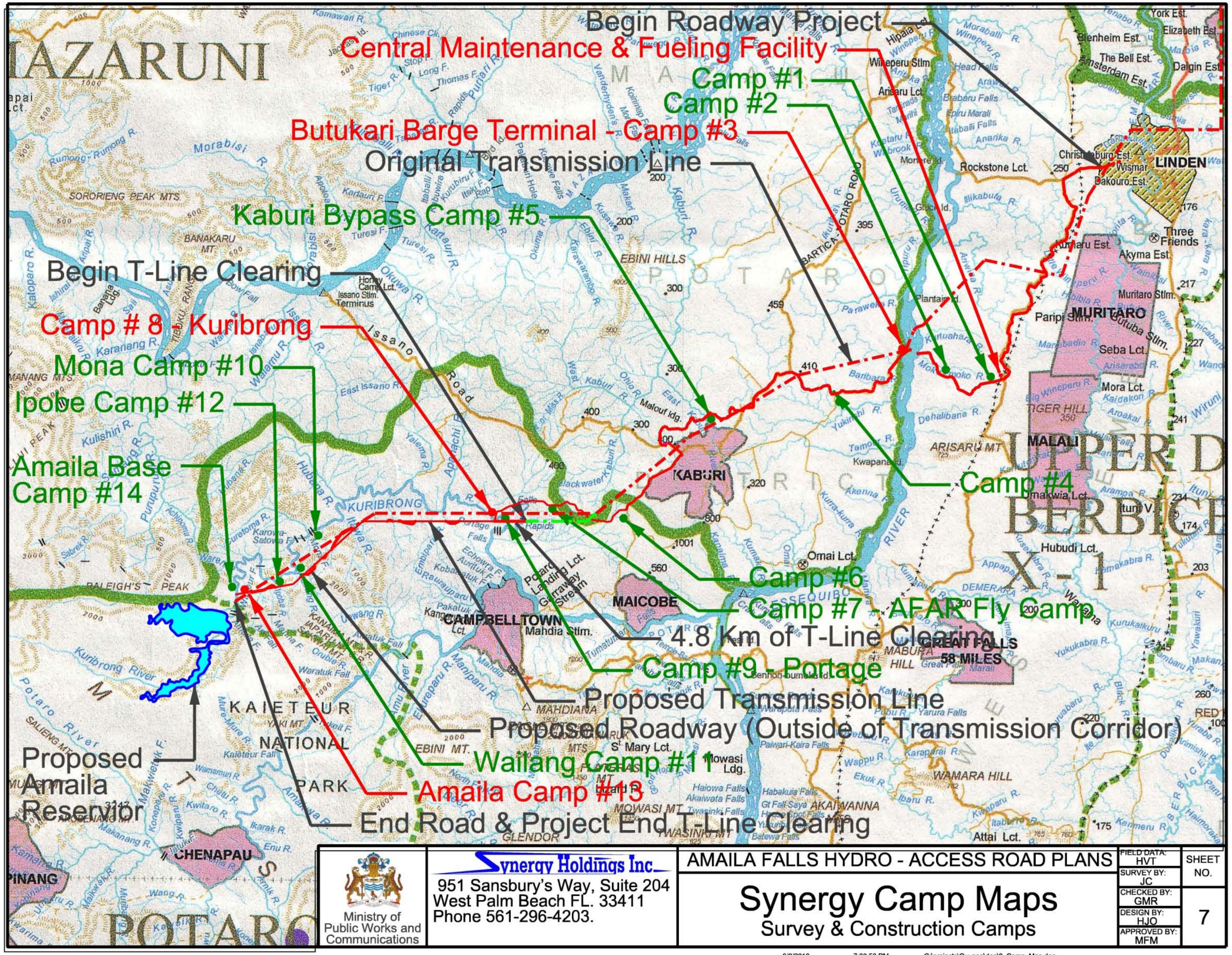


Figure 2.33. Potential Access Road Contractor construction camp locations

equipment maintenance can occur. Maintenance may include greasing the equipment, repairing broken hoses, or maintaining auxiliary equipment. Emergency maintenance may include repairing tracks of an excavator. Maintenance will be avoided in the field, and will be conducted at work camps if possible. Camp and work areas will be controlled to prohibit unauthorized access. The Access Road Contractor Environmental Social Health and Safety Management Plan provides details on environmental management (e.g., potable water, wastewater, waste management, etc.), security, and other requirements for work camps (see Section 7 for details).

2.3.3 Operation and Maintenance

The Project Access Road is being constructed through a contract executed by the GoG. GoG will be responsible for maintaining and managing the Project access road. The Access Road Contractor is currently contracted to provide maintenance services for three years after construction of the roads, to ensure adequacy of the roads to support heavy traffic during Project Hydropower Facility and Electrical Interconnection construction.

The key operation and maintenance activities for the Access Road will include:

- *Surface evaluation and maintenance.* As the main element of the road, the laterite surface plays a key role in the overall ongoing performance of the road. As such, its proper evaluation and maintenance are critical. Access road surface condition and performance will be inspected and monitored routinely; for example, in terms of roughness, distress, etc.

- *Evaluation and maintenance of drainage works.* The proper functioning of drainage systems is required to avoid erosion and sedimentation, access-road damage, and possible impacts on vehicle transit time. Most prominent drainage malfunctions consist of backed-up ditches and drainage pipes as the result of sediment accumulation, erosion of embankments as a result of unanticipated/extensive or misdirected runoff, and accelerated surface wear as the result of diminishing vegetative ground cover. The drainage components and the landscape and grades immediately adjacent to the roadway will be inspected periodically to reveal the sources of particular problems and the appropriate corrective actions. In addition, routine (e.g., semiannual) cleaning of the drainage components and revitalization of runoff, erosion, and sediment control measures will be performed to reduce the probability of malfunction and prevent the need for emergency operations following heavy precipitation events.

- *Maintenance of bridges.* Due to the inherent impact of problems or failures of bridges and the substantial replacement cost, bridges will undergo annual inspections and timely maintenance and repairs. Such inspections will include visual inspection of abutments, bearings, retaining walls, and piers for defects, damage, and deterioration.

- *Signs and signal maintenance.* Routine inspection and maintenance of signs and signals along the access road will be performed to detect and address issues.
- *Evaluation, monitoring, and maintenance of road safety.* Regular appraisal of the road function and appropriateness of design will be performed during operations to help ensure safe conditions.

The GoG will be responsible for access control, as well as other environmental management aspects of Access Road operation and maintenance (see Section 7 for details).

2.4 Workforce

2.4.1 Size

The Project Hydropower Facility and Electrical Interconnection will be constructed by the EPC Contractor, under contract to the Company. The EPC Contractor may engage subcontractors to conduct specific work components.

For the Hydropower Facility, the EPC Contractor estimates an average workforce of about 700 workers and a peak of approximately 1200 workers. The EPC Contractor workforce to construct the Electrical Interconnection is expected to reach a maximum of about 600 workers, but average about 300. The general labor types required for construction include equipment operators, plant operators, mechanics, surveyors, truck drivers, foremen, electricians, carpenters, concrete masons, ironworkers, skilled laborers, and common laborers. The final worker type and distribution (timing) of the construction workforce will be defined by the EPC Contractor.

The estimated workforce for operation and maintenance of the Hydropower Facility and the Electrical Interconnection may be up to approximately 70. In addition to the direct hire operation and maintenance staff, support by other third party contractors and consultants may be provided to support maintenance, security, and other operation and maintenance activities. This third party support will peak during planned outage maintenance events.

The Project Access Road will be constructed by the Access Road Contractor, under contract to the GoG. The estimated peak workforce for the Access Road construction is approximately 50, and includes support staff for logistics, transport, engineering, and project management.

The estimated Access Road workforce during operation and maintenance will be relatively small and intermittent in nature (i.e., many not working full-time exclusively on the access road). The GoG will perform the operation and maintenance either with Ministry of Public Work staff or by subcontracting for such services.

2.4.2 Recruitment

The EPC Contractor, Access Road Contractor, and their subcontractors will be responsible for retaining the required workers for the Project. Some workers will be from outside of Guyana, while many workers will be hired from within Guyana. A significant portion of the workforce will be technical and professional staff required for design and management of the construction operations, while many semi-skilled and unskilled laborers will also be required. Up to 40% or more of the workforce may be semi-skilled and unskilled laborers who may be hired from within Guyana.

The worker recruitment process will be managed by the EPC Contractor and its subcontractors, and the Access Road Contractor (as applicable). Contractual commitments will be obtained from the construction contractors that all workers directly employed on the Project will be employed in accordance with the provisions of national labor law, industry practice, and Project labor requirements (see Section 7 for details). Labor protection provisions will include those pertaining to working hours, overtime, and form and frequency of pay. All Project workers will be fully informed of the work arrangements prior to being hired.

Due to the remote location of the hydropower site and portions of the transmission line, it is anticipated that a number of workers may be recruited from communities located in rural areas in relative proximity to the Project. The Company will work closely with the EPC Contractor to ensure that local communities are informed and involved in the recruiting process. Labor recruitment centers will be set up in major labor pool markets such as Georgetown, Linden, and Bartica. Workers will be recruited without discrimination and hired according to available positions and qualified applicants. The Company and the EPC Contractor will develop a training program to engage affected people to assist them in qualifying for positions. The Company and the EPC Contractor will develop planning measures to discourage worker influx to the site and Project area for employment. Recruiting will not be conducted at the hydropower site. See Section 7 for summary of labor recruitment plan.

2.4.3 Accommodations

Because there are no cities or communities near the hydropower site and large portions of the transmission line and Access Road, temporary housing for construction staff will need to be provided. Housing for Hydropower Facility construction staff will be provided at the hydropower site (see Sections 2.1.2.2 and 2.1.2.3). Transport will be arranged for workers to periodically travel to and from the site. The EPC Contractor will indicate worker compensation arrangements, including work hours and schedule for time off. The hydropower site will have communication facilities available for workers to communicate. The Hydropower Facility operation and maintenance staff will be housed onsite.

Housing for construction workers for the transmission line will be located in Linden and at the hydropower site. However, movable temporary work camps will be located along the transmission line as the work teams move along the alignment. Workers at the Sophia substation will be housed in Georgetown.

Housing for construction workers for the Access Road will be located in temporary work camps along the road (see Section 2.3.2.6).

2.5 Schedule

The current anticipated Project schedule is presented in Table 2.10.

Table 2.10. Project schedule

Activity	Target Date
Begin access road construction (by GoG)	September 2010
Begin hydropower site construction	Mid 2011
Begin transmission line work	Mid 2011
Fill reservoir and begin hydropower commissioning	Mid 2014
Project Operation – Deliver power to GPL	End 2014

The Project Access Road construction is estimated to be completed prior to the start of construction of the Hydropower Facility. The Project Hydropower Facility construction is estimated to be completed in approximately 3 ½ years. Construction of the Electrical Interconnection will require about 2 ½ years, including selection of the final alignment, tower spotting, foundations, installation, and commissioning.