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September 23, 2026

Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, NL A1A 5B2

Attention: Mike McNiven
Senior Regulatory Advisor & Board Secretary

Re: *Reliability and Resource Adequacy Study Review* – Battery Energy Storage System Feasibility Study

Please find enclosed Newfoundland and Labrador Hydro's Battery Energy Storage System Feasibility Study, provided in accordance with the 2024 Resource Adequacy Plan Settlement Agreement.[1]

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO



Shirley A. Walsh
Senior Legal Counsel, Regulatory
SAW/kd

Encl.

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[1] "2025 Build Application – Bay d'Espoir Unit 8 and Avalon Combustion Turbine," Newfoundland and Labrador Hydro, March 21, 2025, sch. 2.

Battery Energy Storage System Feasibility Study

Overview

September 23, 2026

A report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro



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Attachment 2: Battery Energy Storage Feasibility Study – Basis of Estimate – Hatch Ltd.

Attachment 3: Preliminary Cost Estimate – Battery Energy Storage System Feasibility Study – Newfoundland and Labrador Hydro

Attachment 4: Basis of Schedule – Battery Energy Storage System Feasibility Study – Newfoundland and Labrador Hydro

Attachment 5: Battery Energy Storage Feasibility Study – Basis of Schedule – Hatch Ltd.

1.0 Context

Newfoundland and Labrador Hydro ("Hydro") filed the initial Reliability and Resource Adequacy Study ("RRA Study") with the Board of Commissioners of Public Utilities ("Board") in November 2018 ("2018 Filing").[1] Since the 2018 Filing, throughout the continued *Reliability and Resource Adequacy Study Review* proceeding ("*RRA Study Review*"), Hydro has filed regular updates to the RRA Study, including numerous technical notes, additional studies, and third-party reports. The regulatory record is appropriately robust given the rapid transformation of the provincial electricity system, including interconnection, asset retirement, new resources, and increasing demand.

Hydro's 2024 Resource Adequacy Plan,[2] submitted to the Board on July 9, 2024, provides Hydro's recommended Minimum Investment Required Expansion Plan. Subsequent to filing the 2024 Resource Adequacy Plan, in the fall of 2024, Hydro and its experts participated in a series of technical conferences with Board staff and intervening parties, along with their experts. These technical conferences provided an opportunity for fulsome discussion and enhanced understanding of Hydro's *RRA Study Review* and Expansion Plans. As a result of these proceedings, Hydro and the intervenors gained consensus on a number of issues ("Settled Issues") which were specified in a Settlement Agreement.[3] The Settled Issues include agreement that the recommendation to build a new 150 MW unit at Bay d'Espoir (Unit 8) and a 150 MW Combustion Turbine on the Avalon Peninsula is appropriate as part of the first step in addressing the requirements for additional capacity for the Island Interconnected System, and applications for these projects should be filed for evaluation. In line with the Settled Issues, Hydro filed its 2025 Build Application for both of these assets in March 2025; the regulatory proceeding is ongoing.

Hydro will have to make significant investments in the coming years and decades to maintain its legislative obligation of the provision of safe, least-cost, reliable electrical service in an environmentally responsible manner to the province.[4] The recommended assets within Hydro's Minimum Investment Required portfolio are just that, the Minimum Investment Required to meet Hydro's obligations, with

[1] "Reliability and Resource Adequacy Study," Newfoundland and Labrador Hydro, rev. September 6, 2019 (originally filed November 16, 2018).
[2] "2024 Resource Adequacy Plan – An Update to the Reliability and Resource Adequacy Study," Newfoundland and Labrador Hydro, rev. August 26, 2024 (originally filed July 9, 2024).
[3] "2025 Build Application – Bay d'Espoir Unit 8 and Avalon Combustion Turbine ("2025 Build Application")," Newfoundland and Labrador Hydro, March 21, 2025, sch. 2.
[4] *Electrical Power Control Act*, 1994, SNL 1994, c E-5.1, s 3(b)(iii).

additional investment necessary to meet Hydro's most likely to occur Reference Case. As such, through the *RRA Study Review*, Hydro models its system expansion in consideration of various forecast scenarios and within the context of continuously evolving energy policy. The numerous studies that Hydro has completed and planned are all necessary to validate and justify the information that Hydro inputs into its models, which produce critical information on which timely, prudent decisions are to be made.

While the enclosed study provides valuable, necessary information, it cannot and should not be considered independent of the rest of the studies and analyses ongoing through the *RRA Study Review*. Rather, the study is an input that will—along with other studies completed and ongoing—inform Hydro's broader system resource planning process now and into the future.

2.0 Study Background

Hydro retained Hatch Ltd. ("Hatch") to undertake a Battery Energy Storage System ("BESS") Feasibility Study, provided as Attachment 1,[5] evaluating utility-scale BESS installations on the Avalon Peninsula. Four configurations were assessed as shown in Table 1.

Table 1: BESS Options Studied as Part of the BESS Feasibility Study

Option	Capacity	Duration
Option 1	20 MW	4-hour
Option 2	20 MW	8-hour
Option 3	50 MW	4-hour
Option 4	50 MW	8-hour

The feasibility work included:

- Site identification and screening;
- Preliminary engineering and layout development;
- Electrical integration concepts;
- Civil and structural requirements;
- Cost estimating;

[5] The final BESS Feasibility Study from Hatch was accepted by Hydro on June 29, 2026.

- Risk identification; and
- Development recommendations.

2.1 Purpose

The primary aim of the feasibility study was to determine the technical feasibility, preliminary capital cost, and development requirements associated with utility-scale BESS facilities capable of providing reliability and resource adequacy support to the Island Interconnected System. The details of the Class 4 Cost Estimate (as per the Association of the Advancement of Cost Engineering ("AACE")) are provided within the Hatch estimate, provided as Attachment 2.[6]

3.0 Key Equipment Selection and Technical Evaluation

3.1 Energy Storage Use Case

The proposed BESS facilities are intended primarily to provide peak capacity and reliability support. The facilities are anticipated to operate as required during peak demand periods or system contingencies.

3.2 Technology Basis

Hatch evaluated various BESS technologies, predominantly those using lithium-ion battery technology. These included batteries with chemistries including nickel manganese cobalt lithium, nickel cobalt aluminum lithium, and Lithium Iron Phosphate ("LFP"), which all have intrinsic capabilities and limitations.

Through analysis of these options, which accounted for, but were not limited to, properties including battery power, energy and degradation, operating constraints, and end-of-life considerations, it was determined that LFP chemistry was the preferred technology within these design criteria. The conceptual designs utilize containerized battery systems, Power Conversion Systems ("PCS"), Medium-Voltage Transformers ("MVT"), Energy Management Systems ("EMS"), monitoring, and control systems.

[6] The final Basis of Estimate from Hatch was accepted by Hydro on August 6, 2026.

3.3 Site Selection

Five locations were reviewed during the feasibility assessment subject to the selection criterion for this design:[7]

- Hardwoods Terminal Station Greenfield Site;
- Hardwoods Terminal Station Brownfield Site;
- Goulds Substation;
- Virginia Waters Substation; and
- Oxen Pond Terminal Station.

Following screening, the preferred locations were reduced to:

- Hardwoods Terminal Station Greenfield Site;
- Hardwoods Terminal Station Brownfield Site; and
- Goulds Substation.

Of these three, the Hardwoods Greenfield Site was identified as the optimal location for the BESS considering there is relatively flat terrain, superior equipment and construction access, minimal requirement for heavy earthworks and demolition, current (industrial) zoning, and prospective minimal impact on surrounding community and environment.

3.4 Major BESS Design Criteria

The following section highlights the design criteria for the BESS, which includes discussion on design standards, key component design, as well as operating conditions and climatic considerations.

The conceptual design incorporates:

- Battery containers;
- PCS;
- MVTs;

[7] The selection criteria is established in Table 4-1, Page 22 within Attachment 1.

- EMS;
- Protection and control systems;
- Communications and telemetry systems;
- Fire detection and suppression systems; and
- Battery monitoring systems.

The relevant design codes and standards related to the above system components include Canadian Standards Association ("CSA"), Institute of Electrical and Electronics Engineers ("IEEE"), National Fire Protection Association ("NFPA"), and Underwriters Laboratories ("UL").

The BESS is expected to be used as peak period support to improve grid reliability. This assumes less than 100 equivalent full cycles (charge to discharge) per year. Hydro will have dispatch authority and will be able to fully remotely monitor system setpoints and on-system measurement equipment.

The BESS system is designed for the local environment and is fitted with appropriate heating and cooling systems, which will allow the full functionality of the units to -25 degrees Celsius. The enclosures should also withstand site climatic properties such as wind, salt spray, and snow load and any subsequent water ingress potential.

3.5 Electrical Design Requirements

The electrical design criteria cover the following:

- Setpoints – voltage levels and power factors;
- Metering and power quality;
- Protective devices – microprocessor-based relays, collectors, MVTs and feeders;
- Voltage regulation;
- Electrical equipment rooms;
- Medium voltage switchgears;
- High voltage equipment – conductors, step-up transformers, buried cables, and interconnections; and

- Yard lighting and cables (medium voltage/high voltage).

Equipment design will be in accordance with relevant industry and Hydro-accepted standards and codes, such as American National Standards Institute ("ANSI"), American Society for Testing and Materials ("ASTM"), CSA, Federal Communications Commission, IEEE, International Organization for Standardization, National Building Code of Canada ("NBCC"), National Fire Code of Canada, NFPA, National Electrical Manufacturers Association, Society for Protective Coatings, Telecommunications Industry Association, and UL.

The design basis also incorporates interconnection requirements and compliance with Hydro transmission standards.

3.6 Controls Design Criteria

The BESS and all interconnections will be designed for full real-time monitoring, control and data acquisition from both the local (on-site) control system and from Hydro's Energy Control Centre, with supervisory authority selectable via a transfer switch between local and remote control.

The control architecture will outline the requirements and functionality between the PCS, EMS, Supervisory Control and Data Acquisition, and all protection systems.

The control design will conform to Hydro-accepted standards, including cybersecurity and data acquisition standards.

3.7 Civil, Structural, and Geotechnical Design Criteria

This section highlights the design criteria and codes and standards used as part of the civil, structural, and geotechnical design of the BESS.

3.7.1 Civil Design Criteria

Civil design criteria will cover the site development, access road design, stormwater management and overall site layout. This includes details of the following items:

- Site preparation and road design;
- Fencing;

- Substation structures;
- Earthworks and levelling; and
- Stormwater management, hydraulics, ditches, culverts and overall hydrology.

Applicable standards include American Association of State Highway and Transportation Officials, ANSI, ASTM, Canada Occupational Health and Safety Regulations, CSA, Canadian Society for Civil Engineers, NBCC, Transportation Association of Canada, IEEE, and other general requirements (including all applicable municipal, provincial, and federal regulations, methods, and laws).

3.7.2 Structural Design Criteria

The structural design criteria cover all foundations, support structures, and structural components required for the BESS configuration. This includes but is not limited to:

- PCS pads;
- Mounting structures;
- Security and monitoring systems;
- BESS equipment foundations;
- Electrical substations;
- Monitoring and control foundations;
- Any other structural works inside the BESS area.

Applicable codes and standards covering structural design include American Concrete Institute, American Society of Civil Engineers, ASTM, Cement Association of Canada, Canadian Geotechnical Society, CSA, Canadian Institute of Steel Construction, NBCC, National Research Council Canada, and Reinforcing Steel Institute of Canada.

Corrosion control considerations will be based on the climatic conditions of the site and will conform to Hydro requirements, with appropriate material selection based on experience and applicable code.

3.7.3 Geotechnical Design Criteria

Currently, geotechnical reports for the proposed sites do not exist. Thus, the following design assumptions have been made with respect to overall geotechnical design criteria:

- Excavation to assumed 1.5-metre depth;
- Footings to be placed on structural fill;
- Assumed adequate excavation and dewatering of site construction areas;
- Frost protection can be achieved;
- No additional mud slab or cement layer will be required in structural design; and
- Assumed high groundwater table in site area.

Further design considerations and applicable codes and standards will be generated and added as part of the overall design criteria once further geotechnical work and studies are completed.

3.8 Permitting and Regulatory Requirements

Additional environmental, geotechnical, noise, stormwater, and permitting studies are recommended prior to project advancement. Land acquisition and final site selection activities are also required.

4.0 Cost Estimate

Hatch prepared a cost estimate, provided as Attachment 2, in accordance with AACE Class 4 estimating practices, using the design criteria discussed throughout Attachment 1, and considering the BESS configuration at the Hardwoods Greenfield Site. The primary estimate has been completed for **Option 4—**a 50 MW capacity BESS with an 8-hour reserve. All options were estimated as part of the study and are included within Appendices B, C, D, and E of Attachment 2.

Using the data within Hatch's Basis of Estimate, Hydro prepared a preliminary project cost estimate which included details on the basis of the project costs, the estimate classification, the additional costs from Hydro (including updates to Owner's, contingency, escalation and Interest During Construction ("IDC") costs), and relevant project cash flows used to determine some of the aforementioned cost items. Hydro's preliminary cost estimate has been provided as Attachment 3.

It is important to recognize that feasibility studies and associated cost estimates for BESS systems are subject to additional variability due to the rapid evolution of battery technology and the pace of market development for these resources. As a result, the period during which such studies and associated estimates remain valid is generally shorter than for other project types.

4.1 Estimate Classification

The estimate is classified as an AACE Class 4 estimate developed in accordance with AACE 18R-97 (applied to process industries) with an expected accuracy range of:

- -15% to -30% (low side); and
- +20% to +50% (high side).

The estimate is presented in 2026 Canadian Dollars ("CAD"). Costs submitted in other currencies were converted to CAD.

4.2 Pricing Basis

Hatch used a pricing-based coding to ensure confidence within the pricing methodology and ensure alignment with the target class (Class 4) of this estimate. The estimate includes pricing from budgetary quotes, in-house data, factored pricing, and nominal allowances based on industry experience and best practice. Hydro incorporated the available base cost information from Hatch's feasibility work and updated Owner's costs, contingency, escalation, and IDC.

4.3 Direct Costs

Direct costs include those costs for equipment, bulk materials, and construction and installation costs for all permanent facilities. Direct costs include but are not limited to:

- Site development;
- Civil works;
- Electrical equipment;
- Structural components;
- Battery systems;

- PCS; and
- Cabling and installation labour.

Separate material takeoffs were completed for each discipline (structural, electrical, geotechnical, etc.) based on available drawings, manual calculations, and expert discretion, with allowances and expected cost growth factored into estimates.

4.4 Indirect Costs

Indirect costs include but are not limited to:

- Engineering, procurement and construction management ("EPCM") services;
- Construction indirects;
- Freight and logistics;
- Vendor representatives;
- Spare parts;
- Third-party services; and
- First fills of materials such as transformer oil, lubricants, and other items that are not consumed by the process.

Indirect costs are made up of factors and allowances. The factors and allowances are developed based on historical information from similar projects, adjusted to account for site-specific factors.

4.5 Owner's Cost

Owner's cost is determined to be 10% of project direct, indirect, and EPCM costs for each estimated option (i.e., Options 1–4). Owner's cost includes costs from the period of project approval through to project execution and handover to operations groups. Owner's costs include but are not limited to:

- Owner's team cost, home office and site construction management;
- Project development costs prior to board project approval (sunk costs typically);
- Test work development, prefeasibility and feasibility studies;

- Costs associated with environmental studies and permits; and
- Project insurance.

4.6 Escalation and Interest During Construction

Escalation was calculated using Hydro corporate escalation indices as of July 2026 and was applied to a cash flow[8] that is based on the milestone dates included in Hydro's BESS project Basis of Schedule, provided as Attachment 4. The cash flow will be reviewed and updated when the preferred option is chosen.

IDC was calculated on base costs, contingency and escalation, using the same cash flow and based on July 2026 corporate rate assumptions.

4.7 Contingency

Contingency is a provision for unknown project costs which may occur for known scope, but which cannot be identified for estimating purposes. A provision for contingency is included in the estimate for the BESS solution. While this estimate did not include a Quantitative Risk Analysis ("QRA"), a contingency provision of 25% of the project direct, indirect, EPCM and owner's costs, using industry-tested data tables from AACE 119R-21, based on similar Class 4 projects, has been recommended based on defined scope and included detail.

4.8 Estimate Exclusions

The following project exclusions have been incorporated, yet do not represent an exhaustive list:

- Property acquisition;
- Accommodations camp;
- Decommissioning cost; and
- Management reserve, which may be developed as part of a QRA if the BESS scope is progressed.

[8] Please refer to Table 6, Page 6 of Attachment 3.

4.9 Total Installed Cost

Table 2 summarizes the total installed cost[9] for each of the four BESS options presented as part of the feasibility study.

Table 2: Total Installed Cost for BESS Options 1–4 ($ Millions)

Option[10]	Total Installed Cost
Option 1 – 20 MW, 4-Hour	159
Option 2 – 20 M MW, 8-Hour	218
Option 3 – 50 MW, 4-Hour	288
Option 4 – 50 MW, 8-Hour	437

Hydro notes that these costs are not directly comparable to other supply options on a per-MW basis, due to the ELCC of BESS systems compared to other dispatchable resource options within Hydro's supply stack.

Please refer to Section 6, Table 1, Page 3, within Attachment 3 for additional details of the complete total installed cost estimate for each option.

5.0 Schedule

As part of the feasibility study, the contractor had prepared a Project Basis of Schedule, provided as Attachment 5.[11] To validate the project plan, Hydro developed a Basis of Schedule which used inputs from the contractor-supplied schedule, with applicable inputs from Hydro that leverage historical data, internal resource experience, and lead times expected for engineering, long lead equipment, construction, and commissioning.

The schedule covers the selected option at the current stage of the project development (**Option 4—**50 MW with 8-hour reserve). Should a different option be progressed, variations in activity durations and scope would be reflected as part of a new Basis of Schedule and Project Control Schedule.

[9] Total installed cost includes cost items such as direct costs, indirect costs, EPCM costs, Owner's costs, contingency, escalation and IDC.

[10] The capacity in this table represents the installed capacity. The capacity contribution to the system is based on the Effective Load Carrying Capability ("ELCC") as described in the ELCC Study. Please refer to "Evaluating Effective Load Carrying Capability – Overview," Newfoundland and Labrador Hydro, December 9, 2025, att. 1.

[11] The final Basis of Schedule from Hatch was accepted by Hydro on May 19, 2026.

5.1 Schedule Classification

The BESS Project Control Schedule, provided within Hydro's Basis of Schedule (Attachment 4), is classified as a Class 4, Level 2 schedule (as per AACE International Recommended Practice 27R-03). The schedule establishes overall timeframes for engineering and procurement activities, provides a realistic engineering, procurement, and construction sequence and enables the development of a complete cycle of engineering and procurement activities (per work package), to show key stakeholder interactions and to schedule dates for receipt of all vendor data.

Pending further project execution maturity, including design development, authorization timeline changes, execution strategy changes, scope modification, or construction contractor execution optimizations, updates may be required to the Basis of Schedule and Project Control Schedule, which includes potential level of accuracy changes.

5.2 Schedule Development and Key Milestones

The high-level project plan for the BESS project includes the following milestones in Table 3. For additional details surrounding project-specific activities are provided as part of the Basis of Schedule; please refer to Attachment 5.

Table 3: Project Milestones

Milestone	Forecast Completion
FEED[12] Approval to Proceed	Q1 – Year 1
FEED Kickoff	Q2 – Year 1
FEED Engineering Complete	Q4 – Year 1
Project Authorization	Q1 – Year 2
EPCM Kickoff	Q2 – Year 3
Newfoundland and Labrador Department of Environment Approval	Q1 – Year 3
Construction Contractor Mobilized	Q1 – Year 4
Construction Complete	Q1 – Year 6
In Service Date	Q2 – Year 6

[12] Front-End Engineering Design ("FEED").

5.3 Engineering

Engineering is split into two sections: FEED and detailed design. Key milestones within FEED include the engineering activities and preparation of the EPCM request for proposal. Detailed design work includes completion of the engineering documents, full model completion, and procurement support.

5.4 Procurement

Procurement has also been split into two sections: contracts and procurement packages. Contracts to be awarded as part of the BESS project include the EPCM and construction works contractor. Procurement packages are broken down into key equipment, which include but are not limited to:

- Batteries;
- Battery containers;
- Transformers;
- Capacitive Voltage Transformer circuit breakers;
- E-House and E-House equipment;
- Electrical; and
- Bulks.

Lead times are based on Hydro experience and comparable projects, as well as contractor experience.

5.5 Construction and Commissioning

Construction has been scheduled to be completed prior to delivery of specific long-lead items. Commissioning will be completed as soon as the construction activities are completed and delivery of long lead items.

5.6 Permits/Regulatory

It is expected that several environmental-related items, including environmental assessment and relevant provincial and municipal permits, will be needed and are scheduled accordingly. Regulatory requirements for the BESS project will be included as project development progresses.

6.0 Risk Register

Hatch developed a structured risk assessment for the selected option (Option 4). The assessment enabled identification and evaluation of potential risks that could influence project feasibility. These included risks in the following categories:

- Environmental risks;
- Technical risks;
- Regulatory risks;
- Financial risks; and
- Safety risks.

The risks (total of 36) as part of the feasibility study were then scored in terms of likelihood and consequence. The risks have been scored using Hatch internal best practices for risk management; if the project advances, a comprehensive review will follow to review current and any new risk items for evaluation and treatment. Maintaining the record of known risks and opportunities will support decision-making and planning throughout the remainder of the BESS development process.

7.0 Summary and Recommendations

Through preparation of the preliminary feasibility study and associated capital cost estimate and schedule, the following list has been prepared, which highlights key summaries, findings, and recommendations:

- Utility-scale BESS facilities are technically feasible on the Avalon Peninsula.
- LFP battery technology is considered the preferred technical solution.
- Several candidate sites are available for future development, with the Hardwoods Greenfield Site being most optimal.
- Additional environmental, geotechnical, and engineering activities are required prior to project execution.
- Site selection and land acquisition activities should proceed before detailed engineering.

- The current capital cost estimate has been prepared at a feasibility (AACE Class 4) level, corresponding to an expected accuracy range of -15% to -30% on the low side and +20% to +50% on the high side.
- The BESS Project Schedule is a Class 4, Level 2 schedule (as per AACE International Recommended Practice 27R03). It has been built mainly from the feasibility work completed by the contractor (including the design basis and project schedule), with inputs from Hydro based on experience.
- Regulatory and permitting requirements, particularly those related to environmental, provincial, municipal, and construction permits and approvals, will be required as the project advances. These requirements represent an important consideration for further refinement of both the project cost estimate and schedule and will need to be addressed in subsequent project phases.
- The risk register and associated mitigation strategies will be expanded, validated, and updated by Hydro, with support of other stakeholders, as the project advances.

Further refinements, through additional engineering studies and preliminary site work, will support the progression and overall accuracy of the project execution, cost estimate, and schedule.

8.0 Conclusion

Taken together, the feasibility study, project cost estimate, and risk assessments demonstrate that a proposed BESS configuration is technically feasible on the Avalon Peninsula to support reliability and resource adequacy, subject to the expected refinements that accompany progression beyond a feasibility stage assessment. While additional engineering and development activities are required, the study establishes an appropriate basis for future decision-making and progression toward project implementation, if required. Hydro will utilize the findings of this study within its supply stack for use in its expansion plan modeling. Hydro continues to study the feasibility of BESS systems for frequency support, currently planned for completion in the first quarter of 2027.

Attachment 1

Newfoundland and Labrador Hydro Battery Energy Storage Feasibility Study – Design Basis and Work Package Development

Hatch Ltd.



MAJOR PROJECTS CONTRACTOR DOCUMENT FRONT COVER SHEET

Contract Number and Description:	Project Number:
Newfoundland and Labrador Hydro Battery	H376866
Contractor Name:	**Contractor Address:**
Hatch Ltd.	80 Hebron Way - Suite 100, St. John's Newfoundland and Labrador, Canada, A1A 0L9

Document Title:	Total Number of Pages incl. Front Sheet:
NL Hydro BESS Feasibility Study Design Basis and Work Package Development	159
Contractor Document Number:	**Contractor Revision Number:**
H376866-0000-21D-226-0001	1
Contractor Signature/Stamp: John William Albert Catton -- P.Eng. - EGBC — Digitally signed by John William Albert Catton -- P.Eng. - EGBC DN: cn=John William Albert Catton -- P.Eng. - EGBC, c=CA, o=CertifiO Pro, ou=EGBC - Engineers and Geoscientists of British Columbia Date: 2026.06.04 08:32:01 -07'00'	
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SDYBESS-HAT-00000-EN-BOD-0001-01	B0
Document Date (DD-MMM-YYYY):	**Equipment Tag:**
07-May-2026	

Submission Comments: (if urgent submission, please indicate below. Add additional pages if required)

REVIEW DOES NOT CONSTITUTE APPROVAL OF DESIGN DETAILS, CALCULATIONS, TEST METHODS, OR MATERIAL DEVELOPED AND/OR SELECTED BY THE CONTRACTOR, NOR DOES IT RELIEVE THE CONTRACTOR FROM FULL COMPLIANCE WITH CONTRACTUAL OR OTHER OBLIGATIONS.

- ☐ 01 **REVIEWED AND ACCEPTED**
- ☐ 02 **REVIEWED – INCORPORATE COMMENTS, REVISE AND RESUBMIT**
- ☐ 03 **REVIEWED – NOT ACCEPTED**
- ☐ 04 **INFORMATION ONLY**
- ☐ 05 **NOT REVIEWED**

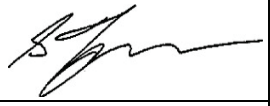
Lead Reviewer	Date (DD-MMM-YYYY)	Project Manager	Date (DD-MMM-YYYY)

General Comments:

Newfoundland and Labrador Hydro
Battery Energy Storage Feasibility Study

Design Basis and Work Package Development

H376866-0000-21D-226-0001

			Catton, John		
2026-05-07	1	Approved for Use	J. Catton	S. Trepanier	M. Carreau
2026-03-26	0	Approved for Use	J. Catton	S. Trepanier	M. Carreau
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**
HATCH					

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1. Executive Summary

1.1 Background

Newfoundland & Labrador Hydro (NL Hydro, the "Client") has commissioned Hatch to support ongoing Resource and Reliability Adequacy (RRA) studies by conducting a Battery Energy Storage System (BESS) Feasibility Study to evaluate four options for the Avalon Peninsula BESS.

The four options evaluated were:

1. 20 MW with a 4-hr reserve (80 MWh at the point of interconnection).
2. 20 MW with an 8-hr reserve (160 MWh at the point of interconnection).
3. 50 MW with a 4-hr reserve (200 MWh at the point of interconnection).
4. 50 MW with an 8-hr reserve (400 MWh at the point of interconnection).

The engineering was completed to an appropriate level of development to support and prepare a Class 4 Cost Estimate and level 3 schedule according to AACE recommended practices.

1.2 Energy Storage Use Case

The BESS is anticipated to complete less than 100 cycles annually, serving reliability needs to provide additional capacity during peak periods. Typical standby State of Charge (SOC) will be from 80% to 85%. This operational use case has been defined directly by the Client.

1.3 Technology Basis

The study focuses on lithium-ion technology, especially Lithium Iron Phosphate (LFP) chemistry due to its safety and maturity. Design considerations include system sizing based on operational parameters, thermal management, safety systems compliant with UL 9540/9540A and NFPA 855, and standard PCS/MVT configurations using 5.1 MWh battery containers and 4 MVA PCS units.

1.4 Site Selection

The project scope includes the assessment and selection of a suitable site for the new BESS. The 5 potential locations that were considered included Hardwoods Terminal Station (Greenfield Site), Hardwoods Terminal Station (Brownfield Site), Goulds Substation, Virginia Waters Substation and Oxen Pond Terminal Station.

Each site location was evaluated using a set of criteria covering general site analysis, electrical integration, site preparation, real estate considerations, community and environmental risks, and safety and security.

Following the preliminary screening, the top three locations identified were Hardwoods Terminal Station (Greenfield Site), Hardwoods Terminal Station (Brownfield Site), and Goulds Substation.

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Hardwoods Terminal Station (Greenfield Site) was selected as the recommended site due to sufficient land availability, fewer construction constraints, more favourable interconnection flexibility at 66 and 230 kV, and minimal environmental and community impact compared to other sites. In contrast, Hardwoods Terminal Station (Brownfield Site) was deprioritized due to the requirement to decommission existing assets, resulting in the loss of capacity for an extended period.

1.5 Design Criteria

The study establishes design requirements to achieve engineering designs to an appropriate level of development to support and prepare a Class 4 Cost Estimate and Level 3 schedule. These requirements are aligned with Association for the Advancement of Cost Engineering (AACE) recommended practices across all engineering disciplines, including:

- Electrical design at 34.5 kV collector system and 66 kV interconnection.
- Civil works for a wetland-adjacent site, requiring grading and drainage design, new access roads, and environmental permitting support.
- Structural design per the National Building Code of Canada (NBCC), with seismic classification assumed as Site Class D.
- Controls and EMS aligned with NL Hydro Supervisory Control and Data Acquisition (SCADA) and cybersecurity standards.
- Environmental considerations including wetland alteration permits (example Permits to Alter a Body of Water), noise mitigation, spill containment, and waste management.

1.6 Risks

In total, 36 risks and 6 opportunities were categorized across technical, environmental, regulatory, and financial domains. 12 were rated high-priority and 17 medium-priority. A formal risk register has been developed, with potential mitigation actions developed for each risk.

1.7 Next Steps

The document outlines actions required to advance to detailed design and procurement:

- Governance and internal approvals.
- Geotechnical investigation.
- Environmental and noise assessments.
- Detailed power system studies.
- Development of procurement specifications and permitting pathways.
- Coordination with utility and regulatory bodies.

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- The next steps for design primarily involve advancing site-specific engineering. This includes geotechnical confirmation, drainage and stormwater refinement, and detailed layout validation. Also, an evaluation of alternative BESS placement areas within the Hardwoods site, particularly southwest of the existing fuel tank, will need to be completed.
- Additional actions include developing detailed fire protection and safety requirements, refining electrical integration and grounding design, and updating layouts based on shortlisted vendor equipment.

2. Introduction

Newfoundland & Labrador Hydro (NL Hydro) is the primary electricity supplier in the province, managing the bulk generation and transmission of electricity across Newfoundland & Labrador (NL). To support the upcoming Resource and Reliability Adequacy (RRA) studies, NL Hydro commissioned Hatch to conduct a Battery Energy Storage System (BESS) Feasibility Study to evaluate four options for the Avalon Peninsula BESS.

The four options evaluated were:

1. 20 MW with a 4-hr reserve (80 MWh at the point of interconnection).
2. 20 MW with an 8-hr reserve (160 MWh at the point of interconnection).
3. 50 MW with a 4-hr reserve (200 MWh at the point of interconnection).
4. 50 MW with an 8-hr reserve (400 MWh at the point of interconnection).

2.1 Abbreviations

Refer to Table 2-1 for a list of abbreviations that are in this document and their definitions.

Table 2-1: Table of Abbreviations

Abbreviation	Definition
AASHTO	American Association of State Highway and Transportation Officials
AACE	Association for the Advancement of Cost Engineering
AC	Alternating Current
ACI	American Concrete Institute
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute
ASTM	ASTM International
ATS	Acceptance Testing Specifications
BESS	Battery Energy Storage System
BIL	Basic Insulation Level
BMS	Battery Management System
BOL	Beginning of Life
CAN	Canadian (standards prefix)

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Abbreviation	Definition
CAN/CSA	Canadian Standards Association prefix
CCTV	Closed Circuit Television
CEC	Canadian Electrical Code
CISC	Canadian Institute of Steel Construction
COHS	Canada Occupational Health and Safety Regulations
CSA	Canadian Standards Association
CSCE	Canadian Society for Civil Engineers
CSPI	Corrugated Steel Pipe Institute
DC	Direct Current
DER	Distributed Energy Resource
DERMS	Distributed Energy Resource Management System
DGSNL	Digital Government and Service NL
DOT	Department of Transportation
ECCC	Environment, Conservation and Climate Change (NL)
EIA	Telecommunications Industry Association
EMI	Electromagnetic Interference
EMS	Energy Management System
EPA	Environmental Protection Act
ESS	Energy Storage System
EV	Electric Vehicle
FCC	Federal Communications Commission
FEL	Front End Loading
FM	Factory Mutual
FOTP	Fiber Optic Test Procedure
HDPE	High Density Polyethylene
HSS	Hollow Structural Section
HV	High Voltage
HVAC	Heating, Ventilation and Air Conditioning
HY-8	FHWA hydraulic software
IDF	Intensity Duration Frequency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
LER	Light Electric Rail
LFP	Lithium Iron Phosphate
LIB	Lithium-Ion Battery
LOTO	Lock Out Tag Out
MGCS	(Undefined – appears in document, likely typo)
MV	Medium Voltage

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Abbreviation	Definition
MVA	Megavolt Ampere
MVAR	Megavolt Ampere Reactive
MVT	Medium Voltage Transformer
MW	Megawatt
NBCC	National Building Code of Canada
NCA	Nickel Cobalt Aluminum
NEMA	National Electrical Manufacturers Association
NETA	InterNational Electrical Testing Association
NFCC	National Fire Code of Canada
NFPA	National Fire Protection Association
NL	Newfoundland and Labrador
NL Hydro	Newfoundland and Labrador Hydro
NLR	Newfoundland and Labrador Regulations
NLSO	Newfoundland and Labrador System Operator
NMC	Nickel Manganese Cobalt
NRC	National Research Council Canada
OFSTP	Optical Fiber Systems Test Procedure
OTDR	Optical Time Domain Reflectometer
PCS	Power Conversion System
PCS-MVT	PCS and MVT skid assembly
PGA	Peak Ground Acceleration
PGV	Peak Ground Velocity
PSCAD	Power Systems CAD (EMT simulation tool)
PSI	Pounds per Square Inch
PV	Photovoltaic
RRA	Resource and Reliability Adequacy
RSIC	Reinforcing Steel Institute of Canada
RSNL	Revised Statutes of Newfoundland and Labrador
RTE	Round Trip Efficiency
SCADA	Supervisory Control and Data Acquisition
SFRS	Seismic Force Resisting System
SI	Metric System
SLD	Single Line Diagram
SOC	State of Charge
SOH	State of Health
SSPC	Society for Protective Coatings
ST/SG/AC	UN Transport of Dangerous Goods code
TAC	Transportation Association of Canada
THD	Total Harmonic Distortion

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Abbreviation	Definition
TIA	Telecommunications Industry Association
TMS	Thermal Management System
TP-S-005	NLSO Technical Requirement Standard
UL	Underwriters Laboratories
ULC	Underwriters Laboratories of Canada
UN	United Nations
UPS	Uninterruptible Power Supply
XC	Site Class C (NBCC)
XD	Site Class D (NBCC)

3. Energy Storage Overview

Energy storage systems (ESS) are garnering increasing interest as their costs continue to decline and as there are increasing intermittent renewable generation sources deployed on power grids. ESS have many potential benefits and can often be used on a grid or microgrid to provide multiple services. In this section, an overview of available energy storage technologies is presented.

There is a wide array of energy storage technologies that are presently available on the market. Depending on the energy storage mechanism, the properties of the ESS will change. For the purposes of this work, the focus is placed exclusively on lithium-ion battery systems, which represent the most commercially mature and widely deployed technology for grid scale applications.

3.1 Lithium-Ion Batteries

Lithium-ion batteries (LIBs) have become the most established and versatile energy storage technology on the market today, outside of pumped hydro. The technology is considered reliable and has established previous installations, compared to other less established ESS technologies.

There is a broad range of available LIB chemistries, each of which has its own applications. Generally, LIBs are regarded as the most versatile BESS technology, offering both high power and high energy capacities. They have the greatest energy density of battery technologies, making them ideal for locations with limited available space for installation. The cost of LIBs is continually decreasing and is expected to continue to decrease over the next several years.[1] Finally, LIBs are relatively easy to maintain compared to other ESS technology, with an average of one to two maintenance visits from the vendor each year.

[1] Electric vehicle battery prices are expected to fall almost 50% by 2026 | Goldman Sachs

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There are three common utility scale lithium-ion battery chemistries typically used for grid scale storage applications. They include:

- **Nickel manganese cobalt lithium (NMC) battery** is the most common battery chemistry. This chemistry typically has the lowest capital cost. It is better suited for higher energy applications and has a limited power response.
- **Nickel cobalt aluminium lithium (NCA)** batteries are also common for grid scale applications. These batteries provide higher power performance, making them better suited for applications with rapid response requirements. However, these batteries typically have higher costs compared to other options.
- **Lithium iron phosphate (LFP)** batteries are used in grid scale applications and are becoming the most adopted chemistry for storage applications. These batteries offer a blend of moderate power and energy capacity making them ideal for versatile applications. LFP batteries are also generally regarded as the safest technology.[2]

Each of these chemistries has its own capabilities and limitations, which need to be matched to the duty cycle and usage. For stationary energy storage, most companies have moved to using LFP as the preferred chemistry, due to its safety and for its lower costs. In Section 5, LFP will be designated as the battery chemistry for the BESS within the design criteria.

3.1.1 Power vs. Energy Battery

Battery cells can be designed to prioritize either high-power output or high energy storage, referred to as power cells and energy cells, respectively. Power-oriented cells use thinner electrodes that support high currents and enable rapid lithium-ion transport between the active material and the electrolyte. Although this configuration allows fast charging and discharging (typically between 15 minutes and one hour) it reduces overall energy capacity because thinner electrodes provide less active material for lithium-ion insertion. Thin electrodes also help prevent lithium plating and dendrite formation by minimizing ion transport distance, reducing the risk of internal short circuits.

In contrast, energy-oriented cells use thicker electrodes with more active material, providing higher lithium-ion storage capacity. This design increases total energy but slows ion transport, limiting the achievable power output. As a result, energy cells generally support moderate discharge rates with total charge or discharge durations of one to four hours and are not suited for sustained high-power operation.

These configuration differences, combined with variations in battery chemistry, result in different cost structures and performance characteristics across power and energy cell types. In practice, manufacturers may offer a range of intermediate designs to balance specific power and energy requirements.

Battery performance can also be described using the C-rate, which is the inverse of the discharge duration (power-to-energy ratio, MW/MWh). A battery that discharges fully in 30 minutes has a 2C rating, whereas a four-hour discharge corresponds to a 0.25C rating.

[2] What are LFP, NMC, NCA Batteries in Electric Cars? | Zecar | Resources | News

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3.1.2 *Battery Degradation*

LIBs experience two types of known capacity fade or degradation: degradation associated with cycling and calendar aging. Given the proposed use cases for the NL Hydro BESS, it is expected that it will experience both cycle and calendar aging associated capacity fade.

Cycle related degradation is a known and predictable phenomenon for LIBs. Cycle degradation is associated with loss of active lithium ions because of charge/discharge cycles. Typically, most LIBs have a capacity fade of approximately 20% after completing 4,000-4,500 full charge/discharge cycles; however, lithium iron phosphate (LFP) cell manufacturers claim a cycle life of over 6,000 full charge/discharge cycles. A typical degradation curve as a function of depth of discharge is shown in Figure 3-1.

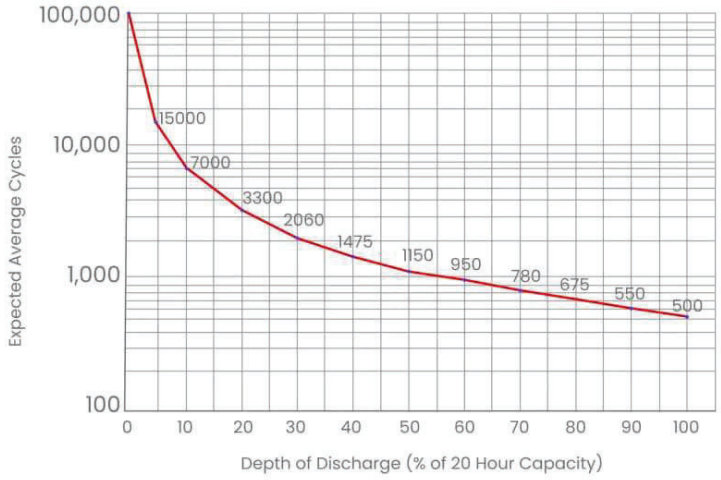


Figure 3-1: Typical Degradation Curve of a Lithium Ion Battery based on Cycle Depth of Discharge[3]

The cycle life of a LIB is dependent on its operating conditions; operating the cell within the vendor specified conditions, completing shallow cycling, at or below the rated power and within the specified temperature range will extend the lifespan of the BESS. However, accelerated degradation can occur if the BESS is operated outside the specified temperature range (degradation is worse if operated outside the range frequently or for extended periods, or under extreme hot or cold conditions), if charging or discharging rates are higher than the rated power, or if the LIB cells are charged above or below the recommended maximum/minimum state of charge (SOC). A single excursion or event would not lead to significant degradation, unless it was extreme (e.g. charging at -40°C); however, routine operation outside the vendor specified bounds can lead to a shortened battery life.

[3] Comprehensive Understanding of Lithium-ion Battery Life Cycle

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In addition to normal operational cycling, periodic controlled test cycles are typically required to verify the actual available capacity of the BESS over the life of the asset. These tests are commonly performed at commissioning, at scheduled maintenance intervals, and after any major operational event that could affect cell health. Industry guidance, including IEC 62619 and IEC 62933, supports periodic capacity verification testing to confirm that degradation remains within the vendor specified warranty curve and to validate long term system performance obligations.

Calendar aging is a relatively unstudied phenomena, as it is only becoming more apparent as lithium-ion batteries are being used for newer applications (EVs, grid storage) where they are kept at high state of charge for extended periods (in contrast to personal electronics where batteries undergo regular cycling). Initial studies have shown that storing a battery cell at higher temperatures and higher state of charge can accelerate the calendar aging process.

Calendar aging has been attributed to the anode, which has a high lithium content during high SOC idling and thus has experienced expansion. The mechanism for calendar degradation is hypothesized to be a reduction of active lithium, since it is consumed in the formation of the solid-electrolyte-interphase layer on the anode. Formation of this interphase is accelerated when the anode is expanded to achieve 100% charging.

There has been indication that different lithium-ion battery chemistries (Nickel Cobalt Aluminum, Nickel Manganese Cobalt, and Lithium Iron Phosphate) have different calendar aging properties. As the project moves into the next phases, it will be important to discuss calendar aging with the vendors and understand its impacts on their specific cell chemistry. Additionally, based on the initial results, it appears important to keep the battery idling at modest temperatures, which will be particularly important during the summer months.

3.2 Lithium-Ion Battery Operating Constraints

LIBs have several operational requirements that must be addressed to ensure safe performance and to achieve their expected service life. Effective thermal management is essential, as battery cells must remain within a defined temperature range. Systems require heating during colder months and cooling during warmer periods to avoid cell degradation or irreversible damage. Although modern LIBs incorporate continuous monitoring and protective disconnects to minimize the likelihood of thermal runaway, containerized systems are still equipped with fire suppression equipment as an additional safeguard. These functions are typically coordinated through the battery management system and associated container-level controls.

Maximizing battery longevity also requires managing the operating state of charge. LIBs perform best when kept between approximately 10 percent and 90 percent state of charge. Operating outside this band increases the risk of over-charging or deep-discharging, which accelerates cell aging. As a result, only about 80 percent of the installed energy capacity is considered usable, and systems must be sized accordingly to meet application requirements.

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Additional operational considerations include round-trip efficiency and self-discharge. LIBs are among the highest-efficiency electrochemical storage technologies, typically achieving 85 to 90 percent efficiency from AC input to AC output. Consequently, 10 to 15 percent of the stored energy is lost to conversion inefficiencies and internal electrical losses. LIBs also experience gradual self-discharge during extended idle periods, often on the order of 3 to 5 percent per month depending on system design and environmental conditions. These losses should be evaluated against the intended use case to ensure that the benefits of the storage system justify the inherent inefficiencies.

Control systems and dispatching strategies represent another important aspect of LIB deployment. Because most sites are expected to operate without on-site personnel, the BESS must be capable of autonomous operation, either through predefined algorithms or via remote operator inputs. Controls must be selected, configured, or customized to meet the requirements of the host grid. Coordination between the original equipment manufacturer's control systems, the dispatch controller, and the broader grid control platform must also be considered when designing and programming the dispatch strategy.

3.3 Battery Energy Storage System Components

The BESS consists of several integrated subsystems that work together to deliver energy to the grid and to store energy for later use. This section focuses on the primary components that define system functionality and grid interaction:

- The battery container, which houses and protects the electrochemical assets.
- The Power Conversion System (PCS), which interfaces the Direct Current (DC) battery elements with the Alternating Current (AC) grid.
- The Energy Management System (EMS), which supervises system operation and dispatch.
- The Medium-Voltage Transformer (MVT), which provides voltage transformation and grid interconnection.
- And the overarching protections and controls that ensure coordinated, compliant, and secure operation across all subsystems.

Figure 3-2 shows a simplified Single Line Diagram (SLD) of a battery ESS connected, representing a BESS supplier's typical scope of supply.

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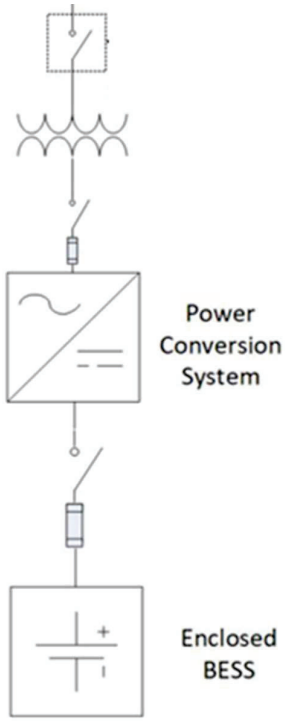


Figure 3-2: Simplified Single-Line Diagram (SLD) of a Battery ESS

3.3.1 Battery Container

The BESS container serves as the primary structural, environmental, and safety enclosure for the battery racks. It is a standardized, factory-built, outdoor-rated unit engineered to maintain lithium-ion cells within tightly controlled operating conditions and to support safe, reliable system performance in accordance with applicable energy storage safety standards.

3.3.1.1 Environmental and Thermal Management

Lithium-ion batteries require a narrow temperature window, typically 15–30°C, to maintain optimal performance, cycle life, and safety. To achieve this, the container integrates a Thermal Management System (TMS) that provides active cooling, heating, and forced-air circulation to remove heat generated during charging and discharging. The TMS ensures uniform thermal distribution across all racks, preventing localized hot spots that can accelerate degradation or create safety risks. The TMS system operates in coordination with the Battery Management System (BMS), modulating cooling or heating based on real-time temperature data reported from individual cells, modules, and racks.

3.3.1.2 Battery Management System (BMS)

The BMS is the central safety and supervisory intelligence of the battery subsystem. It continuously monitors and controls all electrochemical assets within the container to ensure safe, efficient operation. Modern BESS design defines the BMS as a core component responsible for voltage, current, and temperature management; cell balancing; and safety interlocks.

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Key BMS functions integrated within the container include:

- Cell and Module Monitoring: Continuous measurement of cell voltages, temperatures, and current to maintain operation within safe operating limits.
- State Estimation (SOC & State-of-Health (SOH)): Advanced algorithms calculate SOC and SOH, enabling accurate dispatch decisions and preventive maintenance.
- Cell Balancing: Active or passive balancing to maintain voltage uniformity across the battery stack, reducing thermal variation and extending life.
- Safety Protection Logic: Enforcement of overvoltage, undervoltage, overcurrent, short-circuit, and over/under-temperature limits, with automatic isolation of faulted modules when necessary.
- Fault Detection and Alarm Communication: Identification of abnormal conditions, event logging, and notification to higher-level supervisory systems.
- Coordination with EMS and TMS: The BMS exchanges real-time data with the Energy Management System (EMS) to govern charge/discharge limits based on thermal and electrical conditions. It also regulates thermal loads by triggering TMS responses based on monitored temperatures.

The BMS forms a critical part of the container's functional safety architecture and directly supports compliance with UL 9540 system-level safety requirements.

3.3.1.3 *Safety Considerations for Battery Energy Storage Systems*

Fire Safety: While LIBs are generally considered safe technology and the risk of a fire in a battery energy storage system is very low, the lithium-ion chemistry is known to have thermal runaway properties, which can lead to a fire if the system is operated incorrectly. The main safety concern with LIBs is the fire risk, associated with the flammable electrolyte. Depending on the cell configuration, separator design, and electrolyte additives, the risk of fire will vary based on the battery manufacturer. The container incorporates multiple layers of safety systems to reduce the likelihood and consequences of thermal runaway.

The most important strategies to reduce fire risk are:

- Selecting a qualified vendor with a proven and reputable battery system and cells.
- Using qualified technicians to do the installation and commissioning.
- Maintaining the system in a good state-of-repair, with routine maintenance.
- Maintenance of the system is performed by a qualified technician.
- Fire suppression system is routinely checked and maintained as recommended by the vendor.

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BESS suppliers employ several mechanisms to prevent thermal runaway and to mitigate a fire should one occur. The battery cell and module manufacturers design their products to minimize thermal-runaway risk through cell-chemistry selection, separator design, and fire-retardant module construction that inhibits fire propagation between packs. In addition to these passive safety features, BESS units incorporate continuous thermal-monitoring systems, including cell- and module-level temperature sensors, voltage monitoring, and BMS algorithms that detect abnormal heating trends or other precursors to thermal runaway. When such conditions are detected, the BMS issues alarms, initiates protective actions such as load reduction or shutdown, and supports activation of early-stage suppression systems if installed. These monitoring and protection features are subject to periodic testing and maintenance per manufacturer requirements, including sensor calibration, alarm-path verification, and functional testing of BMS protective responses.

When the system is integrated into a series of racks, each battery cell in the system is continuously monitored to check that it is operating within the expected range. If the battery cell goes outside of the expected range or experiences abusive conditions (e.g., high temperature, high voltage, significant vibrations, flooding, etc.), the automated BMS will disconnect the cell or shutdown the system until the abusive conditions have been corrected.

The BMS also interfaces with and supervises the TMS to maintain stable enclosure-level temperatures. If temperatures rise too high or fall too low, the BMS triggers the TMS (cooling, heating, or ventilation components) to restore conditions to within acceptable limits. This coordinated control between the BMS and TMS ensures both safe operation and protection of the battery modules under varying ambient and operational conditions.

Fire detection and suppression systems (typically clean-agent or aerosol-based) are installed to identify and mitigate early-stage thermal events. UL 9540A testing provides data on thermal runaway behavior, gas composition, heat release, and deflagration risk, enabling proper design of fire mitigation strategies, separation distances, and structural venting pathways. While some systems still offer water-based fire suppression via sprinklers, the industry is increasingly moving away from this approach because traditional sprinkler systems cannot stop a BESS thermal-runaway event and may provide limited effectiveness once a battery fire is fully developed.

Pressure-relief panels, directed venting channels, and mechanical overpressure protection features allow controlled release of gases produced during thermal runaway, minimizing the risk of structural deformation or explosion. These features align with best practices established through UL 9540A thermal propagation evaluations. Finally, all containers are outfitted with a smoke/heat detector to trigger the BMS to report an incident to the owner, generate an audio and visual alarm to alert anyone nearby of the risk, and initiate the fire suppression system.

In addition to the safety measures put in place by the battery vendor, a fire response plan will be prepared by the owner and provided to the local fire department and emergency response staff. The fire department and emergency response staff will receive appropriate training on how to handle lithium-ion battery fires.

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Electrical Safety: Battery installations are charged units that retain hazardous voltages even when the system is fully shut down. This must be considered during handling and maintenance. Typical system voltages are in the 500 to 1000 V DC range, and this voltage remains present even if the BESS is electrically disconnected from the grid.

Due to the DC bus always being energized, it is critical that proper lock out tag out (LOTO) provisions, protection devices, and control systems are installed inside the container. These typically include DC disconnect switches, DC contactors, and visible lockable isolation devices designed to safely separate the battery from downstream equipment. Additional internal protections generally include:

- DC circuit breakers or current limiting fuses.
- Ground fault protection.
- Insulation monitoring devices.
- And arc fault detection and mitigation systems.

The BMS enforces protection limits such as over voltage, under voltage, over current, over temperature, under temperature, and thermal runaway response.

When any protective device operates, for example a fuse blowing, a circuit breaker tripping, or a ground fault or arc fault being detected, the condition is reported through the container control system. The BMS logs the event, classifies its severity, and communicates it to the power conversion equipment and the container control system, which then forwards alarms to the supervisory control system (EMS). This ensures operators are aware of the fault, understand the isolation state of the system, and can verify that the BESS has transitioned to a safe operating condition before any maintenance is performed.

Together, these protection and control systems ensure the BESS can be safely isolated during any maintenance activity, whether on the system itself or on associated substation or line equipment. Robust safety practices are essential to account for the persistent presence of stored energy. Typically, visible and lockable disconnects are required to fully isolate the BESS during grid, substation, or container maintenance.

3.3.1.4 Structural and Environmental Durability

BESS enclosures are designed for the environment in which they will operate. They can be weatherproof, corrosion-resistant, and designed for permanent outdoor installation. Best-practice container engineering includes insulated panels to prevent thermal bridging and condensation while supporting tight temperature control across battery racks. Structural integrity and corrosion control recommendations such as C5-M-rated coatings further improve durability in coastal or industrial environments.

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3.3.2 Power Conversion System (PCS)

The PCS is the primary electrical interface between the BESS and the utility grid. It performs bidirectional conversion between DC power from the battery system and AC power at grid voltage and frequency, enabling both charging and discharging operation under grid connected and, where applicable, islanded conditions. Unlike conventional solar PV inverters, PCS units for energy storage are designed for four quadrant operations, fast dynamic response, and sustained operation under frequent cycling and high transient power flows. These characteristics make them integral grid assets rather than passive energy sources.

Grid interactive capabilities have increased significantly in recent projects. Modern PCS units are capable of independently and simultaneously controlling active power and reactive power, providing voltage regulation, power factor control, frequency response, and synthetic inertia where required. Many units support both grid following and grid forming operational modes, which enables participation in ancillary service markets and supports weak grid and microgrid applications.

Integration of the PCS requires careful consideration of electrical performance and control coordination. Fast reaction speeds, typically in the millisecond range, must be aligned with grid code requirements and utility protection schemes. Output filtering and control tuning are required to manage current overshoot, reduce voltage distortion, and maintain harmonic performance within applicable standards. The PCS harmonic footprint, including both steady state harmonic distortion and transient behavior, directly influences transformer selection, grounding design, and point of interconnection compliance.

The PCS incorporates a comprehensive suite of electrical protection functions that safeguard both the equipment and the grid. These include overcurrent and overvoltage protection validated under UL 1741 testing requirements, which ensures safe response to abnormal electrical conditions and short circuit events. Internal fuse protection is also employed as a primary means of interrupting excessive fault currents, with fuses acting as sacrificial elements that prevent equipment damage and fire hazards when exposed to overloads or short circuits, in accordance with UL 1741 safety expectations. Blown fuse conditions are detected by monitoring continuity or changes in voltage potential across the fuse, where a healthy fuse exhibits near zero potential difference and a blown fuse produces a measurable voltage rise. Immediately after a signal fuse failure, an alarm is issued to the controller to signal the occurrence and to engage system protection.

Control responsibility between PCS and higher-level controllers such as the EMS must be clearly defined during the design phase. While the PCS manages inner loop current and voltage control and grid compliance functions, higher level controllers typically issue real time active and reactive power commands and manage operating modes. Clear separation of responsibilities reduces integration risk and improves system stability.

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3.3.3 *Transformer*

The transformer is a passive electrical device that steps up the voltage from the PCS output to the transmission or distribution grid voltage level. Its function is to reduce electrical losses during power transfer and to provide galvanic isolation between the bus and the higher voltage grid. From a design perspective, the impedance of the transformer is a critical parameter as it limits fault current contributions from the BESS during grid disturbances.

If the transformer is an oil-filled unit rather than a dry type, the design must incorporate appropriate oil containment measures to prevent release and environmental contamination. Secondary containment systems are typically required to capture the full oil volume of the largest transformer plus additional freeboard in accordance with SPCC regulations, which helps ensure that leaks or catastrophic failures do not reach soil or waterways. Industry guidelines such as IEEE Std 980 also outline typical containment designs including basins, bunds, and other spill control methods used in substations to mitigate the risks associated with oil filled equipment.

3.3.4 *Protection and Control (P&C)*

The Protection and Controls (P&C) system is comprised of protective relays, circuit breakers, sensors, and associated control logic that safeguard all BESS equipment and the connected grid from electrical faults. It operates as the automated safety, sequencing, and interlocking layer for the facility, by communicating with the BMS, PCS, and station level control systems to process alarms, issue trip commands, and enforce operating limits while managing the orderly energization and de energization of system components.

3.3.5 *Energy Management System (EMS)*

The EMS acts as the supervisory controller for the entire BESS, making real-time, data-driven decisions on how the system charges, discharges, and provides grid services. It controls battery dispatch based on utility grid signals and operational constraints. The EMS coordinates with the BMS and PCS, issuing active and reactive power commands, while taking actions to improve efficiency and maintain system stability.

3.4 Installation, Commissioning, and Ongoing Maintenance

The installation, commissioning, and ongoing maintenance of a grid scale BESS require coordination between the equipment vendor, qualified electrical contractors, and the facility operator. Each phase has distinct technical requirements and involves different levels of specialization, certification, and local workforce participation.

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3.4.1 Installation

In Canada there are several electrical contractors and system integrators with experience installing grid scale BESS equipment, including firms in Ontario, Quebec, Alberta, and British Columbia. These companies routinely perform high voltage and medium voltage installation, equipment setting, conduit work, cable installation, and integration of PCS, transformers, and balance of plant equipment. None of these experienced contractors are currently based in Newfoundland and Labrador, therefore installation support would need to be mobilized from outside the province. Local labour can still participate in civil works, site preparation, and mechanical scope, but vendor trained personnel or experienced Engineering Procurement Construction (EPC) contractors will be required for battery enclosure installation, PCS integration, and system energization.

3.4.2 Commissioning

Commissioning will require a full functional test of the PCS, BMS, EMS controls, and the BESS containers, including confirmation of charge and discharge capability across the normal operating range. This typically includes at least one controlled reference cycle to establish baseline capacity and round-trip efficiency. The system operator must be able to demonstrate that the BESS can follow active and reactive power commands, absorb and deliver power at the rated capability, and respond to grid support functions as required.

Commissioning of a utility scale BESS requires vendor certified specialists for the PCS, BMS, EMS, and containerized battery systems. These individuals are typically supplied either directly by the manufacturer or by a small group of Canadian commissioning contractors who hold current vendor certifications and are familiar with the commissioning sequences required under IEEE 2030.2 and IEC 62933. At present these specialists are primarily located in Ontario, Quebec, and Alberta. Commissioning in Newfoundland and Labrador will therefore require planned mobilization. Local electrical workers can support isolation, switching, thermography, protective relay testing, and medium voltage equipment checks, but final system commissioning cannot be performed without vendor certified personnel.

3.4.3 Ongoing Maintenance

Routine maintenance of a BESS is generally not complex once the system is in operation. Activities such as enclosure inspections, HVAC servicing, cleaning, torque checks, infrared scanning, and balance of plant maintenance can be performed by trained local staff after receiving basic vendor training. The more specialized tasks, including firmware updates, BMS diagnostics, PCS troubleshooting, and cell module replacement, require vendor certification and are typically done by the manufacturer or by authorized service providers. With training programs provided through most major vendors, it is feasible for the organization owning the facility (NL Hydro) to develop in house capability for routine work while relying on outside parties for periodic major service, warranty related work, or component level interventions.

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3.5 AC versus DC Augmentation

As the BESS degrades over time, the system can no longer supply the power and energy capacity that were available at commissioning. One way to address this expected decline is to overbuild the initial system by installing excess battery capacity at the start of the project. While this approach ensures that long-term performance requirements are met, it can significantly increase upfront capital costs and may leave a portion of the installed capacity underutilized in the early years of operation.

To avoid these high initial costs, many projects rely on augmentation. Augmentation involves adding new battery capacity during the life of the system to restore or maintain the required power and energy levels. This strategy distributes investment over time and allows operators to take advantage of future cost reductions and technology improvements. Augmentation can be implemented using either AC or DC integration methods, each with its own benefits and constraints depending on the site design and operational goals.

3.5.1 AC Augmentation

AC augmentation connects new batteries, PCS units, and control systems to the AC side of the system, while the existing system remains unchanged. This approach is highly modular and flexible, making it well suited for retrofits because new capacity can be integrated without modifying the original DC subsystem and with minimal downtime. Industry guidance highlights that AC augmentation is conceptually simpler, with fewer interfaces to existing equipment, which reduces commissioning risk and allows most installation activities to occur while the system remains online. The tradeoff is that this method requires additional PCS units, auxiliary equipment, and physical space for each new AC block, which increases capital cost and site footprint compared with DC side expansion.

3.5.2 DC Augmentation

DC augmentation adds new battery capacity on the DC side ahead of the PCS, typically with DC-to-DC converters that match voltages, control current flow, and isolate aging effects so new batteries operate safely alongside older ones without circulating currents or accelerated wear. This preserves use of the existing PCS and controls, reduces footprint compared with adding new PCS units, and allows staged investment, but total capability remains limited by the installed PCS and DC bus ratings and brief outages are often required for tie ins and commissioning. Over a typical twenty-year lifecycle, changes in containers, modules, battery management systems, and communications can make cross container augmentation harder, so early planning for interface standards, DC bus windows, and controls interoperability is essential and may still require added conversion hardware or requalification.

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3.5.3 Prevalence of AC Augmentation

AC augmentation is typically selected over DC augmentation because it provides a simple, modular, and low-risk method for adding capacity to an existing BESS. New battery blocks connect on the AC side with their own PCS and controls, allowing the original system to remain unchanged and significantly reducing integration complexity. This approach minimizes outages during installation, since most work occurs in parallel with the operating system, making it well suited for retrofits and projects with strict availability requirements.

Additionally, AC augmentation avoids the technical challenges of mixing new and aged batteries on the DC bus, which would require additional equipment to manage voltage differences and aging effects. These complexities make DC augmentation harder to implement. AC augmentation also provides better long-term flexibility, as new blocks function as self-contained units, reducing compatibility issues as BESS technologies evolve over the twenty-year lifecycle.

3.6 Battery End of Life Considerations

The typical projected lifespan for a BESS is ten to twenty years. This lifespan can be influenced by a variety of factors. The primary factors affecting the lifespan are the use case and the operating conditions. Maintaining operation within the vendor specifications is important to ensuring the lifespan is maximized. Additionally, the vendor design can impact the lifespan.

At the end of life, proper disposal of the BESS is critical, as it contains valuable materials which can be re-used, but can also be hazardous to the environment if improperly disposed. As the grid scale lithium-ion battery industry is relatively nascent, the recycling and disposal processes are not fully developed presently.

There has been general interest in the re-use of spent electric vehicle lithium-ion batteries as grid scale batteries. As EV batteries are typically taken out of service when the capacity has faded by 20%, these cells can still be used in other applications where size and mass are not as critical. In the case of grid scale batteries, mass is less constrained, and thus a larger amount of battery cells can be compiled to achieve the desired pack capacity, duration and performance. While this plan extends the life of the battery cells, it does not address the disposal at the final battery cell end of life.

3.6.1 Battery Return to Supplier

Presently, many battery suppliers will take back the battery modules at the end of life. Some suppliers may also have incentives or credits associated with battery return, which can be used towards the next battery.

Grid scale BESSs are comprised of several different components, the container, any necessary thermal management and fire suppression systems, the battery module racks, and the battery modules and cells themselves. It may be possible that the container, fire suppression system and thermal management system be refurbished or repurposed for future uses. This could be done by working with the vendor to determine if they have a refurbishment or re-use program. Alternatively, these items could be sold at the end of life to other markets or recycled to recover valuable parts and materials.

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By returning the batteries to the supplier, the supplier can then re-use the batteries, or process and recycle or dispose of the materials. This process ensures that the batteries are treated properly and do not cause environmental harm if improperly disposed. As well, returning the batteries to the supplier puts the responsibility of disposal on the supplier, instead of on the customer.

3.6.2 Lithium-Ion Battery Recycling

LIBs are difficult to recycle because of their layered construction. Each cell is packaged individually and then assembled into a module, creating a wide range of components and materials that must be separated and purified before they can be used again. Battery racks can sometimes be reused, although they may also be recycled for raw materials.

Battery modules and cells should be recycled whenever refurbishment is not possible. Today, recycling relies on four primary methods: smelting, high temperature incineration, cryogenic freezing followed by shredding, and chemical leaching with liquid-liquid extraction (hydrometallurgy). Specialized processes are required because LIBs often retain some charge at the end of their life and contain flammable electrolyte. For these reasons, the cells usually cannot be safely punctured in normal atmospheric conditions.

Smelting is the most common legacy technique. It can recover copper, nickel, iron, and cobalt, but lithium, aluminum, and manganese are lost during processing. The electrolyte and the plastic battery housings are also destroyed through incineration as part of this method. Examples of companies currently utilizing this method include Redwood Materials out of the United States of America and Umicore out of Belgium.

A second approach uses high temperature incineration. Organic materials, plastics, and lithium are burned and either captured through off gas scrubbing or lost in fly ash. This approach focuses on recovering cobalt through secondary hydrometallurgical treatment. In practice, the environmental and energy burdens remain high compared with simply using hydrometallurgical methods, and lithium recovery is low.

The third method involves cryogenic freezing at approximately -196°C, followed by shredding. The shredded material is mixed with water, which produces lithium hydroxide and hydrogen gas. Cobalt and aluminum are the main recovered materials. Lithium hydroxide is converted to lithium carbonate, which can be recovered at rates between fifteen and twenty six percent. Commercial adoption of a dedicated cryogenic route remains limited, and no major company currently operates a commercial cryogenic-first recycling facility.

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Hydrometallurgical recycling has become the leading method for recovering critical materials from LiBs, using aqueous solutions to dissolve black mass and selectively extract high-purity metals. Unlike smelting or incineration, which destroy organic components and lose most lithium, hydrometallurgical processes routinely achieve recovery rates above ninety five percent for lithium, cobalt, nickel, and manganese, producing battery grade salts suitable for cathode manufacturing. Operating at low temperatures also reduces energy use and greenhouse gas emissions compared to pyrometallurgical routes. Companies commercializing these systems include Primobius in Germany and American Battery Technology Company and Cirba Solutions in the United States. As electric vehicle adoption accelerates, hydrometallurgical recycling is expected to play a central role in cost effective and environmentally responsible materials recovery.

As a result, none of the three legacy processes consistently recovers lithium at meaningful levels under current economics. The main reason is that past lithium prices did not justify recovery costs, and many systems were designed primarily around cobalt and nickel. As electric vehicle volumes rise and regulatory and supply pressures increase, hydrometallurgy is emerging as the preferred commercial pathway, with hybrid flowsheets pairing mechanical pre-processing and targeted hydrometallurgical steps to maximize recovery, purity, and carbon benefits. Recent reviews comparing full life-cycle impacts confirm hydrometallurgy's advantage on energy use and greenhouse-gas metrics against pyro-only routes and show it can deliver battery-grade outputs suitable for direct cathode manufacturing.

3.6.3 Lithium-Ion Battery Recycling Development

Over the next several years, as the electric vehicle and grid scale energy storage industries continue to grow, end -of-life battery management is likely to develop into a key industry. The processes identified above are the current options available for lithium-ion battery disposal. However, as the projected life of the BESS is between 10 to 20 years, it is likely that in this time, the battery refurbishment and recycle industry will develop significantly. There are several research programs and development companies currently investigating the various ways to recycle lithium-ion batteries and recover the lithium for reuse.

Therefore, as the end-of-life of the BESS approaches, a review of the current practices should be completed to identify new opportunities. Additionally, upon purchase of the BESS, NL Hydro should discuss with the supplier if they have a battery return or recycle program.

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4. Project Location

4.1 Site Selection

The scope of the feasibility study includes site assessment and selection. Five potential sites were considered for the project, recommended for deeper investigation by the Client, namely:

1. Hardwoods Terminal Station, Paradise (47°31'24.61"N 52°50'54.23"W) (Greenfield Site), referred to as Hardwoods (Greenfield).
2. Hardwoods Terminal Station, Paradise (47°31'27"N 52°50'47"W) (Brownfield Site), referred to as Hardwoods (Brownfield).
3. Goulds Substation, St. John's (47°29'07.1"N 52°45'54.0"W), referred to as Goulds.
4. Virginia Waters Substation, St. John's (47°36'54.2"N 52°42'12.2"W), referred to as Virgina Waters.
5. Oxen Pond Terminal Station, St. John's (47°34'26.45"N 52°45'22.46"W), referred to as Oxen Pond.

The sites were compared based on the following criteria:

Table 4-1: Site Selection Criteria

Category	Sub-Criterion
General Site Analysis	Grid hosting capacity
	Connection point
	Maintenance and NL Hydro access
	DERMS/SCADA integration capability
Electrical Integration	Connection voltage
	Transmission line length
	Routing considerations
Site Preparation	Land area available
	Grading and clearing requirements
	Expandability for additional BESS capacity
	Flooding
	Site preparation cost estimates
Real Estate Considerations	Lease and property tax costs
	Zoning compliance
Community & Environmental Risks	Noise considerations
	Distance to nearest neighbors
	Environmental permitting (wetlands, protected species)
	Impact on neighboring communities (visual, traffic, etc.)
	Protected areas or species nearby
	Air quality and emissions permitting
Safety and Security	Fire safety access and hydrant availability
	Emergency response time

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More details on the site selection process are described in the Site Assessment Report (H376866-0000-21D-066-0001, refer to Appendix I).

4.1.1 Summary of Evaluation Findings

The results of the preliminary screening and scoring process indicate that three sites demonstrated suitability for a utility scale BESS installation. These sites were Hardwoods (Greenfield), Hardwoods (Brownfield), and Goulds. Each of these locations met the technical and operational requirements identified in the evaluation criteria, including interconnection feasibility, land availability, and overall constructability.

Based on the findings of the Site Assessment, Hardwoods (Greenfield) achieved the highest overall assessment performance among the shortlisted locations. The site demonstrated the most balanced combination of technical, civil, environmental, and social suitability. It has sufficient space to accommodate the full 50 MW and 8-hour BESS configuration without requiring removal of existing infrastructure at the Hardwoods gas turbine plant. This allows the project to proceed on a greenfield site with fewer construction constraints and a lower risk of schedule delays. The site also offers strong interconnection flexibility at both 66 kV and 230 kV. As part of the defined scope for this stage of work, the assessment focused on the primary screened areas; however, in future stages, additional areas (such as the area located southwest of the present location of the fuel tank) should be examined for potential consideration.

In contrast, the Hardwoods (Brownfield) site requires the decommissioning and removal of the existing gas turbine plant and associated fuel systems before BESS installation work can begin. This introduces a significant operational impact because the station would lose the capacity of the combustion turbine for the entire duration of the decommissioning and construction period. That loss of capacity would reduce available system support during a period when the BESS is not yet in service, adding operational risk and limiting flexibility. It also creates schedule dependencies that are not present at the Greenfield site and could extend overall project duration.

From a civil and constructability standpoint, the Hardwoods (Greenfield) site offers several benefits including relatively flat terrain, reasonable equipment and construction access, and less earthworks, demolition, and relocation requirements compared to other shortlisted sites. The site is already zoned for industrial use and is anticipated to pose a lower degree of community and environmental sensitivity compared to the Virginia Waters, Goulds, and Oxen Pond locations, which are located near residential areas, agricultural lands, and parklands. While some wetland considerations exist, the overall community and environmental risk profile remains low relative to the alternatives. In addition, subsurface conditions at the Brownfield site are unknown, including potential soil contamination or remediation that may be required during decommissioning of the site.

Together, these advantages make Hardwoods (Greenfield) the option with the lowest implementation risk and the least operational disruption, providing the most practical foundation for a utility scale BESS installation. Through collaboration and discussion, the site was deemed acceptable to advance the design, and Hatch recommended Hardwoods (Greenfield) to NL Hydro.

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4.1.2 Hardwoods (Greenfield)

The proposed Hardwoods (Greenfield) site is southwest of the existing Hardwoods Terminal Station in Paradise, NL. The available Greenfield space at Hardwoods Terminal Station is shown in Figure 4-1.



Figure 4-1: Hardwoods (Greenfield) Site

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4.2 Climatic Conditions

The Hardwoods (Greenfield) site is the selected BESS location for the feasibility study. The climate in Hardwoods characterized by Table 4-2 to Table 4-6:

Table 4-2: Design Data for the Site Location[4]

Elevation (m)	110
Average Temperature Winter/Summer (°C)	-4/17
Minimum Temperature (°C)	-17
Maximum Temperature (°C)	29
Humidity (%)	70% to 90%

Table 4-3: Historic Average Maximum and Minimum Temperatures for St. John's, NL[5]

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min (°C)	-7.8	-8.4	-5.7	-1.9	-1.6	5.9	11.2	12.1	8.5	4.3	0.0	-4.1
Max (°C)	-0.7	-1.0	1.2	5.6	11.0	15.7	20.9	20.8	17.0	11.2	6.7	2.1

Table 4-4: Historic Extreme Maximum and Minimum Temperatures for St. John's, NL

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min (°C)	-19.5	-22.4	-19.8	-14.1	-6.7	-2.1	1.6	2.3	0.6	-5.4	-13.4	-17.3
Max (°C)	15.7	16.0	16.8	21.0	27.6	27.8	31.2	31.0	29.5	23.7	19.2	17.3

Table 4-5: Historic Average Wind Speed

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind Speed (m/s)	4.7	5.1	4.9	4.5	4.1	3.8	3.6	3.5	3.8	4.1	4.4	4.8

Table 4-6: Historic Average Precipitation

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation (mm)	168	150	146	117	110	95	81	115	121	154	151	166
Average Snow Depth (cm)	21	34	22	7	0	0	0	0	0	1	8	8

[4] ASHRAE climatic design conditions 2009/2013/2017/2021/2025
[5] Canadian Climate Normals 1991-2020 Data - Climate - Environment and Climate Change Canada

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4.3 Seismic Loads

The Seismic Hazard values for St. John's, NL are shown in Table 4-7 below.

Table 4-7: Seismic Conditions for Design Requirements[6]

Seismic Data	
S_a (0.2, X_C)	0.189
S_a (0.2, X_D)	0.233

For structural conceptual design, the site classification is assumed to be Class D. This will need to be confirmed by a geotechnical engineer during the next phase of the project.

4.4 Current Power System

The Hardwoods Terminal Station is a facility with a 50 MW simple cycle gas turbine. The power plant is located within a terminal station consisting of 66 kV and 230 kV bus work, transformers, circuit breakers, and transmission lines. These assets can be utilized by a potential BESS facility.

5. Major BESS Component Design Criteria

The following subsections establish the design criteria for the major equipment that make up the BESS. It establishes the baseline technical assumptions and performance expectations used for feasibility level sizing, layout, integration, and cost estimation across the four study configurations. Criteria apply to all options and are intended to be vendor neutral while remaining representative of Tier One offerings at utility scale.

Basis of design at AACE Class 4:

- A typical market available 5.1 MWh containerized lithium-ion battery system is used as the battery basis for sizing.
- A typical four megavolt ampere PCS and MVT skid is used as the power block basis for design.
- The collector system operates at 34.5 kV and interconnects to the existing Hardwoods Terminal Station at 66 kV as defined in the electrical design criteria.
- Auxiliary services will be supplied by local 34.5kV distribution network.
- All equipment is expected to have a 20-year lifetime.

5.1 Operating Conditions

The installed BESS is expected to complete less than 100 equivalent full cycles per year. It will be used for to provide reliability to the grid, able to supply additional capacity during peak periods.

It is assumed that the BESS will maintain a SOC between 80% and 85% during standby, unless directed by dispatch.

[6] National Building Code of Canada 2025, first printing

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The anticipated round-trip efficiency (RTE) of the system is expected to be approximately 85 to 90 percent at beginning of life (BOL).

Minimum and maximum AC system frequency and voltage limits for continuous operation to be coordinated with NL Hydro grid codes and IEEE guidance.

PCS setpoints and scheduling are coordinated by EMS and plant controller with NL Hydro dispatch authority.

The system has not been sized for black-start capability in this work and will be discussed at a later design stage.

5.2 Site Specific Climate Requirements

Any equipment installed should be provided in an enclosed, weatherized system to meet local climate and seismic conditions.

The solution should be operational down to -17 °C. The system shall be capable of self-protecting against short periods of temperatures at -25 °C, and to continue to operate. Each subcomponent of the BESS shall be self-protecting in the event of failure of any other component (e.g., the battery enclosures shall be able to self-protect against freezing if the MGCS or PCS fails).

To support these requirements, the battery enclosures are expected to include integrated heating systems sized to maintain battery modules within their allowable operating temperature range under low-temperature ambient conditions. These heaters typically operate automatically as part of the thermal management system, but their use can represent a significant station-service load, particularly during extended cold weather.

The enclosure should also be designed to prevent salt, rain and snow entry through ventilation or openings. The site location is approximately 6 km away from the ocean and exposure to salt water must be considered in the BESS design. It is recommended that at least C5 protective paint protection applied to all BESS components.

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5.3 Design Codes and Standards

The codes and standards specific to the design of the BESS are listed in Table 5-1.

Table 5-1: Applicable Codes and Standards

Organization	Standard	Description
NFPA	855	Standard for the Installation of Stationary Energy Storage Systems.
UL	9540	Standard For Safety; Energy Storage Systems and Equipment.
UL	1973	Standard for Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications.
CSA	22.2	No. 107.1 Power Conversion Equipment
UL	9540A	Battery Energy Storage System (ESS) Test Method for cell, module and unit level testing.
NFPA	68	Standard on Explosion Protection by Deflagration Venting.
NFPA	69	Standard on Explosion Prevention Systems.
IEEE	693	IEEE Recommended Practice for Seismic Design of Substations, specifically high seismic performance level qualification.
UN	38.3	UN ST/SG/AC.10/11/rev5 2009, part 38.3 Transport of Dangerous Goods Manual: Lithium Metal and Lithium-Ion Batteries.
UL	1642	Standard for Lithium Batteries.
UL	1741	Power Conversion Systems (Inverters).
NFPA	72	Standard on National Fire Alarm and Signaling Code®.
IEEE	1547	Connecting Distributed Energy Resources.

5.4 BESS Container

In general, the BESS container will be a system composed of the following:

- Containerized factory-assembled BESS certified to UL 9540.
- Cell chemistry of the cells inside the BESS container to be from lithium-ion based chemistries, with a preference for LFP for safety considerations.
  - LFP is preferred over other lithium-ion chemistries for its enhanced thermal stability, lower risk of thermal runaway, and improved tolerance to abusive conditions.
  - LFP is also preferred for ESSs for its long cycle life, stable degradation characteristics, and broad applicability across grid-storage duty cycles.
- Battery modules and BMS tested to UL 1973 and UL 1642.
- Fire, ventilation, and deflagration controls compliant with NFPA 855, NFPA 68 and NFPA 69 respectively.
- Local and remote monitoring of voltage, current, temperature and SOC.

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Thermal Management:

- Active thermal management suitable for Hardwoods site climate as indicated in Section 4.2 and 5.2.

Safety:

- Fire detection per NFPA 72.
- Gas detection and ventilation in compliance with NFPA 69.
- Emergency venting per NFPA 68.
- Isolation devices at module, rack and container level.

For the purposes of the feasibility study, a 5.1 MWh battery is used as a basis for BESS sizing. This is a standard battery and is representative of what is on the current market from a Tier One supplier. No additional work was done to select this battery over other BESS manufacturers and models.

5.5 Power Conversion System

In general, the PCS will be a system with the following requirements:

Standards and Compliance:

- PCS certified to UL 1741.
- PCS grid interface compliant with IEEE 1547.
- Seismic performance qualified to IEEE 693.

Electrical Characteristics:

- Capable of operating at a minimum power factor of 0.90 lagging and leading to meet NL Hydro reactive support expectations.
- Bidirectional capability for both charging and discharging.
- Harmonic performance compliant with IEEE 519 at the point of common coupling.

Protection and Control:

- Integrated anti-islanding protection, over/under-voltage and over/under-frequency protection.
- PCS to include fast control response suitable for grid support functions (frequency response, voltage support).

Environmental:

- Outdoor-rated enclosure mounted on a structural foundation.
- Minimum operating temperature range suitable for Newfoundland climate with integrated heating as required.

A 4 MVA PCS-MVT skid is used as a basis for design at this stage. This was a selection made from the typical technology available at this time.

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5.6 Medium Voltage Transformer

The MVT used for feasibility is modeled as part of a typical four MVA PCS–MVT skid assembly.

Transformer Ratings:

- Nominal medium voltage output at 34.5 kV to match the BESS collector system.
- Transformer impedance consistent with typical vendor offerings to limit fault contribution while allowing PCS operation.

Protection:

- MV fusing or breaker protection coordinated with PCS fault clearing capability.
- Temperature monitoring and alarms per industry standards.

Construction:

- Transformer can be either an oil-filled or dry-type depending on vendor offering.
- Outdoor pad-mounted installation on structural foundation.
- Compliance with CSA transformer standards.

Operation:

- Transformer can be isolated with a MV disconnect switch provided at the main cable entrance.

5.7 Energy Management System

The EMS manages charge, discharge, operational limits and grid interface functions.

Functional Requirements:

- Controls dispatch of the BESS according to NL Hydro operational strategies for reliability and capacity support.
- EMS will maintain SOC of the BESS within 80 to 85 percent during standby periods.
- Generates alarms, status and event logs for operator interface.
- Provides remote supervisory control via SCADA integration.

Communications:

- Compatible with utility communications protocols (for example DNP3, IEC-61850 depending on NL Hydro requirements).
- Secure, redundant communication paths between EMS, PCS, BMS and plant control systems.

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Cybersecurity:

- Shall comply with modern cybersecurity guidelines applicable to DER assets, including role-based access, secure and authenticated communication channels, and event logging.
- Support for future compliance with NL Hydro cyber requirements.
- Network segmentation between EMS, PCS, BMS, and NL Hydro SCADA.

Grid Interface:

- Able to implement real-power and reactive-power commands, power factor control and ramp rate limits.
- Must support scheduling, setpoint control and override commands from NL Hydro.

5.8 Monitoring, Telemetry, and Control

Minimum monitored points include real power, reactive power, voltage, current, frequency, SOC, SOH, transformer temperatures, breaker status, alarms, and events.

Data logging cadence suitable for operations analysis and compliance reporting with synchronized time stamping.

Remote control of real power setpoint, reactive power or power factor setpoint, schedules, and curtailment.

Plant controller coordinates feeder limits, collector bus constraints, and main step-up transformer controls.

5.9 Reliability and Degradation Assumptions

Availability is modeled using typical utility scale expectations for Tier One equipment.

Battery capacity degradation modeled using representative vendor curves and the operating conditions outlined in Section 5.1.

To ensure power and energy capacity over the life of the system, an overbuild and augmentation strategy has been determined for each of the BESS designs, along with an appropriate size of area to support each strategy, included in each design.

An AC augmentation strategy will be utilized for the four BESS designs. This was selected based on the reasons outlined in Section 3.5.

5.10 Layout, Spacing, Noise, Fire and Safety Requirements

Equipment spacing and fire separation meet NFPA 855 and vendor guidance.

Aisle widths and working clearances meet Canadian Electrical Code (CEC), container maintenance requirements, and site safety requirements. Substation design shall follow NL Hydro engineering standards.

DC and medium voltage cable routing planned to minimize heating and voltage drop and preserve maintenance access.

Grounding and bonding meet project electrical criteria and CSA requirements.

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Typical noise measurements indicate that a single BESS container's cooling system can generate approximately 70 to 92 dBA at one meter, while a single PCS unit typically produces noise levels in the mid-70 dBA range. As part of the overall design process, a full facility-level noise assessment will be required to evaluate combined operational noise, confirm compliance with local requirements, and determine whether any mitigation measures are necessary.

The entire BESS facility will be designed to NFPA 855 to meet fire safety requirements.

Equipment spacing, egress, and site access consistent with NFPA 855 and authority having jurisdiction.

Fire detection per NFPA 72 with annunciation to the site control room and SCADA.

Working clearances for operations and emergency responders maintained per code.

5.11 Planned Project and Sizing

NL Hydro is considering the following options for the Avalon Peninsula BESS.

1. 20 MW with a 4-hour reserve (80 MWh at the point of interconnection).
2. 20 MW with an 8-hour reserve (160 MWh at the point of interconnection).
3. 50 MW with a 4-hour reserve (200 MWh at the point of interconnection).
4. 50 MW with an 8-hour reserve (400 MWh at the point of interconnection).

The BESS sizing for each option is summarized in Table 5-2 below.

Table 5-2: BESS Sizing for Four Capacity and Duration Options.

Case	Capacity (MW)	Duration (h)	BOL Nameplate Capacity (Total) (MWh)	Number of Battery Containers
1	20	4	122.40	24
2	20	8	214.20	42
3	50	4	306.00	60
4	50	8	535.50	105

The battery sizing is based on the following assumptions:

- The line losses between the BESS and the Point of Interconnection. Sizing does not account for auxiliary loads for the equipment or the site as vendor offerings can vary wildly in load losses. As this is a grid tied system the loads will be supplied by the grid network and will need to be considered in the next stage of detailed design. Approximate loads are provided in Section 5.12.
- The BESS and PCS-MVT used for this study are standard off-the-shelf products (5.1 MWh and a PCS-MVT skid of 4.0 MVA).

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- The battery sizes account for a five-year “overbuild” of the system to compensate for the first several years of degradation, however, BESS containers for each PCS-MVT skid needed to be sized appropriately for each sizing (as an example, for the four-hour system, for every one PCS-MVT unit, four containers are required to be installed, and for the eight-hour system, there is a ratio of one to seven). This has resulted in a larger overbuild to match PCS-MVT skids to container sizes.

In addition to sizing the Beginning of Life (BOL) Nameplate Capacity, a preliminary augmentation plan was developed for each case. Assuming a BESS lifecycle of about 20 years, the augmentation plan for each case is as follows:

- For Case 1, augmentation will not be required due to the initial overbuild and the required ratios for PCS containers to BESS containers.
- For Case 2, seven batteries (5.1 MWh each, 35.7 MWh installed augmentation amount) will be added at Year 7.
- For Case 3, augmentation will not be required due to the initial overbuild and the required ratios for PCS containers to BESS containers.
- For Case 4, seven batteries will be added at Year 7, and an additional seven batteries will be added at Year 13.

5.12 AC Load Calculations

AC auxiliary services are calculated as per the following assumptions:

- 24 kW per BESS containers auxiliary load (includes controls systems, TMS for heating and cooling, and safety systems).
- 8.2 kW per PCS auxiliary load.
- 10 kW Fire protection.
- 0.5 W/m2 Lighting (50 lux average).
- 15 kW Security system.
- 1.5 kW Protection and Controls.
- 3 kW Communications.
- 1.5 kW SCADA.
- 1.5 kW UPS and Telecommunications.
- 1 kW Tele-protection.

Supply is assumed to come from the Hardwoods Station and is not considered part of the BESS system load.

The loads above are the maximum auxiliary loads required for each of the systems. For the 50 MW, 8-hour system, since each of the battery containers will be limited to operating at one quarter of the maximum power rating (approximately 2.5 MW, limited to 0.625 MW), the thermal management system will not be required to operate at this maximum rating, and a smaller auxiliary transformer can be utilized instead.

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The BESS auxiliary load sizing for each option is summarized in Table 5-3 below.

Table 5-3: BESS Auxiliary Loads Sizing for Four Capacity Options.

Case	Auxiliary Loads (kW)
1	800
2	1500
3*	1900
4*	3500

*Note, the sizing of the auxiliary loads for all four options is based on the maximum load conditions, however, the system would not be expected to operate at these conditions given the lower operating charge and discharge powers than those indicated in the BESS operations manual. As discussed, in Option 4, the BESS will operate at a C-rate of 0.125 as opposed to design operating conditions of 0.5. The thermal management load requirements for the system are expected to be lower even with the additional containers required to be installed. This is identified as a risk, but the design to incorporate a 2.0 MVA auxiliary transformer will remain.

6. Geotechnical Assumptions

Geotechnical reports for the proposed sites do not exist. As a result, the following assumptions will be applied for design purposes:

- The frost penetration depth is assumed to be 1.3 m.
- In the absence of data on competent soil depth, we will assume excavation to a depth of 2.0 m below ground surface.
- Structural fill will be placed in 300 mm loose lifts and compacted to 98% Standard Proctor (95% Modified where applicable).
- Footings will be placed directly on the structural fill, assuming adequate excavation dewatering.
- Frost protection will be achieved by using a foundation wrap within the frost depth of 1.3 m.
- No additional mud slab or cement layer will be required.
- The groundwater table is anticipated to be high due to the site's wetland conditions, but discussions with Hatch's Geotechnical Engineers working in the St. John's office have detailed that there are no liquefiable soils present.

The next steps for the project will require that the necessary geotechnical studies be performed for the site, before additional design work.

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7. Electrical Design Criteria

This section outlines the electrical design criteria that apply to the BESS options under consideration for NL Hydro's Avalon Peninsula BESS Feasibility Study. These criteria establish the technical requirements that guide the configuration, sizing and performance expectations for all electrical systems associated with the BESS facility.

The study evaluates four BESS configurations: 20 megawatts with four hours, 20 megawatts with eight hours, 50 megawatts with four hours and 50 megawatts with eight hours of discharge duration. Although each option varies in power and energy capacity, all configurations will connect to the existing Hardwoods Terminal Station at the 66-kilovolt level and share the same overarching electrical design principles.

The design criteria in this section define the applicable voltage levels, protection philosophy, metering and power quality requirements, high voltage and medium voltage equipment ratings and the performance expectations for the BESS when operating on the NL Hydro system. For this study, these criteria ensure that each BESS configuration can be reliably integrated at Hardwoods Terminal Station, maintain safe coordination with the transmission system and form the foundation for sizing, layout, protection philosophy and cost estimation at the AACE Class 4 level.

7.1 Design Codes and Standards

The codes and standards specific to the electrical design of the BESS are listed in Table 7-1.

Table 7-1: Applicable Codes and Standards

Organization	Standard	Description
ANSI	ANSI C57.114	Seismic guide for Power Transformers and Reactors
ANSI	ANSI IEEE Std 386	IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
ANSI	ANSI NETA ATS	Acceptance Testing Specifications for Electrical Power Equipment and Systems
ASTM	ASTM D3487 16	Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus
CSA	CAN CSA C50 14	Mineral Insulating Oil Electrical for Transformers and Switches
CSA	CAN CSA C802.3 01	Maximum Losses for Power Transformers
CSA	CAN CSA C802.3 15	Minimum Efficiency Values for Power Transformers
CSA	CAN ULC S115	Fire Tests of Firestop Systems
CSA	CSA 22.1	Canadian Electrical Code CEC
CSA	CSA 22.1 21	Canadian Electrical Code Safety Standard for Electrical Installation
CSA	CSA 22.2 No. 0.4 17	Bonding of Electrical Equipment
CSA	CSA 22.2 No. 0.12	Wiring Space and Wire Bending Space in Enclosures Rated 750 V or Less

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Organization	Standard	Description
CSA	CSA 22.2 No. 5	Molded Case Circuit Breakers Molded Case Switches and Circuit Breaker Enclosures
CSA	CSA 22.2 No. 14	Industrial Control Equipment
CSA	CSA 22.2 No. 18.3 12	Conduit Tubing and Cable Fittings
CSA	CSA 22.2 No. 26 13	Construction and Test of Wireways Auxiliary Gutters and Associated Fittings
CSA	CSA 22.2 No. 31	Switchgear Assemblies
CSA	CSA 22.2 No. 41	Grounding and Bonding Equipment
CSA	CSA 22.2 No. 56 17	Flexible Metal Conduit and Liquid Tight Flexible Metal Conduit
CSA	CSA 22.2 No. 58 M89	High Voltage Isolating Switches
CSA	CSA 22.2 No. 62 93	Surface Raceway Systems
CSA	CSA 22.2 No. 94	Special Purpose Enclosures
CSA	CSA 22.2 No. 107.1	Power Conversion Equipment
CSA	CSA 22.2 No. 127	Equipment Wiring
CSA	CSA 22.2 No. 141	Emergency Lighting Equipment
CSA	CSA B72 20	Installation Code for Lightning Protection Systems
CSA	CSA CAN3 C13	Instrument Transformers
CSA	CSA CAN3 C235	Preferred Voltage Levels for AC Systems 0 to 50000 V
CSA	CSA C227.4 06	Three Phase Pad Mounted Distribution Transformers with Separable Insulated High Voltage Connectors
CSA	CSA C22.1	Canadian Electric Code Part One
CSA	CSA G40.20	General Requirements for Rolled or Welded Structural Quality Steel
CSA	CSA W47.1 19	Certification of Companies for Fusion Welding of Steel
CSA	CSA W48 23	Filler Metals and Allied Materials for Metal Arc Welding
CSA	CSA W59 24	Welded Steel Construction
CSA	CSA Z234.1	Metal Practice Guide
CSA	CSA Z462	Workplace Electrical Safety
FCC	FCC EMI Requirements	EMI requirements
IEEE	IEEE 80	Guide for Safety in AC Substation Grounding
IEEE	IEEE 141	Recommended Practice for Electric Power Distribution Industrial Plants
IEEE	IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
IEEE	IEEE 3003.1	Recommended Practice for Grounding of Industrial and Commercial Power Systems
IEEE	IEEE 493	Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems
IEEE	IEEE 62.11	Standard for Metal Oxide Surge Arresters for AC Power Circuits above 1 kV

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Organization	Standard	Description
IEEE	IEEE 1100	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment
IEEE	IEEE 1547 2018	Standard for Interconnecting Distributed Energy Resources with Electric Power Systems
IEEE	IEEE 1547.1 2020	Standard Conformance Test Procedures for Equipment Interconnecting DER with Electric Power Systems
IEEE	IEEE 1584	Guide for Performing Arc Flash Hazard Calculations
IEEE	IEEE 693 2018	Recommended Practice for Seismic Design of Substations
IEEE	IEEE C37.13	Standard for Low Voltage AC Power Circuit Breakers Used in Enclosure
IEEE	IEEE C57.12.00	Standard General Requirements for Liquid Immersed Distribution Power and Regulating Transformers
IEEE	IEEE C57.12.01	Standard General Requirements for Dry Type Distribution and Power Transformers
IEEE	IEEE C57.12.28	Standard for Pad Mounted Equipment Enclosure Integrity
IEEE	IEEE C57.12.90	Standard Test Code for Liquid Immersed Distribution Power and Regulating Transformers
IEEE	IEEE C57.96	Guide for Loading Dry Type Distribution and Power Transformers
IEEE	IEEE C57.106	Guide for Acceptance and Maintenance of Insulating Mineral Oil in Electrical Equipment
IEEE	IEEE C57.120	Standard for Loss Evaluation of Distribution and Power Transformers and Reactors
IEEE	IEEE 837	Standard for Qualifying Permanent Connections Used in Substation Grounding
ISO	ISO 9001	Quality management systems — Requirements
ISO	ISO 14000	Environmental management
NBCC	NBCC	National Building Code of Canada
NFCC	NFCC	National Fire Code of Canada
NFPA	NFPA 110	Standard for Emergency and Standby Power Systems
NFPA	NFPA 780	Standard for the Installation of Lightning Protection
NEMA	NEMA 250	Enclosures for Electrical Equipment one thousand Volts Maximum
SSPC	SSPC	Society for Protective Coatings
TIA EIA	TIA EIA 455 8	FOTP 8 Measurement of Splice or Connector Loss and Reflectance using an OTDR
TIA EIA	TIA EIA 455 59A	FOTP 59 Measurement of Fiber Point Discontinuities Using an OTDR
TIA EIA	TIA EIA 526 14A	OFSTP 14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA EIA	TIA EIA 568 B	Commercial Building Telecommunications Cabling Standard
TIA EIA	TIA EIA 569	Commercial Building Standard for Telecommunications Pathways and Spaces
UL	UL	Underwriters Laboratories (various standards)

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7.2 Voltage Levels

Typical voltage levels and system grounding characteristics used for distribution, motor power, lighting, convenience (power) outlets, control and instrumentation are 120/208Vac, 347/600Vac and 125VDC.

The medium voltage equipment for the connection of the individual battery containers will be the standard 34.5 kV level.

It shall be noted that a nominal medium voltage level of 34.5 kV is commonly selected because it aligns with standard collector system design practice for utility scale renewable energy and BESS installations. Many large scale solar and storage projects use 34.5 kV as the medium voltage collector circuit rating, with PCS units feeding into a 34.5 kV collection system that aggregates power before stepping up to transmission voltage. Most BESS integrators source this transformer size and changing it would result in additional costs.

Interconnection to the existing Hardwoods Terminal Station will utilize the existing 66 kV level, which will provide the cheapest solution and a smaller footprint for the BESS substation.

Auxiliary services are assumed to be supplied by local 34.5kV distribution network.

7.3 Power Factor

The Power Factor will be maintained at or above a specified value during normal loading conditions (i.e., above 0.95). Additional or alternative equipment will be used to improve the power factor to the required value. The BESS will be capable of operating (discharge to the system) at a power factor of 0.90.

7.4 Metering

Metering will be provided at the main 34.5 kV switchgear to monitor power (MW and MVAR), energy consumption, frequency, voltage and current for the facility operational statistics. In general, feeder and motor management relays shall also have electrical measurement features for energy management and shall have direct connectivity to the plant wide power management system.

Revenue class import-export metering will be provided for billing purposes.

7.5 Power Quality

The total harmonic distortion (THD) must be in accordance with the requirements of IEEE 519, over the entire voltage and current range available. If required, harmonic filtering/suppression equipment will be used to improve the THD to the requirement of IEEE.

7.6 Short Circuit Current

The Equipment fault duties shall be carefully considered in the selection of transformer sizes and transformer impedances.

All equipment and materials shall be designed, assembled and inspected in accordance with the maximum fault level in each part of the electrical power system.

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7.7 Protective Devices

A properly coordinated protection system shall be designed for the power system at all voltage levels. The system shall be designed for maximum personal protection, rapid clearing of faults and minimum service interruption. Disconnection of equipment shall be restricted to the minimum amount necessary to isolate the fault from the supply. Wherever possible the protective schemes shall maintain power to process areas from at least one source during any system fault. The protection requirements shall follow NL Hydro standards for type of relays and shall consist of but not limited to the following:

- Differential protection using two different microprocessor-based relays applicable to:34.5/66 kV transformers.
- Main (collector) 34.5 kV buses.
- Instantaneous (short circuit) overcurrent protection is applicable to:
  - 66kV line.
  - Medium Voltage Transformers.
  - 34.5 kV Feeders.

7.8 Voltage Regulation

7.8.1 General

The allowable voltage drops shall be calculated based on the following:

- Connections between power transformers and secondary switchgear shall be short lengths of bus ducts, cable bus or cables with zero voltage drops.
- Connections between distribution transformers and panel boards will be considered as short lengths of cable with zero voltage drops.
- Transformer regulation shall not be considered for normal operating conditions since transformer tap changers will be set to obtain a specified bus voltage level under normal load conditions.
- Transformer impedance shall be considered for voltage drop calculations during starting of large motors.
- The voltage spread between the transformer and utilization equipment terminals shall not exceed ± 5% of the rated voltage of the equipment being served at no load and rated full load conditions.

The allowable voltage drops in feeder cables, based on full load, shall not exceed the following values:

- Secondary distribution feeder cables: 2%
- Transformer feeders: 3%
- Lighting branch circuits between the panel board and the remotest fixture: 3%

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7.9 Electrical Equipment Rooms

Electrical equipment rooms shall meet at least the following:

- Electrical room buildings shall be prefabricated building type. The outside color of buildings shall be in accordance with local or Client's standards;
- Minimum working clearances around electrical equipment within the electrical rooms shall be in accordance with local codes and standard requirements. As default, the CEC and the NBCC codes shall apply. Client's insurer requirements may also need to be considered;
- Size of electrical control room/building shall be determined based on technical requirements, including physical size of the equipment as well as service and maintenance access requirements for the equipment chosen to be installed inside;
- Electrical equipment layouts within the electrical rooms shall be developed so as to facilitate future equipment removal and additions. Switchgear units shall be placed and substations sized so that additional extension cubicles can be conveniently attached to the existing ones. The electrical capacity and physical arrangement of the original installation shall be sized to cater for 10% additional future loads;
- Electrical rooms shall be furnished with suitable cooling/heating and filtered ventilation (HVAC system). The HVAC equipment for the electrical room shall be installed on the outside walls of the housing to allow maximum use of the interior wall space or shall be installed as remote stand-alone units with ducting to the electrical room;
- A positive pressure shall be maintained inside the electrical module to restrict the entrance of dust, dirt, gases and particles from outside;
- All openings through the walls, ceilings, and floors of an electrical room for the passage of conduit, cables or cable trays, shall be sealed with fire resistive material that is FM/ULc approved/listed for this application. The fire resistive rating shall be the same fire rating as the room. This shall also minimize dust infiltration into the room;
- The electrical rooms shall be furnished with fire detection system and with fire suppression system following NL Hydro standards.
- Manual fire extinguishers shall be provided and mounted within the room;
- Electrical equipment rooms shall be provided with two means of egress and shall have a self-closing double-door;
- Electrical rooms shall be curbed and roofed to prevent ingress of water from the process area or outdoors.

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7.10 MV Switchgears

- The MV switchgears line-up shall be an assembly of metal-clad vertical sections in accordance with AINSI/IEE and CSA standards, with an integral busbar system designed to accept plug in circuit breaker units. Each circuit breaker and all equipment for control, metering and protection shall be mounted inside, or on the door of individual compartments.
- MV switchgears shall be arc-resistant, type 2B. Any necessary plenum or ducting for the safe discharge of gases and debris resulting from an internal arc fault shall be provided.
- MV circuit breakers shall be vacuum interrupter type. Circuit breaker assemblies shall be truck-mounted and withdrawable. Three positions for circuit breakers shall be provided: connected, test and disconnected positions, all permissible with the door closed. Each circuit breaker shall be interchangeable with other breakers of the same rating.
- Circuit breakers shall be equipped with required mechanical and electrical interlocking devices to ensure safe operation of equipment during maintenance or testing.
- Padlocking shall be provided for securing the breaker in the connected, test, or disconnected position.
- Busbars shall be secured in place with insulators mechanically braced to withstand forces from the rated short circuit currents for the required duration. Provision for movement of busbars due to thermal effects shall be considered.
- All low voltage control equipment shall be mounted in a separate, fully isolated low voltage compartment. For Arc-Fault Resistant equipment, the compartment shall contain full protection against the effects of an arc-fault in the MV sections.

7.11 HV Equipment

- HV equipment will be selected in accordance with NLSO standard TP-S-005 “Technical requirements for Connection to the NL Transmission System”.
- 66 kV equipment will be rated for 72.5 kV, 350 kV BIL.
- 66kV Breakers will be Dead tank SF6 equipped with bushing type CTs.
- Given that 34.5 kV will be a new voltage level for NL Hydro, and no spare, or mobile, transformer exists, redundant BESS step up transformer capacity will be installed, each transformer capable of handling the full load.
- Overhead HV conductor, rigid bus and buried cable will be selected using a 30 °C ambient temperature and 90 °C conductor temperature to ensure adequate current carrying capacity.
- BESS step up transformers will be equipped with On Load Tap Changers (OLTCs) to ensure proper voltage regulation across the charge and discharge cycles.
- HV equipment ratings will assume a BESS output having a 0.90 pf capability.

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7.12 HV Interconnection

- NLSO TP-S-005 limits the largest generation loss on the island to 155 MW. Given that the BESS project is limited in size to between 20 MW and 50 MW, a single HV interconnection to the gird is sufficient. A 66 kV interconnection is selected to replace the Hardwoods gas turbine at the same delivery point.

7.13 Yard lighting

BESS yard lighting will be designed following the following lighting levels:

- 10 lux security lighting level.
- 50 lux working lighting level.
- 10 lux disconnect switch blade lighting level.

7.14 Cables

All cables will be installed as per the following:

- MV power cables: directly buried in separate trench.
- Control cables: directly buried in separate trench.

8. Controls Design Criteria

The BESS and its interconnection to the Hardwoods Terminal Station bus will be designed for full real time monitoring, control, and data acquisition from both the local E-house control system and the NL Hydro Energy Control Centre, with local or remote supervisory authority selectable through a transfer switch.

The control architecture will clearly define the respective responsibilities of the PCS, EMS, SCADA, and protection systems, including required operational modes such as charging, discharging, reactive power support, grid following operation, and any utility defined modes.

Communications, event logging, and alarm handling will comply with NL Hydro SCADA standards including defined protocols, cybersecurity requirements, and time synchronized data acquisition.

The protection system will incorporate a high-speed primary protection layer and a coordinated slower backup protection system to ensure fault clearing and system stability.

The system will be designed such that the loss of one 34.5/66 kV transformer or one battery container does not result in loss of the BESS to the power system.

Loss of the 66 kV interconnection line, which results in loss of the BESS, is deemed acceptable.

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9. Civil Design Criteria

This section outlines the civil design criteria to support development of the proposed BESS configurations. These criteria establish the assumptions for site layout and development, site preparation, grading, drainage, and road geometry for the Hardwoods (Greenfield) site and apply to all four BESS options.

Civil design criteria are essential because they identify construction, environmental, and long-term site performance requirements that influence the feasibility of each BESS option at the AACE Class 4 stage. Establishing these criteria ensures the site can accommodate the required electrical infrastructure, meet municipal and provincial regulatory expectations, maintain safe year-round access, and manage stormwater in accordance with projected future rainfall intensity data for the region.

The civil scope will cover site development, access road design, and stormwater management for the proposed Hardwoods (Greenfield) site.

9.1 Codes and Standards

Unless noted otherwise within this document, the design of all civil works will be based on applicable parts of the latest revisions of current codes, specifications, standards, and regulations. In addition to these, the design will comply with any laws and regulations of local authorities having jurisdiction over the project site. These codes, standards and documents are declared to be a part of this document, as if fully set forth herein. In the event of conflicting requirements, the most stringent will apply. Table 9-1 details the codes and standards for the Civil Design.

Table 9-1 Civil Design Codes and Standards

Codes and Standards	
AASHTO	American Association of State Highway and Transportation Officials
ANSI	American National Standard Institute
ASTM	ASTM International
COHS	Canada Occupational Health and Safety Regulations
CSA	CSA Group
CSCE	Canadian Society for Civil Engineers
NBCC	National Building Code of Canada 2010
General	All Federal, Provincial, and Local Laws and Regulations
General	Town of Paradise Development Regulations
General	St. John's Development Design Manual
General	Oregon DOT Hydraulic Design Manual – Rational Method
TAC	Transport Association of Canada
IEEE	Institute of Electrical and Electronics Engineers

9.2 Units

All civil calculations, drawings, and specifications shall be in SI (metric) units unless otherwise stated.

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9.3 Design Requirements

The following sections include preliminary civil design requirements.

9.3.1 Site Development

The following sections outline the design requirements and basis of Site Development.

9.3.1.1 Site Preparation

- Clearing and grubbing, consisting of the removal and disposal of all trees, stumps, roots, logs, shrubs, grass, weeds, fallen timber, and other surface litter on the proposed site.
- Stripping the topsoil (where applicable), oversized rocks, and any other organic or deleterious/unsuitable materials. Stripped topsoil shall be removed from site.
- Waste material shall be removed from site.
- Temporary drainage collection and dewatering systems to provide erosion control measures prior to construction activities commencing within the proposed development.

9.3.1.2 Environmental Constraints

Any work that could disturb existing wetlands and natural water courses shall be avoided where possible. Where, and if, disturbance of natural wetlands cannot be avoided, the new installations shall be constructed in a manner that will minimize the impact on the environment and regulatory agencies will have to be engaged before any work is done within the environmentally sensitive areas.

9.3.1.3 Earthworks and Leveling

Earthworks include excavation and backfill for roads, buildings and equipment pads, utility berms, foundation excavation, construction of ditches, diversion channels and berms, dikes, etc. Earthworks shall be carried out in accordance with the following general guidelines:

- Existing unsuitable soils shall be removed from site and replaced with suitable material.
- Granular B shall be placed and compacted over the proof-rolled subgrade to achieve adequate bearing capacities, as required for specific construction activities.
- No loads, including excavated material, traffic of vehicles or heavy machinery shall be allowed near the crest of the slopes (at a distance equal to the height of the excavation) if the slope-support solutions did not take such loads into account.

9.3.1.4 Fencing

Fencing shall be required around the perimeter of the site, with a gate restricting access to the site. An additional 2 m of gravel will be required outside of the fence to account for grounding.

Sufficient clearance will also be maintained inside the fenced perimeter to ensure safe equipment access for maintenance and to meet NFPA 855 requirements for site access and emergency egress, which include maintaining clear access paths for responders and unobstructed movement around equipment.

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9.3.1.5 *Substation Pad Structure*

The granular pad structure for the substation yard will consist of a minimum of 400 mm layer of subbase, and a 200 mm layer of base. The finished grade shall be achieved with a minimum of 150 mm layer of clear stone surface course. All backfill shall be compacted to a minimum 98% Standard Proctor Maximum Dry Density. All granular layers shall meet NL Department of Transportation and Infrastructure Highway Specifications and shall be proof rolled with a compacting roller in static mode.

9.3.2 *Road Design*

- A one-way perimeter access road is required on-site.
- Roads will be subjected to occasional traffic by security, maintenance, and/or firefighting vehicles.
- Unless noted otherwise in technical documents, the roads located on site shall be designed using the following guidelines as listed below.
- Access road shall have a minimum width of 3.6 m.
  - Access roads shall have a minimum 2% transverse cross fall (4% maximum).
  - Access roads shall have a gradient no more than 8%.
  - Vertical Curve Crest shall have a minimum K value of 1 and Vertical Curve Sag shall have a minimum K value of 3.
- Due to a lack of site-specific geotechnical data, a typical road structure has been assumed. The road base shall be 200 mm Granular A, and the sub-base shall be 400 mm Granular B. All granular material shall comply with NL Department of Transportation and Infrastructure Specifications.

9.3.3 *Stormwater Management*

9.3.3.1 *Methodology*

Drainage infrastructure i.e. ditches and culverts shall be sized for the 25-year return period event (Table 9-2) in compliance with design regulations from the local Municipality and Province. Quantity and quality control has not been considered. Stormwater runoff from the proposed site infrastructure shall be collected in a perimeter ditch and conveyed towards a single outlet. Stormwater flowrates shall be calculated using the Rational Method and the formula is shown below in Figure 9-1.

$$Q = C_f C\, i\, A$$

Where:

Q = Peak flow in cubic feet per second (cfs)
C_f = Runoff coefficient adjustment factor to account for reduction of infiltration and other losses during high intensity storms
C = Runoff coefficient to reflect the ratio of rainfall to surface runoff
i = Rainfall intensity in inches per hour (in/hr)
A = Drainage area in acres (ac)

Figure 9-1: Rational Method Equation

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9.3.3.2 *Hydrology*

Design storms shall be determined from the projected IDF data (2041-2070) for the St. John's Airport. This data includes projections between the years 2041 and 2070 for an increase of precipitation due to climate change. The data set is representative of the 20-year design life of the BESS. Table 9-2 below displays the projected IDF data for cumulative rainfall amounts and Table 9-3 displays the rainfall intensity values.

Table 9-2: Projected IDF Data for 2041-2070 (Cumulative)

Duration (min)	Duration (hr)	Return Period (Years)					
		2yr (mm)	5yr (mm)	10yr (mm)	25yr (mm)	50yr (mm)	100yr (mm)
5	0.083	5.74	7.67	8.95	10.56	11.76	12.95
10	0.167	8.57	11.22	12.99	15.21	16.86	18.50
15	0.25	10.99	14.49	16.80	19.73	21.90	24.05
30	0.5	16.14	21.34	24.78	29.13	32.36	35.56
60	1	23.14	30.60	35.54	41.78	46.41	51.01
120	2	32.61	44.05	51.63	61.20	68.30	75.34
360	6	53.88	70.55	81.59	95.53	105.88	116.15
720	12	68.84	90.52	104.88	123.02	136.48	149.84
1440	24	80.61	103.69	118.97	138.27	152.59	166.81

Table 9-3: Projected IDF Data for 2041-2070 (Intensity)

Duration (min)	Duration (hr)	Return Period (Years)					
		2yr (mm)	5yr (mm)	10yr (mm)	25yr (mm)	50yr (mm)	100yr (mm)
5	0.083	68.88	92.04	107.40	126.72	141.12	155.40
10	0.167	51.42	67.32	77.94	91.26	101.16	111.00
15	0.25	43.96	57.96	67.20	78.92	87.6	96.2
30	0.5	32.28	42.68	49.56	58.26	64.72	71.12
60	1	23.14	30.60	35.54	41.78	46.41	51.01
120	2	16.31	22.03	25.82	30.6	34.15	37.67
360	6	8.98	11.76	13.60	15.92	17.65	19.36
720	12	5.74	7.54	8.74	10.25	11.37	12.49
1440	24	3.36	4.32	4.96	5.76	6.36	6.95

9.3.3.3 *Hydraulics*

The following hydraulic criteria outline the assumptions and methods applied in the design of site drainage features, including ditch sizing, culvert selection, and sub-drainage configuration.

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9.3.3.3.1 Ditches

The required perimeter ditch shall be sized with the flowrates found using the Rational Method. Relevant runoff coefficients from the Oregon Hydraulic Design Manual are listed below in Table 9-4 and adjustments for the runoff coefficients based on the design storm are shown in Table 9-5. With the determined flowrates, the ditch sizing and geometry will be designed through an iterative process checking the capacity with the Manning formula. A list of relevant Manning's roughness coefficients or overland sheet flow are found in Table 9-6.

Table 9-4: Runoff Coefficients for the Rational Method

Land Use/Surface	Runoff Coefficient		
	Flat	Rolling	Hilly
Pavement and Roofs	0.90	0.90	0.90
Gravel Pavement	0.85	0.85	0.85
Woodland and Forests	0.10	0.15	0.20
Meadows and Pastureland	0.25	0.30	0.35
Unimproved Areas	0.10	0.20	0.30

Notes:

1. Rolling = ground slope between 2 and 10 percent.
2. Hilly = ground slope greater than 10 percent.

Table 9-5: Runoff Coefficient Adjustment Factors

Recurrence Interval	Runoff Coefficient Adjustment Factor
10 years or less	1.0
25 years	1.1
50 years	1.2
100 years	1.25

Table 9-6: Manning's Roughness Coefficients for Overland Sheet Flow

Land Use/Surface	Manning's Roughness Coefficient
Pavement and Roofs	0.014
Graveled Surfaces	0.020
Industrial Areas	0.050
Meadows	0.150
Woodland and Forests	0.400

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9.3.3.3.2 Culverts

Any required culverts shall be HDPE and designed using previously calculated flows and Figure 4.10 of the CSPI Handbook of Steel Drainage & Highway Construction Products shown below in Figure 9-2.

9.3.3.3.3 Sub-drainage

The sub-drainage design will be performed with inputs from the site and hydrological conditions, taking into account groundwater elevation and rainfall intensity data. The soil and geotechnical properties will also be considered in the design. The layout of the system will also consider the foundation depths and geometry.

At this stage, based on initial assumption, a sub-drainage system shall be provided via a network of 150 mm diameter perforated HDPE pipes with a cover of clear stone and wrapped in geotextile.

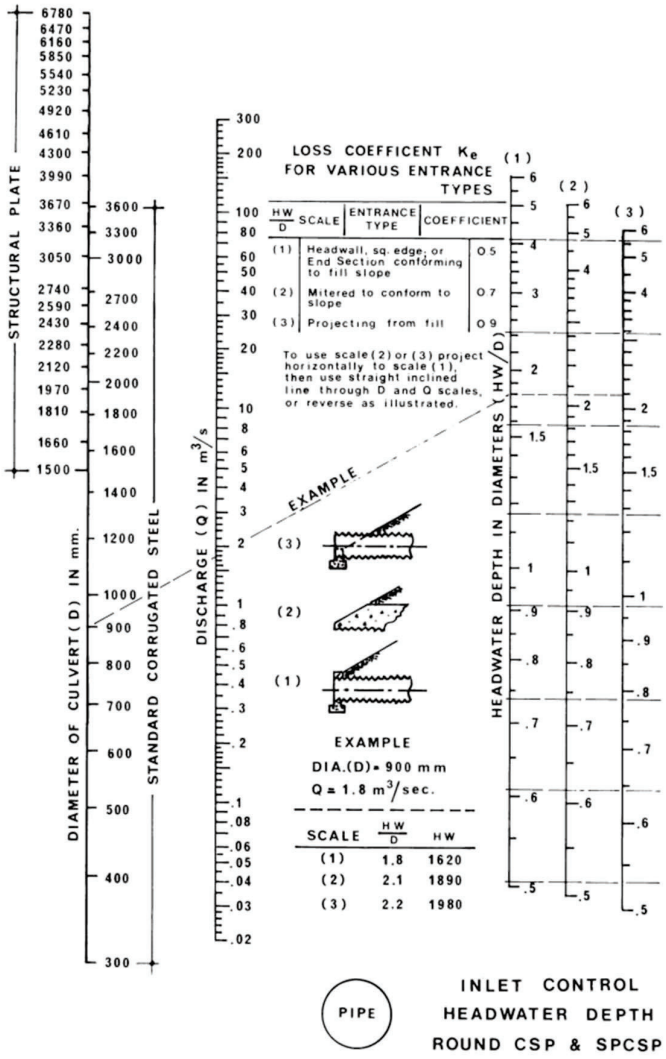


Figure 9-2: Headwater Depth for Round Corrugated Steel Pipe and Structural Plate Corrugated Steel Pipe under Inlet Control

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10. Structural Design Criteria

This section defines the structural design criteria that apply to all foundations, support structures and structural components required for the proposed BESS configurations. These criteria provide the baseline assumptions for the design of BESS equipment foundations, substation foundations, PCS pads, structural elements within the BESS area and mounting structures for security and monitoring systems.

Structural design criteria are critical for ensuring that the BESS equipment is installed on stable, durable and code compliant foundations capable of resisting operational loads, environmental loads and seismic forces. Establishing these criteria at the AACE Class 4 stage ensures that each BESS option can be safely supported on the Hardwoods (Greenfield) site, that foundations are aligned with geotechnical conditions, and that long term performance and equipment serviceability are maintained throughout the life of the installation.

The requirements in this section form the basis for preliminary structural sizing, foundation design, material selection and load assumptions that will be carried forward into the next project phase.

This design criteria will cover the structural design of the following:

- BESS equipment foundations.
- Electrical Substation foundations.
- E-house foundations.
- Structural works inside the BESS area.
- PCS-MVT Foundations.
- Security systems and CCTV supports and foundations inside the BESS area.

10.1 Codes and Standards

Unless specifically stated otherwise, the design of all buildings, structures and related facilities shall be based on applicable parts of the following codes, specifications, standards, regulations and other references. In addition to these, the design shall comply with any laws or regulations of local authorities. In the event of conflicting requirements, the most stringent specifications shall apply. The latest available revision of the following standards shall be applied. Table 10-1 lists the design codes and standards utilized for this section of the design basis.

Table 10-1: List of Structural Codes and Standards

Organization	Standard or Document	Description
National Research Council Canada (NRC)	National Building Code of Canada (NBCC)	National building requirements for Canada
CSA Group	CSA A23.1 and CSA A23.2	Concrete materials construction methods and test methods for concrete constituents
CSA Group	CSA A23.3	Design of concrete structures
CSA Group	CSA A283	Qualification code for concrete testing laboratories

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Organization	Standard or Document	Description
CSA Group	CAN CSA A3000	Cementitious materials compendium
CSA Group	CSA G30.18	Carbon steel bars for concrete reinforcement
CSA Group	CSA G40.20 and CSA G40.21	Requirements for rolled or welded structural steel and structural quality steel
CSA Group	CSA S16	Design of steel structures
CSA Group	CSA S37	Antennas towers and antenna supporting structures
CSA Group	CSA W59	Welded steel construction
ASTM International	ASTM A36	Carbon structural steel
ASTM International	ASTM A53	Steel pipe black and zinc coated welded and seamless
ASTM International	ASTM A108	Carbon and alloy steel cold finished bars
ASTM International	ASTM A276	Stainless steel bars and shapes
ASTM International	ASTM A307	Carbon steel bolts studs threaded rods sixty thousand PSI tensile strength
ASTM International	ASTM A563	Carbon and alloy steel nuts inch and metric
ASTM International	ASTM A786	Hot rolled steel floor plates
ASTM International	ASTM A992	Structural steel shapes
ASTM International	ASTM A1011	Hot rolled steel sheet and strip various grades
ASTM International	ASTM C260	Air entraining admixtures for concrete
ASTM International	ASTM C309	Liquid membrane forming curing compounds
ASTM International	ASTM C494 or C494M	Chemical admixtures for concrete
ASTM International	ASTM C1017 or C1017M	Chemical admixtures for flowing concrete
ASTM International	ASTM C1059 or C1059M	Latex agents for bonding fresh to hardened concrete
ASTM International	ASTM D1751	Preformed expansion joint filler for concrete paving
ASTM International	ASTM F1554	Steel anchor bolts thirty six fifty five and one hundred five ksi yield strength
ASTM International	ASTM F3125 or F3125M	High strength structural bolts and assemblies
ASTM International	ASTM F436 or F436M	Hardened steel washers
ASTM International	ASTM F1136 or F1136M	Zinc or aluminum protective coatings for fasteners
American Concrete Institute (ACI)	ACI 305R	Guide to hot weather concreting
American Concrete Institute (ACI)	ACI 306R	Guide to cold weather concreting
American Concrete Institute (ACI)	ACI 309R	Guide for consolidation of concrete
Cement Association of Canada	Design and Control of Concrete Mixtures	Industry reference for concrete mixture design
Canadian Institute of Steel Construction (CISC)	Code of Standard Practice for Structural Steel	Standard practice for steel fabrication and erection
Reinforcing Steel Institute of Canada (RSIC)	Manual of Standard Practice	Reinforcing steel practice guide
Canadian Geotechnical Society	Canadian Foundation Engineering Manual	Guidance for foundation engineering
American Society of Civil Engineers (ASCE)	ASCE or SEI 37	Design loads on structures during construction

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11. Units

All calculations, dimensions or material sizes included in design briefs and on drawings are to be in metric units (SI units) according to the Weights and Measures Act R.S.C., 1985, c. W-6

11.1 Design Parameters

11.1.1 Design Loads

The minimum design loads and forces shall be in accordance with NBCC and as defined in the following sections.

To determine the specified snow, wind and seismic loads, the Post Disaster importance category shall be utilized.

11.1.1.1 Dead Loads

Dead loads shall consist of the total dead weight of all permanent structural and non-structural components, including equipment, fireproofing, insulation, piping, ducting, electrical conduit, and foundations. Foundation dead loads shall include the weight of the soil and subgrade immediately above the foundation.

The minimum dead loads shall be in accordance with Table 11-2, or to NBCC whichever is more stringent.

11.1.1.2 *Live Loads Due to Use and Occupancy*

Live loads include floor area loads, equipment handling loads, laydown loads, truck wheel loads, personnel, active earth pressure and similar items. The floor area live load will be omitted from areas occupied by equipment under which no access is provided and whose weight has been included in dead load.

The contents of fixed equipment are included in the operating live load.

The design live loads will be shown both in the design briefs and on the drawings.

The minimum live loads shall be in accordance with Table 11-3, or to NBCC, whichever is more stringent.

Floors supporting fixed equipment will be designed for the load from the equipment with appropriate impact factors over the floor area occupied by the equipment plus the applicable uniform live load over the remaining floor area.

Where stationary equipment may be rolled on the floor during construction or during maintenance and where forklifts are used, floor shall be designed for such loadings. The effects of impact shall be taken into consideration.

11.1.1.3 *Piping and Cable Tray*

For miscellaneous piping, duct and cable tray loads, all floor loads shall be increased by 1.4 kPa. This allowance should be treated as a live load for analysis and noted on the drawings for the floors or roofs incorporating the allowance. This load is cumulative and carried to columns.

All load assumptions shall be written on the engineering documents.

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11.1.1.4 *Differential Support Settlement*

The effects and amount of expected differential support settlement must be considered as per the geotechnical report (once it has been completed, relying on assumptions at this stage, see Section 6).

If differential settlements are anticipated, detailing of the structures should allow for rectification of the settlement or mitigation of the effects of the settlement.

11.1.1.5 *Equipment Loads*

Equipment loads shall be as supplied by the equipment manufacturer and shall be certified prior to issuing drawings for construction and shall include:

- Equipment dead loads, including the loads of fixed equipment.
- Operating live load, including contents of fixed equipment, during normal operations.
- Upset operating weight, including contents of fixed equipment, filled to maximum capacity.

Laydown areas and laydown area loads shall be determined under interdisciplinary coordination. Designated laydown areas and laydown area loads shall be clearly shown on design drawings with allowance for appropriate signage.

Equipment live loads shall include operating loads.

Floors with containment shall be designed for the expected load imposed by the containment of the spilled material.

11.1.1.6 Wind Loads

Wind loads on structures shall be in accordance with the NBCC using climatic data for the location of St. John's.

No reduction shall be made for the shielding effect between adjacent pieces of equipment or structures.

For ice-sensitive structures, ice accretion shall be added to the exposed elements to determine the projected area.

For maintenance or temporary plant operations, wind loads can be determined based on a probability of being exceeded in any one year of 1 in 10. For St. John's, the 1 in 10-year wind pressure is equivalent to 80% of the design wind pressure of the 1 in 50 years. This procedure aligns with ASCE/SEI 37 recommendations for a construction period lasting up to one year. For longer periods, refer to ASCE/SEI 37 recommendations.

11.1.1.7 *Snow, Ice and Rain Loads*

Snow and rain loading for structures shall be in accordance with the NBCC, using climatic data for the location.

For the effect of ponding due to rain loads on buildings and enclosed structures, refer to the NBCC.

Atmospheric ice loads due to freezing rain, snow, and in-cloud icing shall be considered in the design of ice-sensitive structures.

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Ice-sensitive structures are defined as structures for which the effect of an atmospheric icing load governs the design of part or all the structure.

At St. John's, when considering ice-sensitive structures, 40 mm of ice accretion shall be considered with a unit weight of 9.8 kN/m3. (Ref.: CAN/CSA-S37-18 Antennas, towers, and antenna-supporting structures Code. Figure 1)

11.1.1.8 *Seismic Loads*

All buildings, structures and components shall be designed for seismic forces according to the NBCC using climatic data for the location.

As noted earlier, the site classification is assumed to be Class D. This will need to be confirmed by a geotechnical engineer during the next phase of the project.

In loading combinations including seismic motions, the design live loads will be limited to the live load during operation, which is defined as the live load expected to be present at operation.

In laydown areas, the actual weight of the equipment as spread out on the floor will be considered.

The following information shall be clearly indicated in the design calculations and drawing notes:

- The peak ground acceleration (PGA), peak ground velocity (PGV), and the 5% damped spectral response acceleration values, Sa(T), for the reference ground conditions (Site Class C) for periods T of 0.2 s, 0.5 s, 1.0 s, 2.0 s, 5.0 s and 10 .0 s based on a 2% probability of exceedance in 50 years.
- The Site Class.
- The Importance factor.
- The fundamental lateral periods considered in each direction.
- The seismic force modification factors Rd (ductility-related factor) and Ro (over strength-related factor) and the selected seismic force resisting system (SFRS) in each direction.
- The Seismic Weight considered.
- The design base shear considered in each direction.

11.1.1.9 *Temporary/Construction Loads*

Temporary and construction loads will be considered.

11.1.1.10 *Earth Loads*

The relevant soil properties for the design of the foundations shall be based on the geotechnical report.

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11.1.1.10.1 Lateral Earth Pressures

The following criteria outline the lateral earth pressure conditions that shall be applied in the design of retaining structures based on their expected deformation characteristics.

- Active pressures - shall be used to design flexible structures, such as cantilever retaining walls. The “active” pressure coefficient shall be taken per the geotechnical report.
- At rest pressures - shall be used to design rigid structures, such as tied retaining walls and concrete tunnels. The “at rest” pressure coefficient shall be taken per the geotechnical report, but not less than K_O =0.44.
- Passive pressures shall not be assumed to resist lateral forces unless substantial movement can be accommodated (e.g. free-standing retaining walls).

11.1.1.10.2 Surcharge to Retaining Walls

All retaining walls shall be designed for the actual surcharges applied, or the effect of the conditions described below, whichever provides the worst effect for design.

- Minimum Surcharge - The minimum surcharge for which a retaining structure shall be designed is 14.4 kPa.
- Normal Road Traffic - Where the edge of a road is within a horizontal distance from the top of a retaining structure equal to one half of its clear height, the wall shall be designed for a road vertical surcharge of 20 kPa in addition to normal earth pressures.

11.1.1.11 *Stairs, Ladders and Railings*

Ladders shall be in accordance with the NBCC.

Handrails and stair risers and runs shall be in accordance with the NBCC.

Handrails shall be designed for the loads as defined in the NBCC.

11.1.1.12 *Load Factors and Load Combinations*

All load factors and combinations shall be in accordance with the NBCC.

Any increase in the load factor for live loads should be clearly identified in the design notes.

11.1.2 ***Stability Design***

For stability based on factored loads, the elements shall be designed against overturning, sliding, uplift and buoyancy such as:

- (Destabilising Action)/(Stabilising Action) < 0.90.

Refer to section 11.1.7 for determining of the stabilising effects.

For evaluating maximum uplift, sliding and overturning, the minimum dead load shall be used in load combinations that include wind loading.

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11.1.3 Connections

Field connections shall be bolted unless field welds are specifically called for on the final drawings. All connections to be symmetrical except on lightly loaded secondary members and have two or more bolts in the line of action. Bracing connections are to have a minimum of two bolts.

In general, bolted connections will be the bearing type, fully tensioned, using high strength bolts compliant with ASTM F3125 grade A325, and having at minimum ¾ inch diameter. The use of snug-tight bolted connections may be considered for structures not part of a SFRS and not subjected to vibrations, reversal or repeating loads.

All connections shall be designed according to the applicable seismic regulations.

Bracing axial member connections will be designed for the force shown on the drawings; or if no force is shown, the greater of the following forces:

- The full capacity of the member in compression (accounting for slenderness).
- 50% of the full capacity of the member's gross area in tension.

Beam end connections which are not subjected to moments and axial forces will be designed to develop a minimum shear load resistance equal to 50% of the shear capacity of the member. Reactions where the design shear is greater than this value will be shown on the drawings. Note that composite construction will induce higher reactions.

Beam end connections that are designed to carry bending moment shall be noted as such on the drawings along with the moment values.

Splice connections shall be designed for the loads shown. Show axial, shear and bending forces to satisfy all loading conditions. To simplify the listing of the data, an upper bound for all forces can be given, provided this does not unduly affect the economy of the connection.

Connections to hollow structural sections (HSS) shall be seal welded and all open ends shall be capped. HSS used in high temperature areas or HSS to be galvanized shall have appropriate drilled ventilation holes.

Gusset plates shall be a minimum of 10 mm thick.

Where applied connection forces exceed the capacity of these standard connections, the connection shall be individually designed.

11.1.4 Corrosion

In areas where steel surfaces are exposed to saline water, corrosion resistant paint, coatings or additives shall be applied to protect the steel. In accordance with NL Hydro requirements, all substation steel shall be hot dipped galvanized.

Rolled steel and other structural shapes shall not be positioned in such a way as to hold moisture. Where necessary, provisions shall be made for drainage.

Maintain adequate space between components to facilitate painting. Avoid structural pockets and provide adequate drain-holes where required.

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Shedder plates or a suitable infill grout should be used where necessary to protect beam/column and column/footing connections from collecting moisture or process liquids or other corrosive agents.

11.1.5 *Deflections*

Deflection limitations for structures shall conform to CSA S16.

All deflections shall conform to the applicable seismic regulations.

11.1.6 *Depth to Span Ratios*

Member depth-to-span ratios will not be less than the following values in Table 11-1.

Table 11-1: Minimum Depth/Span Ratios

	Minimum Depth/Span Ratio
Beams supporting equipment.	1/20
Floor, roof, walkway and platform beams.	1/24

11.1.7 *Foundations*

The preferred method of transferring shear loads from base plates to concrete footing are as follows:

- For minor columns and for major columns with nominal shear loads, friction between the column base plate and the grout and bolt shear capacities (half of the group) may be utilized.
- For major columns with significant shear loads, shear keys shall be used.

When shear is transferred using friction and/or anchor rod shear capacity, the design of the anchor rods shall consider the concurrent tension and shear generated in the anchor rods using linear interaction. Limitations of applicable seismic regulations shall be considered.

The bending developing in the grout thickness, shall also be considered when designing the anchor rods in shear without shear key.

Lateral loads on footings shall be transferred to the soil by friction and passive resistance. The calculated passive resistance shall be reduced by 0.5 and the friction resistance against sliding shall be reduced by a factor of 0.8 to ensure that the lateral displacements are kept to acceptable limits as per Canadian Foundation Manual Table 8-1.

11.1.7.1 *Seismic Design of Foundation*

Seismic Design of footings shall be designed according to the Clause 21.10 of CSA A23.3.

11.1.8 *Concrete Structures*

Concrete structures shall be designed in accordance with CSA A23.3.

Concrete structures will be designed with due consideration given to location and spacing of expansion joints, control joints and construction joints. Construction joint locations shall be shown on drawings.

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11.1.8.1 Concrete Reinforcement

Minimum reinforcement cover and reinforcing bars splicing shall be in accordance with CSA A23.3.

11.1.9 Steel Structures

11.1.9.1 General

Structural steel shall be designed in accordance with CSA S16.

11.1.10 Transportation and Constructability

Careful consideration shall be given to the size of fabricated members and subassemblies to ensure that they are suitable for transportation to the site by road, by sea and for on-site maneuvering. Reference shall be made to construction group for maximum weights and dimensions. Any design of a subassembly shall be made in consultation with the construction manager and the design coordinator early in the design process to agree on the extent, number of units, load factors and loading conditions.

Details shall be so arranged as to allow the elements of structures to be broken down to suit road transportation to site, existing structures and craneage requirements with provision for site splices and connections.

Welded cleats proud of the overall elements should be avoided as damage during transportation is likely.

11.2 Minimum Design Dead Loads

Table 11-2: Minimum Design Dead Loads

Material	Minimum Dead Load	Notes
Backfill	19.0 kN/m^3	Verify with geotechnical reports
Reinforced concrete	25.5 kN/m^3	Based on a heavier aggregate
Reinforced concrete < 2% steel	23.6 kN/m^3	
Reinforced concrete > 2% steel	25.1 kN/m^3	
Steel	77.0 kN/m^3	

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11.3 Minimum Design Live Loads

Table 11-3: Minimum Design Live Loads

Description	Uniform Load (kPa)	Concentrated Load (kN)
Control rooms	12.0	9.0 [7]
Electrical Rooms: Floor beams if suspend cable trays below Floor design Switch gear room	 14.4 9.6 7.9	 9.0 [4]
Handrail and guard rails	As per applicable local code	
Instrumentation rooms	4.8	-
Personnel Access - Not used for storage or equipment support. Not vehicle, cranes or monorail accessible. Platforms Stairs, stairways and walkways	 4.8 4.8	 - 4.5
Sidewalks	12.0	36.0
Surcharge outside and adjacent to structures	12.0	36.0 [8]

12. Environmental Design Criteria

There currently are no BESS operating in the province of NL, and therefore there is uncertainty on the requirements under the *Environmental Protection Act* (EPA) for such a facility to operate. Although not explicitly listed as a designated undertaking, the BESS would likely be required by the minister to be registered under the *Environmental Assessment Regulations* as other types of power generating plants with a capacity of more than one megawatt are listed as designated undertakings.

Considering the nature of BESS, it is likely that the facility will require a Certificate of Approval under the EPA. The following subsections outline typical requirements under issued Certificates of Approval that likely will apply to the BESS. Specific requirements would need to be refined in consultation with the NL Department of Environment, Conservation and Climate Change (NL-DECCC).

[7] Load placed upon any 0.76 m x 0.76 m square, not combined with uniform live load.
[8] Wheel load not to be combined with uniform live load – railroad surcharge, where applicable, shall be considered according to Manual for Railway Engineering, AREMA 2007.

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12.1 Activities Affecting Bodies of Water

The proposed greenfield site at Hardwoods is currently on a delineated wetland. The infilling of this wetland will require a Section 48 Permit to Alter a Body of Water which the regulator may require engineered compensation for the loss of ecological services such as those listed below which are highlighted in the Newfoundland and Labrador Policy for Development in Wetlands:

- Collecting and storing runoff.
- Moderating and attenuating downstream flood flows.
- Reducing downstream flooding and erosion.

These ecological services at the hardwoods site may be considered a higher priority when compared with wetlands in other areas of the province due to the urban nature of the Waterford River catchment and the resulting hydrological impacts of urban development.

Surface water run-off from the facility must comply with 'Schedule A' of the '*Environmental Control Water and Sewage Regulations*', 2003 (NLR 65/03).

12.2 Noise

Efforts are typically required to minimize and control noise resulting from the operation of a facility. BESS can emit noise that would be considered nuisance levels to adjacent properties, depending on the proximity of receptors, and it will likely need to be demonstrated to NL-DECCC that the design has been optimized to lower the noise level to a reasonable amount. Mitigations to demonstrate this could include the siting in a currently industrial area. As there are currently no regulations regarding noise thresholds or criteria provincially, federal guidance should be used to assess anticipated noise levels. Such guidance includes *Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessment:* Noise (Health Canada, 2017).

The Town of Paradise has a Noise and Nuisance By-Law that may also apply to the project; however, many noise generating activities are permitted during quiet hours if they are greater than 100 m from a residential area which applies to the Hardwoods Greenfield site. Activities over 100 m may still be prohibited if in the opinion of the Enforcement Authority disturbs or may disturb the peace and tranquility of the public. A noise study will need to be conducted to better understand the noise impacts of the project.

12.3 Waste Management

Waste generated at the facility will be subject to compliance with the EPA. Non-industrial waste will need to be stored in a manner acceptable to NL-DECCC and on at least a weekly basis be disposed of:

- At an authorized waste disposal site, with the permission of the owner/operator of the site.
- Or by some other means acceptable to NL-DECCC.

If required, industrial waste shall be disposed of by a licensed operator.

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12.4 Spill Prevention and Containment

Specific recommendations found on a hazardous products Safety Data Sheet (SDS) relative to storage and handling should be followed. The BESS will have hazardous chemicals that will likely require to meet spill prevention and containment specifications required at other industrial sites. These measures specify areas in which chemicals are used or stored shall have spill containment systems constructed with impermeable floors, walls, dykes or curbs as applicable and be configured, maintained, inspected and repaired as follows:

- They shall not discharge to the environment.
- They shall have an effective secondary containment capacity of at least 110% of the chemical storage tank capacity, in the case of a single storage container.
- If there is more than one storage container, the spill containment system shall be able to retain no less than 110% of the capacity of the largest container or 100 % of the capacity of the largest container plus 10% of the aggregate capacity of all additional containers, whichever is greater.
- They shall be kept clear of material that may compromise the containment capacity.
- They may include a floor drain system provided that the floor drains, and the place or device to which they drain, are configured in such a manner that the required effective secondary containment capacity is maintained.
- Every year they shall be visually inspected for their liquid containing integrity, and repairs shall be made when required.
- And once every ten years, spill containment systems shall be inspected, by a means other than visual inspection, for their liquid containing integrity, and repairs shall be made when required.
- Design Considerations should also be given to the following Guidance documents, if applicable, published by the Pollution Prevention Division (PPD) of NL_DECCC:
  - ‘Precipitation Drainage of Dyke Areas” GD-PPD-040.
  - ‘Best Management Practices for the storage of waste dangerous goods/hazardous waste (WDG/HW) at business sites’ GD-PPD-077.

12.5 Contingency Plan

NL-DECCC will likely require a Contingency Plan for the operation of the BESS. The Plan will need to describe the actions to be taken in the event of a spill of a toxic or hazardous material.

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12.6 Used Oil and Used Glycol

Many BESS systems feature cooling systems that require glycol. Glycol will have to be handled in accordance with the *Used Oil and Used Glycol Control Regulations* which include but are not limited to the following:

- Used oil and used glycol shall not be mixed and shall be stored in separate:
  - Closed containers.
  - Registered tanks.
  - Or tanks that have an active approval for DGSNL.
- Used oil and used glycol shall be disposed of by a company licensed for the handling and disposal of such products.
- Information on used glycol that is generated by BESS shall be submitted to the Department for review by January 31 each year. This shall include a description of:
  - The type(s) of glycol used.
  - The approximate total volume of used glycol generated during the previous year.
  - And the method of disposal for the used glycol.
- If used glycol generated off-site is stored in the on-site storage tank(s), the information listed above shall also be required for the off-site systems.

12.7 Decommissioning and Restoration

NL-DECCC will likely require a Decommissioning and Restoration Plan for the BESS. Although they may not require this plan until a time closer to the decommissioning of the facility, it is valuable to design the facility with a perspective on how the facility will eventually have to be decommissioned. The guidelines listed below are generally provided as an appendix to relevant Certificates of Approval and are intended to provide some general guidance as to the expectations of NL-DECCC regarding the development of the Decommissioning and Restoration Plan, and to identify areas that are of particular concern or interest.

Decommissioning and Restoration Plans are intended to present the scope of activities that a owner shall undertake at the time of final closure and/or decommissioning of the industrial properties. Where it is useful and practical to do so owners are encouraged to begin undertaking some of the activities outlined in the Plan prior to final closure and decommissioning. The objectives of the restoration work to be undertaken typically includes:

- To ensure that abandoned industrial facilities do not endanger public health or safety.
- To prevent progressive degradation and to enhance the natural recovery of areas affected by industrial activities.
- To ensure that industrial facilities and associated wastes are abandoned in a manner that will minimize the requirement for long term maintenance and monitoring.

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- To mitigate, and if possible, prevent, the continued loadings of contaminants and wastes to the environment. The primary objective shall be to prevent the release of contaminants into the environment. Where prevention is not practical due to technical or economic limitations then activities intended to mitigate the consequence of such a release of contaminants shall become the objective of restoration work.
- To return affected areas to a state compatible with the original undisturbed condition, giving due consideration to practical factors including economics, aesthetics, future productivity and future use.
- And to plan new facilities to facilitate eventual rehabilitation.

13. AACE Class 4 Designs

Using the design criteria outlined in Sections 4 through 12, the project team developed a conceptual design for the addition of a new BESS at the selected project site. The project deliverables are included in the appendices of this report. A list of reference documents is shown Table 13-1. The study establishes design requirements to achieve engineering designs to an appropriate level of development to support and prepare a Class 4 Cost Estimate and Level 3 schedule. These requirements are aligned with Association for the AACE recommended practices across all engineering disciplines.

Table 13-1: List of Project Deliverables and Reference Documents

No.	Reference in Document	Document Title	Hatch Document No.	Revision
Item 1	Appendix B	Hardwoods Site 50 MW 8 Hours BESS General Arrangement	H376866-0000-260-272-0001	D
Item 2	Appendix A	Hardwoods Site 50 MW 8 Hours BESS Station Layout	H376866-0000-260-272-0003	D
Item 3	Appendix B	Hardwoods Site 50 MW 4 Hours BESS General Arrangement	H376866-0000-260-272-0004	C
Item 4	Appendix A	Hardwoods Site 50 MW 4 Hours BESS Station Layout	H376866-0000-260-272-0005	C
Item 5	Appendix B	Hardwoods Site 20 MW 8 Hours BESS General Arrangement	H376866-0000-260-272-0006	C
Item 6	Appendix A	Hardwoods Site 20 MW 8 Hours BESS Station Layout	H376866-0000-260-272-0007	C
Item 7	Appendix B	Hardwoods Site 20 MW 4 Hours BESS General Arrangement	H376866-0000-260-272-0008	C
Item 8	Appendix A	Hardwoods Site 20 MW 4 Hours BESS Station Layout	H376866-0000-260-272-0009	C
Item 9	Appendix C	Hardwoods Site 50 MW 8 Hours BESS Single Line Diagram	H376866-0000-260-288-0001	D
Item 10	Appendix C	Hardwoods Site 50 MW 4 Hours BESS Single Line Diagram	H376866-0000-260-288-0002	C
Item 11	Appendix C	Hardwoods Site 20 MW 8 Hours BESS Single Line Diagram	H376866-0000-260-288-0003	C
Item 12	Appendix C	Hardwoods Site 20 MW 4 Hours BESS Single Line Diagram	H376866-0000-260-288-0004	C

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No.	Reference in Document	Document Title	Hatch Document No.	Revision
Item 13	Appendix C	Hardwoods Site BESS Interconnection Single Line Diagram	H376866-0000-260-288-0010	B
Item 14	Appendix E	Hardwoods Site 50 MW 8 Hours BESS General Foundation Plan	H376866-0000-231-260-0002	C
Item 15	Appendix G	Hardwoods Site 50 MW 8 Hours E-House Foundation Plan	H376866-0000-231-260-0003	B
Item 16	Appendix H	Hardwoods Site 50 MW 8 Hours Transformers Foundation Plan	H376866-0000-231-260-0004	B
Item 17	Appendix F	Hardwoods Site 50 MW 8 Hours BESS Containers Foundation Plan	H376866-0000-231-260-0005	B
Item 18	Appendix E	Hardwoods Site 50 MW 4 Hours BESS General Foundation Plan	H376866-0000-231-260-0020	B
Item 19	Appendix E	Hardwoods Site 20 MW 8 Hours BESS General Foundation Plan	H376866-0000-231-260-0021	B
Item 20	Appendix E	Hardwoods Site 20 MW 4 Hours BESS General Foundation Plan	H376866-0000-231-260-0022	B
Item 21	Appendix D	Hardwoods Greenfield Site - 50 MW 8 Hour BESS - Civil Site Layout	H376866-0000-220-272-0001	C
Item 22	Appendix D	Hardwoods Greenfield Site - 50 MW 4 Hour BESS - Civil Site Layout	H376866-0000-220-272-0002	A
Item 23	Appendix D	Hardwoods Greenfield Site - 20 MW 8 Hour BESS - Civil Site Layout	H376866-0000-220-272-0003	A
Item 24	Appendix D	Hardwoods Greenfield Site - 20 MW 4 Hour BESS - Civil Site Layout	H376866-0000-220-272-0004	A
Item 25	Appendix D	Hardwoods Greenfield Site - 50 MW 8 Hour BESS - Sections	H376866-0000-220-273-0001	A
Item 26	Appendix D	Hardwoods Greenfield Site - 50 MW 4 Hour BESS - Sections	H376866-0000-220-273-0002	A
Item 27	Appendix D	Hardwoods Greenfield Site - 20 MW 8 Hour BESS - Sections	H376866-0000-220-273-0003	A
Item 28	Appendix D	Hardwoods Greenfield Site - 20 MW 4 Hour BESS - Sections	H376866-0000-220-273-0004	A
Item 29	Appendix J	Site Assessment Report	H376866-0000-21D-066-0001	0

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14. Risks and Mitigations

Hatch completed a structured risk assessment over the project for the proposed site and associated BESS design configuration. The purpose of the assessment was to identify, categorize, and evaluate potential risks that could influence the feasibility of the project. All identified risks were classified into key categories including:

- Environmental risks.
- Social risks.
- Technical risks.
- Regulatory risks.
- Financial risks.
- Safety risks.

After categorization, each risk was evaluated for likelihood and consequence using predefined rating scales and descriptors from Hatch's corporate risk matrix. Scores were assigned based on available data and engineering judgement This produced:

- A clear ranking of risks by significance.
- Identification of risks requiring design intervention.
- Differentiation between broadly acceptable, tolerable, and high-priority risks.
- A formal risk matrix summarizing the evaluation outcomes.

The entire process followed Hatch's standard risk-management methodology and was documented in the project Risk Register (H376866-0000-120-131-0001).

14.1 Summary of Risk Register

The completed project Risk Register documents all thirty-six identified risks, along with their root causes, consequences, and the potential preventive or mitigating controls. For each risk, Hatch assigned an initial likelihood and consequence rating using the corporate risk matrix, producing an initial risk score consistent with the standardized methodology. Mitigation actions detailing follow up steps were defined to guide future risk reduction efforts, and the register clearly categorizes each risk.

Although treatment actions have been identified, the risks have not yet undergone reassessment to determine residual ratings. Hatch recommends NL Hydro assign appropriate personnel for each risk and to work on the associated mitigations as the project progresses to the next phase. The register will therefore serve as a baseline for ongoing risk management, providing clear visibility of the most significant threats at this stage of project development. The initial risk ranking distribution captured in the file includes twelve high-level risks, seventeen medium risks, and seven low risks, with the remaining items classified as opportunities. This gave a total of thirty-six risks identified and six opportunities. This provides the project team with a prioritized overview of areas requiring further engineering definition, coordination, or mitigation.

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Overall, the risk register establishes a framework for continued monitoring and refinement as the project progresses into future stages. NL Hydro will need to ensure that responsible individuals are identified for each risk and to own the associated mitigation actions. Maintaining the record of known risks and opportunities will support the decision making and planning throughout the remainder of the BESS development process.

15. Next Steps

The preceding sections of this Design Basis have established technical assumptions, performance targets, and integration requirements for the proposed BESS designs for the four site capacities. This work has been developed at a feasibility level to inform the RRA studies by defining feasible system configurations, operating capabilities, and constraints. Building on this feasibility definition, the following next steps provide a structured path for the Client to proceed toward procurement, detailed design, and deployment. The recommended next steps for the Client are provided in Table 15-1:

Table 15-1: Recommended Next Steps

Category	Items
Project Approval	Identify the decision makers for technical, commercial, and scheduling matters to streamline communication throughout the next project phases.
Establishing BESS Use Cases	Conduct an extensive use case assessment to identify and prioritize the operational functions the BESS must fulfill, including energy shifting, peak demand management, grid support services, resiliency objectives, and any location specific needs. This assessment should define performance expectations, operational constraints, and value streams to guide system sizing, control strategies, and economic evaluation.
Data and Documentation Provision	Collect all remaining site data including updated single line diagrams, load profiles, geotechnical reports, and survey information required for the next phase of detailed engineering. Confirm utility interconnection requirements and supply any utility correspondence or application status updates. Share cybersecurity and SCADA integration standards to finalize communication and control architecture.
Required Site Assessments	Complete a geotechnical assessment to confirm soil conditions, bearing capacity, subsurface profiles, and any ground improvement requirements for the BESS foundation system. Complete applicable environmental assessments including noise impact assessment, hazardous materials screening, wildlife or habitat review, stormwater management requirements, and any other jurisdiction specific evaluations.
Stakeholder Coordination	Identify key internal and external stakeholders including utility contacts, permitting authorities, and IT or facilities personnel. Schedule coordination meetings to align on scope boundaries, communication protocols, and any site access requirements.
Final Site Selection and Land Acquisition	Perform a final site assessment from additional areas to be examined for potential consideration. Confirm final site selection and begin land acquisition investigations and procurement process.

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Category	Items
Additional Design Work	Complete detailed evaluation of potential alternative BESS placements within the Hardwoods Greenfield property, including the area southwest of the existing fuel tank, to confirm final siting, clearances, and fire separation requirements. Advance site-specific engineering including geotechnical interpretation, foundation design, drainage and sub-drain design, and stormwater/wetland mitigation planning. Conduct detailed fire protection, safety access, and emergency response planning in accordance with NFPA 855, Large Scale Fire Testing, and vendor UL 9540A test data. Develop noise mitigation measures following completion of the noise impact assessment. Refine electrical system integration including grounding design, protection coordination, cable routing, auxiliary transformer sizing, and SCADA/EMS communications architecture. Update layouts, footprints, structural requirements, and balance-of-plant design based on shortlisted BESS vendor equipment and verified physical dimensions. Prepare construction access, sequencing, and temporary work planning given wetland and soil constraints.
Procurement and Commercial Preparation	Confirm procurement strategy including preferred vendor lists, tendering approach, and any commercial constraints that may influence equipment selection. Develop technical specifications for major system components and integration requirements. This should include: • Performance requirements, • Applicable standards, • Factory testing expectations, • Site acceptance criteria, • And quality assurance provisions to support procurement and vendor evaluation. Review and validate project budgetary assumptions to support the transition into procurement and detailed estimating. Assess market availability and supplier lead times for key electrical and BESS components, noting that several suppliers are currently quoting extended manufacturing and delivery timelines. Initiate early engagement with shortlisted vendors to confirm production slots, evaluate alternative suppliers where appropriate, and incorporate realistic lead times into the project schedule and risk management approach.
Permitting and Regulatory Actions	Initiate required permitting pathways including environmental, electrical, and fire safety related approvals. Provide any existing authority comments, conditions, or requirements that may affect layout or technical specifications.
Operational Planning	Define operational objectives including charging and dispatch priorities, resilience requirements, and expected performance outcomes. Identify operational ownership during commissioning, warranty, and long-term operations.

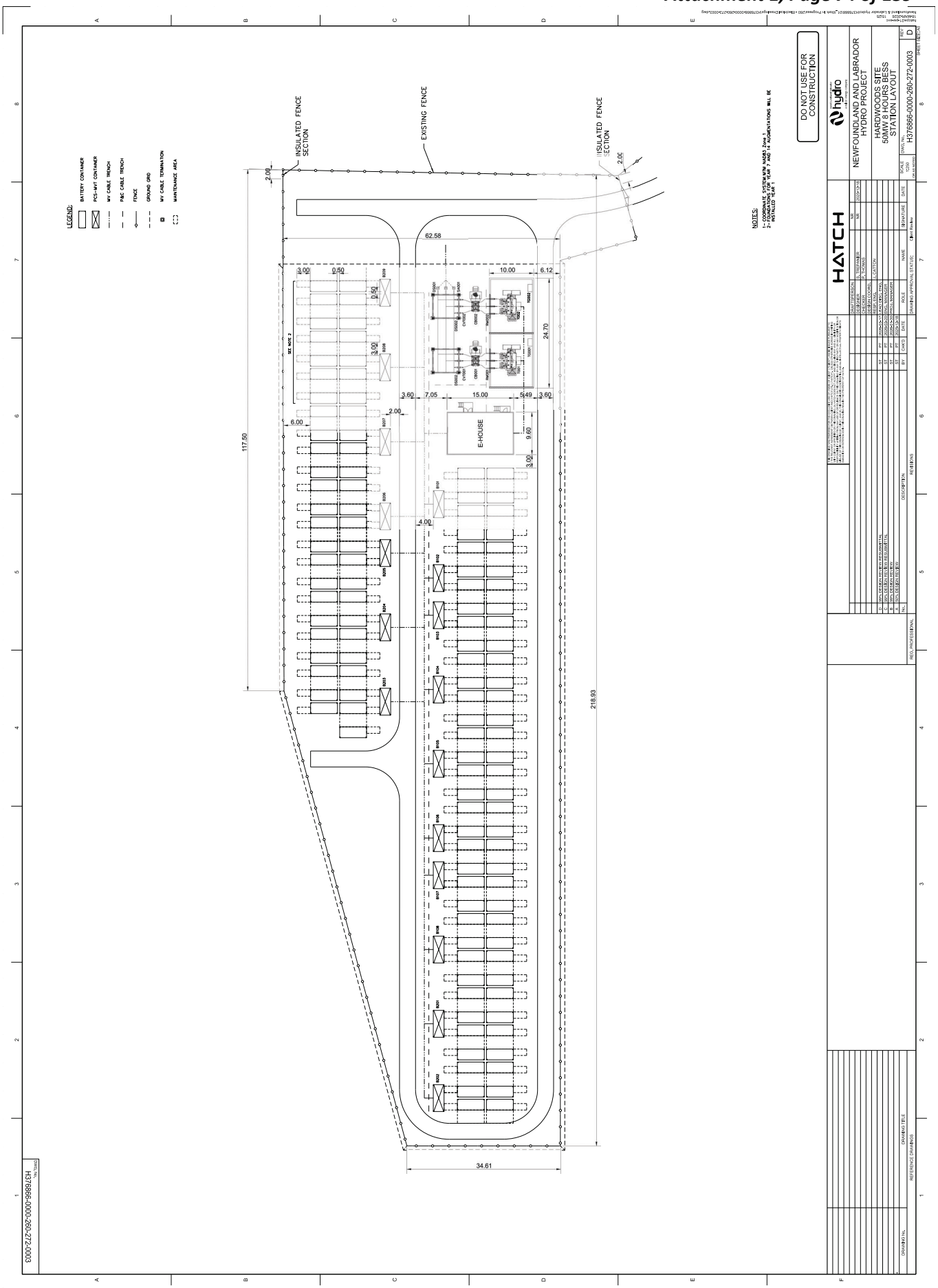
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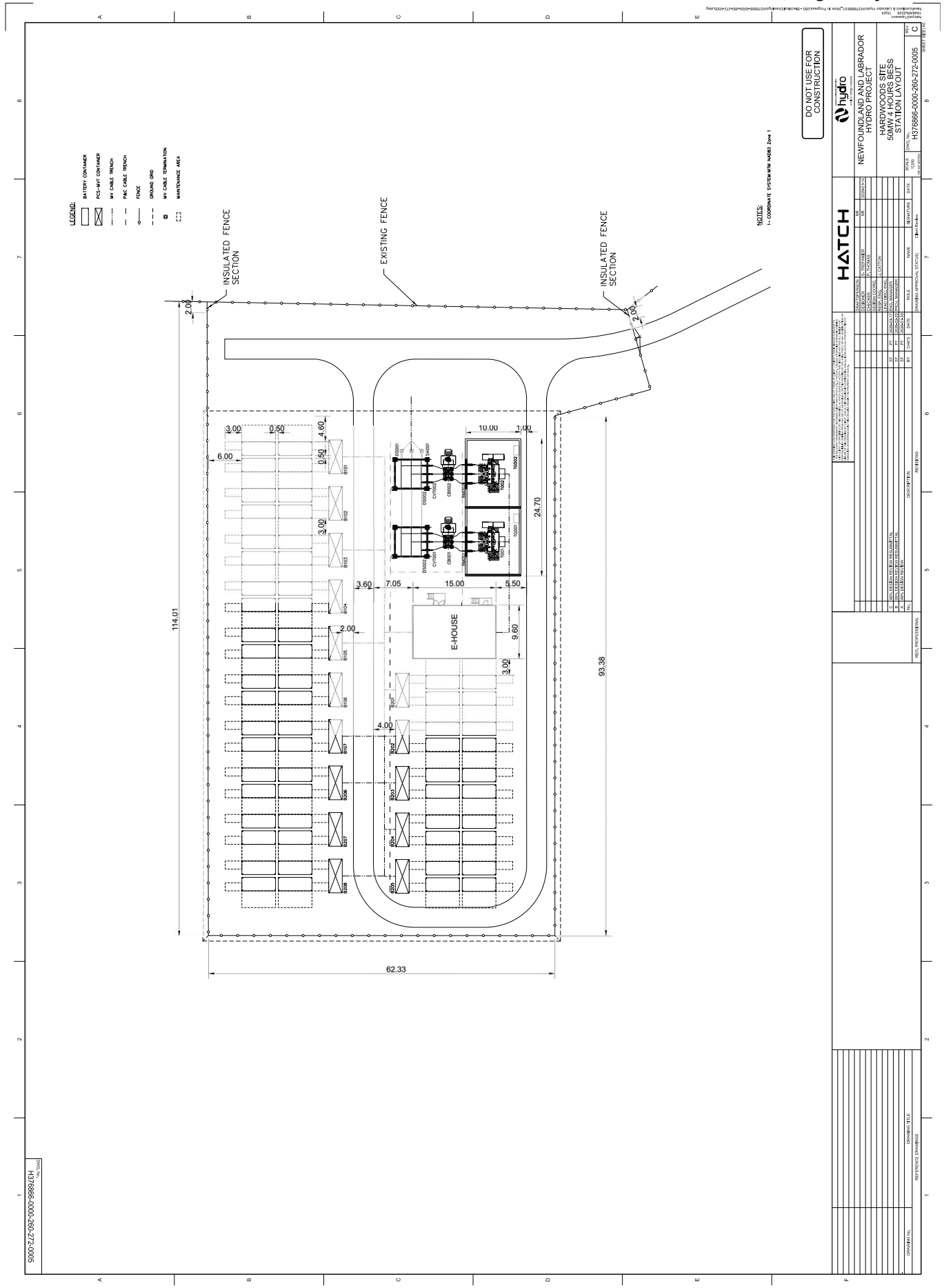
Category	Items
Power System Studies	Detailed load flow studies across system load levels and generation dispatches to ensure the BESS charging and discharge modes do not result in overloads of system elements and that steady state voltages remain within acceptable limits. The load flow studies will also determine the appropriate power factor for the BESS at the final interconnection location. Short circuit studies to determine applicable circuit breaker ratings, requirements for circuit breaker replacements, short circuit ratio and synchronous condenser support. Power system stability studies to assess the control system parameters of the BESS to respond to system conditions. Further define if the BESS should be configured for more than just an energy source with controls such as reactive power control/voltage support, frequency response, etc. Electromagnetic transient studies (i.e. PSCAD) to assess BESS interactions with HVdc controls of the Soldiers Pond Converter Station and requirements for synchronous condenser support.
Schedule and Coordination Milestones	Confirm key project milestones and required delivery dates to ensure alignment with project schedule and procurement lead times. Provide constraints related to outage windows, construction sequencing, or site access limitations.

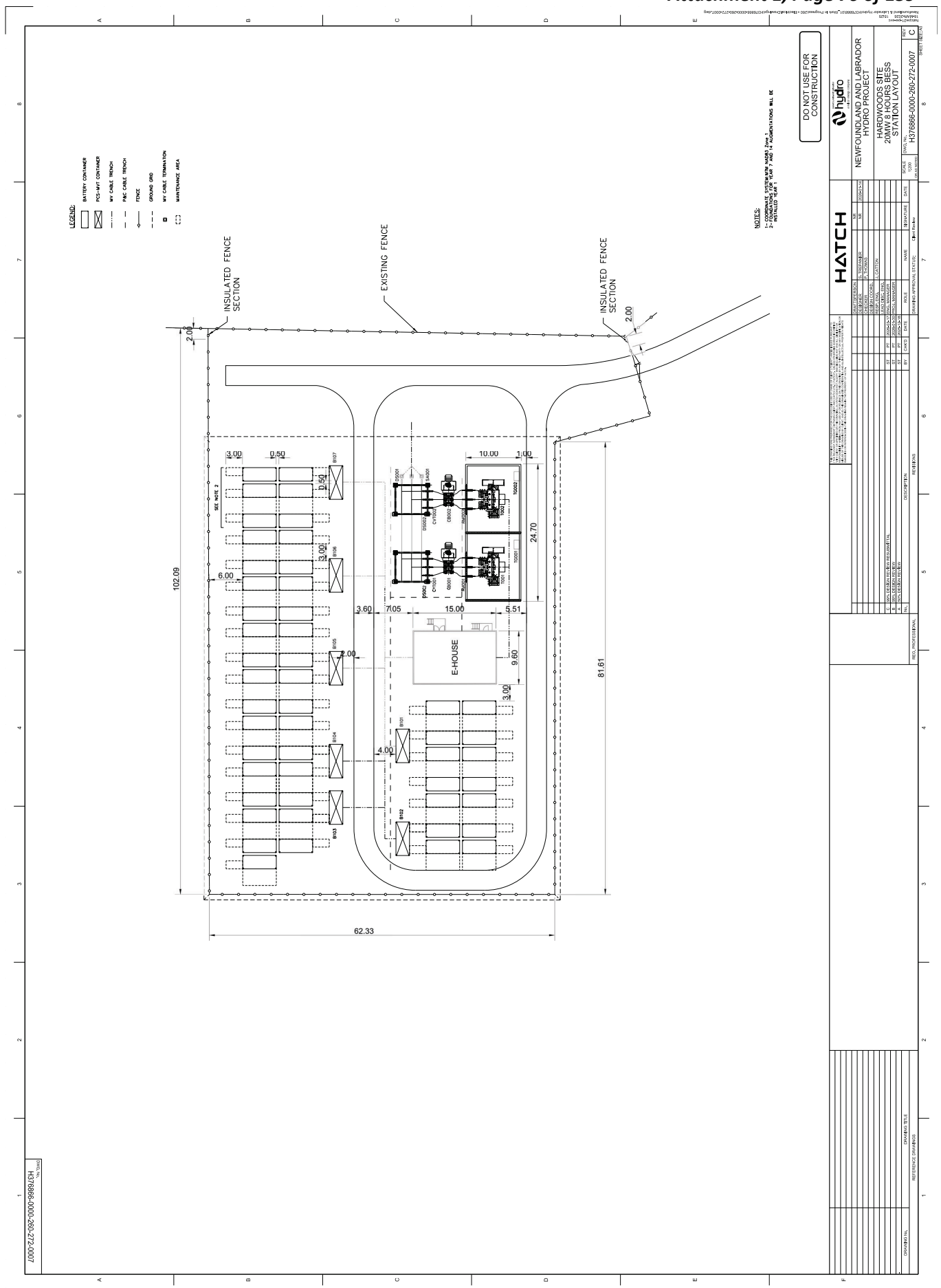
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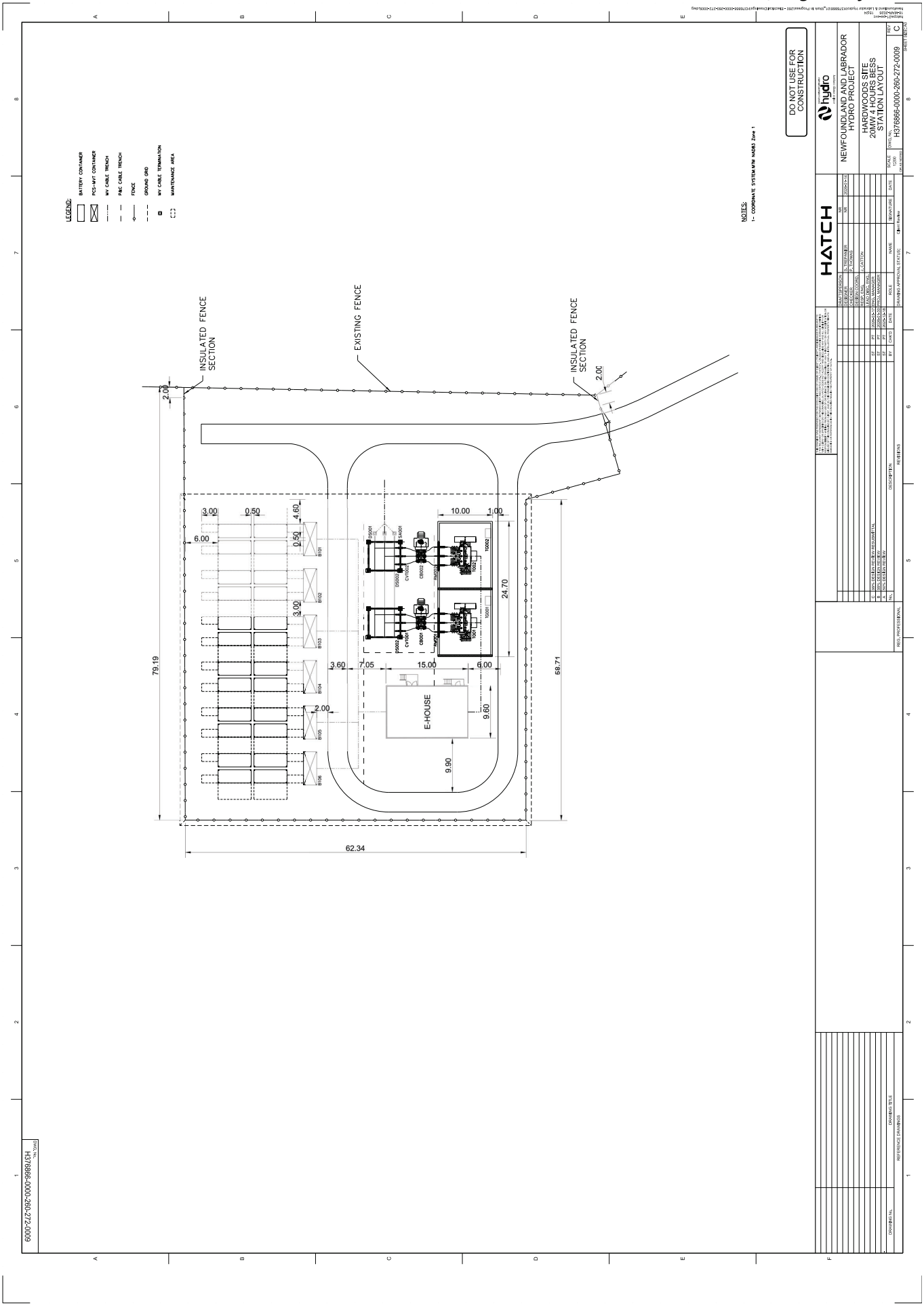
Appendix A
Hardwoods – BESS Station Layout Drawings

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LEGEND:
BATTERY CONTAINER
PCS+MVT CONTAINER
MV CABLE TRENCH
P&C CABLE TRENCH
FENCE
GROUND GRID
MV CABLE TERMINATION
MAINTENANCE AREA
INSULATED FENCE SECTION
EXISTING FENCE
INSULATED FENCE SECTION
2.00
62.58
3.00
0.50
10.00
6.12
24.70
3.60
7.05
15.00
5.49
3.60
2.00
E-HOUSE
9.60
3.00
4.00
6.00
117.50
218.93
34.61
NOTES:
1- ENERGY STORAGE SYSTEM WITH MODEL Zero 1
2- FOUNDATIONS FOR YEAR 7 AND 14 AUGMENTATIONS WILL BE INSTALLED YEAR 1
DO NOT USE FOR CONSTRUCTION
HATCH
hydro
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS SITE
50MW 8 HOURS BESS
STATION LAYOUT
H376886-0000-260-272-0003
D
H376886-0000-260-272-0003


LEGEND:
BATTERY CONTAINER
PCS+MVT CONTAINER
MV CABLE TRENCH
PMC CABLE TRENCH
FENCE
GROUND GRID
MV CABLE TERMINATION
MAINTENANCE AREA
INSULATED FENCE SECTION
EXISTING FENCE
INSULATED FENCE SECTION
NOTES:
1- COORDINATE SYSTEM NAD83 Zone 7
E-HOUSE
114.01
93.38
62.33
24.70
15.00
10.00
9.60
7.05
6.00
4.60
3.60
3.00
2.00
1.00
0.50
DO NOT USE FOR CONSTRUCTION
HATCH
hydro
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS SITE
50MW 4 HOURS BESS
STATION LAYOUT
H376866-0000-260-272-0005
REV C
SHEET 1 OF 1
REFERENCE DRAWINGS
DRAWING TITLE
DRAWING No.


LEGEND:
BATTERY CONTAINER
PCS+MVT CONTAINER
MV CABLE TRENCH
PWC CABLE TRENCH
FENCE
GROUND GRID
MV CABLE TERMINATION
MAINTENANCE AREA
INSULATED FENCE SECTION
EXISTING FENCE
INSULATED FENCE SECTION
NOTES:
1- FOUNDATIONS FOR YEAR 7 AND 14 AUGMENTATIONS WILL BE INSTALLED YEAR 1
DO NOT USE FOR CONSTRUCTION
E-HOUSE
102.09
81.61
62.33
24.70
9.60
10.00
15.00
7.05
5.51
3.60
6.00
3.00
2.00
4.00
0.50
1.00
2.50
HATCH
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS SITE
20MW 8 HOURS BESS
STATION LAYOUT
H376866-0000-260-272-0007
REFERENCE DRAWINGS
DRAWING TITLE
DRAWING No.
THIS DRAWING


LEGEND:
BATTERY CONTAINER
PCS+MVT CONTAINER
MV CABLE TRENCH
PMC CABLE TRENCH
FENCE
GROUND GRID
MV CABLE TERMINATION
MAINTENANCE AREA
NOTES:
1- COORDINATE SYSTEM WITH NAD83 Zone 1
DO NOT USE FOR CONSTRUCTION
INSULATED FENCE SECTION
EXISTING FENCE
INSULATED FENCE SECTION
2.00
2.00
3.00
0.50
4.60
6.00
0.50
3.00
2.00
10.00
1.00
24.70
3.60
7.05
15.00
6.00
E-HOUSE
9.60
9.90
79.19
68.71
62.34
B101
B102
B103
B104
B105
B106
CB001
CB002
CV1001
CV1002
DS001
DS002
TM1001
TM1002
T1001
T1002
SD001
SD002
HATCH
hydro
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS SITE
20MW 4 HOURS BESS
STATION LAYOUT
H376866-0000-260-272-0009
C
DRAWING TITLE
REFERENCE DRAWINGS
DRAWING No.
REQ. PROFESSIONAL
REVISIONS
DESCRIPTION
DRAWING APPROVAL STATUS
SIGNATURE
DATE
NAME
ROLE
SCALE
SHEET
REV
DWG No.

Appendix B
Hardwoods – BESS General Arrangement Drawings

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DRAWING No.	DRAWING TITLE
REFERENCE DRAWINGS	

REG. PROFESSIONAL

No.	DESCRIPTION	BY	CHKD	DATE
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C	99% DESIGN REVIEW RESUBMITAL	ST	PT	2026-02-20
B	95% DESIGN REVIEW	ST	PT	2026-01-30
A	50% DESIGN REVIEW	ST	PT	2025-12-19

REVISIONS

HATCH

ROLE	NAME	SIGNATURE	DATE
DRAFTSPERSON		NR	
DESIGNER	S. TREPANIER	NR	2025-12-19
CHECKER	P. THOMAS	-	-
DESIGN COORD.	-	-	-
RESP. ENG.	J. CATTON	-	-
LEAD DISC. ENG.		-	-
ENG. MANAGER		-	-
PROJ. MANAGER		-	-

DRAWING APPROVAL STATUS: Client Review

Hydro

NEWFOUNDLAND AND LABRADOR HYDRO PROJECT

HARDWOODS SITE
50MW 8HOURS BESS
GENERAL ARRANGEMENT

SCALE 1:200 OR AS NOTED | DWG. No. H376866-0000-260-272-0001 | REV D | SHEET SIZE: A0

BORDER/NAMES STAKES SPILES



DRAWING No.	DRAWING TITLE
REFERENCE DRAWINGS	

No.	DESCRIPTION	BY	CHKD	DATE
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B	95% DESIGN REVIEW	ST	PT	2026-02-20
A	50% DESIGN REVIEW	ST	PT	2025-12-19
REVISIONS				

REG. PROFESSIONAL

HATCH

ROLE	NAME	SIGNATURE	DATE
DRAFTSPERSON		NR	
DESIGNER	S. TREPANIER	NR	2026-04-14
CHECKER	P. THOMAS	-	-
DESIGN COORD.	-	-	-
RESP. ENG.	J. CATTON	-	-
LEAD DISC. ENG.		-	-
ENG. MANAGER		-	-
PROJ. MANAGER		-	-

DRAWING APPROVAL STATUS: Client Review

Hydro

NEWFOUNDLAND AND LABRADOR HYDRO PROJECT

HARDWOODS SITE
50MW 4 HOURS BESS
GENERAL ARRANGEMENT

SCALE	DWG. No.	REV
1:200 OR AS NOTED	H376866-0000-260-272-0004	C

SHEET SIZE: A0

BORDER/NAMES STAKES SPLES



DWG. No. H376866-0000-260-272-0006

HATCH

DRAFTSPERSON		NR	
DESIGNER	S. TREPANIER	NR	2025-04-14
CHECKER	P. THOMAS	-	-
DESIGN COORD.	-	-	-
RESP. ENG.	J. CATTON	-	-
LEAD DISC. ENG.		-	-
ENG. MANAGER		-	-
PROJ. MANAGER		-	-
DRAWING APPROVAL STATUS:	Client Review		

No.	DESCRIPTION	BY	CHKD	DATE
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B	95% DESIGN REVIEW	ST	PT	2024-02-20
A	50% DESIGN REVIEW	ST	PT	2023-12-19

REVISIONS

ROLE	NAME	SIGNATURE	DATE

REG. PROFESSIONAL

DRAWING No.	DRAWING TITLE
REFERENCE DRAWINGS	

Hydro

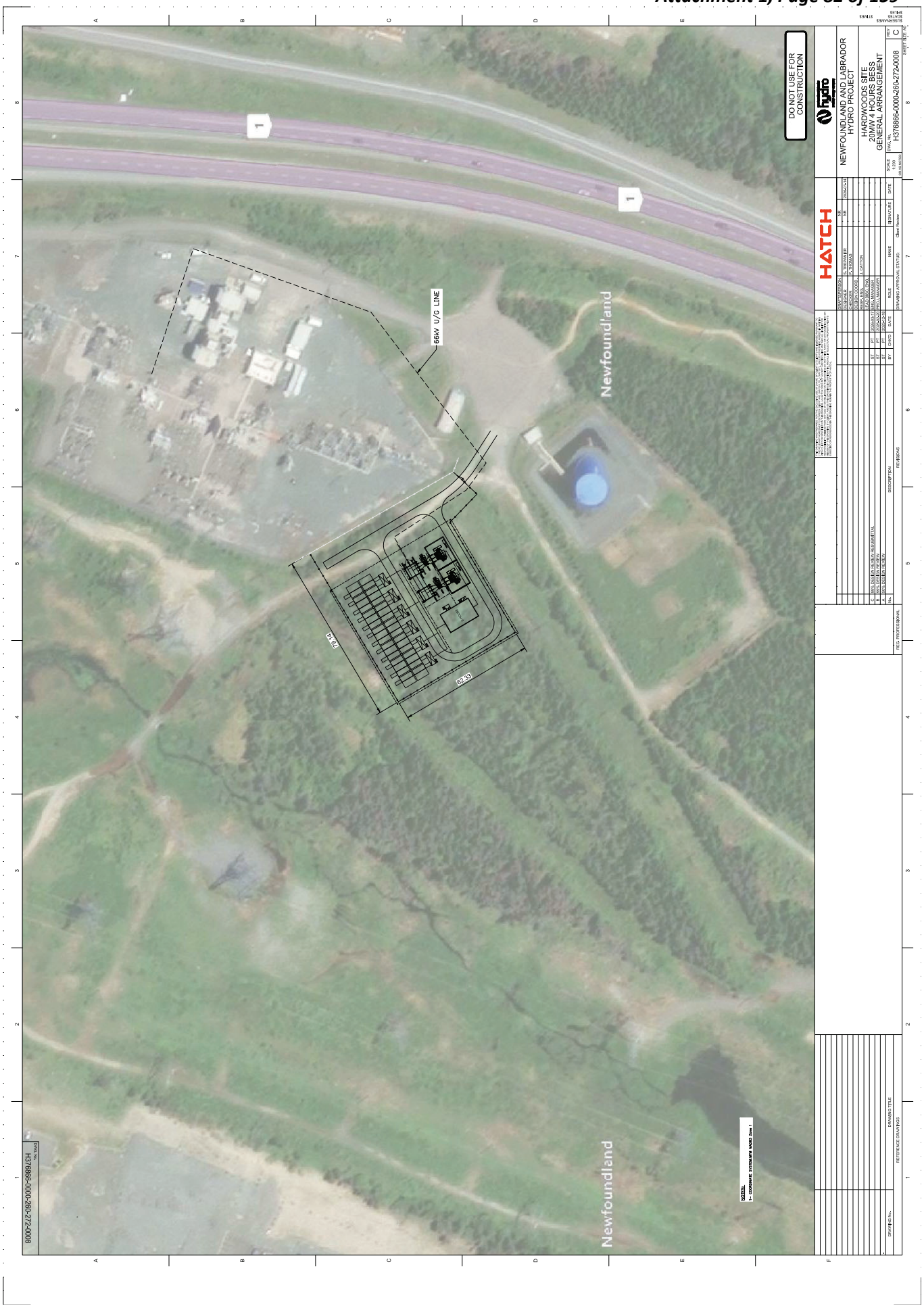
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT

HARDWOODS SITE
20MW 8 HOURS BESS
GENERAL ARRANGEMENT

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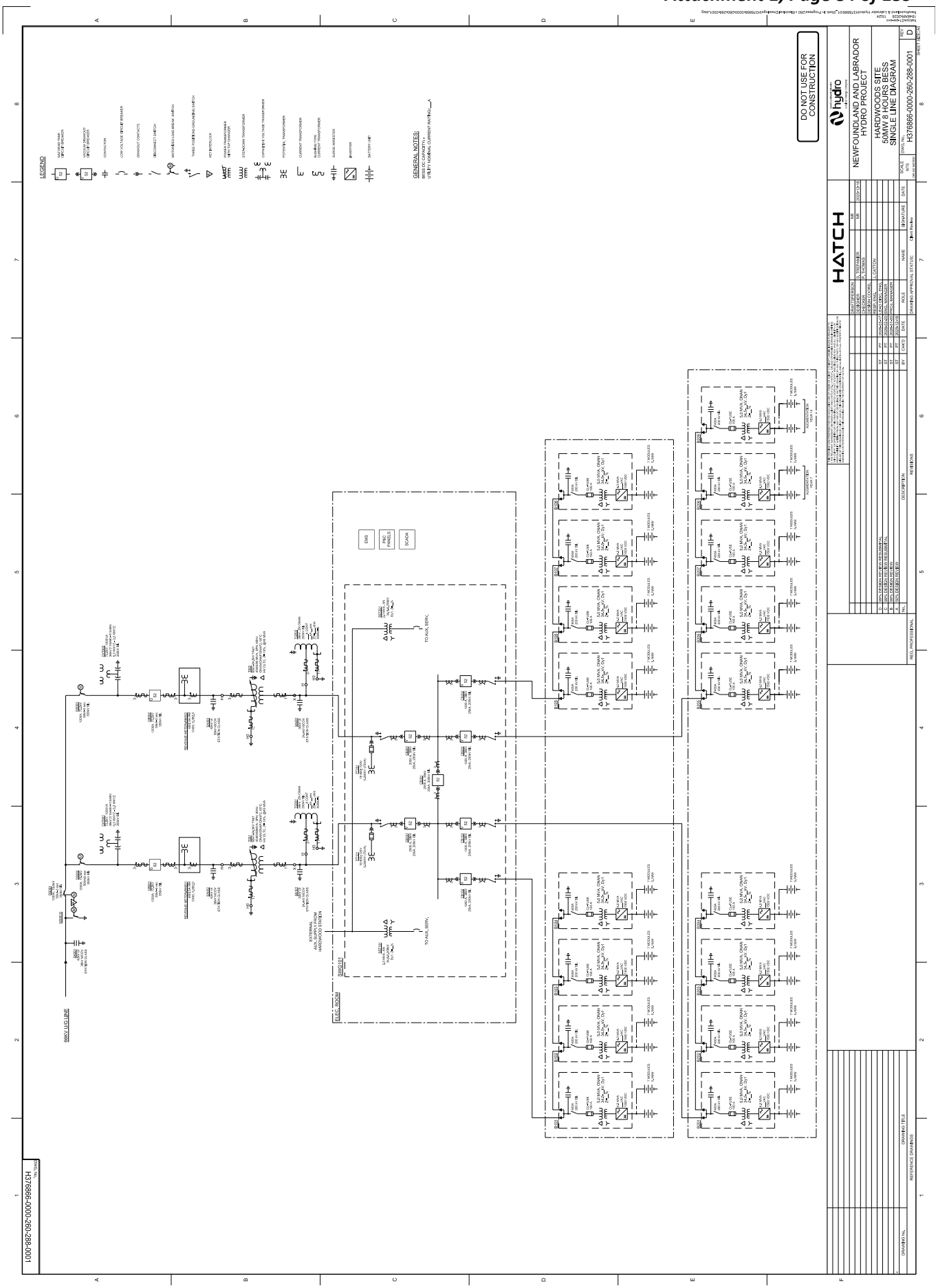
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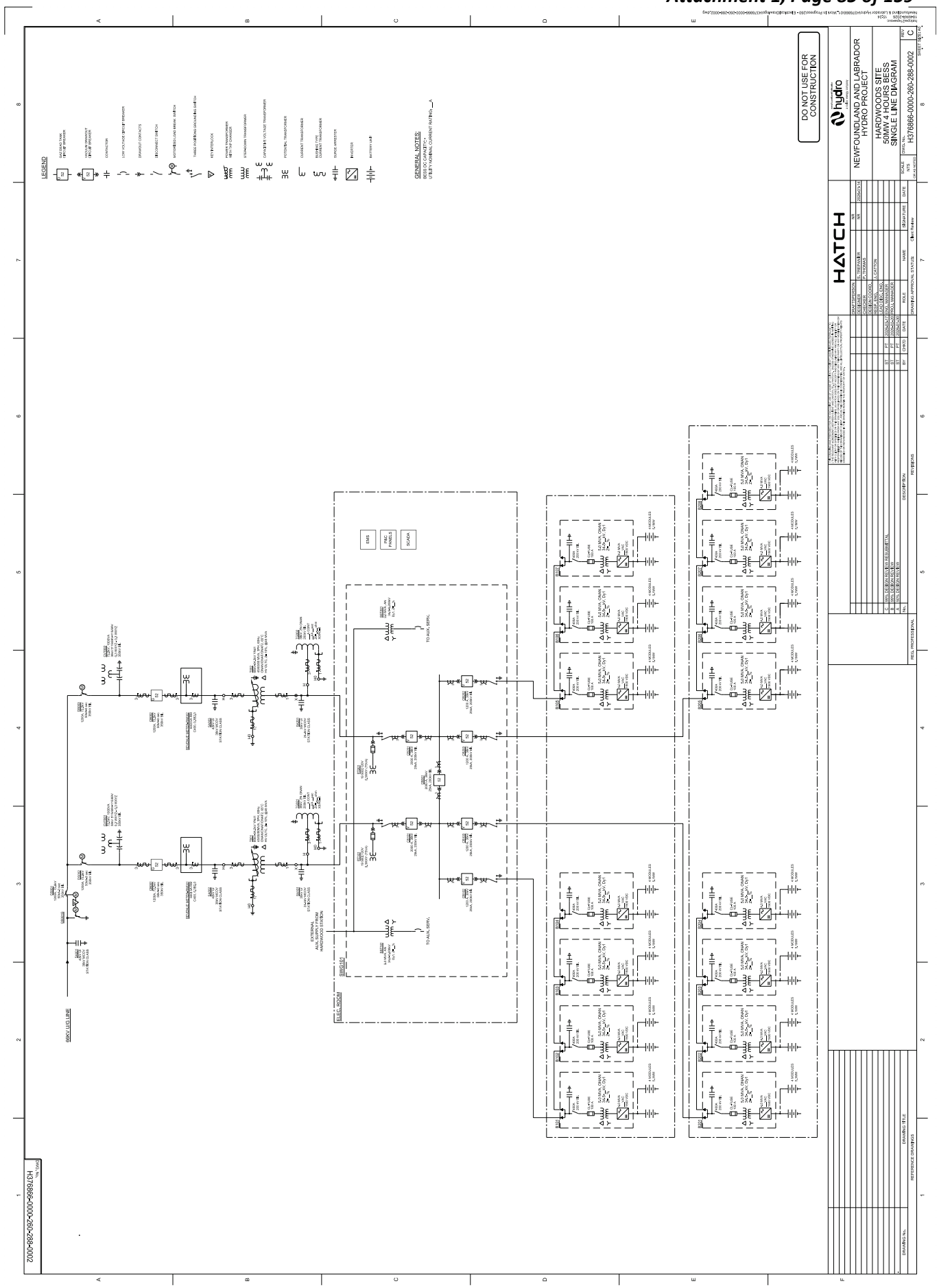
BURGESS MAIN SITES

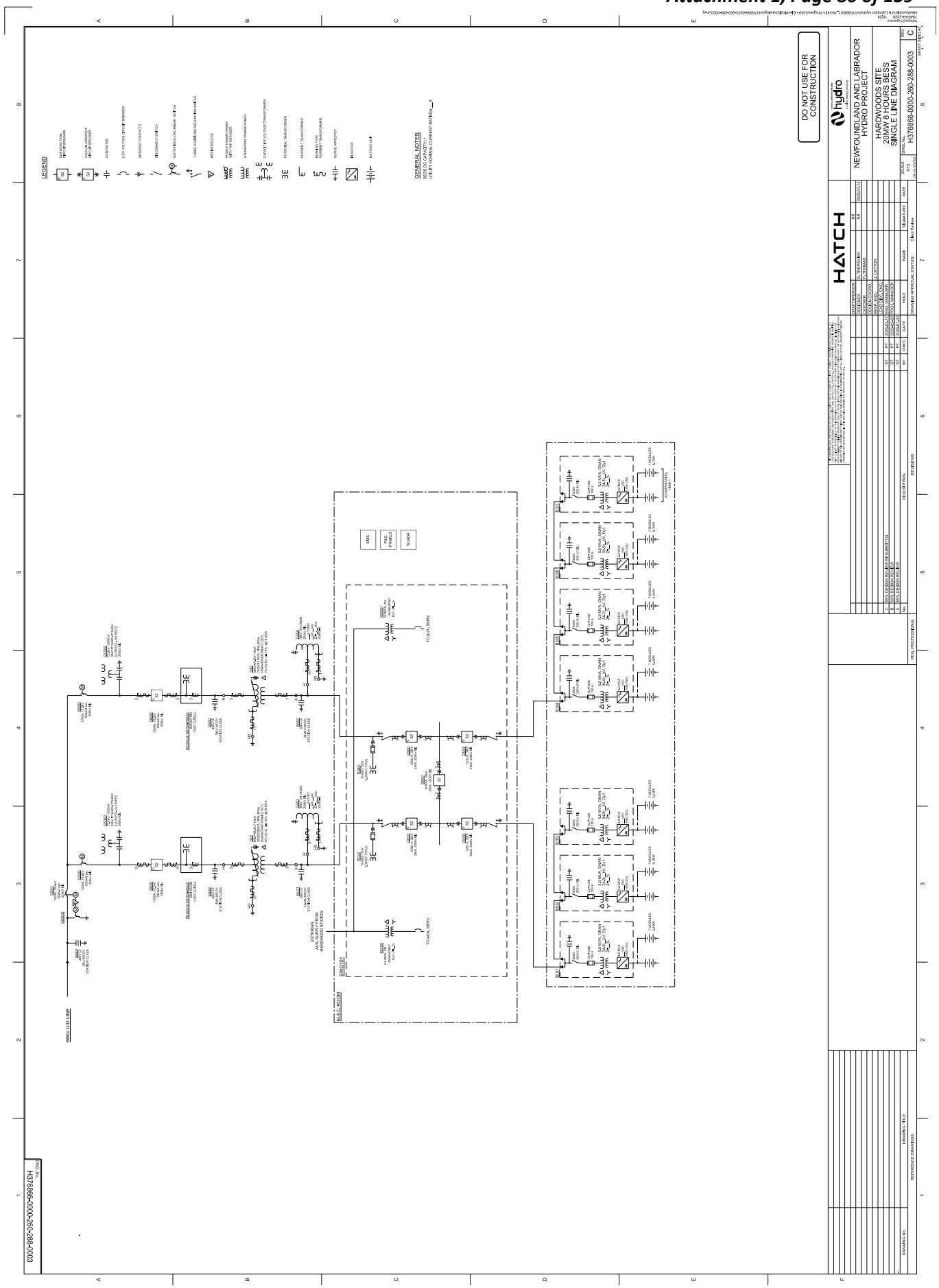

DO NOT USE FOR CONSTRUCTION
66kV U/G LINE
Newfoundland
Newfoundland
Newfoundland
NOTES:
1. COORDINATE SYSTEM:NAD83 Zone 1
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS SITE
20MW 4 HOURS BESS
GENERAL ARRANGEMENT
H378686-0000-260-272-0008
C
HATCH

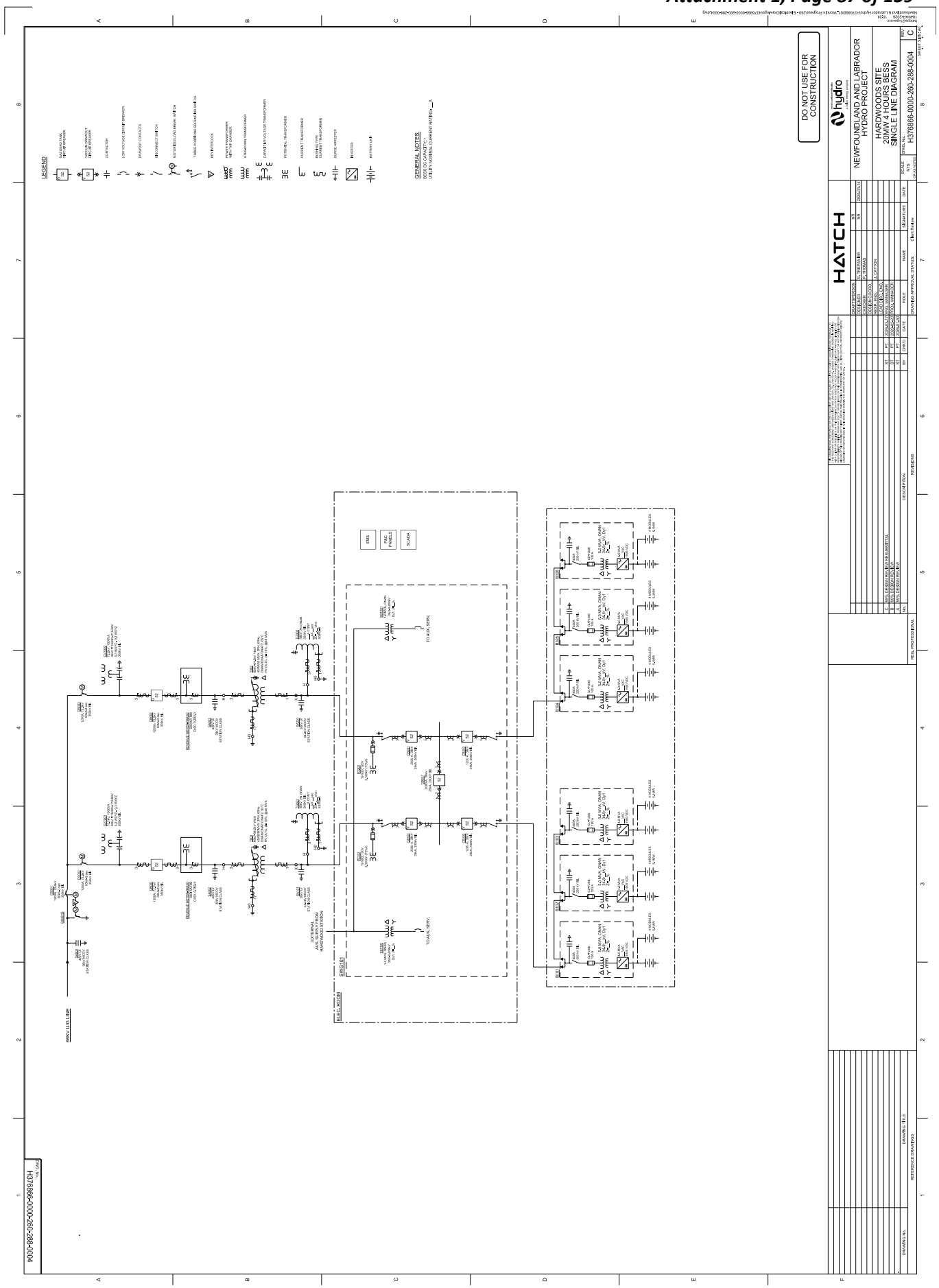
Appendix C
Hardwoods – BESS Single Line Diagram Drawings

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DO NOT USE FOR CONSTRUCTION
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS SITE
50MW 8 HOURS BESS
SINGLE LINE DIAGRAM
H376866-0000-260-208-0001
D
HATCH
hydro
LEGEND
GENERAL NOTES:
69KV LUG LINE
BESS ROOM
EMS
PAD HMI&S
SCADA
TO MAIN SWGR
TO AUX SWGR
AUXILIARY TRANSFORMER
AUXILIARY SWGR
DRAWING TITLE
REFERENCE DRAWINGS
REVISIONS
DESCRIPTION
DRAWING APPROVAL STATUS:

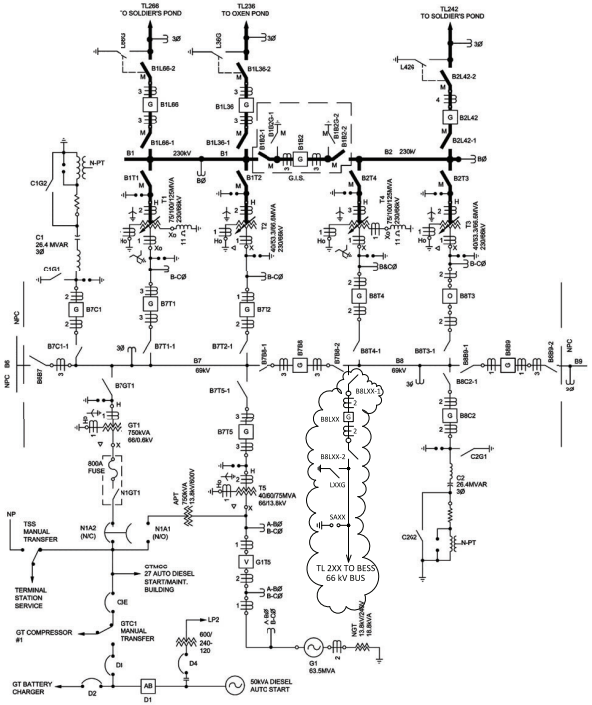

DO NOT USE FOR CONSTRUCTION
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS SITE
50MW 4 HOURS BESS
SINGLE LINE DIAGRAM
H376886-0000-260-288-0002
LEGEND
GENERAL NOTES:
25kV UG LINE
BESS ROOM
EMS
PAC PANELS
SCADA
TO MAIN SWGR
EXTERNAL AUX SUPPLY FROM HARDWOODS SYSTEM
SWGR
XFMR
INVERTER
BATTERY
REFERENCE DRAWINGS
REG. PROFESSIONAL


DO NOT USE FOR CONSTRUCTION
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS SITE
20MW 8 HOURS BESS
SINGLE LINE DIAGRAM
H376886-0000-260-288-0003
C
LEGEND
GENERAL NOTES:
66KV LVD LINE
BESS ROOM
SWGR
EMS
PAC PANELS
SCADA
TO HVAC SWGR
TO AUX SWGR
EXTERNAL AUX SUPPLY FROM HARDWOODS STATION
HATCH
hydro


LEGEND
GENERAL NOTES:
DO NOT USE FOR CONSTRUCTION
HATCH
hydro
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS SITE
20MW 4 HOURS BESS
SINGLE LINE DIAGRAM
H376866-0000-260-288-0004
BESS ROOM
EMS
PAC PANELS
SCADA
66KV LVD LINE
EXTERNAL AUX SUPPLY FROM HARDWOODS STATION
TO AUX SWGR
SWGR01
DRAWING TITLE
REFERENCE DRAWINGS
DRAWING No.
H376866-0000-260-288-0004

DWG. No.
H376866-0000-260-288-0010

NOTES:
CIRCUIT BREAKER B8LXX
72.5 kV CLASS, 1200 A, 31.5 kA, 350 kV BIL
DISCONNECT SWITCHES B8LXX-1 AND B8LXX-2
72.5 kV CLASS, 1200 A, 350 kV BIL
TL2XX 66 kV TRANSMISSION LINE
CONNECT BESS TO HWD 66 kV BUS B8
FOR OVERHEAD 477 kcmil, 26/7, ACSR, "HAWK" AT 90 C CONDUCTOR TEMPERATURE
OR ELECTRICAL EQUIVALENT (559 kcmil, 19, AASC)
FOR BURIED CABLE 4 X 1C 500 kcmil, COPPER XPLE CABLE (ONE SPARE)



DO NOT USE FOR CONSTRUCTION

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A	99% DESIGN REVIEW	ST	PT	2026-01-26

ROLE	NAME	SIGNATURE	DATE
DRAFTSPERSON		NR	
DESIGNER	S. TREPANIER	NR	2025-12-18
CHECKER	P. THOMAS		
DESIGN COORD.			
RESP. ENG.	J. CATTON		2023-05-24
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ENG. MANAGER			
PROJ. MANAGER			2023-05-25

DRAWING APPROVAL STATUS: Client Review

HATCH

hydro

NEWFOUNDLAND AND LABRADOR HYDRO PROJECT

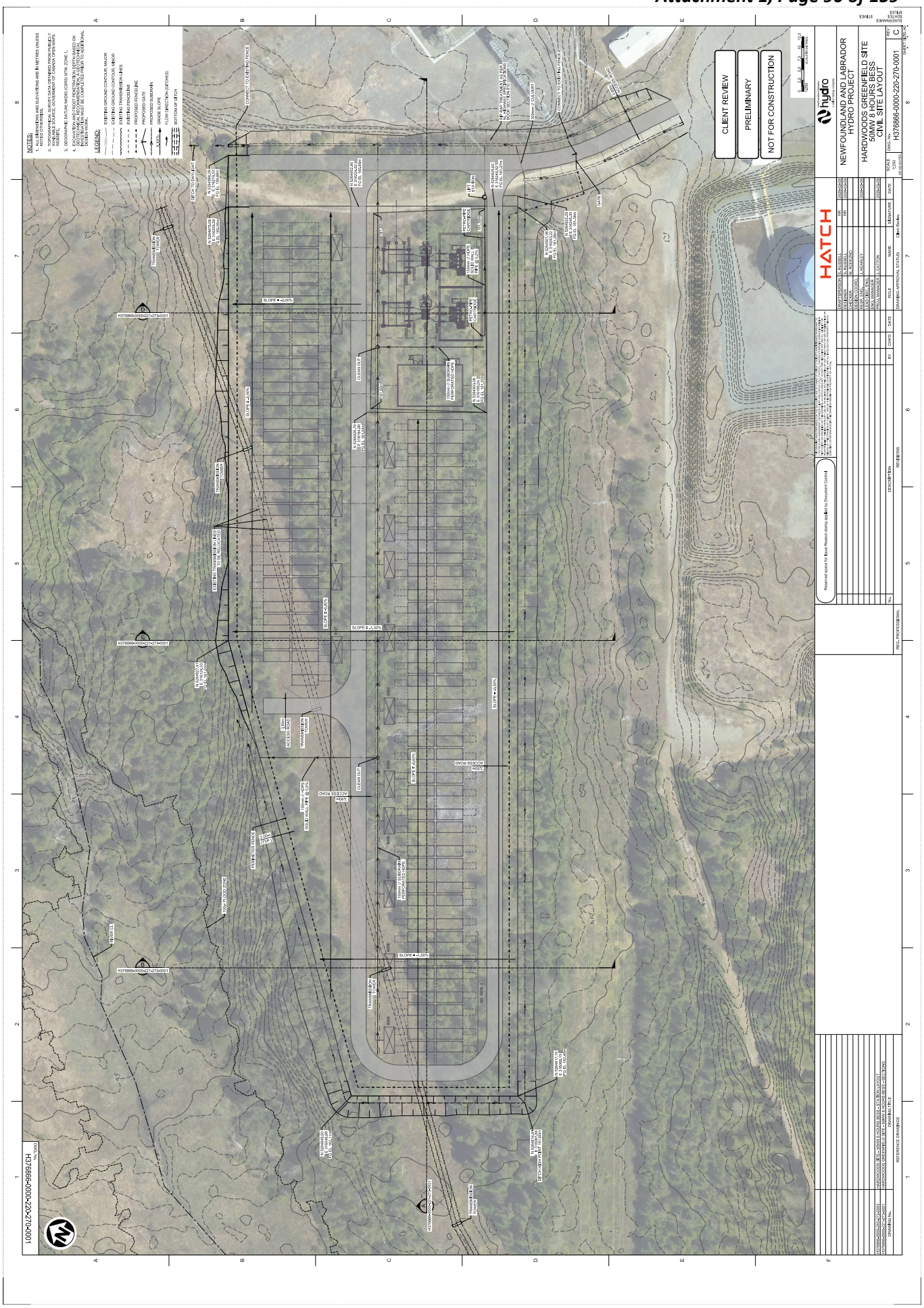
HARDWOODS SITE
BESS INTERCONNECTION
SINGLE LINE DIAGRAM

DRAWING No.	DRAWING TITLE
REFERENCE DRAWINGS	REG. PROFESSIONAL

SCALE: NTS OR AS NOTED
DWG. No.: H376866-0000-260-288-0010
REV: B
SHEET SIZE: A1

Appendix D
Hardwoods – BESS Civil Drawings

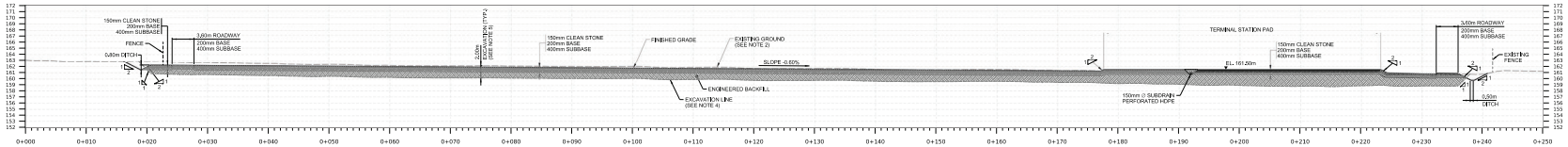
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NOTES:
1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. TOPOGRAPHICAL SURVEY DATA OBTAINED FROM PUBLICLY AVAILABLE SOURCE: GOVERNMENT OF CANADA OPEN MAPS WEBSITE.
3. GEODETIC DATUM: NAD83 (CSRS) MTM, ZONE 1.
4. EXCAVATION AND FROST PENETRATION DEPTH BASED ON GEOTECHNICAL INVESTIGATION REPORT. FINAL DESIGN TO BE COMPLETED PRIOR TO ADDITIONAL INVESTIGATION.
LEGEND:
EXISTING GROUND CONTOUR, MAJOR
EXISTING GROUND CONTOUR, MINOR
EXISTING TRANSMISSION LINES
PROPOSED FENCELINE
PROPOSED SUBDIVISION
GRADE SLOPE
FLOW DIRECTION (DITCHES)
BOTTOM OF DITCH
CLIENT REVIEW
PRELIMINARY
NOT FOR CONSTRUCTION
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS GREENFIELD SITE
50MW 8 HOURS BESS
CIVIL SITE LAYOUT
H376866-0000-220-270-0001
C
HATCH
hydro

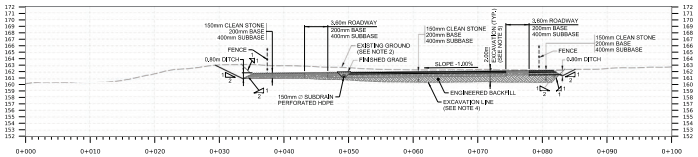
DWG. No. H376866-0000-221-273-0001

NOTES:
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3. GEOGRAPHIC DATUM: NAD83 (CSRS) MTM, ZONE 1.
4. EXCAVATION AND FROST PENETRATION DEPTH BASED ON GEOTECHNICAL RECOMMENDATION, A GEOTECHNICAL INVESTIGATION MUST BE COMPLETED PRIOR TO ADDITIONAL DESIGN WORK.
5. EXCAVATION LIMIT SHOWN IS INDICATIVE, ADEQUATE FROST PROTECTION COVER AND CABLE CLEARANCE SHOULD BE PROVIDED FOR ALL FOUNDATION EXCAVATION, SEE STRUCTURAL DRAWINGS H376866-0000-221-260-0002 TO 0005 FOR REFERENCE.

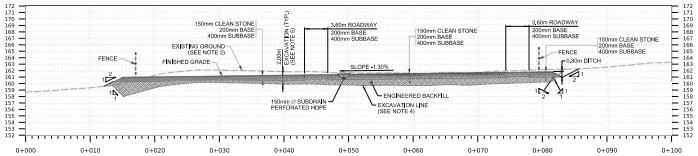
LEGEND:
- EXISTING GROUND
- FINISHED GRADE
- EXCAVATION LINE
- 150mm CLEAN STONE
- 200mm BASE
- 400mm SUBBASE
- COMMON FILL



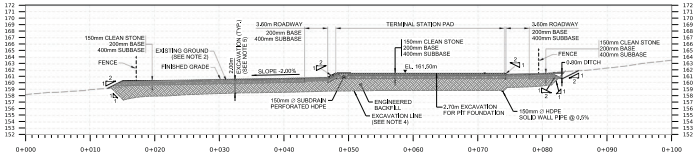
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SECTION B
SCALE: 1:250 H376866-0000-221-270-0001



SECTION C
SCALE: 1:250 H376866-0000-221-270-0001



SECTION D
SCALE: 1:250 H376866-0000-221-270-0001

CLIENT REVIEW
PRELIMINARY
NOT FOR CONSTRUCTION

0 2.5 5.0 7.5 10 12.5
1:250 SCALE IN METRES

H376866-0000-222-270-0001	HARDWOODS GREENFIELD SITE - 50MW 8 HOURS BESS - CIVIL SITE LAYOUT
DRAWING No.	DRAWING TITLE
REFERENCE DRAWINGS	

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DESIGNER	S. RUSSELL	NR	2024-03-01
CHECKER	M. RODEZNO		2024-03-01
DESIGN COORD.			
RESP. ENG.	J. KEARLEY		2024-03-01
LEAD DISC. ENG.			
ENG. MANAGER			
PROJ. MANAGER	J. CATTON		2024-03-01
DRAWING APPROVAL STATUS:	Client Review		

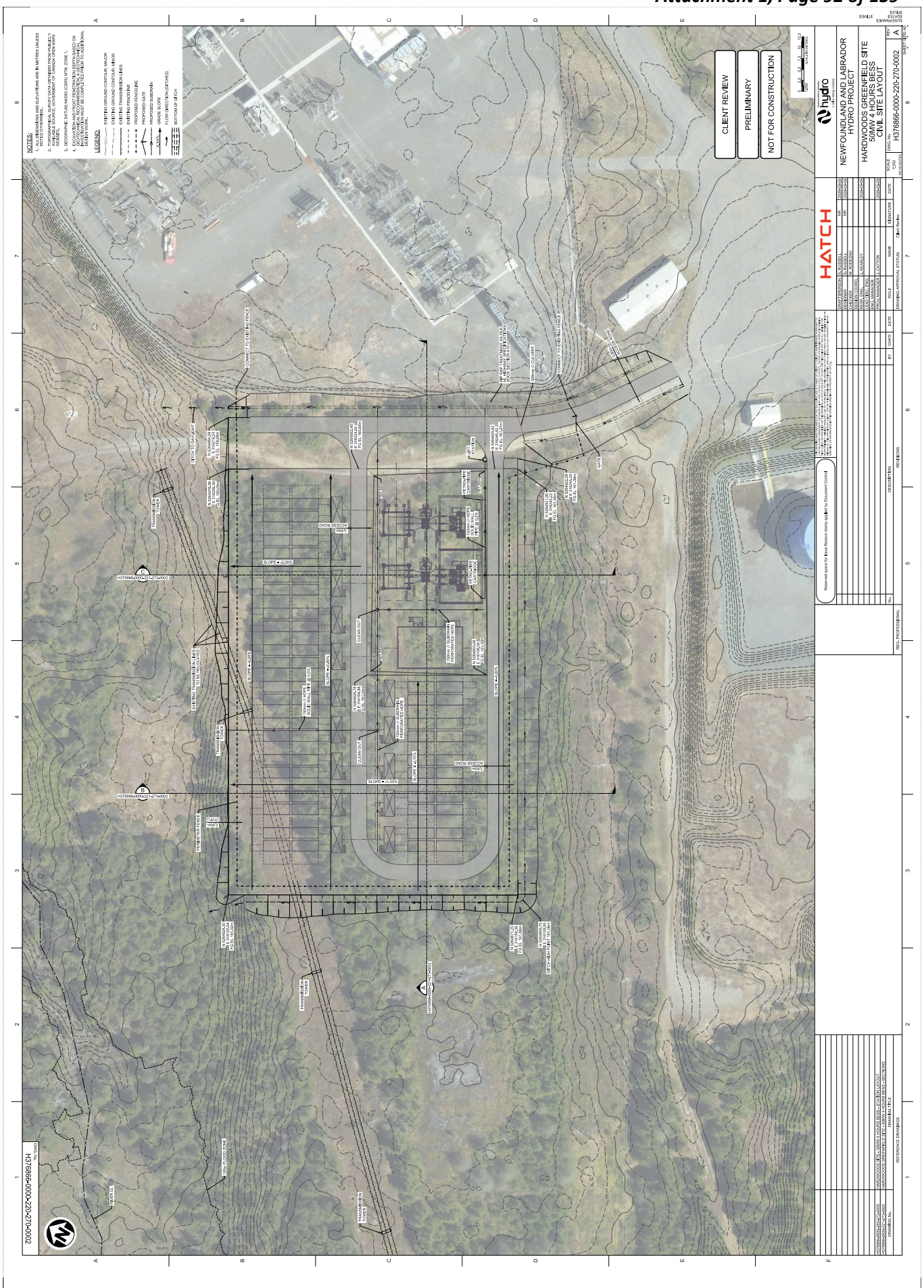
newfoundland power / hydro — an emera company

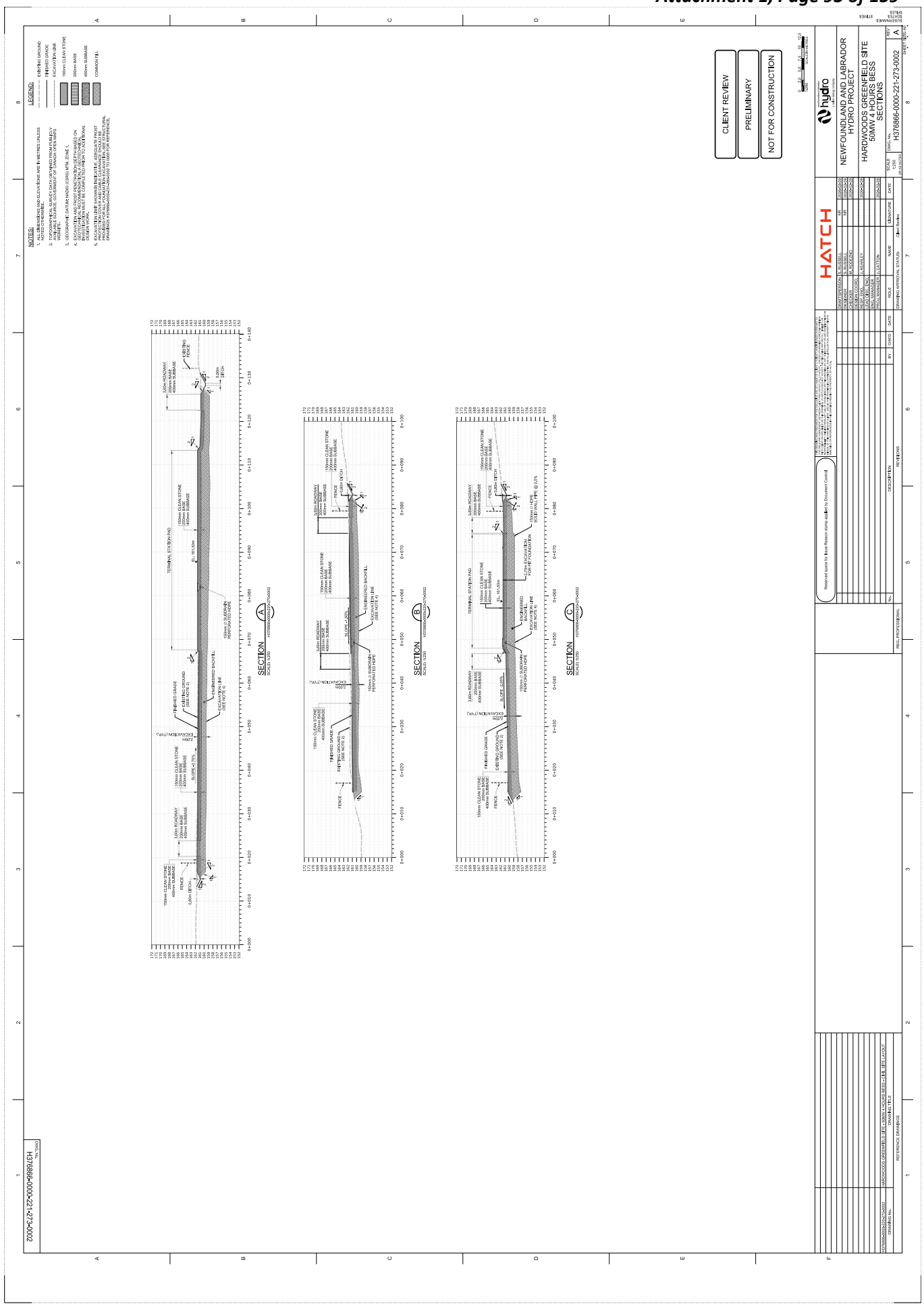
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT

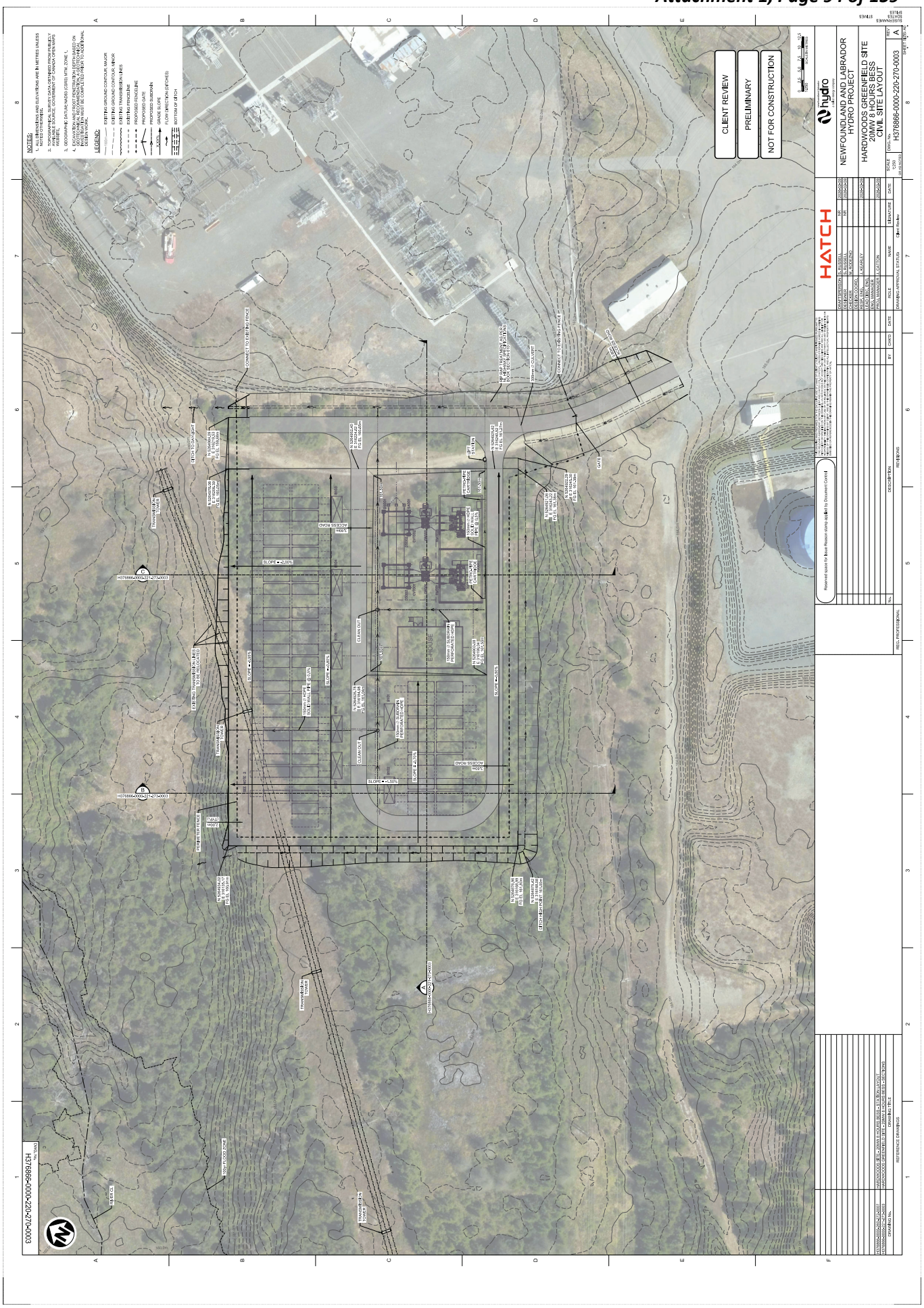
HARDWOODS GREENFIELD SITE
50MW 8HOURS BESS
SECTIONS

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1:250 (22x34) OR AS NOTED	H376866-0000-221-273-0001	C
	SHEET SIZE: A1	

BORDER/TITLE BLOCK STYLES


NOTES:
1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. TOPOGRAPHICAL SURVEY DATA OBTAINED FROM PUBLICLY AVAILABLE SOURCE: GOVERNMENT OF CANADA OPEN MAPS WEBSITE.
3. GEOGRAPHIC DATUM: NAD83 (CSRS) MTM, ZONE 1.
4. EXCAVATION AND FROST PENETRATION DEPTH BASED ON INVESTIGATION MUST BE COMPLETED PRIOR TO ADDITIONAL DESIGN WORK.
LEGEND:
EXISTING GROUND CONTOUR, MAJOR
EXISTING GROUND CONTOUR, MINOR
EXISTING TRANSMISSION LINES
EXISTING PIPELINE
PROPOSED PIPELINE
PROPOSED GATE
PROPOSED SUBDIVISION
GRADE SLOPE
FLOW DIRECTION (DITCHES)
BOTTOM OF DITCH
CLIENT REVIEW
PRELIMINARY
NOT FOR CONSTRUCTION
HATCH
hydro
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS GREENFIELD SITE
50MW 4 HOURS BESS
CIVIL SITE LAYOUT
H376866-0000-220-270-0002
A
ACCESS ROAD
FENCE
TRANSMISSION LINE
CLEARCUT
SLOPE = 2.00%
SLOPE = 4.00%
SLOPE = 4.50%
CONNECT TO EXISTING FENCE
GATE
H376866-0000-220-270-0002


LEGEND:
EXISTING GROUND
FINISHED GRADE
EXCAVATION LINE
150mm CLEAN STONE
200mm BASE
400mm SUBBASE
COMMON FILL
NOTES:
1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. TOPOGRAPHICAL SURVEY DATA OBTAINED FROM PUBLICLY AVAILABLE SOURCE: GOVERNMENT OF CANADA OPEN MAPS WEBSITE.
3. GEOGRAPHIC DATUM: NAD83 (CSRS) MTM, ZONE 1.
4. EXCAVATION AND FROST PENETRATION DEPTHS BASED ON PRELIMINARY ASSUMPTIONS. GEOTECHNICAL INVESTIGATION MUST BE COMPLETED PRIOR TO ADDITIONAL DESIGN WORK.
5. EXCAVATION LIMIT SHOWN IS INDICATIVE. ADEQUATE FROST PROTECTION MUST BE PROVIDED FOR ALL FOUNDATIONS. EXCAVATION PRIOR TO EXCAVATION. SEE STRUCTURAL DRAWINGS FOR BACKFILL REQUIREMENTS FOR EACH FOUNDATION TYPE.
SECTION A
SECTION B
SECTION C
CLIENT REVIEW
PRELIMINARY
NOT FOR CONSTRUCTION
HATCH
hydro
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS GREENFIELD SITE
50MW 4 HOURS BESS
SECTIONS
H376866-0000-221-273-0002
A


NOTES:
LEGEND:
CLIENT REVIEW
PRELIMINARY
NOT FOR CONSTRUCTION
HATCH
hydro
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS GREENFIELD SITE 20MW 8 HOURS BESS
CIVIL SITE LAYOUT
H376866-0000-220-270-0003
A
ACCESS ROAD
PERIMETER FENCE
TRANSFORMER
SUBSTATION
CLEAR CUT
SLOPE = 2.00%
SLOPE = 4.00%
CONNECT TO EXISTING FENCE
GATE

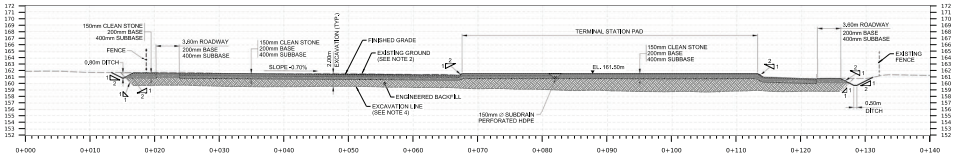
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NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. TOPOGRAPHICAL SURVEY DATA OBTAINED FROM PUBLICLY AVAILABLE SOURCE, GOVERMENT OF CANADA OPEN MAPS WEBSITE.
3. GEOGRAPHIC DATUM: NAD83 (CSRS) MTM, ZONE 1.
4. EXCAVATION AND FROST PENETRATION DEPTH BASED ON GEOTECHNICAL RECOMMENDATION, A GEOTECHNICAL INVESTIGATION MUST BE COMPLETED PRIOR TO ADDITIONAL DESIGN WORK.
5. EXCAVATION LIMIT SHOWN IS INDICATIVE, ADEQUATE FROST PROTECTION COVER AND CABLE CLEARANCE SHOULD BE PROVIDED FOR ALL FOUNDATION EXCAVATION, SEE STRUCTURAL DRAWINGS H376866-0000-221-273-0002 TO 0005 FOR REFERENCE.

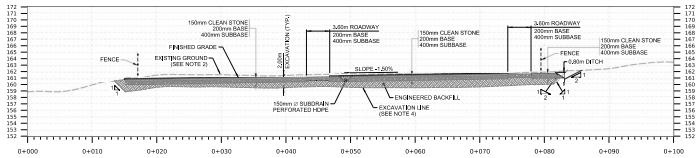
LEGEND:

- EXISTING GROUND
- FINISHED GRADE
- EXCAVATION LINE
- 150mm CLEAN STONE
- 200mm BASE
- 400mm SUBBASE
- COMMON FILL



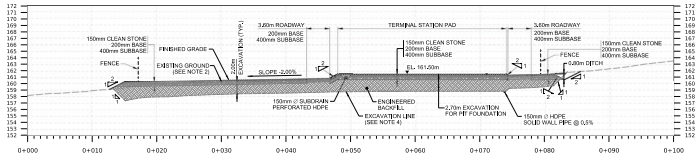
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SECTION B

SCALE: 1:250 H376866-0000-220-270-0002



SECTION C

SCALE: 1:250 H376866-0000-220-270-0002

CLIENT REVIEW

PRELIMINARY

NOT FOR CONSTRUCTION

0 2.5 5.0 7.5 10 12.5

1250 SCALE IN METRES

H376866-0000-222-270-0003	HARDWOODS GREENFIELD SITE - 20MW 8 HOURS BESS - CIVIL SITE LAYOUT
DRAWING No.	DRAWING TITLE
REFERENCE DRAWINGS	

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CHECKER	M. RODEZNO		2024-03-01
DESIGN COORD.			
RESP. ENG.	J. KEARLEY		2024-03-01
LEAD DISC. ENG.			
ENG. MANAGER			
PROJ. MANAGER	J. CATTON		2024-03-01
DRAWING APPROVAL STATUS:	Client Review		

newfoundland power hydro a fortis energy company

NEWFOUNDLAND AND LABRADOR HYDRO PROJECT

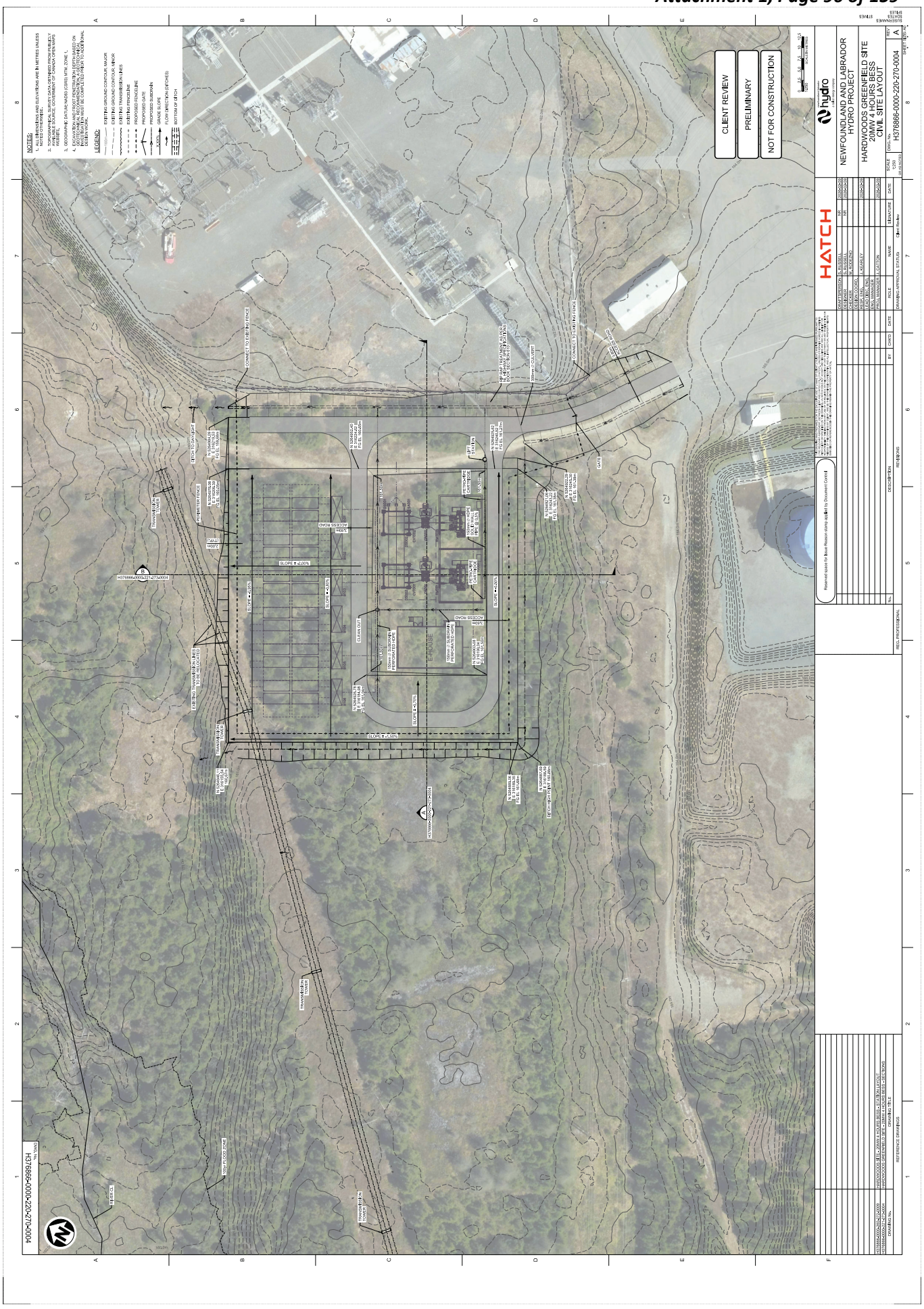
HARDWOODS GREENFIELD SITE 20MW 8 HOURS BESS SECTIONS

SCALE	DWG. No.	REV.
1:250 OR AS NOTED	H376866-0000-221-273-0003	A

SHEET SIZE: A1

BIDSPACE STYLES

Battery Energy Storage System Feasibility Study – Overview
Attachment 1, Page 95 of 159


NOTES:
LEGEND:
CLIENT REVIEW
PRELIMINARY
NOT FOR CONSTRUCTION
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hydro
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS GREENFIELD SITE 20MW 4 HOURS BESS CIVIL SITE LAYOUT
H376866-0000-220-270-0004
A
SCALE 1:500
Reserved space for Base Reason stamp, as set by Document Control
REFERENCE DRAWINGS
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REG. PROFESSIONAL SEAL
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DRAWING APPROVAL STATUS
Client Review
PROJECT No. H376866-0000
PROJECT TITLE HARDWOODS SITE - 20MW 4 HOURS BESS - CIVIL SITE LAYOUT
DRAWING No. H376866-0000-220-270-0004
REV A
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ACCESS ROAD
PERIMETER FENCE
GATE
CLEAR CUT
BLOCK 1
BLOCK 2
BLOCK 3
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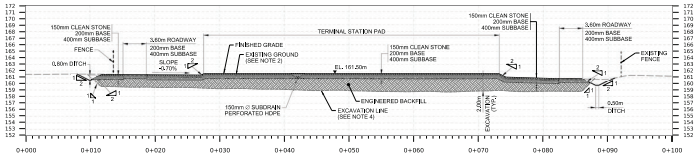
DWG. No. H376866-0000-221-273-0004

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. TOPOGRAPHICAL SURVEY DATA OBTAINED FROM PUBLICLY AVAILABLE SOURCE, GOVERMENT OF CANADA OPEN MAPS WEBSITE.
3. GEOGRAPHIC DATUM: NAD83 (CSRS) MTM, ZONE 1.
4. EXCAVATION AND FROST PENETRATION DEPTH BASED ON GEOTECHNICAL RECOMMENDATION, A GEOTECHNICAL INVESTIGATION MUST BE COMPLETED PRIOR TO ADDITIONAL DESIGN WORK.
5. EXCAVATION LIMIT SHOWN IS INDICATIVE, ADEQUATE FROST PROTECTION COVER AND CABLE CLEARANCE SHOULD BE PROVIDED FOR ALL FOUNDATION EXCAVATION, SEE STRUCTURAL DRAWINGS H376866-0000-221-280-0002 TO 0005 FOR REFERENCE.

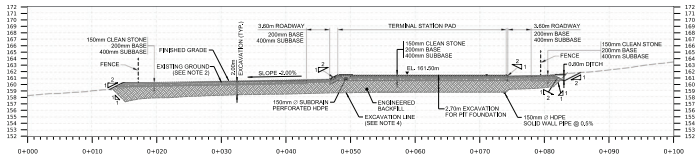
LEGEND:

- EXISTING GROUND
- FINISHED GRADE
- EXCAVATION LINE
- 150mm CLEAN STONE
- 200mm BASE
- 400mm SUBBASE
- COMMON FILL



SECTION A

SCALE: 1:250 H376866-0000-221-270-0004



SECTION B

SCALE: 1:250 H376866-0000-221-270-0004

CLIENT REVIEW

PRELIMINARY

NOT FOR CONSTRUCTION

0 2.5 5.0 7.5 10 12.5

1:250 SCALE IN METRES

H376866-0000-222-270-0004	HARDWOODS GREENFIELD SITE - 20MW 4 HOURS BESS - CIVIL SITE LAYOUT
DRAWING No.	DRAWING TITLE
REFERENCE DRAWINGS	

Reserved space for Issue Reason stamp applied by Document Control

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CHECKER	M. RODEZNO		2024-03-01
DESIGN COORD.			
RESP. ENG.	J. KEARLEY		2024-03-01
LEAD DISC. ENG.			
ENG. MANAGER			
PROJ. MANAGER	J. CATTON		2024-03-01

DRAWING APPROVAL STATUS: Client Review

No.	DESCRIPTION	BY	CHKD	DATE

REVISIONS

REG. PROFESSIONAL

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NEWFOUNDLAND AND LABRADOR HYDRO PROJECT

HARDWOODS GREENFIELD SITE 20MW 4 HOURS BESS SECTIONS

ROLE	NAME	SIGNATURE	DATE

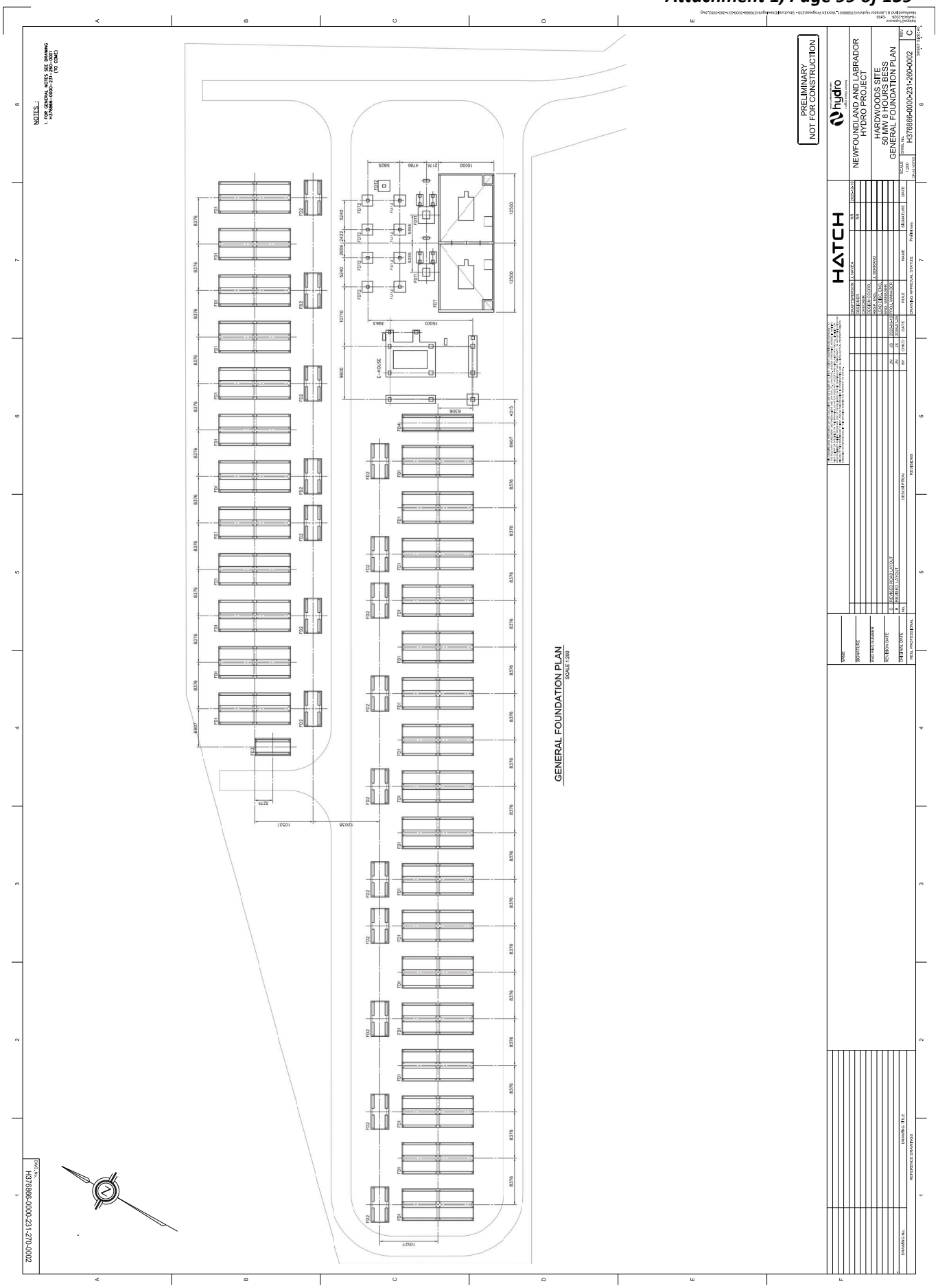
SCALE	DWG. No.	REV.
1:250 (22 IN.) OR AS NOTED	H376866-0000-221-273-0004	A

SHEET SIZE: A1

BIDSPACE STYLES

Appendix E
Hardwoods – BESS General Foundation Plans (Structural Drawings)

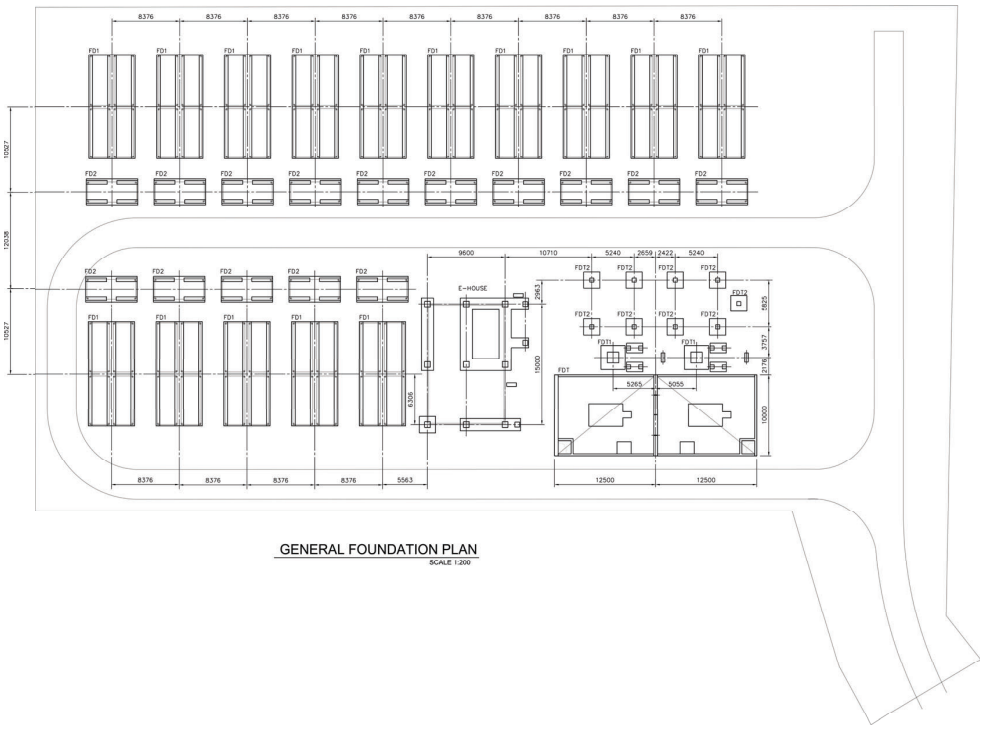
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NOTES:
1. FOR GENERAL NOTES, SEE DRAWING H376886-0000-231-260-0001
PRELIMINARY
NOT FOR CONSTRUCTION
GENERAL FOUNDATION PLAN
SCALE 1:200
NEWFOUNDLAND AND LABRADOR HYDRO PROJECT
HARDWOODS SITE
50 MW 8 HOURS BESS
GENERAL FOUNDATION PLAN
H376886-0000-231-260-0002
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DWG. No. H376866-0000-231-270-0020

NOTES :

1. FOR GENERAL NOTES SEE DRAWING H376866-0000-231-260-0001 (TO COME)



GENERAL FOUNDATION PLAN
SCALE 1:200

PRELIMINARY
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CHECKER			
DESIGN COORD.			
RESP. ENG.	J. SERRANO		
LEAD DISC. ENG.			
ENG. MANAGER			
PROJ. MANAGER			

DRAWING APPROVAL STATUS Preliminary

NEWFOUNDLAND AND LABRADOR HYDRO PROJECT

HARDWOODS SITE
50 MW 4 HOURS BESS
GENERAL FOUNDATION PLAN

SCALE	DWG. No.	REV
1:200 (OR AS NOTED)	H376866-0000-231-260-0020	B

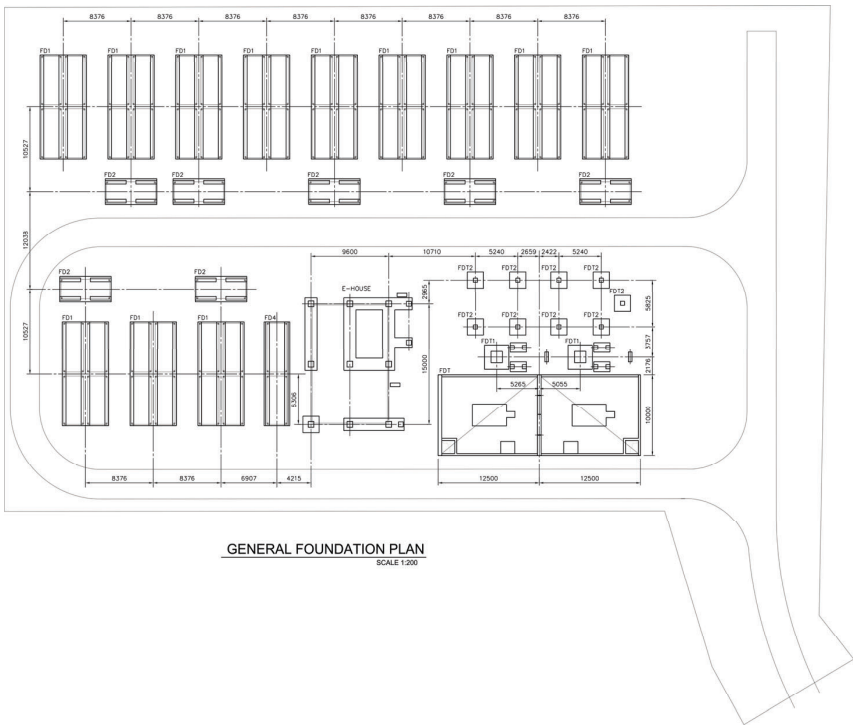
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DWG. No. H376866-0000-231-270-0021

NOTES :

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GENERAL FOUNDATION PLAN
SCALE 1:200

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NEWFOUNDLAND AND LABRADOR HYDRO PROJECT

HARDWOODS SITE
20 MW 8 HOURS BESS
GENERAL FOUNDATION PLAN

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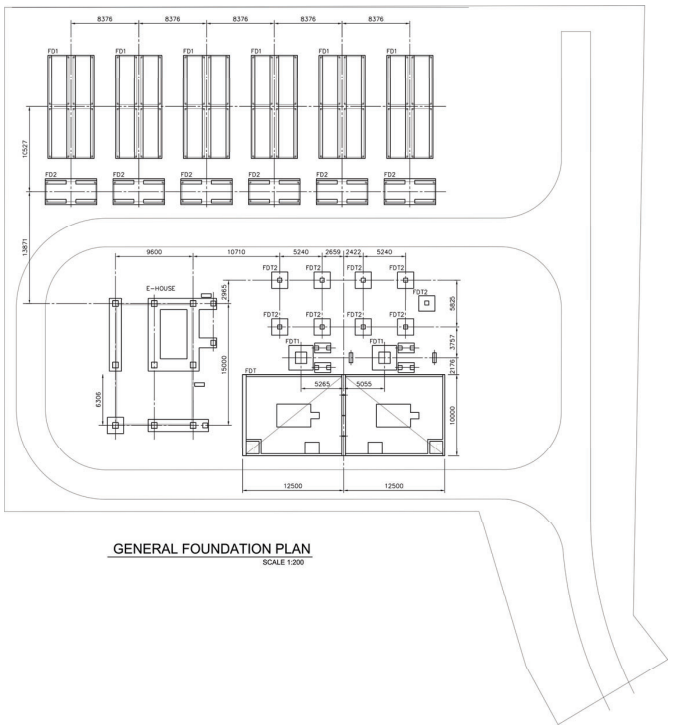
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DWG. No. H376866-0000-231-270-0022

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GENERAL FOUNDATION PLAN
SCALE 1:200

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REFERENCE DRAWINGS	

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SIGNATURE
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REVISION DATE
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ENG. MANAGER			
PROJ. MANAGER			

DRAWING APPROVAL STATUS Preliminary

newfoundland labrador hydro a nalcor energy company

NEWFOUNDLAND AND LABRADOR HYDRO PROJECT

HARDWOODS SITE
20 MW 4 HOURS BESS
GENERAL FOUNDATION PLAN

SCALE	DWG. No.	REV
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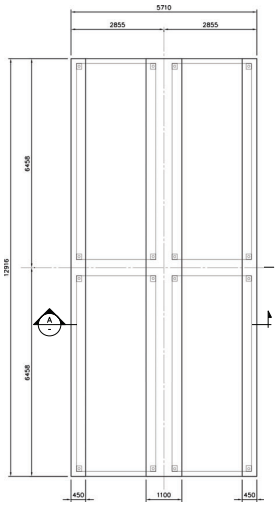
Appendix F
Hardwoods – BESS Containers Foundation Plan (Structural Drawings)

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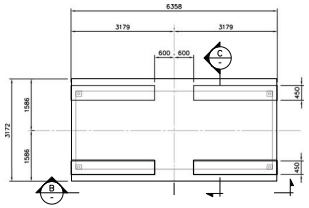
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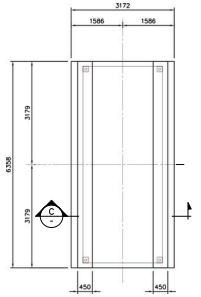
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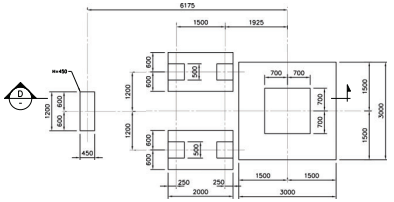
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SCALE 1:50



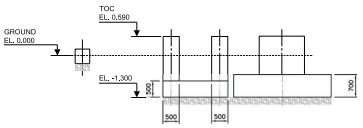
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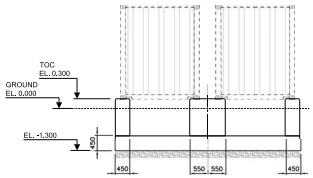
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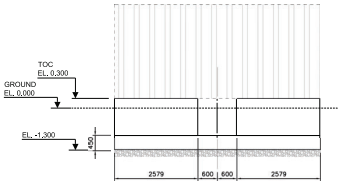
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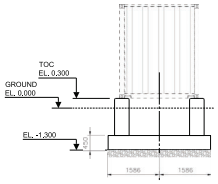
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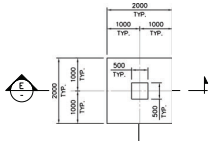
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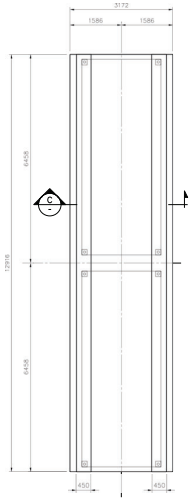
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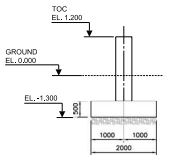
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FOUNDATION FD4 PLAN
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SECTION E
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NEWFOUNDLAND AND LABRADOR
HYDRO PROJECT

HARDWOODS SITE
50 MW 8 HOURS BESS
CONTAINERS FOUNDATION

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1:200	H376866-0000-231-260-0005	B
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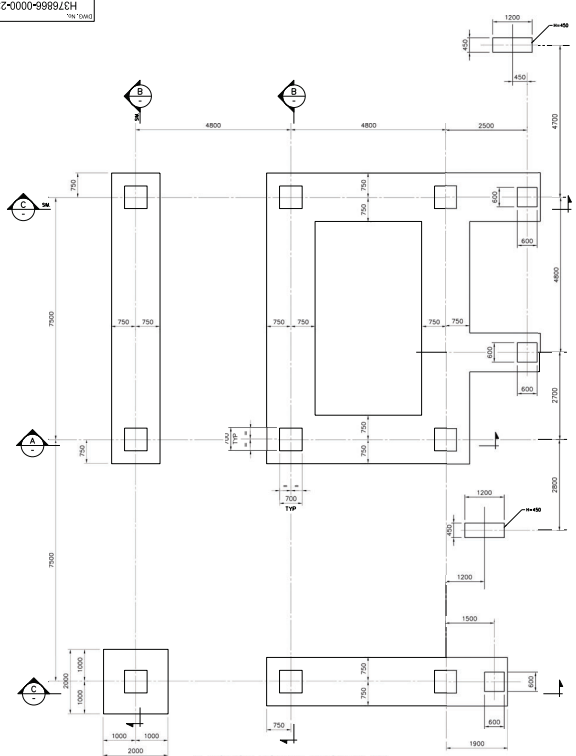
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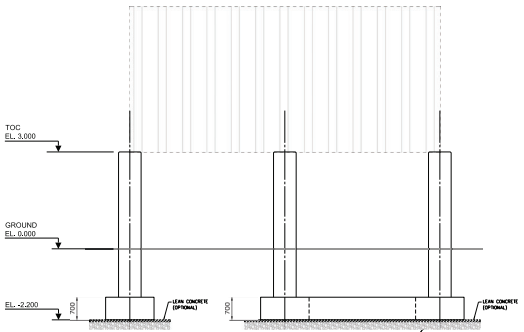
Appendix G
Hardwoods – BESS E-House Foundation Plan (Structural Drawings)

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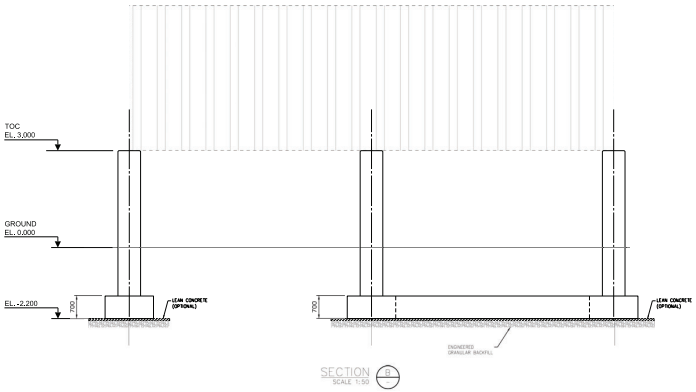
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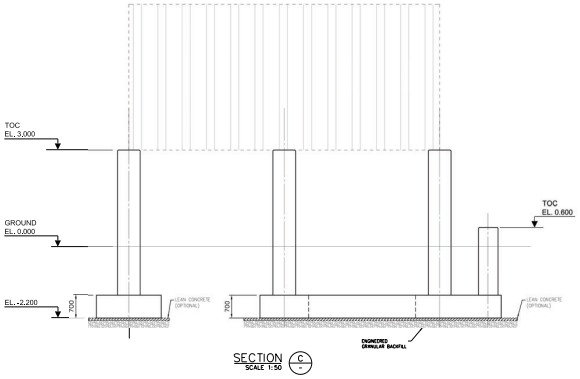
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SECTION A
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SECTION B
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SECTION C
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NEWFOUNDLAND AND LABRADOR HYDRO PROJECT

HARDWOODS SITE
50 MW 8 HOURS BESS
E-HOUSE FOUNDATION PLAN

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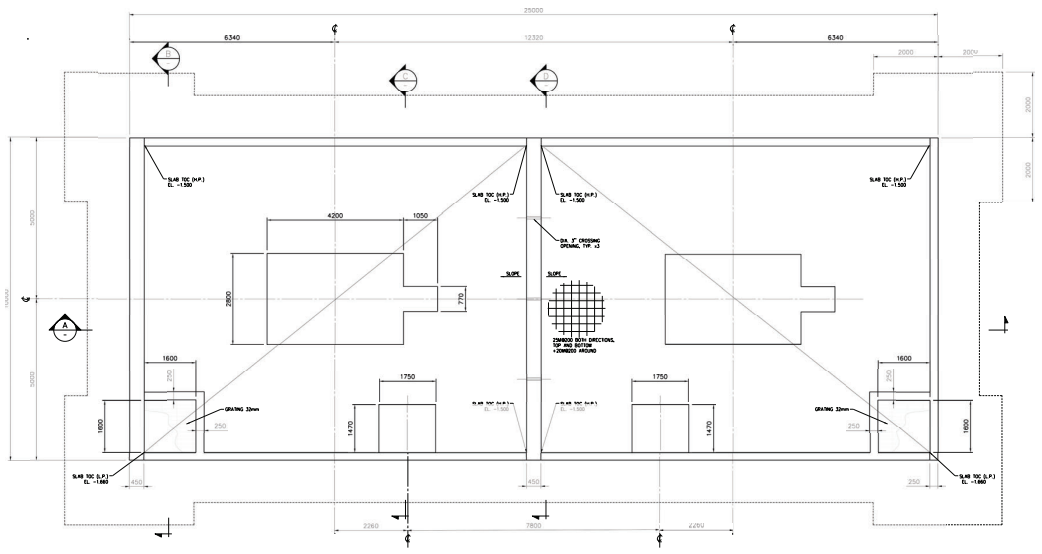
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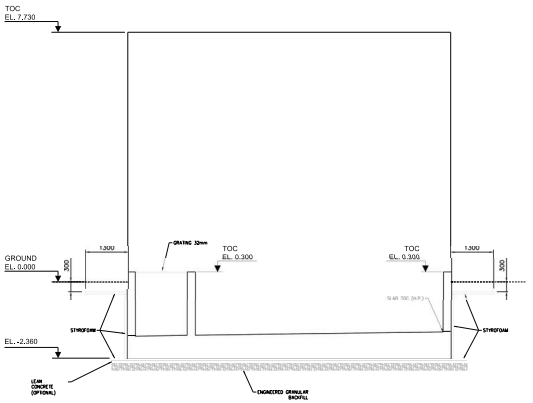
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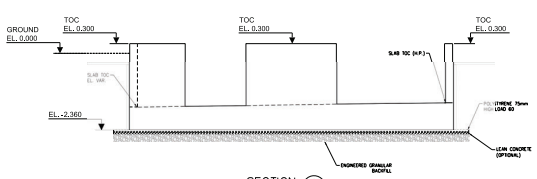
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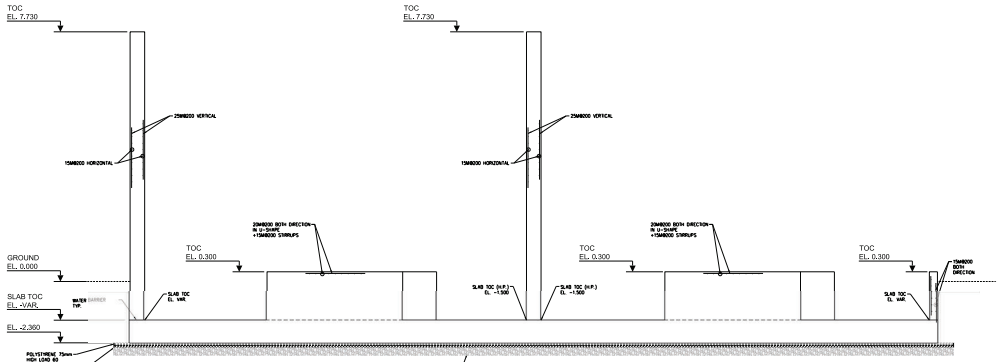
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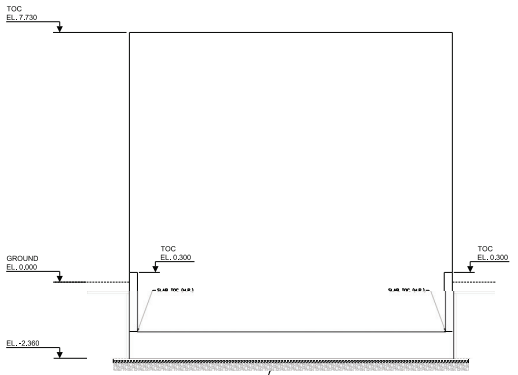
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SECTION A
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NEWFOUNDLAND AND LABRADOR HYDRO PROJECT

HARDWOODS SITE
50 MW 8 HOURS BESS
TRANSFORMERS FOUNDATION PLAN

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Appendix I

Site Assessment Report

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Contract Number and Description: Newfoundland and Labrador Hydro Battery	**Project Number:** H376866
Contractor Name: Hatch Ltd.	**Contractor Address:** 80 Hebron Way - Suite 100, St. John's Newfoundland and Labrador, Canada, A1A 0L9

Document Title: Site Assessment Report	**Total Number of Pages incl. Front Sheet:** 46
Contractor Document Number: H376866-0000-21D-066-0001	**Contractor Revision Number:** 0
Contractor Signature/Stamp: John William Albert Catton -- P.Eng. - EGBC. Digitally signed by John William Albert Catton -- P.Eng. - EGBC DN: cn=John William Albert Catton -- P.Eng. - EGBC, c=CA, o=CertifiO Pro, ou=EGBC - Engineers and Geoscientists of British Columbia Date: 2026.05.28 09:55:08 -07'00'	
NLH Document Number: SDYBESS-HAT-00000-EN-REP-0002-01	**NLH Revision Number:** B0
Document Date (DD-MMM-YYYY)**:** 16-Jan-2026	**Equipment Tag:**

Required Return Date (DD-MMM-YYYY)**:**	**Cost Variance:** Yes ☐ No ☐	**Schedule Variance:** Yes ☐ No ☐
Submission Comments: (if urgent submission, please indicate below. Add additional pages if required)		

REVIEW DOES NOT CONSTITUTE APPROVAL OF DESIGN DETAILS, CALCULATIONS, TEST METHODS, OR MATERIAL DEVELOPED AND/OR SELECTED BY THE CONTRACTOR, NOR DOES IT RELIEVE THE CONTRACTOR FROM FULL COMPLIANCE WITH CONTRACTUAL OR OTHER OBLIGATIONS.

- ☐ 01 **REVIEWED AND ACCEPTED – NO COMMENTS**
- ☐ 02 **REVIEWED – INCORPORATE COMMENTS, REVISE AND RESUBMIT**
- ☐ 03 **REVIEWED – NOT ACCEPTED**
- ☐ 04 **INFORMATION ONLY**
- ☐ 05 **NOT REVIEWED**

Lead Reviewer	Date (DD-MMM-YYYY)	Project Manager	Date (DD-MMM-YYYY)

General Comments:

Newfoundland and Labrador Hydro
Newfoundland and Labrador Hydro Battery
H376866

Engineering Report
Engineering Management
Site Assessment Report

Report

Site Assessment Report

H376866-0000-21D-066-0001

			Karen Perry.	Catton, John	Jl. Hiscock.
2025-01-16	0	Approved for Use	K. Perry	J. Catton	J. Hiscock
DATE	**REV.**	**STATUS**	**PREPARED BY**	**CHECKED BY**	**APPROVED BY**
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1. Executive Summary

Newfoundland and Labrador Hydro (NL Hydro) has identified the need for additional system capacity in the 2024 Reliability and Resource Adequacy Report and the 2024 NL System Operator Annual Planning Assessment. To support the next Resource Adequacy Plan (RAP), NL Hydro commissioned Hatch to conduct a comprehensive site assessment for a Battery Energy Storage System (BESS) on the Avalon Peninsula. The study evaluated five candidate sites:

1. Hardwoods Terminal Station (Hardwoods), Paradise (47°31'24.61"N 52°50'54.23"W) (Greenfield Site).
2. Hardwoods Terminal Station (Hardwoods), Paradise (47°31'27"N 52°50'47"W) (Brownfield Site).
3. Goulds Substation (Goulds), St. John's (47°29'07.1"N 52°45'54.0"W).
4. Virginia Waters Substation (Virgina Waters), St. John's (47°36'54.2"N 52°42'12.2"W).
5. Oxen Pond Terminal Station (Oxen Pond), St. John's (47°34'26.45"N 52°45'22.46"W).

The assessment considered BESS configurations of 20 MW and 50 MW with four- and eight-hour reserves, with the largest option requiring approximately 535.5 MWh and 105 battery units. Key evaluation factors included interconnection feasibility at 66 kV and 230 kV, site preparation requirements, zoning compliance, environmental sensitivity, and community impacts. Risks such as proximity to residential areas, wetlands, regulatory constraints, and schedule dependencies were also analyzed. Comparison of the sites were performed against different criteria including technical, environmental, social, and real estate.

Findings and Recommendations:

- Preferred Site: Hardwoods Greenfield offers the most favorable conditions, including sufficient land for a 50 MW/8-hour system, strong interconnection flexibility, and lower industrial tax rates;
- Second Option: Hardwoods Brownfield benefits from existing infrastructure but is constrained by the need to decommission the existing gas turbine plant, introducing timeline uncertainty;
- Third Option: Goulds provides good accessibility but requires significant civil work and coordination with Newfoundland Power;
- Virginia Waters and Oxen Pond were deemed less suitable due to higher environmental and social risks, including proximity to sensitive residential areas and complex permitting requirements.

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The report concludes that Hardwoods Greenfield should be prioritized for detailed feasibility and design studies, with Hardwoods Brownfield and Goulds as secondary options.

2. Introduction

Newfoundland and Labrador Hydro (NL Hydro) is the primary electricity supplier in the province, managing the generation, transmission, and distribution of electricity across Newfoundland and Labrador (NL).

To provide information for the next Resource Adequacy Plan (RAP), NL Hydro commissioned Hatch to complete a Battery Energy Storage System (BESS) Feasibility Study for four options for the Avalon Peninsula BESS:

1. 20 MW with a four-hour reserve.
2. 20 MW with an eight-hour reserve.
3. 50 MW with a four-hour reserve.
4. 50 MW with an eight-hour reserve.

As part of this work, Hatch performed a comprehensive site investigation to identify and assess both Brownfield and Greenfield locations suitable for the development of a BESS on the Avalon Peninsula. Each candidate site was evaluated for its capacity to accommodate a 50 MW BESS with an 8-hour energy reserve (the largest facility size in consideration), considering spatial requirements, topography, and constructability. The results of this assessment are detailed within this report, which evaluated the different sites on several criteria.

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3. Site Description

As part of the study, Hatch was required to complete a site investigation of four potential sites for the BESS. Four site visits were originally planned on November 17, 2025, to Hardwoods (two potential sites in this location), Goulds and Virginia Waters. However, during the day, it was decided that an additional visit to Oxen Pond Terminal Station would be beneficial. The reason that this additional site was included in the site visit and subsequent investigation was because NL Hydro, in consultation with Newfoundland (NF) Power, suggested it may be a viable location. The site maps for each of the sites are included in Appendix A and photos from the site visits are included in Appendix B.

The sites visited were located at:

1. Hardwoods Terminal Station (Hardwoods), Paradise (47°31'24.61"N 52°50'54.23"W) (Greenfield Site).
2. Hardwoods Terminal Station (Hardwoods), Paradise (47°31'27"N 52°50'47"W) (Brownfield Site).
3. Goulds Substation (Goulds), St. John's (47°29'07.1"N 52°45'54.0"W).
4. Virginia Waters Substation (Virgina Waters), St. John's (47°36'54.2"N 52°42'12.2"W).
5. Oxen Pond Terminal Station (Oxen Pond), St. John's (47°34'26.45"N 52°45'22.46"W) (additional site).

Hatch employees Karen Perry and Ian Walker, along with NL Hydro employees Crystal O'Dea and Paul Murphy completed the site visits. Employees from NF Power accompanied Hatch and NL Hydro at the Virginia Waters Substation visit.

The site visits were conducted to verify physical site conditions, assess interconnection feasibility, and identify potential constraints that could impact design and implementation. Observations made during the visit will inform the technical and economic analysis within the overall feasibility study, ensuring alignment with project objectives and regulatory requirements.

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3.1 Site 1, Hardwoods (Greenfield Site)

The Hardwoods Greenfield site (located at approximately 47°31'24.61"N 52°50'54.23"W) is situated just south-west of the existing Hardwoods Terminal Station in the community of Paradise, bordered by St. John's on the North and South. The area is adjacent to established transmission infrastructure, and NL Hydro currently operates a 230 kV terminal station at Hardwoods. The most practical connection point for this site would be through a direct tie-in to the existing 230 kV terminal station at Hardwoods, as its proximity allows for efficient integration without the need for significant new transmission infrastructure.

The site has multiple landowners, but the surrounding region includes mixed-use land with some industrial and undeveloped areas. Preliminary observations suggest minimal wetland presence, though a detailed environmental assessment would be required. The terrain is generally level, but clearing of vegetation and possible grading would be necessary. There are few overhead lines that may interfere with construction (i.e., wood pole relocations/ alignment), and the site benefits from good accessibility with existing road connections to major routes in St. John's connected via the Trans-Canada Highway. Commercial buildings are present within approximately 300 m of the proposed location. Refer to Figure 3-1 for a map of the site.

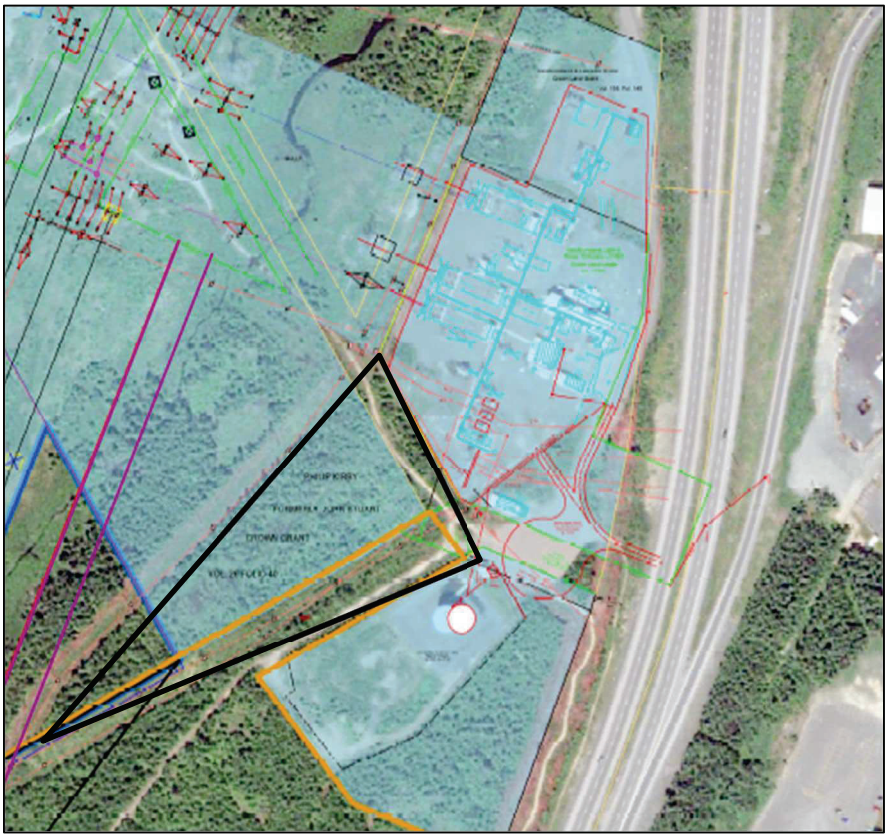


Figure 3-1: Map of Site (Greenfield)

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3.2 Site 2, Hardwoods (Brownfield Site)

The Hardwoods Gas Turbine Plant is located near St. John's, NL, in the community of Paradise, bordered by St. John's on the North and South. It is situated close to the Trans-Canada Highway (Route 1) and within the footprint of the Hardwoods Terminal Station, which is part of NL Hydro's transmission network. The approximate coordinates of the site are 47°31'27"N 52°50'47"W.

The Hardwoods Gas Turbine Plant is a 50 MW simple-cycle combustion turbine station within a terminal station featuring 66 kV and 230 kV equipment. In service since 1976, it primarily operates as a synchronous condenser but also provides peaking and emergency backup power. The 13.8 kV turbine output connects via an enclosed bus duct to a circuit breaker in the switchgear assembly.

Based on an assessment of the site, the Brownfield site would require the removal of the gas turbine and tank farm infrastructure prior to being able to construct the BESS. Additionally, portions of the existing parking lot would be needed to accommodate the required site footprint. The Brownfield location land is owned by NL Hydro and has easy access from the Trans-Canada Highway. If expansion is required, NL Hydro will need to acquire additional land outside the boundaries of the current station site. Refer to Figure 3-2 for a map of the site.

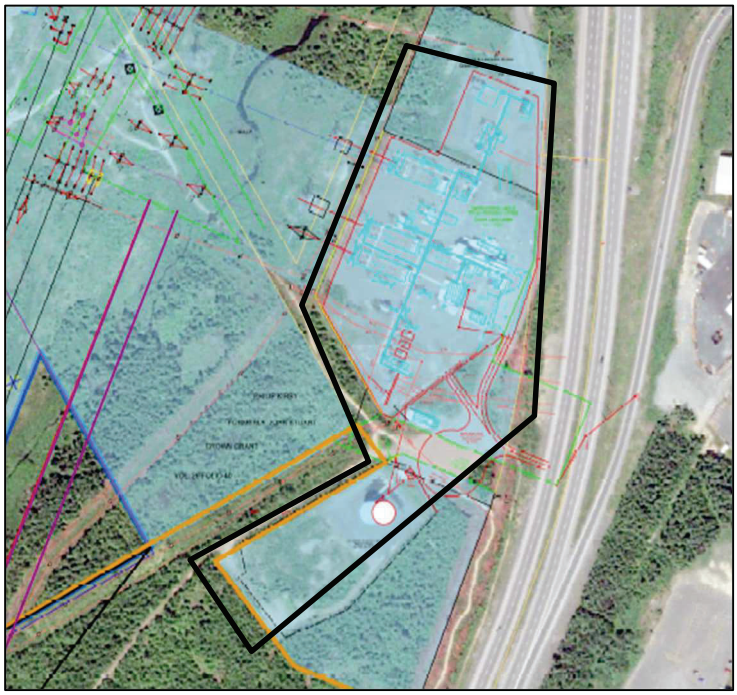


Figure 3-2: Map of Site (Brownfield)

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3.3 Site 3, Goulds (Greenfield Site)

The Goulds location (located at approximately 47°29'07.1"N 52°45'54.0"W) is off Main Road and behind an existing Newfoundland Power substation. In addition to the 66 kV Newfoundland Power substation, NL Hydro has discussed the potential for adding a 230 kV terminal station in the area. Therefore, the connection point could either be 66 kV or 230 kV depending on if the terminal station is developed.

During the assessment it could not be determined who owned the land, however in the region there is significant farmland. If this option was chosen, the next stage of work would require identification of ownership. There is evidence of some wetland areas, but further investigation would be required. The ground is level, but clearing, grubbing and backfill would be required. There are limited overhead lines that would impact installation. The site is easily accessible, and road access exists to the main road in the Goulds. The facility would be within 200 m of residential dwellings. The site map is shown in Figure 3-3,

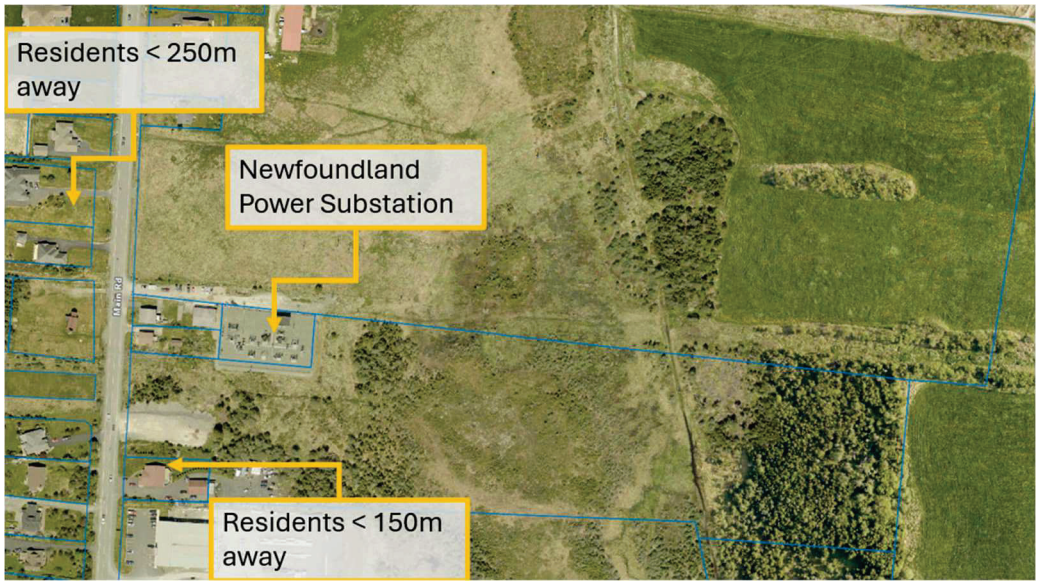


Figure 3-3: Map of Site 3, Goulds

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3.4 Site 4, Virgina Waters Substation (Greenfield Site)

The Virginia Waters substation (located at approximately 47°36'54.2"N 52°42'12.2"W) is in the east end of St. John's and is a 66 kV Newfoundland Power owned substation. The facility would be within 100 m of a residential dwelling. The site is easily accessible from the Trans-Canada Highway through Stavanger Drive.

The location showed evidence of trails and walking paths, and the property borders a residential property. The site is on an incline (~15-20 m elevation differential) and would take significant civil work to remove vegetation and level for installation of the BESS. Further to this, there are transmission lines over the area that will need to be removed for installation of the system. There are nearby protected wetlands but not within the existing land boundary. The site map is shown in Figure 3-4.

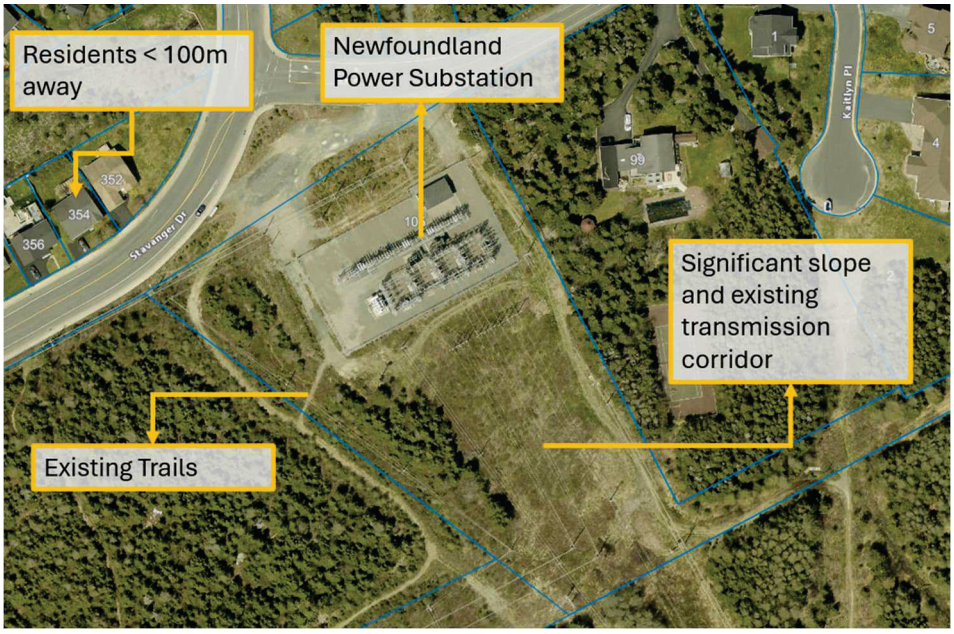


Figure 3-4: Map of Site 4, Virginia Waters

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3.5 Site 5, Oxen Pond (Greenfield Site)

The Oxen Pond terminal station (located at approximately 47°34'26.45"N 52°45'22.46"W) is an NL Hydro 230 kV terminal station with access from Mount Scio Road. The location would be within 100 m of a residential dwelling on the east side of the site. The site is easily accessible from Mount Scio Road and is close to the Trans-Canada Highway. There are transmission lines that run through the site that may need to be relocated.

The land that could be used for the installation of the BESS is uneven and would require ground leveling and vegetation removal. Further investigation is required to determine the land ownership of the area for the system. The site map is shown in Figure 3-5.

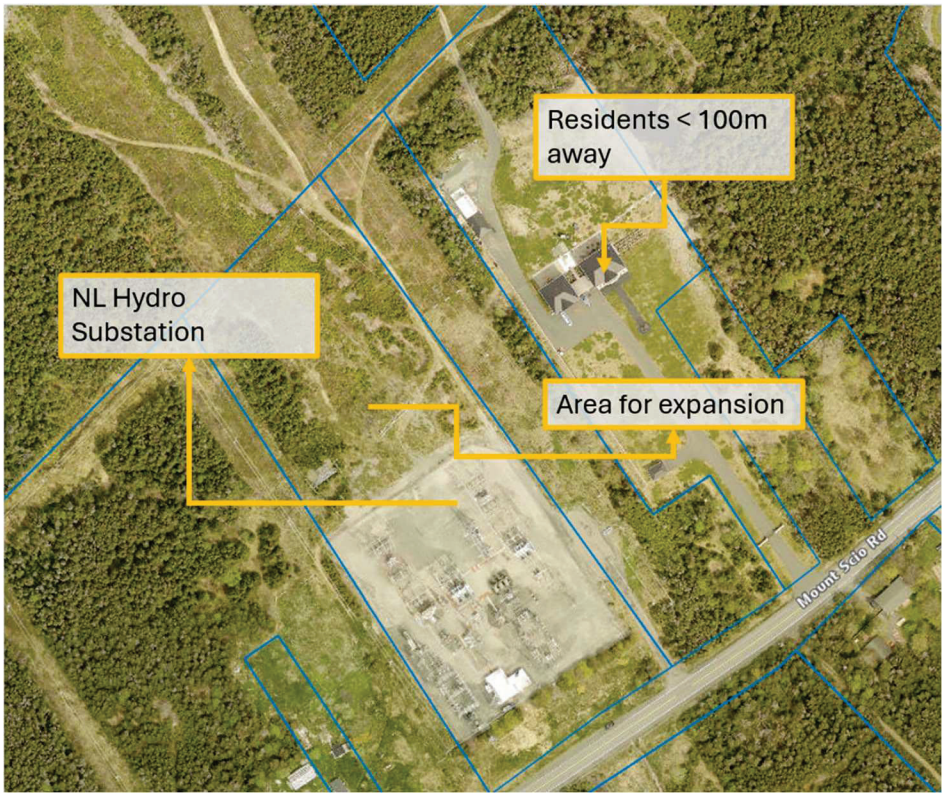


Figure 3-5: Map of Site 5, Oxen Pond

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4. Site Assessment Process

4.1 Objective

The primary objective of this assessment is to identify and select the most suitable site for the proposed project. In addition, the assessment seeks to evaluate technical feasibility, identify environmental and social risks, and highlight potential constraints that could affect project implementation. By addressing these objectives, the assessment provides a basis for informed decision-making and risk mitigation throughout the planning process.

4.2 Methodology

The site assessment was conducted using a structured approach to evaluate technical, environmental, and social factors influencing project feasibility for placement of the BESS. The methodology combined on-site inspections, data collection, and review of existing documentation. Key parameters such as site layout, infrastructure condition, accessibility, and regulatory compliance were analyzed. Environmental considerations included land use, biodiversity, water resources, and potential impacts on air quality. Social aspects focused on community proximity, stakeholder interests, and safety. This approach ensures that all relevant factors are assessed consistently, providing a clear basis for informed decision-making and enabling the selection of the most appropriate site.

4.3 Selection Criteria

Site selection criteria establish a systematic framework for assessing potential BESS locations. They encompass technical, commercial, environmental, and safety considerations to ensure compliance with project requirements and long-term reliability. Each criterion addresses factors such as interconnection feasibility, site preparation, regulatory compliance, and community impacts.

Sites were assessed against six major categories, each containing specific sub-criteria, as listed in Table 4-1.

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Table 4-1: Selection Criteria Categories and Sub-Criteria

Category	Sub-Criterion
General Site Analysis	Grid hosting capacity
	Connection point
	Maintenance and NLH access
	DERMS/SCADA integration capability
Electrical Integration	Connection voltage
	Transmission line length
	Routing considerations
Site Preparation	Land area available
	Grading and clearing requirements
	Expandability for additional BESS capacity
	Flooding
	Site preparation cost estimates
Real Estate Considerations	Lease and property tax costs
	Zoning compliance
Community & Environmental Risks	Noise considerations
	Distance to nearest neighbors
	Environmental permitting (wetlands, protected species)
	Impact on neighboring communities (visual, traffic, etc.)
	Protected areas or species nearby
	Air quality and emissions permitting
Safety and Security	Fire safety access and hydrant availability
	Emergency response time

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4.4 Data Sources Utilized

The site selection process incorporated a range of authoritative data sources to ensure a thorough evaluation of each location. Information was provided by the client for each of the sites. Hatch also relied on its experience with the Newfoundland transmission system, and public information. All of these sources were leveraged to determine the necessary information for site suitability. Key sources included:

- First Nation Profiles Interactive Map – Used to identify Indigenous land considerations and ensure compliance with cultural and legal requirements. [Link: First Nation profiles interactive map];
- Land Use Details – Provided zoning information and development constraints for each potential site. [Link: ArcGIS Web Application];
- Flood Hazard V2 – Assessed flood risk and potential water-related hazards impacting site suitability. [Link: Flood Hazard V2];
- Simplified Seismic Hazard Map for Canada, the Provinces and Territories – Evaluated seismic risk and structural resilience requirements. [Link: Simplified seismic hazard map for Canada, the provinces and territories];
- St. John's Map Viewer – Offered detailed municipal mapping for infrastructure, access routes, zoning, hydrant placement, and surrounding land use. [Link: St. John's Map Viewer];
- Taxation – City of St. John's – Reviewed property tax implications and municipal cost factors. [Link: Taxation - City of St Johns];
- 2025 Schedule of Taxes & Rates – Used to estimate ongoing operational costs and financial feasibility for each location. [Link: 2025 Schedule of Taxes & Rates Updated (1).pdf].

4.5 Screening Process and Scoring

A preliminary screening was conducted to compare potential sites using a simplified evaluation framework. Each site was assessed against key technical, environmental, and social criteria identified during the initial planning phase. The purpose of this screening was to quickly highlight strengths and weaknesses, enabling efficient shortlisting for detailed assessment.

The scoring system applied an action threshold matrix approach to indicate relative suitability:

- Green: Criteria fully met or present minimal risk; site considered highly suitable;
- Yellow: Criteria partially met or moderate risk identified; criterion requires further review;
- Red: Criteria not met or significant risk present; criterion posed a significant risk to site suitability and would require mitigation.

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This qualitative scoring method provided a clear visual representation of site performance across multiple dimensions, supporting transparent and rapid decision-making during the early selection stage.

The final Evaluation Matrix can be found in Appendix C.

5. Environmental and Social Impact Assessment

As part of the site investigation, Hatch completed a preliminary assessment of relevant environmental and social study aspects for each site.

5.1 Site 1, Hardwoods (Greenfield Site)

Hardwoods (Greenfield) is surrounded by heavy industrial activities. As such, it is zoned by the Town of Paradise as “Industrial General”. Under the Paradise Development Regulations, “Hazardous Industry”, which is likely what the BESS would be considered, is a discretionary use. There are several trails running through the site that are likely indicators of some public use, though no public use was observed during the site visit. There is also a school in the area that may cause some public concern for the location, though electrical equipment has been on the site which predates the school. The site’s baseline noise level is quite high with the surrounding industry and the adjacent highway and roads.

The site will encroach on delineated wetlands, which will require additional permitting and design considerations. There were no Species of Conservation Concern (SOCC) identified on the site visit; however, they are possibly present considering the footprint includes relatively mature trees, shrubs, and the mentioned wetland. It would be recommended to submit a request from the Atlantic Canada Conservation Data Centre (AC CDC) to identify historical observations of SOCC once a site has been selected.

5.2 Site 2, Hardwoods (Brownfield Site)

Hardwoods (Brownfield) is a well-established site that is also surrounded by heavy industrial activities. As such, it is zoned by the Town of Paradise as “Industrial General”. Under the Paradise Development Regulations, “Hazardous Industry”, which is likely what the BESS would be considered, is a discretionary use. The Brownfield site includes an existing diesel storage tank, combustion turbines, and related equipment and therefore has no existing public use. There is also a school in the area that may cause some public concern for the location, though electrical equipment has been on the site which predates the school. The site’s baseline noise level is quite high with the surrounding industry and the adjacent highway and roads.

The site is free from delineated wetlands and has little vegetation. There were no SOCC identified on the site visit, and due to the industrial nature, it is reasonably unlikely to find significant SOCC. It is still recommended to submit a request from the AC CDC to identify historical observations of SOCC once a site has been selected.

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5.3 Site 3, Goulds (Greenfield Site)

The Goulds is surrounded by light commercial activities such as an existing Newfoundland Power substation, an alternator repair shop, and agricultural land. It is zoned by the City of St. John's as "Rural". Under the St. John's Development Regulations, "Public Utility", which is likely what the BESS would be considered, is a permitted use. There were ATV tracks observed around the existing substation that is an indicator of some public use, though no public use was observed during the site visit. The site's baseline noise level is moderate with the surrounding businesses and the adjacent road.

The site will encroach on delineated wetlands, which will require additional permitting and design considerations. There were no SOCC identified on the site visit, however it is possible considering the footprint includes relatively mature trees, shrubs, and the mentioned wetland. It would be recommended to submit a request from the AC CDC to identify historical observations of SOCC once a site has been selected.

5.4 Site 4, Virgina Waters Substation (Greenfield Site)

Virginia Waters is surrounded by residential properties and an existing Newfoundland Power substation. It is zoned by the City of St. John's as "Open Space". Under the St. John's Development Regulations, "Public Utility", which is likely what the BESS would be considered, is a permitted use. There are several trails running through the site that are a likely indicator of public use, though no public use was observed during the site visit. The site's baseline noise level is moderate with the Trans-Canada Highway and adjacent road, however because of the residential nature of the area increased noise would likely be of concern.

The site is free of delineated wetlands, however there are relatively mature trees and shrubs throughout the site. There were no SOCC identified on the site visit, but there is an artificial nesting platform maintained by Newfoundland Power for osprey which is occupied during the breeding bird season. This nesting platform includes a live feed camera which is open to the public for viewing online. The continual presence of osprey, the relatively mature trees, and shrubs suggest that it is possible that SOCC may be found in the area. It would be recommended to submit a request from the AC CDC to identify historical observations of SOCC once a site has been selected.

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5.5 Site 5, Oxen Pond (Greenfield Site)

Oxen Pond is surrounded by residential properties, Pippy Park, Memorial Universities Botanical Gardens, and the existing NL Hydro terminal station. It is zoned by the City of St. John's as "C.A. Pippy Park Zone". Under the St. John's Development Regulations, any development within the C.A. Pippy Park Zone is to be determined by the C.A. Pippy Park Commissions. The Commission was established under the *Pippy Park Commission Act* and was created to maintain a land bank for the development of institutions in a connected parkland setting, to provide recreational opportunities for residents, and to protect and conserve natural habitats and features. There is evidence of public use on the trails which cross the site that connect with other trails in the park. The site's baseline noise level is relatively low mainly from road traffic on Mount Scio Road. The site would be relatively sensitive to noise because of the residential properties and surrounding park.

The site is free of delineated wetlands, however there are mature trees and shrubs which are connected to the larger park throughout the site. There were no SOCC identified on the site visit, but the presence of the surrounding park, the relatively mature trees, and shrubs suggest that it is possible that SOCC may be found in the area. It would be recommended to submit a request from AC CDC to identify historical observations of SOCC once a site has been selected.

6. BESS Sizing

NL Hydro is considering the following options for the Avalon Peninsula BESS.

1. 20 MW with a four-hour reserve.
2. 20 MW with an eight-hour reserve.
3. 50 MW with a four-hour reserve.
4. 50 MW with an eight-hour reserve.

The BESS sizing for each option is summarized in Table 6-1 below.

Table 6-1: BESS Sizing for Four Capacity and Duration Options.

Case	Capacity (MW)	Duration (h)	Beginning of Life (BOL) Nameplate Capacity (Total) (MWh)	Number of Batteries
1	20	4	122.40	24
2	20	8	214.20	42
3	50	4	306.00	60
4	50	8	535.50	105

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The battery sizing is based on the following assumptions:

- The line losses between the BESS and the Point of Interconnection as well as the Auxiliary Load losses are based on industry standards;
- A 5.1 MWh battery is used as the base BESS technology for sizing;
- The Power Conversion System Medium Voltage Transformer skid (PCS-MVT skid) size will be 4000 kVA;
- The battery sizes account for a five-year “overbuild” of the system to compensate for the first several years of degradation, however, BESS containers for each PCS-MVT skid needed to be sized appropriately for each sizing (as an example, for the four-hour system, for every one PCS-MVT unit, four containers are required to be installed, and for the eight-hour system, there is a ratio of one to seven). This has resulted in a larger overbuild to match PCS-MVT skids to container sizes.

In addition to sizing the Beginning of Life (BOL) Nameplate Capacity, a preliminary augmentation plan was developed for each case. Assuming a BESS lifecycle of about 20 years, the augmentation plan for each case is as follows:

- For Case 1, augmentation will not be required due to the initial overbuild and the required ratios for PCS containers to BESS containers;
- For Case 2, seven batteries (5.1 MWh each, 35.7 MWh installed augmentation amount) will be added at Year 7;
- For Case 3, augmentation will not be required due to the initial overbuild and the required ratios for PCS containers to BESS containers;
- For Case 4, seven batteries will be added at Year 7, and an additional seven batteries will be added at Year 13.

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7. Evaluation and Criteria Findings

This section summarizes the findings of the evaluation process for the Site Selection Assessment. Highlights for each of the sites for the Site Criteria Categories are discussed along with notable risks and constraints.

7.1 Site 1, Hardwoods (Greenfield Site)

7.1.1 Electrical Evaluation

Hardwoods Terminal Station (Hardwoods) is the western end of the existing Hardwoods – Oxen Pond Loop which supplies the St. John's metro area, Paradise, Conception Bay South and Southern Shore. The station consists of three 230 kV transmission line terminations on a 230 kV load bus arrangement with a 230 kV bus tie circuit breaker, four 230/66 kV transformers (T1 to T4), a 66 kV load bus with a bus tie circuit breaker, two 66 kV shunt capacitor banks (C1 and C2), a nominal 50 MW aeroderivative combustion turbine, and two 66 kV box type structures at opposite ends of the 66 kV main buses. The box structures at each end of the 66 kV bus are the delivery points to Newfoundland Power 66 kV transmission network.

Both the 66 kV and 230 kV transmission systems appear to have sufficient capacity to host a BESS in the 20 to 50 MW capacity range based on the thermal capacities of the 66 kV and 230 kV transmission lines. Additional steady state load flow studies are required to confirm actual capacity

Connection of the BESS can be achieved at the 230 kV voltage level with the installation of a 230 kV breaker bay (2 x 230 kV motor operated disconnect switches and 20 kV power circuit breaker) in line with the 230/66 kV transformer T4. The connection of the BESS will require a 230 kV line that must cross over two existing 230 kV transmission lines. It is noted that the empty circuit breaker bay has historically been designated as the location for a new 230 kV transmission line for future expansion of the Hardwoods – Oxen Pond Loop to include two new 230/66 kV infeed stations (one in the east and one in the west). The Greenfield site will require approximately 300 m of new 230 kV steel heavy angle structures. The Brownfield site will require approximately 400 m of new 230 kV steel heavy angle structures.

Connection of the BESS can be achieved at the 66 kV voltage level through repurpose of the existing 66 kV circuit breaker bay for T5 and the combustion turbine, or installation of a new 66 kV circuit breaker bay in the historical location for T6 and second nominal 50 MW combustion turbine (located opposite the T4 and T3 66 kV terminations to the main 66 kV bus. The 66 kV connection may be achieved using single wood pole 66 kV transmission and potentially 66 kV Teck cable. The transmission path is between approximately 270 and 300 m depending on the 66 kV actual breaker bay being considered.

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Of note is the installed 230/66 kV transformer capacity. Historically, the determination of 230/66 kV transformer capacity additions in the Hardwoods – Oxen Pond Loop considers the ability to supply the total peak load forecast of Newfoundland Power for the region with the largest 230/66 kV transformer (at present a 250 MVA unit at Oxen Pond) out of service and the Hardwoods combustion turbine operating at 50 MW. Interconnecting the proposed BESS to the 230 kV bus at Hardwoods will have a potential negative impact on transformer capacity addition in the Hardwoods – Oxen Pond Loop. However, connecting the proposed BESS to the 66 kV side of the Hardwoods station will positively impact the transformer capacity addition decisions.

From a transmission interconnection perspective, Hatch recommends the 66 kV point of interconnection.

7.1.2 Site Preparation Evaluation

The land required for the installation of the BESS would have to be acquired by NL Hydro; an approximate 1.5 hectares would be necessary. There is a site located to the southwest of the existing terminal station that would provide the space needed.

This site exhibits a flat terrain with gentle 1.2% sloping up towards the southeast, which provides favorable conditions for construction and minimizes extensive grading requirements. The natural slope facilitates surface water runoff in the direction of the adjacent stream located further west, offering an opportunity for efficient stormwater management through controlled discharge. Capturing runoff with a ditch on the south and grading the site following the natural slope to achieve surface drainage will help prevent water pooling and ensure proper site drainage. Elevation changes across the site are minimal, reducing the need for significant cut-and-fill operations and supporting cost-effective site preparation.

Site preparation will begin with relocation of approximately 300 meters of 66 kV transmission lines. Clearing and grubbing approximately 1.5 hectares of wooded area to remove all existing vegetation, organic matter, and root systems will be required as well. Following clearing, topsoil will be stripped to expose competent subgrade for structural loads. Stripped material may be stockpiled for potential reuse in erosion control measures. “Engineered fill” would then be placed to reach the finished grade. Due to proximity to the floodplain, erosion protection measures must be considered on the western side of the site.

At present there is no geotechnical report available, and this gap will have to be addressed at a future stage.

The site benefits from access to Kenmount Road and the Trans-Canada Highway from the existing terminal access road, which facilitates efficient transportation of construction material and equipment. Additionally, the available land within the property provides adequate laydown areas for temporary storage, staging equipment, and assembly operations.

Finally, a 600-meter-long fence line will be required to secure the area.

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7.1.3 Real Estate Considerations

The Hardwoods site is located in Paradise, NL. Paradise has lower industrial tax rates than neighboring St. John's. However, there are multiple landowners in the area which would require NL Hydro to either enter long term lease arrangements or purchase from private landowners.

The property is zoned Industrial General in the Township of Paradise and is likely classified as a Hazardous Industry, which is a discretionary use requiring Council approval; however, no zoning changes are needed.

7.1.4 Community and Environmental Risk

The Hardwoods (Greenfield) site is in an industrial area with few neighbors close by, though there is a school not too far away. There were no SOCC observed or likely to be present due to the industrial nature of the area. There are delineated wetlands present which would require additional permitting and design considerations. There is some evidence of public use. The site presents a relatively low risk from a community and environment perspective.

7.1.5 Safety and Risk Evaluation

The site has fire suppression onsite with an established water hydrant connection, which supports rapid firefighting operations and simplifies hose lay and water supply logistics. The nearest responding station is the Mount Pearl Fire Station at 2 Olympic Drive in Mount Pearl The distance is approximately 4.8 kilometers with an estimated response time of five to eight minutes. As a Greenfield location, fire safety access will need to be incorporated into the design; however, this is not considered an issue and does not eliminate the site from selection.

7.2 Site 2, Hardwoods (Brownfield Site)

7.2.1 Electrical Evaluation

Please refer to the description in Section 7.1.1. The site will have similar electrical considerations to those identified for the Hardwoods Greenfield Site.

7.2.2 Site Preparation Evaluation

As an existing terminal station, site preparation involves demolition and removal of equipment and infrastructure, including the gas turbine and fuel tank. There is a risk of encountering contaminated soils that would require remediation, especially in the fuel tank area. There will be clearing and grubbing of a smaller area, around 0.5 hectares, to the southwest of the fuel storage area.

This site, as mentioned in Section 7.1.2, already benefits from an access road from Kenmount Road and the Trans-Canada Highway.

Drainage can be managed through existing measures and additional channels for the expanded area, conveying runoff towards the stream at the west. Flooding risk is low.

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Land acquisition required to accommodate expansion, especially in the case of the higher capacity BESS configurations.

7.2.3 Real Estate Considerations

The Hardwoods site is located in Paradise, NL. Paradise has lower industrial tax rates then neighboring St. John's. However, there are multiple landowners in the area which would require NL Hydro to either enter long term lease arrangements or purchase from private landowners.

Zoned in township of Paradise for Industrial General. Likely considered a Hazardous Industry which is a discretionary use requiring Council approval, but no changes to zoning.

7.2.4 Community and Environmental Risk

The Hardwoods (Brownfield) site is within an industrial footprint with few neighbors close by, though there is a school not too far away. There were no SOCC observed or likely to be present due to the industrial nature of the area. There are no delineated wetlands present, and no public use identified. The site presents a relatively low risk from a community and environment perspective.

7.2.5 Safety and Risk Evaluation

The site is supported by fire suppression onsite and an existing water hydrant connection, enabling quick water access and streamlined incident control for first responders. Primary coverage is from the Mount Pearl Fire Station at 2 Olympic Drive in Mount Pearl. The distance is approximately 4.8 kilometers with an estimated response time of five to eight minutes. The combination of onsite suppression and hydrant connectivity reduces initial attack times and supports continuous flow for extended operations, improving risk mitigation for facility and personnel.

7.3 Site 3, Goulds (Greenfield Site)

7.3.1 Electrical Evaluation

The Goulds Substation (Goulds) is owned and operated by Newfoundland Power. It is the connection point in the west end of the St. John's region that connects the Southern Shore, downtown St. John's and Mount Pearl to Hardwoods. The station contains five 66 kV transmission lines. The station layout has utilized all sides of the existing 66 kV bus and box structures. The western end of the station is utilized for 66/12.5 kV transformation and distribution feeders. The eastern end is utilized for transmission line terminations with no empty face on the 66 kV box structure for an additional 66 kV line termination. Connection to Goulds directly will require expansion of the station to the east and re-termination of one existing 66 kV line. Alternatively, routing an existing Newfoundland Power 66 kV line in and out of the new BESS station may be more practical. The 66 kV line built for the BESS at Goulds is estimated to be between 150 and 200 m in length.

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Given that Goulds is a Newfoundland Power asset, a new fiber optic communications path and RTU for connection to the NL Hydro Energy Control Center (ECC) must be sourced.

As the NL Hydro BESS will be connected to Newfoundland Power assets, the site will require the addition of import/export revenue class metering to account for charging/discharging energy as part of billing exercises between the two utilities.

7.3.2 Site Preparation Evaluation

The site exhibits a flat terrain with an approximate 1% sloping towards the east, which provides favorable conditions for construction and minimizes extensive grading requirements. The natural slope facilitates surface water runoff in the direction of the adjacent ditch located further east, offering an opportunity for efficient stormwater management through controlled discharge. Elevation changes across the site are minimal, reducing the need for significant cut-and-fill operations and supporting cost-effective site preparation.

Site preparation will begin with clearing and grubbing a 1.5-hectare plot, including 0.7 hectares of wooded area, to remove all existing vegetation, organic matter, and root systems. Following clearing, topsoil will be stripped to expose competent subgrade for structural loads. Stripped material may be stockpiled for potential reuse in erosion control measures. Engineered fill would be then placed to reach the finished grade.

At present there is no geotechnical report available, and this gap will have to be addressed at a future stage.

The site benefits from access to NL Route 10 with a 30-meter extension to the existing terminal station access road. Additionally, the available land within the property provides adequate laydown areas for temporary storage, staging equipment, and assembly operations.

The required fence for this site will likely span between 500 and 600 meters.

7.3.3 Real Estate Considerations

Zoned in St. John's for Rural. Likely considered a Public Utility which would be permitted use.

7.3.4 Community and Environmental Risk

The Goulds site is near a light commercial area with a mix of land use around it. There were no SOCC observed but it was possible to be present due to the nature of the area. There are delineated wetlands present which would require additional permitting and design considerations. There is evidence of some public use. The site presents a relatively moderate risk from a community and environment perspective.

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7.3.5 Safety and Risk Evaluation

The nearest hydrant is located on Main Road opposite number 264 approximately one kilometer from the site. A new hydrant will need to be installed at the site to ensure direct water supply and reduce hose lay distances. Emergency coverage is provided by the Goulds Fire Station at 550 Main Road in Goulds. The distance is approximately 6.4 kilometers with an estimated response time of six to eight minutes. As a Greenfield location, fire safety access will need to be incorporated into the design; however, this is not considered an issue and does not eliminate the site from selection. Until a site hydrant is installed, preplans should include water shuttle and temporary supply tactics to maintain adequate fire flow for initial and sustained operations.

7.4 Site 4, Virgina Waters Substation (Greenfield Site)

7.4.1 Electrical Evaluation

The Virginia Waters Substation is owned and operated by Newfoundland Power. It is a primary connection point between Oxen Pond Terminal Station and the east end of the region. The station connects four Newfoundland Power 66 kV transmission lines. The empty site adjacent to Virginia Waters along the Outer Ring Road has long been the proposed location for a new 230/66 kV infeed in the east end referred to as Snow's Road. Locating a nominal 50 MW BESS near Virginia Waters will utilize the space allocated for the future 230/66 kV infeed station.

The thermal ratings of the existing Newfoundland Power 66 kV transmission lines appear to provide ample capacity for the proposed BESS interconnection. A detailed load flow analysis will be required to confirm.

Connection to the existing 66 kV bus will require a new 66 kV circuit breaker bay. Alternatively, re-routing an existing 66 kV transmission line from Oxen Pond to Virgina Waters in and out of the new BESS is also a viable option. The new 66 kV transmission build is estimated at 100 m in length.

Given that Virginia Waters is a Newfoundland Power asset, a new fiber optic communications path and RTU for connection to the NL Hydro ECC must be sourced.

As the NL Hydro BESS will be connected to Newfoundland Power assets, the site will require the addition of import/export revenue class metering to account for charging/discharging energy as part of billing exercises between the two utilities.

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7.4.2 Site Preparation Evaluation

The land available within the existing station is not sufficient to house the BESS. The proposed site would be in the adjacent land to the east. This site has a steeper average slope, ranging between 2 and 2.5%, with a sharp drop towards the south. It is a wooded area, which requires approximately 2 hectares clearing and grubbing.

At present there is no geotechnical report available, and this gap will have to be addressed at a future stage.

There is an existing access road off Stavanger Road, which would require extending approximately 40 meters to the site.

The existing slope favors adequate drainage, grading the site to convey stormwater towards the south and an existing channel on the side of the Trans-Canada Highway. There is a low risk of flooding.

A fenceline of approximately 600 m is required for securing the site.

7.4.3 Real Estate Considerations

Zoned in St. John's for Open Space. Likely considered a Public Utility which is a permitted use requiring Council approval, but no changes to zoning.

7.4.4 Community and Environmental Risk

The Virginia Waters site is around a residential area with several residential properties in the area. There were no SOCC observed but an established artificial nest platform is present where Osprey nest during the breeding bird season. There are no delineated wetlands, but there is evidence of public use on the trails. The site presents a relatively high risk from a community and environment perspective.

7.4.5 Safety and Risk Evaluation

Hydrant coverage is strong with nearest hydrants at 352 and 366 Stavanger Drive at approximately one hundred meters, enabling short hose lays and reliable municipal water access. The first due station is the St John’s Regional Fire Department Central Fire Station at 45 Central Street in St John’s. The distance is approximately three to four kilometers with an estimated response time of five to seven minutes. As a Greenfield location, fire safety access will need to be incorporated into the design; however, this is not considered an issue and does not eliminate the site from selection. Close hydrant spacing and short response times support rapid containment and continuity of operations for the substation environment.

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7.5 Site 5, Oxen Pond (Greenfield Site)

7.5.1 Electrical Evaluation

The Oxen Pond Terminal Station (Oxen Pond) is the eastern infeed location for the existing Hardwoods – Oxen Pond Loop. The site is space constrained. It consists of two 230 kV line terminations, three 230/66 kV power transformers (T1 to T3), and two 66 kV shunt capacitor banks (C1 and C2). The main 66 kV bus includes a 66 kV bus tie circuit breaker. The 66 kV side of the station is very congested with the two 66 kV delivery points to Newfoundland Power being 66 kV box structures directly in front of the main 66 kV bus work. Access to the 66 kV bus is further impeded by the location of the station control building, which is situated between the two Newfoundland Power box structures. Connection of the proposed BESS to the 66 kV bus is difficult.

Connection to the 230 kV bus is possible with the addition of a new 230 kV circuit breaker bay opposite the existing 230/66 kV T1 transformer connection to the main 230 kV bus. The 230 kV connection line may cross over one of the existing 230 kV transmission lines. The line length is estimated to be approximately 240 m. Given space limitations at site, 230 kV expansion would be along the existing 230 kV right of way. This complicates the BESS location and potential requirement to re-route the existing 230 kV lines.

As noted in the evaluation of the Hardwoods site, a 230 kV BESS connection at Oxen Pond results in the same impact on 230/66 kV transformer capacity in the Hardwoods-Oxen Pond Loop.

7.5.2 Site Preparation Evaluation

The available land within NL Hydro's property is not sufficient for the proposed BESS installation. An additional 8,000 m^2 of land would be required, with the risk of encroaching on park grounds.

The topography varies through the site from gentle sloping on the south to a steep 7.5% slope on the north. This site would require greater cut-and-fill operations and would possibly need retaining structures to protect neighboring properties.

From a drainage perspective, this site could be graded to convey runoff on the surface and through channels.

At present there is no geotechnical report available, and this gap will have to be addressed at a future stage.

Relocation of approximately 600 m of high-voltage transmission lines would also be required.

The access to this site is available from Mt. Scio Road through the existing terminal station access road.

The approximate length of fence for the site would be 600 m.

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7.5.3 Real Estate Considerations

Zoned in St. John's as C.A. Pippy Park Zone. Uses and zone standards are delegated to the C.A. Pippy Park Commission.

7.5.4 Community and Environmental Risk

The Oxen Pond site is around a park area with residential properties on both sides, backing on parkland. There were no SOCC observed but their presence is relatively likely compared to other sites evaluated due to the presence of the protected parkland around the site. There are no delineated wetlands, but there is evidence of public use on the trails which connect with other trails in the park. The site presents a relatively high risk from a community and environment perspective.

7.5.5 Safety and Risk Evaluation

The nearest hydrant is at 283 Mount Scio Road approximately 450 m from the site. A new hydrant should be installed at the site to provide direct connection and reduce supply friction losses and setup times. The primary responding station is the Kenmount Fire Station at 5 Kiwanis Street in St John's NL. The distance is approximately 2.5 kilometers with an estimated response time of four to six minutes. As a Greenfield location, fire safety access will need to be incorporated into the design; however, this is not considered an issue and does not eliminate the site from selection. With a site hydrant and preplanned access routes, the location can achieve faster water supply establishment and improved safety performance during emergency operations.

8. Constraints and Risks

Given the preliminary level of engineering for each of the sites they shared many similar constraints and risks.

- Distance to residential dwellings: This includes distance to residential dwellings and developments with each of the locations being within <500 m of residential property. There is potential social pushback from industrial development in the region;
- Information Gaps: There is limited geotechnical and environmental information available and as such there is some risk with the civil development of each of the sites. Hardwoods and the Goulds both show signs of wetlands;
- Civil: Virginia Waters requires significant grading (15–20 m elevation differential) and removal of overhead lines, increasing cost and schedule risk. Goulds and Hardwoods Greenfield require clearing and backfilling of wetlands, which may lead to unforeseen geotechnical challenges;
- Community and Social Concerns: The Oxen Pond location is within the Pippy Park area which may result in social concerns being raised and increased regulatory hurdles. Several sites are next to neighborhoods and recreational areas making them highly sensitive to public opposition;

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- Technical and grid integration risks: Connecting at 230 kV at Hardwoods or Oxen Pond could accelerate the need for additional 230/66 kV transformer capacity in the Hardwoods–Oxen Pond loop, impacting NL Hydro's long-term expansion plans. NF Power owned substations (Goulds and Virginia Waters) require coordination for SCADA integration and fiber optic communications, adding complexity and dependency on third-party timelines;
- Regulatory: Hardwoods sites require discretionary approval under "Hazardous Industry" classification. Oxen Pond falls under C.A. Pippy Park zoning, which is governed by a separate commission, adding complexity to permitting.

9. Recommendations

Based on the technical, environmental, and commercial evaluations, the top three sites for the proposed Battery Energy Storage System (BESS) are **Hardwoods Greenfield**, **Hardwoods Brownfield**, and **Goulds**.

The Hardwoods Greenfield site is the preferred option because it offers ample land for a 50 MW, 8-hour reserve system, strong interconnection flexibility at both 66 kV and 230 kV, and lower industrial tax rates compared to St. John's. It can be constructed without the decommissioning of existing equipment at Hardwoods Terminal Station.

The Hardwoods Brownfield site ranks second due to its existing infrastructure and proximity to the Hardwoods Terminal Station, which simplifies interconnection; however, its feasibility is constrained by the need to decommission the gas turbine, introducing schedule uncertainty.

Goulds is the third option, offering good accessibility and potential for future 230 kV expansion, but it requires significant civil work and coordination with Newfoundland Power for interconnection, which adds complexity.

While Virginia Waters and Oxen Pond were considered, both present higher environmental and social risks, including proximity to sensitive residential areas and regulatory challenges, making them less favorable at this stage.

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Appendix A
Site Maps

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Figure A 1: Hardwoods Site (47°31'27"N 52°50'47"W)

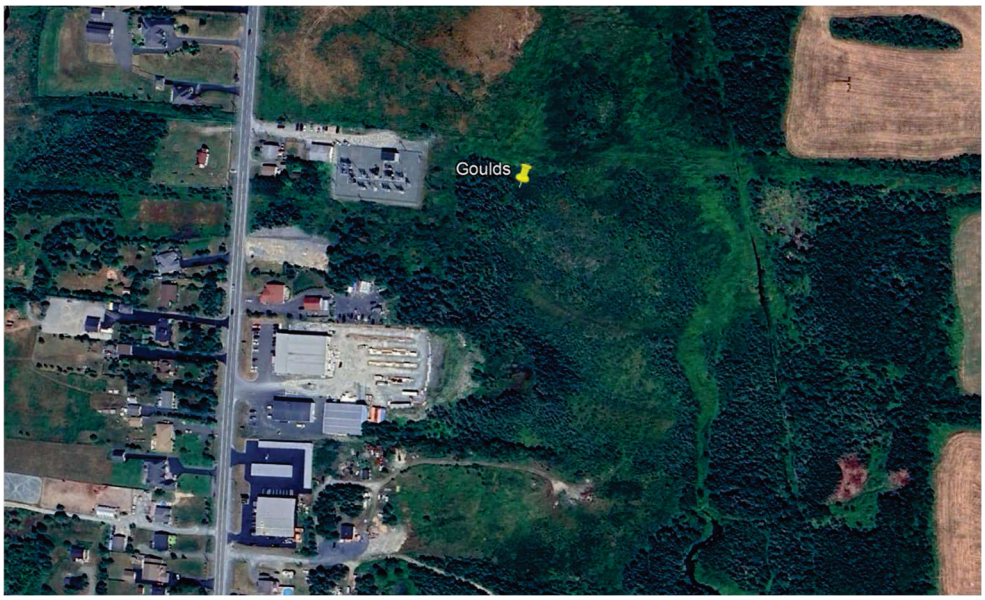


Figure A 2: Goulds Site (47°29'07.1"N 52°45'54.0"W)

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Figure A 3: Virginia Waters Substation Site (47°36'54.2"N 52°42'12.2"W)



Figure A 4: Oxen Pond Site (47°34'26.45"N 52°45'22.46"W)

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Appendix B
Site Visit Photos

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B.1 Hardwoods Terminal Station



Figure B 1: Hardwoods Gas Turbine

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Figure B 2: Hardwoods Transmission Lines

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Figure B 3: Greenfield Site for Hardwoods

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B.2 Goulds Substation



Figure B 4: Newfoundland Power Substation Goulds

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Figure B 5: Transmission Line Goulds



Figure B 6: Greenfield Site Goulds

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Figure B 7: Greenfield Site Goulds

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B.3 Virginia Waters Substation



Figure B 8: Transmission Lines Virginia Waters



Figure B 9: Greenfield Site Virginia Waters

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Figure B 10: Substation at Virginia Waters

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B.4 Oxen Pond Terminal Station



Figure B 11: Substation at Oxen Pond

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Figure B 12: Transmission Lines at Oxen Pond



Figure B 13: Greenfield Site at Oxen Pond

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Figure B 14: Greenfield Site at Oxen Pond

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Appendix C
Evaluation Matrix

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Site Number	Site 1	Site 2	Site 3	Site 4	Site 5
Site Name	**Hardwoods (Greenfield Site)**	**Hardwoods (Brownfield Site)**	**Goulds**	**NLF Power Site, Virginia Waters Substation**	**Oxen Pond**
Site Coordinates	**47°31'24.61"N 52°50'54.23"W**	**47°31'27"N 52°50'47"W (47.524167, -52.846389)**	**47°29'07.1"N 52°45'54.0"W (47.4853056,-52.7651030)**	**47°36'54.2"N 52°42'12.2"W**	**47°34'26.45"N 52°45'22.46"W**
Parameter					
General site analysis					
Grid hosting capacity	The 230/66 kV tranformer capacity at Hardwoods and Oxen Pond are planned on the basis of being able to supply all firm load on the 66 kV system with one transformer out of service and the combustion turbine operating at 50 MW. A 230 kV BESS connection with the HWD combustion turbine retired will advance the requirment for additional 230/66 kV transformer capacity in the loop. A 66 kV BESS connection with the combustion turbine required will have less of an impact.	The 230/66 kV tranformer capacity at Hardwoods and Oxen Pond are planned on the basis of being able to supply all firm load on the 66 kV system with one transformer out of service and the combustion turbine operating at 50 MW. A 230 kV BESS connection with the HWD combustion turbine retired will advance the requirment for additional 230/66 kV transformer capacity in the loop. A 66 kV BESS connection with the combustion turbine required will have less of an impact.	66 kV lines at the NP Goulds Substations have rated capacity to incorporate the 50 MW injection. The 66 kV bus configuration utilizes all sides of existing 66 kV box structures. an expansion of the existing 66 kV bus to the east side with relocation of an existing 66 kV line termination and circuit breaker bay. Alternatively, one of the 66 kV lines could be routed in and out of the new BESS station.	66 kV lines at the NP Virginia Waters Substations have rated capacity to incorporate the 50 MW injection. May require a 66 kV bus extension to accomdate the new 66 kV line to the BESS depending on existing 66 kV breaker bays.	The 230/66 kV tranformer capacity at Hardwoods and Oxen Pond are planned on the basis of being able to supply all firm load on the 66 kV system with one transformer out of service and the combustion turbine operating at 50 MW. A 230 kV BESS connection with the HWD combustion turbine retired will advance the requirment for additional 230/66 kV transformer capacity in the loop. A 66 kV BESS connection with the combustion turbine required will have less of an impact.
Connection point	230/66 kV Transformers at Terminal Station are labeled T1, T2, T4 and T3 from left to right when viewed from 66 kV bus. There is space located on the 230 kV side of T4 for a fourth 230 kV circuit breaker bay. Alternatively, a 66 kV connection can be accomodated at or near the NL Hydro 66 kV bus tie circuit brekaer between T2 and T4. Use of the existing T5 breaker bay for the combustion turbine or the proposed T6 breaker bay for a historically proposed second combustion turbine.	230/66 kV Transformers at Terminal Station are labeled T1, T2, T4 and T3 from left to right when viewed from 66 kV bus. There is space located on the 230 kV side of T4 for a fourth 230 kV circuit breaker bay. Alternatively, a 66 kV connection can be accomodated at or near the NL Hydro 66 kV bus tie circuit brekaer between T2 and T4. Use of the existing T5 breaker bay for the combustion turbine or the proposed T6 breaker bay for a historically proposed second combustion turbine.	NL Hydro has long term plan for a new 230/66 kV station in the west end. Historically this would be located at Handy Pond. 230 kV routing to Handy Pond has to be verified given the Galway development. An alternative location for the west end station is near Galway. To avoid negative impact on 230/66 kV transformer capacity in the loop, 66 kV connection may be more appropriate in the near term. This would require expansion of NP Goulds Substation or tapping an exiting 66 kV line	The location next to VIR has historically been allocated for a new 230/66 kV infeed station called Snow's Road. It is the proposed site of the BESS connection to the existing VIR 66 kV bus is most practical at this time.	Space is a constaint at Oxen Pond. For future 230 kV conenction to Snows Road/Virginia Waters NL Hydro is proposing a 230 kV station expansion along the 230 kV ROW to the north. The 66 kV box structres that supply NP are located in front of the main 66 kV bus. The remainder of the 66 kV access is blocked by the control building which sits between the two NP 66 kV box structures. The opposite side of the NL Hydro 66 kV bus is congested due to the 230/66kV transformer connections and two 66 kV shunt capacitor banks. The 230/66 kv transformers are labeled T2, T1 and T3 left to right when viewed from the 66 kV side. Given the limited 66 kV access, a 230 kV connection may be more practical. Space for a 230 kV connection exists opposite T1.
Maintenance and NL Hydro Access	Site will need to accommodate proper roads for site access, but is easily accesible by NL Hydro operations and maintenance teams.	Site is easily accesible by NL Hydro operations and maintenance teams.	Site will need to accommodate proper roads for site access, but is easily accesible by NL Hydro operations and maintenance teams. Upgrae of the existing access road.	Site will need to accommodate proper roads for site access, but is easily accesible by NL Hydro operations and maintenance teams.	Site will need to accommodate proper roads for site access, but is easily accesible by NL Hydro operations and maintenance teams.
DERMS/SCADA integration capability	Existing SCADA at site with communications to ECC at HYdro Place. May need additional RTU	Existing SCADA at site with communications to ECC at Hydro Place. May need additional RTU	Will require installation of RTU and Communications to ECC at Hydro Place. Additional revenue metering will be required as this will be a NL Hydro asset connecting to a Newfoundland Power site, where we would be charging and discharging, NL Hydro will need to acccount for import and export energy for billing purposes.	Will require installation of RTU and Communications to ECC at Hydro Place. Additional revenue metering will be required as this will be a NL Hydro asset connecting to a Newfoundland Power site, where we would be charging and discharging, NL Hydro will need to acccount for import and export energy for billing purposes.	Existing SCADA at site with communications to ECC at Hydro Place. May need additional RTU.
Electrical interconnection					
Connection voltage	230 kV and 66 kV viable	230 kV and 66 kV viable	66 kV	66 kV	230 kV
Transmission Line Length	230 kV - approx 300 m : 66 kV approx 300 m	230 kV - approx 400 m : 66 kV approx 270 m	Approx 150 - 200 m	approx 100 m	approx 240 m
Comments on transmission line routing	230 kV crossing of two existing 230 kV lines: 66 kV may require crossing existing 66 kV and/or application of 66 kV teck cable	230 kV crossing of two existing 230 kV lines: 66 kV may require crossing existing 66 kV and/or application of 66 kV Teck cable	Reroute of an existing NP 66 kV line in and out of new BESS 66/34.5 kV station is most practical. Additional revenue metering	no expected 66 kV line crossings	one 230 kV line crossing
Site preparation					
Land area available	Multiple land owners. >20 acres of land. To confirm which areas are owend by NL Hydro.	Multiple land owners. >20 acres of land. To confirm which areas are owend by NL Hydro.	~15 acres of land	~3 acres of land (plus additional land to left of site)	~2.5 acres of land
Site preparation considerations (grading, clearing)	Clearing of forest, backfilling of wetland and grading area	Removal of generation station equipment, removal of vegetation, grading	Clearing of forest, grading area	Clearing of forest, grading area	Clearing of forest, grading area, transmission lines and tower present
Capability to expand BESS for additional capacity	Available area	Existing station equipment constraints usable area	Available area	Available area	Limited area, encroaching on park grounds
Flooding considerations	Low; 0.2 km away from an area with low to significant flooding risk	Low; Established site with good drainage	Low; 0.5km away from an area with low to significant flooding risk	Low flood risks	Low flood risks
Site preparation costs	Potential wetlands in area.	Possible contaminated soils, Demolition and Removal of existing infrastructure/equipment	Wetlands present in area.	Fairly steep grade towards the TCH	Steep grades towards the TCH
Commercial considerations					
Lease and property tax costs	Paradisel tax rate lower then St. John's	Paradisel tax rate lower then St. John's	St. John's commercial tax structure	St. John's commercial tax structure	St. John's commercial tax structure
Zoning compliance	Zoned in township of Paradise for Industrial General. Likely considered a Hazardous Industry which is a discretionary use requiring Council approval, but no changes to zoning.	Zoned in township of Paradise for Industrial General. Likely considered a Hazardous Industry which is a discretionary use requiring Council approval, but no changes to zoning.	Zoned in St. John's for Rural. Likely considered a Public Utility which is a permitted use.	Zoned in St. John's for Open Space. Likely considered a Public Utility which is a discretionary use requiring Council approval, but no changes to zoning.	Zoned in St. John's as C.A. Pippy Park Zone. Uses and zone standards are delegated to the C.A. Pippy Park Commission.
Community & Environmental Risks					
Noise considerations	Current site of Hardwoods combustion turbine, near Trans Canada Hwy	Current site of Hardwoods combustion turbine, near Trans Canada Hwy	Not a lot of residential development around the area. Several businesses adjacent such as an alternator shop and hardware store that would not be particularly sensative to noise.	Close to many affluent residential properties. Likely very sensative to noise.	Within Pippy Park and adjacent to affluent residents and Memorial Universities Botanical Gardens. Likely to be sensative to noise.
Nearest neighbors (distance in meters)	250 m from commercial buildings Nors Construction Equipment ST Mount Pearl	130 m from commercial buildings Nors Construction Equipment ST Mount Pearl	70 m from residential community property line	90 m from residential community property line	69 from residential community property line
Environmental Permitting (wetlands, protected species)	Wetland present in allotted area	Existing site of equipment	Site would be directly over a wetland, site map states wetland currently requires further study.	No wetlands present at site. Artificial Osprey nest structure present	No wetlands present at site. Within an urban park which will require permission from park.
Impact on neighboring communities (visual, traffic, etc.)	Low impact as its currently in an industrial area	Low impact as its currently in an industrial area	Medium impact as it is a mixed use area.	High impact as it's a residential area with established trails and culturally significant resources such as berries along the trails.	High impact as it's a park area with on a rural road that has little industry in the area.
Protected areas or species nearby	None identified or likely. Require ACCDC request to confirm	None identified or likely. Require ACCDC request to confirm	None identified but possible. Require ACCDC request to confirm	Osprey nest observed.	None identified but within a park and species such as protected birds possible as it is surrounded by the park.
Safety & Security					
Fire safety access and hydrant availability	Fire suppression onsite, water hydrant connection	Fire suppression onsite, water hydrant connection	MAIN RD, Opp #264 (approximately 1 km away). New fire hydrant at site will need to be installed.	Nearest Hydrants are at 352 and 366 STAVANGER DR (approximately 100 m)	Nearest hydrant is at 283 MOUNT SCIO RD (approximately 450 m). New fire hydrant at site will need to be installed.
Emergency response time (nearest fire station)	Mount Pearl Fire Station Address: 2 Olympic Drive, Mount Pearl, NL A1N 4K3 Distance: ~4.77 km Estimated Response Time: ~5–8 minutes	Mount Pearl Fire Station Address: 2 Olympic Drive, Mount Pearl, NL A1N 4K3 Distance: ~4.77 km Estimated Response Time: ~5–8 minutes	Goulds Fire Station Address: 550 Main Road, Goulds, NL A1S 1E4 Distance: ~6.39 km Estimated Response Time: ~6–8 minutes	St. John's Regional Fire Department – Central Fire Station Address: 45 Central Street, St. John's, NL A1C 3P3 Distance: Approximately 3–4 km from the given coordinates. Response Time: 5–7 minutes (including dispatch, turnout, and travel).	Kenmount Fire Station Address: 5 Kiwanis Street, St. John's, NL Distance: Approximately 2.5 km from your coordinates Response Time: 4–6 minutes (including dispatch, turnout, and travel).

Appendix J

List of Standards

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Standard	Full Name of Standard	Standard Description	Primary engineering area	Link
NFPA 855	NFPA 855 - Installation of stationary energy storage systems	Installation of stationary energy storage systems	Electrical, Fire and life safety	https://www.nfpa.org/codes-and-standards/855
UL 9540	UL 9540 - Safety for energy storage systems and equipment	Safety for energy storage systems and equipment	Electrical, Product safety	https://www.ul.com/resources/ul-9540
UL 1973	UL 1973 - Batteries for stationary and rail applications	Batteries for stationary and rail applications	Electrical, Product safety	https://www.ul.com/services/ul-1973
CSA C22.2 No. 107.1	CSA C22.2 No. 107.1 - Power conversion equipment	Power conversion equipment	Electrical	https://www.csagroup.org/store/
UL 9540A	UL 9540A - Test method for thermal runaway and propagation in energy storage systems	Test method for thermal runaway and propagation in energy storage systems	Electrical, Fire and life safety	https://www.ul.com/services/ul-9540a
NFPA 68	NFPA 68 - Explosion protection by deflagration venting	Explosion protection by deflagration venting	Fire and life safety, Mechanical	https://www.nfpa.org/codes-and-standards/68
NFPA 69	NFPA 69 - Explosion prevention systems	Explosion prevention systems	Fire and life safety, Mechanical	https://www.nfpa.org/codes-and-standards/69
IEEE 693	IEEE 693 - Recommended practice for seismic design of substations	Recommended practice for seismic design of substations	Electrical, Structural	https://standards.ieee.org/standard/693
UN 38.3	UN 38.3 - Transport of dangerous goods, lithium and lithium ion batteries	Transport of dangerous goods, lithium and lithium ion batteries	Logistics, Product safety	https://unece.org/transport/documents
UL 1642	UL 1642 - Lithium cell safety	Lithium cell safety	Electrical, Product safety	https://www.ul.com/services/ul-1642
UL 1741	UL 1741 - Power conversion systems for interconnection	Power conversion systems for interconnection	Electrical	https://www.ul.com/services/ul-1741
NFPA 72	NFPA 72 - National fire alarm and signaling code	National fire alarm and signaling code	Fire and life safety	https://www.nfpa.org/codes-and-standards/72
IEEE 1547	IEEE 1547 - Interconnection and interoperability of distributed energy resources	Interconnection and interoperability of distributed energy resources	Electrical, Controls	https://standards.ieee.org/standard/1547
IEEE 519	IEEE 519 - Limits for harmonic control in power systems	Limits for harmonic control in power systems	Electrical, Power quality	https://standards.ieee.org/standard/519
Canadian Electrical Code	Canadian Electrical Code - Requirements for electrical installations	Requirements for electrical installations	Electrical	https://www.csagroup.org/store/
NLSO TP S 005	NLSO TP S 005 - Technical requirements for connection to the NL transmission system	Technical requirements for connection to the NL transmission system	Electrical, Interconnection	https://nlh.nl.ca
IEC 61850	IEC 61850 - Communication networks and systems for power utility automation	Communication networks and systems for power utility automation	Controls and communications	https://webstore.iec.ch
DNP3	DNP3 - Distributed network protocol for SCADA telemetry	Distributed network protocol for SCADA telemetry	Controls and communications	https://www.dnp.org
National Building Code of Canada 2010	National Building Code of Canada 2010 - Building code referenced for civil works	Building code referenced for civil works	Civil	https://nrc.canada.ca
National Building Code of Canada 2015	National Building Code of Canada - Building code referenced for structural design	Building code referenced for structural design	Structural	https://nrc.canada.ca
National Building Code of Canada 2025	National Building Code of Canada - Seismic hazard values and references	Seismic hazard values and references	Structural, Seismic	https://nrc.canada.ca
Town of Paradise Development Regulations	Town of Paradise Development Regulations - Local development requirements	Local development requirements	Civil, Permitting	https://www.townofparadise.ca
St. John's Development Design Manual	St. John's Development Design Manual - Municipal design expectations and criteria	Municipal design expectations and criteria	Civil	https://www.stjohns.ca
Oregon DOT Hydraulic Design Manual, Rational Method	Oregon DOT Hydraulic Design Manual, Rational Method - Rainfall runoff and drainage design method	Rainfall runoff and drainage design method	Civil, Stormwater	https://www.oregon.gov/odot
Transportation Association of Canada guidance	Transportation Association of Canada guidance - Transportation and roadway design guidance	Transportation and roadway design guidance	Civil, Roads	https://www.tac-atc.ca
CSPI Handbook of Steel Drainage and Highway Construction Products	CSPI Handbook of Steel Drainage and Highway Construction Products - Hydraulic design charts for culverts	Hydraulic design charts for culverts	Civil, Stormwater	https://cspi.ca
CSA A23.1 and CSA A23.2	CSA A23.1 and CSA A23.2 - Concrete materials, methods, and test practices	Concrete materials, methods, and test practices	Structural	https://www.csagroup.org/store/
CSA A23.3	CSA A23.3 - Design of concrete structures	Design of concrete structures	Structural	https://www.csagroup.org/store/
CSA A23.4	CSA A23.4 - Precast concrete materials and construction	Precast concrete materials and construction	Structural	https://www.csagroup.org/store/
CSA A283	CSA A283 - Qualification code for concrete testing laboratories	Qualification code for concrete testing laboratories	Structural, QA QC	https://www.csagroup.org/store/
CAN CSA A3000	CAN CSA A3000 - Cementitious materials compendium	Cementitious materials compendium	Structural	https://www.csagroup.org/store/
CSA G30.18	CSA G30.18 - Carbon steel bars for concrete reinforcement	Carbon steel bars for concrete reinforcement	Structural	https://www.csagroup.org/store/
CSA G40.20 and CSA G40.21	CSA G40.20 and CSA G40.21 - General requirements and grades for structural steel	General requirements and grades for structural steel	Structural	https://www.csagroup.org/store/
CSA S16	CSA S16 - Design of steel structures	Design of steel structures	Structural	https://www.csagroup.org/store/
CSA S37	CSA S37 - Antennas, towers, and antenna supporting structures	Antennas, towers, and antenna supporting structures	Structural	https://www.csagroup.org/store/
CSA W59	CSA W59 - Welded steel construction	Welded steel construction	Structural, Fabrication	https://www.csagroup.org/store/
ASTM A36	ASTM A36 - Carbon structural steel	Carbon structural steel	Structural, Materials	https://www.astm.org
ASTM A53	ASTM A53 - Steel pipe, black and galvanized	Steel pipe, black and galvanized	Structural, Mechanical	https://www.astm.org
ASTM A108	ASTM A108 - Cold finished carbon and alloy steel bars	Cold finished carbon and alloy steel bars	Structural, Materials	https://www.astm.org
ASTM A276	ASTM A276 - Stainless steel bars and shapes	Stainless steel bars and shapes	Structural, Materials	https://www.astm.org
ASTM A307	ASTM A307 - Carbon steel bolts and studs	Carbon steel bolts and studs	Structural, Fasteners	https://www.astm.org
ASTM A563	ASTM A563 - Carbon and alloy steel nuts	Carbon and alloy steel nuts	Structural, Fasteners	https://www.astm.org
ASTM A786	ASTM A786 - Hot rolled floor plates	Hot rolled floor plates	Structural, Materials	https://www.astm.org
ASTM A992	ASTM A992 - Structural steel shapes	Structural steel shapes	Structural, Materials	https://www.astm.org
ASTM A1011	ASTM A1011 - Hot rolled sheet and strip steels	Hot rolled sheet and strip steels	Structural, Materials	https://www.astm.org
ASTM C260	ASTM C260 - Air entraining admixtures for concrete	Air entraining admixtures for concrete	Structural, Concrete	https://www.astm.org
ASTM C309	ASTM C309 - Membrane forming compounds for curing concrete	Membrane forming compounds for curing concrete	Structural, Concrete	https://www.astm.org
ASTM C494 and C494M	ASTM C494 and C494M - Chemical admixtures for concrete	Chemical admixtures for concrete	Structural, Concrete	https://www.astm.org
ASTM C1017 and C1017M	ASTM C1017 and C1017M - Admixtures for flowing concrete	Admixtures for flowing concrete	Structural, Concrete	https://www.astm.org
ASTM C1059 and C1059M	ASTM C1059 and C1059M - Latex agents for bonding concrete	Latex agents for bonding concrete	Structural, Concrete	https://www.astm.org
ASTM D1751	ASTM D1751 - Preformed expansion joint filler for concrete	Preformed expansion joint filler for concrete	Structural, Civil	https://www.astm.org
ASTM F1554	ASTM F1554 - Anchor bolts, 36, 55, and 105 ksi	Anchor bolts, 36, 55, and 105 ksi	Structural, Fasteners	https://www.astm.org
ASTM F3125 and F3125M	ASTM F3125 and F3125M - High strength structural bolts and assemblies	High strength structural bolts and assemblies	Structural, Fasteners	https://www.astm.org
ASTM F436 and F436M	ASTM F436 and F436M - Hardened steel washers	Hardened steel washers	Structural, Fasteners	https://www.astm.org
ASTM F1136 and F1136M	ASTM F1136 and F1136M - Zinc aluminum corrosion protective coatings for fasteners	Zinc aluminum corrosion protective coatings for fasteners	Structural, Corrosion protection	https://www.astm.org
ACI 305R	ACI 305R - Guide to hot weather concreting	Guide to hot weather concreting	Structural, Concrete construction	https://www.concrete.org
ACI 306R	ACI 306R - Guide to cold weather concreting	Guide to cold weather concreting	Structural, Concrete construction	https://www.concrete.org
ACI 309R	ACI 309R - Guide for consolidation of concrete	Guide for consolidation of concrete	Structural, Concrete construction	https://www.concrete.org
ACI 351.3	ACI 351.3 - Foundations for dynamic equipment	Foundations for dynamic equipment	Structural, Foundations	https://www.concrete.org
Cement Association of Canada Design and Control of Concrete Mixtures	Cement Association of Canada Design and Control of Concrete Mixtures - Concrete mix design and practice reference	Concrete mix design and practice reference	Structural, Concrete	https://cement.ca
CISC Code of Standard Practice for Structural Steel	CISC Code of Standard Practice for Structural Steel - Standard practice for fabrication and erection	Standard practice for fabrication and erection	Structural, Fabrication	https://cisc-icca.ca
Reinforcing Steel Institute of Canada Manual of Standard Practice	Reinforcing Steel Institute of Canada Manual of Standard Practice - Rebar detailing and placement practice	Rebar detailing and placement practice	Structural	https://www.rebar.org

Standard	Full Name of Standard	Standard Description	Primary engineering area	Link
Occupational Health and Safety Act NL and OHS Regulations	Occupational Health and Safety Act NL and OHS Regulations - Provincial safety legislation applied to construction and operations	Provincial safety legislation applied to construction and operations	HSE	https://www.gov.nl.ca
Canadian Foundation Engineering Manual	Canadian Foundation Engineering Manual - Guidance for geotechnical and foundation design	Guidance for geotechnical and foundation design	Geotechnical, Structural	https://www.cgs.ca
ASCE SEI 37	ASCE SEI 37 - Design loads on structures during construction	Design loads on structures during construction	Structural, Temporary works	https://www.asce.org
ASHRAE Climatic Design Conditions	ASHRAE Climatic Design Conditions - Weather design data used for HVAC and envelope criteria	Weather design data used for HVAC and envelope criteria	Civil, Mechanical, Environmental	https://www.ashrae.org
ANSI C57.114	ANSI C57.114 - Seismic guide for Power Transformers and Reactors	Seismic guide for Power Transformers and Reactors	Electrical, Structural, Seismic	https://ieeexplore.ieee.org/document/89902
ANSI IEEE Std 386	ANSI IEEE Std 386 - IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV	IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV	Electrical	https://standards.ieee.org/ieee/386/5745/
ANSI NETA ATS	ANSI NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems	Acceptance Testing Specifications for Electrical Power Equipment and Systems	Electrical, Testing and commissioning	https://www.netaworld.org/standards/ansi-neta-ats
ASTM D3487 16	ASTM D3487 16 - Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus	Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus	Electrical, Materials	https://www.astm.org/d3487-16.html
CAN CSA C50 14	CAN CSA C50 14 - Mineral Insulating Oil Electrical for Transformers and Switches	Mineral Insulating Oil Electrical for Transformers and Switches	Electrical, Materials	https://www.csagroup.org/store/
CAN CSA C802.3 01	CAN CSA C802.3 01 - Maximum Losses for Power Transformers	Maximum Losses for Power Transformers	Electrical, Efficiency	https://www.csagroup.org/store/
CAN CSA C802.3 15	CAN CSA C802.3 15 - Minimum Efficiency Values for Power Transformers	Minimum Efficiency Values for Power Transformers	Electrical, Efficiency	https://www.csagroup.org/store/
CAN ULC S115	CAN ULC S115 - Fire Tests of Firestop Systems	Fire Tests of Firestop Systems	Fire and life safety	https://canada.ul.com/ulcstandards/
CSA 22.1	CSA 22.1 - Canadian Electrical Code CEC	Canadian Electrical Code CEC	Electrical	https://www.csagroup.org/store/
CSA 22.1 21	CSA 22.1 21 - Canadian Electrical Code Safety Standard for Electrical Installation	Canadian Electrical Code Safety Standard for Electrical Installation	Electrical	https://www.csagroup.org/store/
CSA 22.2 No. 0.4 17	CSA 22.2 No. 0.4 17 - Bonding of Electrical Equipment	Bonding of Electrical Equipment	Electrical	https://www.csagroup.org/store/
CSA 22.2 No. 0.12	CSA 22.2 No. 0.12 - Wiring Space and Wire Bending Space in Enclosures Rated 750 V or Less	Wiring Space and Wire Bending Space in Enclosures Rated 750 V or Less	Electrical	https://www.csagroup.org/store/
CSA 22.2 No. 5	CSA 22.2 No. 5 - Molded Case Circuit Breakers Molded Case Switches and Circuit Breaker Enclosures	Molded Case Circuit Breakers Molded Case Switches and Circuit Breaker Enclosures	Electrical, Switchgear	https://www.csagroup.org/store/
CSA 22.2 No. 14	CSA 22.2 No. 14 - Industrial Control Equipment	Industrial Control Equipment	Electrical, Controls	https://www.csagroup.org/store/
CSA 22.2 No. 18.3 12	CSA 22.2 No. 18.3 12 - Conduit Tubing and Cable Fittings	Conduit Tubing and Cable Fittings	Electrical	https://www.csagroup.org/store/
CSA 22.2 No. 26 13	CSA 22.2 No. 26 13 - Construction and Test of Wireways Auxiliary Gutters and Associated Fittings	Construction and Test of Wireways Auxiliary Gutters and Associated Fittings	Electrical	https://www.csagroup.org/store/
CSA 22.2 No. 31	CSA 22.2 No. 31 - Switchgear Assemblies	Switchgear Assemblies	Electrical, Switchgear	https://www.csagroup.org/store/
CSA 22.2 No. 41	CSA 22.2 No. 41 - Grounding and Bonding Equipment	Grounding and Bonding Equipment	Electrical, Grounding	https://www.csagroup.org/store/
CSA 22.2 No. 56 17	CSA 22.2 No. 56 17 - Flexible Metal Conduit and Liquid Tight Flexible Metal Conduit	Flexible Metal Conduit and Liquid Tight Flexible Metal Conduit	Electrical	https://www.csagroup.org/store/
CSA 22.2 No. 58 M89	CSA 22.2 No. 58 M89 - High Voltage Isolating Switches	High Voltage Isolating Switches	Electrical, Switchgear	https://www.csagroup.org/store/
CSA 22.2 No. 62 93	CSA 22.2 No. 62 93 - Surface Raceway Systems	Surface Raceway Systems	Electrical	https://www.csagroup.org/store/
CSA 22.2 No. 94	CSA 22.2 No. 94 - Special Purpose Enclosures	Special Purpose Enclosures	Electrical, Enclosures	https://www.csagroup.org/store/
CSA 22.2 No. 107.1	CSA 22.2 No. 107.1 - Power Conversion Equipment	Power Conversion Equipment	Electrical	https://www.csagroup.org/store/
CSA 22.2 No. 127	CSA 22.2 No. 127 - Equipment Wiring	Equipment Wiring	Electrical	https://www.csagroup.org/store/
CSA 22.2 No. 141	CSA 22.2 No. 141 - Emergency Lighting Equipment	Emergency Lighting Equipment	Electrical, Fire and life safety	https://www.csagroup.org/store/
CSA B72 20	CSA B72 20 - Installation Code for Lightning Protection Systems	Installation Code for Lightning Protection Systems	Electrical, Lightning protection	https://www.csagroup.org/store/
CSA CAN3 C13	CSA CAN3 C13 - Instrument Transformers	Instrument Transformers	Electrical, Transformers	https://www.csagroup.org/store/
CSA CAN3 C235	CSA CAN3 C235 - Preferred Voltage Levels for AC Systems 0 to 50000 V	Preferred Voltage Levels for AC Systems 0 to 50000 V	Electrical, Power systems	https://www.csagroup.org/store/
CSA C227.4 06	CSA C227.4 06 - Three Phase Pad Mounted Distribution Transformers with Separable Insulated High Voltage Connectors	Three Phase Pad Mounted Distribution Transformers with Separable Insulated High Voltage Connectors	Electrical, Transformers	https://www.csagroup.org/store/
CSA C22.1	CSA C22.1 - Canadian Electric Code Part One	Canadian Electric Code Part One	Electrical	https://www.csagroup.org/store/
CSA G40.20	CSA G40.20 - General Requirements for Rolled or Welded Structural Quality Steel	General Requirements for Rolled or Welded Structural Quality Steel	Structural, Materials	https://www.csagroup.org/store/
CSA W47.1 19	CSA W47.1 19 - Certification of Companies for Fusion Welding of Steel	Certification of Companies for Fusion Welding of Steel	Structural, Fabrication	https://www.csagroup.org/store/
CSA W48 23	CSA W48 23 - Filler Metals and Allied Materials for Metal Arc Welding	Filler Metals and Allied Materials for Metal Arc Welding	Structural, Welding	https://www.csagroup.org/store/
CSA W59 24	CSA W59 24 - Welded Steel Construction	Welded Steel Construction	Structural, Fabrication	https://www.csagroup.org/store/
CSA Z234.1	CSA Z234.1 - Metal Practice Guide	Metal Practice Guide	General, Documentation	https://www.csagroup.org/store/
CSA Z462	CSA Z462 - Workplace Electrical Safety	Workplace Electrical Safety	HSE, Electrical safety	https://www.csagroup.org/store/
FCC EMI Requirements	FCC EMI Requirements - EMI requirements	EMI requirements	Electrical, EMC	https://www.fcc.gov/engineering-technology/laboratory-division/general/equipment-authorization
IEEE 80	IEEE 80 - Guide for Safety in AC Substation Grounding	Guide for Safety in AC Substation Grounding	Electrical, Grounding	https://ieeexplore.ieee.org/document/7109078
IEEE 141	IEEE 141 - Recommended Practice for Electric Power Distribution Industrial Plants	Recommended Practice for Electric Power Distribution Industrial Plants	Electrical, Power distribution	141-1993 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants | IEEE Standard | IEEE Xplore
IEEE 242	IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems	Electrical, Protection	https://ieeexplore.ieee.org/document/974402
IEEE 3003.1	IEEE 3003.1 - Recommended Practice for Grounding of Industrial and Commercial Power Systems	Recommended Practice for Grounding of Industrial and Commercial Power Systems	Electrical, Grounding	https://ieeexplore.ieee.org/document/8793247
IEEE 493	IEEE 493 - Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems	Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems	Electrical, Reliability	https://ieeexplore.ieee.org/document/4264700
IEEE 62.11	IEEE 62.11 - Standard for Metal Oxide Surge Arresters for AC Power Circuits above 1 kV	Standard for Metal Oxide Surge Arresters for AC Power Circuits above 1 kV	Electrical, Surge protection	https://ieeexplore.ieee.org/document/9246994
IEEE 1100	IEEE 1100 - Recommended Practice for Powering and Grounding Sensitive Electronic Equipment	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment	Electrical, Power quality	https://ieeexplore.ieee.org/document/1638205
IEEE 1547 2018	IEEE 1547 2018 - Standard for Interconnecting Distributed Energy Resources with Electric Power Systems	Standard for Interconnecting Distributed Energy Resources with Electric Power Systems	Electrical, Controls	https://standards.ieee.org/standard/1547-2018.html

Standard	Full Name of Standard	Standard Description	Primary engineering area	Link
IEEE 1547.1 2020	IEEE 1547.1 2020 - Standard Conformance Test Procedures for Equipment Interconnecting DER with Electric Power Systems	Standard Conformance Test Procedures for Equipment Interconnecting DER with Electric Power Systems	Electrical, Testing and commissioning	https://standards.ieee.org/standard/1547_1-2020.html
IEEE 1584	IEEE 1584 - Guide for Performing Arc Flash Hazard Calculations	Guide for Performing Arc Flash Hazard Calculations	Electrical, HSE	https://standards.ieee.org/standard/1584-2018.html
IEEE 693 2018	IEEE 693 2018 - Recommended Practice for Seismic Design of Substations	Recommended Practice for Seismic Design of Substations	Electrical, Structural, Seismic	https://standards.ieee.org/standard/693-2018.html
IEEE C37.13	IEEE C37.13 - Standard for Low Voltage AC Power Circuit Breakers Used in Enclosure	Standard for Low Voltage AC Power Circuit Breakers Used in Enclosure	Electrical, Switchgear	https://ieeexplore.ieee.org/document/7366534
IEEE C57.12.00	IEEE C57.12.00 - Standard General Requirements for Liquid Immersed Distribution Power and Regulating Transformers	Standard General Requirements for Liquid Immersed Distribution Power and Regulating Transformers	Electrical, Transformers	https://ieeexplore.ieee.org/document/9690124
IEEE C57.12.01	IEEE C57.12.01 - Standard General Requirements for Dry Type Distribution and Power Transformers	Standard General Requirements for Dry Type Distribution and Power Transformers	Electrical, Transformers	https://ieeexplore.ieee.org/document/9269795
IEEE C57.12.28	IEEE C57.12.28 - Standard for Pad Mounted Equipment Enclosure Integrity	Standard for Pad Mounted Equipment Enclosure Integrity	Electrical, Enclosures	https://standards.ieee.org/ieee/C57.12.28/11094
IEEE C57.12.90	IEEE C57.12.90 - Standard Test Code for Liquid Immersed Distribution Power and Regulating Transformers	Standard Test Code for Liquid Immersed Distribution Power and Regulating Transformers	Electrical, Testing and commissioning	https://ieeexplore.ieee.org/document/9707753
IEEE C57.96	IEEE C57.96 - Guide for Loading Dry Type Distribution and Power Transformers	Guide for Loading Dry Type Distribution and Power Transformers	Electrical, Transformers	https://ieeexplore.ieee.org/document/6725564
IEEE C57.106	IEEE C57.106 - Guide for Acceptance and Maintenance of Insulating Mineral Oil in Electrical Equipment	Guide for Acceptance and Maintenance of Insulating Mineral Oil in Electrical Equipment	Electrical, Transformers	https://standards.ieee.org/ieee/C57.106/5361
IEEE C57.120	IEEE C57.120 - Standard for Loss Evaluation of Distribution and Power Transformers and Reactors	Standard for Loss Evaluation of Distribution and Power Transformers and Reactors	Electrical, Transformers	https://standards.ieee.org/ieee/C57.120/4868
IEEE 837	IEEE 837 - Standard for Qualifying Permanent Connections Used in Substation Grounding	Standard for Qualifying Permanent Connections Used in Substation Grounding	Electrical, Grounding	https://standards.ieee.org/ieee/837/10271
ISO 9001	ISO 9001 - Quality management systems — Requirements	Quality management systems — Requirements	Quality, Management systems	https://www.iso.org/standard/62085.html
ISO 14000	ISO 14000 - Environmental management standards family overview	Environmental management standards family overview	Environmental, Management systems	https://www.iso.org/standards/popular/iso-14000-family
QS 9000	QS 9000 - Automotive quality management system standard (obsolete, superseded by IATF 16949)	Automotive quality management system standard (obsolete, superseded by IATF 16949)	Quality, Automotive	https://16949store.com/iatf-16949-standards/what-is-qs-9000/
NBCC	NBCC - National Building Code of Canada	National Building Code of Canada	Structural, Civil	https://nrc.canada.ca/en/certifications-evaluations-standards/codes-canada
NFCC	NFCC - National Fire Code of Canada	National Fire Code of Canada	Fire and life safety	https://nrc.canada.ca/en/certifications-evaluations-standards/codes-canada
NFPA 110	NFPA 110 - Standard for Emergency and Standby Power Systems	Standard for Emergency and Standby Power Systems	Electrical, Fire and life safety	https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=110
NFPA 780	NFPA 780 - Standard for the Installation of Lightning Protection Systems	Standard for the Installation of Lightning Protection Systems	Electrical, Lightning protection	https://www.nfpa.org/product/id/p0780code
NEMA 250	NEMA 250 - Enclosures for Electrical Equipment 1000 Volts Maximum	Enclosures for Electrical Equipment 1000 Volts Maximum	Electrical, Enclosures	https://www.nema.org/standards/view/ansi-nema-250
SSPC	SSPC - Society for Protective Coatings standards (now AMPP)	Society for Protective Coatings standards (now AMPP)	Structural, Coatings	https://www.ampp.org/standards
TIA EIA 455 8	TIA EIA 455 8 - FOTP 8 Measurement of Splice or Connector Loss and Reflectance using an OTDR	FOTP 8 Measurement of Splice or Connector Loss and Reflectance using an OTDR	Communications, Fiber optics	https://tiaonline.org/standards/
TIA EIA 455 59A	TIA EIA 455 59A - FOTP 59 Measurement of Fiber Point Discontinuities Using an OTDR	FOTP 59 Measurement of Fiber Point Discontinuities Using an OTDR	Communications, Fiber optics	https://tiaonline.org/standards/
TIA EIA 526 14A	TIA EIA 526 14A - OFSTP 14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant	OFSTP 14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant	Communications, Fiber optics	https://tiaonline.org/standards/
TIA EIA 568 B	TIA EIA 568 B - Commercial Building Telecommunications Cabling Standard	Commercial Building Telecommunications Cabling Standard	Communications, Cabling	https://tiaonline.org/standards/
TIA EIA 569	TIA EIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces	Commercial Building Standard for Telecommunications Pathways and Spaces	Communications, Cabling infrastructure	https://tiaonline.org/standards/
UL	UL - Underwriters Laboratories standards and certification	Underwriters Laboratories standards and certification	Product safety	https://www.ul.com/resources/ul-standards
CSA C88:16 (R2021)	Power Transformers and Reactors	Standard is written in reference to two winding transformers	Electrical, Transformers	CSA C88:16 (R2021) | Codes & Standards | Product | CSA Group
IEEE 980 2013	IEEE Guide for Containment and Control of Oil Spills in Substations	Guide for Containment and Control of Oil Spills in Substations	Civil, Structural	https://standards.ieee.org/ieee/980/5004/

Attachment 2

Battery Energy Storage Feasibility Study – Basis of Estimate

Hatch Ltd.



MAJOR PROJECTS CONTRACTOR DOCUMENT FRONT COVER SHEET

Contract Number and Description:	**Project Number:**
Newfoundland and Labrador Hydro Battery	H376866
Contractor Name:	**Contractor Address:**
Hatch Ltd.	80 Hebron Way - Suite 100, St. John's Newfoundland and Labrador, Canada, A1A 0L9

Document Title:	**Total Number of Pages incl. Front Sheet:**
Basis of Estimate	41
Contractor Document Number:	**Contractor Revision Number:**
H376866-0000-600-610-0001	0
Contractor Signature/Stamp: John William Albert Catton -- P.Eng. - EGBC Digitally signed by John William Albert Catton -- P.Eng. - EGBC DN: cn=John William Albert Catton -- P.Eng. - EGBC, c=CA, o=CertifiO Pro, ou=EGBC - Engineers and Geoscientists of British Columbia Date: 2026.08.04 06:51:20 -07'00'	
NLH Document Number:	**NLH Revision Number:**
SDYBESS-HAT-00000-ES-BOE-0001-01	B0
Document Date (DD-MMM-YYYY)**:**	**Equipment Tag:**
27-JUL-2026	

Submission Comments: **(if urgent submission, please indicate below. Add additional pages if required)**

REVIEW DOES NOT CONSTITUTE APPROVAL OF DESIGN DETAILS, CALCULATIONS, TEST METHODS, OR MATERIAL DEVELOPED AND/OR SELECTED BY THE CONTRACTOR, NOR DOES IT RELIEVE THE CONTRACTOR FROM FULL COMPLIANCE WITH CONTRACTUAL OR OTHER OBLIGATIONS.

- ☐ **01 REVIEWED AND ACCEPTED**
- ☐ **02 REVIEWED – INCORPORATE COMMENTS, REVISE AND RESUBMIT**
- ☐ **03 REVIEWED – NOT ACCEPTED**
- ☐ **04 INFORMATION ONLY**
- ☐ **05 NOT REVIEWED**

Lead Reviewer	**Date** (DD-MMM-YYYY)	**Project Manager**	**Date** (DD-MMM-YYYY)

General Comments:

Battery Energy Storage Feasibility Study

Basis of Estimate

			Singhal, Radhika		Catton, John
2026-07-27	0	Approved for Use	R. Singhal	A. Popa	J. Catton
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**
	HATCH				

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NOTICE TO READER

This report was prepared by Hatch Ltd. ("**Hatch**") for the sole and exclusive benefit of Newfoundland and Labrador Hydro (the "**Owner**") for the purpose of documenting the basis for the estimate for the Battery Energy Storage Feasibility Study (the "**Project**").

This report is meant to be read as a whole, and sections should not be read or relied upon out of context. The report includes information provided by the Owner and by certain other parties on behalf of the Owner. Unless specifically stated otherwise, Hatch has not verified such information and does not accept any responsibility or liability in connection with such information.

This report contains the expression of the opinion of Hatch using its professional judgment and reasonable care, based upon information available at the time of preparation. The quality of the information, conclusions, and estimates contained in this report is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

As this report is a scoping study, all estimates and projections contained in this report are based on limited and incomplete data. Accordingly, while the work, results, estimates and projections in this report may be generally indicative of the nature and quality of the Project, they are not definitive. No representations or predictions are intended as to become the results of future work, and Hatch does not promise that the estimates and projections in this report will be sustained in future work.

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1. General

1.1 Introduction

This Basis of Estimate for the Battery Energy Storage System (BESS) Feasibility Study Project provides a summary of the project capital costs and explains the methodology, conditioning assumptions, and exclusions.

1.2 Overview

Newfoundland & Labrador (NL) Hydro is the primary electricity supplier for the residents of Newfoundland & Labrador. They manage the bulk generation and transmission of electricity across Newfoundland & Labrador. NL Hydro contracted Hatch to complete a BESS Feasibility Study for four options for the On-Avalon BESS:

Option 1: 20 MW with a 4-hour reserve (80 MWh at the point of interconnection).

Option 2: 20 MW with an 8-hour reserve (160 MWh at the point of interconnection).

Option 3: 50 MW with a 4-hour reserve (200 MWh at the point of interconnection).

Option 4: 50 MW with an 8-hour reserve (400 MWh at the point of interconnection).

This document outlines the basis used to develop a Capital Expenditure Estimate (CAPEX) Association for the Advancement of Cost Engineering (AACE) Class 4 cost estimate for the Battery Energy Storage Study Project, based on the Design Basis (H376866-0000-21D-226-0001) developed for the project that utilized the Hardwoods Greenfield site location. The Class 4 estimate was developed in accordance with AACE 18R-97 (applied to process industries) and has an estimate accuracy range on lower side of -15% to -30% and on higher side of +20% to +50%.

The CAPEX has incorporated designs, quantity estimates, cost information, and execution strategies developed as part of the Select option. For simplification, **Option 4** has been selected for presentation in this Basis of Estimate, as it represents the most technically complex design evaluated as part of the feasibility project. The remaining three options follow the same cost estimating methodology outlined in this document, with their respective details included in the Appendices, following an AACE Class 4 methodology.

Refer to Appendix B, Appendix C, Appendix D, and Appendix E for more details on the capital cost estimate.

1.3 Project Objectives

This report was prepared by Hatch Associates Ltd. (“Hatch”) for the sole and exclusive benefit of NL Hydro (the “Owner”) for the purpose of assisting the Owners to develop a Class 4 estimate for the Battery Energy Storage Feasibility Study, Newfoundland & Labrador.

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1.4 List of Acronyms

Table 1-1 shows the list of acronyms and abbreviations for this Estimate Basis.

Table 1-1: List of Acronyms/Abbreviations

Acronyms/Abbreviations	Definitions
AACE	Association for the Advancement of Cost Engineering
BESS	Battery Energy Storage System
CAPEX	Capital Expenditure
CAD	Canadian Dollars
CWP	Construction Work Package
EEL	Electrical Equipment List
EMS	Energy Management System
EPC	Engineering & Procurement
EPCM	Engineering, Procurement & Construction Management
FS	Feasibility Study
GA	General Arrangement
LOA	Living out Allowance
MEL	Mechanical Equipment List
MTO	Material Take-off
MW	Megawatt
NLH	Newfoundland & Labrador Hydro
PCS	Power Conversion System
PF	Productivity Factor
QRA	Quantitative Risk Assessment
Q1	First Quarter
RP	Recommended Practice
TIC	Total Installed Cost
USD	United States Dollar
WBS	Work Breakdown Structure

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1.5 Estimate Parameters

The capital estimate was prepared in alignment with AACE International Recommended Practice AACE 18R-97 (applied to process industries), as well as the current Hatch Discipline Guide – Project Capital Cost Estimate (PLP-620-020-0001).

The AACE Class 4 cost estimate is compiled based on the following parameters:

- The targeted accuracy for this CAPEX estimate is -15%/+50%, in line with a Class 4 estimate as determined by Hatch document PLP-620-020-0001. Refer to Appendix A for the table detailing the classification information;
- The estimate base date is Q1-2026;
- The estimate is presented in Canadian Dollars (CAD). Costs submitted in other currencies were converted to CAD;
- The requirement for escalation in the CAPEX is discussed further in Section 7;
- All units of measure are in the metric system.

1.6 Estimate Software

The Capex estimate is developed in a standard Hatch Microsoft Excel template. The Excel file includes a buildup of unit rates with estimating price coding references and all typical coding structures.

1.7 Structure and Coding of the Estimate

1.7.1 CAPEX Work Breakdown Structure

The CAPEX Work Breakdown Structure (WBS) is a systematically consistent method of categorizing the overall project scope by breaking it down into definable elements. WBS is a project-oriented hierarchy of geographical/work areas or facilities that defines the total work to be performed. The project WBS has been incorporated into various project documents including equipment numbering, drawings, requests for quotation, project execution planning/scheduling, the CAPEX, etc. It is a key device used to integrate the project deliverables.

1.7.2 Trade Codes

Trade Codes are used to collect the estimate of items into groups of work of a similar nature or discipline. The standard Trade Code is an alpha character which is directly aligned with the project's standard discipline descriptions. The Trade Code is defined as the first character which indicates discipline.

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The Trade Codes used in the CAPEX are listed below in Table 1-2.

Table 1-2: Trade Codes

Trade Code	Trade Description
A	Site Development
C	Concrete
D	Roadworks, Drainage & Paving
E	Earthworks
F	Architectural
J	Control & Instrumentation
L	Electrical Equipment
M	Mechanical Equipment
N	Mechanical Platework & Tanks
P	Pipework & Fittings
R	Cable Ladder, Tray, and Conduit
S	Structural Steel
V	Owner's Cost
W	Wire & Cable
Y	Indirect
Z	Provisions (including Contingency)

1.7.3 Pricing Basis Coding

The pricing coding for material, equipment and subcontract costs is indicated on each line of the estimate by a coding structure. The intent of the coding structure is to provide confidence that the pricing methodology is aligned with expectations for the target class of estimate. The value of each pricing code may be used to facilitate analysis and reporting of the estimate. The coding structure used in the CAPEX are listed below in Table 1-3, Table 1-4, Table 1-5, Table 1-6 and Table 1-7.

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Table 1-3: Maturity Matrix Table

Code	Description
P1	Firm Quote
P2	Budget Quote
P3	In-house Database
P4	Factored
P5	Allowance

Table 1-4: Option-1 Cost Summary based on Price Code

Code	Sum cost-CAD
P2	$56,798,130
P3	$ 4,369,002
P4	$ 3,335,368
P5	$ 450,000

Table 1-5: Option-2 Cost Summary based on Price Code

Code	Sum cost-CAD
P2	$78,877,444
P3	$ 6,057,291
P4	$ 4,135,202
P5	$ 450,000

Table 1-6: Option-3 Cost Summary based on Price Code

Code	Sum cost-CAD
P2	$106,163,676
P3	$ 6,953,282
P4	$ 4,566,306
P5	$ 450,000

Table 1-7: Option-4 Cost Summary based on Price Code

Code	Sum cost-CAD
P2	$160,848,212
P3	$ 10,454,891
P4	$ 7,489,910
P5	$ 450,000

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1.7.4 Cost Codes/Resource Types

Cost Resources are used to collect cost items into groups. All CAPEX costs are represented in 1 of the 5 resources shown in Table 1-8.

Table 1-8: Cost Code/Resource Types Used

Resource Code	Description
L	Labour
M	Material
E	Equipment
S	Subcontract
Y	Indirect

1.7.5 Foreign Exchange Rates

Costs submitted in other currencies are converted to CAD according to published exchange rates for Q1 2026. No provision is included for currency fluctuation or any fees applicable to currency exchange. The components in USD costs are the Battery Container, Power Conversion System (PCS), the Energy Management System (EMS) unit for the BESS, and associated freight costs, and total cost varies for each option based on the number of units required.

FOREX used in the CAPEX are listed below Table 1-9.

Table 1-9: FOREX

Currency	Code	Rate	Inverse
Canadian Dollars	CAD	1.00	1.00
United States Dollars	USD	0.73	1.36

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2. Classification Estimate

The CAPEX was prepared in accordance with guidelines established by the Association for the Advancement of Cost Engineering (AACE) for a Class 4 estimate.

The process design basis and system configuration are defined, with preliminary engineering deliverables such as single line diagrams (SLDs), layouts, equipment lists, and specifications providing a basis for quantity take-offs and cost development. Major equipment has been identified and supported by budgetary vendor input, while bulk quantities have been derived from drawings and supplemented with industry informed allowances. Collectively, this level of definition, combined with the use of normalized historical data and selective vendor engagement, is consistent with the expected maturity for a Class 4 estimate and supports the reliability of the resulting cost range. The applicable AACE standard for this cost estimate classification and determination of its accuracy ranges is Recommended Practice AACE 18R-97 (applied to process industries). This is a generic estimating practice standard which has been developed and published by AACE and it provides guidelines for applying the general principles of estimating and estimate classification to project cost estimates (i.e., cost estimates that are used to evaluate, approve and/or fund projects).

The capital cost estimate consists of four major cost groupings: Direct Costs, Indirect Costs, Contingency and Owner's Costs.

The standard AACE 18R-97 estimate classification matrix is shown in Table 2-1.

Table 2-1: AACE 18R-97 Estimate Classification Matrix

AACE Estimate Class	Primary Characteristic	Secondary Characteristic		
	Maturity Level of Project Definition (Expressed as % of Complete Definition)	**End Usage** (Purpose of Estimate)	**Methodology** (Estimating Method)	**Expected Accuracy Range** (Variation Low/High Ranges in 80% Confidence Interval)
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgement, or analogy.	L: -20% to -50% H: +30% to +100%
Class 4	**1% to 15%**	**Study or feasibility**	**Equipment factored or parametric models.**	**L: -15% to -30% H: +20% to +50%**
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly-level line items.	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off.	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off.	L: -3% to -10% H: +3% to +15%

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3. Total Installed Cost

A complete summary table of the total installed cost CAPEX including all contingencies and owner's cost values is provided below in Table 3-1, Table 3-2, Table 3-3, and Table 3-4.

Table 3-1: Total Installed Cost Summary-Option 1

Option 1: 20 MW with a four-hour reserve-CAPEX Summary, by Trade									
					SUBTOTALS				
Trade	Description	TOTAL COST (CAD)	% of Direct Cost	% of Total Cost	EQUIPMENT	MATERIAL	LABOUR	SUBCONTRACT	LABOUR HOURS
A	Site Development	801,800	1%	1%	-	38,902	56,659	706,245	259
C	Concrete	3,446,100	5%	3%	-	1,221,048	2,225,097	-	11,814
D	Roadworks, Drainage & Paving	73,200	0%	0%	-	10,025	21,193	41,991	97
E	Earthwork	3,335,400	5%	3%	-	2,689,772	368,415	277,181	1,517
L	Electrical Equipment	54,118,300	83%	43%	51,630,062	80,714	2,407,499	-	13,974
S	Structural Steel	353,700	1%	0%	-	72,734	80,984	200,000	387
W	Wire & Cable	2,824,000	4%	2%	-	2,302,682	521,298	-	2,904
	DIRECT COSTS	**64,952,500**	**100%**	**51%**	**51,630,062**	**6,415,877**	**5,681,146**	**1,225,416**	**30,953**
	SUBTOTAL DIRECT COSTS	**64,952,500**	**100%**	**51%**	**51,630,062** 79%	**6,415,877** 10%	**5,681,146** 9%	**1,225,416** 2%	**30,953**
Y	Indirect Cost	32,588,500							
	INDIRECT COSTS	**32,588,500**							
	SUBTOTAL DIRECT + INDIRECT COSTS	**97,541,000**							
Z	Contingency	24,385,300							
	CONTINGENCY	**24,385,300**							
	SUBTOTAL DIRECT + INDIRECT COSTS + CONTINGENCY	**121,926,300**							
V	Owner's Cost	5,196,200							
	OWNER'S COST	**5,196,200**							
	TOTAL COST DIRECT + INDIRECT + CONTINGENCY + OWNER'S COST	**127,122,500**							

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Table 3-2: Total Installed Cost Summary-Option 2

Option 2: 20 MW with an eight-hour reserve-CAPEX Summary, by Trade							SUBTOTALS		
Trade	Description	TOTAL COST (CAD)	% of Direct Cost	% of Total Cost	EQUIPMENT	MATERIAL	LABOUR	SUBCONTRACT	LABOUR HOURS
A	Site Development	818,700	1%	0%	-	45,793	66,669	706,245	305
C	Concrete	4,883,800	5%	3%	-	1,710,487	3,173,302	-	16,848
D	Roadworks, Drainage & Paving	85,100	0%	0%	-	10,750	26,646	47,744	122
E	Earthwork	4,320,400	5%	2%	-	3,421,485	553,602	345,275	2,280
L	Electrical Equipment	75,736,600	85%	43%	72,566,043	80,714	3,089,837	-	17,935
S	Structural Steel	353,700	0%	0%	-	72,734	80,984	200,000	387
W	Wire & Cable	3,321,600	4%	2%	-	2,698,176	623,451	-	3,474
	DIRECT COSTS	**89,519,900**	**100%**	**51%**	**72,566,043**	**8,040,139**	**7,614,491**	**1,299,263**	**41,351**
	SUBTOTAL DIRECT COSTS	**89,519,900**	**100%**	**51%**	**72,566,043** 81%	**8,040,139** 9%	**7,614,491** 9%	**1,299,263** 1%	**41,351**
Y	Indirect Cost	45,190,700							
	INDIRECT COSTS	**45,190,700**							
	SUBTOTAL DIRECT + INDIRECT COSTS	**134,710,600**							
Z	Contingency	33,677,700							
	CONTINGENCY	**33,677,700**							
	SUBTOTAL DIRECT + INDIRECT COSTS + CONTINGENCY	**168,388,300**							
V	Owner's Cost	7,161,600							
	OWNER'S COST	**7,161,600**							
	TOTAL COST DIRECT + INDIRECT + CONTINGENCY + OWNER'S COST	**175,549,900**							

Table 3-3: Total Installed Cost Summary-Option 3

Option 3: 50 MW with a four-hour reserve-CAPEX Summary, by Trade							SUBTOTALS		
Trade	Description	TOTAL COST (CAD)	% of Direct Cost	% of Total Cost	EQUIPMENT	MATERIAL	LABOUR	SUBCONTRACT	LABOUR HOURS
A	Site Development	825,500	1%	0%	-	48,549	70,673	706,245	324
C	Concrete	5,852,800	5%	3%	-	2,040,434	3,812,345	-	20,241
D	Roadworks, Drainage & Paving	85,100	0%	0%	-	10,750	26,646	47,744	122
E	Earthwork	4,671,700	4%	2%	-	3,741,478	551,771	378,458	2,273
L	Electrical Equipment	102,603,700	87%	44%	98,614,384	80,714	3,908,642	-	22,687
S	Structural Steel	353,700	0%	0%	-	72,734	80,984	200,000	387
W	Wire & Cable	3,740,700	3%	2%	-	3,046,176	694,537	-	3,870
	DIRECT COSTS	**118,133,200**	**100%**	**51%**	**98,614,384**	**9,040,834**	**9,145,599**	**1,332,446**	**49,903**
	SUBTOTAL DIRECT COSTS	**118,133,200**	**100%**	**51%**	**98,614,384** 83%	**9,040,834** 8%	**9,145,599** 8%	**1,332,446** 1%	**49,903**
Y	Indirect Cost	60,150,800							
	INDIRECT COSTS	**60,150,800**							
	SUBTOTAL DIRECT + INDIRECT COSTS	**178,284,000**							
Z	Contingency	44,571,000							
	CONTINGENCY	**44,571,000**							
	SUBTOTAL DIRECT + INDIRECT COSTS + CONTINGENCY	**222,855,000**							
V	Owner's Cost	9,450,700							
	OWNER'S COST	**9,450,700**							
	TOTAL COST DIRECT + INDIRECT + CONTINGENCY + OWNER'S COST	**232,305,700**							

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Table 3-4: Total Installed Cost Summary-Option 4

Option 4: 50 MW with an eight-hour reserve-CAPEX Summary, by Trade									
					SUBTOTALS				
Trade	Description	TOTAL COST (CAD)	% of Direct Cost	% of Total Cost	EQUIPMENT	MATERIAL	LABOUR	SUBCONTRACT	LABOUR HOURS
A	Site Development	904,100	1%	0%	-	80,560	117,322	706,245	537
C	Concrete	9,106,900	5%	3%	-	3,149,034	5,957,823	-	31,632
D	Roadworks, Drainage & Paving	94,700	0%	0%	-	11,127	27,567	55,967	126
E	Earthwork	7,675,100	4%	2%	-	6,162,548	912,943	599,580	3,760
L	Electrical Equipment	156,659,600	87%	44%	150,954,339	80,714	5,624,595	-	32,647
S	Structural Steel	353,700	0%	0%	-	72,734	80,984	200,000	387
W	Wire & Cable	4,448,900	2%	1%	-	3,595,741	853,191	-	4,754
	DIRECT COSTS	**179,243,000**	**100%**	**51%**	**150,954,339**	**13,152,458**	**13,574,424**	**1,561,792**	**73,843**
	SUBTOTAL DIRECT COSTS	**179,243,000**	**100%**	**51%**	**150,954,339** 84%	**13,152,458** 7%	**13,574,424** 8%	**1,561,792** 1%	**73,843**
Y	Indirect Cost	91,882,400							
	INDIRECT COSTS	**91,882,400**							
	SUBTOTAL DIRECT + INDIRECT COSTS	**271,125,400**							
Z	Contingency	67,781,400							
	CONTINGENCY	**67,781,400**							
	SUBTOTAL DIRECT + INDIRECT COSTS + CONTINGENCY	**338,906,800**							
V	Owner's Cost	14,339,400							
	OWNER'S COST	**14,339,400**							
	TOTAL COST DIRECT + INDIRECT + CONTINGENCY + OWNER'S COST	**353,246,200**							

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4. Direct Costs

Direct costs are the costs of all equipment and bulk materials, together with construction and installation costs for all permanent facilities. Examples of direct costs include, but are not limited to the following:

- Supply, assembly, and installation of permanent equipment;
- Supply, fabrication, and installation of bulk materials;
- Supplemental resources for equipment and bulk material installation, such as labor and construction equipment;
- Site preparations (bulk earthworks) and the construction of roads and storm water ditching;
- Supply, fabrication, and erection of permanent buildings and associated services;
- Supply, fabrication, erection of utilities, and distribution systems;
- Contractor's distributable costs such as mobilization and demobilization, overheads and profit, supervision, general construction equipment including construction cranes, small tools, and consumables used in construction, etc.

4.1 Quantity Development

4.1.1 Site Development

Civil Material Take-Offs (MTO) is a combination of information extracted from the Civil model as well as manual calculations for the design cost estimate development. The MTO includes the following:

- Clearing and Grubbing;
- Topsoil striping;
- Mass excavation
- New granular materials (Fill);
- Underground utility infrastructure;
- Other civil infrastructure on site.

As noted, all quantities are subject to change as civil model progresses.

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4.1.1.1 *Civil Assumptions and Exclusions*

Anticipated wetland conditions for the site, assumption was made in coordination with geotechnical SME with site familiarity. The following assumptions and exclusions were considered during preparation of the civil MTO:

- The frost depth is 1.3 m below the finished grade;
- The ground water table is 0.5 m below the finished grade;
- The important factor for the project is Post Disaster since it is public infrastructure;
- The competent soil or engineered backfill is found at the base of all foundations.

Note: Post disaster requirements have been addressed through the design basis, with systems and equipment specified to meet enhanced resilience and performance criteria consistent with critical public infrastructure. The estimate reflects this by incorporating the resulting increases in material specifications and construction requirements associated with designing to post disaster standards.

4.1.2 *Structural*

MTOs were developed from the foundation model and categorized based on Area and type (equipment footings, structural footings, ground slab, etc.).

Dimensions in the foundation model are based on either preliminary calculation or historical dimensions from similar projects, accounting for differences in bearing capacity.

Concrete strengths are based on capacity requirements, client standards, and structural design criteria documents, and are identified in the item description.

Any special coatings (i.e., floor coatings) are identified in the item description.

No concrete demolition is expected to be required.

The Structural steel was not modelled and is accounted for using allowances.

No structural steel demolition is expected.

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4.1.3 Electrical

Electrical MTOs are extracted from the single-line diagrams, layouts, and sectional drawings for use in the project estimate development.

An electrical equipment list was developed to include major electrical equipment.

Costs are based on a combination of budgetary vendor quotations for major electrical equipment and historical data from Hatch's internal cost database (quotations obtained in the past two years). Historical and vendor derived costs were normalized to the specific project configuration by scaling against key technical parameters, including installed energy capacity for battery systems and power capacity for power conversion and associated balance of plant equipment. All normalized costs were escalated to 2026 price levels using the Canadian Consumer Price Index (CPI) to reflect general inflation, with adjustments applied consistently across all cost categories to maintain comparability. Initial overbuild accounting for battery degradation was considered in CAPEX estimates.

The developed SLDs were used to develop the cable schedule and MTOs for the estimate.

66 kV transmission lines related rework is included as a lump sum MTO consisting of the removal of 7 wood poles and the installation of 8 wood poles.

Cable termination installation costs have been included in the estimate using an applied adjustment factor to cable quantities and installation activities. Testing of cables is assumed to be executed as part of the EPCM scope.

4.2 Growth and Waste Allowance

4.2.1 Quantity Growth

Quantity growth (also referred to as take-off allowance) is applied in the form of an increase to the taken-off quantity and is intended to allow for the most likely final quantity (and therefore cost) in the estimate. Quantity growth allowances are applied as percentages based on historical data and estimators experience, depending on the maturity of engineering competition. Quantity growth is applied to a 'neat quantity' (or 'base quantity') to arrive at an estimated 'final quantity.' Reported costs are calculated based on final quantities.

4.2.2 Cost Growth

Estimates generally base their costs on quotations, price lists, estimates provided by the vendors, etc. Due to incompleteness of the project development, all those uncommitted costs rarely consider final specifications or commercial terms and conditions.

A cost growth allowance is an amount added to the activity to account for the expected increase in costs to anticipate the values of tender period or award. The Growth allowance is based on Hatch Discipline Guide for Project Capital Cost Estimates, which uses the AACE classification system.

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4.2.3 *Wastage*

A wastage (or construction waste allowance) allows for the fact that some materials will be purchased but not installed due to unavoidable losses from over-pour, off-cutting, theft, and errors. Common items where waste allowances are applicable are the following: wire cable, cable tray and conduit, piping, concrete, grout, siding, and block work, etc.

The application of both quantity and cost growth allowances was considered with the participation of engineering and procurement. Standard wastage allowances are used.

The percentage of growth Allowance & Waste Allowance, included in the estimate ,were defined depending on the activity, shown in Table 4-1.

Table 4-1-Growth Allowance

Trade Code	Activity	Growth Allowance	Waste Allowance
A	Site Development	25%	5%
D	Drainage and Roads	25%	5%
E	Earthworks	25%	5%
C	Concrete	20%	5%
S	Structural Steel	15%	5%
F	Architectural	15%	8%
L	Electrical Equipment	0%	0%
W	Wire and Cable	20%	10%

4.3 Installation Costs

The installation labour component was calculated using the following major sub-components:

(i) All-in labour rates.

(ii) Labour hours (base hours x productivity factor).

4.3.1 *All-in Labour Rates*

The all-in labour rates developed in this CAPEX are divided into the following portions: direct labor, contractor distributable, construction equipment, and living out allowance (LOA).

The direct labour rates used in the estimate are developed using a combination of public published base rates and Hatch in-house data from similar projects. Separate Labour rates are developed for each discipline to accommodate different crew sizes and construction equipment. Final assumptions are presented in Table 4-2.

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The All-in Labour Rates include the following components:

Direct labour component:

- Direct Hourly Base Wage;
- Overtime Premiums;
- Nightshift Premiums (if applicable);
- Fringes and Benefits;
- Burdens.

Contractor distributable component (these are considered contractor indirect and not construction indirect as shown in the indirect cost section):

- Small Tools and Consumables;
- Personal Protective Equipment (PPE);
- Contractor - Mobilization/Demobilization;
- Contractor - Temporary Site Facilities;
- Supervision and Administration;
- Health/Safety/Environment/Quality;
- Fees and Insurances;
- Head Office Operations;
- Mark-up and Profit;
- Construction Equipment Component;
- Living Out Allowance (LOA) component (which includes travel and accommodation).

Note: Heavy lift cranes (over 80 tons) are not included in the labour rate and instead are included in the indirect costs section of the estimate. The estimate assumes that 50% of the construction workforce will require Living Out Allowance (LOA) due to the anticipated availability of local labour and the project's proximity to established population centers. It is assumed that the remaining 50% of the workforce can be sourced locally and will commute daily to the project site without the need for LOA support.

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Table 4-2: Labour All-In Unit Rate Breakdown in CAD

Code	Discipline	All-In Labour Rates (CAD)
A	Site Development	218.38
C	Concrete	188.35
D	Roadworks, Drainage & Paving	218.38
E	Earthworks	242.79
F	Architectural	189.53
J	Control & Instrumentation	167.49
L	Electrical Equipment	172.28
M	Mechanical Equipment	196.56
N	Mechanical Platework & Tanks	209.52
P	Pipework & Fittings	173.43
Q	Insulation	179.49
R	Cable Ladder, Tray & Conduit	179.49
S	Structural Steel	209.14
W	Wire & Cable	179.49

4.3.2 Labour Hours

The labour hours development for labour has 2 components:

i) Standard man-hours.

ii) Productivity factor:

The standard man-hours (or labour-hours, or yet industrial work hours) are standard average hours estimated using historical benchmarked data, previous benchmarked projects, and estimator's experience.

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4.3.3 *Productivity, Difficulty, Level of Effort*

Productivity Factor (PF) – Since the man-hours are standard factors; adjustments are necessary to reflect the specific conditions at the project site. Those adjustments are made using a Productivity Factor Scorecard, which analyses and rates the labour efficiency based on site and on working conditions.

Productivity values are assessed using Hatch's productivity factor score card. Calculations are prepared based on estimators' experience. PF includes factors such as weather at site during construction, site congestion, and work access labour availability within region (site-specific productivity), as well as paid breaks, safety talks, and tool clean up (non-productive daily time loss). The productivity assessment is calculated below in Table 4-3.

Table 4-3: Productivity Assessment

Item Description	Category	Weighted Value
Size of Project	Medium job few fallback positions.	1.05
Site and Congestion	Work is in open area/easy access.	0.90
Labour availability	Average crafts/few contractors/very little unemployment.	1.20
Craft Type and Skills	Union agreement/less than average skills/some familiarity with required standards/new working teams.	1.25
Timing/Schedule	Tight schedule but no overtime required/some drawing and material delays.	1.15
Supervision On Job (Front Line)	Limited number of good, experienced supervisors available.	1.15
Mechanization	Labour intensive operations-some crafts limited numbers and capabilities of equipment.	2.00
Work Complexity Against Standards	Increased complexity and density of trades with increasing pipe, electrical and control requirements.	1.20
Material, tools, and equipment availability	Materials, tools, and equipment arrive to site on time.	1.00
Absenteeism	5% per day.	1.15
Craft Turnover	5% to 10% turnover per month.	1.20
Contracting Strategy	Target Price.	1.20
Workday and Rotation	Ten-hour day/Five Day Week.	0.95
Weather conditions	Expected delays due to weather conditions.	1.20
	Assessed Total	**16.60**
	Productivity Assessment (Assessed Total/Count of Assessed)	**1.19**

Installation base hours are based on Newfoundland and Labrador, Canada, and in-house databases for similar projects. Labour hours are adjusted by a productivity multiplier to consider project-specific requirements. Hatch developed productivity based on two components, non-productive time and site conditions.

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The labour productivity factor considers issues that affect labor hours regardless of the environment where the work is being completed. This productivity looks at the break walk times, toolbox meetings, clean up, etc. Table 4-4 provides an example of details on the productivity factor calculated, based on initial estimates by Hatch.

Table 4-4: Site Time Loss Table

Normal Productivity			
Description	**Occurrence**	**Current**	
		Minutes	**Total Minutes**
Travel from Accommodation to Site	-	-	-
Walk/Unloading from Bus Drop-off Area to Contractor Office	-	-	-
Walk from Office to Work Area	1	5	5
Toolbox/Health & Safety Meetings	1	20	20
Wash Break (Morning)	1	5	5
Morning Break Walk (To & From)	1	5	5
Morning Break	1	15	15
Wash Break (Lunch)	1	5	5
Lunch Break Walks (To & From)	1	5	5
Unpaid Lunch Break	-	-	-
Wash Break (Afternoon)	1	5	5
Afternoon Break Walk (To & From)	1	5	5
Afternoon Break	1	15	15
Afternoon Break Walk (To & From)	1	5	5
Workstation Clean Up	1	15	15
Wash Break (End-of-Day)	1	5	5
Walk to Contractor Trailer for Pick-up	1	5	5
		Total Minutes Lost	**115**
		Total Workday in Minutes - 10 hrs. x 60 mins	600
		Effective Time Minutes	485
		Normal Productivity (Calculated Base PF Factor)	**1.24**

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Productivity accounts for site-specific or project-specific issues. A productivity factor will be assumed for the project based on input from execution specialists who are familiar with working with the North American contractors. The productivity factor used for all disciplines within the CAPEX is shown below in Table 4-5.

Table 4-5: Productivity Factor

PF Factor	Value
Assessed Total	16.60
Productivity Assessment	1.19
Normal Productivity	1.24
Total Productivity Adjustment (Productivity Assessment * Normal Productivity)	**1.47**
Total Efficiency Factor	0.68

5. Indirect Costs

Indirect costs include the following:

- Any applicable temporary construction facilities including temporary worker lodgings/services, secure lay-down areas, warehouses, scaffolding, etc.;
- Temporary construction services including IT, catering, camp and office cleaning services, worker transportation to the job site, etc.;
- Freight and logistics;
- Vendor representatives;
- First fills of materials such as transformer oil, lubricants, and other items that are not consumed by the process;
- Start-up/commissioning spares, capital spares;
- Engineering, procurement and construction management services (including travel expenses);
- Third-party engineering and other services.

Indirect costs are made up of factors and allowance. The factors and allowances are developed based on historical information from similar projects, adjusted to account for site-specific factors. An indirect cost summary with basis is provided below in Table 5-1.

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Table 5-1: Indirect Cost % Summary

Category	% of Direct Cost	Basis
Engineering, procurement, construction management	20%	Engineering, Procurement, Construction Management including expenses.
Construction Indirects	8%	Includes: Site Emergency Services, Laydown Area, Construction Site Security, Construction Services, Temporary Facilities.
Freight	15%	Cost of transport equipment and materials to site from supplier deposits (Does not include duties).
Vendor's Representatives	4%	Large packages require representatives during construction as well as commissioning for warranty purposes.
Spare Parts	2%	Commissioning and Startup.
Spare Parts	4%	Capital Spares.
Third Party Services	1%	Allowance for 3rd Party Eng. Services (Excludes Geotech Study, EA studies, Noise Study, etc. Included in Owners Costs).
Other Indirect Costs	lot	Heavy Cranes, First Fills.

5.1 Engineering, Procurement, Construction Management (EPCM)

The scope of services includes the following, project control, multidisciplinary engineering, procurement, and construction management activities. Scope of responsibility for this section is supported by the deliverables list included in the signed contract, which includes:

- **Project Management and Services:**
  - Project Management;
  - Project Controls;
  - Project Schedule;
  - Progress Tracking;
  - Progress Reporting;
  - Estimating;
  - Cost Control;
  - HR and Industrial Relations;
  - Document Management;
  - Project Controls Deliverables;
  - Risk Management.

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- **Execution Planning:**
  - Project Execution Strategy;
  - Project Management Strategy;
  - Project Controls Strategy;
  - Construction Management Strategy;
  - Health and Safety Strategy;
  - Quality Management Strategy.
- **Detailed Engineering:**
  - FEED;
  - Process;
  - Risk;
  - Mechanical;
  - Piping;
  - Layout and Coordination;
  - Civil;
  - Structural;
  - Instrumentation and Controls (I&C);
  - Electrical;
  - Grounding Studies;
  - Arc Flash Studies;
  - Additional Studies (Fresh Water Supply, Hydraulic Modeling, Early Works, etc.).
- **Procurement and Contracts:**
  - Procurement of Equipment and Materials and Field Contracts.
- **Construction Management:**
  - Construction Management and Supervision of the Site Construction Contractor.
- **Project Closeout:**
  - Substantial completion, commissioning support, deficiency resolution, turnover of final documentation and as built records, contract closeout and final reporting.

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5.2 Construction Indirects

- **Construction Indirects:**
  - Temporary Offices;
  - Warehousing;
  - Storage and Preservation;
  - Sheds;
  - Furniture;
  - Bathrooms;
  - Connections;
  - Reticulation and Consumption of Power;
  - Sewage and Water;
  - Staff;
  - Communications;
  - First Aid;
  - Site Security;
  - Site Vehicles;
  - Parking and Lay-down Areas;
  - Summer Dedusting;
  - Snow Removal, etc.;
  - Major and Heavy Lift Cranes (over 80 t): an allowance was made for heavy cranes.

5.3 Freight

Costs for freight are developed for all equipment and bulk material. The freight estimate is developed based on the information provided by quotations/estimates from vendors (if provided). When not available, freight is factored using percentages from other firm's price and quotes as guidelines.

Bulks are factored using historical percentages or information provided by suppliers. If delivery to site is included in the supply cost, they are excluded from the freight calculation.

5.4 Vendor Representatives

Costs for vendor representatives are factored for construction, pre-commissioning and hot-commissioning stages.

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5.5 Spare Parts

Spare parts were categorized as:

- **Commissioning and Start-up Spare Parts:** Spare parts required specifically due to initial high wear, and which may fail due to abnormal operating conditions during start-up and commissioning but are not considered normal operating spares;
- **Capital Spare Parts:** Spare parts that are recommended to maintain plant operability in case of catastrophic failure or accident, or replace components taken out of service for major maintenance**.**

5.6 Third Party Services

Third party engineering services such as surveying, laser scanning, specialty x-ray services (e.g., buried services); testing has been assessed based on information received to date. The costs have been factored as 1% of the direct cost.

5.7 Miscellaneous Indirect Cost

Miscellaneous indirect costs included within the CAPEX are:

- Heavy Cranes.

6. Owner Costs

Owner's cost suggested by Hatch to NL Hydro is 8% in this estimate for all options.

Owner's Costs include the period from approval to proceed with project execution through to project handover to the operations group and close out. Typical Owner's Cost items include, but are not limited to:

- Owner's Team Cost, Home Office and Site Construction Management;
- Project Development Costs prior to board project approval (sunk costs typically) including Test Work Development, Prefeasibility and Feasibility Studies;
- Costs associated with Environmental Studies and Permits;
- Project Insurance;
- Owner's Risk and Reserve;
- Forward Escalation, if not included in Other Costs section;
- Land Acquisition and Right of Way;
- Finance and Interest charges.

7. Escalation

No provisions for escalation of costs have been evaluated for any of the options.

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8. Contingency

Contingency is a provision for unknown project costs which may occur for the known scope of the project, but which cannot be identified for estimating purposes due to the lack of complete, accurate and detailed information, as well as limited engineering knowledge.

The addition of contingency is required to capture the most likely cost of the project at execution.

Project contingency is not intended to cover scope changes or project exclusions.

This estimate did not include a Quantitative Risk Analysis (QRA). Recommending a contingency provision of 25% above the base estimate based on Hatch Class 4 similar projects, based on defined scope and detail.

9. Estimate Reviews

To ensure consistency of the information transfer and overall estimate assembly, the following checkpoints and estimate reviews listed below were performed prior to the final issuance of the CAPEX.

9.1 Review Process

A summary of the review steps is indicated in Table 9-1.

Table 9-1: Estimate Reviews

	Review	Responsibility	Checklist
Hatch Internal Review	MTO Review	Hatch Discipline Leads.	Quantities and completeness of MTOs prior to issue to estimate.
	Multi-Discipline Review	Hatch Discipline Leads, Hatch Estimating, Hatch Engineering Manager, and Project Manager, Construction.	Completeness, proper transfer of MTO information and duplications, Unit pricing completeness by construction.
	Management Team Review	Hatch Estimating Lead, Project Manager, and Sponsors.	Estimate Metrics Indirect Costs.
	Peer Review	Independent Senior Hatch Estimator.	Complete Estimate Review.

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10. Estimate Exclusions

The following list is not included in the CAPEX.

- Taxes and Duties;
- Schedule delays and/or Associated Costs, such as those caused by:
  - Unexpected Site Conditions;
  - Unidentified Ground Conditions;
  - Labour Disputes;
  - Force Majeure;
  - Permit Applications (Government approval for any new development).
- Development Fees and Approval Costs;
- Impacts to variance in Rates or Estimates provided by construction;
- Insurance Fees – if applicable;
- Cost of any disruption to normal operations;
- Economy Factors/Pressure on Labour Productivity (less skilled workforce);
- Any costs incurred to accelerate the work or to get the work back on schedule if it deviates from the baseline plan (such as overtime charges, expediting charges, etc.);
- Allowances for any changes to the scope of the project;
- Allowance for the risks associated with legal or regulatory environment;
- Allowances for either:
  - General project risks that could affect any project (such as variations in market conditions that could affect equipment, commodities and/or labour costs, labour unrest, disputes with local residents, geotechnical or process-related design issues, delays due to the late receipt of equipment or materials, poor performance by contractors, force majeure, etc.);
  - Risks that are specific to this Project.

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Appendix A:

Discipline Guide Project Capital Cost Estimate (PLP-620-020-0001) Excerpts & Estimate Maturity Classification

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Table A - 1: Estimate Classification

Comparison of Quality of Estimate Classifications					
Hatch Project Life Cycle Classification	FEL 1		FEL 2	FEL 3	FEL 4
	Conceptual Study		Pre-Feasibility Study	Feasibility Study	Implementation Phase
Hatch Classification	*Level 1*		*Level 2*	*Level 3*	*Level 4*
Gate Review Level	*Gate 1*		*Gate 2*	*Gate 3*	
AACE Classification	*Class 5*	*Class 4*	*Class 3*	*Class 2*	Class 1
Also known as:	Order of Magnitude Est.			Detailed Estimate	Definitive Estimate
End Use (Typical purpose of estimate)	Concept Screening; Comparison of alternatives; Prelim. Investigation	Concept Study; Identification of requirements and cost of Level 2 Study	Budgetary, Viability; Determine validity of business case	Appropriation or Control; Detailed control baseline for monitoring variation to budget	Check Estimate or Bid/Tender – detailed validation typically against discreet parts of total project
Methodology	Capacity factored, parametric models, judgment, or analogy, Stochastic estimating approach	Equipment factored, Major equipment quotes; benchmarked or parametric models	Semi-detailed; assembly level line items; gross WBS and work packages; budget vendor quotations	Detailed MTOs, unit costs with some forced detailed take-offs; planning; defined work packages; Firm Bids/Tenders.	Detailed MTOs and unit costs; Same as Level 3 but uses actual productivity, etc.
Level of Engineering Definition	**0% to 1%**	**1% to 5%**	**5% to 20%**	**15% to 30%**	**50% to 100%**
Level of Contingency	30% to 50% or more	30% to 50%	20% to 30%	10% to 20% based on contingency risk analysis	Up to 10% based on contingency risk analysis
Indicative Probability Range	No better than 80%		Not greater than 90%	Not greater than 90%	Not greater than 90%
Predicted Accuracy Range High	+100%	+50%	+30%	+15%	+10%
Low	–50%	–30%	–20%	-10%	–10%

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Table A - 2: Estimate Maturity Classification

Comparison of Quality of Estimate Classifications					
Hatch Project Life Cycle Classification	**FEL 1**		**FEL 2**	**FEL 3**	**FEL 4**
	Conceptual Study		**Pre-Feasibility Study**	**Feasibility Study**	**Implementation Phase**
Hatch Classification	***Level 1***		***Level 2***	***Level 3***	***Level 4***
Gate Review Level	***Gate 1***		***Gate 2***	***Gate 3***	
AACE Classification	***Class 5***	***Class 4***	***Class 3***	***Class 2***	**Class 1**
Process					
Plant Capacity	Assumed	Preliminary	Defined	Final	Final
Control Philosophy	None	None	Outlined	Detailed	Finalized
Energy & Material Bal.	Estimated	Estimated	Preliminary	Optimized	Complete
P & IDs	None	None	Detailed for Major Systems	Optimized and final	Complete
Definition					
Plot Plans	None	None	Preliminary	Detailed	Complete
GA Drawing by Area/Facility	Sketch/None	Sketch/None	Preliminary	Detailed	Complete
Equipment List	None	Assumed – major equipment only	Preliminary List	Detailed	Complete
Civil/Structural Drawings	None	None	Preliminary	Advanced	Complete
Electrical Drawings	None	None	None	Some Detail	Advanced/Complete
Electrical Single Line Drawings	None	None	Preliminary	Some Detail	Complete
Design Criteria	Outlined	Outlined	Preliminary	Optimized and Final	Complete
Specifications/Data Sheets	None	Assumed	Preliminary	Detailed	Complete
CAPITAL COST ESTIMATE					
Infrastructure costs: Power, Water, Roads, Rail	Assumed	Investigated	Finalize Detail	Finalized	Finalized
Vendor Selection	None	None	Major Equipment Only	Selected for major equipment. Other mostly complete	Complete
Mechanical Equipment	Data bank/Factored	Benchmark Project factored Preliminary List, major equipment	Multiple source budget quote Preliminary List	Vendor quotes for major & some minor equipment Detailed List	Purchase order Complete
Electrical Equipment	Factored Price	Benchmark Project factored Preliminary List, major equipment	Multiple source budget quote Preliminary List	Vendor quotes for major & some minor equipment Detailed List	Bids/POs/Tenders Complete
Electrical Bulks	Factored Price	Benchmark Project factored	Budget Quote Factored MTOs/Take Offs	Budget Quote Factored/Take-offs	Final Quote Final MTO
Civil Work	Factored Price	Benchmark Project factored	Unit Rates/Built-up rates Take-off plus allowances	Built-up Rates Take-off	Final Quotes Final MTO
Structural Work	$/unit vol./factored pricing Factored Mass	$/unit vol./unit rates Prelim Take-off/factored	Preliminary In-house Pricing from database Take-off sketches plus allowances	Budget Quotations and in-house pricing Material Take-off	Tender Prices Final MTO from AFC drawings
Piping & Instrumentation	Factored % Mechanical equipment	Factored % Mechanical equipment	Budget Quotes Take-off large bore/factored small bore	Budget/Firm Quotations Take-off Large and Small bore	Tender Prices Final MTO
Installation Labor	Factored	Factored	Workhours Typical Site Agreement	Workhours Specific Site Agreement	Workhours Contracts
Indirect Costs	% of total	% of total	Preliminary Calculation or factored	Detail calculation	Detail calculation
Spare Parts	% of total	% of total	% of total	% of total plus spares list	Substantially Complete
Owners Costs	Factored off TIC	Factored off TIC	Factored off TIC or preliminary estimate	Detailed estimate	Detailed estimate
Contingency	Factored off TIC	Factored off TIC	Factored off TIC or calculated from deterministic or probabilistic model	Probabilistic risk model	Probabilistic risk model
Inflation/Escalation	Factored off TIC	Factored off TIC	Factored off TIC based on preliminary schedule	Calculation based on project schedule and cash flow	Calculation based on project schedule and cash flow

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Appendix B

CAPEX Option 1

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ID #	Estimate Number	Rev.	Trade	Price Code	Price Code Description	Scope	Bill Description	Remarks
							Preliminary	
1	-001	0	A				Environmental Cost	
							Excavation & Backfilling	
1	-001	A	E				Clearing and grubbing	
2	-002	A	E				150mm Topsoil stripping	
3	-003	B	E				Removal of Unsuitable Material	Assuming removal of 2 meter layer from surface to suitable subgrade, transport and disposal offsite
4	-004	B	E				Mass Excavation	
5	-005	B	E				Structural Fill layer, Class C Granular from bottom of excavation to subgrade	Excludes quantities for pavement structures
6	-006	B	E				150mm surface layer of 5-20mm Clear stone	
7	-007	B	E				200mm base layer Class A granulars	
8	-008	B	E				400mm minimum sub-base layer of Class B granulars	
9	-009	B	E				Ditch Excavation	
10	-010	B	E				Nonwoven needle-punched geotextile	
11	-011	B	E				Trenching	Assuming depth of 1.2m and side slopes of 2:1
12	-012	B	E				Backfill, Type 1 material bedding for direct buried cables, 450mm layer	Type 1 (25mm minus) spec according to NL DTI Standard Specifications for Aggregate for Roadwork
							Drainage	
1	-001	A	D				Supply and Install 150mm Ø HDPE perforated subdrains	Including Excavation
2	-002	A	D				Supply and Install 150mm Ø HDPE solid wall sub-drains	
3	-003	A	D				Geotextile cover for subdrains, Class IV	
4	-004	A	D				50mm Clear stone bedding	
5	-005	A	D				Rip-Rap 300mm Ø	Stormwater discharge
6	-006	A	D				Supply and Install Petro-Pipe PIFH-620 or similar	Stormwater discharge at the transformer containment pit
7	-007	A	D				Supply and Install 300mm Ø culvert	
8	-008	A	D				Supply and install of lift station	
9	-009	A	D				Supply and install of clean out structures	
							Site Development	
1	-001	B	A				Fencing, chain link fence, 2400-mm height, as per NL Highway Construction Standards	Unsure of height
2	-002	A	A				Double Swing Gates, 6-m width	Unsure of height
2	-003	B	A				Relocation of Transmission line	Lump Sum cost
3	-004	B	A				Relocation of Fire Hydrant	Lump Sum cost
							Concrete & Steel	
1	-001	0	C		CONCRETE	Battery pack containers	Mat foundations, t=450 mm	
2	-002	0	C				Walls, t=450 mm	
3	-003	0	C				Walls, t=1100 mm	
4	-004	0	C				Steel angle for anchoring, L89x89x13	
5	-005	0	C				Mechanical anchors, Kwik Bolt KB-TZ 2 5/8x6 in carbon steel	
6	-006	0	C			Main electrical room	Strip footings, t=700 mm	
7	-007	0	C				Isolated footing, t=700 mm	
8	-008	0	C				Pilasters, 0.7 m x 0.7 m	
9	-009	0	C				Stairs pads	
10	-010	0	C				Cast-in-place anchors, 55 ksi	
11	-011	0	C			Transformers basin	Mat foundations, t=700 mm	
12	-012	0	C				Walls, t=250 mm	
13	-013	0	C				Firewalls, t=450 mm, h=9 m	
14	-014	0	C				Equipment bases over the mat	
15	-015	0	C				Insulation polystyrene, t=75 mm, Highload 60	
16	-016	0	C				Water stop	
17	-017	0	C			Circuit breaker	Isolated footing, t=600 mm	
18	-018	0	C				Pilasters, 1.4 m x 1.4 m	
19	-019	0	C				Pilasters, 0.5 m x 0.5 m	
20	-020	0	C				Cast-in-place anchors, 55 ksi	
21	-021	0	C			Bus Support	Isolated footing, t=500 mm	
22	-022	0	C				Pilasters, 0.5 m x 0.5 m	
23	-023	0	S		STRUCTURAL	Main access door	Steel columns and beams - Rolled sections - 31 to 60 kg/m	
24	-024	0	S				Grating 38x4.8 serrated, type 30-102	
25	-025	0	S				Handrails (sloped)	
26	-026	0	S				Handrails (straight)	
27	-027	0	S				Stair treads, 915 mm x 300 mm x 32 serrated	
28	-028	0	S			Second exit door	Steel columns and beams - Rolled sections - 31 to 60 kg/m	
29	-029	0	S				Grating 38x4.8 serrated, type 30-102	
30	-030	0	S				Handrails (sloped)	
31	-031	0	S				Handrails (straight)	
32	-032	0	S				Stair treads, 915 mm x 300 mm x 32 serrated	
33	-033	0	S			Circuit breaker	Steel columns and beams - Rolled sections - 16 to 30 kg/m	
34	-034	0	S				Steel columns and beams - Rolled sections - 31 to 60 kg/m	
35	-035	0	S				Grating 38x4.8 serrated, type 30-102	
36	-036	0	S				Handrails (sloped)	
37	-037	0	S				Handrails (straight)	
37	-037	0	S				Stair treads, 915 mm x 300 mm x 32 serrated	
38	-038	0	S			Box Structure	Box Structure	
							Major Electrical MTO	
1	-001	0	L		Major Electrical Equipments		Battery Container	6.1 m x 2.4 m x 2.9 m,43.5 tonnes
2	-002	0	L				PCS-MVT Skid	6.1 m x 2.4 m x 2.9 m,18 tonnes
3	-003	0	L				Energy Management System	
4	-004	0	L				66kV surge arresters	
5	-005	0	L				66kV disc. Switch w/ground sw	
6	-006	0	L				66kV disc. Switch	
7	-007	0	L				66kV CVT	
8	-008	0	L				66kV breaker	
9	-009	0	L				66kV revenue meter	
10	-010	0	L				66-34.5kV power transformer 45/60/80MVA	
11	-011	0	L				34.5KV grounding transformer	
12	-012	0	L				34.5kV switchgear 9 cells	
13	-013	0	L				E room	
14	-014	0	L				P&C panels	
15	-015	0	L				34.5kV padmount transformer	
16	-016	0	W				38kv 500kcmil Cu cable	
17	-017	0	L				SCADA panel	
18	-018	0	W				Grounding grid 4/0 bare	
19	-019	0	W		1c 1000kcmil 69kV cable		1c 1000kcmil 69kV cable	
20	-020	0	L		69kV cable termination		69kV cable termination	
							Total Direct Cost	
							Indirect Cost	
1			Y				EPCM	% of Direct Cost
2			Y				Construction Indirects	% of Direct Cost
3			Y				Freight(% of Equipment & Material)	% of Equipment & Material
4			Y				Vendor Representatives(% of Equipment)	% of Equipment
5			Y				Spare Parts - Commissioning and Startup(% of Equipment)	% of Equipment
6			Y				Spare Parts - Capital(% of Equipment)	% of Equipment
7			Y				Third-Party Services	% of Direct Cost
8			Y				First Fills for Transformers	
9			Y				Heavy Cranes-90t	
							Total Indirect Cost	
							Total Direct + Indirect Cost	
							Owner's Cost	
1			V				Owner's Cost	% of Direct Cost
							Contingency	
1			Z				Contingency	Excludes Owner's Cost
							Grand Total	

QUANTITY / LABOUR

ID #	Estimate Number	Unit of Measure	Bill Quantity	Quantity Maturity	Growth	Final Quantity	Unit Labour Hours	Cost Maturity	PF	Total Labour Hours	Hourly Wage ($/hr.)	Currency	FOREX	Net Final Split Amounts Labour
	Preliminary													
1	-001	Lot	1	N/a	0%	1.00		L						$ -
	Excavation & Backfilling													
1	-001	m2	7231	preliminary	25%	9,038.75		L	0.00	-	242.79	CAD	1.00	$ -
2	-002	m3	1085	preliminary	25%	1,356.81		L	0.00	-	242.79	CAD	1.00	$ -
3	-003	m3	9154	preliminary	25%	11,442.25		L	0.00	-	242.79	CAD	1.00	$ -
4	-004	m3	1068	preliminary	25%	1,335.00		L	0.00	-	242.79	CAD	1.00	$ -
5	-005	m3	5865	preliminary	25%	7,331.25	0.08	L	1.47	860	242.79	CAD	1.00	$ 208,873
6	-006	m3	627	preliminary	25%	783.75	0.08	L	1.47	92	242.79	CAD	1.00	$ 22,330
7	-007	m3	1108	preliminary	25%	1,385.00	0.08	L	1.47	163	242.79	CAD	1.00	$ 39,460
8	-008	m3	2262	preliminary	25%	2,827.50	0.08	L	1.47	332	242.79	CAD	1.00	$ 80,558
9	-009	m3	1017	preliminary	25%	1,271.25		L	0.00	-	242.79	CAD	1.00	$ -
10	-010	m2	4948	preliminary	25%	6,185.00		L	0.00	-	242.79	CAD	1.00	$ -
11	-011	m3	408	preliminary	25%	510.00	0.08	L	1.47	60	242.79	CAD	1.00	$ 14,530
12	-012	m3	86	preliminary	25%	106.88	0.07	L	1.47	11	242.79	CAD	1.00	$ 2,664
	Drainage													
1	-001	m	91	preliminary	25%	113.75		L	0.00	-	218.38	CAD	1.00	$ -
2	-002	m	44	preliminary	25%	55.00		L	0.00	-	218.38	CAD	1.00	$ -
3	-003	m^2	263	preliminary	25%	329.06		L	0.00	-	218.38	CAD	1.00	$ -
4	-004	m^3	16	preliminary	25%	19.80	0.20	L	1.47	6	218.38	CAD	1.00	$ 1,268
5	-005	m^3	4	preliminary	25%	5.25		L	0.00	-	218.38	CAD	1.00	$ -
6	-006	ea	2	preliminary	25%	2.50		L	0.00	-	218.38	CAD	1.00	$ -
7	-007	m	8	preliminary	25%	10.00	2.72	L	1.47	40	218.38	CAD	1.00	$ 8,713
8	-008	ea	1	preliminary	25%	1.25	16.00	L	1.47	29	218.38	CAD	1.00	$ 6,407
9	-009	ea	1	preliminary	25%	1.25	12.00	L	1.47	22	218.38	CAD	1.00	$ 4,805
	Site Development													
1	-001	m	235	preliminary	25%	293.75	0.50	L	1.47	215	218.38	CAD	1.00	$ 47,049
2	-002	ea	1	preliminary	25%	1.25	24.00	L	1.47	44	218.38	CAD	1.00	$ 9,610
2	-003	Lot	1	allowance	0%	1.00		L	0.00	-	218.38	CAD	1.00	$ -
3	-004	Lot	1	allowance	0%	1.00		L	0.00	-	218.38	CAD	1.00	$ -
	Concrete & Steel													
1	-001	m^3	270.0	preliminary	20%	324.00	6.00	L	1.47	2,852	188.35	CAD	1.00	$ 537,095
2	-002	m^3	120.0	preliminary	20%	144.00	6.50	L	1.47	1,373	188.35	CAD	1.00	$ 258,601
3	-003	m^3	105.0	preliminary	20%	126.00	6.50	L	1.47	1,201	188.35	CAD	1.00	$ 226,276
4	-004	kg	900.0	preliminary	20%	1,080.00	0.05	L	1.47	79	188.35	CAD	1.00	$ 14,919
5	-005	EA	375.0	preliminary	20%	450.00	0.15	L	1.47	99	188.35	CAD	1.00	$ 18,649
6	-006	m^3	50.0	preliminary	20%	60.00	5.00	L	1.47	440	188.35	CAD	1.00	$ 82,885
7	-007	m^3	5.0	preliminary	20%	6.00	5.00	L	1.47	44	188.35	CAD	1.00	$ 8,288
8	-008	m^3	25.0	preliminary	20%	30.00	8.00	L	1.47	352	188.35	CAD	1.00	$ 66,308
9	-009	m^3	1.0	preliminary	20%	1.20	6.00	L	1.47	11	188.35	CAD	1.00	$ 1,989
10	-010	kg	150.0	preliminary	20%	180.00	0.80	L	1.47	211	188.35	CAD	1.00	$ 39,785
11	-011	m^3	205.0	preliminary	20%	246.00	6.00	L	1.47	2,165	188.35	CAD	1.00	$ 407,794
12	-012	m^3	35.0	preliminary	20%	42.00	6.50	L	1.47	400	188.35	CAD	1.00	$ 75,425
13	-013	m^3	90.0	preliminary	20%	108.00	9.00	L	1.47	1,426	188.35	CAD	1.00	$ 268,547
14	-014	m^3	65.0	preliminary	20%	78.00	6.00	L	1.47	686	188.35	CAD	1.00	$ 129,301
15	-015	m^2	385.0	preliminary	20%	462.00	0.07	L	1.47	47	188.35	CAD	1.00	$ 8,935
16	-016	m	60.0	preliminary	20%	72.00	0.07	L	1.47	7	188.35	CAD	1.00	$ 1,392
17	-017	m^3	20.0	preliminary	20%	24.00	4.00	L	1.47	141	188.35	CAD	1.00	$ 26,523
18	-018	m^3	5.0	preliminary	20%	6.00	5.00	L	1.47	44	188.35	CAD	1.00	$ 8,288
19	-019	m^3	1.0	preliminary	20%	1.20	7.00	L	1.47	12	188.35	CAD	1.00	$ 2,321
20	-020	kg	20.0	preliminary	20%	24.00	0.80	L	1.47	28	188.35	CAD	1.00	$ 5,305
21	-021	m^3	20.0	preliminary	20%	24.00	4.00	L	1.47	141	188.35	CAD	1.00	$ 26,523
22	-022	m^3	5.0	preliminary	20%	6.00	6.00	L	1.47	53	188.35	CAD	1.00	$ 9,946
23	-023	tonne	1.7	preliminary	15%	1.96	20.00	L	1.47	57	209.14	CAD	1.00	$ 11,995
24	-024	m^2	15.0	preliminary	15%	17.25	0.50	L	1.47	13	209.14	CAD	1.00	$ 2,646
25	-025	tonne	0.3	preliminary	15%	0.29	95.00	L	1.47	40	209.14	CAD	1.00	$ 8,379
26	-026	tonne	0.2	preliminary	15%	0.23	80.00	L	1.47	27	209.14	CAD	1.00	$ 5,645
27	-027	each	20.0	preliminary	15%	23.00	0.45	L	1.47	15	209.14	CAD	1.00	$ 3,175
28	-028	tonne	0.8	preliminary	15%	0.92	20.00	L	1.47	27	209.14	CAD	1.00	$ 5,645
29	-029	m^2	3.0	preliminary	15%	3.45	0.80	L	1.47	4	209.14	CAD	1.00	$ 847
30	-030	tonne	0.3	preliminary	15%	0.29	95.00	L	1.47	40	209.14	CAD	1.00	$ 8,379
31	-031	tonne	0.1	preliminary	15%	0.12	80.00	L	1.47	13	209.14	CAD	1.00	$ 2,822
32	-032	each	20.0	preliminary	15%	23.00	0.45	L	1.47	15	209.14	CAD	1.00	$ 3,175
33	-033	tonne	0.5	preliminary	15%	0.58	22.00	L	1.47	19	209.14	CAD	1.00	$ 3,881
34	-034	tonne	1.2	preliminary	15%	1.38	20.00	L	1.47	40	209.14	CAD	1.00	$ 8,467
35	-035	m^2	10.0	preliminary	15%	11.50	0.80	L	1.47	13	209.14	CAD	1.00	$ 2,822
36	-036	tonne	0.3	preliminary	15%	0.29	95.00	L	1.47	40	209.14	CAD	1.00	$ 8,379
37	-037	tonne	0.1	preliminary	15%	0.12	80.00	L	1.47	13	209.14	CAD	1.00	$ 2,822
37	-037	each	12.0	preliminary	15%	13.80	0.45	L	1.47	9	209.14	CAD	1.00	$ 1,905
38	-038	lot	1.0	allowance	0%	1.00		L	0.00	-	209.14	CAD	1.00	$ -
	Major Electrical MTO													
1	-001	EA	24	conceptual	0%	24.00	150.00	L	1.47	5,281	172.28	CAD	1.00	$ 909,783
2	-002	EA	6	conceptual	0%	6.00	60.00	L	1.47	528	172.28	CAD	1.00	$ 90,978
3	-003	EA	1	conceptual	0%	1.00	200.00	L	1.47	293	172.28	CAD	1.00	$ 50,544
4	-004	EA	3	conceptual	0%	3.00	15.00	L	1.47	66	172.28	CAD	1.00	$ 11,372
5	-005	EA	1	conceptual	0%	1.00	75.00	L	1.47	110	172.28	CAD	1.00	$ 18,954
6	-006	EA	2	conceptual	0%	2.00	60.00	L	1.47	176	172.28	CAD	1.00	$ 30,326
7	-007	EA	6	conceptual	0%	6.00	32.00	L	1.47	282	172.28	CAD	1.00	$ 48,522
8	-008	EA	2	conceptual	0%	2.00	180.00	L	1.47	528	172.28	CAD	1.00	$ 90,978
9	-009	EA	6	conceptual	0%	6.00	40.00	L	1.47	352	172.28	CAD	1.00	$ 60,652
10	-010	EA	2	conceptual	0%	2.00	900.00	L	1.47	2,640	172.28	CAD	1.00	$ 454,892
11	-011	EA	2	conceptual	0%	2.00	180.00	L	1.47	528	172.28	CAD	1.00	$ 90,978
12	-012	EA	1	conceptual	0%	1.00	450.00	L	1.47	660	172.28	CAD	1.00	$ 113,723
13	-013	EA	1	conceptual	0%	1.00	640.00	L	1.47	939	172.28	CAD	1.00	$ 161,739
14	-014	EA	8	conceptual	0%	8.00	80.00	L	1.47	939	172.28	CAD	1.00	$ 161,739
15	-015	EA	2	conceptual	0%	2.00	150.00	L	1.47	440	172.28	CAD	1.00	$ 75,815
16	-016	m	900	conceptual	0%	900.00	0.27	L	1.47	356	179.49	CAD	1.00	$ 63,977
17	-017	EA	1	conceptual	0%	1.00	80.00	L	1.47	117	172.28	CAD	1.00	$ 20,217
18	-018	m	900	conceptual	0%	900.00	0.13	L	1.47	172	179.49	CAD	1.00	$ 30,804
19	-019	m	2700	preliminary	20%	3,240.00	0.50	L	1.47	2,376	179.49	CAD	1.00	$ 426,516
20	-020	ea	6	preliminary	0%	6.00	10.74	L	1.47	95	172.28	CAD	1.00	$ 16,285
	Total Direct Cost													$ 5,238,344
	Indirect Cost													
1		%	20%	allowance	0%	0.20	-	L	1.37	-	-	CAD	1.00	$ -
2		%	8%	allowance	0%	0.08	-	L	1.37	-	-	CAD	1.00	$ -
3		%	15%	allowance	0%	0.15	-	L	1.37	-	-	CAD	1.00	$ -
4		%	4%	allowance	0%	0.04	-	L	1.37	-	-	CAD	1.00	$ -
5		%	2%	allowance	0%	0.02	-	L	1.37	-	-	CAD	1.00	$ -
6		%	4%	allowance	0%	0.04	-	L	1.37	-	-	CAD	1.00	$ -
7		%	1%	allowance	0%	0.01	-	L	1.37	-	-	CAD	1.00	$ -
8		lot	1	allowance	0%	1.00	-	L	1.37	-	-	CAD	1.00	$ -
9		lot	1	allowance	0%	1.00	-	L	1.37	-	-	CAD	1.00	$ -
	Total Indirect Cost													$ -
	Total Direct + Indirect Cost													$ 5,238,344
	Owner's Cost													
1		%	8%	allowance	0%	0.08	-	L	0.00	-	-	CAD	1.00	$ -
	Contingency													
1		%	25%	historical	0%	0.25	-	L	0.00	-	-	CAD	1.00	$ -
	Grand Total													$ 5,238,344

MATERIAL

ID #	Estimate Number	Unit Material ($ / Unit)	Currency	FOREX	Cost Maturity	Material Price Growth	Material Price Growth	Material Price Growth	Material Price Growth	Net Final Split Amounts Material
	Preliminary									
1	-001									$ -
	Excavation & Backfilling									
1	-001		CAD	1.00		0%	$ -	5%	$ -	$ -
2	-002		CAD	1.00		0%	$ -	5%	$ -	$ -
3	-003		CAD	1.00		0%	$ -	5%	$ -	$ -
4	-004		CAD	1.00		0%	$ -	5%	$ -	$ -
5	-005	206.98	CAD	1.00	P4	0%	$ -	5%	$ 75,871.11	$ 1,593,293
6	-006	206.98	CAD	1.00	P4	0%	$ -	5%	$ 8,111.03	$ 170,332
7	-007	206.98	CAD	1.00	P4	0%	$ -	5%	$ 14,333.37	$ 301,001
8	-008	206.98	CAD	1.00	P4	0%	$ -	5%	$ 29,261.80	$ 614,498
9	-009		CAD	1.00		0%	$ -	5%	$ -	$ -
10	-010		CAD	1.00		0%	$ -	5%	$ -	$ -
11	-011	18.00	CAD	1.00	P4	0%	$ -	5%	$ 459.00	$ 9,639
12	-012	9.00	CAD	1.00	P4	0%	$ -	5%	$ 48.09	$ 1,010
	Drainage									
1	-001		CAD	1.00		0%	$ -	5%	$ -	$ -
2	-002		CAD	1.00		0%	$ -	5%	$ -	$ -
3	-003		CAD	1.00		0%	$ -	5%	$ -	$ -
4	-004	25.00	CAD	1.00	P3	0%	$ -	5%	$ 24.75	$ 520
5	-005		CAD	1.00		0%	$ -	5%	$ -	$ -
6	-006		CAD	1.00		0%	$ -	5%	$ -	$ -
7	-007	49.00	CAD	1.00	P3	0%	$ -	5%	$ 24.50	$ 515
8	-008	6,500.00	CAD	1.00	P3	0%	$ -	5%	$ 406.25	$ 8,531
9	-009	350.00	CAD	1.00	P3	0%	$ -	5%	$ 21.88	$ 459
	Site Development									
1	-001	105.00	CAD	1.00	P3	0%	$ -	5%	$ 1,542.19	$ 32,386
2	-002	4,964.54	CAD	1.00	P3	0%	$ -	5%	$ 310.28	$ 6,516
2	-003		CAD	1.00		0%	$ -	5%	$ -	$ -
3	-004		CAD	1.00		0%	$ -	5%	$ -	$ -
	Concrete & Steel									
1	-001	784.35	CAD	1.00	P3	0%	$ -	5%	$ 12,706.47	$ 266,836
2	-002	952.35	CAD	1.00	P3	0%	$ -	5%	$ 6,856.92	$ 143,995
3	-003	952.35	CAD	1.00	P3	0%	$ -	5%	$ 5,999.81	$ 125,996
4	-004	3.10	CAD	1.00	P3	0%	$ -	5%	$ 167.40	$ 3,515
5	-005	10.00	CAD	1.00	P3	0%	$ -	5%	$ 225.00	$ 4,725
6	-006	784.35	CAD	1.00	P3	0%	$ -	5%	$ 2,353.05	$ 49,414
7	-007	784.35	CAD	1.00	P3	0%	$ -	5%	$ 235.31	$ 4,941
8	-008	784.35	CAD	1.00	P3	0%	$ -	5%	$ 1,176.53	$ 24,707
9	-009	784.35	CAD	1.00	P3	0%	$ -	5%	$ 47.06	$ 988
10	-010	6.00	CAD	1.00	P3	0%	$ -	5%	$ 54.00	$ 1,134
11	-011	784.35	CAD	1.00	P3	0%	$ -	5%	$ 9,647.51	$ 202,598
12	-012	952.35	CAD	1.00	P3	0%	$ -	5%	$ 1,999.94	$ 41,999
13	-013	784.35	CAD	1.00	P3	0%	$ -	5%	$ 4,235.49	$ 88,945
14	-014	2,293.20	CAD	1.00	P3	0%	$ -	5%	$ 8,943.48	$ 187,813
15	-015	45.00	CAD	1.00	P3	0%	$ -	5%	$ 1,039.50	$ 21,830
16	-016	14.00	CAD	1.00	P3	0%	$ -	5%	$ 50.40	$ 1,058
17	-017	784.35	CAD	1.00	P3	0%	$ -	5%	$ 941.22	$ 19,766
18	-018	784.35	CAD	1.00	P3	0%	$ -	5%	$ 235.31	$ 4,941
19	-019	784.35	CAD	1.00	P3	0%	$ -	5%	$ 47.06	$ 988
20	-020	6.00	CAD	1.00	P3	0%	$ -	5%	$ 7.20	$ 151
21	-021	784.35	CAD	1.00	P3	0%	$ -	5%	$ 941.22	$ 19,766
22	-022	784.35	CAD	1.00	P3	0%	$ -	5%	$ 235.31	$ 4,941
23	-023	7,800.00	CAD	1.00	P3	0%	$ -	5%	$ 762.45	$ 16,011
24	-024	300.00	CAD	1.00	P3	0%	$ -	5%	$ 258.75	$ 5,434
25	-025	10,500.00	CAD	1.00	P3	0%	$ -	5%	$ 150.94	$ 3,170
26	-026	9,500.00	CAD	1.00	P3	0%	$ -	5%	$ 109.25	$ 2,294
27	-027	150.00	CAD	1.00	P3	0%	$ -	5%	$ 172.50	$ 3,623
28	-028	7,800.00	CAD	1.00	P3	0%	$ -	5%	$ 358.80	$ 7,535
29	-029	300.00	CAD	1.00	P3	0%	$ -	5%	$ 51.75	$ 1,087
30	-030	10,500.00	CAD	1.00	P3	0%	$ -	5%	$ 150.94	$ 3,170
31	-031	9,500.00	CAD	1.00	P3	0%	$ -	5%	$ 54.63	$ 1,147
32	-032	150.00	CAD	1.00	P3	0%	$ -	5%	$ 172.50	$ 3,623
33	-033	7,000.00	CAD	1.00	P3	0%	$ -	5%	$ 201.25	$ 4,226
34	-034	7,800.00	CAD	1.00	P3	0%	$ -	5%	$ 538.20	$ 11,302
35	-035	300.00	CAD	1.00	P3	0%	$ -	5%	$ 172.50	$ 3,623
36	-036	10,500.00	CAD	1.00	P3	0%	$ -	5%	$ 150.94	$ 3,170
37	-037	9,500.00	CAD	1.00	P3	0%	$ -	5%	$ 54.63	$ 1,147
37	-037	150.00	CAD	1.00	P3	0%	$ -	5%	$ 103.50	$ 2,174
38	-038		CAD	1.00		0%	$ -	5%	$ -	$ -
	Major Electrical MTO									
1	-001		CAD	1.00		0%	$ -	0%	$ -	$ -
2	-002		CAD	1.00		0%	$ -	0%	$ -	$ -
3	-003		CAD	1.00		0%	$ -	0%	$ -	$ -
4	-004		CAD	1.00		0%	$ -	0%	$ -	$ -
5	-005		CAD	1.00		0%	$ -	0%	$ -	$ -
6	-006		CAD	1.00		0%	$ -	0%	$ -	$ -
7	-007		CAD	1.00		0%	$ -	0%	$ -	$ -
8	-008		CAD	1.00		0%	$ -	0%	$ -	$ -
9	-009		CAD	1.00		0%	$ -	0%	$ -	$ -
10	-010		CAD	1.00		0%	$ -	0%	$ -	$ -
11	-011		CAD	1.00		0%	$ -	0%	$ -	$ -
12	-012		CAD	1.00		0%	$ -	0%	$ -	$ -
13	-013		CAD	1.00		0%	$ -	0%	$ -	$ -
14	-014		CAD	1.00		0%	$ -	0%	$ -	$ -
15	-015		CAD	1.00		0%	$ -	0%	$ -	$ -
16	-016	300.00	CAD	1.00	P2	1%	$ 2,700	15%	$ 40,500.00	$ 313,200
17	-017		CAD	1.00		0%	$ -	0%	$ -	$ -
18	-018	15.50	CAD	1.00	P3	2%	$ 279	15%	$ 2,092.50	$ 16,322
19	-019	525.00	CAD	1.00	P2	1%	$ 17,010	15%	$ 255,150.00	$ 1,973,160
20	-020	12,935.00	CAD	1.00	P3	4%	$ 3,104	0%	$ -	$ 80,714
	Total Direct Cost									$ 4,362,003
	Indirect Cost									
1										$ -
2										$ -
3										$ -
4										$ -
5										$ -
6										$ -
7										$ -
8										$ -
9										$ -
	Total Indirect Cost									$ -
	Total Direct + Indirect Cost									$ 4,362,003
	Owner's Cost									
1										$ -
	Contingency									
1										$ -
	Grand Total									$ 4,362,003

EQUIPMENT / SUBCONTRACT / NET FINAL AMOUNT / NET RATE / Sourcing

ID #	Estimate Number	Unit Equipment ($ / Unit)	Currency	FOREX	Price Growth Code	Equipment Price Growth	Net Final Split Amounts Equipment	Unit Subcontract Cost ($ / Unit)	Currency	FOREX	Cost Maturity	Subcontract Price Growth	Net Final Split Amounts Subcontract	Net Final Amount	Net Rate	Item Source	Cost Source
	Preliminary																
1	-001						$ -	250,000.00	CAD	1.00	P5	0%	$ 250,000	$ 250,000	$ 250,000.00	Electrical MTO	P5
	Excavation & Backfilling																
1	-001						$ -	3.47	CAD	1.00	P4	0%	$ 31,364	$ 31,364	$ 3.47	Civil MTO	P4
2	-002						$ -	11.93	CAD	1.00	P4	0%	$ 16,175	$ 16,175	$ 11.93	Civil MTO	P4
3	-003						$ -	11.93	CAD	1.00	P4	0%	$ 136,506	$ 136,506	$ 11.93	Civil MTO	P4
4	-004						$ -	22.92	CAD	1.00	P4	0%	$ 30,598	$ 30,598	$ 22.92	Civil MTO	P4
5	-005						$ -		CAD	1.00		0%	$ -	$ 1,802,167	$ 245.82	Civil MTO	P4
6	-006						$ -		CAD	1.00		0%	$ -	$ 192,661	$ 245.82	Civil MTO	P4
7	-007						$ -		CAD	1.00		0%	$ -	$ 340,460	$ 245.82	Civil MTO	P4
8	-008						$ -		CAD	1.00		0%	$ -	$ 695,056	$ 245.82	Civil MTO	P4
9	-009						$ -	20.00	CAD	1.00	P4	0%	$ 25,427	$ 25,427	$ 20.00	Civil MTO	P4
10	-010						$ -	6.00	CAD	1.00	P4	0%	$ 37,110	$ 37,110	$ 6.00	Civil MTO	P4
11	-011						$ -		CAD	1.00		0%	$ -	$ 24,169	$ 47.39	Civil MTO	P4
12	-012						$ -		CAD	1.00		0%	$ -	$ 3,674	$ 34.38	Civil MTO	P4
	Drainage																
1	-001						$ -	55.00	CAD	1.00	P3	0%	$ 6,256	$ 6,256	$ 55.00	Civil MTO	P3
2	-002						$ -	55.00	CAD	1.00	P3	0%	$ 3,025	$ 3,025	$ 55.00	Civil MTO	P3
3	-003						$ -	6.00	CAD	1.00	P3	0%	$ 1,974	$ 1,974	$ 6.00	Civil MTO	P3
4	-004						$ -		CAD	1.00		0%	$ -	$ 1,788	$ 90.32	Civil MTO	P3
5	-005						$ -	140.00	CAD	1.00	P3	0%	$ 735	$ 735	$ 140.00	Civil MTO	P3
6	-006						$ -	12,000.00	CAD	1.00	P3	0%	$ 30,000	$ 30,000	$ 12,000.00	Civil MTO	P3
7	-007						$ -		CAD	1.00		0%	$ -	$ 9,228	$ 922.75	Civil MTO	P3
8	-008						$ -		CAD	1.00		0%	$ -	$ 14,938	$ 11,950.32	Civil MTO	P3
9	-009						$ -		CAD	1.00		0%	$ -	$ 5,264	$ 4,211.49	Civil MTO	P3
	Site Development																
1	-001						$ -					0%	$ -	$ 79,435	$ 270.42	Civil MTO	P3
2	-002						$ -					0%	$ -	$ 16,126	$ 12,900.74	Civil MTO	P3
2	-003						$ -	426,244.68	CAD	1.00	P3	0%	$ 426,245	$ 426,245	$ 426,244.68	Civil MTO	P3
3	-004						$ -	30,000.00	CAD	1.00	P3	0%	$ 30,000	$ 30,000	$ 30,000.00	Civil MTO	P3
	Concrete & Steel																
1	-001						$ -						$ -	$ 803,931	$ 2,481.27	Structural & Concrete MTO	P3
2	-002						$ -						$ -	$ 402,596	$ 2,795.81	Structural & Concrete MTO	P3
3	-003						$ -						$ -	$ 352,272	$ 2,795.81	Structural & Concrete MTO	P3
4	-004						$ -						$ -	$ 18,435	$ 17.07	Structural & Concrete MTO	P3
5	-005						$ -						$ -	$ 23,374	$ 51.94	Structural & Concrete MTO	P3
6	-006						$ -						$ -	$ 132,299	$ 2,204.98	Structural & Concrete MTO	P3
7	-007						$ -						$ -	$ 13,230	$ 2,204.98	Structural & Concrete MTO	P3
8	-008						$ -						$ -	$ 91,015	$ 3,033.83	Structural & Concrete MTO	P3
9	-009						$ -						$ -	$ 2,978	$ 2,481.27	Structural & Concrete MTO	P3
10	-010						$ -						$ -	$ 40,919	$ 227.33	Structural & Concrete MTO	P3
11	-011						$ -						$ -	$ 610,392	$ 2,481.27	Structural & Concrete MTO	P3
12	-012						$ -						$ -	$ 117,424	$ 2,795.81	Structural & Concrete MTO	P3
13	-013						$ -						$ -	$ 357,493	$ 3,310.12	Structural & Concrete MTO	P3
14	-014						$ -						$ -	$ 317,114	$ 4,065.56	Structural & Concrete MTO	P3
15	-015						$ -						$ -	$ 30,765	$ 66.59	Structural & Concrete MTO	P3
16	-016						$ -						$ -	$ 2,451	$ 34.04	Structural & Concrete MTO	P3
17	-017						$ -						$ -	$ 46,289	$ 1,928.70	Structural & Concrete MTO	P3
18	-018						$ -						$ -	$ 13,230	$ 2,204.98	Structural & Concrete MTO	P3
19	-019						$ -						$ -	$ 3,309	$ 2,757.55	Structural & Concrete MTO	P3
20	-020						$ -						$ -	$ 5,456	$ 227.33	Structural & Concrete MTO	P3
21	-021						$ -						$ -	$ 46,289	$ 1,928.70	Structural & Concrete MTO	P3
22	-022						$ -						$ -	$ 14,888	$ 2,481.27	Structural & Concrete MTO	P3
23	-023						$ -						$ -	$ 28,006	$ 14,325.56	Structural & Concrete MTO	P3
24	-024						$ -						$ -	$ 8,080	$ 468.39	Structural & Concrete MTO	P3
25	-025						$ -						$ -	$ 11,549	$ 40,168.92	Structural & Concrete MTO	P3
26	-026						$ -						$ -	$ 7,939	$ 34,517.25	Structural & Concrete MTO	P3
27	-027						$ -						$ -	$ 6,798	$ 295.55	Structural & Concrete MTO	P3
28	-028						$ -						$ -	$ 13,180	$ 14,325.56	Structural & Concrete MTO	P3
29	-029						$ -						$ -	$ 1,933	$ 560.42	Structural & Concrete MTO	P3
30	-030						$ -						$ -	$ 11,549	$ 40,168.92	Structural & Concrete MTO	P3
31	-031						$ -						$ -	$ 3,969	$ 34,517.25	Structural & Concrete MTO	P3
32	-032						$ -						$ -	$ 6,798	$ 295.55	Structural & Concrete MTO	P3
33	-033						$ -						$ -	$ 8,107	$ 14,099.12	Structural & Concrete MTO	P3
34	-034						$ -						$ -	$ 19,769	$ 14,325.56	Structural & Concrete MTO	P3
35	-035						$ -						$ -	$ 6,445	$ 560.42	Structural & Concrete MTO	P3
36	-036						$ -						$ -	$ 11,549	$ 40,168.92	Structural & Concrete MTO	P3
37	-037						$ -						$ -	$ 3,969	$ 34,517.25	Structural & Concrete MTO	P3
37	-037						$ -						$ -	$ 4,079	$ 295.55	Structural & Concrete MTO	P3
38	-038						$ -	200,000.00	CAD	1.00	P5		$ 200,000	$ 200,000	$ 200,000.00	Structural & Concrete MTO	P5
	Major Electrical MTO																
1	-001	838,458.84	USD	1.36	P2	2%	$ 27,914,642						$ -	$ 28,824,426	$ 1,201,017.74	Electrical MTO	P2
2	-002	409,486.65	USD	1.36	P2	2%	$ 3,408,239						$ -	$ 3,499,218	$ 583,202.94	Electrical MTO	P2
3	-003	1,635,294.12	USD	1.36	P2	2%	$ 2,268,480						$ -	$ 2,319,024	$ 2,319,023.53	Electrical MTO	P2
4	-004	5,000.00	CAD	1.00	P2	2%	$ 15,300						$ -	$ 26,672	$ 8,890.76	Electrical MTO	P2
5	-005	30,000.00	CAD	1.00	P2	2%	$ 30,600						$ -	$ 49,554	$ 49,553.82	Electrical MTO	P2
6	-006	25,000.00	CAD	1.00	P2	2%	$ 51,000						$ -	$ 81,326	$ 40,663.06	Electrical MTO	P2
7	-007	10,000.00	CAD	1.00	P2	2%	$ 61,200						$ -	$ 109,722	$ 18,286.96	Electrical MTO	P2
8	-008	150,000.00	CAD	1.00	P2	2%	$ 306,000						$ -	$ 396,978	$ 198,489.17	Electrical MTO	P2
9	-009	15,000.00	CAD	1.00	P2	2%	$ 91,800						$ -	$ 152,452	$ 25,408.71	Electrical MTO	P2
10	-010	5,000,000.00	CAD	1.00	P2	2%	$ 10,200,000						$ -	$ 10,654,892	$ 5,327,445.86	Electrical MTO	P2
11	-011	900,000.00	CAD	1.00	P2	2%	$ 1,836,000						$ -	$ 1,926,978	$ 963,489.17	Electrical MTO	P2
12	-012	1,800,000.00	CAD	1.00	P2	2%	$ 1,836,000						$ -	$ 1,949,723	$ 1,949,722.93	Electrical MTO	P2
13	-013	2,500,000.00	CAD	1.00	P2	2%	$ 2,550,000						$ -	$ 2,711,739	$ 2,711,739.28	Electrical MTO	P2
14	-014	80,000.00	CAD	1.00	P2	2%	$ 652,800						$ -	$ 814,539	$ 101,817.41	Electrical MTO	P2
15	-015	150,000.00	CAD	1.00	P2	2%	$ 306,000						$ -	$ 381,815	$ 190,907.64	Electrical MTO	P2
16	-016					0%	$ -						$ -	$ 377,177	$ 419.09	Electrical MTO	P2
17	-017	100,000.00	CAD	1.00	P2	2%	$ 102,000						$ -	$ 122,217	$ 122,217.41	Electrical MTO	P2
18	-018					0%	$ -						$ -	$ 47,125	$ 52.36	Electrical MTO	P3
19	-019					0%	$ -						$ -	$ 2,399,676	$ 740.64	Electrical MTO	P2
20	-020					0%	$ -						$ -	$ 97,000	$ 16,166.59	Electrical MTO	P3
	Total Direct Cost						$ 51,630,062						$ 1,225,416	$ 64,952,500			
	Indirect Cost																
1							$ -	64,952,500.39	CAD	1.00	X	0%	$ 12,990,500	$ 12,990,500	$ 64,952,500.39		X
2							$ -	64,952,500.39	CAD	1.00	X	0%	$ 5,196,200	$ 5,196,200	$ 64,952,500.39		X
3							$ -	55,992,064.22	CAD	1.00	X	0%	$ 8,398,810	$ 8,398,810	$ 55,992,064.22		X
4							$ -	51,630,061.69	CAD	1.00	X	0%	$ 2,065,202	$ 2,065,202	$ 51,630,061.69		X
5							$ -	51,630,061.69	CAD	1.00	X	0%	$ 1,032,601	$ 1,032,601	$ 51,630,061.69		X
6							$ -	51,630,061.69	CAD	1.00	X	0%	$ 2,065,202	$ 2,065,202	$ 51,630,061.69		X
7							$ -	64,952,500.39	CAD	1.00	X	0%	$ 649,525	$ 649,525	$ 64,952,500.39		X
8							$ -	102,000.00	CAD	1.00	X	0%	$ 102,000	$ 102,000	$ 102,000.00		X
9							$ -	88,476.99	CAD	1.00	X	0%	$ 88,477	$ 88,477	$ 88,476.99		X
	Total Indirect Cost						$ -						$ 32,588,518	$ 32,588,518			
	Total Direct + Indirect Cost						$ 51,630,062						$ 33,813,934	$ 97,541,018			
	Owner's Cost																
1							$ -	64,952,500.39	CAD	1.00	X	0%	$ 5,196,200	$ 5,196,200	$ 64,952,500.39	Suggested 8%	
	Contingency																
1							$ -	97,541,018.29	CAD	1.00	X	0%	$ 24,385,255	$ 24,385,255	$ 97,541,018.29	Std. Class 4	
	Grand Total						$ 51,630,062						$ 63,395,388	$ 127,122,473			

Appendix C

CAPEX Option 2

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HATCH

ID #	0	Number	Estimate Number	Rev.	Trade	Price Code	Price Code Description	Scope	Bill Description	Remarks	Unit of Measure	Bill Quantity	Quantity Maturity	Growth	Final Quantity
											QUANTITY				
									Preliminary						
1	D	1	-001	0	A				Environmental Cost		Lot	1	N/a	0%	1.00
									Excavation & Backfilling						
1	D	1	-001	A	E				Clearing and grubbing		m2	9060	preliminary	25%	11,325.00
2	D	2	-002	A	E				150mm Topsoil stripping		m3	1359	preliminary	25%	1,698.75
3	D	3	-003	B	E				Removal of Unsuitable Material	Assuming removal of 2 meter layer from surface to suitable subgrade, transport and disposal offsite	m3	12071	preliminary	25%	15,089.06
4	D	4	-004	B	E				Mass Excavation		m3	1068	preliminary	25%	1,335.00
5	D	5	-005	B	E				Structural Fill layer, Class C Granular from bottom of excavation to subgrade	Excludes quantities for pavement structures	m3	7414	preliminary	25%	9,267.50
6	D	6	-006	B	E				150mm surface layer of 5-20mm Clear stone		m3	837	preliminary	25%	1,046.25
7	D	7	-007	B	E				200mm base layer Class A granulars		m3	1342	preliminary	25%	1,677.50
8	D	8	-008	B	E				400mm mininmum sub-base layer of Class B granulars		m3	2741	preliminary	25%	3,426.25
9	D	9	-009	B	E				Ditch Excavation		m3	1047	preliminary	25%	1,308.15
10	D	10	-010	B	E				Nonwoven needle-punched geotextile		m2	6525	preliminary	25%	8,156.25
11	D	11	-011	B	E				Trenching	Assuming depth of 1.2m and side slopes of 2:1	m3	2713	preliminary	25%	3,391.50
12	D	12	-012	B	E				Backfill, Type 1 material bedding for direct buried cables, 450mm layer	Type 1 (25mm minus) spec according to NL DTI Standard Specifications for Aggregate for Roadwork	m3	569	preliminary	25%	710.72
									Drainage						
1	D	1	-001	A	D				Supply and Install 150mm Ø HDPE perforated subdrains		m	126	preliminary	25%	157.50
2	D	2	-002	A	D				Supply and Install 150mm Ø HDPE solid wall subdrains		m	78	preliminary	25%	97.50
3	D	3	-003	A	D				Geotextile cover for subdrains, Class IV		m²	398	preliminary	25%	497.25
4	D	4	-004	A	D				50mm Clear stone bedding		m³	24	preliminary	25%	29.92
5	D	5	-005	A	D				Rip-Rap 300mm Ø		m³	4	preliminary	25%	5.25
6	D	6	-006	A	D				Supply and Install Petro-Pipe PIFH-620 or similar		ea	2	preliminary	25%	2.50
7	D	7	-007	A	D				Supply and Install 300mm Ø culvert		m	8	preliminary	25%	10.00
8	D	8	-008	A	D				Supply and install of lift station	Stormwater discharge at the transformer containment pit	ea	1	preliminary	25%	1.25
9	D	9	-009	A	D				Supply and install of clean out structures	Stormwater discharge at the transformer containment pit	ea	2	preliminary	25%	2.50
									Site Development						
1	D	1	-001	B	A				Fencing, chain link fence, 2400-mm height, as per NL Highway Construction Standards	Unsure of height	m	285	preliminary	25%	356.25
2	D	2	-002	A	A				Double Swing Gates, 6-m width	Unsure of height	ea	1	preliminary	25%	1.25
2	D	3	-003	B	A				Relocation of Transmission line	Lump Sum cost	Lot	1	allowance	0%	1.00
3	D	4	-004	B	A				Relocation of Fire Hydrant	Lump Sum cost	Lot	1	allowance	0%	1.00
									Concrete & Steel						
1	D	1	-001	0	C		CONCRETE	Battery pack containers	Mat foundations, t=450 mm		m³	515.0	preliminary	20%	618.00
2	D	2	-002	0	C				Walls, t=450 mm		m³	225.0	preliminary	20%	270.00
3	D	3	-003	0	C				Walls, t=1100 mm		m³	200.0	preliminary	20%	240.00
4	D	4	-004	0	C				Steel angle for anchoring, L89x89x13		kg	1725.0	preliminary	20%	2,070.00
5	D	5	-005	0	C				Mechanical anchors, Kwik Bolt KB-TZ2 5/8x6 in carbon steel		EA	700.0	preliminary	20%	840.00
6	D	6	-006	0	C			Main electrical room	Strip footings, t=700 mm		m³	50.0	preliminary	20%	60.00
7	D	7	-007	0	C				Isolated footing, t=700 mm		m³	5.0	preliminary	20%	6.00
8	D	8	-008	0	C				Pilasters, 0.7 m x 0.7 m		m³	25.0	preliminary	20%	30.00
9	D	9	-009	0	C				Stairs pads		m³	1.0	preliminary	20%	1.20
10	D	10	-010	0	C				Cast-in-place anchors, 55 ksi		kg	150.0	preliminary	20%	180.00
11	D	11	-011	0	C			Transformers basin	Mat foundations, t=700 mm		m³	205.0	preliminary	20%	246.00
12	D	12	-012	0	C				Walls, t=250 mm		m³	35.0	preliminary	20%	42.00
13	D	13	-013	0	C				Firewalls, t=450 mm, h=9 m		m³	90.0	preliminary	20%	108.00
14	D	14	-014	0	C				Equipment bases over the mat		m³	65.0	preliminary	20%	78.00
15	D	15	-015	0	C				Insulation polystyrene, t=75 mm, Highload 60		m²	385.0	preliminary	20%	462.00
16	D	16	-016	0	C				Water stop		m	60.0	preliminary	20%	72.00
17	D	17	-017	0	C			Circuit breaker	Isolated footing, t=600 mm		m³	20.0	preliminary	20%	24.00
18	D	18	-018	0	C				Pilasters, 1.4 m x 1.4 m		m³	5.0	preliminary	20%	6.00
19	D	19	-019	0	C				Pilasters, 0.5 m x 0.5 m		m³	1.0	preliminary	20%	1.20
20	D	20	-020	0	C				Cast-in-place anchors, 55 ksi		kg	20.0	preliminary	20%	24.00
21	D	21	-021	0	C			Bus Support	Isolated footing, t=500 mm		m³	20.0	preliminary	20%	24.00
22	D	22	-022	0	C				Pilasters, 0.5 m x 0.5 m		m³	5.0	preliminary	20%	6.00
23	D	23	-023	0	S		STRUCTURAL	Main access door	Steel columns and beams - Rolled sections - 31 to 60 kg/m		tonne	1.7	preliminary	15%	1.96
24	D	24	-024	0	S				Grating 38x4.8 serrated, type 30-102		m²	15.0	preliminary	15%	17.25
25	D	25	-025	0	S				Handrails (sloped)		tonne	0.3	preliminary	15%	0.29
26	D	26	-026	0	S				Handrails (straight)		tonne	0.2	preliminary	15%	0.23
27	D	27	-027	0	S				Stair treads, 915 mm x 300 mm x 32 serrated		each	20.0	preliminary	15%	23.00
28	D	28	-028	0	S			Second exit door	Steel columns and beams - Rolled sections - 31 to 60 kg/m		tonne	0.8	preliminary	15%	0.92
29	D	29	-029	0	S				Grating 38x4.8 serrated, type 30-102		m²	3.0	preliminary	15%	3.45
30	D	30	-030	0	S				Handrails (sloped)		tonne	0.3	preliminary	15%	0.29
31	D	31	-031	0	S				Handrails (straight)		tonne	0.1	preliminary	15%	0.12
32	D	32	-032	0	S				Stair treads, 915 mm x 300 mm x 32 serrated		each	20.0	preliminary	15%	23.00
33	D	33	-033	0	S			Circuit breaker	Steel columns and beams - Rolled sections - 16 to 30 kg/m		tonne	0.5	preliminary	15%	0.58
34	D	34	-034	0	S				Steel columns and beams - Rolled sections - 31 to 60 kg/m		tonne	1.2	preliminary	15%	1.38
35	D	35	-035	0	S				Grating 38x4.8 serrated, type 30-102		m²	10.0	preliminary	15%	11.50
36	D	36	-036	0	S				Handrails (sloped)		tonne	0.3	preliminary	15%	0.29
37	D	37	-037	0	S				Handrails (straight)		tonne	0.1	preliminary	15%	0.12
38	D	38	-038	0	S				Stair treads, 915 mm x 300 mm x 32 serrated		each	12.0	preliminary	15%	13.80
39	D	39	-039	0	S			Box Structure	Box Structure		lot	1.0	allowance	0%	1.00
									Major Electrical MTO						
1	D	1	-001	0	L		Battery Container		Battery Container	6.1 m x 2.4 m x 2.9 m,43.5 tonnes	per container	42	conceptual	0%	42.00
2	D	2	-002	0	L		PCS-MVT Skid		PCS-MVT Skid	6.1 m x 2.4 m x 2.9 m,18 tonnes	per container	6	conceptual	0%	6.00
3	D	3	-003	0	L		Energy Management System		Energy Management System		per unit	1	conceptual	0%	1.00
4	D	4	-004	0	L		66kV surge arresters		66kV surge arresters		per unit	3	conceptual	0%	3.00
5	D	5	-005	0	L		66kV disc. Switch w/ground sw		66kV disc. Switch w/ground sw		per unit	1	conceptual	0%	1.00
6	D	6	-006	0	L		66kV disc. Switch		66kV disc. Switch		per unit	2	conceptual	0%	2.00
7	D	7	-007	0	L		66kV CVT		66kV CVT		per unit	6	conceptual	0%	6.00
8	D	8	-008	0	L		66kV breaker		66kV breaker		per unit	2	conceptual	0%	2.00
9	D	9	-009	0	L		66kV revenue meter		66kV revenue meter		per unit	6	conceptual	0%	6.00
10	D	10	-010	0	L		66-34.5kV power transformer 45/60/80MVA		66-34.5kV power transformer 45/60/80MVA		per unit	2	conceptual	0%	2.00
11	D	11	-011	0	L		34.5KV grounding transformer		34.5KV grounding transformer		per unit	2	conceptual	0%	2.00
12	D	12	-012	0	L		34.5kV switchgear 9 cells		34.5kV switchgear 9 cells		per unit	1	conceptual	0%	1.00
13	D	13	-013	0	L		E room		E room		per unit	1	conceptual	0%	1.00
14	D	14	-014	0	L		P&C panels		P&C panels		per unit	8	conceptual	0%	8.00
15	D	15	-015	0	L		34.5kV padmount transformer		34.5kV padmount transformer		per unit	2	conceptual	0%	2.00
16	D	16	-016	0	W		38kv 500kcmil Cu cable		38kv 500kcmil Cu cable		m	2000	conceptual	0%	2,000.00
17	D	17	-017	0	L		SCADA panel		SCADA panel		per unit	1	conceptual	0%	1.00
18	D	18	-018	0	W		Grounding grid 4/0 bare		Grounding grid 4/0 bare		m	1600	conceptual	0%	1,600.00
19	D	19	-019	0	W		1c 1000kcmil 69kV cable		1c 1000kcmil 69kV cable		m	2700	preliminary	20%	3,240.00
20	D	20	-020	0	L		69kV cable termination		69kV cable termination		ea	6	preliminary	0%	6.00
									Total Direct Cost						
	I								**Indirect Cost**						
1	I				Y				EPCM	% of Direct Cost	%	20%	allowance	0%	0.20
2	I				Y				Construction Indirects	% of Direct Cost	%	8%	allowance	0%	0.08
3	I				Y				Freight(% of Equipment & Material)	% of Equipment & Material	%	15%	allowance	0%	0.15
4	I				Y				Vendor Representatives(% of Equipment)	% of Equipment	%	4%	allowance	0%	0.04
5	I				Y				Spare Parts - Commissioning and Startup(% of Equipment)	% of Equipment	%	2%	allowance	0%	0.02
6	I				Y				Spare Parts - Capital(% of Equipment)	% of Equipment	%	4%	allowance	0%	0.04
7	I				Y				Third-Party Services	% of Direct Cost	%	1%	allowance	0%	0.01
8	I				Y				First Fills for Transformers		lot	1	allowance	0%	1.00
9	I				Y				Heavy Cranes-90t		lot	1	allowance	0%	1.00
									Total Indirect Cost						
									Total Direct + Indirect Cost						
									Owner's Cost						
1	OC				V				Owner's Cost	% of Direct Cost	%	8%	allowance	0%	0.08
									Contingency						
1	C				Z				Contingency	Excludes Owner's Cost	%	25%	historical	0%	0.25
									Grand Total						

ID #	Unit Labour Hours	Cost Maturity	PF	Total Labour Hours	Hourly Wage ($/hr.)	Currency	FOREX	Net Final Split Amounts Labour	Unit Material ($/Unit)	Currency	FOREX	Cost Maturity	Material Price Growth	Material Growth $	Material Waste Growth%	Material Waste $	Net Final Split Amounts Material
	LABOUR								MATERIAL								
Preliminary																	
1		L	0.00					$ -									$ -
Excavation & Backfilling																	
1		L	0.00	-	242.79	CAD	1.00	$ -		CAD	1.00		0%	$ -	5%	$ -	$ -
2		L	0.00	-	242.79	CAD	1.00	$ -		CAD	1.00		0%	$ -	5%	$ -	$ -
3		L	0.00	-	242.79	CAD	1.00	$ -		CAD	1.00		0%	$ -	5%	$ -	$ -
4		L	0.00	-	242.79	CAD	1.00	$ -		CAD	1.00		0%	$ -	5%	$ -	$ -
5	0.08	L	1.47	1,088	242.79	CAD	1.00	$ 264,039	206.98	CAD	1.00	P4	0%	$ -	5%	########	$ 2,014,097
6	0.08	L	1.47	123	242.79	CAD	1.00	$ 29,809	206.98	CAD	1.00	P4	0%	$ -	5%	########	$ 227,380
7	0.08	L	1.47	197	242.79	CAD	1.00	$ 47,793	206.98	CAD	1.00	P4	0%	$ -	5%	########	$ 364,569
8	0.08	L	1.47	402	242.79	CAD	1.00	$ 97,617	206.98	CAD	1.00	P4	0%	$ -	5%	########	$ 744,623
9		L	0.00	-	242.79	CAD	1.00	$ -					0%	$ -	5%	$ -	$ -
10		L	0.00	-	242.79	CAD	1.00	$ -					0%	$ -	5%	$ -	$ -
11	0.08	L	1.47	398	242.79	CAD	1.00	$ 96,627	18.00	CAD	1.00	P3	0%	$ -	5%	$ 3,052.35	$ 64,099
12	0.07	L	1.47	73	242.79	CAD	1.00	$ 17,718	9.00	CAD	1.00	P3	0%	$ -	5%	$ 319.82	$ 6,716
Drainage																	
1		L	0.00	-	218.38	CAD	1.00	$ -		CAD	1.00		0%	$ -	5%	$ -	$ -
2		L	0.00	-	218.38	CAD	1.00	$ -		CAD	1.00		0%	$ -	5%	$ -	$ -
3		L	0.00	-	218.38	CAD	1.00	$ -		CAD	1.00		0%	$ -	5%	$ -	$ -
4	0.20	L	1.47	9	218.38	CAD	1.00	$ 1,917	25.00	CAD	1.00	P3	0%	$ -	5%	$ 37.40	$ 785
5		L	0.00	-	218.38	CAD	1.00	$ -		CAD	1.00		0%	$ -	5%	$ -	$ -
6		L	0.00	-	218.38	CAD	1.00	$ -		CAD	1.00		0%	$ -	5%	$ -	$ -
7	2.72	L	1.47	40	218.38	CAD	1.00	$ 8,713	49.00	CAD	1.00	P3	0%	$ -	5%	$ 24.50	$ 515
8	16.00	L	1.47	29	218.38	CAD	1.00	$ 6,407	6,500.00	CAD	1.00	P3	0%	$ -	5%	$ 406.25	$ 8,531
9	12.00	L	1.47	44	218.38	CAD	1.00	$ 9,610	350.00	CAD	1.00	P3	0%	$ -	5%	$ 43.75	$ 919
Site Development																	
1	0.50	L	1.47	261	218.38	CAD	1.00	$ 57,059	105.00	CAD	1.00	P3	0%	$ -	5%	$ 1,870.31	$ 39,277
2	24.00	L	1.47	44	218.38	CAD	1.00	$ 9,610	4,964.54	CAD	1.00	P3	0%	$ -	5%	$ 310.28	$ 6,516
2		L	0.00	-	218.38	CAD	1.00	$ -		CAD	1.00	P3	0%	$ -	5%	$ -	$ -
3		L	0.00	-	218.38	CAD	1.00	$ -		CAD	1.00	P3	0%	$ -	5%	$ -	$ -
Concrete & Steel																	
1	6.00	L	1.47	5,439	188.35	CAD	1.00	$ 1,024,459	784.35	CAD	1.00	P3	0%	$ -	5%	########	$ 508,965
2	6.50	L	1.47	2,574	188.35	CAD	1.00	$ 484,877	952.35	CAD	1.00	P3	0%	$ -	5%	########	$ 269,991
3	6.50	L	1.47	2,288	188.35	CAD	1.00	$ 431,002	952.35	CAD	1.00	P3	0%	$ -	5%	########	$ 239,992
4	0.05	L	1.47	152	188.35	CAD	1.00	$ 28,595	3.10	CAD	1.00	P3	0%	$ -	5%	$ 320.85	$ 6,738
5	0.15	L	1.47	185	188.35	CAD	1.00	$ 34,812	10.00	CAD	1.00	P3	0%	$ -	5%	$ 420.00	$ 8,820
6	5.00	L	1.47	440	188.35	CAD	1.00	$ 82,885	784.35	CAD	1.00	P3	0%	$ -	5%	$ 2,353.05	$ 49,414
7	5.00	L	1.47	44	188.35	CAD	1.00	$ 8,288	784.35	CAD	1.00	P3	0%	$ -	5%	$ 235.31	$ 4,941
8	8.00	L	1.47	352	188.35	CAD	1.00	$ 66,308	784.35	CAD	1.00	P3	0%	$ -	5%	$ 1,176.53	$ 24,707
9	6.00	L	1.47	11	188.35	CAD	1.00	$ 1,989	784.35	CAD	1.00	P3	0%	$ -	5%	$ 47.06	$ 988
10	0.80	L	1.47	211	188.35	CAD	1.00	$ 39,785	6.00	CAD	1.00	P3	0%	$ -	5%	$ 54.00	$ 1,134
11	6.00	L	1.47	2,165	188.35	CAD	1.00	$ 407,794	784.35	CAD	1.00	P3	0%	$ -	5%	$ 9,647.51	$ 202,598
12	6.50	L	1.47	400	188.35	CAD	1.00	$ 75,425	952.35	CAD	1.00	P3	0%	$ -	5%	$ 1,999.94	$ 41,999
13	9.00	L	1.47	1,426	188.35	CAD	1.00	$ 268,547	784.35	CAD	1.00	P3	0%	$ -	5%	$ 4,235.49	$ 88,945
14	6.00	L	1.47	686	188.35	CAD	1.00	$ 129,301	2,293.20	CAD	1.00	P3	0%	$ -	5%	$ 8,943.48	$ 187,813
15	0.07	L	1.47	47	188.35	CAD	1.00	$ 8,935	45.00	CAD	1.00	P3	0%	$ -	5%	$ 1,039.50	$ 21,830
16	0.07	L	1.47	7	188.35	CAD	1.00	$ 1,392	14.00	CAD	1.00	P3	0%	$ -	5%	$ 50.40	$ 1,058
17	4.00	L	1.47	141	188.35	CAD	1.00	$ 26,523	784.35	CAD	1.00	P3	0%	$ -	5%	$ 941.22	$ 19,766
18	5.00	L	1.47	44	188.35	CAD	1.00	$ 8,288	784.35	CAD	1.00	P3	0%	$ -	5%	$ 235.31	$ 4,941
19	7.00	L	1.47	12	188.35	CAD	1.00	$ 2,321	784.35	CAD	1.00	P3	0%	$ -	5%	$ 47.06	$ 988
20	0.80	L	1.47	28	188.35	CAD	1.00	$ 5,305	6.00	CAD	1.00	P3	0%	$ -	5%	$ 7.20	$ 151
21	4.00	L	1.47	141	188.35	CAD	1.00	$ 26,523	784.35	CAD	1.00	P3	0%	$ -	5%	$ 941.22	$ 19,766
22	6.00	L	1.47	53	188.35	CAD	1.00	$ 9,946	784.35	CAD	1.00	P3	0%	$ -	5%	$ 235.31	$ 4,941
23	20.00	L	1.47	57	209.14	CAD	1.00	$ 11,995	7,800.00	CAD	1.00	P3	0%	$ -	5%	$ 762.45	$ 16,011
24	0.50	L	1.47	13	209.14	CAD	1.00	$ 2,646	300.00	CAD	1.00	P3	0%	$ -	5%	$ 258.75	$ 5,434
25	95.00	L	1.47	40	209.14	CAD	1.00	$ 8,379	10,500.00	CAD	1.00	P3	0%	$ -	5%	$ 150.94	$ 3,170
26	80.00	L	1.47	27	209.14	CAD	1.00	$ 5,645	9,500.00	CAD	1.00	P3	0%	$ -	5%	$ 109.25	$ 2,294
27	0.45	L	1.47	15	209.14	CAD	1.00	$ 3,175	150.00	CAD	1.00	P3	0%	$ -	5%	$ 172.50	$ 3,623
28	20.00	L	1.47	27	209.14	CAD	1.00	$ 5,645	7,800.00	CAD	1.00	P3	0%	$ -	5%	$ 358.80	$ 7,535
29	0.80	L	1.47	4	209.14	CAD	1.00	$ 847	300.00	CAD	1.00	P3	0%	$ -	5%	$ 51.75	$ 1,087
30	95.00	L	1.47	40	209.14	CAD	1.00	$ 8,379	10,500.00	CAD	1.00	P3	0%	$ -	5%	$ 150.94	$ 3,170
31	80.00	L	1.47	13	209.14	CAD	1.00	$ 2,822	9,500.00	CAD	1.00	P3	0%	$ -	5%	$ 54.63	$ 1,147
32	0.45	L	1.47	15	209.14	CAD	1.00	$ 3,175	150.00	CAD	1.00	P3	0%	$ -	5%	$ 172.50	$ 3,623
33	22.00	L	1.47	19	209.14	CAD	1.00	$ 3,881	7,000.00	CAD	1.00	P3	0%	$ -	5%	$ 201.25	$ 4,226
34	20.00	L	1.47	40	209.14	CAD	1.00	$ 8,467	7,800.00	CAD	1.00	P3	0%	$ -	5%	$ 538.20	$ 11,302
35	0.80	L	1.47	13	209.14	CAD	1.00	$ 2,822	300.00	CAD	1.00	P3	0%	$ -	5%	$ 172.50	$ 3,623
36	95.00	L	1.47	40	209.14	CAD	1.00	$ 8,379	10,500.00	CAD	1.00	P3	0%	$ -	5%	$ 150.94	$ 3,170
37	80.00	L	1.47	13	209.14	CAD	1.00	$ 2,822	9,500.00	CAD	1.00	P3	0%	$ -	5%	$ 54.63	$ 1,147
38	0.45	L	1.47	9	209.14	CAD	1.00	$ 1,905	150.00	CAD	1.00	P3	0%	$ -	5%	$ 103.50	$ 2,174
39		L	0.00	-	209.14	CAD	1.00	$ -		CAD	1.00		0%	$ -	5%	$ -	$ -
Major Electrical MTO																	
1	150.00	L	1.47	9,241	172.28	CAD	1.00	$ 1,592,121		CAD	1.00		0%	$ -	0%	$ -	$ -
2	60.00	L	1.47	528	172.28	CAD	1.00	$ 90,978		CAD	1.00		0%	$ -	0%	$ -	$ -
3	200.00	L	1.47	293	172.28	CAD	1.00	$ 50,544		CAD	1.00		0%	$ -	0%	$ -	$ -
4	15.00	L	1.47	66	172.28	CAD	1.00	$ 11,372		CAD	1.00		0%	$ -	0%	$ -	$ -
5	75.00	L	1.47	110	172.28	CAD	1.00	$ 18,954		CAD	1.00		0%	$ -	0%	$ -	$ -
6	60.00	L	1.47	176	172.28	CAD	1.00	$ 30,326		CAD	1.00		0%	$ -	0%	$ -	$ -
7	32.00	L	1.47	282	172.28	CAD	1.00	$ 48,522		CAD	1.00		0%	$ -	0%	$ -	$ -
8	180.00	L	1.47	528	172.28	CAD	1.00	$ 90,978		CAD	1.00		0%	$ -	0%	$ -	$ -
9	40.00	L	1.47	352	172.28	CAD	1.00	$ 60,652		CAD	1.00		0%	$ -	0%	$ -	$ -
10	900.00	L	1.47	2,640	172.28	CAD	1.00	$ 454,892		CAD	1.00		0%	$ -	0%	$ -	$ -
11	180.00	L	1.47	528	172.28	CAD	1.00	$ 90,978		CAD	1.00		0%	$ -	0%	$ -	$ -
12	450.00	L	1.47	660	172.28	CAD	1.00	$ 113,723		CAD	1.00		0%	$ -	0%	$ -	$ -
13	640.00	L	1.47	939	172.28	CAD	1.00	$ 161,739		CAD	1.00		0%	$ -	0%	$ -	$ -
14	80.00	L	1.47	939	172.28	CAD	1.00	$ 161,739		CAD	1.00		0%	$ -	0%	$ -	$ -
15	150.00	L	1.47	440	172.28	CAD	1.00	$ 75,815		CAD	1.00		0%	$ -	0%	$ -	$ -
16	0.27	L	1.47	792	179.49	CAD	1.00	$ 142,172	300.00	CAD	1.00	P2	1%	$ 6,000	15%	########	$ 696,000
17	80.00	L	1.47	117	172.28	CAD	1.00	$ 20,217		CAD	1.00		0%	$ -	0%	$ -	$ -
18	0.13	L	1.47	305	179.49	CAD	1.00	$ 54,763	15.50	CAD	1.00	P3	2%	$ 496	15%	$ 3,720.00	$ 29,016
19	0.50	L	1.47	2,376	179.49	CAD	1.00	$ 426,516	525.00	CAD	1.00	P2	1%	$ 17,010	15%	########	$ 1,973,160
20	10.74	L	1.47	95	172.28	CAD	1.00	$ 16,285	12,935.00	CAD	1.00	P3	4%	$ 3,104	0%	$ -	$ 80,714
Total Direct Cost								$ 7,171,690									$ 5,986,264
Indirect Cost																	
1	-	L	1.37	-	-	CAD	1.00	$ -									$ -
2	-	L	1.37	-	-	CAD	1.00	$ -									$ -
3	-	L	1.37	-	-	CAD	1.00	$ -									$ -
4	-	L	1.37	-	-	CAD	1.00	$ -									$ -
5	-	L	1.37	-	-	CAD	1.00	$ -									$ -
6	-	L	1.37	-	-	CAD	1.00	$ -									$ -
7	-	L	1.37	-	-	CAD	1.00	$ -									$ -
8	-	L	1.37	-	-	CAD	1.00	$ -									$ -
9	-	L	1.37	-	-	CAD	1.00	$ -									$ -
Total Indirect Cost								$ -									$ -
Total Direct + Indirect Cost								$ 7,171,690									$ 5,986,264
Owner's Cost																	
1	-	L	0.00	-	-	CAD	1.00	$ -									$ -
Contingency																	
1	-	L	0.00	-	-	CAD	1.00	$ -									$ -
Grand Total								$ 7,171,690									$ 5,986,264

ID #	Unit Equipment ($/Unit)	Currency	FOREX	Price Growth Code	Equipment Price Growth	Net Final Split Amounts Equipment	Unit Subcontract Cost ($/Unit)	Currency	FOREX	Cost Maturity	Subcontract Price Growth	Net Final Split Amounts Subcontract	Net Final Amount	Net Rate	Item Source	Cost Source
	EQUIPMENT						SUBCONTRACT						NET FINAL AMOUNT	NET RATE	Sourcing	
Preliminary																
1						$ -	250,000.00	CAD	1.00	P5	0%	$ 250,000	$ 250,000	$ 250,000.00	Electrical MTO	P5
Excavation & Backfilling																
1						$ -	3.47	CAD	1.00	P4	0%	$ 39,298	$ 39,298	$ 3.47	Civil MTO	P4
2						$ -	11.93	CAD	1.00	P4	0%	$ 20,266	$ 20,266	$ 11.93	Civil MTO	P4
3						$ -	11.93	CAD	1.00	P4	0%	$ 180,013	$ 180,013	$ 11.93	Civil MTO	P4
4						$ -	22.92	CAD	1.00	P4	0%	$ 30,598	$ 30,598	$ 22.92	Civil MTO	P4
5						$ -					0%	$ -	$ 2,278,135	$ 245.82	Civil MTO	P4
6						$ -					0%	$ -	$ 257,189	$ 245.82	Civil MTO	P4
7						$ -					0%	$ -	$ 412,363	$ 245.82	Civil MTO	P4
8						$ -					0%	$ -	$ 842,240	$ 245.82	Civil MTO	P4
9						$ -	20.00	CAD	1.00	P4	0%	$ 26,163	$ 26,163	$ 20.00	Civil MTO	P4
10						$ -	6.00	CAD	1.00	P4	0%	$ 48,938	$ 48,938	$ 6.00	Civil MTO	P4
11						$ -					0%	$ -	$ 160,726	$ 47.39	Civil MTO	P3
12						$ -					0%	$ -	$ 24,434	$ 34.38	Civil MTO	P3
Drainage																
1						$ -	55.00	CAD	1.00	P3	0%	$ 8,663	$ 8,663	$ 55.00	Civil MTO	P3
2						$ -	55.00	CAD	1.00	P3	0%	$ 5,363	$ 5,363	$ 55.00	Civil MTO	P3
3						$ -	6.00	CAD	1.00	P3	0%	$ 2,984	$ 2,984	$ 6.00	Civil MTO	P3
4						$ -					0%	$ -	$ 2,702	$ 90.32	Civil MTO	P3
5						$ -	140.00	CAD	1.00	P3	0%	$ 735	$ 735	$ 140.00	Civil MTO	P3
6						$ -	12,000.00	CAD	1.00	P3	0%	$ 30,000	$ 30,000	$ 12,000.00	Civil MTO	P3
7						$ -					0%	$ -	$ 9,228	$ 922.75	Civil MTO	P3
8						$ -		CAD	1.00		0%	$ -	$ 14,938	$ 11,950.32	Civil MTO	P3
9						$ -		CAD	1.00		0%	$ -	$ 10,529	$ 4,211.49	Civil MTO	P3
Site Development																
1						$ -						$ -	$ 96,336	$ 270.42	Civil MTO	P3
2						$ -						$ -	$ 16,126	$ 12,900.74	Civil MTO	P3
2						$ -	426,244.68	CAD	1.00			$ 426,245	$ 426,245	$ 426,244.68	Civil MTO	P3
3						$ -	30,000.00	CAD	1.00			$ 30,000	$ 30,000	$ 30,000.00	Civil MTO	P3
Concrete & Steel																
1						$ -						$ -	$ 1,533,423	$ 2,481.27	Structural & Concrete MTO	P3
2						$ -						$ -	$ 754,868	$ 2,795.81	Structural & Concrete MTO	P3
3						$ -						$ -	$ 670,994	$ 2,795.81	Structural & Concrete MTO	P3
4						$ -						$ -	$ 35,333	$ 17.07	Structural & Concrete MTO	P3
5						$ -						$ -	$ 43,632	$ 51.94	Structural & Concrete MTO	P3
6						$ -						$ -	$ 132,299	$ 2,204.98	Structural & Concrete MTO	P3
7						$ -						$ -	$ 13,230	$ 2,204.98	Structural & Concrete MTO	P3
8						$ -		CAD	1.00		0%	$ -	$ 91,015	$ 3,033.83	Structural & Concrete MTO	P3
9						$ -						$ -	$ 2,978	$ 2,481.27	Structural & Concrete MTO	P3
10						$ -						$ -	$ 40,919	$ 227.33	Structural & Concrete MTO	P3
11						$ -						$ -	$ 610,392	$ 2,481.27	Structural & Concrete MTO	P3
12						$ -						$ -	$ 117,424	$ 2,795.81	Structural & Concrete MTO	P3
13						$ -						$ -	$ 357,493	$ 3,310.12	Structural & Concrete MTO	P3
14						$ -		CAD	1.00		0%	$ -	$ 317,114	$ 4,065.56	Structural & Concrete MTO	P3
15						$ -						$ -	$ 30,765	$ 66.59	Structural & Concrete MTO	P3
16						$ -						$ -	$ 2,451	$ 34.04	Structural & Concrete MTO	P3
17						$ -						$ -	$ 46,289	$ 1,928.70	Structural & Concrete MTO	P3
18						$ -						$ -	$ 13,230	$ 2,204.98	Structural & Concrete MTO	P3
19						$ -		CAD	1.00		0%	$ -	$ 3,309	$ 2,757.55	Structural & Concrete MTO	P3
20						$ -						$ -	$ 5,456	$ 227.33	Structural & Concrete MTO	P3
21						$ -						$ -	$ 46,289	$ 1,928.70	Structural & Concrete MTO	P3
22						$ -						$ -	$ 14,888	$ 2,481.27	Structural & Concrete MTO	P3
23						$ -						$ -	$ 28,006	$ 14,325.56	Structural & Concrete MTO	P3
24						$ -						$ -	$ 8,080	$ 468.39	Structural & Concrete MTO	P3
25						$ -		CAD	1.00		0%	$ -	$ 11,549	$ 40,168.92	Structural & Concrete MTO	P3
26						$ -						$ -	$ 7,939	$ 34,517.25	Structural & Concrete MTO	P3
27						$ -						$ -	$ 6,798	$ 295.55	Structural & Concrete MTO	P3
28						$ -						$ -	$ 13,180	$ 14,325.56	Structural & Concrete MTO	P3
29						$ -		CAD	1.00		0%	$ -	$ 1,933	$ 560.42	Structural & Concrete MTO	P3
30						$ -						$ -	$ 11,549	$ 40,168.92	Structural & Concrete MTO	P3
31						$ -						$ -	$ 3,969	$ 34,517.25	Structural & Concrete MTO	P3
32						$ -		CAD	1.00		0%	$ -	$ 6,798	$ 295.55	Structural & Concrete MTO	P3
33						$ -						$ -	$ 8,107	$ 14,099.12	Structural & Concrete MTO	P3
34						$ -						$ -	$ 19,769	$ 14,325.56	Structural & Concrete MTO	P3
35						$ -						$ -	$ 6,445	$ 560.42	Structural & Concrete MTO	P3
36						$ -						$ -	$ 11,549	$ 40,168.92	Structural & Concrete MTO	P3
37						$ -		CAD	1.00		0%	$ -	$ 3,969	$ 34,517.25	Structural & Concrete MTO	P3
38						$ -						$ -	$ 4,079	$ 295.55	Structural & Concrete MTO	P3
39						$ -	200,000.00	CAD	1.00	P5		$ 200,000	$ 200,000	$ 200,000.00	Structural & Concrete MTO	P5
Major Electrical MTO																
1	838,458.84	USD	1.36	P2	2%	$ 48,850,624						$ -	$ 50,442,745	$ 1,201,017.74	Electrical MTO	P2
2	409,486.65	USD	1.36	P2	2%	$ 3,408,239						$ -	$ 3,499,218	$ 583,202.94	Electrical MTO	P2
3	1,635,294.12	USD	1.36	P2	2%	$ 2,268,480						$ -	$ 2,319,024	$ 2,319,023.53	Electrical MTO	P2
4	5,000.00	CAD	1.00	P2	2%	$ 15,300						$ -	$ 26,672	$ 8,890.76	Electrical MTO	P2
5	30,000.00	CAD	1.00	P2	2%	$ 30,600						$ -	$ 49,554	$ 49,553.82	Electrical MTO	P2
6	25,000.00	CAD	1.00	P2	2%	$ 51,000						$ -	$ 81,326	$ 40,663.06	Electrical MTO	P2
7	10,000.00	CAD	1.00	P2	2%	$ 61,200						$ -	$ 109,722	$ 18,286.96	Electrical MTO	P2
8	150,000.00	CAD	1.00	P2	2%	$ 306,000						$ -	$ 396,978	$ 198,489.17	Electrical MTO	P2
9	15,000.00	CAD	1.00	P2	2%	$ 91,800						$ -	$ 152,452	$ 25,408.71	Electrical MTO	P2
10	5,000,000.00	CAD	1.00	P2	2%	$ 10,200,000						$ -	$ 10,654,892	$ 5,327,445.86	Electrical MTO	P2
11	900,000.00	CAD	1.00	P2	2%	$ 1,836,000						$ -	$ 1,926,978	$ 963,489.17	Electrical MTO	P2
12	1,800,000.00	CAD	1.00	P2	2%	$ 1,836,000						$ -	$ 1,949,723	$ 1,949,722.93	Electrical MTO	P2
13	2,500,000.00	CAD	1.00	P2	2%	$ 2,550,000						$ -	$ 2,711,739	$ 2,711,739.28	Electrical MTO	P2
14	80,000.00	CAD	1.00	P2	2%	$ 652,800						$ -	$ 814,539	$ 101,817.41	Electrical MTO	P2
15	150,000.00	CAD	1.00	P2	2%	$ 306,000						$ -	$ 381,815	$ 190,907.64	Electrical MTO	P2
16						$ -						$ -	$ 838,172	$ 419.09	Electrical MTO	P2
17	100,000.00	CAD	1.00	P2	2%	$ 102,000						$ -	$ 122,217	$ 122,217.41	Electrical MTO	P2
18						$ -						$ -	$ 83,779	$ 52.36	Electrical MTO	P3
19					0%	$ -						$ -	$ 2,399,676	$ 740.64	Electrical MTO	P2
20					0%	$ -						$ -	$ 97,000	$ 16,166.59	Electrical MTO	P3
Total Direct Cost						$ 72,566,043						$ 1,299,263	$ 89,519,937			
Indirect Cost																
1						$ -	89,519,936.94	CAD	1.00	X	0%	$ 17,903,987	$ 17,903,987	$ 89,519,936.94		X
2						$ -	89,519,936.94	CAD	1.00	X	0%	$ 7,161,595	$ 7,161,595	$ 89,519,936.94		X
3						$ -	78,552,307.94	CAD	1.00	X	0%	$ 11,782,846	$ 11,782,846	$ 78,552,307.94		X
4						$ -	72,566,043.50	CAD	1.00	X	0%	$ 2,902,642	$ 2,902,642	$ 72,566,043.50		X
5						$ -	72,566,043.50	CAD	1.00	X	0%	$ 1,451,321	$ 1,451,321	$ 72,566,043.50		X
6						$ -	72,566,043.50	CAD	1.00	X	0%	$ 2,902,642	$ 2,902,642	$ 72,566,043.50		X
7						$ -	89,519,936.94	CAD	1.00	X	0%	$ 895,199	$ 895,199	$ 89,519,936.94		X
8						$ -	102,000.00	CAD	1.00	X	0%	$ 102,000	$ 102,000	$ 102,000.00		X
9						$ -	88,476.99	CAD	1.00	X	0%	$ 88,477	$ 88,477	$ 88,476.99		X
Total Indirect Cost						$ -						$ 45,190,709	$ 45,190,709			
Total Direct + Indirect Cost						$ 72,566,043						$ 46,489,972	$ 134,710,646			
Owner's Cost																
1						$ -	89,519,936.94	CAD	1.00	X	0%	$ 7,161,595	$ 7,161,595	$ 89,519,936.94	Suggested 8%	
Contingency																
1						$ -	134,710,646.18	CAD	1.00	X	0%	$ 33,677,662	$ 33,677,662	$ 134,710,646.18	Std.Class 4	
Grand Total						$ 72,566,043						$ 87,329,229	$ 175,549,903			

Appendix D

CAPEX Option 3

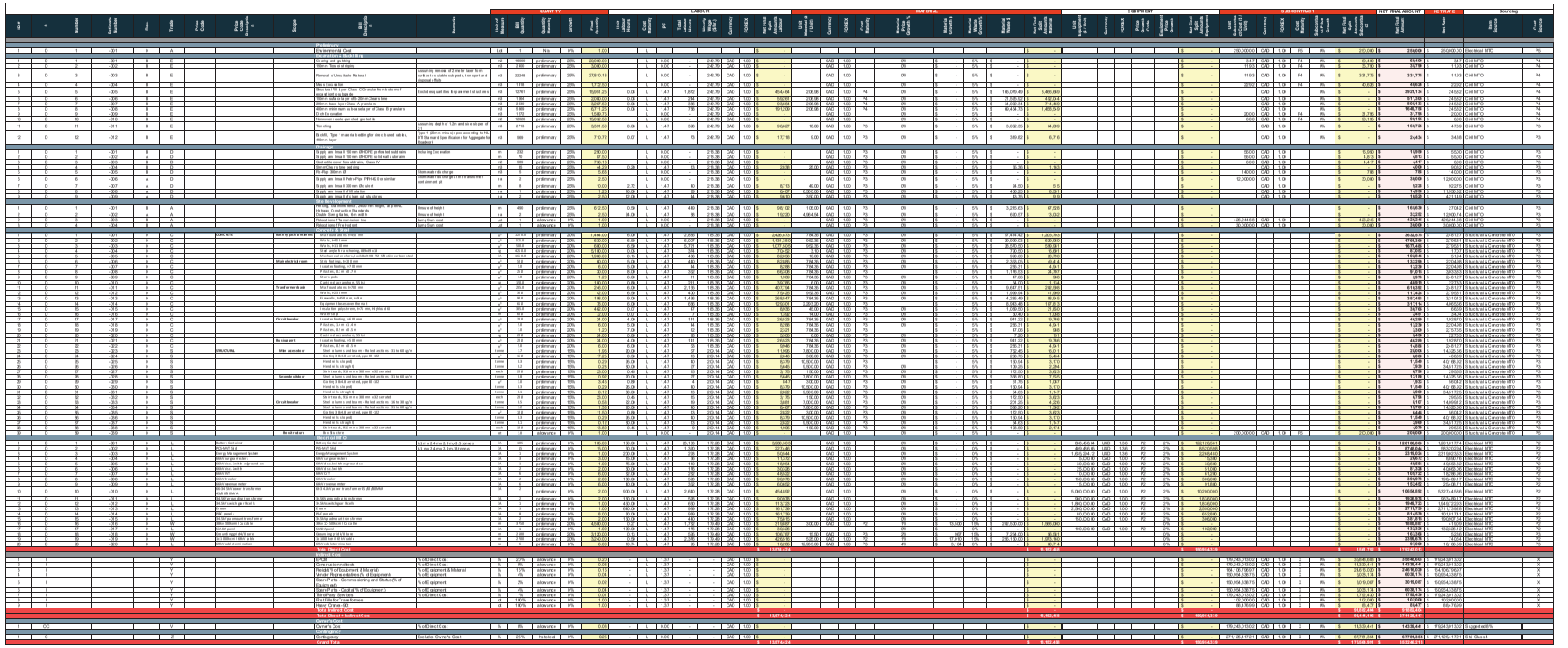
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Scope	Bill Description	Remarks	Unit of Measure	Bill Quantity	Net Final Split Amounts Subcontract	Net Final Amount	Net Rate	Item Source	Cost Source
	Preliminary								
	Environmental Cost		Lot	1	$ 250,000	$ 250,000	$ 250,000.00	Electrical MTO	P5
	Excavation & Backfilling								
	Clearing and grubbing		m2	10130	$ 43,939	$ 43,939	$ 3.47	Civil MTO	P4
	150mm Topsoil stripping		m3	1520	$ 22,660	$ 22,660	$ 11.93	Civil MTO	P4
	Removal of Unsuitable Material	Assuming removal of 2 meter layer from surface to suitable subgrade, transport and disposal offsite	m3	13435	$ 200,345	$ 200,345	$ 11.93	Civil MTO	P4
	Mass Excavation		m3	1068	$ 30,598	$ 30,598	$ 22.92	Civil MTO	P4
	Structural Fill layer, Class C Granular from bottom of excavation to subgrade	Excludes quantities for pavement structures	m3	8129	$ -	$ 2,497,837	$ 245.82	Civil MTO	P4
	150mm surface layer of 5-20mm Clear stone		m3	943	$ -	$ 289,760	$ 245.82	Civil MTO	P4
	200mm base layer Class A granulars		m3	1498	$ -	$ 460,298	$ 245.82	Civil MTO	P4
	400mm mininmum sub-base layer of Class B granulars		m3	3059	$ -	$ 939,954	$ 245.82	Civil MTO	P4
	Ditch Excavation		m3	1058	$ 26,451	$ 26,451	$ 20.00	Civil MTO	P4
	Nonwoven needle-punched geotextile		m2	7262	$ 54,465	$ 54,465	$ 6.00	Civil MTO	P4
	Trenching	Assuming depth of 1.2m and side slopes of 2:1	m3	1367	$ -	$ 80,967	$ 47.39	Civil MTO	P3
	Backfill, Type 1 material bedding for direct buried cables, 450mm layer	Type 1 (25mm minus) spec according to NL DTI Standard Specifications for Aggregate for Roadwork	m3	569	$ -	$ 24,434	$ 34.38	Civil MTO	P3
	Drainage								
	Supply and Install 150mm Ø HDPE perforated subdrains	Including Excavation	m	126	$ 8,663	$ 8,663	$ 55.00	Civil MTO	P3
	Supply and Install 150mm Ø HDPE solid wall subdrains		m	78	$ 5,363	$ 5,363	$ 55.00	Civil MTO	P3
	Geotextile cover for subdrains, Class IV		m²	398	$ 2,984	$ 2,984	$ 6.00	Civil MTO	P3
	50mm Clear stone bedding		m³	24	$ -	$ 2,702	$ 90.32	Civil MTO	P3
	Rip-Rap 300mm Ø	Stormwater discharge	m³	4	$ 735	$ 735	$ 140.00	Civil MTO	P3
	Supply and Install Petro-Pipe PIFH-620 or similar	Stormwater discharge at the transformer containment pit	ea	2	$ 30,000	$ 30,000	$ 12,000.00	Civil MTO	P3
	Supply and Install 300mm Ø culvert		m	8	$ -	$ 9,228	$ 922.75	Civil MTO	P3
	Supply and install of lift station		ea	1	$ -	$ 14,938	$ 11,950.32	Civil MTO	P3
	Supply and install of clean out structures		ea	2	$ -	$ 10,529	$ 4,211.49	Civil MTO	P3
	Site Development								
	Fencing, chain link fence, 2400-mm height, as per NL Highway Construction Standards	Unsure of height	m	305	$ -	$ 103,096	$ 270.42	Civil MTO	P3
	Double Swing Gates, 6-m width	Unsure of height	ea	1	$ -	$ 16,126	$ 12,900.74	Civil MTO	P3
	Relocation of Transmission line	Lump Sum cost	Lot	1	$ 426,245	$ 426,245	$ 426,244.68	Civil MTO	P3
	Relocation of Fire Hydrant	Lump Sum cost	Lot	1	$ 30,000	$ 30,000	$ 30,000.00	Civil MTO	P3
	Concrete & Steel								
Battery pack containers	Mat foundations, t=450 mm		m³	680.0	$ -	$ 2,024,714	$ 2,481.27	Structural & Concrete MTO	P3
	Walls, t=450 mm		m³	300.0	$ -	$ 1,006,491	$ 2,795.81	Structural & Concrete MTO	P3
	Walls, t=1100 mm		m³	260.0	$ -	$ 872,292	$ 2,795.81	Structural & Concrete MTO	P3
	Steel angle for anchoring, L89x89x13		kg	2250.0	$ -	$ 46,087	$ 17.07	Structural & Concrete MTO	P3
	Mechanical anchors, Kwik Bolt KB-TZ2 5/8x6 in carbon steel		EA	925.0	$ -	$ 57,656	$ 51.94	Structural & Concrete MTO	P3
Main electrical room	Strip footings, t=700 mm		m³	50.0	$ -	$ 132,299	$ 2,204.98	Structural & Concrete MTO	P3
	Isolated footing, t=700 mm		m³	5.0	$ -	$ 13,230	$ 2,204.98	Structural & Concrete MTO	P3
	Pilasters, 0.7 m x 0.7 m		m³	25.0	$ -	$ 91,015	$ 3,033.83	Structural & Concrete MTO	P3
	Stairs pads		m³	1.0	$ -	$ 2,978	$ 2,481.27	Structural & Concrete MTO	P3
	Cast-in-place anchors, 55 ksi		kg	150.0	$ -	$ 40,919	$ 227.33	Structural & Concrete MTO	P3
Transformers basin	Mat foundations, t=700 mm		m³	205.0	$ -	$ 610,392	$ 2,481.27	Structural & Concrete MTO	P3
	Walls, t=250 mm		m³	35.0	$ -	$ 117,424	$ 2,795.81	Structural & Concrete MTO	P3
	Firewalls, t=450 mm, h=9 m		m³	90.0	$ -	$ 357,493	$ 3,310.12	Structural & Concrete MTO	P3
	Equipment bases over the mat		m³	65.0	$ -	$ 317,114	$ 4,065.56	Structural & Concrete MTO	P3
	Insulation polystyrene, t=75 mm, Highload 60		m²	385.0	$ -	$ 30,765	$ 66.59	Structural & Concrete MTO	P3
	Water stop		m	60.0	$ -	$ 2,451	$ 34.04	Structural & Concrete MTO	P3
Circuit breaker	Isolated footing, t=600 mm		m³	20.0	$ -	$ 46,289	$ 1,928.70	Structural & Concrete MTO	P3
	Pilasters, 1.4 m x 1.4 m		m³	5.0	$ -	$ 13,230	$ 2,204.98	Structural & Concrete MTO	P3
	Pilasters, 0.5 m x 0.5 m		m³	1.0	$ -	$ 3,309	$ 2,757.55	Structural & Concrete MTO	P3
	Cast-in-place anchors, 55 ksi		kg	20.0	$ -	$ 5,456	$ 227.33	Structural & Concrete MTO	P3
Bus Support	Isolated footing, t=500 mm		m³	20.0	$ -	$ 46,289	$ 1,928.70	Structural & Concrete MTO	P3
	Pilasters, 0.5 m x 0.5 m		m³	5.0	$ -	$ 14,888	$ 2,481.27	Structural & Concrete MTO	P3
Main access door	Steel columns and beams - Rolled sections - 31 to 60 kg/m		tonne	1.7	$ -	$ 28,006	$ 14,325.56	Structural & Concrete MTO	P3
	Grating 38x4.8 serrated, type 30-102		m²	15.0	$ -	$ 8,080	$ 468.39	Structural & Concrete MTO	P3
	Handrails (sloped)		tonne	0.3	$ -	$ 11,549	$ 40,168.92	Structural & Concrete MTO	P3
	Handrails (straight)		tonne	0.2	$ -	$ 7,939	$ 34,517.25	Structural & Concrete MTO	P3
	Stair treads, 915 mm x 300 mm x 32 serrated		each	20.0	$ -	$ 6,798	$ 295.55	Structural & Concrete MTO	P3
Second exit door	Steel columns and beams - Rolled sections - 31 to 60 kg/m		tonne	0.8	$ -	$ 13,180	$ 14,325.56	Structural & Concrete MTO	P3
	Grating 38x4.8 serrated, type 30-102		m²	3.0	$ -	$ 1,933	$ 560.42	Structural & Concrete MTO	P3
	Handrails (sloped)		tonne	0.3	$ -	$ 11,549	$ 40,168.92	Structural & Concrete MTO	P3
	Handrails (straight)		tonne	0.1	$ -	$ 3,969	$ 34,517.25	Structural & Concrete MTO	P3
	Stair treads, 915 mm x 300 mm x 32 serrated		each	20.0	$ -	$ 6,798	$ 295.55	Structural & Concrete MTO	P3
Circuit breaker	Steel columns and beams - Rolled sections - 16 to 30 kg/m		tonne	0.5	$ -	$ 8,107	$ 14,099.12	Structural & Concrete MTO	P3
	Steel columns and beams - Rolled sections - 31 to 60 kg/m		tonne	1.2	$ -	$ 19,769	$ 14,325.56	Structural & Concrete MTO	P3
	Grating 38x4.8 serrated, type 30-102		m²	10.0	$ -	$ 6,445	$ 560.42	Structural & Concrete MTO	P3
	Handrails (sloped)		tonne	0.3	$ -	$ 11,549	$ 40,168.92	Structural & Concrete MTO	P3
	Handrails (straight)		tonne	0.1	$ -	$ 3,969	$ 34,517.25	Structural & Concrete MTO	P3
	Stair treads, 915 mm x 300 mm x 32 serrated		each	12.0	$ -	$ 4,079	$ 295.55	Structural & Concrete MTO	P3
Box Structure	Box Structure		lot	1.0	$ 200,000	$ 200,000	$ 200,000.00	Structural & Concrete MTO	P5
	Major Electrical MTO								
	Battery Container	6.1 m x 2.4 m x 2.9 m,43.5 tonnes	per container	60	$ -	$ 72,061,065	$ 1,201,017.74	Electrical MTO	P2
	PCS-MVT Skid	6.1 m x 2.4 m x 2.9 m,18 tonnes	per container	15	$ -	$ 8,748,044	$ 583,202.94	Electrical MTO	P2
	Energy Management System		per unit	1	$ -	$ 2,319,024	$ 2,319,023.53	Electrical MTO	P2
	66kV surge arresters		per unit	3	$ -	$ 26,672	$ 8,890.76	Electrical MTO	P2
	66kV disc. Switch w/ground sw		per unit	1	$ -	$ 49,554	$ 49,553.82	Electrical MTO	P2
	66kV disc. Switch		per unit	2	$ -	$ 81,326	$ 40,663.06	Electrical MTO	P2
	66kV CVT		per unit	6	$ -	$ 109,722	$ 18,286.96	Electrical MTO	P2
	66kV breaker		per unit	2	$ -	$ 396,978	$ 198,489.17	Electrical MTO	P2
	66kV revenue meter		per unit	6	$ -	$ 152,452	$ 25,408.71	Electrical MTO	P2
	66-34.5kV power transformer 45/60/80MVA		per unit	2	$ -	$ 10,654,892	$ 5,327,445.86	Electrical MTO	P2
	34.5KV grounding transformer		per unit	2	$ -	$ 1,926,978	$ 963,489.17	Electrical MTO	P2
	34.5kV switchgear 9 cells		per unit	1	$ -	$ 1,949,723	$ 1,949,722.93	Electrical MTO	P2
	E room		per unit	1	$ -	$ 2,711,739	$ 2,711,739.28	Electrical MTO	P2
	P&C panels		per unit	8	$ -	$ 814,539	$ 101,817.41	Electrical MTO	P2
	34.5kV padmount transformer		per unit	2	$ -	$ 381,815	$ 190,907.64	Electrical MTO	P2
	38kv 500kcmil Cu cable		m	3000	$ -	$ 1,257,258	$ 419.09	Electrical MTO	P2
	SCADA panel		per unit	1	$ -	$ 122,217	$ 122,217.41	Electrical MTO	P2
	Grounding grid 4/0 bare		m	1600	$ -	$ 83,779	$ 52.36	Electrical MTO	P3
	1c 1000kcmil 69kV cable		m	2700	$ -	$ 2,399,676	$ 740.64	Electrical MTO	P2
	69kV cable termination		ea	6	$ -	$ 97,000	$ 16,166.59	Electrical MTO	P3
	Total Direct Cost				$ 1,332,446	$ 118,133,264			
	Indirect Cost								
	EPCM	% of Direct Cost	%	20%	$ 23,626,653	$ 23,626,653	$ 118,133,263.91		X
	Construction Indirects	% of Direct Cost	%	8%	$ 9,450,661	$ 9,450,661	$ 118,133,263.91		X
	Freight(% of Equipment & Material)	% of Equipment & Material	%	15%	$ 15,840,202	$ 15,840,202	$ 105,601,344.29		X
	Vendor Representatives(% of Equipment)	% of Equipment	%	4%	$ 3,944,575	$ 3,944,575	$ 98,614,384.23		X
	Spare Parts - Commissioning and Startup(% of Equipment)	% of Equipment	%	2%	$ 1,972,288	$ 1,972,288	$ 98,614,384.23		X
	Spare Parts - Capital(% of Equipment)	% of Equipment	%	4%	$ 3,944,575	$ 3,944,575	$ 98,614,384.23		X
	Third-Party Services	% of Direct Cost	%	1%	$ 1,181,333	$ 1,181,333	$ 118,133,263.91		X
	First Fills for Transformers		lot	1	$ 102,000	$ 102,000	$ 102,000.00		X
	Heavy Cranes-90t		lot	1	$ 88,477	$ 88,477	$ 88,476.99		X
	Total Indirect Cost				$ 60,150,764	$ 60,150,764			
	Total Direct + Indirect Cost				$ 61,483,209	$ 178,284,027			
	Owner's Cost								
	Owner's Cost	% of Direct Cost	%	8%	$ 9,450,661	$ 9,450,661	$ 118,133,263.91	Suggested 8%	
	Contingency								
	Contingency	Excludes Owner's Cost	%	25%	$ 44,571,007	$ 44,571,007	$ 178,284,027.50	Std. Class 4	
	Grand Total				$ 115,504,877	$ 232,305,695			

Appendix E

CAPEX Option 4

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Battery Energy Storage System Feasibility Study – Overview

Attachment 2, Page 41 of 41

Attachment 3

Preliminary Cost Estimate – Battery Energy Storage System Feasibility Study

Newfoundland and Labrador Hydro



Preliminary Cost Estimate

Battery Energy Storage System Feasibility Study

NLH Doc. No. SDYBESS-NLH-00000-ES-BOE-0001-01

Comments: This document describes the methodology and results of capital cost estimate prepared for the BESS scope of work.	Total # of Pages (including Cover): 10
INTERNAL USE ONLY	

Revision	Date (DD-MMM-YYYY)	Issue Reason	Prepared By Sr. Estimator	Checked By Project Manager	Approved by Project Controls Manager	Approved by Program Manager
B1	21-Sep-2026	Use	Doug Maloney	Crystal O'Dea	Tony Scott	Marc Cullen

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Additional Approvals

Additional approvals required for further authorization due to document contents, complexity, prescribed requirements, or multi-departmental involvement.

Position	Name	Signature	Date (DD-MMM-YYYY)
Sr. Manager, Major Projects, PM & Engineering	Stephen Parsons		22-Sep-2026

Revision History

Changes to the content of this document are recorded in the Revision History table below. Minor or immaterial edits—such as formatting adjustments or typographical corrections—may not be listed.

Revision No.	Revision Date	Location	Reason

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1.0 Background

Newfoundland and Labrador Hydro (NL Hydro) is studying the feasibility of adding a Battery Energy Storage System (BESS) to the provincial electrical system. NL Hydro contracted Hatch Ltd. (Hatch) to complete the study, with four BESS options being considered:

- **Option 1:** 20 MW, 4-hour capacity
- **Option 2:** 20MW, 8-hour capacity
- **Option 3:** 50MW, 4-hour capacity
- **Option 4:** 50MW, 8-hour capacity

Hatch issued SDYBESS-HAT-00000-ES-BOE-0001-01 Battery Energy Storage Feasibility Study Basis of Estimate Revision A5 for review in July 2026. This report provided Class 4 feasibility estimates for the four options listed above.

2.0 References

The following is a list of documents that either are referenced in this document or are relevant to the subject matter contained within.

Reference	Document Title
SDYBESS-HAT-00000-ES-BOE-0001-01	Hatch - Battery Energy Storage Feasibility Study Basis of Estimate
SDYBESS-HAT-0000-EN-BOD-0001-01	NL Hydro BESS Feasibility Study Design Basis and Work Package Development
AACE RP 18R-97	Cost Estimate Classification System – As Applied in Engineering, Procurement and Construction for the Process Industries
AACE RP 119R-21	Cost Estimate Accuracy Range and Contingency Determination Using Tables Derived from Parametric Risk Models
SDYBESS-NLH-00000-ES-BOS-0001-01	BESS Project – Basis of Schedule

3.0 Estimate Development

The estimates for the four options were developed by Hatch, and include direct costs, indirect costs, owners cost and contingency. NL Hydro then made adjustments and additions based on NL Hydro practices, as described below.

The BESS estimates were developed as described below.

- The base cost estimates from Hatch were reviewed, and the direct and indirect costs were incorporated in the estimate.
- Hatch calculated Owner's Cost as 8% of direct costs, which covers the period from approval to proceed with project execution through to handover and closeout. This percentage has been increased by NL Hydro to 10% of direct + indirect + EPCM costs, in line with NL Hydro practice.
- Hatch calculated Contingency as 25% of direct + indirect costs, while NL Hydro calculated contingency as 25% of direct + indirect + EPCM + owner's costs.[1]

  Note that at the current option assessment phase of the project, a Quantitative Risk Assessment (QRA) has not been done. Upon selection of the preferred option and development of a Class 3 estimate, a QRA will be completed, and contingency will be calculated using a hybrid parametric/expected value risk assessment methodology.

- NL Hydro added escalation, which was calculated using the July 2026 NL Hydro corporate escalation indices, applied to a cash flow that is based on the milestone dates included in NL Hydro's SDYBESS-NLH-00000-ES-BOS-0001-01 Battery Energy Storage System Feasibility Study - Basis of Schedule. The cash flow will be reviewed and updated when the preferred option is chosen.
- NL Hydro added Interest During Construction (IDC) at 4.649%, based on July 2026 corporate assumptions, calculated on base costs, contingency and escalation, using the same cash flow.

4.0 Assumptions

- The estimated cost is presented in 2026 dollars.
- The project is assumed to start in 2027 with approval to proceed with FEED, and finish in 2032.
- The Hardwoods Greenfield site is assumed as the basis for all four options.
- Civil assumptions are outlined in Section 4.1.1.1 of the Hatch Basis of Estimate.
- Concrete and earthworks quantities are adjusted for 150cm excavation depth.
- Supply and installation of steel box structure has been added to the estimate.
- No concrete or steel demolition is expected to be required.
- A single 66kV interconnection to the grid is sufficient.
- Hatch used the developed Single Line Diagrams to develop electrical equipment lists, cable schedule, and Material Take-off.
- Hatch applied quantity and cost growth allowances and wastage allowances to take-off quantities as appropriate.

[1] This contingency percentage is consistent with AACE Recommended Practice 119R-21 Cost Estimate Accuracy Range and Contingency Determination Using Tables Derived from Parametric Risk Models, which recommends a contingency of 20% for a Class 4 estimate with medium technology and medium complexity, factored by 1.2 to allow for critical risks. i.e. 20% x 1.2 = 25%

- 50% of the construction workforce will require a living out allowance.
- Site productivity factors were developed by Hatch and applied to site work.
- EPCM was calculated as 20% of direct costs.
- Construction indirects were calculated as 8% of direct costs.
- Freight was calculated as 15% of equipment and materials.

5.0 Exclusions

The following items are excluded from this estimate:

- Property Acquisition.
- Accommodations camp and associated logistics.
- Decommissioning cost.
- Management Reserve, which will be developed as part of a QRA if the BESS scope is progressed.

6.0 Estimate Results

A summary of the BESS estimate is shown in Table 1.

More detailed summaries of the base costs for each option are shown in Tables 2, 3, 4, and 5.

The preliminary estimated cash flow for the project is shown in **Table 6.**

Table 1: BESS Preliminary Cost Estimate

	BESS Option 1 20MW, 4 hour	BESS Option 2 20MW, 8 hour	BESS Option 3 50MW, 4 hour	BESS Option 4 50MW, 8 hour
Direct Costs	$ 66,263,823	$ 90,961,656	$ 119,654,487	$ 181,332,348
Indirect Costs	$ 20,177,919	$ 27,867,249	$ 37,118,060	$ 56,366,028
EPCM	$ 13,252,765	$ 18,192,331	$ 23,930,897	$ 36,266,470
Owners Cost	$ 9,969,451	$ 13,702,124	$ 18,070,344	$ 27,396,485
Base Cost Subtotal	**$ 109,663,958**	**$ 150,723,360**	**$ 198,773,789**	**$ 301,361,330**
Contingency	**$ 27,415,989**	**$ 37,680,840**	**$ 49,693,447**	**$ 75,340,333**
Escalation	**$ 10,804,363**	**$ 14,853,527**	**$ 19,614,628**	**$ 29,725,754**
IDC	**$ 11,049,823**	**$ 15,169,477**	**$ 19,929,828**	**$ 30,249,620**
TOTAL	**$ 158,934,134**	**$ 218,427,204**	**$ 288,011,692**	**$ 436,677,037**

Table 2: BESS Option 1 Base Cost

Category	Description	Estimated Cost
Direct		**66,263,823**
	Site Development	801,806
	Concrete	3,659,290
	Roadworks, Drainage & Paving	73,209
	Earthwork	3,594,870
	Electrical Equipment	54,398,275
	Structural Steel	912,393
	Wire & Cable	2,823,980
Indirect		**20,177,919**
	Construction Indirects	5,301,106
	First Fills for Transformers	102,000
	Freight	8,832,692
	Heavy Cranes - 90t	88,477
	Spare Parts - Capital	2,076,402
	Spare Parts - Commissioning & Startup	1,038,201
	Third Party Services	662,638
	Vendor Representatives	2,076,402
EPCM		**13,252,765**
Owner's Cost		**9,969,451**
	Grand Total	**109,663,958**

Table 3: BESS Option 2 Base Cost

Category	Description	Estimated Cost
Direct		**90,961,656**
	Site Development	818,707
	Concrete	5,200,164
	Roadworks, Drainage & Paving	95,996
	Earthwork	4,602,680
	Electrical Equipment	76,010,089
	Structural Steel	912,393
	Wire & Cable	3,321,627
Indirect		**27,867,249**
	Construction Indirects	7,276,932
	First Fills for Transformers	102,000
	Freight	12,205,619
	Heavy Cranes - 90t	88,477
	Spare Parts - Capital	2,913,842
	Spare Parts - Commissioning & Startup	1,456,921
	Third Party Services	909,617
	Vendor Representatives	2,913,842
EPCM		**18,192,331**
Owner's Cost		**13,702,124**
	Grand Total	**150,723,360**

Table 4: BESS Option 3 Base Cost

Category	Description	Estimated Cost
Direct		**119,654,487**
	Site Development	825,467
	Concrete	6,183,835
	Roadworks, Drainage & Paving	85,140
	Earthwork	5,029,704
	Electrical Equipment	102,877,235
	Structural Steel	912,393
	Wire & Cable	3,740,713
Indirect		**37,118,060**
	Construction Indirects	9,572,359
	First Fills for Transformers	102,000
	Freight	16,269,240
	Heavy Cranes - 90t	88,477
	Spare Parts - Capital	3,955,775
	Spare Parts - Commissioning & Startup	1,977,888
	Third Party Services	1,196,545
	Vendor Representatives	3,955,775
EPCM		**23,930,897**
Owner's Cost		**18,070,344**
	Grand Total	**198,773,789**

Table 5: BESS Option 4 Base Cost

Category	Description	Estimated Cost
Direct		**181,332,348**
	Site Development	904,127
	Concrete	9,732,921
	Roadworks, Drainage & Paving	94,661
	Earthwork	8,299,666
	Electrical Equipment	156,939,648
	Structural Steel	912,393
	Wire & Cable	4,448,932
Indirect		**56,366,028**
	Construction Indirects	14,506,588
	First Fills for Transformers	102,000
	Freight	24,732,206
	Heavy Cranes - 90t	88,477
	Spare Parts - Capital	6,049,374
	Spare Parts - Commissioning & Startup	3,024,687
	Third Party Services	1,813,323
	Vendor Representatives	6,049,374
EPCM		**36,266,470**
Owner's Cost		**27,396,485**
	Grand Total	**301,361,330**

Table 6: BESS Preliminary Cash Flow

	2027	2028	2029	2030	2031	2032	Total
BESS Option 120MW, 4 hour	$2,350,098	$2,491,894	$20,827,857	$53,525,780	$53,360,194	$26,378,311	**$158,934,134**
BESS Option 220MW, 8 hour	$3,230,001	$3,424,887	$29,015,684	$72,849,278	$73,368,795	$36,538,560	**$218,427,204**
BESS Option 350MW, 4 hour	$4,259,721	$4,516,737	$38,993,234	$93,898,470	$97,454,286	$48,889,244	**$288,011,692**
BESS Option 450MW, 8 hour	$6,458,171	$6,847,834	$59,456,860	$142,520,445	$147,093,539	$74,300,187	**$436,677,037**

7.0 Estimate Class

Based on the project definition maturity guidelines in AACE Recommended Practices 18R-97, and the maturity assessment presented by Hatch in Appendix A of SDYBESS-HAT-0000-ES-BOE-0001-01 BESS – Basis of Estimate, the estimate is considered Class 4.

Attachment 4

Basis of Schedule – Battery Energy Storage System Feasibility Study

Newfoundland and Labrador Hydro



Basis of Schedule

Battery Energy Storage System Feasibility Study

SDYBESS-NLH-00000-ES-BOS-0001-01

Comments: The BESS Feasibility Study Basis of Schedule documents the basis and assumptions underpinning the BESS Project Feasibility Study Control Schedule. It documents the initial execution intent, sequence, and assumptions at a point in time. **This document contains confidential and commercially sensitive information. Access to this report and the information contained within is restricted and should only be shared with the written approval of the Manager of Project Controls for Major Projects.**	**Total # of Pages (including Cover):** **35**
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Revision	Date (DD-MMM-YYYY)	Issue Reason	Prepared By Project Planner, Major Projects	Approved By Manager, Project Controls, Major Projects	Approved by Project Manager, BESS Project	Approved by Program Manager Major Projects
B1	18-Sep-2026	Use	Jason Ash	Tony Scott	Crystal O'Dea	Marc Cullen

These signatures are required to confirm compliance with Major Projects procedures. This document cannot be finalized or distributed without this approval. Any version of this document without these signatures is not considered final.

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newfoundland labrador hydro	**Basis of Schedule** **Battery Energy Storage System Feasibility Study**				
NLH Doc. No.	**SDYBESS-NLH-00000-ES-BOS-0001-01**	**Revision**	**B1**	**Page**	**i**

Additional Approvals

Additional approvals required for further authorization due to document contents, complexity, prescribed requirements, or multi-departmental involvement.

Position	Name	Signature	Date (DD-MMM-YYYY)
Senior Manager, PM & Engineering, Major Projects	Stephen Parsons		18-SEP-2026

Revision History

Changes to the content of this document are recorded in the Revision History table below. Minor or immaterial edits—such as formatting adjustments or typographical corrections—may not be listed.

Revision No.	Revision Date	Location	Reason
1	18-Sep-2026	Page 4: Section 5.2	AACE International Recommended Practice 37R-06 replaced with AACE International Recommended Practice 27R-03: PUB approval extended from 6 to 12 months
2	18-Sep-2026	Page 6: Section 5.2	Figure 2 replaced: PUB approval extended from 6 to 12 months
3	18-Sep-2026	Page 6: Section 7.1	Figure 3 replaced: PUB approval extended from 6 to 12 months
4	18-Sep-2026	Page 15: Section 8.0	Figure 4 replaced: PUB approval extended from 6 to 12 months
5	18-Sep-2026	Page 15: Section 8.0	Figure 5 replaced: PUB approval extended from 6 to 12 months
6	18-Sep-2026	Page 1-1: Attachement 1	Attachement 1 replaced: PUB approval extended from 6 to 12 months

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Attachment 1: BESS Project – Project Control Schedule
Attachment 2: BESS Project Control Schedule – WBS Structure

1.0 Executive Summary

The Schedule covers the largest version of the options being studied in this phase; a 50 MW with an 8-hr reserve (400 MWh at the point of interconnection (POI)). This option drives the maximum scope for engineering, procurement, construction, permitting, and commissioning and therefore represents a conservative basis for schedule development. All smaller options would be expected to follow the same workflow with equal or reduced durations, allowing the schedule to be readily scaled if a different configuration is selected.

2.0 Abbreviations and Definitions

Term	Definition
AACE	The Association for the Advancement of Cost Engineering. An international industry organization that publishes many Recommended Practices (RPs) to aid in guiding project management professionals in many aspects of project execution. AACE RPs provide useful guidance but are not standards.
BESS	Battery Energy Storage System
BOS	Basis of Schedule. A companion document to the Control Schedule (CS) that explains, in narrative form, the Control Schedule as well as the various assumptions made in developing the schedule and planning the project.
CBE	Commercial Bid Evaluation
COD	Commercial Operation Date
CP	Critical Path
CPM	Critical Path Method. A project scheduling technique used to identify the longest sequence of dependent activities (the critical path) that determines the shortest possible project duration. CPM helps prioritize tasks, manage resources, and assess the impact of delays on overall project completion.
CT	Current Transformer
CVT	Capacitive Voltage Transformer
EPCM	Engineering, Procurement and Construction Management. A project delivery model where the consultant provides engineering design, procures materials and equipment, and manages construction on behalf of Hydro.
EWP	Engineering Work Package
FEP	Front End Planning

Term	Definition
FEED	Front End Engineering and Design
HV	High Voltage
IFC	Issued for Construction
IFR	Issued for Review
IFT	Issued for Tender
MP	Major Projects Department of Hydro.
MW	Megawatt
NL HYDRO	Newfoundland and Labrador Hydro and its affiliates, successors, and assigns.
P6	Oracle Primavera Project Planner Version 6. The preeminent project planning software application used in North America for large engineering and construction projects. Hydro currently uses Release 24 of this application.
PCS	Project Control Schedule. The project schedule, developed at a control level, is used to plan project execution, monitor its performance, and make execution decisions.
POI	Point of Interconnection
RFA	Recommendation for Approval
RFP	Request for Proposals.
RFR	Request for Review
SRA	Schedule Risk Assessment
TF	Total Float. A key component of the Critical Path Method (CPM) schedule technique. Total Float is a measurement of how much an activity can be delayed without impacting project completion.
VQS	Vendor Quality Surveillance
WBS	Work Breakdown Structure

3.0 Scope Summary

The Basis of Schedule describes the key assumptions and parameters used to develop the project's overall schedule. The schedule covers engineering, procurement and construction activities for the Newfoundland and Labrador Hydro 50 MW Battery Storage Project. The execution strategy assumed for the purpose of schedule development is to complete a Front-End Engineering Design (FEED) engineering phase to further define the project. Execution will use an Engineering, Procurement and Construction Management (EPCM) execution strategy.

This Basis of Schedule documents the current execution intent, sequence, assumptions, risks, and opportunities developed during the Feasibility Study phase of the project. Further project execution maturity, including design development, authorization timeline changes, execution strategy changes, scope modification, or construction contractor execution optimizations, may require updates of the PCS as well as this Basis of Schedule.

4.0 Purpose

The schedule is used to guide the Execution of the Project. The project schedule follows a Work Breakdown Structure (WBS) which largely represents the breakdown by phase, discipline then deliverable for the activities within the project scope. The schedule integrates sequencing of activities (network logic), activity durations, calendars, constraints and identifies the critical paths. The schedule was prepared to inform the estimated timeline of the project at the feasibility study phase. Due to an unknown start of the project, dates seen in schedule are for reference only.

The schedule was developed to achieve the following objectives:

- Establish the overall timeframes of engineering & procurement service activities for planning, staffing and costing purposes.
- Reflect a realistic engineering, procurement and construction sequence and time frame that is within +/- 20% accuracy (based on preliminary engineering pre-FEED).
- Develop complete cycles of engineering & procurement activities per package, which is required for two reasons; to indicate key stakeholder timelines and interactions with the EPCM contractor, and to schedule the receipt of vendor data for all procurement packages, which are required for (and logically linked to) the completion of detailed engineering activities.
- Provide a Level 2 schedule that can be used to communicate expected duration, critical items and other items related to schedule.
- Identify the critical path(s) throughout the execution.
- Identify opportunities through execution strategy changes.

5.0 Schedule Structure

5.1 Tools/Applications

The PCS is prepared in Oracle Primavera Version 6, Release 24. Future Contractor and Supplier tools and applications are unknown at this point; however, contractual arrangements will require the use of industry-typical applications, nominally Oracle Primavera or equivalent. This is a standard approach on major projects to ensure the quality of contractor schedule data.

5.2 Schedule Structure

The BESS Project PCS, provided as Attachment 1 to this Basis of Schedule, is a Class 4, Level 2 schedule (as per AACE International Recommended Practice 27R-03). It has been built mainly from Feasibility Study Completed by Hatch (SDYBESS-HAT-00000-PL-REP-0001-01), leveraging historical data, NL Hydro internal resource experience, the Major Projects Phased Approval Process (Figure 2), with current estimated lead times for Engineering, Long Lead Equipment, construction and commissioning. The PCS contains activities that develop a full project view of the scope, these activities track and forecast the project's progression through standard paths of development, from engineering, to procurement, to construction and finally commissioning. As this project progresses, and Consultants and Contractors are awarded scopes, the Consultants and Contractors will develop schedules that contain a greater level of detail with more activities. These schedules will then be utilized to update the BESS Project PCS, with additional activities added to the PCS as required to accurately represent the forecast for scope completion.

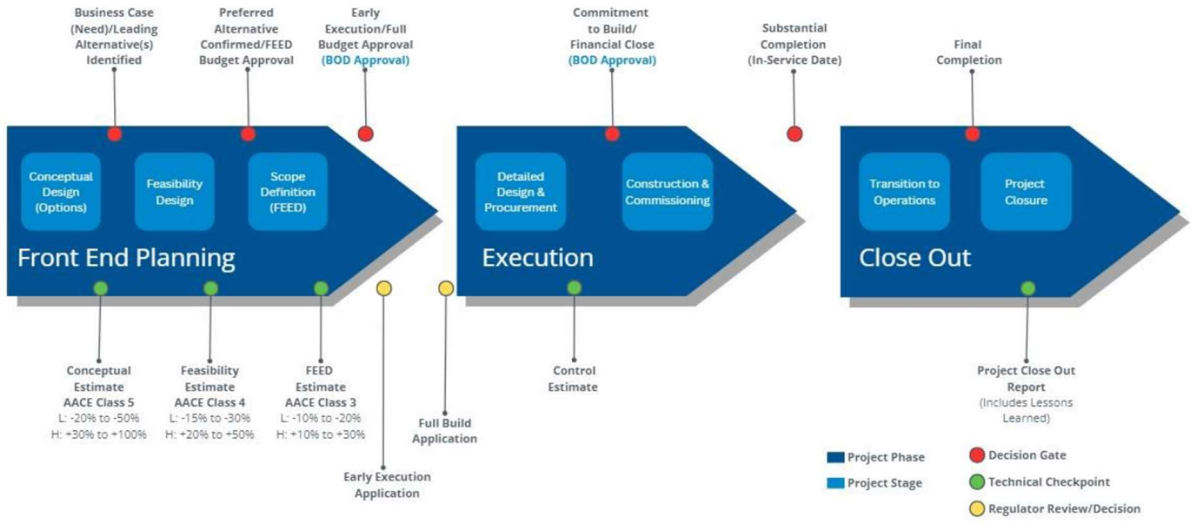


Figure 1: Major Projects Phased Approval Process

This phased definition of the Project life cycle has been summarized in the BESS Project PCS - WBS Structure, provided as Attachment 2 to this Basis of Schedule.

Table 1 provides a summary of the Schedule Structure at the Level 1 and Level 2 WBS Level; **Figure 2** shows the schedule summarized to the same levels. A full Schedule WBS listing is provided in **Figure 2**.

Table 1: Schedule Structure

WBS Level 1	WBS Level 2	Items/Description
Milestones	-	Start and finish milestones marking key project specific activities from the schedule.
FEP	-	Activities related to the FEP Stage of the project. Progressing the project towards Project Sanction and Execution Phase. NL HYDRO Responsible Scope and PUB Reviews.
Permitting	Environmental	Activities related to environmental assessment and approval, as well as provincial and municipal permits.
	Yearly Construction Permits	Activities related to the permitting process. These activities are required annually, and the activity duration allocates time for applications preparation, review and consultation, and approval.
Execution	Engineering	Activities associated with the FEED and Detailed Engineering phases of the project, including all engineering deliverables for the project.
	Procurement	Activities associated with the Procurement required for the project, including contracts and materials/equipment.
	Construction	Activities associated with the construction execution of the project, including all disciplines.
	Commissioning & Startup	Activities associated with the pre-commissioning, commissioning and startup/energization of the asset.
Project Closeout	-	Activities associate with the project closeout, including Certification and Handover, Closeout (invoicing, punch lists, reports, etc).

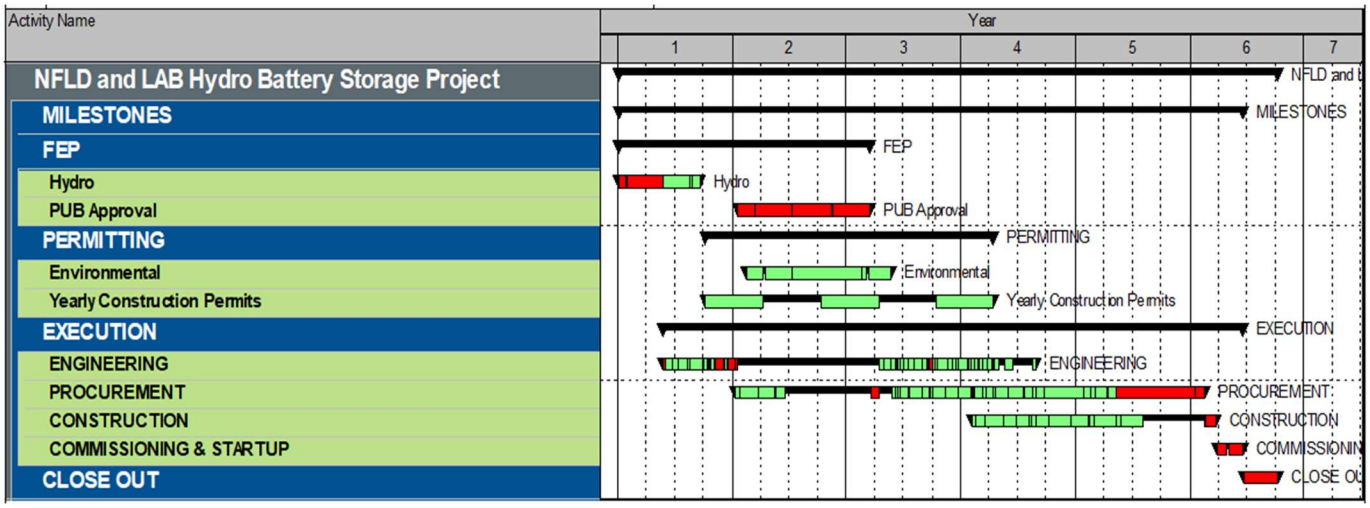


Figure 2: BESS Project Schedule Level 1 & 2 WBS Summary

5.3 Calendars

One project calendar was used for the project. The calendar includes all Newfoundland & Labrador Stat Holidays and 2-week Christmas Break. 8 hours per working day. (Work hours are not used as the schedule is not resource loaded).

As this project is located on the Avalon Peninsula there is no winter weather restrictions applied to the schedule.

Table 2: Schedule Calendars

Schedule Calendar	Application
5 Day Week 8hr / Day W/Holidays	5-day work week, with an 8-hour working day. Statutory holidays are excluded from workdays. Planned 2-week work stoppage for Christmas break.

5.4 Application Specific Calculation Methods

The schedule uses the Retained Logic method of schedule calculation. The Total Float (TF) method is used to determine the project's Critical Path; the criteria used is the default method where TF <= 0 is considered critical. The TF is determined based on the activity predecessor calendar and is calculated as Finish Float.

These are the application's default settings and will be used for schedule management and reporting.

6.0 Scope of Schedule and Exclusions

6.1 EPCM Engineering

The Engineering scope includes engineering, as well as drawings, specifications and data sheets for procurement of equipment, incorporation of vendor data as needed to complete engineering and detailed design.

6.2 Procurement

Procurement activities include Request for Proposal (RFP), technical and commercial evaluation, conforming specification, Recommendation for Award (RFA), vendor data review, expediting and Vendor Quality Surveillance (VQS). These activities are required to support the final selection and purchase of vendor equipment and the expediting and quality assurance of vendor design and fabrication. The procurement schedule was developed with a two-stage procurement approach: the first stage is procurement activities scheduled on a forward path timeline to get vendor data needed to support engineering program, and the second stage is to support equipment fabrication and delivery to site to meet the projects in service dates.

6.3 Construction

The construction schedule has only been defined to the point of achieving an approximate duration for activities and a general sequence. The construction schedule will be further updated in FEED phase to include an updated estimate of labour and key quantities to validate the assumptions made for sequence and durations. The overall project timeline is comparable with other similar project schedules except for the transformer's installation and subsequent activities. The transformer procurement should be advanced prior to the EPCM award.

6.4 Commissioning

The commissioning activities are simply place holders and approximate the duration required after construction completion to bring the plant into service. The commissioning schedule should be updated in FEED and again by the EPCM contractor.

6.5 Exclusions

The schedule excludes any activities required outside the boundary limits of the project to tie into existing infrastructure.

The schedule excludes site acquisition and work and permitting associated with powerline relocations, it is assumed this will be completed prior to commencement of construction, it has been identified as a risk in the feasibility study report by the consultant.

7.0 Schedule Development Basis

7.1 General

The project schedule is a live document that will be refined throughout the life of the project and depends on the quality of the information on which the schedule is based. Schedule quality improves as engineering definition, and execution strategies are progressively developed.

7.2 Resources

No Resourcing is included in the schedule. Resources should be added once the FEED has progressed to a substantially complete level.

7.3 Engineering

The engineering section of the schedule is broken down by discipline. The disciplines have a general section that includes activities like design criteria which are common to all packages and is further broken down into single discipline Engineering Work Packages (EWPs). If applicable, this enables preparation of equipment and material specifications for procurement. The schedule has been developed on a forward path, to get the procurement packages issued as early as possible, and subsequently to receive the vendor data in time, to enable finalization of engineering activities. Multi-disciplinary engineering activities will be required to proceed in parallel with substantial overlaps to maintain the schedule.

7.4 Procurement

The procurement scope reflects full cycles of procurement packages for main scope items in the EPCM scope and has been developed up to the delivery. Please note that full extent of procurement packages will be determined early in the next phase of the project.

7.5 Construction

The construction schedule is considered a mixed level 1 / 2 schedule. The durations are based on experience and have not been validated with the estimate quantities at this time. However, the confidence in the overall duration is high when compared to similar other projects that have been used as a comparison.

The construction schedule currently shows the earliest possible start of construction, however if the transformers are not advanced as described in the opportunities section, the start could be delayed by up to 6 months.

Each Sub-Section below provides an overview with a listing of assumptions, issues, risks, and opportunities, by each Phase/Schedule WBS heading of the project.

7.6 Milestones

7.6.1 Overview

This section of the schedule is used to summarize key events and activities for quick reference. The milestones will reflect the dates from the detailed activities in the other phases of the schedule. As these summary milestones reflect the schedule logic, all milestones in this section of the schedule will utilize a 7-day calendar. The listing of milestones will be determined by the BESS Project Manager. They can be added/modified as required to ensure proper visibility of key events.

A listing of the current milestones is shown in **Figure 3**.

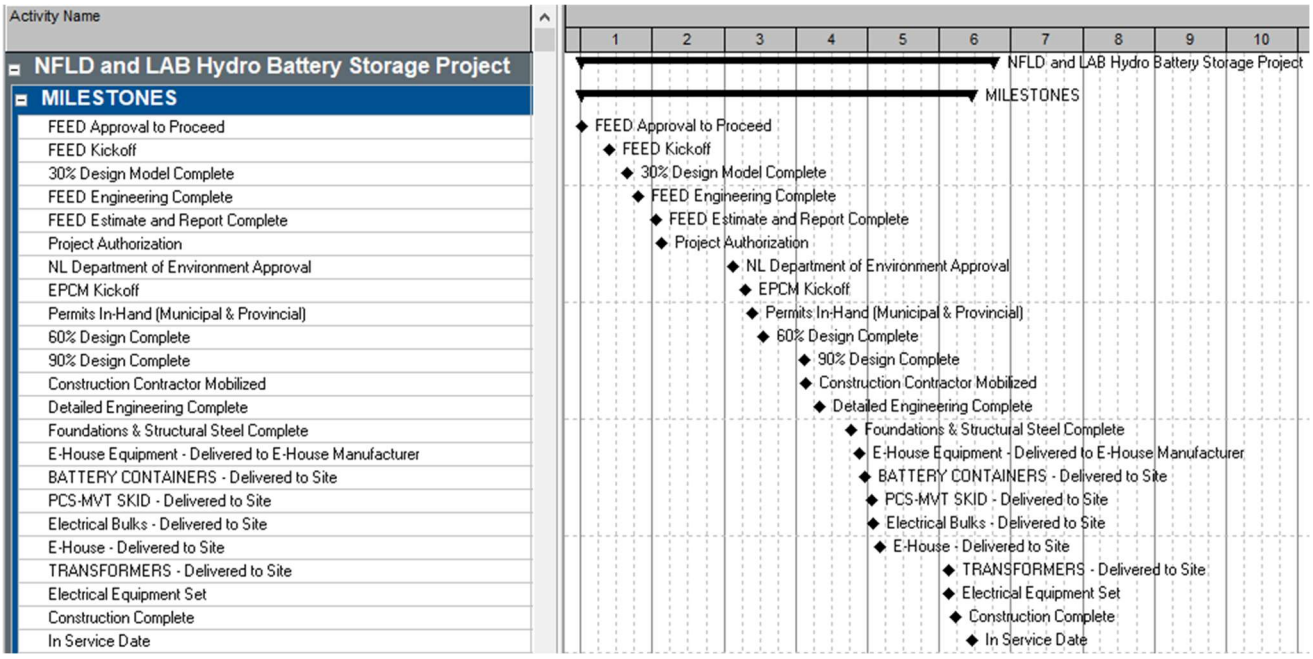


Figure 3: BESS Project Schedule Milestones

7.6.2 Assumptions

As the Milestone listing is a summary of details contained in the schedule, there are no schedule assumptions in this section of the schedule.

7.6.3 Risks/Opportunities

As the Milestone listing is a summary of details contained in the schedule, there are no Risks or Opportunities in this section of the schedule.

7.7 FEP - NL HYDRO and PUB

NL HYDRO Activities, documents and activities related to PUB approval, progressing the project towards Detailed Design, Project Sanction and Execution Phase. Activities and Durations are based on NL HYDRO experience and reference from previous work scopes.

Includes the project charter, the procurement of the FEED consultant, contract strategy and risk workshop/report.

7.8 Permitting

There are 2 sub WBS nodes, Environmental and Yearly Construction Permits:

- **Environmental:** Activities related to environmental assessment and approval, as well as provincial and municipal permits.
- **Yearly Construction Permits:** Activities related to the permitting process. These activities are required annually, and the activity duration allocates time for applications preparation, review, consultation, and approval.

7.8.1 Overview

NL Hydro Resources will determine the Permits and Regulatory requirements for the BESS Project, including duration and timing.

7.8.2 Assumptions

The assumptions for the Yearly Construction Permits section of the schedule are:

- Permit activity is included for each year of project.
- Permits are required annually and must be secured before construction work can commence for that year.
- The duration assumed for the permits, from preparation to approval, is assumed to be 6 months. To support the construction season commencing on 01-May, preparation of permits will have to commence during the previous year.

The assumptions for the Environmental section of the schedule are:

- Environmental Assessment is required to be completed, submitted and released by the Department of Environment.

All specific permits / approvals associated with construction execution will be the responsibility of the construction contractor, under the oversight of the EPC consultant (acting as agents of NL Hydro), and will be planned and obtained in such a time that they will not affect construction / project completion activities.

7.8.3 Risks/Opportunities

7.8.3.1 Risks

Regulatory approvals could take longer than assumed, which could negatively affect the project timeline, including impacting the planned seasonality of the construction work. This, in turn, could have a significant impact on project cost and schedule on this project.

7.8.3.2 Opportunities

If regulatory approvals are granted more quickly than assumed, this may present opportunities. If this were to occur, there would need to be an evaluation as to the potential schedule opportunity that may be gained. There is no non-working winter period for construction since this project is on the Avalon Peninsula so any gains on permits and regulatory can be fully realized for construction as well as procurement. There could be opportunities gained in the design and construction readiness work phases that could reduce risks within the construction timelines.

7.8.4 Execution

7.8.4.1 Overview

The execution phase of the schedule is divided by WBS headings for Engineering, Procurement, Construction, Inspection & Commissioning and Closeout. This basis of schedule is derived from Basis of Schedule prepared by Hatch listed under Section 3 Attachments.

Engineering:

Engineering is split into 2 sections FEED and Detailed Design. The FEED section includes the FEED level engineering activities, model up to 30% review as well as preparation of the EPCM RFP. Detailed engineering section includes the completion of the engineering documents, completion of the model and engineering in support of procurement.

Procurement:

Procurement is split into 2 sections Contracts and Procurement Packages. The only contracts required for this project is the EPCM and the Works Contractor, these activities are under the Contracts WBS. Procurement Packages are broken out for all the equipment required for the project, including batteries, battery containers, transformers, CVTs, circuit breakers, E-House, E-House Equipment and Electrical Bulks. Each section has activities to represent the full duration of the procurement process for each contract or equipment.

Lead times are based on NL Hydro experience, data from other ongoing or completed NL Hydro Projects and schedule, and reference to Hatch Feasibility Study Documents.

Times are assumed to include negotiations, testing, etc.

The longest lead time is expected to be the Transformers, once the PO is signed it is estimated at approximately 2 years for delivery; other terminal station equipment has significant lead times (12 months for several).

Construction:

Construction has been scheduled to be substantially complete prior to the delivery of the transformers, once they arrive they only scope remaining is the installation of the transformers and then into testing and commissioning.

A temporary camp is required to be procured and installed for the execution of the project.

Commissioning & Startup:

Commissioning activities will be completed as soon as construction activities are completed regardless of the time of year.

Start-up activities start immediately after commissioning activities are completed in the attached schedule but tying the asset into the operating grid will have to be coordinated with Hydro operations team to ensure safe and efficient execution. Timing of the outages are not available for planning purposes at the time of preparing this document.

Closeout:

Closeout tasks encompass any number of items a contractor may require following construction, including certification of a final invoice, as building documents and submission of final reports. Four months of closeout activities have been allocated.

7.8.4.2 Assumptions

Assumptions for the execution phase:

- Plant Capacity 50 MW with an 8-hr reserve at the POI.
- The current schedule is indicative of the plant design in the future phases.
- Delivery durations are estimates taken from recent experience or similar projects and professional knowledge.
- Long Lead items are not procured until EPCM is awarded.
- The engineering deliverables are sequenced to support the procurement strategy.
- Procurement activities begin upon completion of engineering for each package.
- The schedule assumes a 10-day Hydro review and approval cycle for all document and procurement specifications.
- Project Authorization is 1 month after FEED Completion.
- Permitting by Hydro starts after Project Authorization
- IFC dates are dependent on receiving vendor data in a timely manner.
- The average planned cycle durations used for a procurement package and engineering reviews are as per **Tables 3-1, 3-2** and **3-3**.

Table 3-1: Schedule Durations for Engineering Reviews

Engineering Review Activity	Responsibility	Duration (Working Days)	Cumulative Duration
Internal Review & Revise Package	EPCM	10	10
Hydro Review and Approval	Hydro	10	20
Revise & Issue for Use / bid	EPCM	10	30

Table 3-2: Planned Package Procurement Cycle Time

Procurement Activity	Responsibility	Duration (Working Days)	Cumulative Duration
Issue RFP to Vendor	EPCM	5	5
Bid Period	EPCM	20	25
Technical Evaluation / CBE / RFA	EPCM	30	55
RFA Approval	Hydro	20	75
Conforming Specification	EPCM	5	80
Award	EPCM / Hydro	20	100
Vendor Kick-off meeting (5 days after award)	EPCM / Hydro	5	105
First Vendor Data	Supplier	40	145

Table 3-3: Planned Procurement Cycle Time

Procurement Activity	Responsibility	Duration (Working Days)	Cumulative Duration
Issue RFP to Vendor	EPCM	10	10
Bid Period	EPCM	40	50
Technical Evaluation / CBE / RFA	EPCM	40	90
RFA Approval	Hydro	20	110
Award	EPCM / Hydro	20	130

7.8.5 Risks/Opportunities

7.8.5.1 Risks

- The schedule was developed with the assumption that upon the award the EPCM contract study work related to capacity has been finalized in the FEED phase with a clear scope to begin Detailed engineering and procurement. If further study work is required, this will impact on the overall duration.
- The schedule does not include Contingency or Reserve. This is determined by Hydro after a proper SRA (Schedule Risk Analysis) has been performed. This exercise is typically a FEED phase function.

- A schedule Quality Assessment has not been performed on this schedule. In the FEED phase it is expected that the engineering firm will perform a Quality Assessment using Acumen Fuse software or equivalent.
- Delays to the EPCM Consultant contract could impact the ability to complete the required engineering and award of the BESS Project Construction Contract.
- Construction contractors experiencing a period of high demand for services, resulting in a reduction in available work force.
- Land acquisition will impact the schedule and COD if not approved in time to mobilize site in alignment with the activities in the PCS (attachment 1).
- Government review and approval of the Environmental Assessment may take longer than planned (7.5 months), which could delay permitting and the works contractor ability to mobilize and execute project scope.
- Delays in securing site access / local protests preventing access to the site. Any delays in providing unobstructed access to the site would negatively impact the short construction season. This would increase the risk of schedule slippage.
- There has been no consideration for weather related delays or productivity. If during the project there are significantly differing climatic conditions than the historical norms for the area, that could result in a shorter construction season, may impact upon the ability to construct as planned.
- Forest fires, were they to occur, could impact upon the construction season, and lead to schedule impacts.
- Ability to get outages for tie-in.
- Conflicts with other transmission projects in NL.
- Trade labour availability

7.8.5.2 Opportunities

- Hydro should develop the Transformers package during FEED phase. This will occur long before the EPCM is awarded and save approximately 6 to 8 months on the construction schedule. This would require free issue to the EPCM contractor and would introduce some risk if delays occur and have an impact on the EPCM contractor.

8.0 Overarching Critical Path

The overarching critical path for the BESS Project starts from the approval to proceed with FEED, then going through the procurement process to select the FEED Consultant and completing the FEED deliverables and revised estimate.

Next the FEED engineering documentation is used to create the RFP for the EPCM contract, then flowing through the procurement cycle to select the EPCM contractor, and at the same time the FEED Estimate (CAPEX) is used to create the PUB review documentation and kick off the PUB approval process.

Then the detailed engineering phase starts, and the CP goes through the engineering of the transformers, the procurement cycle to award of the transformers supply, delivery, installation and commissioning of the transformers.

Final stage of the project is the completion of final reports, as built documents, handover packages and final invoicing.

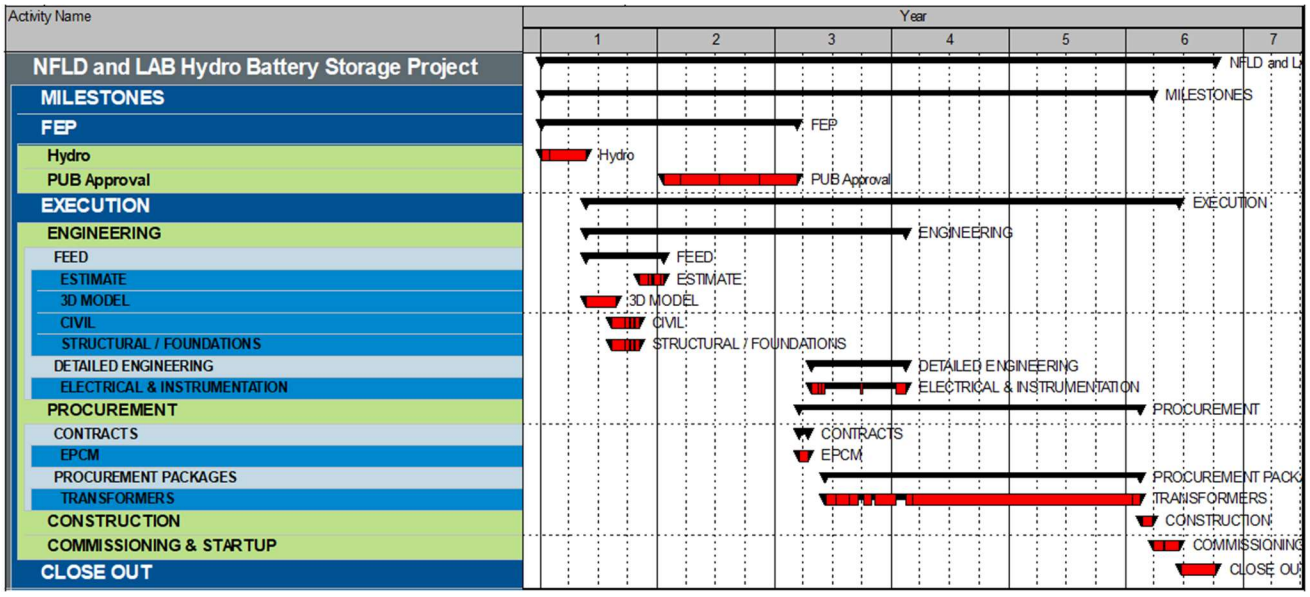


Figure 4: BESS Project Critical Path Roll up Schedule

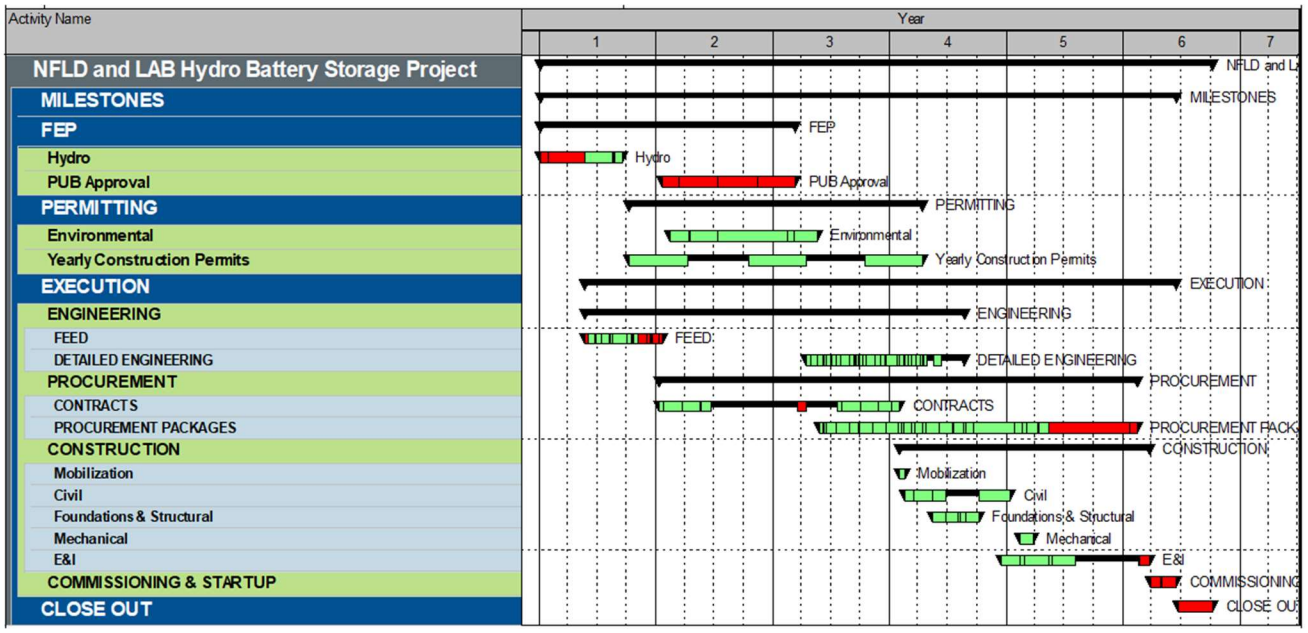


Figure 5: BESS Project Summary Schedule

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9.0 Schedule Contingency/Schedule Reserve

The PCS does not include any schedule contingency or schedule reserve. The PCS contains deterministic information with the strategy being to steward the project schedule to the earliest possible completion date.

10.0 PCS Updates/Revisions

The PCS will be updated and revised at key points throughout the project life cycle in accordance with the Major Projects change control process. The following milestones represent known instances when updates to the PCS will occur:

- FEED Contract Award:
  Upon award, the FEED Consultant will provide more detailed information to support the engineering review and design of the BESS Project scope. The PCS will be updated to reflect contractual milestone dates, revised activity durations, and any adjustments to strategy.
- EPCM Contract Award:
  Upon award, the EPCM Consultant will provide more detailed information to support the engineering review and design of the BESS Project scope. The PCS will be updated to reflect contractual milestone dates, revised activity durations, and any adjustments to strategy.
- Long Lead Materials Award:
  If any of the long lead materials as outlined in this document cause any delays to the construction scope of the BESS Project, update to the PCS may be required.
- Construction Contract Award:
  Following contract award, the Construction Contractor will submit a detailed schedule outlining the execution strategy. This schedule will be used to update the PCS, as necessary.

Additional updates to the PCS may be required as the project progresses; however, such updates will only be permitted through the project's formal change management process and with approval from Senior Management.

11.0 Reference Documents

The following is a list of documents that either are referenced in this Battery Storage Basis of Schedule document or are relevant to the subject matter contained within.

Document Reference	Title
AACE RP 38R-06	Documenting the Schedule Basis[1]
AACE RP 91R-16	Schedule Development[2]

[1] AACE International. (June 18, 2009) Recommended Practice 38R-06, *Documenting the Schedule Basis*. <https://www.pathlms.com/aace/courses/2928/documents/3823>.
[2] AACE International. (August 13, 2020) Recommended Practice 91R-16, *Schedule Development*. <https://www.pathlms.com/aace/courses/2928/documents/9508>.

Document Reference	Title
AACE RP 37R-06	Schedule Levels of Detail[3]
AACE RP 27R-03	Schedule Classification System[4]
SDYBESS-HAT-00000-PL-REP-0001-01	BESS Project Basis of Schedule (by Hatch)

3 AACE International. (March 20, 2010) Recommended Practice 37R-06, Schedule Levels of Detail - As Applied in Engineering, Procurement, and Construction. < https://www.pathlms.com/aace/courses/2928/documents/3822>
4 AACE International. (November 12, 2010) Recommended Practice 27R-03, Schedule Classification System. <https://www.pathlms.com/aace/courses/2928/documents/3811 >

Basis of Schedule

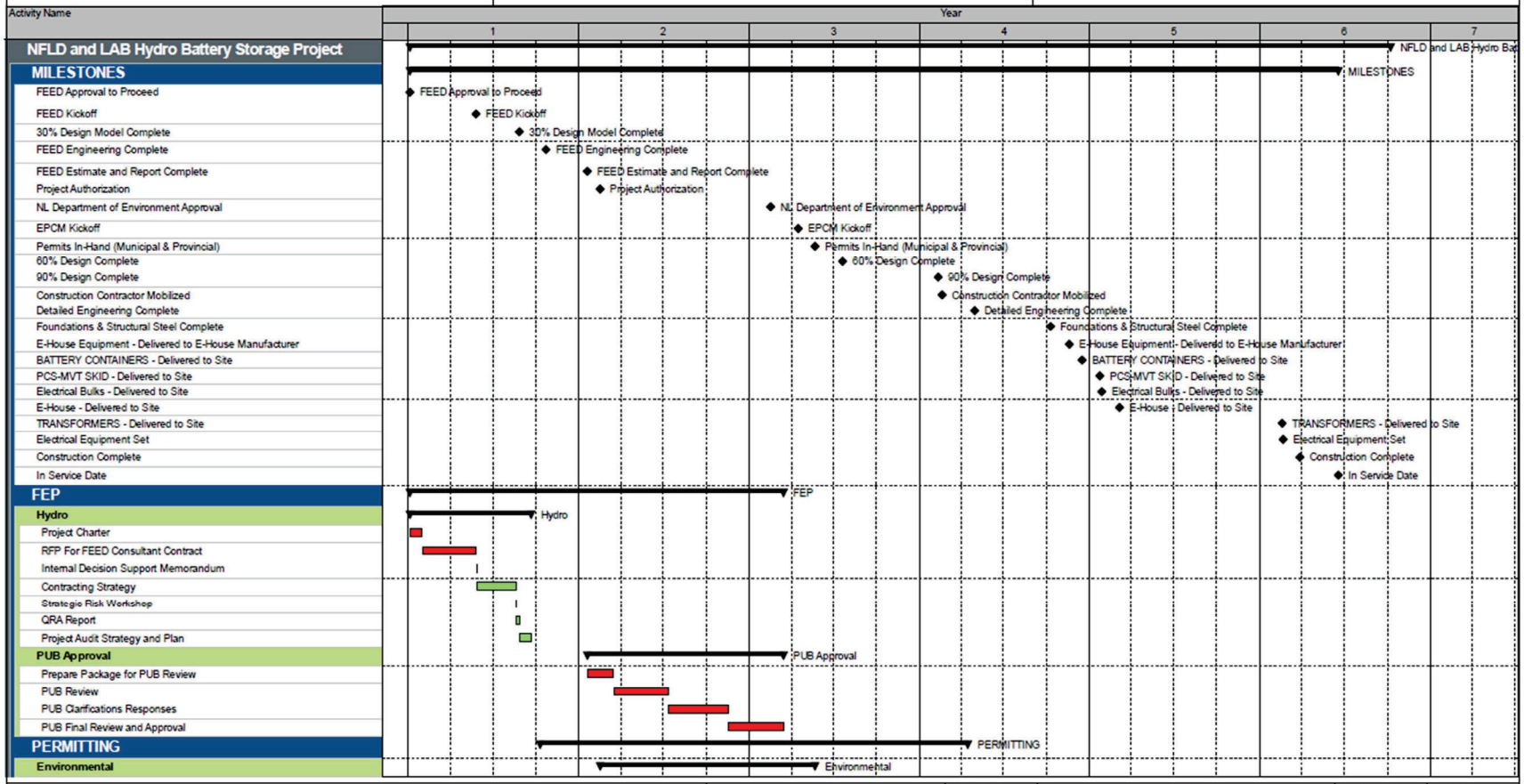
Battery Energy Storage System Project

Attachment 1: BESS Project – Project Control Schedule

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NFLD and LAB Hydro Battery Storage Project
Project Control Schedule

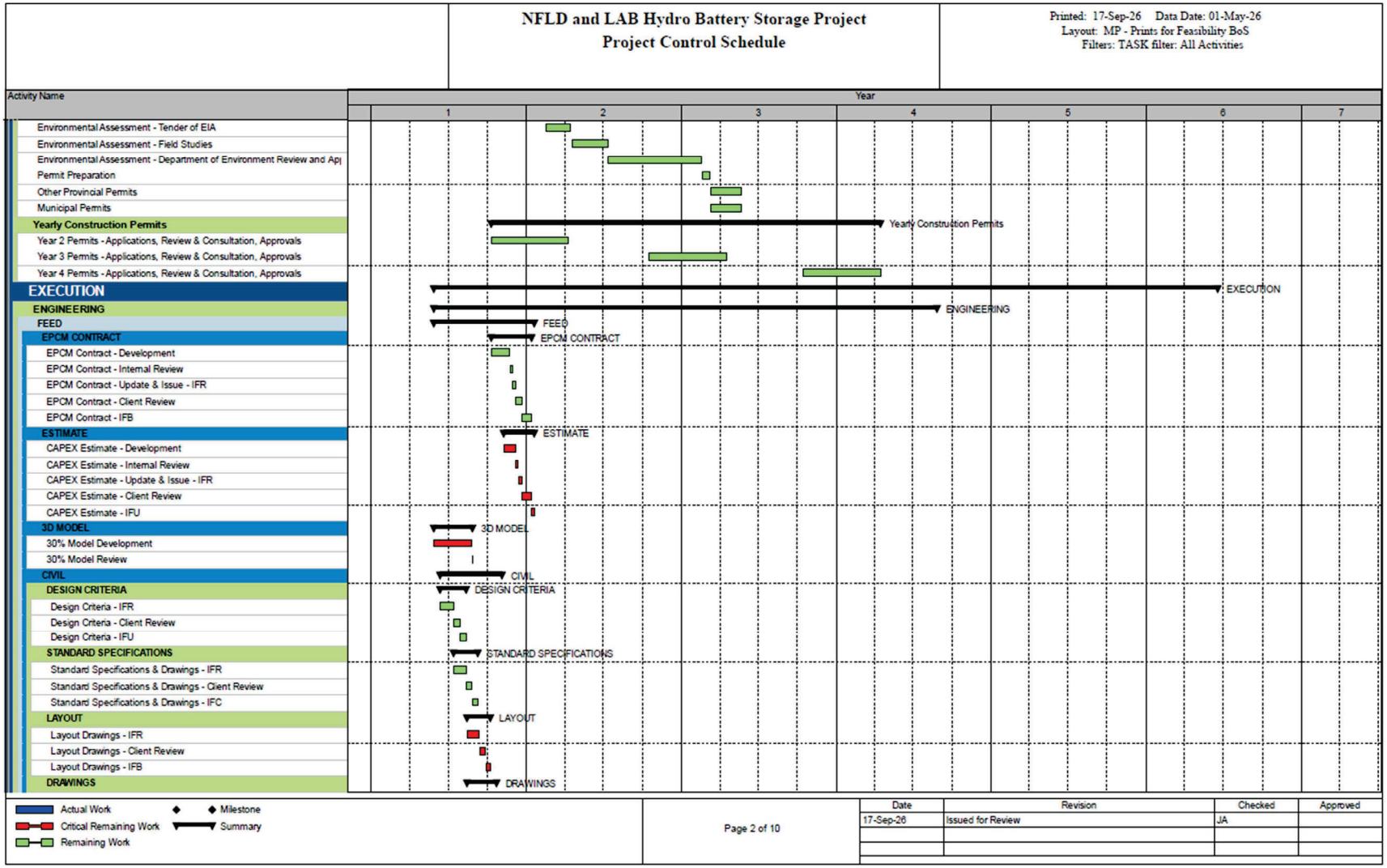
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Filters: TASK filter: All Activities



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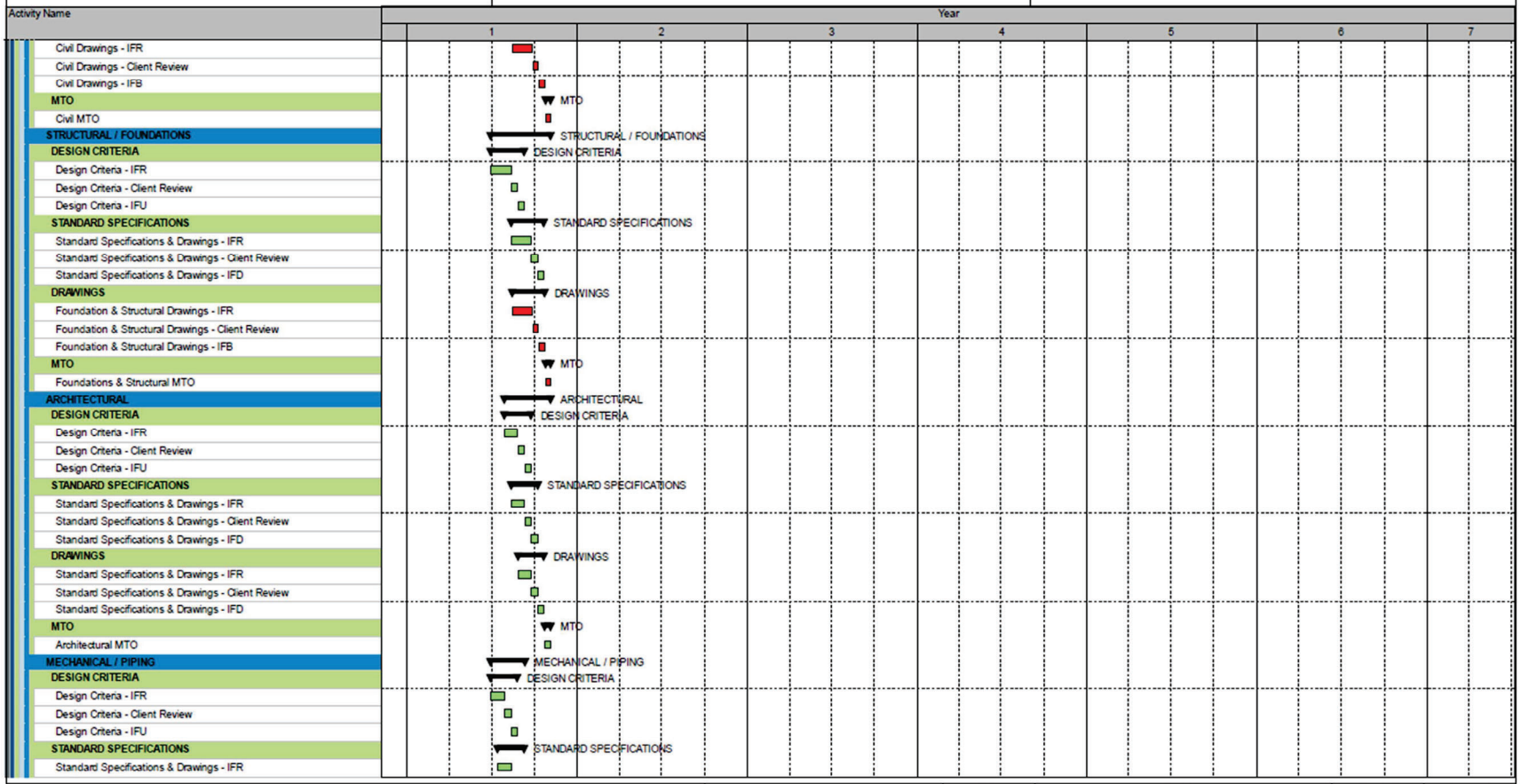


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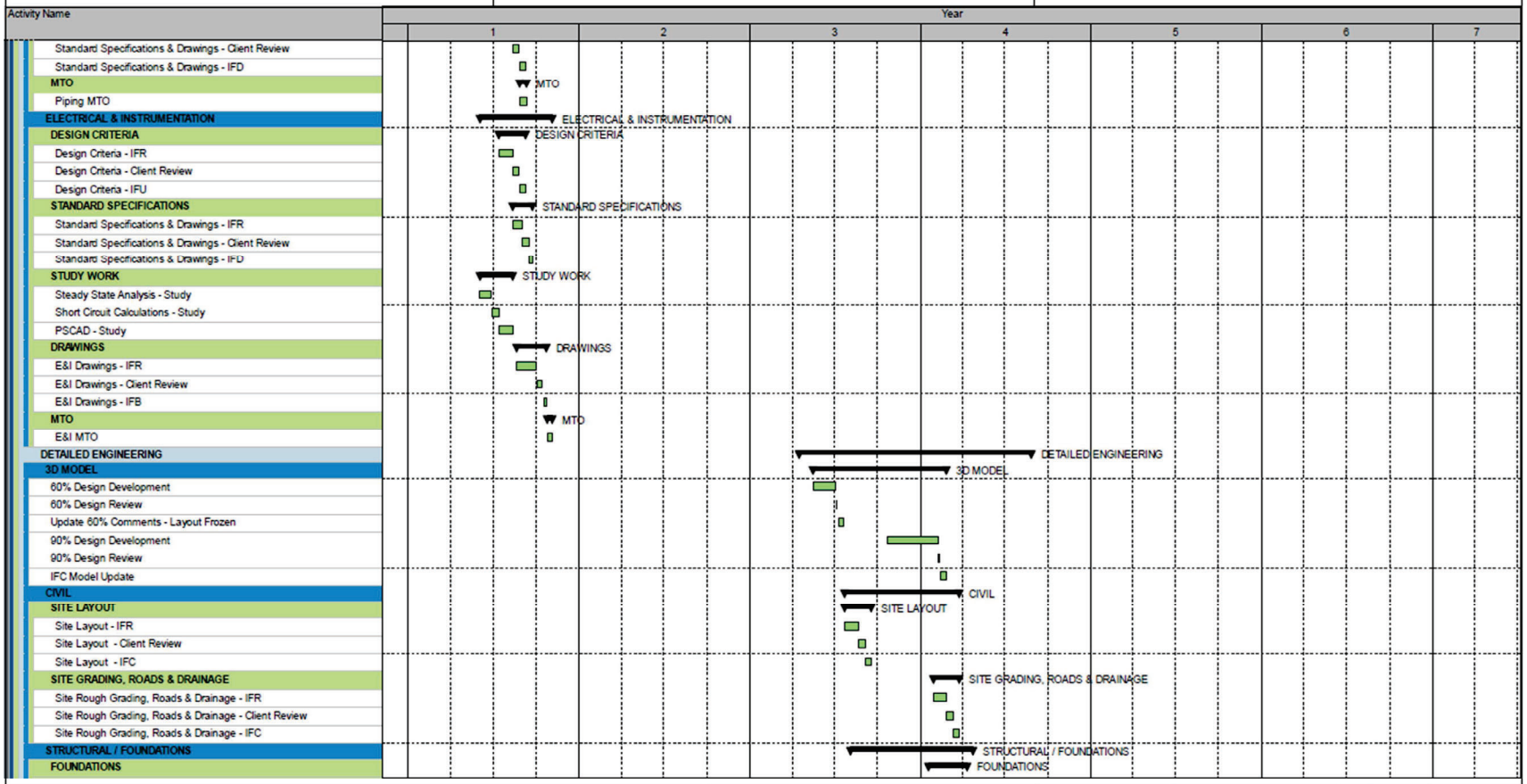
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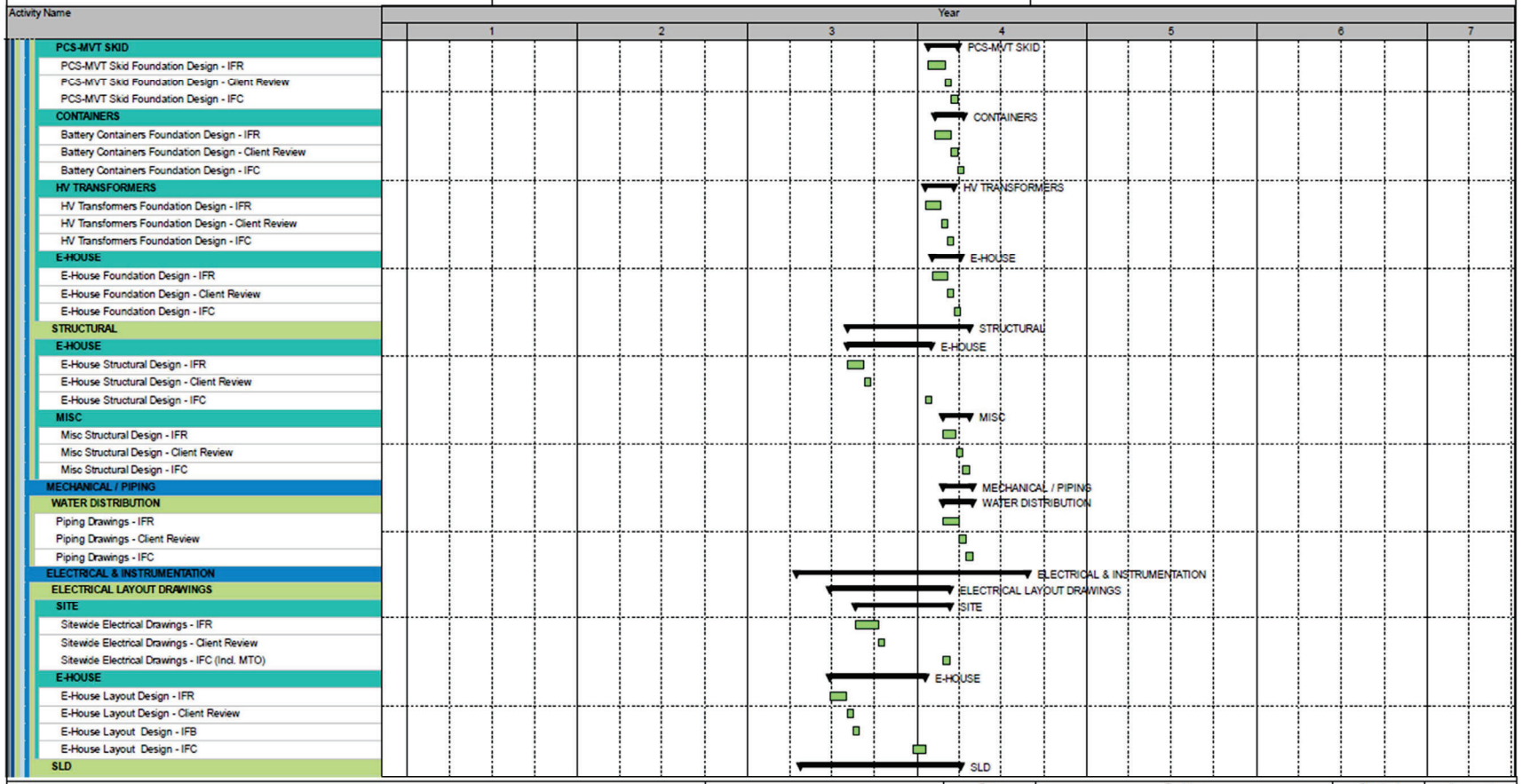
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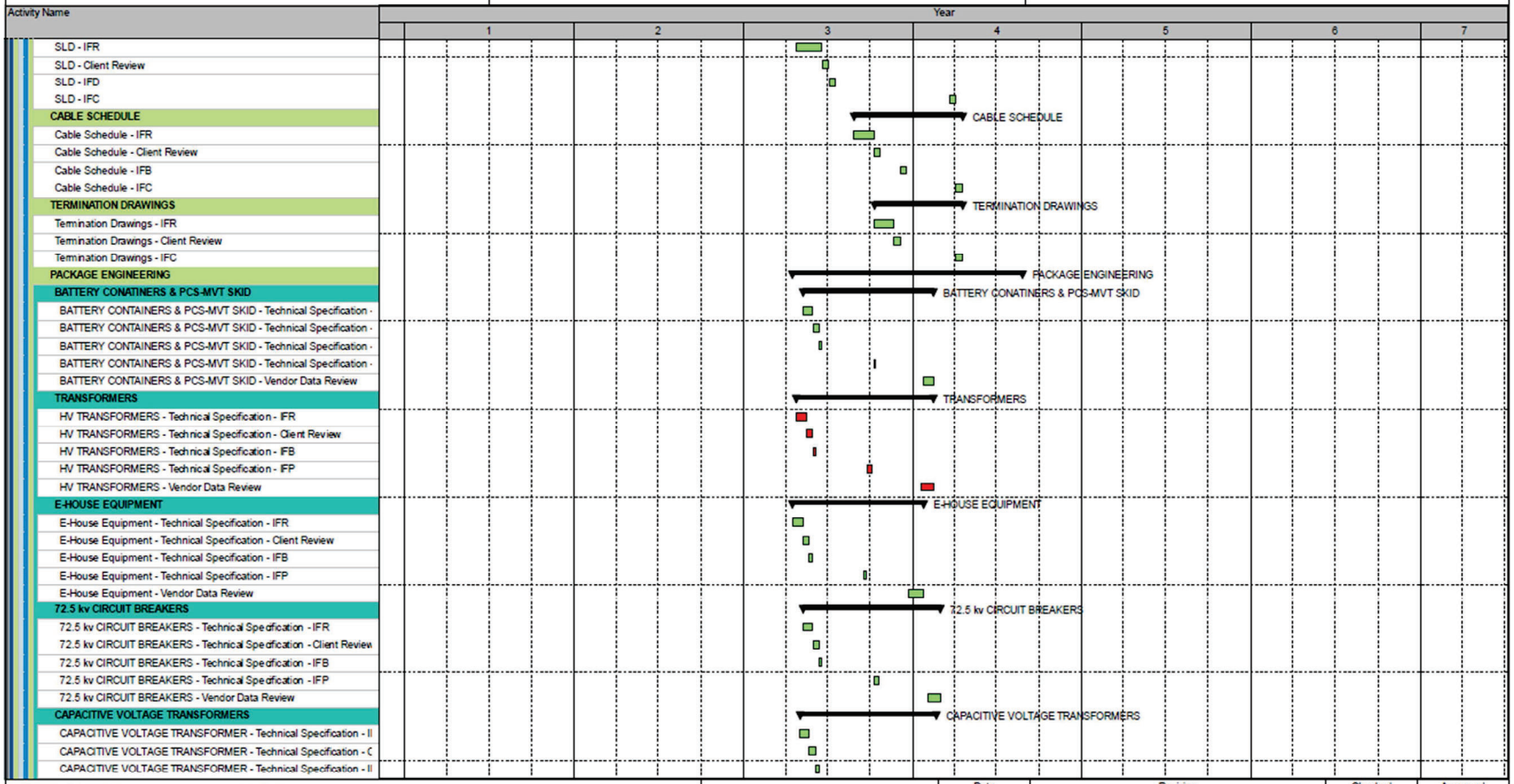
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Project Control Schedule

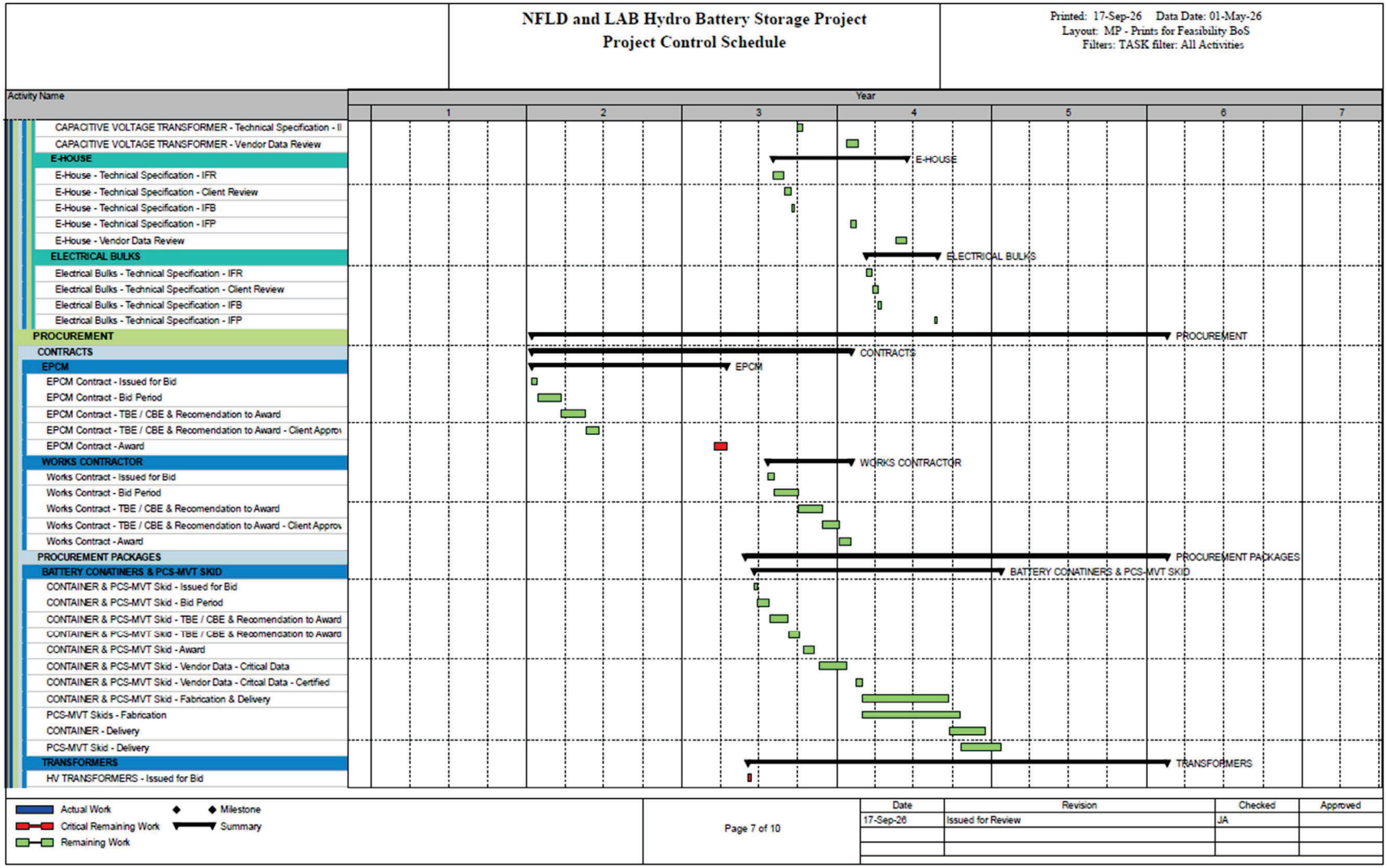
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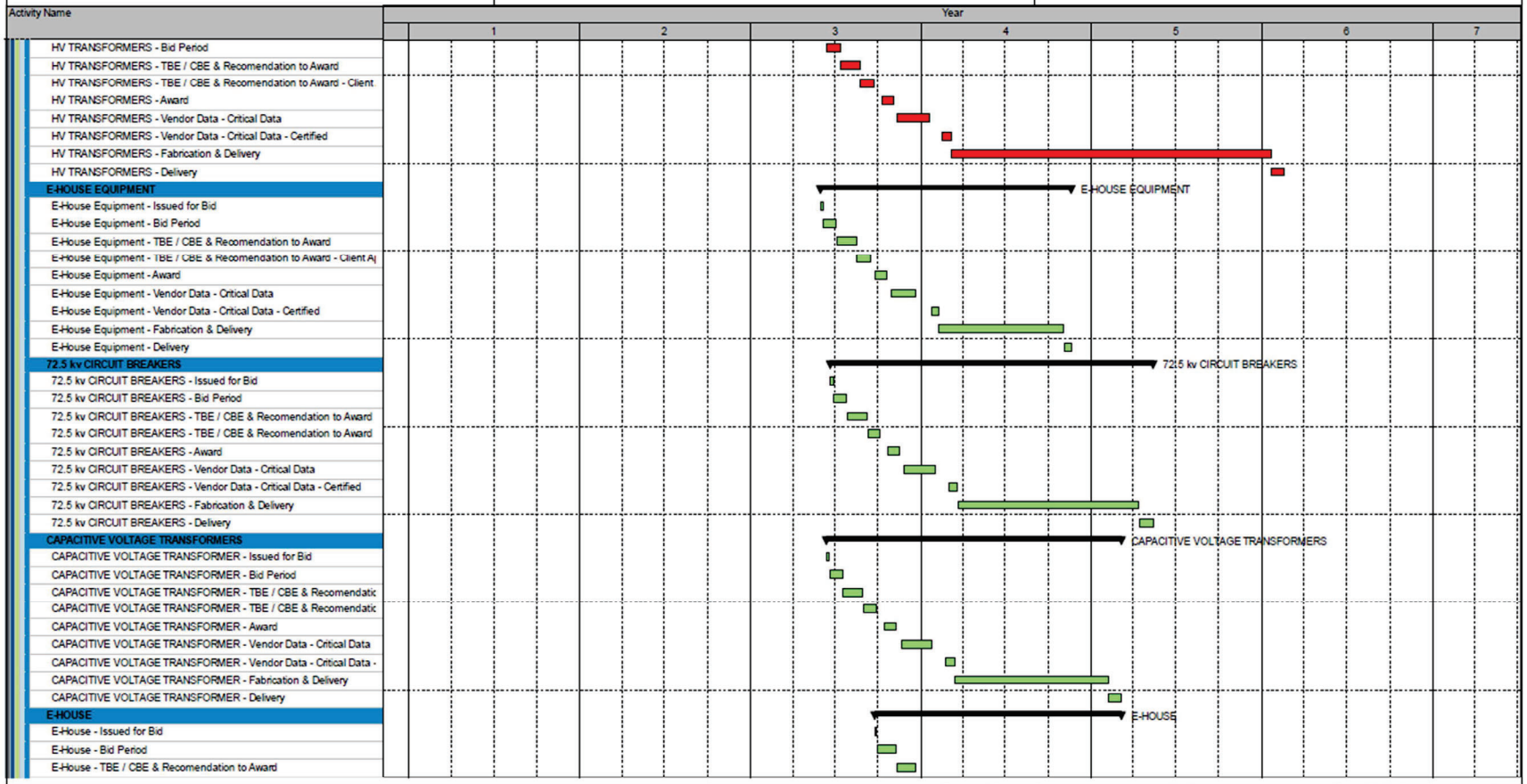


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Project Control Schedule

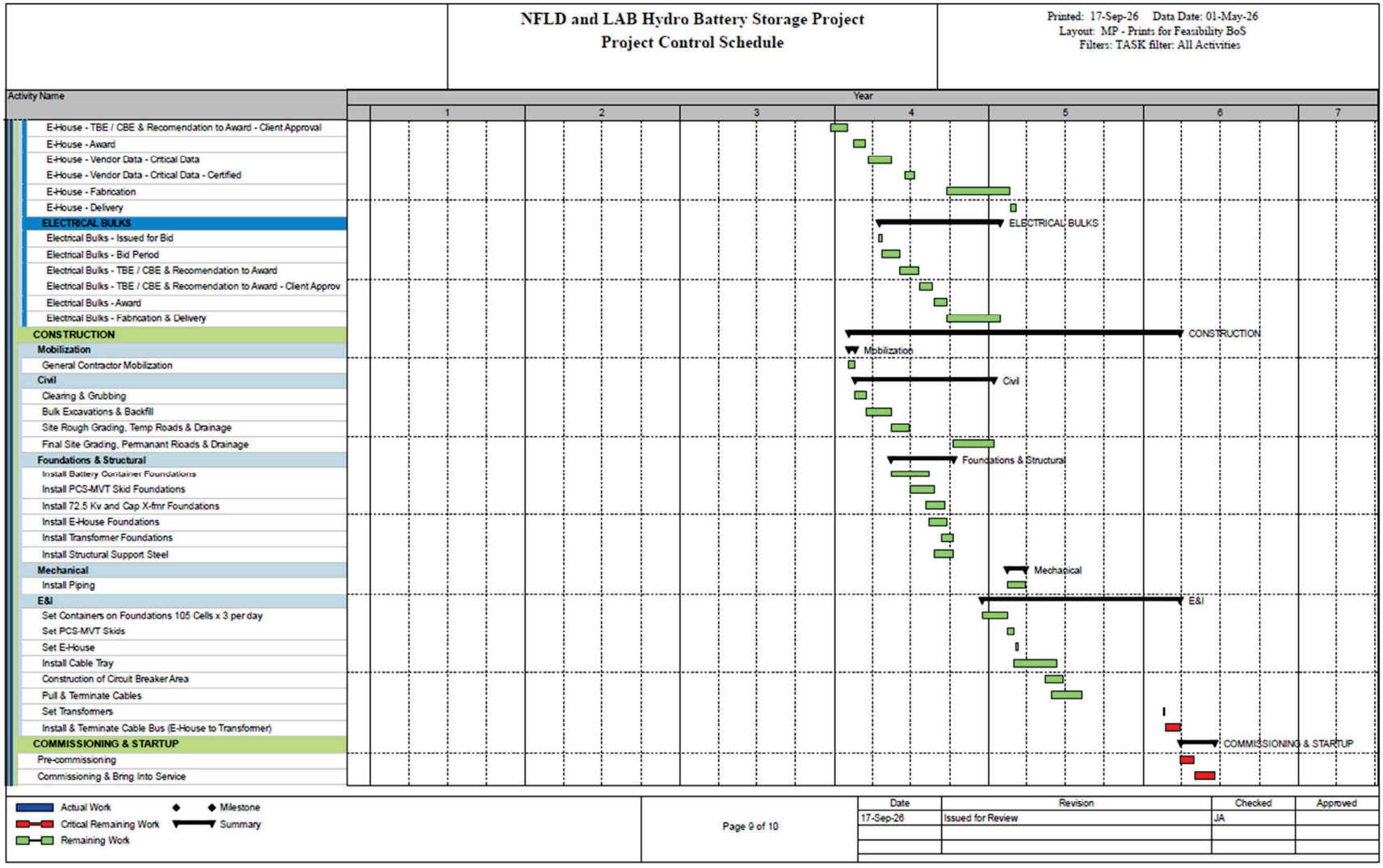
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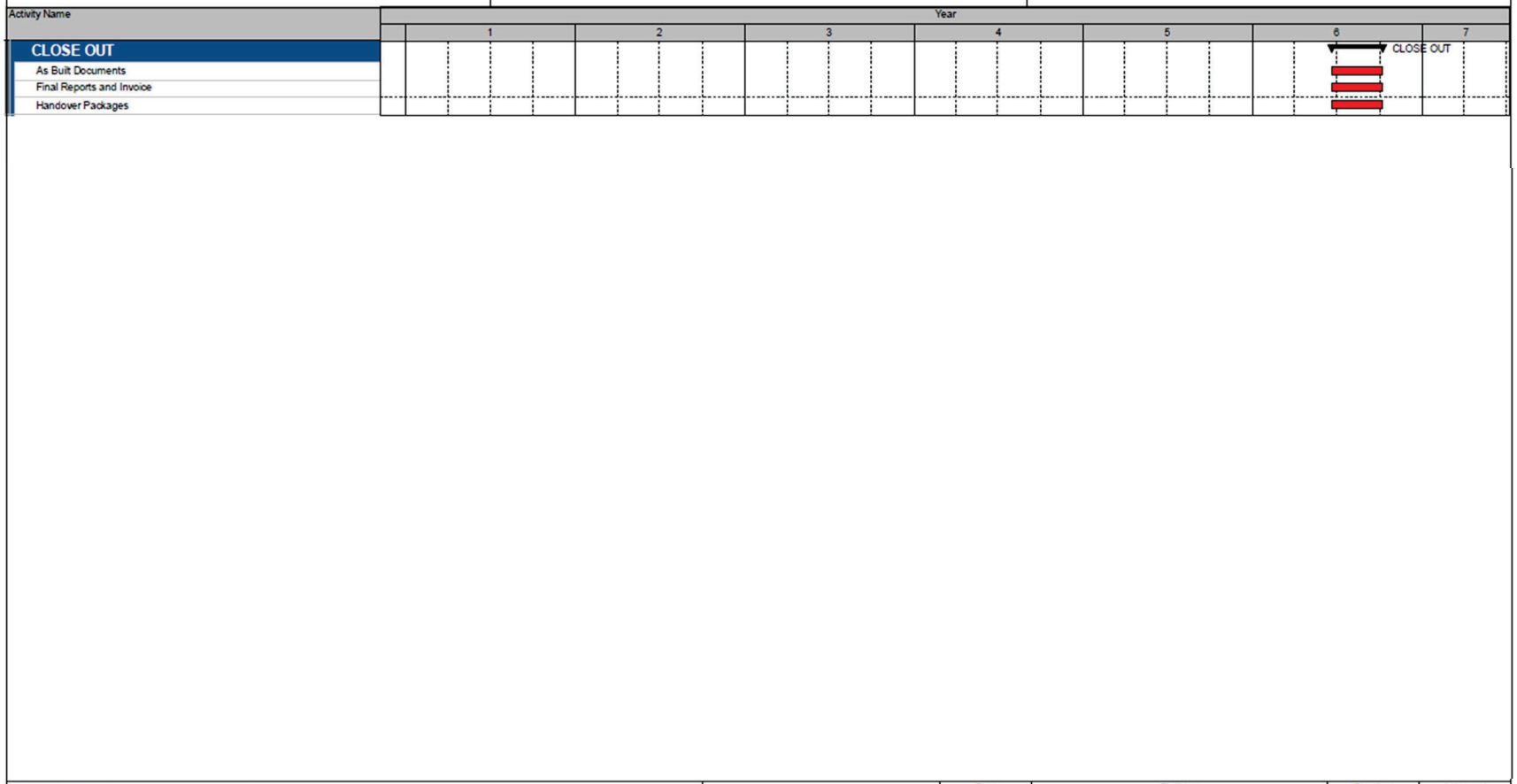


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Basis of Schedule

Battery Energy Storage System Project

Attachment 2: BESS Project Control Schedule – WBS Structure

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newfoundland labrador hydro	**Basis of Schedule** **Battery Energy Storage System Feasibility Study**				
NLH Doc. No.	**SDYBESS-NLH-00000-ES-BOS-0001-01**	**Revision**	**B1**	**Page**	**2-1**

NFLD and LAB Hydro Battery Storage Project
Project WBS

Printed: 27-Aug-26 Data Date: 01-May-26
Layout: MP - Prints for Feasibility BoS
Filters: TASK filter: All Activities

Activity Name
NFLD and LAB Hydro Battery Storage Project
MILESTONES
FEP
Hydro
PUB Approval
PERMITTING
Environmental
Yearly Construction Permits
EXECUTION
ENGINEERING
FEED
DETAILED ENGINEERING
PROCUREMENT
CONTRACTS
PROCUREMENT PACKAGES
CONSTRUCTION
Mobilization
Civil
Foundations & Structural
Mechanical
E&I
COMMISSIONING & STARTUP
CLOSE OUT

Page 1 of 1

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Attachment 5

Battery Energy Storage Feasibility Study – Basis of Schedule

Hatch Ltd.



MAJOR PROJECTS CONTRACTOR DOCUMENT FRONT COVER SHEET

Contract Number and Description: Newfoundland and Labrador Hydro Battery	**Project Number:** H376866
Contractor Name: Hatch Ltd.	**Contractor Address:** 80 Hebron Way - Suite 100, St. John's Newfoundland and Labrador, Canada, A1A 0L9

Document Title: Basis of Schedule	**Total Number of Pages incl. Front Sheet:** 14
Contractor Document Number: H376866-0000-612-610-0001	**Contractor Revision Number:** 0
Contractor Signature/Stamp: John William Albert Catton -- P.Eng. - EGBC Digitally signed by John William Albert Catton -- P.Eng. - EGBC DN: cn=John William Albert Catton -- P.Eng. - EGBC, c=CA, o=CertifiO Pro, ou=EGBC - Engineers and Geoscientists of British Columbia Date: 2026.05.12 10:47:07 -07'00'	
NLH Document Number: SDYBESS-HAT-00000-PL-REP-0001-01	**NLH Revision Number:** B0
Document Date (DD-MMM-YYYY)**:** 08-May-2026	**Equipment Tag:**

Submission Comments: **(if urgent submission, please indicate below. Add additional pages if required)**

REVIEW DOES NOT CONSTITUTE APPROVAL OF DESIGN DETAILS, CALCULATIONS, TEST METHODS, OR MATERIAL DEVELOPED AND/OR SELECTED BY THE CONTRACTOR, NOR DOES IT RELIEVE THE CONTRACTOR FROM FULL COMPLIANCE WITH CONTRACTUAL OR OTHER OBLIGATIONS.

- ☐ **01 REVIEWED AND ACCEPTED**
- ☐ **02 REVIEWED – INCORPORATE COMMENTS, REVISE AND RESUBMIT**
- ☐ **03 REVIEWED – NOT ACCEPTED**
- ☐ **04 INFORMATION ONLY**
- ☐ **05 NOT REVIEWED**

Lead Reviewer	Date (DD-MMM-YYYY)	Project Manager	Date (DD-MMM-YYYY)

General Comments:

Newfoundland and Labrador Hydro
Battery Storage
H376866

Project Controlst
Planning and Scheduling
Basis of Schedule

Basis of Schedule

H376866-0000-612-610-0001

				Karen Perry.	Catton, John
2026-05-08	0	Approved for Use	R. Roy	K. Perry	J. Catton
DATE	**REV.**	**STATUS**	**PREPARED BY**	**CHECKED BY**	**APPROVED BY**
HATCH					

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1. Summary

The Schedule covers the largest version of the options being studied in this phase; a 50 MW with an 8-hr reserve (400 MWh at the point of interconnection (POI)). This option drives the maximum scope for engineering, procurement, construction, permitting, and commissioning and therefore represents a conservative basis for schedule development. All smaller options would be expected to follow the same workflow with equal or reduced durations, allowing the schedule to be readily scaled down if a different configuration is selected.

2. Purpose of this Document

The Basis of Schedule describes the key assumptions and parameters used to develop the project's overall schedule. The schedule covers engineering, procurement and construction activities for the Newfoundland and Labrador Hydro 50 MW Battery Storage Project. The execution strategy assumed for the purpose of schedule development is to complete a Front-End Engineering Design (FEED) (Front-End Loading 3 (FEL3)) engineering phase to further define the project. Execution (FEL4) will use an Engineering, Procurement and Construction Management (EPCM) execution strategy.

3. Schedule Quality and Expectations

3.1 Schedule Expectations

The schedule is used to guide the Execution of the Project. The project schedule follows a Work Breakdown Structure (WBS) which largely represents the breakdown by phase, discipline then deliverable for the activities within the project scope. The schedule integrates sequencing of activities (network logic), activity durations, calendars, constraints and identifies the critical paths. The schedule was prepared to inform the estimated timeline of the project at the feasibility study phase. Due to an unknown start of the project, dates seen in schedule are for reference only.

The schedule was developed to achieve the following objectives:

- Establish the overall timeframes of engineering & procurement service activities for planning, staffing and costing purposes.
- Reflect a realistic engineering, procurement and construction sequence and time frame. +/- 20%.
- Develop complete cycles of engineering & procurement activities per package, which is required for two reasons; to show key stakeholder and interactions with the EPCM contractor, and to schedule the dates for the receipt of vendor data for all procurement packages, which are required for the completion of detailed engineering activities.

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- Schedule engineering activities on a forward path based on the most efficient workflows.
- Provide a Level 2 Engineering, Procurement and Construction (EPC) schedule that can be used to communicate expected duration, critical items and other items related to schedule.
- Identify the critical path(s) throughout the execution.
- Identify opportunities through execution strategy changes.

4. Schedule Structure, Tools and Applications

4.1 Software

The schedule is developed in Primavera version 24.12.

4.2 Calendars

1 project calendar was used for the project. The calendar includes all Newfoundland & Labrador Stat Holidays and 2-week Christmas Break. 8 hours per working day. (Work hours are not used as the schedule is not resource loaded).

No other calendars could be used for winter works etc., as it is unknown when this project will be executed or the strategy of the EPCM contractor. The non-working times can be addressed in the next phase once timing of the project has been established.

4.3 Activity Codes

No activity codes were used in this Association for the Advancement of Cost Engineering (AACE) Class 4 schedule.

4.4 Schedule WBS

The WBS is primary set up for project organization and does not reflect the Project. The WBS will be further developed in subsequent phases of the project. It is sufficient for a feasibility level schedule Functional Breakdown Structure (FBS). See Figure 4-1.

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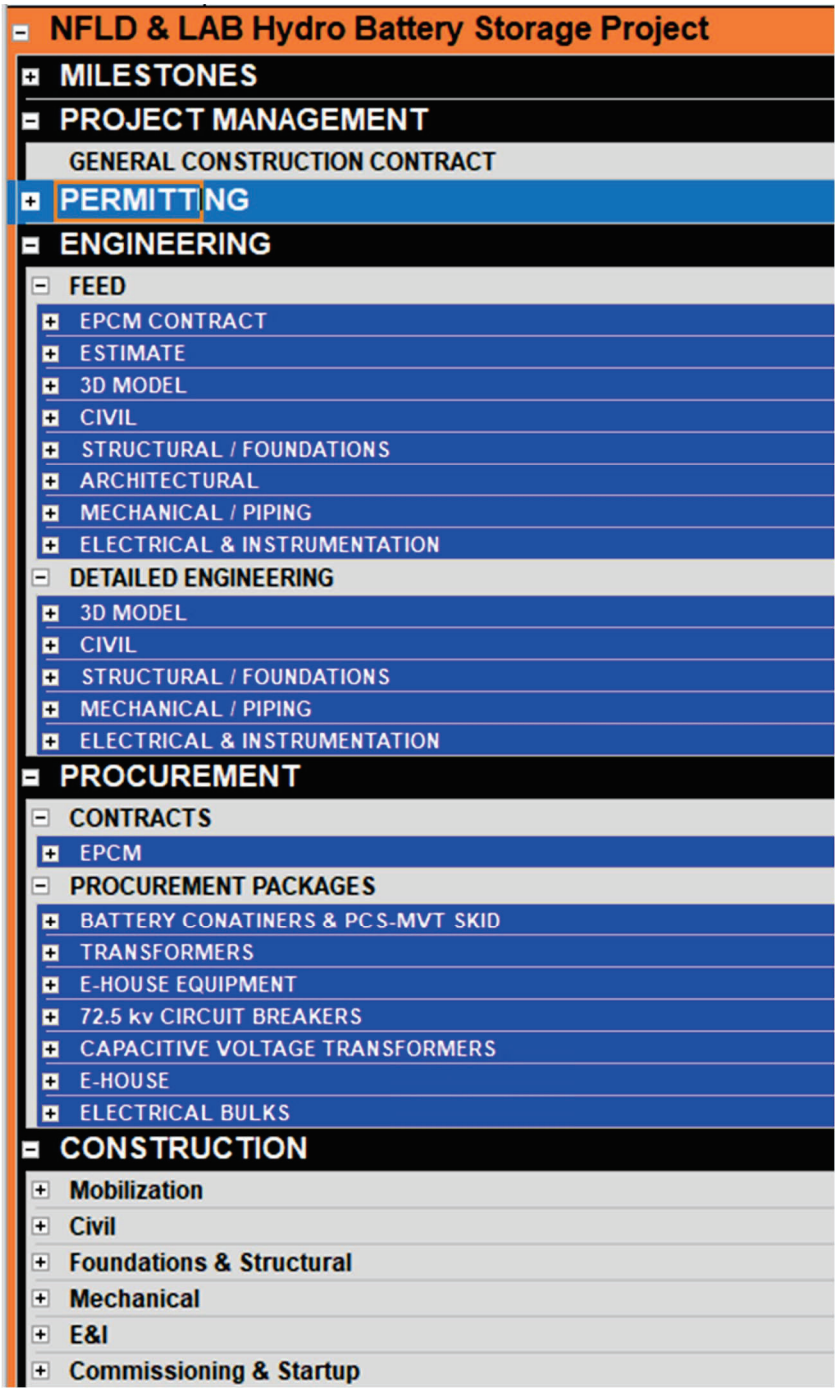


Figure 4-1: Schedule WBS

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4.5 Scope of Schedule and Exclusions

4.5.1 EPCM Engineering

The Engineering scope includes engineering, as well as drawings, specifications and data sheets for procurement of equipment, incorporation of vendor data as needed to complete engineering and detailed design.

4.5.2 Procurement

Procurement activities include Request for Proposal (RFP), technical and commercial evaluation, conforming specification, Recommendation for Award (RFA), vendor data review, expediting and Vendor Quality Surveillance (VQS). These activities are required to support the final selection and purchase of vendor equipment and the expediting and quality assurance of vendor design and fabrication.

The procurement schedule was developed with a two-stage procurement approach: the first stage is procurement activities scheduled on a forward path timeline to get vendor data needed to support engineering program, and the second stage is to support equipment fabrication and delivery to site to meet the projects in service dates.

4.5.3 Construction

The construction schedule has only been defined to the point of achieving an approximate duration for activities and a general sequence. The construction schedule will be further updated in FEED phase to include an updated estimate of labour and key quantities to validate the assumptions made for sequence and durations. The overall project timeline is comparable with other similar project schedules except for the transformer's installation and subsequent activities. The transformer procurement should be advanced prior to the EPCM award.

4.5.4 Commissioning

The commissioning activities are simply place holders and approximate the duration required after construction completion to bring the plant into service. The commissioning schedule should be updated in FEED and again by the EPCM contractor.

4.5.5 Exclusions

The schedule excludes any owner's activities required outside the boundary limits of the project to tie into existing infrastructure.

The schedule excludes site acquisition and work and permitting associated with powerline relocations, it is assumed this will be completed by the client prior to commencement of construction, it has been identified as a risk in the feasibility report.

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4.6 Key Assumptions

- Plant Capacity 50 MW with an 8-hr reserve at the POI.
- The current schedule is indicative of the plant design in the future phases.
- Delivery durations are estimates taken from recent experience or similar projects and professional knowledge.
- Long Lead items are not bidden out or purchased until EPCM is awarded.
- The engineering deliverables are sequenced to support the procurement strategy.
- Procurement activities begin upon completion of engineering for each package.
- The schedule assumes a 10-day client review and approval cycle for all document and procurement specifications.
- FID (Final Investment Decision) is 1 month after FEED Completion.
- Permitting by client starts after FID
- IFC dates are dependent on receiving vendor data in a timely manner.
- The average planned cycle durations used for a procurement package are as per Table 4-2. A single round of client review comments on all engineering deliverables.

4.7 Major Opportunities

- Develop the Transformers package during FEED phase and client should be awarded once FID has been approved. This will occur long before the EPCM is awarded and save approximately 6 to 8 months on the construction schedule. This would require free issue to the EPCM contractor and would introduce some risk if delays occur and have an impact on the EPCM contractor.

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Table 4-1: Schedule Durations for Engineering Reviews

Engineering Review Activity	Responsibility	Duration (Working Days)	Cumulative Duration
Internal Review & Revise Package	EPCM	10	10
Client Review and Approval	Client	10	20
Revise & Issue for Use / bid	EPCM	10	30

Table 4-2: Planned Package Procurement Cycle Time

Procurement Activity	Responsibility	Duration (Working Days)	Cumulative Duration
Issue RFP to Vendor	EPCM	5	5
Bid Period	EPCM	20	25
Technical Evaluation / CBE / RFA	EPCM	30	55
RFA Approval	Client	20	75
Conforming Specification	EPCM	5	80
Award	EPCM / Client	20	100
Vendor Kick-off meeting (5 days after award)	EPCM / Client	5	105
First Vendor Data	Supplier	40	145

Table 4-3: Planned EPCM Procurement Cycle Time

Procurement Activity	Responsibility	Duration (Working Days)	Cumulative Duration
Issue RFP to Vendor	EPCM	10	10
Bid Period	EPCM	40	50
Technical Evaluation / CBE / RFA	EPCM	40	90
RFA Approval	Client	20	110
Award	EPCM / Client	20	130

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5. Project Schedule

5.1 Key Dates

Table 5-1 presents the major project milestones based on early dates extracted from the project schedule. These milestones are identified at the top of the schedule.

Table 5-1: Project Milestones

Activity ID	Project Milestone	Timeline
M-1160	FEED Kickoff	1-May-26
M-1170	30% Design Model Complete	29-Jul-26
M-1035	FEED Engineering Complete	25-Sep-26
M-1015	FEED Estimate and Report Complete	7-Dec-26
M-1025	FID (Final Investment Decision)	12-Jan-27
M-1000	EPCM Kickoff	21-Jun-27
M-1060	60% Design Complete	29-Sep-27
M-1110	NL Department of Environment Approval	20-Jan-28
M-1070	90% Design Complete	19-Apr-28
M-1080	Detailed Engineering Complete	7-Jul-28
M-1005	Permits In-Hand (Municipal & Provincial)	7-Jul-28
M-1090	Construction Contractor Mobilized	21-Jul-28
M-1050	Electrical Bulks - Delivered to Site	29-Jan-29
M-1030	E-House Equipment - Delivered to E-House Manufacturer	26-Feb-29
M-1010	BATTERY CONTAINERS - Delivered to Site	14-Mar-29
M-1100	Foundations & Structural Steel Complete	26-Mar-29
M-1130	PCS-MVT SKID - Delivered to Site	28-Mar-29
M-1040	E-House - Delivered to Site	9-May-29
M-1020	TRANSFORMERS - Delivered to Site	19-Apr-30
M-1140	Electrical Equipment Set	24-Apr-30
M-1150	Construction Complete	29-May-30
M-1120	In Service Date	27-Aug-30

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5.2 Critical Path

The Critical path in the schedule is defined by the longest path. The critical path is through the FEED phase, followed by the award of the EPCM contract which will start the procurement process for the High Voltage (HV) Transformers. Once the Purchase Order (PO) is placed it is estimated at approximately 2 years for delivery. Once delivered final electrical connections and testing can be completed. The critical path is illustrated below in Figure 5-1.

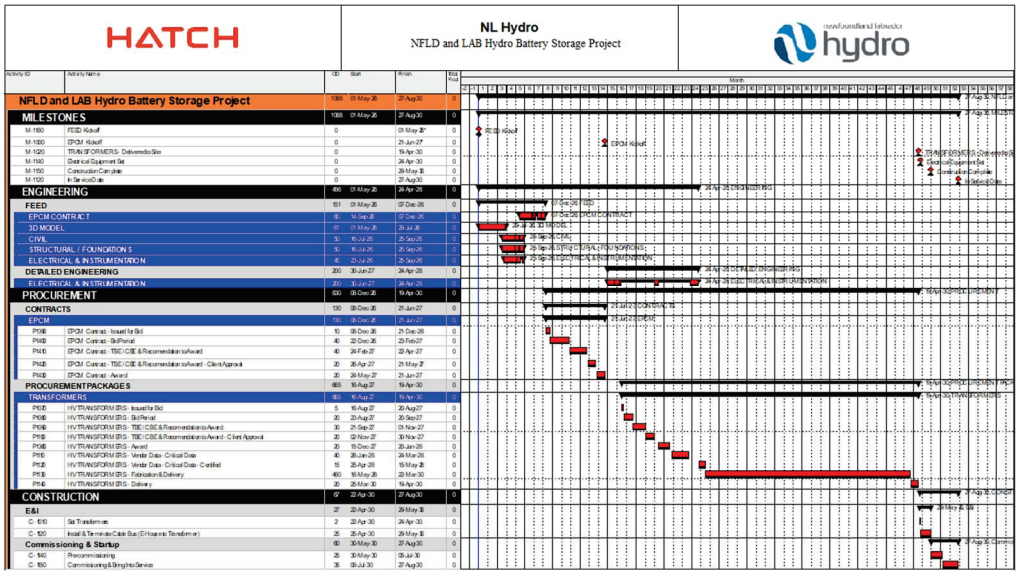


Figure 5-1: Project Critical Path

5.3 Schedule Summary

The project schedule is summarized and presented below in Figure 5-2.

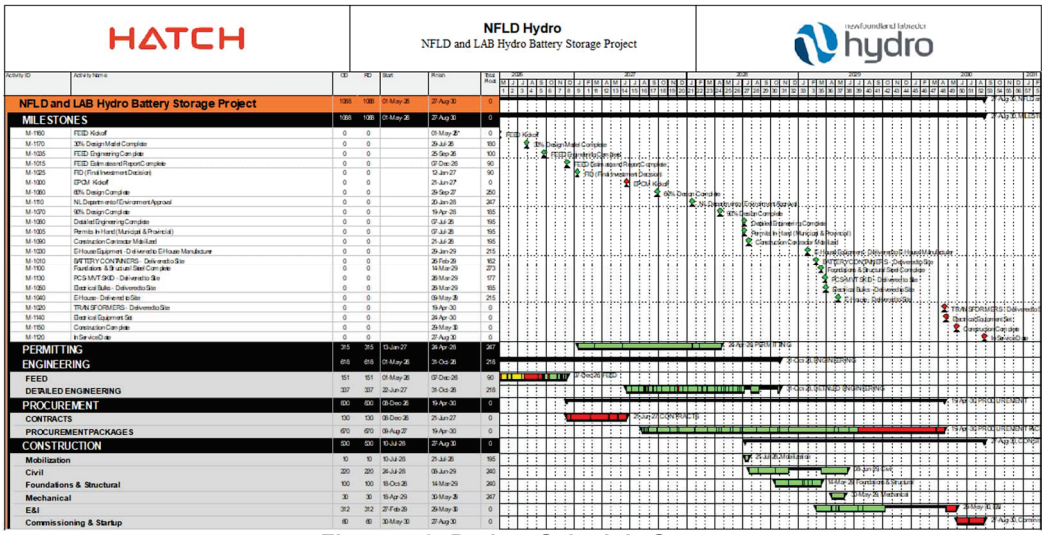


Figure 5-2: Project Schedule Summary

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6. Schedule Development Basis

6.1 General

The project schedule is a live document that will be refined throughout the life of the project and depends on the quality of the information on which the schedule is based. Schedule quality improves as engineering definition and execution strategies are progressively developed.

6.2 Resources

No Resourcing is included in the schedule. Resources should be added once the FEED has progressed to a substantially complete level.

6.3 Engineering

The engineering section of the schedule is broken down by discipline. The disciplines have a general section that includes activities like design criteria which are common to all packages and is further broken down into single discipline Engineering Work Packages (EWPs). If applicable, this enables preparation of equipment and material specifications for procurement. The schedule has been developed on a forward path, to get the procurement packages issued as early as possible, and subsequently to receive the vendor data in time, to enable finalization of engineering activities. Multi-disciplinary engineering activities will be required to proceed in parallel with substantial overlaps to maintain the schedule.

6.4 Procurement

The procurement scope reflects full cycles of procurement packages for main scope items in the EPCM scope and has been developed up to the delivery. Please note that full extent of procurement packages will be determined early in the next phase of the project.

6.5 Construction

The construction schedule is considered a level 1 / 2 schedule. The durations are based on experience and have not been validated with the estimate quantities at this time. However, the confidence in the overall duration is high when compared to similar other projects that have been used as a comparison.

The construction schedule currently shows the earliest possible start of construction, however if the transformers are not advanced as described in the opportunities section, the start could be delayed by up to 6 months.

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6.6 Risk and Contingency Provisions

The schedule was developed with the assumption that upon the award the EPCM contract study work related to capacity has been finalized in the FEED phase with a clear scope to begin Detailed engineering and procurement. If further study work is required, this will impact on the overall duration.

There is no inherent risk built into the baseline schedule, however, as the project progresses, and to maintain or mitigate impacts to the milestone dates, certain tasks may be advanced out of sequence or at risk of change. These will be identified and communicated with the client on a case-by-case basis.

The schedule does not include Contingency or Reserve. This is determined by the client after a proper SRA (Schedule Risk Analysis) has been performed. This exercise is typically a FEED phase function.

A schedule Quality Assessment has not been performed on this schedule. In the FEED phase it is expected that the engineering firm will perform a Quality Assessment using Acumen Fuse software or equivalent.

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