Appendix V

Risk Assessment Workshop Report

Client:	Pattern Energy
Project:	PATT-2401 – Argentia Renewables ERP
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Title:	Risk Assessment Workshop Report
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Issued For:	Issued for Use

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Prepared By	Date

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Approved By	Date

Revision History			
Revision	Date	Issued For	Issued By
P01	21-Mar-2024	Client Review	Yejide Emioladipupo
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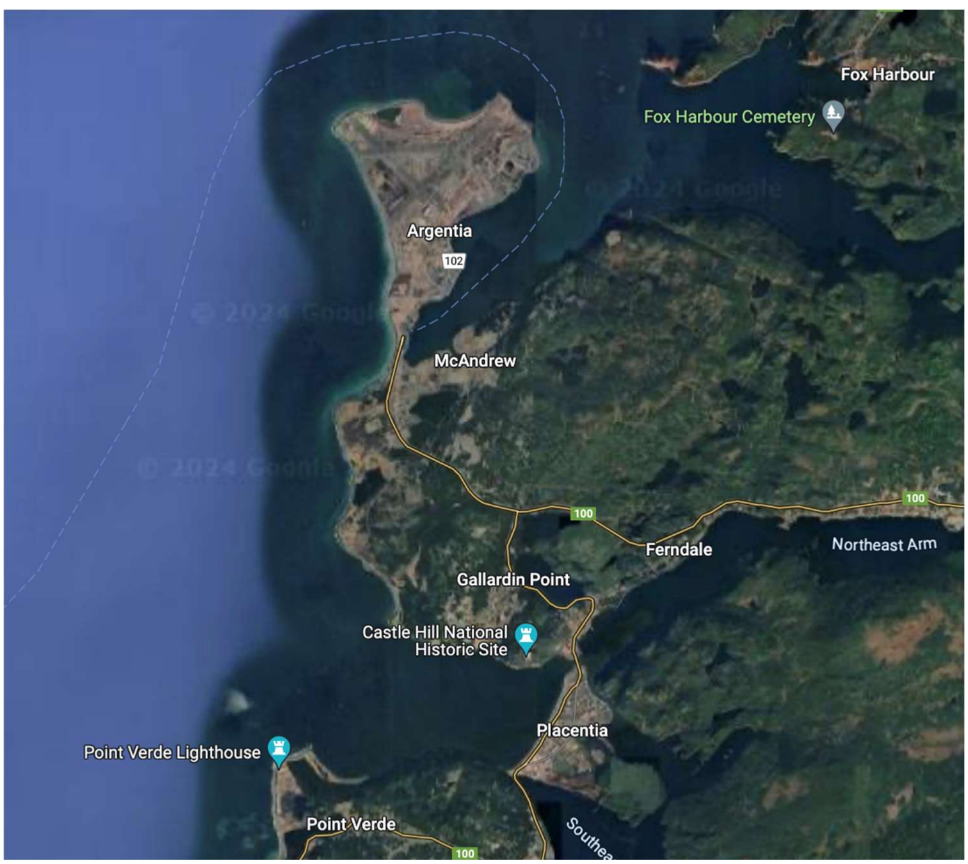
R0	23-July-2024	Use	Kirsten Moores

1.0 INTRODUCTION

The Pattern Canada Argentia Renewables Wind Energy to Green Hydrogen and Ammonia Project is in Argentia within the municipal boundary of Placentia on the Avalon Peninsula of Newfoundland and Labrador.

The Project is a green hydrogen and ammonia production, storage, and export facility powered the Argentia Wind Facility. The Argentia Green Fuels Facility will produce hydrogen through the electrolysis of water using renewable and low-carbon energy sources. Nitrogen captured by air separation units will also use renewable energy. Ammonia will be produced from hydrogen and nitrogen in the ammonia synthesis unit via the Haber-Bosch process. Wind energy generation and the power supply available from the NHL grid constitutes a unique scenario where the energy used to produce hydrogen and ammonia is truly green. Green fuels synthesis requires a large energy input; however, renewable and low-carbon energy sources make it green hydrogen versus the alternative use of petroleum producing grey hydrogen product.



trajectorE was engaged by Pattern Energy as part of the project to conduct a series of Structured What-If Analysis workshops were held over the course of three days. The first session occurred over the course of two days (February 21st & 23rd, 2024) focusing on Hydrogen and Ammonia Production, Ammonia Storage and Ammonia Ship Loading and the second session occurring on May 3rd, 2024, to cover Hydrogen Storage at the site. Event scenarios that were identified during the SWIFT workshop that involved a release of ammonia were modelled using an atmospheric dispersion modelling software program for denser-than-air releases (SLAB). Hydrogen release effects modelling was conducted using fundamental predictive point source and explosion modelling for dispersion, thermal impacts due to fire, and overpressure due to explosion. The modelling results can be found in separate reports: Ammonia Dispersion Cloud Modelling Report, PATT-2401-HRP-002 and Hydrogen Release Effects Report, PATT-2401-HRP-003.

For the purposes of this assessment only the Hydrogen & Ammonia Plant and Loading Facility is considered; the Wind Farm has been excluded.

2. STRUCTURED WHAT-IF ANALYSIS RISK ASSESSMENT

2.1 METHODOLOGY

The Structured What-If Analysis (SWIFT) is a type of high-level Process Hazard Analysis (PHA) – one of the key components of Process Safety Management (PSM), shown below in Figure 2.1.

Figure 2.1 – Process Safety Management Elements.

The SWIFT uses a structured brainstorming technique to identify major potential hazards and then using a risk matrix the likelihood and impact of said hazards is quantified. Through this mitigation measures to be considered for each hazard can be identified during the planning and design stage of the project.

For each of the workshop sessions a variety of subject matter experts were involved to leverage their knowledge on the process and project, while also drawing on experience to identify and quantify the risks and further recommend mitigation measures. A Facilitator from trajectorE was responsible for ensuring the team followed the structured process for the risk assessment. A record of deviations, risk rankings and recommendations were recorded by a "Scribe".

For each of the workshop sessions the scope of the project was divided into nodes based upon the conceptual plant layout. Prior to the beginning of brainstorming hazards, the battery limits of each node were discussed. Brainstorming of hazards for each node was prompted by a set of guidewords. The guidewords used in the session were as follows:

- Process Upset
- Equipment Failure
- Instrumentation Failure
- Utility Failure
- Weather
- Human Error
- Procedures
- Training
- Security

Using these guidewords each node was assessed by following the below sequential steps:

- Possible hazardous events identified contained within the area of the node as it relates to each guideword.
- Cause of each event identified in step 1 identified.
- Consequence of the event identified.
- Categorization of the event assigned.
- Risk associated with each event was quantified using the Risk Matrix supplied by trajectorE in Appendix A.
- Recommendations were made based on the event and associated Risk Ranking.

Note that the SWIFT review is not intended to be a design review, therefore any design discussions along with any other discussion which fell outside of the scope of the review were recorded in the Parking Lot found in Appendix D.

2.2 SCOPE OF WORKSHOP

The What-If workshop series was conducted based on several principles. The risk assessment is based upon information from the Argentia Renewables Green Ammonia Plant Feasibility Study from Atkins Realis (formerly SNC Lavalin). The only potential changes to the design that was considered was during the second session of the workshop (Node D) the concept of a above ground compressed Hydrogen buffer tank (~17 ton capacity). All other potential changes to the design that would be expected to take place during normal design development in subsequent engineering phases were not considered. Where items were raised related to potential improvements during the risk assessment, these were noted in the Parking Lot in Appendix D. Other principles used to complete the SWIFT workshop sessions were as follows:

1) The level of detail of discussion commenced with <15% of engineering completion.
2) Assumed normal stable plant operating conditions.
3) Physical boundaries confined within the three nodes shown (Nodes A, B, C & D)
4) Where information is lacking the worst-case scenario event is assumed.
5) Assumed that engineering work is completed at standard best practice.
6) The assessment is focused on process safety hazards not occupational health and safety hazards.
7) Risks were assessed based on unmitigated, worst-case events based on the knowledge of the team involved in the workshop. Mitigation measure, while fully expected to be implemented, were not included in the risk assessment at this time.

The project has also been divided up into Nodes A, B, C and D based on location on the Concept Site Plot Plan. Definition of Nodes on the plot plan can be found in Appendix B. Each node was defined as:

- Node A – Hydrogen & Ammonia Production
- Node B – Ammonia Storage
- Node C – Ammonia Ship Loading
- Node D – Hydrogen Storage

2.3 STRUCTURED WHAT-IF ANALYSIS SESSION

The SWIFT workshops were held over three days on February 21st & 23rd and May 3rd, 2024 online via Microsoft Teams meeting. Partaking in each session was a group of individuals from Pattern Energy and trajectorE Engineering and each session was facilitated by trajectorE. Table 2.1 below summarizes the list of attendees for each day.

Table 2.1 – List of SWIFT Workshop Attendees

			Session 1		Session 2
Name	**Organization**	**Role**	**Day 1**	**Day 2**	**Day 3**
Dariel Adato Felhandler	Pattern Energy	Sr. Preconstruction Manager, Green Fuels	✓	✓	✓
Scott Dufour	Pattern Energy	Business Development, Green Hydrogen	✓	✓	✓

Lauge Nielsen	Pattern Energy	Canadian Markets and Asset Expansion Director	✓	✓	
Don Stevens	trajectorE	Senior Process Consultant	✓	✓	
Heiko Leers	trajectorE	Senio Process Consultant			✓
Craig Ryan	trajectorE	Emergency Response Specialist	✓	✓	✓
Sean Breen	trajectorE	Process Engineer	✓	✓	
Andrew Sinclair	trajectorE	Facilitator	✓	✓	✓
Kirsten Moores	trajectorE	Scribe	✓	✓	✓

The Event Scenarios, Causes, Consequences, Risks and Recommendations can be found in the Worksheet in Appendix C. Any other issues outside of the scope of the sessions that were identified can be found in the Parking Lot in Appendix D.

2.4 RESULTS OF WORKSHOP

A total of 72 "What-If" Scenarios were identified during the series of SWIFT sessions. Some of these scenarios were not risk ranked due to being outside of the scope of the sessions for various reasons including if the impact was production related or not directly related to Health and Safety, Environment or Community Impact. However, these scenarios were left in the worksheet for completeness and should be considered in future PHA's for the project. The scenarios that were ranked are shown below in Table 2.2 and 2.3. Some scenarios identified fall under multiple categories and as a result for the purposes of tallies shown in Tables 2.2 and 2.3 have been counted towards multiple associated categories.

Table 2.2 – Risks by Level

Level	Total Risks
Very Low	0
Low	0
Medium	47
High	14
Very High	0
Extreme	0

Table 2.3 – Risks by Category

Categories	Total Risks
Health & Safety	54
Environment	10

Community Impact	4

Out of the 72 event scenarios, 8 were identified as triggers for potential ammonia release. These events were identified as high-risk events requiring further analysis, through vapor cloud modelling. There were also 10 event scenarios identified as triggers for potential hydrogen release. These are identified in Table 2.4 and 2.5 and modelled for potential impact in a separate reports.

It should also be noted that Argentia Renewables plans to install double wall ammonia storage tanks, as well as auto-isolating valves on both hydrogen and ammonia tanks. These will substantially reduce the probability and impact of an ammonia or hydrogen spill or leakage event.

Table 2.4: Ammonia Release Event Scenarios

Event Scenario	Scenario #	Event Description	Type of Release
Ammonia Synthesis Area	1	Failure of reactor in electrolyser. Contents empties within 10 minutes	Catastrophic Failure of Reactor
	2	Steam generation system failure because of a tube rupture. Causing a runaway reaction and possible ammonia release	Full Pipe Rupture Ammonia Synthesis Unit
Ammonia Transfer Lines	3	Transfer line failing as a result of vehicle striking the pipe, poor maintenance, overpressure etc.	Full Pipe Rupture – One 12” Line
Recycle Line	4	Over pressure or poor maintenance of cycle line resulting in full pipe rupture	Full Pipe Rupture – 12”
Loading Arm	5	Over pressure of both loading arms causing full rupture	Full Pipe Rupture – Both 12” Lines
	6	Over pressure of one loading arm causing full pipe rupture	Full Pipe Rupture – One 12” Line
Ammonia Storage Tank	7	Catastrophic release of ammonia from storage tank. Full vessel emptied in 10 minutes	Catastrophic Failure of Tank
	8	Inlet pipe to ammonia tank full rupture of pipe	Full Pipe Rupture - Ammonia Inlet Pipe

Table 2.5: Hydrogen Release Event Scenarios

Event Scenario	Scenario #	Event Description	Type of Release
Air Separation Unit	1	Mixing Drum Pipe Rupture	Full flow
	2	Catastrophic Failure of Mixing Drum	Full Flow+Vessel empty
Electrolyser/H2 Storage Unit	3	Pipe Rupture for electrolyser discharge header	Full Flow
	4	Catastrophic Failure of Electrolyser H_2 Side Containment	Full Flow+Vessel empty
	6	Catastrophic Failure for Electrolyser Containment	Vessel Explosion
Ammonia Synthesis Unit	7a	Pipe Rupture of Recirculation line after NH_3 Condenser	Full Flow
	7b	Pipe Rupture of Reactor inlet piping	Full Flow
	8	Catastrophic Failure of Reactor	Full Flow+Vessel empty

3.0 RECOMMENDATIONS

It is expected that through prudent and responsible engineering design development many of the risks identified will be mitigated during upcoming design phases of the project. To ensure that all recommendations shown in the SWIFT Worksheet in Appendix C are actioned and fully managed it is recommended that this list of risks be transferred to the overall project risk register and tracked and managed accordingly.

Issues that were identified in the series of SWIFT workshop sessions but that fell outside of the scope of the risk assessment or were tabled to the Parking Lot in Appendix D. These should also appropriately be addressed as the project progresses as determined by the project team.

After completion of the first SWIFT Session (Nodes A, B & C), all associated scenarios which had the potential of forming a downwind ammonia vapor cloud were subsequently used as inputs to prepare cloud modelling assessment. In addition, release events that had the potential to result in a hydrogen release were also used as inputs to hydrogen release effects modelling.

Ammonia modelling was conducted using commercial atmospheric dispersion modelling software and explained in Ammonia Dispersion Cloud Modelling Report, PATT-2401-HRP-002. Hydrogen release effects modelling was conducted using fundamental predictive point source and explosion modelling for dispersion, thermal impacts due to fire, and overpressure due to explosion. This is separately reported in Hydrogen Release Effects Report, PATT-2401-HRP-003.

Periodic updates to these models should be made to address upcoming design changes. Emergency response detailed planning should incorporate the results of this analysis.

APPENDIX A
RISK MATRIX

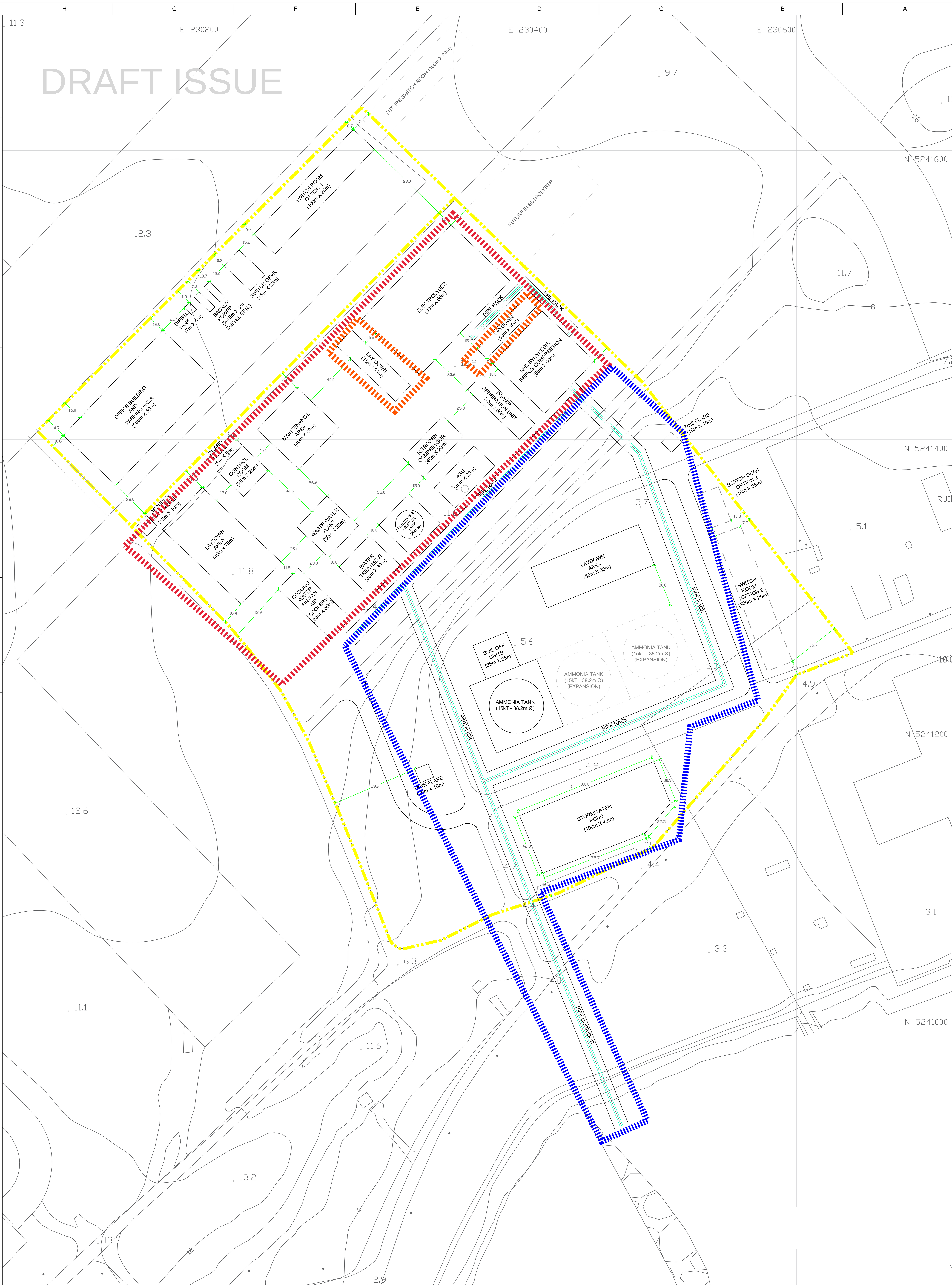
Impact Ranking	Health & Safety	Environment	Community Impact
1	Slight Health Effects/injury	Limited spill/release <70L contained within site footprint	Local community impact
2	Minor Health Effects/injury requiring medical assistance - Recovery within hours	Reportable on site spill/release >70L contained within site footprint	Local municipality impact. Reversible in short term
3	Moderate health effects/injury requiring medical treatment - restricted work day case	Reportable spill/release outside of site footprint (on land)	Regional district/provincial impact. Reversible in the mid term
4	Major Health effects/injury requiring emergency medical treatment (LTI)	Reportable offsite marine spill	Regional impact. Reversible in the long term
5	Fatality or life-altering injury	Major uncontained environmental spill. Causing major harm to local ecosystems requiring extensive cleanup	Permanent impact

Likelihood Ranking	Probability of Occurring in a Given Year	Description
1	<1%	For a system failure: this event has not happened in industry in the last 50 yrs For a natural hazard (earthquake, flood, windstorm, etc): 1 in 100yrs or longer
2	1-10%	One occurrence during the life of the facility (20-30years)
3	11-33%	One occurrence at the most in a ten-year period of operation
4	34-99%	One occurrence in 1 year of operation
5	100%	Could occur once a month or more

		IMPACT				
		1	2	3	4	5
LIKELIHOOD	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5

Risk Levels (<=)	Level
2	VERY LOW
4	LOW
9	MEDIUM
12	HIGH
16	VERY HIGH
25	EXTREME

APPENDIX B
SITE PLOT PLANS WITH NODES



REV	DATE	REVISION DESCRIPTION	DRN	CHK	APP
00	13.10.23	ISSUED FOR REVIEW	TS	BH	CN

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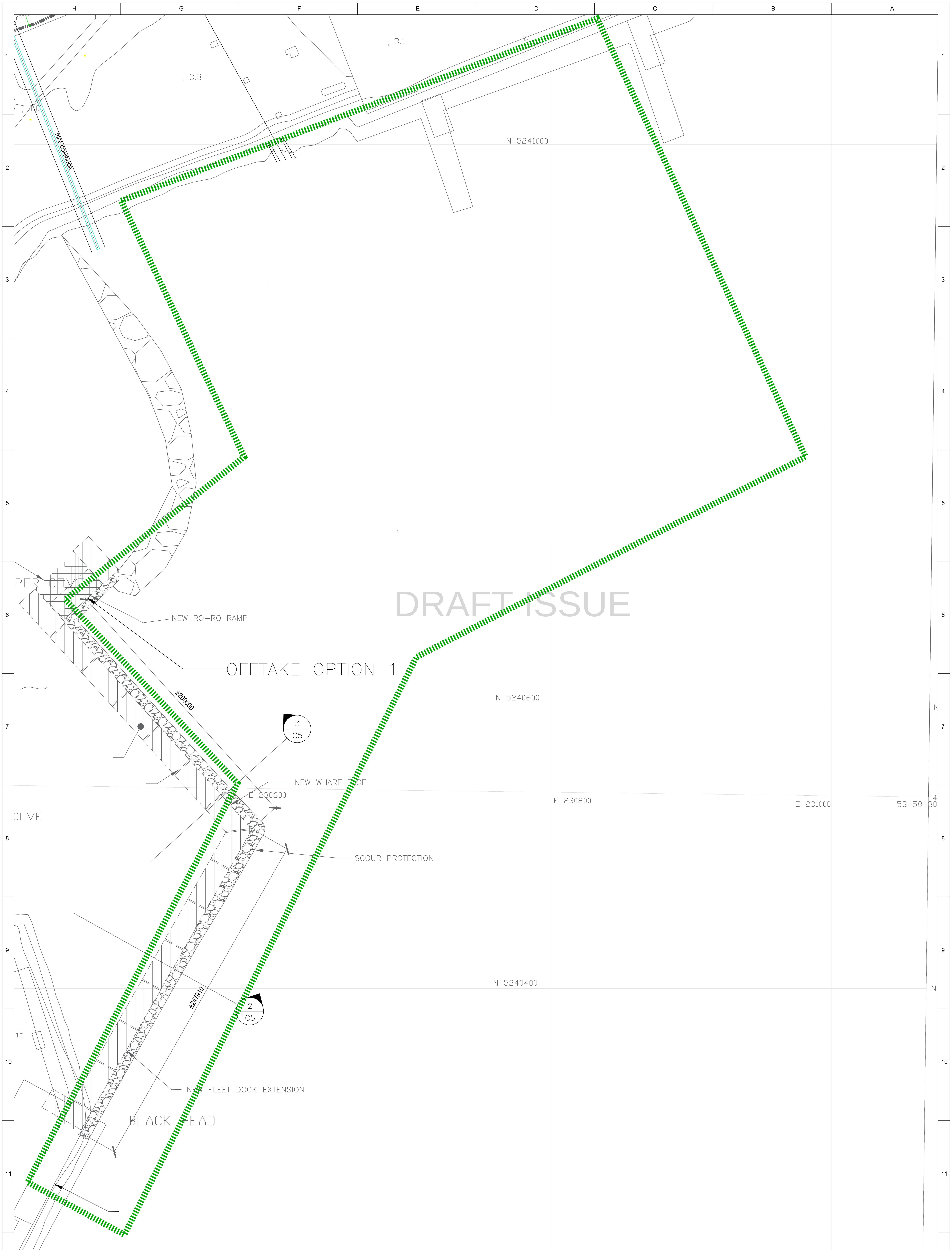
PREPARED	JS	13.10.2023
DRAWN	TS	13.10.2023
CHECKED	BH	13.10.2023
APPROVED	CN	13.10.2023
SCALE 1:1000	FORMAT	B1

PROJECT: Argentia Renewables - Feasibility Study

DRAWING TITLE: CONCEPT PLOT PLAN

DRAWING NUMBER: SNC-XX-XX-DDRW-Z-0002

REV: 00



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SCALE 1:1000	FORMAT	B1

PROJECT
Argentia Renewables - Feasibility Study

DRAWING TITLE
CONCEPT SITE PLAN

DRAWING NUMBER
SNC-XX-XX-DDRW-Z-0001

REV
00

APPENDIX C
SWIFT WORKSHEET

NODE A									
Guidewords	**Ref. No.**	**Events: What if?**	**Potential Consequences**	**Category**	**Impact**	**Existing Safeguards**	**Likelihood**	**Risk Ranking**	**Recommendations**
Process Upset	A.1	Catalyst run off in ASU. As a result of an ASU process upset.	Exothermic reaction (Reactor failure). Possible explosion	Health&Safety	5	Proper engineering design practice	1	5	1. Process Safety awareness training for employees. 2. Trigger ERT to respond
	A.2	Compressed hydrogen release or a fire in the electrolyser. The Electrolyser Building is a confined space posing an added hazard. The release or fire could be a result of seal failure, flange leaks or failure of the gas collection system	Fire Explosive	Health&Safety	5	Proper engineering design practice	1	5	1. Hydrogen gas monitors 2. Proper Alarms 3. Ventilation 4. Fire suppression 5. Hazardous area classification for electrical systems
	A.3	Ammonia release in the Ammonia synthesis area. In the form of fugitive emissions. A result of slow leaks from flanges, seals, etc.	Operator exposure	Health&Safety	3	Proper engineering design practice	4	12	1. Personal gas monitors 2. Area monitors 3. Proactive repairs of high exposure areas 4. Breathing apparatus' (escape pack) in high risk areas
	A.4	Ammonia release in the Ammonia synthesis area. As a result of a catastrophic failure of mixing drum or pipeline	Vapor Cloud formed Esphyxiation	Health&Safety	5	Proper engineering design practice	2	10	1. Proper maintenance procedures and training 2. Personal gas monitors 3. Area Monitors 4. Escape packs 5. Properly trained ERT team
	A.5	Oxygen fire resulting from disruption of oxygen venting (excess oxygen)	Fire (accelerated)	Health&Safety	5	Proper engineering design practice	1	5	1. Locate vent at high elevation
	A.6	Waste water discharge to environment off spec (temperature, composition, etc.). A result of possible failure of the water treatment system	Off spec environmental release (reportable)	Environment	4	Proper engineering design practice	3	12	1. Proper waste water monitoring and testing program
Equipment Failure	A.7	An explosive atmosphere created in the Electrolyser area from Membrane failure (membrane rupture mixing hydrogen and oxygen)	Production loss Explosive atmosphere created Explosion if ignition source present	Health&Safety	5	Proper engineering design practice	1	5	
	A.8	ASU: Compressor trip, valves not operating	See above A.1						
	A.9	Failure of the ammonia flare	Environmental release.	Environment	3	Proper engineering design practice	3	9	1. Proper maintenance procedures and training 2. Stable propane supply
	A.10	Cooling tower failure	See above A.1-8						
	A.11	Compressor failure causing an overpressure of Nitrogen	Asphyxiation	Health&Safety	5	Proper engineering design practice	1	5	1. Proper maintenance 2. Alarms
	A.12	Steam generation system failure due to tube ruptures.	Runaway reaction Release	Health&Safety	5	Proper engineering design practice	2	10	1. Proper maintenance 2. Alarms 3.Procedures 4. Testing 5. Redundancy within design
	A.13	Fire protection system failure during a fire event	Fire scenario covered above. See A.2 & A.5						
Instrumentation Failure	A.14	Control system failure. This could have multiple potential causes such as no backup battery, network issues, etc.	Risk not individually assessed as consequences could be any of the others mentioned in this assessment						1. Ensure design consider fail safe states
Utility Failure	A.15	Water supply system failure	Emergency Plant shutdown	Health&Safety	3	Pressure relief system	1	3	1. Install process water tank (buffer)
	A.16	Power failure (NL Hydro feed or Pattern energy wind farm feed)	Production loss Emergency shutdown	Production loss not risk ranked as part of ERP Risk Assessment		Proper engineering design practice Emergency Generator to put plant in safe mode (Emergency shutdown)	Production loss not risk ranked as part of ERP Risk Assessment		
	A.17	Air supply failure	Production Loss	Production loss not risk ranked as part of ERP Risk Assessment					
Weather	A.18	Instrument air lines freeze	Production loss	Production loss not risk ranked as part of ERP Risk Assessment					
	A.19	Electrolyser (too cold or too hot for operation). Due to loss of heat in building during a cold weather event	Need to verify with the vendor on temperature extremes for electrolyser. Moved to Parking Lot						
	A.20	Road wash outs. As a result of extreme weather event	Site team safely stranded temporarily (Production loss)	Production loss not risk ranked as part of ERP Risk Assessment					
	A.21	Surge from ocean (tidal wave/washout) from an extreme weather event	Flood Equipment Damage Production loss	Environment	5		1	5	1. consider flood mitigation in design 2. establish weather conditions in design basis FEL2 onward
	A.22	Cooling towers frozen from extreme weather event	See A.10						
	A.23	Tropical Storm/Hurricane/Wind storm	Building damage		5		1	5	1. establish weather condition basis in FEL 2 onward
Human Error	A.24	Control room operator ignoring warning alarms/signals	Could result in a wide variety of consequences		5		2	10	1. Implementing ISA 18 Alarm Management Standard
	A.25	Maintenance personnel not following best practices for regular maintenance (PMs and inspections skipped)	Could result in any of the equipment failures mentioned about (A.7-13)		5		2	10	1. Robust maintenance program
	A.26	Lack of communication/ miscommunication between control room operator and marine terminal (ammonia storage, vessel loading area)	Production loss Over pressure of storage tank (overfilling tank)	Risk ranked on Node C. See C.5					
Procedures	A.27	Startup after scheduled maintenance outages (loss of control in the plant)	Not Risk ranked as outside of scope of review.						1. Prepare SOPs for plant startup and shutdown
	A.28	Ammonia release, fire,etc affecting other stakeholders in the area (Marine Atlantic,etc). This is as a result of not communicating with Port of Argentia "neighbors" about a ship for the Ammonia plant coming	Any process upset, equipment failure scenarios discussed above	Captured above in scenarios A.1 - 6					1. Incident protocol (call list including "neighbors" in PoA)
	A.29	Ship arrives unscheduled during non loading period. A result of poor communication between parties on when loading period is	Can't fill ship until loading period commences Production loss / demurrage cost for ship delay	Production loss / cost impact not risk ranked as part of ERP Risk Assessment					
Training	A.30	Improper training for different operating scenarios (emergency shutdown, startup after planned maintenance,etc)	See above A.27						
	A.31	Emergency scenario training is insufficient	People at risk unknowingly	Health&Safety	5		2	10	1. Develop training program (ammonia awareness program)
Security	A.32	Cyber security breach of control system	Malicious release of dangerous gases or other high risk scenarios	Occupational Health&Safety	5		2	10	1. Control system to implement cybersecurity best practices 2. Implement cyber security awareness training for workforce
	A.33	Breach of security (unauthorized personnel entering site) using water ways or land	Theft Production disruption Mischief	Outside of scope of risk review					

NODE B									
Guidewords	**Ref. No.**	**Events: What if?**	**Potential Consequences**	**Category**	**Severity**	**Existing Safeguards**	**Likelihood**	**Risk Ranking**	**Recommendations**
Process Upset	B.1	Overpressure of feed line. As a result of a surge event (unexpected valve closure)	Ruptured line causing a leak of ammonia	Health&Safety	4	Best practice engineering	2	8	1. Routing of the line away from high traffic areas
	B.2	Over or under pressure of storage tank (tank failure). Could be a result of control system failure(temp control, level control, etc) or boil off package failure	Rupture of tank (release of ammonia)	Health&Safety	5	Best practice engineering Secondary containment included in tank design	1	5	
	B.3	Over or under pressure of storage tank (tank failure). Could be a result of control system failure (level control, temp control, etc)	Rupture of tank (release of ammonia)	Community Impact	5	Best practice engineering Secondary containment included in tank design ERP plan in place for surrounding community	1	5	
Equipment Failure	B.4	Storage tank failure resulting from compromised tank integrity (corrosion)	Minor ammonia leak	Health&Safety	3	Best practice engineering Secondary containment included in tank design	2	6	3. Preventative Maintenance Program to be established
	B.5	Failure of feed line. Where both the feed line and tank connection fail	Slow leak of ammonia. See above B.1						
	B.6	Failure of recirculating pump	See above B.1-B.3						
Instrumentation Failure	N/A								
Utility Failure	B.7	Boil off package lost as a result of a loss of power	Ammonia released through flare	Risk assessment not required. Assumed flare is working in this case. If assumed flare fails refer to A.9					
Weather	B.8	Snow or ice build up in area as a result of a weather event.	Ice break off resulting in equipment failure (see B.4-6) Ice hitting people (outside of scope)						
Human Error	B.9	Transfer line rupture. As a result of a vehicle striking the transfer line	Ruptured line and release of ammonia	Health&Safety	4	Best engineering design practice	2	8	6. Strategic pipe routing 7. Physical barriers in place
	B.10	Release of ammonia. Due to the line not being properly maintained	Maintenance personnel exposed to ammonia	Health&Safety	2	Best engineering design practice	3	6	5. Ammonia awareness training 6. Proper PPE 3.Maintenance Procedures 4. LOTO
Procedures	N/A								
Training	N/A								
Security	N/A								

NODE C									
Guidewords	**Ref. No.**	**Events: What if?**	**Potential Consequences**	**Category**	**Severity**	**Existing Safeguards**	**Likelihood**	**Risk Ranking**	**Recommendations**
Process Upset	C.1	Surge event causing a loading arm failure by over pressurizing the line. Resulting in a piping system rupture over water.	Environmental spill (marine), affecting pH level and short term habitat impact on marine life in the harbour.	Environment	4	Best engineering practice.	2	8	Define and model potential marine impact and implement appropriate preventative measures and clean-up plans.
Equipment Failure	C.2	Loading arm failure when Ferry loading/offloading passengers, ammonia vapor cloud travels toward ferry terminal (mechanical failure of structure or piping system failure). Could be a result of weather event, operator fatigue, etc.	Full force spray out of the weakest point of arm until shut off	Community Impact	4	Best engineering practice	1	4	1. Communication Protocols to be developed in conjunction with PoA & Marine Atlantic for loading boat
Instrumentation Failure	N/A								
Utility Failure	N/A								
Weather	C.3	High winds at loading time during which a line break or leak occurs.	Line break/leak in a marine environment	Environment	5	Best engineering practice	1	5	1. Cut off wind speed for loading 2. Communication protocols with ship 3. Consider anemometer to be used
Human Error	C.4	Incorrectly hooked up loading hose. Hose becomes dislodged causing a release onto ships deck	Personnel exposure	Health&Safety	4	Best engineering practice	1	4	1. PPE 2. Training 3. Procedures
	C.5	Start loading before ship crew is ready or vice versa (plant crew is not ready). As a result of miscommunication between the crews.	Personnel exposure	See C.4 for Risk Ranking and Recommendations					
	C.6	Major breakage in line due to incorrect boat mooring	See above C.1, C.2, C.4						
	C.7	Overfilling ship due to failing to shut off feed to the ship in a timely manner.	Release on ship deck (personnel exposure) See above	See C.4 for Risk Ranking					1. Ship should comply with appropriate standards & regs (proper equipment)
Procedures	N/A								
Training	N/A								
Security	C.8	MARSEC rules violated at the loading dock. Note: Besides plant security during ship loading MARSEC rules apply for international ship activities. (Marine)	MARSEC Level 3 event Production loss	Not risk ranked due to being outside scope. However, should be considered in future studies					1. MARSEC requirements need to be considered in design

NODE D

Guidewords	Ref. No.	Events: What if?	Potential Consequences	Category	Severity	Existing Safeguards	Likelihood	Risk Ranking	Recommendations
Process Upset	D.1	Overpressure of the storage tank as a result of overfilling.	Catastrophic failure of the hydrogen tank	Occupational Health&Safety	5	Best engineering practice	2	10	1.Review tank wall design 2.Consider overpressure design controls 3.Consider lowest traffic area for tank location
	D.2	Overpressure of the storage tank as a result of overfilling.	Jet flame (flange fire)	Occupational Health&Safety	4	Best engineering practice	2	8	1.Flame detection system 2.Robust Maintenance Program 3.Failsafe control system 4.Consider appropriate fixed fire suppression
	D.3	Overheating of the storage tank causing overpressure with impingement of flame.	Catastrophic failure of the hydrogen tank	Occupational Health&Safety	5	Best engineering practice	2	10	1. Review tank wall design 2. Consider overpressure design controls 3. Consider lowest traffic area for tank location
	D.4	Overheating of the storage tank causing overpressure with impingement of flame.	Jet flame (flange fire)	Occupational Health&Safety	4	Best engineering practice	2	8	1. Flame detection system 2.Robust Maintenance Program 3.Failsafe control system 4.Consider appropriate fixed fire suppression
	D.5	Over pressure of piping causing a failure	Jet flame (flange fire)	Occupational Health&Safety	4	Best engineering practice	2	8	1.Proper procedures and training 2.Flame detection system 3.Robust Maintenance Program 4.Failsafe control system 5.Consider appropriate fixed fire suppression
Equipment Failure	D.6	External damage to the hydrogen tank affecting the integrity	Catastrophic failure of the hydrogen tank	Occupational Health&Safety	5	Best engineering practice	2	10	1.Access restriction to tank area 2.Procedures for working around hydrogen system 3.Guarding of hydrogen tank 4.Training 5.Location of tank away from high traffic areas
	D.7	External damage to the hydrogen tank affecting the integrity	Jet flame (flange fire)	Occupational Health&Safety	4	Best engineering practice	2	8	1.Access restriction to tank area 2.Procedures for working around hydrogen system 3.Guarding 4.Training 5.Location of tank away from high traffic areas 6.Consider appropriate fixed fire suppression
	D.8	Material failure in hydrogen storage tank	Catastrophic failure of hydrogen tank	Occupational Health&Safety	5	Best engineering practice	1	5	1.Ensure material of construction is correct 2.QA/QC during tank construction (i.e weld inspections, etc)
	D.9	Piping and/or valves failure for the hydrogen piping as a result of external damage	Jet flame (flange fire)	Occupational Health&Safety	4	Best engineering practice	2	8	1.Access restriction to tank area 2.Procedures for working around hydrogen tank 3.Guarding 4.Training 5.Location of tank away from high traffic areas 6.Consider appropriate fixed fire suppression
	D.10	Piping and/or valves failure for the hydrogen piping as a result of material failure	Jet flame (flange fire)	Occupational Health&Safety	4	Best engineering practice	2	8	1.Ensure material of construction is correct 2.QA/QC during tank construction (i.e weld inspections, etc) 3.Consider appropriate fixed fire suppression 4.Robust maintenance management system 5.Management of change for replacement parts
Instrumentation Failure	D.11	Instrumentation fails leading to any of the above events(level, pressure sensors, etc)	See above D.1-D.10						
Utility Failure	D.12	Power failure causing instrumentation failure	See above D.11						1. Back up power for instrumentation
Weather	D.13	Snowstorm causing the tank to be inaccessible during jet flame event	Jet flame event persists longer than needed	Occupational Health&Safety	5	Best engineering practice	1	5	1.Procedure (snow clearing during winter) 2.Snow clearing considered during design (roadways large enough to accommodate equipment)
	D.14	Lightening strike on hydrogen tank	Catastrophic failure of hydrogen tank	Occupational Health&Safety	5	Best engineering practice	1	5	1.Lightening protection for tank
Human Error	D.15	Incorrect valve positioning (either open or closed) causing a build up of pressure.	Pipe over pressure event leading to jet flame	Occupational Health&Safety	4	Best engineering practice	2	8	1.Training and procedures 2.Overpressure protection
	D.16	Contact with hydrogen tank by vehicle affecting tank integrity	Jet flame (flange fire)	Occupational Health&Safety	4	Best engineering practice	2	8	1.Access restriction to tank area 2.Procedures for working around hydrogen tank 3.Guarding 4.Training 5.Location of tank away from high traffic areas 6.Consider appropriate fixed fire suppression
Procedures	D.17	Incorrect operation of hydrogen tank on ramp up, shutdown, or emergency shut down	Catastrophic Failure of hydrogen tank	Occupational Health&Safety	5	Best engineering practice	1	5	1.Start up, emergency shutdown and planned shutdown procedures
	D.18	Poor maintenance of tank components compromising integrity of the system	Jet flame (flange fire)	Occupational Health&Safety	4	Best engineering practice	2	8	1.Ensure material of construction is correct 2.QA/QC during tank construction (i.e weld inspections, etc) 3.Consider appropriate fixed fire suppression 4.Robust maintenance management system 5.Management of change for replacement parts
Training	D.19	Incorrect identification of a leak (hydrogen versus ammonia)	Jet flame leading to catastrophic failure of tank	Occupational Health&Safety	5	Best engineering practice	1	5	1.Fire detection system 2.Develop procedure for secondary validation of fire 3.Consider apropriate fixed fire suppression 4.Emergency response procedure for hydrogen leak 5.Training and Procedures
	D.20	Incorrect identification of a leak (hydrogen versus ammonia)	Jet flame undetected leading to personnel injury	Occupational Health&Safety	4	Best engineering practice	2	8	1.Fire detection system 2.Develop procedure for secondary validation of fire 3.Consider apropriate fixed fire suppression 4.Emergency response procedure for hydrogen leak 5.Training and Procedures
	D.21	Incorrect response to hydrogen leak scenario	Jet flame undetected leading to personnel injury	Occupational Health&Safety	4	Best engineering practice	2	8	1.Training and Procedures 2.Third party responder training and drills (Coordination with local emergency services)
Security	N/A								

APPENDIX D
PARKING LOT

Parking Lot/ Issue Summary
NODE A
What is the volume of vapor released which triggers a report to the government regulator?
Ask vendors what risks exist if water is lost to electrolyser?
Clarify whether regulatory cyber security requirements applicable to Pattern if power being generated to grid (NL Hydro)
Hydrogen tanks (not in FEL 1 docs) should be noted for future PHA's
Follow up with vendor on specifics of membrane failure
Ask vendor about electrolyser operating specifications (temperature extremes, etc)
NODE B
Permitting requirements around Ammonia, hydrogen?
Consider whether flare runs continually or intermittently (is flare event even required)
NODE C
Ensure that authorization for workers in shipping facility (international) is taken into account. Usually there is certain security clearance requirements for those working in international ports
Explosion modelling for blast radiuses of tank ruptures
Water suitability assessment (Coast Guard)
NODE D
What are the regulations and limits around a hydrogen event (Flare or release to atmosphere) from emissions standpoint

Appendix W

Mitigation Measures

Appendix W: Mitigation Measures

Table W-1 Mitigation Measures.

Item	VC[1]	Potential Interaction and Rationale	Mitigation Measures	Project Phase[2]	Applicable Area[3]	Examples of Successful Mitigation Use on Other Projects[4]	Effectiveness (1-3)[5]
1	All VCs	Fragmentation or alteration of wild land which has inherent value to wildlife and people.	Project footprint and disturbed areas will be minimized and limited to the space required to accommodate necessary infrastructure. Existing roads, trails, and disturbed areas will be used wherever feasible.	C, O, D	AB, PIL	WEGH2, VBWEP, BLWPP	1
2	All VCs	Hydrocarbon and/or chemical leak or spill.	A) Maintain inventory of oil spill response equipment. B) Deploy resources to minimize the effects of the spill or leak, such as using absorbents or neutralizing agents. C) Personnel on-site will be trained to use firefighting equipment. D) Deploy firefighting equipment to extinguish fires, if applicable. E) All spills will be reported and cleaned up as soon as feasible, with contaminated soils removed from site for disposal at an approved/licensed location. F) Follow the Emergency Response/Contingency Plan (and Hazardous Materials Response and Training Plan, which specify the actions required both to prevent and respond to any release of chemicals to avoid water and soil contamination.	U	ALL	A) VBWEP, HIW B),C) WEGH2 D) HIW E) WEGH2, VBWEP, HIW	1
3	All VCs	Mismanagement of waste (general to all types of wastes) presenting a hazard to human health and the environment.	A) All waste storage areas will have appropriate signage. B) Incompatible materials will not be stored near each other. C) All waste containers must be labeled. The waste management vendor will provide the labels. D) Waste storage area is fenced and gated as applicable, to prevent public access. E) All hazardous waste is stored below eye level. F) Adequate ventilation is provided via normal airflow. G) Heavy containers are stored on lower shelves and with sufficient space between containers. H) Waste containers must be in good condition and compatible with the waste stored therein. I) Waste containers must be inspected at least monthly for labeling, condition, leaks and/or spills. J) Waste containers must not be opened, handled, or stored in a manner that may rupture the container or cause the containers to leak. K) Waste containers must be always closed during storage, except when waste is being added. In the case of liquid chemical hazardous waste, regulations do not permit funnels to remain in waste containers after filling. L) Secondary containment is required for containers of liquid waste when the waste is stored in quantities of greater than 45 L or when necessary to separate incompatibles or high hazard waste. M) Follow the Transportation of Dangerous Goods regulations. N) Fire detection and protection systems will be installed in high-risk areas such as fuel and hazardous material storage. O) A suitable fire extinguisher is present. P) Hazardous products will be stored according to industrial requirements and standards, and safely secured so that access is limited to authorized personnel. Q) Project staff and contractors will adhere to the waste management procedures to be included in the EPP and the Waste Management Plan.	C, O, D	ALL	A) WEGH2 C) VBWEP D) WEGH2 H) VBWEP I) VBWEP M) VBWEP N) WEGH2 O) VBWEP P) WEGH2 Q) WEGH2, VBWEP	1
4	All VCs	Dislodging of wind tower or turbine blade.	A) Perform routine inspections. B) Isolate the wind turbine or tower from the power grid to prevent electrical accidents. C) Implement lockout/tagout procedures to ensure that the turbine is de-energized and cannot be accidentally restarted during the dislodging process.	U	AB, AP	A) WEGH2 B) HIW	1
5	All VCs	Improper use or management of explosives and blasting activities.	A) Blasting activities (if required) will be included under a contract service agreement with the explosives supplier. B) Blasters will have a valid blasters certificate issued by the NL DECC. C) An Explosives and Blasting Management Plan will be developed by the blasting contractor to provide direction for the safe storage, handling and use of explosives and explosive components at the Project site, to address the safety of the public and Project personnel, and protection of both the environment and Project components. D) Blasting patterns and procedures will be used to reduce shock or instantaneous peak noise levels. E) Blasts should be designed to meet the required noise and vibration limits.	C	ALL	A) WEGH2 B) WEGH2, VBWEP C) WEGH2 D) WEGH2, VBWEP E) HIW F) WEGH2, VBWEP, HIW G) WEGH2, VBWEP H) WEGH2, BLWPP	1

Item	VC[1]	Potential Interaction and Rationale	Mitigation Measures	Project Phase[2]	Applicable Area[3]	Examples of Successful Mitigation Use on Other Projects[4]	Effectiveness (1-3)[5]
			F) Time delay blasting cycles or blast mats will be used, if necessary, to control the scatter of blasted material. G) Blasting will not occur in the vicinity of fuel storage facilities. H) Nearby residents will be notified of any blasting activities.				
6	All VCs	Mismanagement of sewage.	Regular checks of sewage levels to ensure they are not overfilled.	C, O, D	AP	WEGH2, BLWPP, HIW, VBWEP	1
7	All VCs	Improper function of Argentia Green Fuels Facility.	A) The Project will be designed and constructed to meet applicable engineering codes, safety standards, and best management practices. B) The Argentia Green Fuels Facility will be routinely inspected, and regular maintenance will take place to ensure proper operation.	ALL	AP	A) WEGH2	1
8	AqE	Project development affecting the aquatic environment.	Adhere to the Environmental Protection Plan (EPP) when conducting any work that affects or may affect components of the aquatic environment (e.g., lakes, streams, groundwater table).	C	AB, PIL	HIW	2
9	AqE	Project development affecting the marine environment.	Ensure adherence to all applicable legislation and regulations governing the marine environment.	ALL	AP	WEGH2	1
10	AqE	Long term effects to local water resources.	A) Develop water level monitoring thresholds and adaptive water management strategies for the Placentia PPWSA ponds to increase the system resilience. B) Further investigate regional hydrology to evaluate what drawdown value should be considered 'critically low' for the ponds. C) Based on consultation with NL DECC, bathymetry studies will be completed of water resources to refine baseline water resource data in advance of construction and operations. D) If it is determined based on water monitoring during Operations that Project drawdown of available water could cause a temporary water shortage or any material water quality changes to the Placentia municipal water supply, Project consumption of water affecting the Placentia municipal water supply would be curtailed until this condition is no longer met.	O	AP, AB		3
11	AqE	Potential change in fish health, survival, and habitat from in-water work and construction.	A) Any in-water work will be limited. B) In-water work will be planned to respect DFO timing windows to protect fish in NL. C) If fording is required, follow DFO's temporary ford code of practice. D) Ensure proper installation of crossing structures. E) Ensure road, shoulder, and crossing structures are well maintained. F) Standard and approved methodology will be applied to construction practices when culverts and bridges are being installed.	ALL	AB, AP	B) HIW C) VBWEP D) VBWEP E) HIW F) VBWEP	1
12	AqE	Potential change in fish health, survival, and habitat from runoff during use of roads.	Ensure site and access roads will be maintained in good condition.	C, O, D	AB		1
13	AqE	Potential change in fish health, survival, and habitat from Project activities.	A) Monitor fish populations for change in community structure, abundance/biomass, and growth. B) Monitor fish habitat conditions.	C, O	AB		2
14	AqE	Potential change in American eel health and survival from Project activities.	Monitor American eel populations for change in abundance and biomass.	C, O	AB		2
15	AqE	Potential water quality effects from effluent discharge.	Ensure effluent and wastewater comply with applicable regulatory approvals and discharge criteria.	O	AP	VBWEP	1
16	AqE, TE	Changes in water quality as a result of Project activities in or near water.	Monitor water quality.	C, O, D	ALL		2
17	AqE, TE	Change in wetland and waterbody quantity and function due to Project construction.	A) Maintain undisturbed buffer strips more than 30 m wide surrounding waterbodies and wetlands, except for where access roads are close to such crossings. B) Permanent infrastructure will be sited outside of wetlands to the extent feasible. Otherwise, a Permit to Alter a Body of Water will be sought from NL DECC Water Resources Division. C) Store any stockpiled materials at least 30 m away from wetlands, woodlands, wildlife habitats, and waterbodies. D) Site maintenance, vehicle maintenance, and fueling will be done in specified areas more than 30 m away from wetlands and waterbodies. Such locations will include drainage control features.	C, O, D	AB, PIL	A) VBWEP, HIW B) HIW C) HIW D) HIW E) BLWPP, HIW F) WEGH2, VBWEP, HIW G) WEGH2	1

Item	VC[1]	Potential Interaction and Rationale	Mitigation Measures	Project Phase[2]	Applicable Area[3]	Examples of Successful Mitigation Use on Other Projects[4]	Effectiveness (1-3)[5]
			E) Where construction activities occur within 30 m of a wetland, install and maintain construction fencing to clearly define the construction footprint area to prevent damage to vegetation. F) Erosion and sediment control measures will be implemented prior to and during construction near wetlands and waterbodies to prevent siltation and disturbance. G) Maintain erosion and sediment control measures until re-vegetation of disturbed areas is complete. H) Remove as little riparian vegetation as feasible. I) Access road runoff will be diverted through drainage ditches into vegetated areas or through sediment barriers to prevent exposed soil or road materials from entering waterbodies or wetlands.			H) HIW I) HIW, BLWPP	
18	AtE	Diminished sound quality due to increased noise generation and increased vibration levels.	A) All employees, contractors and subcontractors are to receive an environmental induction training related to Project-specific and standard noise and vibration mitigation measures. B) A noise monitoring program may be carried out for the duration of the works in accordance with a prepared Construction Noise and Vibration Management Plan, and any approval and license conditions. C) Where feasible, use quieter equipment, using only the necessary sized and powered equipment for Project activities. D) Maintain vehicles and equipment in good working order, ensuring that mufflers are functional. E) Use quieter and less vibration emitting construction methods where reasonable and feasible. F) Where feasible, construction should be carried out during the standard daytime working hours. G) Work generating high noise and/or vibration levels will be scheduled during less sensitive time periods. If the work cannot be undertaken during the day, it will be completed before 11:00 pm. H) Avoid or minimize out of hours movements where feasible. I) Where additional activities may only result in a marginal noise increase and speed up works, the duration of the effect will be limited by concentrating noisy activities at one location and moving to another as quickly as feasible. J) Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles operating past outside normal working hours (11:00 pm to 6:00 am). K) Plan traffic flow, parking, and loading/unloading areas to minimize reversing movements onsite. L) Delivery vehicles to be fitted with straps rather than chains for unloading, wherever feasible. M) Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. N) Those employed by the Project will take measures to reduce personal noise on the jobsite (e.g., no loud stereos/radios).	C, O, D	ALL	A) WEGH2, BLWPP, HIW, VBWEP D) WEGH2, VBWEP, HIW, BLWPP I) WEGH2	1
19	AtE	Increased noise and vibration levels affecting sensitive or residential receptors.	A) The offset distance between noisy equipment and adjacent sensitive receptors is to be maximized where feasible. B) Equipment that is used intermittently will be throttled down or shut down when not in use. C) Only necessary equipment will be kept on site. D) Loading/unloading of materials/deliveries will occur as far as feasible from sensitive receptors. E) Dedicated loading/unloading areas are to be shielded if close to sensitive receptors. F) Select site access points and roads as far as feasible away from sensitive receptors. G) Locate compounds away from sensitive receptors and discourage access from local roads. H) Use structures to shield residential receptors from noise (e.g., shed placement). I) The use of noisy equipment (e.g., mulchers, jack hammers) in very close proximity to receptors should be limited where feasible to standard construction hours. J) Maintain a minimum setback distance of 600 m between the Argentia Wind Facility wind turbines and sensitive receptors (e.g., occupied residences). K) Maximize offset distance between Argentia Green Fuels Facility and adjacent receptors.	C, O, D	AB, PIL		1
20	AtE	Increased vibration levels affecting adjacent buildings.	A) Attenuated vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage. B) Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage.	C, D	AP		1
21	AtE	Project noise exceeding the Health Canada Noise Guideline.	In particular, 27 Power Street, Dunville, NL requires temporary hoarding to adhere to the Health Canada Noise Guideline.	C	AB		3

Item	VC[1]	Potential Interaction and Rationale	Mitigation Measures	Project Phase[2]	Applicable Area[3]	Examples of Successful Mitigation Use on Other Projects[4]	Effectiveness (1-3)[5]
22	AtE	Facility emissions contributing to a reduction in air quality and an increase in atmospheric GHG levels.	A) Implement control measures such that emissions generated from flare stacks are reduced. B) Emission control devices will minimize emissions to remain within industry standards.	O	AP	A) WEGH2 B) BLWPP, HIW	1
23	AtE, LRU	Vehicle and equipment emissions contributing to a reduction in air quality and an increase in atmospheric GHG levels. Engine noise diminishing sound quality.	A) Where feasible, use mobile equipment with Tier 4 engines. B) Vehicles and equipment are to be turned off when left stationary for extended periods. C) The idling of engines will be avoided whenever possible.	C, O, D	ALL	B) WEGH2 C) WEGH2, BLWPP, HIW	1
24	AtE, TE	Project lighting diminishing ambient lighting levels and causing disturbance to wildlife.	A) Project lighting will be limited to that which is necessary for safe and efficient Project activity. B) Install the fewest number of site-illuminating lights feasible in the Project Area. C) Utilize flashing warning lights that turn off completely between flashes. D) Use only flashing lights at night at the lowest intensity and fewest number of flashes per minute as required by Transport Canada. E) Where feasible, construction, maintenance, and decommissioning activities will be conducted during daylight hours for increased visibility and to avoid light and noise pollution effects at night. F) Should nighttime work be required, lighting to be limited to what is necessary for safety and efficiency. G) Minimize pilot warning and obstruction lighting on all tall structures as feasible. H) Wind turbine and meteorological tower lighting levels will be at the minimum allowed by Transport Canada for aeronautical safety and white or red strobe lights may be used with the minimum intensity and flashes per minute allowable. I) Ground-level external lights on buildings and wind turbine bases will be pointed downward and shall use motion or heat sensors when possible and permitted. J) Engage in a wildlife-friendly lighting plan.	C, O, D	ALL	A) WEGH2, BLWPP, VBWEP B) VBWEP, BLWPP C) WEGH2, HIW D) HIW E) WEGH2, HIW, BLWPP F) BLWPP G) HIW, BLWPP H) WEGH2, VBWEP, BLWPP, HIW I) WEGH2, HIW J) WEGH2	1
25	AtE, HHQL, TE	Dust generation resulting in a reduction in air quality.	A) Implement speed limits and, where necessary, speed bumps to limit dust generation. B) Implement control measures such as road watering, application of approved chemical suppressants, or physical barriers, where appropriate, to reduce fugitive dust generation on exposed surfaces (e.g., unpaved roads, laydown areas, stockpiles). C) Specific stockpiles of topsoil, overburden, and other potentially dust-generating materials will be kept covered, where practical, and used as soon as practical, or will be appropriately temporarily vegetated. D) The Explosives and Blasting Management Plan will include design measures to reduce dust generation.	C, O, D	AB, PIL	A) WEGH2, BLWPP HIW B) WEGH2, VBWEP C) WEGH2, BLWPP	1
26	HHQL	Waste management may be of concern to residents.	Contractors will adhere to EPP guidance regarding the use and storage of hazardous materials, waste disposal, and vegetation clearing.	C, O, D	ALL		1
27	HHQL	Shadow flicker of 30 hours per year is exceeded at one receptor.	A) The wind farm developer will work with the dwelling owner to reduce the incidence of shadow flicker to meet the 30-hour threshold. B) Where applicable a turbine-specific curtailment schedule may be implemented.	O	AB	A) WEGH2 B) HIW	3
28	HHQL	Shadow flicker during the daytime causing visual nuisance.	A) Implement a curtailment schedule to minimize duration of shadow flicker effects. B) Where feasible, install screening (e.g., trees, fence) to reduce shadow flicker effects.	O	AB, AP		2
29	HHQL, TE	Ice throw and ice fall hazard posing a risk of injury to people and animals, or property damage.	A) Equip turbines with ice throw mitigation technology (e.g., heated blades, low friction coatings). B) Restrict site access to authorized personnel only. C) Use Anti- and De-Icing Technologies such as blade heating technology. D) Use an ice detection system, which can stop the turbine when ice build-up reaches a critical point. E) Shutdown the turbines during rotor icing periods. F) Equip turbines with ice protection devices to provide safe worker access. G) Educate and train employees in potential risks in accordance with best practices and guidelines. H) Add public education and warning signage that explain hazards to prevent members of the public from entering maximum ice throw areas during periods of rotor icing. I) Follow best practices detailed by CanREA.	O	AB, AP	A) HIW E) WEGH2 G) WEGH2 H) WEGH2	2

Item	VC[1]	Potential Interaction and Rationale	Mitigation Measures	Project Phase[2]	Applicable Area[3]	Examples of Successful Mitigation Use on Other Projects[4]	Effectiveness (1-3)[5]
30	HHQL, LRU	Effects to nearby landowners, wind projects commonly developed with minimum setbacks from sensitive receptors	Project wind turbines will be set back at least the greater of 600 m or 3.0 times the blade tip height of the wind turbines. Furthermore, the Project will micro-site wind turbines to further minimize visibility to nearby landowners to the extent practicable and reduce turbine heights (e.g., from 120 m to 99 m) where feasible.	C	AB, AP		2
31	HCR	Physical disturbance of archaeological materials or sites causing a loss of integrity and/or quality.	A) Avoid registered archaeological sites and resources situated within the Project Area. B) Avoid any other structures or features eligible for registration with the PAO, Heritage NL, or the Town of Placentia as a Municipal Heritage Site.	C, O, D	AB, PIL	A) VBWEP	1
32	HCR	Accidental damage to archaeologically significant materials or sites.	Complete a Historic Resources Impact Assessment (HRIA) prior to conducting any Project activities that may alter or disturb any existing structural remains or terrain identified in the HROA as having High potential for existing and/or as-of-yet undiscovered historic and archaeological resources.	C, O, D	AB, PIL		1
33	LRU	Project activities being incompatible with designated land use.	The Project will apply for the appropriate rezoning under the Municipal Plan.	C	AB		1
34	LRU	Land tenure and quarry accessibility issues.	The Project will consult and work with the Mineral Lands division of NL DIET to ensure that project site safety is maintained while mitigating any issues from the mineral licences and their holders. Agreements will be made with existing quarries.	C, O, D	AB		1
35	LRU	Interactions with Canadian Coast Guard radar installation at Pearce Peak.	In order to reduce potential effects to CCG radar activities in the general area of Placentia and the Port of Argentia, the Project will continue to work with the CCG to minimize potential effects that wind turbines may pose to radar activities. This will include the micro-siting of wind turbines and may also include other mitigations such as funding software upgrades to utilize existing radar capabilities, based on direct consultation with the CCG.	C	AB, AP		3
36	LRU	Alteration of recreational and/or subsistence land use along Project Interconnect Line	Plan to route electrical infrastructure and access roads along existing rights-of-way wherever feasible to reduce infrastructure footprint.	C, O, D	AB, PIL		1
37	LRU	Project traffic resulting in traffic congestion or increased risk of traffic accident.	A) All appropriate traffic control signage and controls will be in place as described by the Traffic Control Manual 2018 from the NL DIET. B) All drivers will be familiar with Project rules and measures related to pedestrian safety.	C, O, D	ALL	A) WEGH2, BLWPP	1
38	LRU	Project traffic during ferry-related traffic surges resulting in traffic congestion or increased risk of traffic accident.	Work with Marine Atlantic schedule to avoid traffic congestion during the arrival and departure of the marine ferry.	C, O, D	AP, AB		2
39	LRU	Transportation of oversized and overweight loads resulting in traffic congestion or increased risk of traffic accident.	A) Movements of oversized and overweight loads will be limited in number and scheduled based on arrival of components to the Port. B) Oversized and overweight traffic will be scheduled to avoid known peak traffic periods.	C, O, D	AP, AB		2
40	LRU	Project activities impeding or restricting future land development.	The project will apply for the appropriate permits within the Municipal Planning Area of Placentia.	C	AB		1
41	LRU, SE	Visual interactions with local tourism.	A) Facilitate hiking trail development in the Argentia Backlands through identification of viewing areas and coordination of trail route selection. B) The Project will collaborate with local tourism stakeholders. C) Design and install Project infrastructure to avoid, or maximize safe distances to, the RV Park and existing / proposed hiking trails.	C, O, D	AB		1
42	LRU, SE	Concerns from public related to the increase in heavy equipment operation or increased risk of collision with heavy equipment.	Employees and contractors who operate any motorized vehicle as part of this Project, including heavy equipment, will adhere to the following policies: A) Ensure all licenses and permits are up to date. B) Follow all vehicle and roadway rules and regulations. C) Respect the road space and its use by other drivers and pedestrians of the local communities. D) Follow all designated traffic control measures, both inside and outside the Project access routes.	ALL	AB, AP	A) BLWPP B) WEGH2, HIW	1

Item	VC[1]	Potential Interaction and Rationale	Mitigation Measures	Project Phase[2]	Applicable Area[3]	Examples of Successful Mitigation Use on Other Projects[4]	Effectiveness (1-3)[5]
			F) Exercise courtesy towards others. G) Turn off all flashing and rotating warning light beacons when on public roadways, unless required. H) Maintain a safe following distance from other vehicles and avoid traveling in convoys, unless required. I) Drive in full compliance with the Traffic Management Plan.				
43	LRU, SE, TE	Concerns from public related to the removal of vegetation. Habitat loss and/or fragmentation.	Project micro-siting, including the twinning of lines along existing linear corridors such as transmission lines and roads, where practicable, will be done to reduce the volume of vegetation removal and limit damage associated with construction and maintenance activities.	C, O, D	AB, PIL	WEGH2	1
44	TE	Project development affecting the terrestrial environment.	Adhere to the EPP when conducting any work that affects or may affect components of the terrestrial environment (e.g., soils, flora, fauna).	ALL	AB, PIL	HIW	1
45	TE	Change in quantity and function of sensitive areas due to Project construction.	Sensitive areas (e.g., wetlands, rare plant occurrences) will be identified prior to construction and appropriate buffers will be flagged and maintained around these areas where feasible.	C	AB, PIL	WEGH2, VBWEP	1
46	TE	Possible mortality, disturbance, and/or displacement of nesting birds. Loss and/or degradation of nesting habitat.	A) Vegetation clearing will be conducted outside the temporal window of the bird breeding season where feasible. B) A qualified Avian Biologist will be present during clearing activities to supervise vegetation removal and carry out nest surveys. C) If an active nest is discovered, activities will be halted, and setback buffers will be established. No vegetation clearing will occur within 800 m of a bald eagle or osprey nest during the nesting season (March 15 to July 31) or within 200 m during the remainder of the year. The 200 m buffer also applies to all other raptor nests (e.g. Northern Goshawk, Sharp-shinned Hawk, Merlin, American Kestrel, Great-horned Owl, Boreal Owl, Northern Saw-whet Owl). The location of all raptor nest sites will be reported to the Wildlife Division. For other bird nests, setback distances will be established according to ECCC's Guidelines to Avoid Harm to Migratory Birds. Generally, most songbirds will be given a 50 m buffer around any nests, but this buffer will often vary according to species, landscape context, and degree of disturbance. SAR will be given setbacks according to consultations with NL WD and ECCC.	C	AB, PIL	A) WEGH2, VBWEP, HIW B) WEGH2, BLWPP, HIW C) WEGH2, VBWEP, HIW	1
47	TE	Reduced habitat availability for bats, disturbance from anthropogenic activity.	Bat roosting surveys will be conducted on any structures within the Project Area and preventative measures will be implemented to ensure bats do not occupy buildings. Any bats detected within buildings will be left undisturbed until after the maternity season (in the case of maternity roosts) and Canadian Wildlife Health Cooperative guidelines will be followed.	C, O	AB	HIW	1
48	TE	Disturbance to bat maternity roosts from anthropogenic activity.	During the bat roosting season, any trees proposed for removal and any suitable rock crevices or caves in areas proposed for blasting will be searched for signs of maternity roosts by a qualified Biologist. A buffer will be established around any active roosts found within the construction footprint site, in consultation with NL WD.	C	AB, PIL	HIW	1
49	TE	Direct mortality of bats or birds caused by collision with moving wind turbine blades.	A) Install bird flight diverters in areas of relatively high risk of collision with infrastructure. B) Curtail turbines below a cut-in speed of 3.5 m/s during the autumnal bat migration period. C) Curtail turbines during Year One at wind speeds below 6 m/s, from dusk to dawn, when ambient air temperatures are above six degrees Celsius, between July 1 and September 30.	C, O, D	AB, AP	A) WEGH2, BLWPP, HIW B) WEGH2, VBWEP, HIW C) VBWEP	3
50	TE	Bird and bat population decline as a result of wind turbine mortalities.	A) A post-construction mortality monitoring program will be established in consultation with NL WD. Carcass searches will be conducted at all turbines between April and October for at least the first year, with thermal camera and/or acoustic monitoring occurring at least in the first, second, fifth, and seventh years of operations. Surveys will be designed to account for searcher efficiency and scavenger rates. C) An adaptive management framework will be used to introduce new mitigation measures if high fatality rates are observed as per the EPP.	O	AB, AP	A) WEGH2, VBWEP, HIW B) WEGH2, VBWEP, HIW C) WEGH2, VBWEP, HIW	3
51	TE	Loss and fragmentation of rare plant habitat.	Project infrastructure will be micro-sited to avoid rare plants where feasible.	C	ALL	WEGH2	1
52	TE	Loss and fragmentation of rare lichen habitat.	A) Before any clearing of suitable habitat types for rare lichen species, or habitat adjacent to such suitable habitat types, surveys should be conducted to identify any existing thalli. B) Where boreal felt lichen exist within or adjacent to proposed construction sites, thalli should be translocated outside of the construction zone and beyond associated buffers. C) Other rare lichen species like the observed blue felt lichen, require a buffer as the crustose form of the species will not as easily survive transplanting. An appropriate buffer will be established for this species through consultation with NL WD.	C	AB, PIL	A) WEGH2 B) BLWPP C) HIW	1

Item	VC[1]	Potential Interaction and Rationale	Mitigation Measures	Project Phase[2]	Applicable Area[3]	Examples of Successful Mitigation Use on Other Projects[4]	Effectiveness (1-3)[5]
			D) As Project planning advances, further information can be collected through field surveys in areas identified for Project construction and containing habitat suitable for blue felt lichen. E) Project infrastructure will be micro-sited to avoid rare lichen occurrences where feasible.				
53	TE, HHQL	Human hazard or injury due to interaction with wildlife.	A Wildlife Response Protocol will be developed and implemented. Project personnel must record and report all wildlife sightings and human-wildlife interactions and conflicts.	ALL	ALL	HIW	2
54	TE	Increased wildlife activity.	The work area will be kept clean and free from leftover foods which can attract wildlife.	C	ALL	WEGH2, VBWEP	1
55	TE	Disturbance and/or harm to terrestrial wildlife due to noise and vibration from blasting activities.	A) Limit the affected area of blasting to minimize disturbance to wildlife while carrying out blasting operations, in accordance with relevant Federal and Provincial guidelines and standards. B) Prior to blasting (or other noise-elevated activity), a qualified biologist is to undertake an area search of the intended blasting area to determine whether wildlife is present on the day on blasting. C) If wildlife is encountered in the blasting zone, deterrence measures are to be employed, up to implementation of a delay in blasting until the wildlife have vacated the area. D) Time delay blasting cycles or blast mats will be used to control debris generated from blasting. E) Develop suitable blasting timing windows and standard best management practices to minimize the extent of noise, vibration, and slope instability from blasting. F) Blasting will only occur in areas that have been cleared of vegetation. G) The Environmental Monitor will check the site prior to and during blasting activities to ensure compliance with the Explosives and Blasting Management Plan.	C	AB, PIL	A) VBWEP, HIW B) WEGH2, VBWEP, HIW C) WEGH2, HIW D) WEGH2, VBWEP, HIW E) HIW F) HIW G) HIW	1
56	TE	Mortality to wildlife as a result of vehicles using access roads.	A) Establish Project speed limits that are protective of wildlife (e.g., 30-50 km/hr). B) Post signage and monitor for adherence to the limits set. C) Instruct all staff to obey speed limits and traffic laws and to remain vigilant for wildlife while driving. D) Roadkill will be removed from Project roads to reduce vehicular collision risk. E) Include speed limit requirements in construction and operations wildlife trainings.	C, O, D	ALL	A) BLWPP, HIW B) BLWPP, HIW C) WEGH2, VBWEP, HIW D) VBWEP	1
57	TE	Loss and/or fragmentation of wildlife habitat due to vegetation clearing.	A) Vegetation removal will be minimized to the extent feasible. B) The area of disturbance will be limited to the construction footprint area. C) Minimize the size of cleared areas to limit the area of exposed soil. D) Clearing, grubbing, and topsoil overburden removal will be clearly identified in the field using flagging and survey stakes. E) If clearing is necessary during spring and summer, a qualified biologist will conduct a survey and identify any significant areas for setbacks (e.g., bird nests, potential bat roost trees or structures). Setback distances will be species-specific, but at least 30 m will be applied. F) Consideration should be given to the use of suitable local vegetation as part of any revegetation programs associated with the Project.	C, O, D	AB, PIL	A) VBWEP, HIW B) HIW C) HIW D) WEGH2, HIW F) WEGH2, BLWPP, VBWEP, HIW	1
58	TE	Possible mortality, harm, disturbance, and/or harassment to wildlife due to construction activities.	As per the Construction EPP, Environmental Monitors will be present during construction activities such as clearing vegetation, dewatering, and blasting to ensure adherence to environmental regulations.	C	ALL	HIW	1
59	TE	Possible harm, harassment, and/or mortality of SAR.	A) Monitoring and mitigation for SAR will be conducted as per the Draft SAR IMMP and PCMP. B) Staff will receive formal training on how to recognize SAR that may be present in the Project Area and the proper procedure to follow if SAR are encountered as per the EPP. C) Any SAR involved in a vehicle collision will be reported to NL WD. D) Upon discovery of a previously unknown SAR, work will be stopped until NL WD can be consulted.	C, O, D	ALL	A) WEGH2, BLWPP B) WEGH2, VBWEP, HIW C) BLWPP, HIW D) HIW	1
60	TE	Possible destruction and/or fragmentation of avian SAR habitat. Possible harm, harassment, and/or mortality of SAR.	Construction work must stop immediately within 10 m of a SAR observation until a qualified biologist can confirm the species has vacated the construction disturbance footprint. If the species is not present within the vicinity of the previous observation after a 24-hour period, work can resume.	C	ALL	HIW	1
61	TE	Loss and fragmentation of sensitive habitat due to Project construction.	Buffer areas will be created where feasible around any environmentally sensitive areas, such as those identified in baseline surveys (i.e., yellow birch stands for blue felt lichen).	C	AB, PIL	VBWEP	2
62	TE	Damage to vegetation due to soil or water contamination by	Vehicles, heavy equipment, and machinery will be properly maintained and regularly inspected to reduce the risk of fluid leaks.	C, O, D	ALL	WEGH2, VBWEP, HIW	1

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		oils, gasoline, grease, and other materials.					
63	TE	Herbicide use resulting in damage to ecological community.	The Project will refrain from using herbicides on the regrowth of the understory along the Project Interconnect Line and in any cleared areas within the Project Area.	C, O, D	AB, PIL	HIW	1
64	TE	Reduction in soil quality due to mixing of topsoil and subsoils.	Strip and store topsoil (where present) from temporary work areas separately from subsoils and maintain for reclamation use after construction.	C	AB	HIW	2
65	TE	Reduction in soil quality due to the release of contaminants.	Construction sites are to be kept tidy; waste and debris will be collected and stored in appropriate containers on-site and disposed of off-site to an approved facility.	ALL	ALL	WEGH2, VBWEP, HIW	1
66	TE, AqE, AtE	Reduction in soil and surface water quantity/quality from erosion, sedimentation and compaction.	A) Ensure erosion and sedimentation control measures are in good repair and properly functioning prior to conducting daily work. B) Repair erosion and sedimentation control measures as required prior to commencing daily construction activities. C) Construction sites will be routinely monitored to identify areas of potential erosion and the necessary erosion and sediment control measures will be implemented. D) Ensure roadway culverts are designed and installed to maintain existing drainage patterns. E) Grade disturbed/remediated slopes and soil stockpiles to compact the soil, reduce erosion, and prevent slope instability. F) Geotechnical field assessments shall be done to identify unstable conditions such as high erosion potential, slope instability, and rock fall hazards. G) To protect exposed and/or sensitive soil and to avoid compacting or hardening of natural ground surface, mobile construction equipment is to travel on designated vehicle access roads.	C, O, D	ALL	A) HIW, BLWPP B) HIW, BLWPP C) WEGH2, VBWEP, HIW D) VBWEP, HIW E) HIW F) WEGH2 G) HIW	1
67	SE	Lack of awareness of respectful workplace policies and health and safety policies.	Workforce training will be provided to address topics such as Pattern's Equity, Diversion and Inclusion Commitment statement and health and safety policies.	C, O, D	ALL	WEGH2	1
68	SE	Employees and contractors engaging in unsafe work practices.	Ensure all employees and contractors comply with workers' health and safety regulations.	C, O, D	ALL		1
69	SE	Employment opportunities and contracts are given to non-local residents resulting in a lack of community support for the project.	Work with the Province, educational and training institutions, Indigenous Peoples and stakeholders to identify skilled trade shortages relative to the Project, and to identify training needs and opportunities to contribute to a sustainable Project workforce. Hire locally/regionally as much as feasible to the extent that labour force with appropriate training and skills is available.	C, O, D	ALL	WEGH2	1
70	SE	Local communities not benefitting from increased economic activity in the region.	Procure goods and services locally/regionally or provincially as much as feasible to the extent that they are available.	C, O, D	ALL		1
71	SE	Community benefits not resulting in long-lasting, meaningful positive effects.	Create a Regional Community Benefits Program to ensure that benefits to municipalities and Local Service Districts in the region have a lasting effect.	C, O, D	ALL		2
72	SE	Influx of temporary workers causing strain on local health and social services.	Institute worker health and safety programs to promote the health, safety, and wellbeing of workers, to avoid or reduce use of local health and social services.	C	ALL		1
73	SE	Influx of temporary workers causing strain on local tourism infrastructure.	Include local cultural venues and events in sponsorship programs to help alleviate any effects due to lack of availability of tourist accommodations.	C	ALL		2
74	SE	Influx of temporary workers causing a strain on local transportation options.	Develop incentives to encourage worker carpooling and/or bussing options.	C	ALL		2
75	SE	Underrepresentation of women and minorities in Project workforce.	Institute policies and programs to facilitate the inclusion and success of women and other groups typically underrepresented in heavy industry, such as a gender equity and diversity plan for the Project. Inclusion of procurement and retention policies will be included in the plan.	C, O, D	ALL	WEGH2	1
76	SE	Town of Placentia unprepared to accommodate the Project in	A) Enter into a shared services agreement with the Town of Placentia. B) Work with the Town of Placentia to increase training and capacity in emergency response infrastructure	C, O, D	ALL	B) WEGH2	2

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		scope of municipal services for emergency response and water supply.	and services. C) Work with the Town of Placentia to ensure equitable allocation of community water supplies that can satisfy local needs.				
77	SE	Lack of engagement with the public and other stakeholders, which has the potential to delay the project.	A) Provide meaningful two-way engagement with the public. B) Ensure timely information sharing and responses. C) Tailor engagement efforts to meet the various interests and needs of stakeholders. D) Provide informed decision making based on feedback gathered.	C, O, D	ALL	A) WEGH2 B) WEGH2	2

NOTES
[1] AtE (Atmospheric Environment), AqE (Aquatic Environment), HCR (Heritage and Cultural Resources), HHQL (Human Health and Quality of Life), LRU (Land and Resource Use), TE (Terrestrial Environment), SE (Socio-economic Environment).
[2] C (Construction), O (Operations and Maintenance), D (Decommissioning and Rehabilitation), U (Unplanned Events), ALL (All Phases).
[3] AB (Argentia Backlands), AP (Argentia Peninsula), PIL (Project Interconnect Line), ALL (All Areas).
[4] WEGH2 (Port au Port-Stephenville Wind Power and Hydrogen Generation Project [Project Nujio'qonik GH2]), VBWEP (Voisey's Bay Wind Energy Project), HIW (Henvey Inlet Wind), BLWPP (Bear Lake Wind Power Project).
[5] Level of Effectiveness rated using a 1-3 range scale, where 1 = Regulatory requirement/standard condition; 2 = Industry Standard Practice; 3 = Customized to the Project/Location or is Innovative, Requires Effects Monitoring.