APPENDIX G
CONSEQUENCE IMPACT ASSESSMENT REPORT

Consequence Impact Assessment

Fuel Green Ammonia & Hydrogen Plant

H368078-0000-121-066-0001

2022-10-18	1	Approved for Use	Vic Esterhuizen	Michel Carreau,	Michel Carreau	Mark Savory
DATE	**REV.**	**STATUS**	**PREPARED BY**	**CHECKED BY**	**APPROVED BY**	**APPROVED BY**
					Hatch Project Manager	**Client Project Manager**

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Acronyms

The following acronyms in Table 0-1 were used in this Quantitative Risk Assessment (QRA) report to ensure a standard alliance between information documented in this report which is in accordance with international guidelines regarding the evaluation of fire and explosion risk assessments and other general acronyms.

Table 0-1: Acronyms used in this report

Acronym / Unit	Description
ALARP	As Low As Reasonably Practical
EPA	Environmental Protection Agency
ERPG	Emergency Response Planning Guidelines
DNV	Det Norske Veritas
BLEVE	Boiling liquid expanding vapour explosion
kW/m2	Kilowatt per square meter (used for heat radiation impact)
LFL	Lower Flammability Limit
LPG	Liquefied Petroleum Gas
SDS	Safety Data Sheet (SDS)
NFPA	National Fire Protection Association
OHSA	Occupational Health Safety Act
psi	Pounds per square inch (use for explosion blast impact)
PHA	Process Hazard Assessment
PLP	Project Life cycle Process
psi	Pounds per square inch
Phast	Process hazard assessment software tool
PRV	Pressure Relief Valve
PSV	Pressure Safety Valve
QRA	Quantitative Risk Assessment
SFPE	Society of Fire Protection Engineering
TNT	Tri Nitro Toluene
TNO	Toegepast Nederlandse Organisatie
UFL	Upper Flammability Limit
cVCE	Confined Vapour Cloud Explosions
uVCE	Unconfined Vapour Cloud Explosions
VBR	Volume Blockage Ratio (used to indicate the level of congestion of a confined structure)

1. Project Information

Hatch Ltd. (Hatch) was retained by EverWind Fuels ("EWF" or "the Client") to undertake a Phase I Environmental Site Assessment (ESA) as part of an independent assessment for the potential purchase of the NuStar Terminal site located in Point Tupper, Nova Scotia.

The property under study is approximately 1,400 acres in size, generally located along Industrial Park Road, Port Malcolm Road and Bear Island Road in Point Tupper, Nova Scotia (hereafter the "Phase I Property"), as illustrated in Figure 1-1. The Phase I Property was developed in the late 1960s for industrial use, specifically as a gas fractionation plant, storage and distribution terminals, and auxiliary operations.

The purpose of this report is to identify and document the potential consequence impact from identified worst case potential toxic and flammable hazard scenarios which could reasonably practically occur at the EverWind Fuel Green Ammonia & Hydrogen Plant.

The key objective for this report is to perform a consequence impact assessment and to evaluate if the proposed location of the ammonia (NH_3) and hydrogen (H_2), facilities are at safe separation distances from adjacent existing facilities and community.

Figure 1-2 and Figure 1-3 represents the initial proposed location for the hydrogen and ammonia plant, respectively. Figure 1-4 represents the latest proposed location for the hydrogen and ammonia plant.

Hatch will determine preliminary a safety perimeter around ammonia and hydrogen plant, inside which plant hazards are within acceptable tolerance. Hatch will propose mitigations where applicable to reduce major risks.

It is noted that the closest residential houses are at 4.8 km from the proposed ammonia and hydrogen facilities. However, the adjacent industrial facility is 763 m from the H_2 and 1051 m from the NH_3 plants.

We note that the safety perimeter around the ammonia and hydrogen plant remains the same even if the location of the plants is changed. This report presents the results in the context of the initial layout and discuss the result based on latest layout.

Figure 1-1: Proposed Location of the NH_3 and H_2 Facilities (Initial Layout)

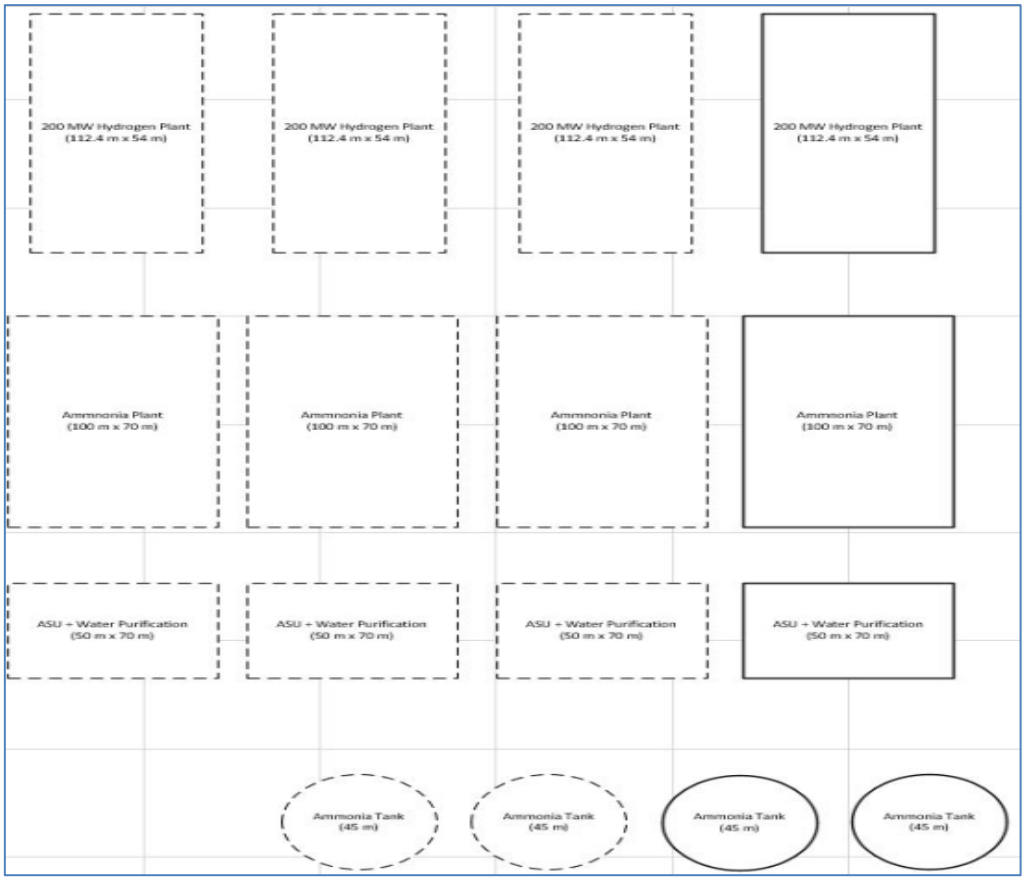


Figure 1-2: Typical Process Layout of the NH_3 and H_2 facilities

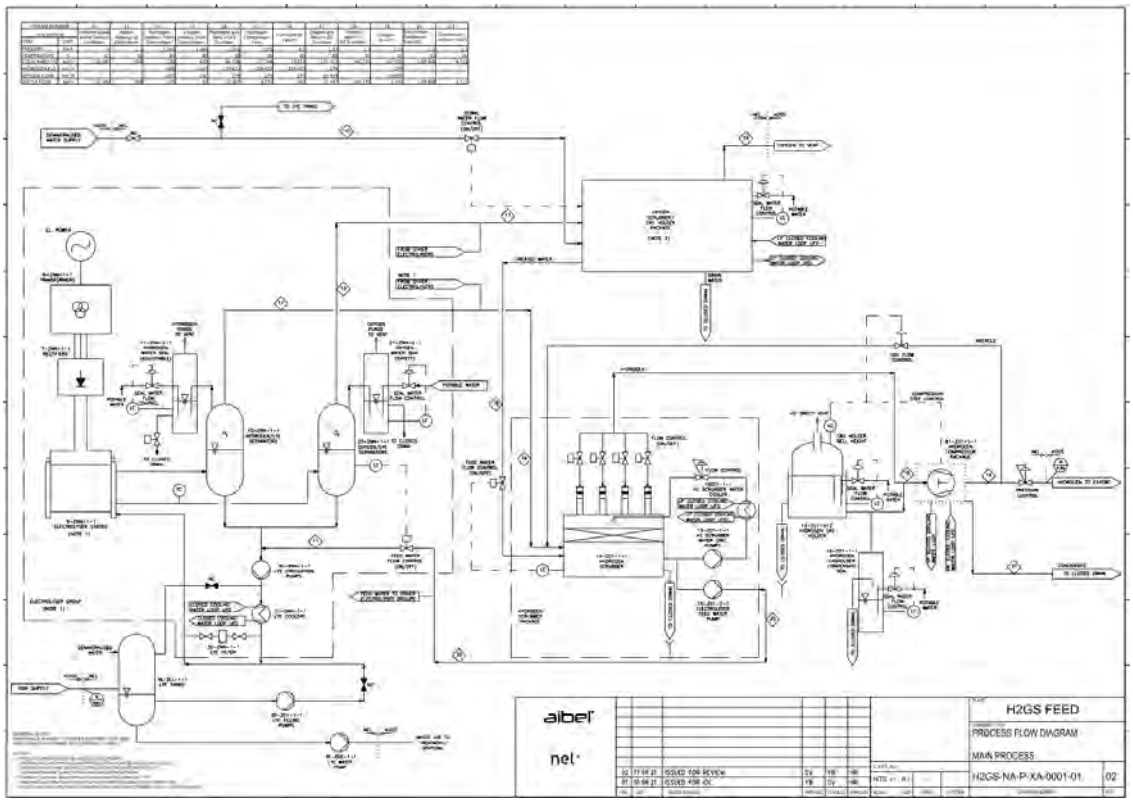


Figure 1-3: Typical Process Flow Diagram for H_2 Circuit

Figure 1-4: Latest Proposed Layout

2. Executive Summary

The consequence impact calculations were done using Phast 8.61 (Process Hazard Assessment Software Tool) developed by DNV to evaluate the impact for explosion and toxic scenarios related NH_3 and H_2 release events and to determine the hazard zones.

It is important to note that the focus of this report is a preliminary consequence impact assessment for identified worst case toxic and flammable hazard scenarios which could reasonably practically at the EverWind Fuel green ammonia and hydrogen plant. Extreme catastrophic event, with very low probability of occurrence, are not considered, as typically done for such analysis.

Note:

Given the current level of project development, additional study is required to determine the preferred ammonia loadout piping arrangement (i.e., two 28" pipelines, or one 36" pipeline), as discussed in Section 4.6.2 of Hatch's FEL1 report H368078-0000-100-066-0001, Rev. 0. For the purposes of the consequence and impact assessment, the loss of containment from a single 28", 1200 m, pipeline was considered for this assessment. If a 36" pipeline is deemed preferable as per further engineering study, an intermediate automated isolation valves may be implemented to minimize total ammonia release volume to be a similar quantity as for a 28" pipeline section.

The result of the report is preliminary based on the engineering developed at the time of this assessment. A new version of this report will be produced at the next engineering phase once the sizing of the major equipment and layout is fixed.

2.1 Explosion and Fire Hazards

An iterative approach was utilized by evaluating the consequential effects of a potential fire ball hazard and confined vapor cloud explosion (cVCE) as well as unconfined vapor cloud explosion (uVCE) events.

The TNO Multi-Energy methodology [1] was used to evaluate confined and/or unconfined vapour cloud explosion scenarios. TNO refers to “Toegepast Nederlandse Organisatie” or alternatively the Netherlands Organization for Applied Scientific Research, who established the TNO Multi-Energy methodology. The TNO Multi-Energy methodology covers the blast propagation, blast interaction, the confined volume structural response related to the release of flammable gas or ignition of flammable vapours. DNV GL Phast software was used to evaluate the dispersion and impact of gas explosions.

In terms of fire ball events an unignited release of hydrogen will form a flammable gas cloud and then eventually disperse until the gas concentration is below the lower flammable limit (LFL) and can no longer be ignited. The methodology used to estimate the radiant heat flux from a fire to a target in terms of a fireball includes the use DNV GL Phast software.

2.1.1 Consequence Impact (explosion events)

The explosion impact assessment was done for identified scenarios at the hydrogen facility listed in Table 6-1 which could lead to unconfined vapour cloud (uVCE) or confined vapour cloud (cVCE) explosion events. The explosion event which presented the greatest consequence impact is a cVCE at the hydrogen electrolyser stacks which result in that an overpressure of (2 kPa) could reach a distance of 450 m.

Sensitivity explosion impact calculations indicate that blast wave of 7 kPa could reached a distance of 147 m and an overpressure blast wave of 20 kPa could reach a distance of 61 m (refer to Appendix E).

With reference to Figure 1-1, the consequence aerial map view in Appendix E and the summary results in Table 6-1 the initial proposed hydrogen facility which is located at approximately 763 m from the existing industrial tank area will not pose an unacceptable explosion or fire risk exceeding 2 kPa .

With regards to Figure 1-4 which provide the aerial map view for the latest location of the H_2 facility which is approximately 600 m from the closest existing industrial facilities will not pose an unacceptable explosion or fire risk exceeding 2 kPa. However, although existing and new occupied buildings may be exposed to a blast wave of less than 2 kPa it is recommended to provide blast protection film on windows and the construction of the buildings need to withstand the blast wave. The closest existing industrial tank area is located outside the 65 m radius and thus potential domino impact events is not foreseen form the latest facility. location.

2.1.2 Consequence Impact (fire events)

Resources such as DNV and Lees indicate that a 10% cross sectional area opening on a pipeline is considered as large leaks. Thus, the fireball scenario which represent the greatest consequence impact is due to a possible large leak on the 1100 mm (43.3’’) hydrogen pipe header which is connected to the H_2 scrubber (refer to Table 6-2 and Appendix G).

NFPA 80A[2] along with data in Table 5.5.4.2 of NFPA 921[3] indicated that steel equipment or structures will not require protection when exposed to a thermal radiation level of 12.5 kW/m^2 or less and that a thermal radiation of 23 kW/m^2 is considered acceptable heat radiation level

[1] http://www.sciencedirect.com/science/article/pii/0304389485800224 and http://onlinelibrary.wiley.com/doi/10.1002/prs.680150211/full

[2] https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=80A

[3] https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=921

to steel structures provided cooling is applied within 15 minutes. With reference to Table 6-2, a thermal heat radiation of 37.5 kW/m^2 zone could reach 43 m and a thermal heat radiation of 12.5 kW/m^2 could reach 53 m.

Process plant administrative, service and occupied operational buildings indicated on the initial layout drawing Figure 1-1 and latest layout drawing Figure 1-4 are both located outside the 5 kW/m^2 thermal heat radiation zone from jet fire or fireball events. This implies that no changes to the process plant layout is required due to the impact from fire events which could occur at the proposed H_2 facility.

2.2 Toxic Hazards

The consequences of any release of toxic material are strongly dependent upon the rate at which the material is diluted and dispersed in the atmosphere to levels which can be considered safe concentrations. Liquid releases are heavily dependent on the surface area of the pool which could be formed inside the containment area.

In terms of a **liquid** release, the evaporation rate from the chemical pool will determine the toxic gas cloud volume and hazard zone or impact radius. In terms of a **vapour** release the leak/release rate from the vapour phase of a vessel or gas in in pipeline will determine the toxic gas cloud volume for estimating the hazard zone or impact radius.

For this project, DNV-GL Phast software was used to evaluate the consequence impact of toxic scenarios. Toxic impact assessments are evaluated in terms of the Emergency Response Planning Guidelines (ERPG) and according to the American Industrial Hygiene Association standards. The ERPG-2 exposure level (200 ppm for an ammonia cloud) is considered the maximum concentration level to which it is believed nearly all persons could be exposed for up to one hour without experiencing irreversible or serious health effects or symptoms that could influence an individual's ability to take protective action. This means a person will smell a strong NH_3 odour and experience some eye irritation, as well as symptoms that could influence an individual ability to take protective action, but he/she will recover from the health effects.

Further to the above the Emergency Planning Association (EPA) guidelines define that a weather condition "F" at 1.5 m/s wind speed as classified as a worst weather case and this wind speed and weather classification should be considered in all risk assessments.

2.2.1 Consequence Impact Ammonia release at Ship Vessel and NH_3 Tanks

The facility which poses the highest risk of an ammonia cloud is a potential release at the harbour during off-loading at the ship vessel.

The worst-case scenario considers loss of containment from a two-phase vessel where the release material is from the vapour side of the ship vessel through a 25 mm hole due to flange gasket opening. The storage pressure inside the ship vessel is 400 kPa.

The toxic exposure duration was considered 3600 seconds (one hour) to be able to isolate the leak. The vapour release flow rate through a 25mm opening at -33 0C and 4 kPa was estimated to be 9.23 kg/s. The ammonia cloud footprint in Appendix D indicate that an ERPG-2 value (200 ppm) under calm wind (1.5 m/s) weather classification "F" 1.5 m/s could reach a distance of 3371 m (refer to Table 6-3 for summary NH_3 results).

With reference to **initial** proposed site location Figure 1-1 and consequence aerial map Appendix A the existing industrial facilities which is located at approximatively 1051 m from the NH_3 storage tanks could be exposed to ERPG-1 and ERPG-2 risk level (scenario 3.1.1). and could be exposed to ERPG-3 from the ship vessel located at 610 m (scenario 3.1.4)

With reference to **latest** proposed site location to Figure 1-4 the existing industrial facilities which is now located at approximatively 600 m from the NH_3 storage tanks (scenario 3.1.1) and remains at 610 m from the ship vessel (scenario 3.1.3) resulting in that existing industrial facilities could be exposed to ERPG-1 , ERPG-2 and ERPG-3 risk levels.

The location of the ammonia pipeline route did not change (scenario3.1.2) and the results indicates that it does not pose a risk level of exceeding ERPG-2.

2.2.2 Consequence Impact Ammonia release harbor loading facility

The ammonia cloud footprint in Appendix C is related to a full-bore pipeline failure of one of the 508 mm (20”) off-loading arms at the harbour. The pipeline through the loading arm operates at a pressure of 400 kPa and gas flow temperature of -33 ^{0}C. The volume, which could be released through a gasket opening resulting in an equivalent hole size of 25 mm hole for a duration of 30 minutes, before isolation could be applied, was estimated to be $\pm$ 30.41 m^3. Phast modeling results for a calm wind (1.5 m/s) weather classification “F” indicate that an ERPG-2 value (200 ppm) could reach a distance of 361 m for this release event.

With reference to initial layout Figure 3-3, the toxic results Table 6-3 and the consequence aerial map Appendix C the existing industrial tank facilities which is located at 610 m from the initial proposed location of the vessel (ship) and ammonia off-loading arm could be exposed to ERPG-1 and ERPG-2 risk levels from a potential release during off-loading at the harbour.

With reference to Figure 1-4 the ammonia pipeline route location id not change, and location of the ammonia off-loading remains at 610 m from the existing infrastructure facilities resulting in that the risk exposure of existing facilities remain at ERPG-1, ERPG-2 and ERPG-3 risk levels due to a potential ammonia release event.

2.3 Discussion and Recommendations

Despite a best effort to investigate multiple potential scenarios as part of the consequence impact assessment, experience has demonstrated that the consequential outcomes of most industrial incidents have been difficult to accurately predict. It is important to bear in mind that a scenario different than the ones investigated herein might occur.

2.3.1 Explosion and Fire Impact

With regards to explosion scenarios, projectiles are typically part of explosion events and could significantly impact infrastructure or the integrity of process buildings which may compromise the safety of the personnel. The assessment of projectiles as well as the impact on personnel outside occupied buildings did not form part of this scope. Operational and maintenance personnel may be exposed to an explosion or fire event while working outside on the plant. These situations are considered to be occupational hazards, as workers are performing activities in a hazardous area. Non of the explosion or fire risk which could occur at the prosed NH_3 and H_2 facility will have an impact of concerns due to the safe separation distance between the facilities.

In order to minimise the consequence of potential explosion or fire events the following mitigations should be considered:

- Ensure that critical equipment is located outside the heat radiation of concern (e.g., electrical and instrument cables to be located outside the 12.5 kW/m^2 zone) or the provision of passive fire protection should be included in the design requirements.
- Ensure that the selection of pumps, motors, instrumentation, and other electrical components comply with the applicable electrical hazard zone, which will minimise the probability of ignition at the hydrogen plant.
- Ensure that the NH_3 tank are locate outside the 20 kPa explosion zone (not closer than 60 m) from the hydrogen plant to minimise secondary risks and domino events.

2.3.2 Toxic Impact

With regards to toxic ammonia scenarios, natural weather and wind conditions may differ from the generic values which was considered for this risk assessment.

In order to minimise the consequence of potential ammonia release the following mitigations should be considered:

- The activation for closure of the shut-off valve on the connection point of the NH_3 transfer gas pipeline feeding needs to be automated from a signal on pressure loss or leak detection, in order to minimise the volume of the gas cloud if a leak occurs.
- Update of existing infrastructure off-site emergency response plans to include the potential risk of an NH_3 cloud which could have an imapct on personnel.
- Compile an on-site and off-site emergency response plan for the EverWind Fuel Green Ammonia & Hydrogen Plant.

2.3.3 Conclusion

Operational and maintenance personnel may be exposed to an ammonia cloud or hydrogen explosion or fire event during normal activities while working on the plant. These situations are considered to be occupational hazards as workers are performing activities in a hazardous area and need to be trained accordingly. In terms of a frequency of events, the proposed NH_3 and H_2 facilities should apply maintenance strategies, integrity evaluations and safe operation procedures to minimize and maintain a very low probability of loss of containment of an ammonia release or ignition of flammable gas clouds.

Further to the above it is recommended that the project team assist the client with the establishment or update of the emergency procedures, which needs to include the potential hazards of an NH_3 or Hydrogen release events. This emergency procedure must support the operational requirements in terms of an on-site and off-site actions which should be communicated to the local municipality who is responsible for the effective execution of the emergency response plan.

For future expansion, the location of operational buildings (facilities that reasonably require that personnel need to be in the hazard zone to conduct their normal duties) should be located at a safe separation distance of at least 150 m from the hydrogen facility to ensure they are outside the 7kPa blast zone.

- End Executive Summary -

3. Hazard Identification and Screening

A self-assessment methodology was used to identify and screen process risks which could result in a hydrogen gas explosion event and/or toxic event due to a release of ammonia.

The project is currently in the feasibility phase and based on preliminary data the following hydrogen and ammonia release events were considered relevant for this risk assessment.

3.1 Toxic Hazard Screening (Ammonia)

Toxic impact assessments are evaluated in terms of the Emergency Response Planning Guidelines (ERPG) and according to the American Industrial Hygiene Association standards.

According to the Emergency Response Planning Guidelines, the ERPG-1 level for ammonia is 25 ppm to 200 ppm. This level represents the maximum concentration level to which it is believed nearly all persons could be exposed for up to one hour without other than mild, transient adverse health effects or without perceiving a clearly defined odour. This means there may be some odour and a person could smell the release, but only mild, transient health effects will occur with no significant irritation to the human body.

The ERPG-2 level for ammonia is 200 ppm to 1000 ppm, which represents, the maximum concentration level to which it is believed nearly all persons could be exposed for up to one hour without experiencing irreversible or serious health effects or symptoms. This means a person will smell a strong odour and experience some eye irritation, as well as symptoms that could influence an individual ability to take protective action due to dizziness effects, but he/she will recover from the health effects.

The ERPG-3 level for Ammonia is greater than 1000 ppm and represents, the exposure level to which it is believed nearly all persons could be exposed to for up to one hour without experiencing or developing life-threatening health effects. This means a person will smell a very strong odour and experience serious eye irritation. The person will definitely not have the ability to take protective action as well as permanent health effects could occur, but he/she should not die due to the health effects.

3.1.1 Scenario 1 (NH_3 storage tank)

The ammonia storage tanks are single wall (carbon steel) with outer pre-pressed concrete wall to act as secondary containment and the design criteria ensure compliance to API 650. The ammonia is refrigerated at an operating temperature of -33^0 C and stored liquified into tanks. The largest storage tank has an internal diameter of 45 m and a height of 36 m to accommodate 51,573 m^3 at an average operating pressure below 4 kPa. Figure 3-1 provide a typical view of ammonia tank installations.

The most likely loss of containment event for Scenario 1 is considered to be from a two-phase vessel where the released material is from the vapour side through a 25 mm opening due to a flange gasket failure or the opening of the relief valve. Although the pressure relief valve discharge operates at a maximum set pressure of 15 kPa, the storage operating pressure is below 4 kPa.

The leak duration was considered a 10 minutes before auto reset of the relief valve or to stop the leak. The release flow rate through a 25 mm opening at -33 ^{0}C and 4 kPa was estimated to be 6.064 kg/s. Thus in 10 minutes (600 seconds) the total NH_3 vapour cloud mass would be **3638.40 kg.**

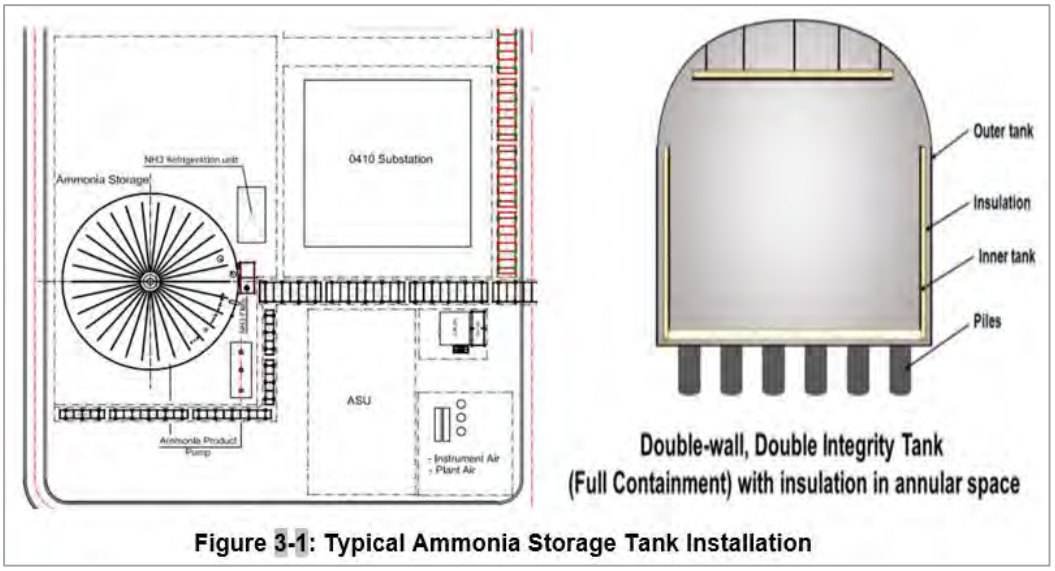


Figure 3-1: Typical Ammonia Storage Tank Installation

Figure 3-1: Typical Ammonia Storage Tank Installation

3.1.2 Scenario 2 (NH_3 transfer pipeline leak)

As stated in the executive summary this consequence assessment was done for a 28" ammonia transfer line. The ammonia is pipelined from the ammonia tanks, near the ammonia plant to the offload facility at the harbour via a 711.2 mm (28") pipeline. The pipeline is located at 0.5 m elevation above grade and is shown as a green line in Figure 3-3 which takes a route along the coastline and main public road till the interconnecting pipe racks of the hydrogen and ammonia storage facilities at the process plant. The separation distance between existing infrastructure tank facility with regards to the initial layout (Figure 3-3) and latest layout (Figure 1-4) of the ammonia pipeline route remains at +- 512 m.

The ammonia is pumped from each of the two storage tanks at a flow rate of 1,700,000 kg/h to the harbour at –33 ^{0}C and 400 kPa. For this risk assessment the release scenario will be based on loss of containment which will lead to liquid pool outside the pipe from where an NH_3 cloud will be formed.

The facility consists of two (2) NH_3 tanks and feed from the port is provided by two (2) independent pipelines. Each of the ammonia pipelines has a diameter of 711.2 mm (28") and a design basis assumption is that auto shut-off valves can stop the feed in the event of loss of containment. The assumption also consider that the isolation valves are spaced at approximately 1.2 km (distance between main isolation valves).

The worst-case loss of containment event (Scenario 2) is related to a catastrophic pipeline failure of 711.2 mm (28") diameter (above ground event) which may result in a potential **liquid** NH_3 **pool** with a release volume equivalent to the volume between the auto shut-off valves from **one pipeline** namely 476.71 m^3.

Assumption is that the auto shut-off valves can stop the feed within 60 seconds in the event of loss of containment and that the liquid pool will fully evaporate within this period.

The ammonia cloud mass which could be formed from this liquid release (pool) at an evaporation rate (airborne quantity) of 89.77 kg/s using the formulae in Figure 3-2 below was estimated as 60*89.77 = **5386.21 kg**

$$\text{Airborne Quantity (AQ)} = 4.751 \times 10^{-6}\, D^2\, P_a \sqrt{\frac{MW}{T+273}}$$

where

P_a = absolute pressure = (P_g + 101.35)

P_g = gauge pressure (kPa gauge)

MW = molecular weight of the material

T = temperature (°C)

D = diameter of the hole (millimeters)

Figure 3-2: Estimation of Airborne Quantity (kg/s) from a liquid release

Figure 3-3: Ammonia pipeline route "green" line to the Process Plant

3.1.3 Scenario 3 (NH_3 leak from the ship loading arm at harbor)

The ammonia is off-loaded at a pressure of 400 kPa and the transfer temperature to the process facilities as well as the storage temperature of the ammonia in the ship (vessel) is at -33^{0}C. Assumed 4 loading arms of 20'' each with a length of 150 m.

Scenario 3 considers an ammonia release at the harbour due to failure of the 505 mm (20") diameter loading arm at harbour. The loading arm is connected to a ship (vessel) which contains 50,000 tonnes and the release duration is 30 minutes to isolate the loading arm leak.

The liquid release volume is estimated using the cross-sectional area of 0.2027 m^2 and multiply it with the pipe length of 150 m (section between isolation valves) which result in a potential ammonia **liquid pool** of 30,41 m^3. Assumption is that leak will be isolated within 30 minutes in the event of loss of containment and that the liquid pool will fully evaporate within this period.

Using the airborne quantity formulae listed in Figure 3-2 the ammonia cloud mass which could be formed from this liquid pool at an evaporation rate of 35.51 kg/s is then estimated as 1800*35.51 = **63918 kg.**

3.1.4 Scenario 4 (NH_3 leak from the ship vessel at harbor)

The ammonia in the ship vessel is stored at a pressure of 400 kPa at -33^{0}C. Scenario 4 is very similar to Scenario 1, where the loss of containment is considered to be from a two-phase vessel where the released material is from the vapour side of the ship storage compartment through a 25 mm opening due to a flange gasket failure.

The difference is that the storage pressure of the NH_3 in the ship vessel is at 400 kPa and the leak duration was considered a 60 minutes before isolation of such a leak.

Under these storage conditions the release flow rate through a 25 mm opening at -33 ^{0}C and 400 kPa was estimated to be 9.23 kg/s. Thus in 3600 seconds the total NH_3 vapour cloud mass would be 9.23 * 3600 = **33,228 kg.**

3.2 Fire and Explosion Hazard Screening (Hydrogen)

The hydrogen is produced by the electrolyser modules at a rate of 4,446 kg/h at 100 kPa. It is then compressed at 150 MPa to feed into ammonia process. A hydrogen buffer storage will store 16000 kg of hydrogen at 150 MPa in 100 kg (16 tubes).

The scope is limited to potential loss of containment events to assess the fire thermal radiation and explosion and their consequences associated with potential fire and explosion events caused by a release of hydrogen.

Note: A building and/or equipment integrity review, a fire code review and a probabilistic assessment of the event likelihood for the scenarios considered in this assessment is not part of this scope of work, and should be pursued in subsequent phases of the project.

Qualitative judgement has been used to predict the potential nature of the fire and explosion scenarios based on the operating conditions and external environment (that is extent of congestion / confinement) into which the gas is released.

A release of flammable product (such as hydrogen) will be subjected to stoichiometric mixing, which implies that the approximate mid-range between the Lower Flammable Limit (LFL) and the Upper Flammable Limit (UFL) will be attained.

This stoichiometric mixing gives an indication of the actual mass of the vapour cloud that could be physically involved in a cVCE or uVCE.

The scenarios that were considered to provide the most probable loss of containment events at the hydrogen facility are the following:

- Explosion event due to a connection leak at electrolyser stack
- Explosion event due to a connection leak within the hydrogen compressor enclosure (on the high-pressure discharge line).
- Fireball event due to a connection leak on a hydrogen main manifold

The hazard scenarios presented above have been assessed using the TNO Multi-Energy, fireball and jet fire methods in the DNV GL's Phast consequence modelling software. The following input parameters were used for the consequence modelling:

- Flame speed of hydrogen gas 312 cm/s

- Heat of combustion (LHV) hydrogen gas 119.94 MJ/kg
- Windspeed and Pasquil stability: 1.5 m/s F and 5 m/s D;
  - A low windspeed and stable Pasquil stability category (1.5F) typically results in 'worst case' dispersion modelling results, that is longer hazard distances to the lower flammable limit (LFL) because there is less atmospheric air movement to assist with dilution and dispersion of the gas cloud
  - A higher windspeed and more neutral Pasquil stability (5D) typically results in short dispersion distances due to the increased atmospheric turbulence but also results in increased jet flame lengths as the wind acts to elongate the flame. This in turn results in longer hazard ranges to the specified thermal radiation levels.

DNV Phast software manual require the specification of the wind speed and atmospheric stability and provide the following meteorological Pasquill guidance (refer to Figure 3-4).

For this risk assessment the Pasquill classes 1.5D (neutral day/night low wind); 1.5 F (calm night low wind) and 5D (neutral day/night high wind) was selected for the sensitivity analysis of our results.

STABILITY CATEGORIES					
Surface Wind Speed at 10 m (m sec^{-1})	Day			Night	
	Incoming Solar Radiation			Thinly overcast or $\geq$ $^3/_8$ Low Cloud	$\leq$ $^3/_8$ Cloud
	Strong	Moderate	Slight		
< 2	A	A – B	B	D	D
2 – 3	A – B	B	C	E	F
3 – 5	B	B – C	C	D	E
5 – 6	C	C – D	D	D	D
> 6	D	D	D	D	D
Note: Neutral class D should be assumed for overcast conditions during day or night.					

Figure 3-4: Key to Stability Categories (Pasquill-Turner)

The above Pasquill atmospheric stability categories are used to describe the stability of the lower layers of the atmosphere and thus allowing their use in estimating the dispersion of released material.

- **Unstable Atmospheres** (Stability classes A, B, C) are a combination of convective effects and mechanical mixing, it is characteristic of a churning or very turbulent environment and is generally associated with daytime, warm almost cloudless or clear sunny day with light winds.
- **Neutral Atmospheres** (Stability Class D) are dominated by mechanical turbulence where the convective effects and the earth's radiation is suppressed by an overcast cloud layer. These conditions can exist during the day or night and occur in cloudy conditions or where there is a strong wind to cause the mechanical mixing in the lower atmosphere.
- **Stable Atmospheres** (Stability classes E, F, G) are characterised by an absence of convection conditions and low wind speeds near the surface. They are generally associated with clear, calm nights where there is a cooling of the ground and the lower layers of the atmosphere.

3.2.1 Scenario 5 (Hydrogen electrolyser stack)

Although one floor level of the hydrogen building is 111.4 m (length), 53.7 m (width) and 11 m height which leads to a total internal floor volume of 65,804 m3 the fire/explosion scenario considers ignition of the hydrogen cloud which could be formed, around the electrolyser stack at any one of the floor levels while it is within the flammable (worst case) concentration in air (refer to Figure 3-5). The fuel-air equivalence ratio is defined as the ratio between the actual fuel-air mixture and the stoichiometric fuel-air mixture.

Further to the above the TNO-Multi Energy methodology include the estimation of the volume blockage ratio (VBR) of a confinement area. This refers to the available openings in a structure or confinement area/room around the leak point which could be filled with flammable gas.

Typically, the VBR value for high dense structures/buildings is considered >75% objects; medium dense structures/buildings is considered to have 35%-75% objects and for low dense structures/buildings <35% objects

The structure around the electrolyser module contains piping, valves and other equipment, thus it is assumed that if a gas leak would occur at the electrolyser stacks the confinement is considered a volume of 38.5 m X 12 m X 9 m (4158 m^3). The congestion is assumed to be medium dense with a VBR value of 55% (refer to Figure 3-5 and Figure 3-6) result in an estimated cloud volume of 1871 m^3

Using the gas law principals, the calculated vapour density of hydrogen gas mixture in air indicates an estimated value of 0.082 kg/m^3 at a H_2 gas release temperature of 25º C and atmospheric pressure of 101.32 kPa, the cloud mass using a volume of 1871 m^3 is then estimated as **154.27 kg** which was used to used for the TNO Multi-Energy explosion calculation.

The explosion event at the electrolyser based on the confinement structure is considered a **two-dimensional** confined vapour cloud explosion, which implies that the blast wave can expand into two directions direction, namely to the east and west walls. The flame speed of hydrogen is 312 cm/s and for a semi confined two-dimensional confined vapour cloud explosion (cVCE) event, an explosion blast **curve 6** was used for the TNO Multi-Energy explosion calculation.

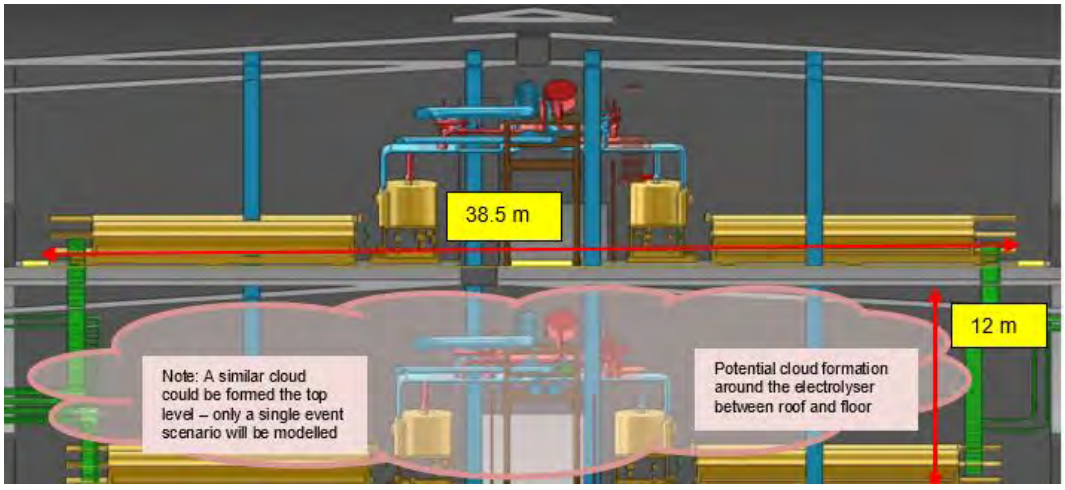


Figure 3-5: Model view of the Electrolyser Module 1st and 2nd floor elevations

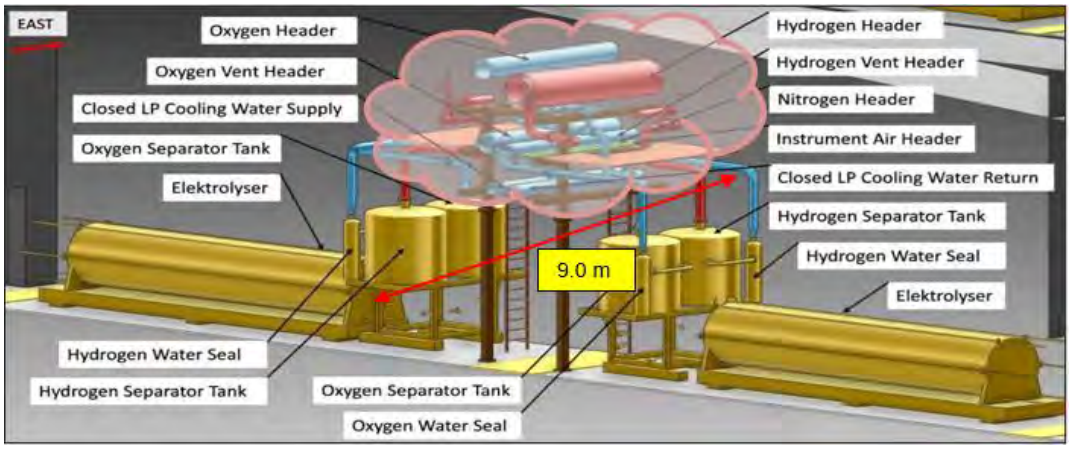


Figure 3-6: Model view of the Electrolyser Module

3.2.2 Scenario 6 (Hydrogen compressor enclosure)

In this scenario, the hydrogen compressor is also located inside the production building. The compressor will be fitted with strategic gas detection monitoring and shut-off valves (ESD) at the compressor suction and discharge lines that will close upon gas detection at 25% of the hydrogen LFL. This assumption means that enough dilution air must be used to always maintain a concentration of **less than 25%** of the LFL, according to the National Fire Protection Association standard NFPA 68[4]

The flammable mass of the confined vapor cloud for this scenario was estimated as the mass released due to a loose fitting and the gas is escaping resulting in the formation of a flammable cloud around the compressor enclosure. The volume of the confined vapour cloud is calculated using dimensions from preliminary design data of the compressor enclosure (refer to Figure 3-7). Based on this preliminary design data, the enclosure dimensions have been considered as follows for this evaluation:

- Height (H) = 14 m; Width (W) = 14 m and Length (L) = 6 m
- Cloud Volume (V) is estimated (H*L*W) = **1,176 m^3**

The structure around the hydrogen compressor is considered low dense, resulting in a volume blockage ratio (VBR) of 10%. This leads to a calculated TNO hydrogen cloud volume of 1058 m^3. As a result, the mass of hydrogen considered to contribute to the two-dimensional confined vapour cloud explosion is estimated as **87.26 kg** using a release temperature of 25˚C and atmospheric pressure of 101.32 kPa**.**

For this scenario, since the vapour cloud is confined to the compressor enclosure it is considered to fall under a two-Dimensional blast wave and hydrogen has a flame speed of 312 cm/s. Therefore, based on Baker- Strehlow methodology, the overpressure blast curve results in the selection of a confined cVCE blast strength of **6** for this application.

[4] https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=68

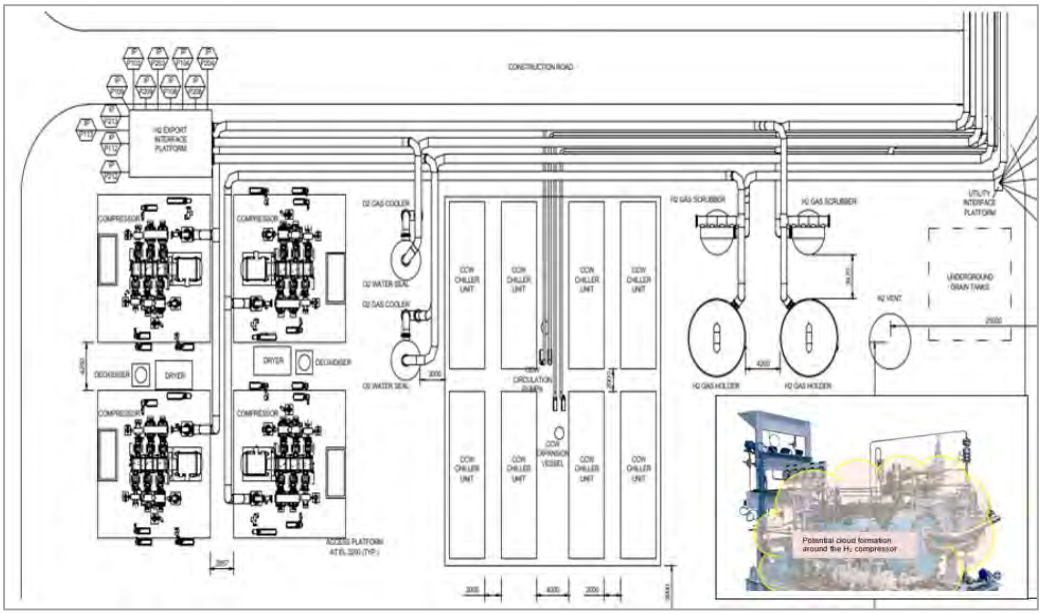


Figure 3-7: H_2 Building which contains 4 compressors

3.2.3 Scenario 7 (Hydrogen fireball main header leak)

Although the hydrogen product delivery line (main header) will be protected by a PSV with its discharge directed to vent system the possibility of a leak due to overpressure result in a gasket, flange or valve opening could occur.

Industrial guidance state that in for cases where no shutoff valves are installed the release duration should be assumed 30 minutes to make provision for repairs or leak sealing. For cases where emergency shutoff valves without automatic detection and activation is installed on equipment, the release duration can be taken as 10 minutes and for cases where emergency shutoff valves with automatic detection and activation is installed on equipment, the release duration may be taken as 5 minutes.

For this risk assessment and to evaluate a worst credible case scenario the release duration was taken as 30 minutes. The main H_2 header feeding the gas scrubber is a 1100 mm (43.3')' line size. Industrial guidance assumed for pipes greater than 101 mm (4") in diameter that 10% of all flange leaks contribute to leaks in the range of 0-50 mm (for instance 25 mm holes), with the remaining 90% being attributed to the 0-10 mm range (for instance 5 mm holes). The pressure in the header is 103 kPa and assume a large leak of 25 mm due to a gasket or coupling failure.

The methodology used to estimate the radiant heat flux from a fire to a target in terms of a fireball include research data and formulas from J. R. Lawson and J. G. Quintiere "Slide- Rule Estimates of Fire Growth, NBSIR 85-3196" [5], Norwegian Fire Research Laboratory "Handbook for Fire Calculations, Fire Risk Assessment in the Process Industry" [6] and General Approach to Thermal Radiation Modelling Section 2.2 (Shokri & Beyler) [7]

5 https://www.govinfo.gov/content/pkg/GOVPUB-C13-0b00c7eb528589feec8e598fa086f76c/pdf/GOVPUB-C13-0b00c7eb528589feec8e598fa086f76c.pdf

6 https://archive.org/details/SINTEF2003HandbookForFireCalculationsAndFireRiskAssessmentInTheProcessIndustry

7 https://ir.canterbury.ac.nz/bitstream/handle/10092/4959/thesis_fulltext.pdf?sequence=1

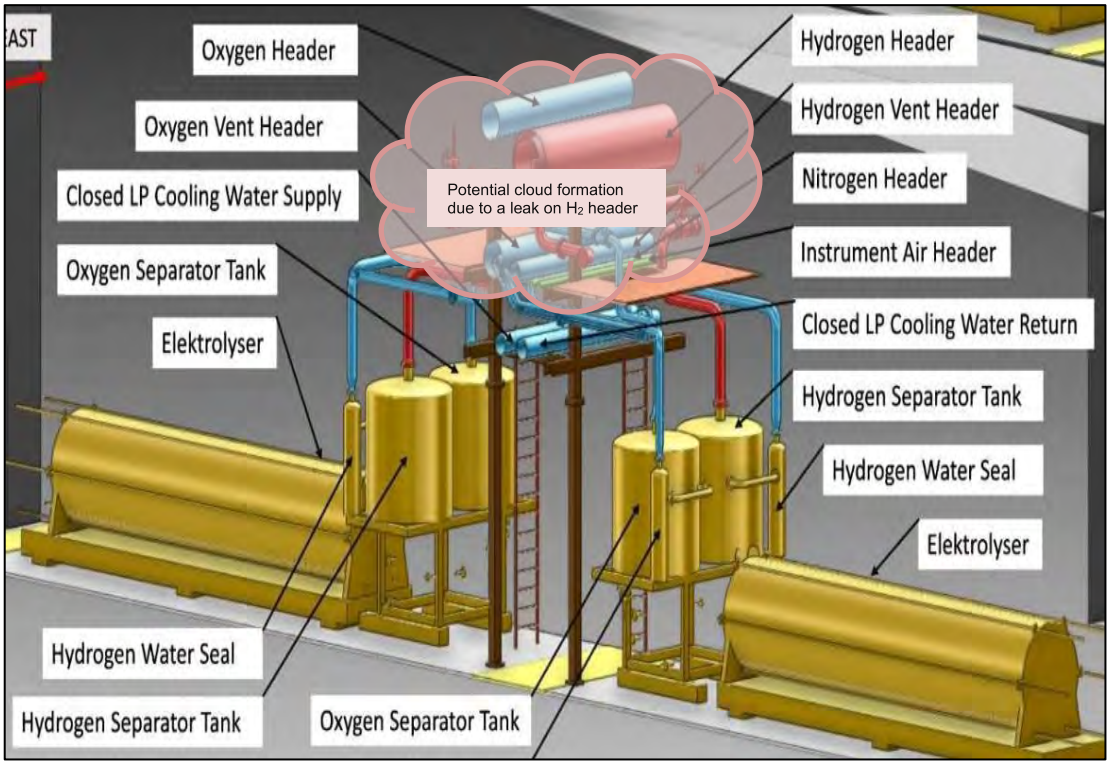


Figure 3-8: Hydrogen Header Vapour Cloud Illustration

3.2.4 Scenario 8 (Compressed Hydrogen Storage)

This scenario did not form part of the initial consequence impact assessment when Phast modeling was done. The scenario is based on a potential release event which could occur at the hydrogen compression and storage unit.

Figure 3-9 provide a typical view of a hydrogen compression and storage unit.

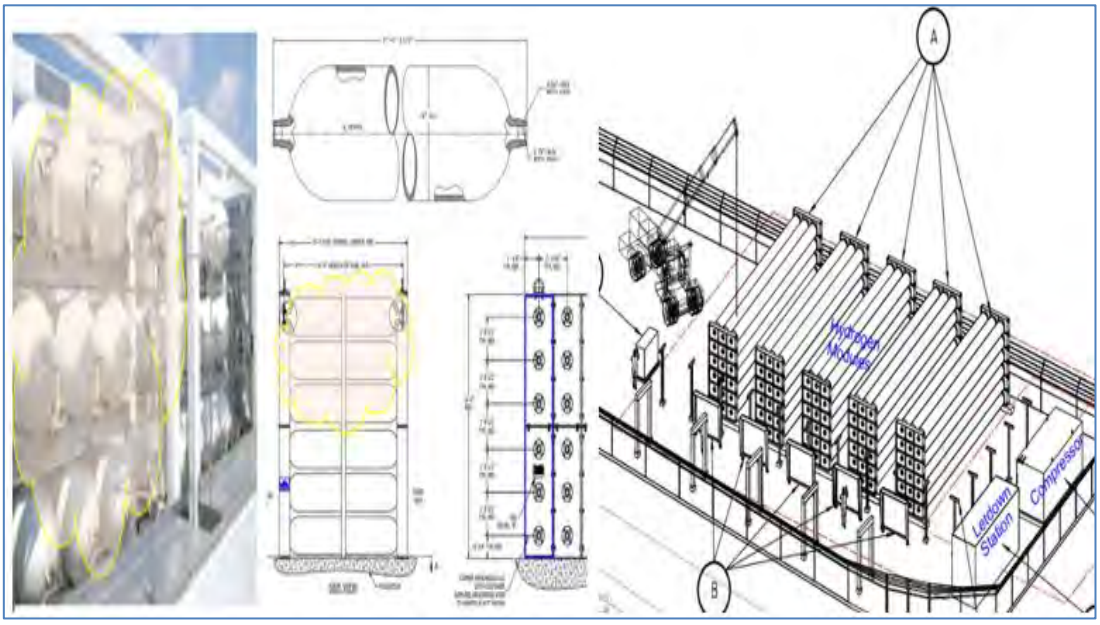


Figure 3-9: Typical Hydrogen Compression & Storage Facility

The preliminary high level consequence impact considering the installing of a compressor operating between 700 kPa to 23000 kPa with four tons of H_2 compressed hydrogen cylinders.

A wide variety of types of explosions may occur which includes unconfined explosions (overpressure generated by presence of obstacles), confined explosions (overpressure generated through a combination of confinement and obstacles), external explosions (a phenomenon associated with confined, vented explosions), internal explosions (e.g., within a flare stack), physical explosions (e.g., a failing pressure vessel) and BLEVEs.

Based on Hatch experience on similar projects, unconfined vapour cloud (uVCE) modeling work was done for a potential vapour cloud which could be formed in front of the hydrogen storage modules when H_2 gas escape through a typical 2 ¾”-8UN thread with O-ring seal with an adapter plug equivalent to 9/16” MP cone and threaded fitting on the tank nozzle. The leak is considering a "hole" size large enough approximately 10% of the cross-sectional area of the interconnection piping between the modules.

Further to the above, it also assumes that all the mass is evacuated from one tank (over time) as the design and construction of these facilities does not includes any isolation facilities to stop the leak (no ESD valves).

Considering that the above scenario case as a preliminary event which could occur at the EverWind Fuels facility an unconfined vapour cloud explosion (uVCE), assuming a release of 169 kg hydrogen could occur an overpressure blast wave of 2 kPa could reached 157 m and 7 kPa could reach 45 m in approximatively less than 30 minutes.

4. Overpressure Criteria

Table 23.14.4.1.5(b), “Property Damage Criteria”, from NFPA 921 [8] has been reproduced below as Table 4-1 and was used to provide guidance for property damage from explosions which could occur inside the hydrogen (production) building. In particular, those items shown in bold in represent the overpressure threshold categories that were established for each of the scenarios analyzed.

Based on information in Table 4-1, the following are important considerations with respect to limiting thresholds for this study:

- A blast force of 2.07 kPa is the threshold pressure at which a very high likelihood that no serious damage beyond this value would is expected to occur. Although this blast force relates to missile limits, some damage might occur to building ceilings and that window glass might be damaged; and
- An explosion force of 20.70 kPa could result in a steel frame building distorted and pulled away from foundations. This value is used for the acceptable overpressure limit for the location of nearby critical fixed plant and surface infrastructure.

8 NFPA 921: Guide for Fire and Explosion Investigations

Table 4-1: Property Damage Criteria (NFPA 921)

Overpressure		Possible Damage Description
(psi)	(kPa)	
0.03	0.21	Occasional breaking of large glass windows already under strain 100% ear damage to persons outdoors
0.04	0.28	Loud noise (143 dB). Sonic boom glass failure
0.15	1.04	Typical pressure for glass failure. 50% ear damage (persons indoors)
0.30	**2.07**	**Safe distance for location of non brick buildings (probability 0.95 no severe damage beyond this value to building constructed from brick) Missile limit.**
0.67	4.62	Minor damage to building structures. Safe separation distance for location of buildings constructed from brick.
1.02	**7.00**	**Partial demolition of houses, made uninhabitable**
1.30	9.00	Steel frame of clad building slightly distorted.
1.5	10.40	Internal walls and roofs of brick buildings blown in. Danger of projectile objects. Steel frame of cladded building distorted.
2.0 to 3.0	**13.80 to 20.70**	**Shattering of non-reinforced concrete or cinder block wall panels** **Heavy machines (large pumps/motors) moved from locations.**
2.30	15.90	Lower limit of serious structural damage
2.50	17.30	50% destruction of un-reinforced buildings. 70% ear damage to persons indoors.
3.00	**20.70**	**Steel frame building distorted and pulled away from foundations.** **Damage to vessels and process piping.**
3.00 – 4.10	20.70 to 28.30	Collapse of self-framing steel panel buildings. Cladding of light industrial buildings ruptured. Rupture of oil storage tanks.
4.80	33.10	Failure of reinforced concrete structures.
5.00	**34.50**	**Near destruction of reinforced buildings.**
5.5 – 7.00	**34.50 to 48.30**	**Total destruction of reinforced buildings (collapsing).** **Heavy process equipment (drums, vessels, columns, etc.) moved from locations**
7.00	48.3	Loaded rail wagons overturned.
7.00 – 8.00	48.30 to 55.20	Shearing/flexure failure of brick wall panels [20.3 cm to 30.5 cm thick, not reinforced]; Sides of steel frame buildings blown in.
9.00	62.10	Loaded rail wagons completely demolished
10.00	**69.00**	**Probable total destruction of reinforced buildings and process equipment.**
30.00	206.90	Steel towers blown down.
88.00	606.80	Crater damage.

5. Fire Heat Radiation Criteria

API 521 and NFPA 80A, along with data in Table 5.5.4.2 of NFPA 921, have been consolidated and presented in Table 5-1 below, which describes the effect of radiation heat flux on buildings, structures, plant equipment and humans.

Where an applicable scenario has been identified in this study (i.e., fireball), Table 5-1 will be used as guidance to determine if an incident involving the release of heat radiation due to a leak on the main hydrogen header has a significant effect on the location of the process plant and personal in the surrounding (existing) plant areas.

Table 5-1: Effect of Radiant Heat Flux

Radiant Heat Flux kW/m^2	Comment or Observed Effect
1.2	Received from the sun at noon in summer
2.5	Human skin experiences pain with 33 seconds exposure and blisters in 79 seconds with second-degree burn injury.
5	Human skin experiences pain with 13 seconds exposure and blisters in 29 seconds with second-degree burn injury
12.5	30 % Chance of a fatality for long exposure. Piloted ignition of wood. Melting of electrical cabling and plastic tubing. Generally steel equipment will not require protection when exposed to a heat radiation level of 12.5 kW/m^2 or less. At this radiation level the unprotected metal temperature stabilizes at about 300^{o}C
15	Human skin experiences pain with 3 seconds exposure and blisters in 6 seconds with second-degree burn injury
23	100 % Chance of fatality for long exposure to people and 10 % chance of fatality for instantaneous exposure. Pressure vessels need to be relieved, or failure would occur. Acceptable heat radiation level to steel structures provided cooling is applied within 15 minutes
37.5	Unprotected steel equipment will quickly exceed the critical metal temperature (just above 400^{o}C), which could result in the equipment losing its mechanical integrity and causing escalation of the fire event.
60	100 % Chance of fatality for instantaneous exposure
80	Thermal Protective Performance (TPP) test for protective clothing
170	Maximum heat flux as currently measured in a post flashover fire compartment

6. Consequence Analysis

6.1 Explosion and Fire events

It should be noted that the consequence analysis results listed in Table 6-1 and Appendix E, Appendix F and Appendix G are considered to be the base case results for an internal explosion event inside the hydrogen (production) building.

Despite the best effort to investigate potential gas cloud formation scenarios as part of this consequence impact assessment, experience has demonstrated that most industrial incidents have been difficult to accurately predict the impact and it is important to bear in mind that a scenario different than the one investigated herein might occur.

Moreover, projectiles are typical in explosion events and could significantly impact adjacent facilities or equipment integrity and compromise the safety of personnel; this was excluded from the scope of this consequence impact assessment.

Table 6-1: TNO-Multi Energy Explosion (cVCE) – Overpressure Results

Reference	Scenario Description	Distance Downwind to Defined Overpressure		
		(2 kPa)	(7 kPa)	(20 kPa)
Scenario 5 - Appendix E: Hydrogen Electrolyser Stacks	Ignition of a H_2 gas cloud, which could from around the electrolyser stacks	450 m	147 m	61 m
Scenario 6 - Appendix F: Hydrogen Compressor	Ignition of a H_2 cloud around the compressor enclosure	385 m	126 m	52 m

The above results indicate that adjacent industrial tank area and infrastructure or buildings located within 610 m from the hydrogen plant is considered to be at a safe separation distance due to that the explosion impact from the Hydrogen plant will be less that 2 kPa.

However, potential domino impact events could occur inside the Hydrogen plant boundaries due to that infrastructure or equipment such as control rooms, ammonia tanks or silos which are located within 65 m from the hydrogen electrolyser stacks could be exposed to an overpressure of 20 kPa.
Table 6-2 provide the consequence impact results in terms of a fireball event due to a gas leak on the main hydrogen header which feed the H_2 scrubber.

Table 6-2: Jet fire and Fireball Impact Results

Hazard Scenario	Fireball Radius	Distance from Hydrogen release Point			
		2.5 kW/m^2	5 kW/m^2	12.5 kW/m^2	37.5 kW/m^2
Scenario 7 - Appendix G: Ignition of a gas cloud around the hydrogen header. The gas lead is considered a 25 mm leak on the main H_2 header line 1100 mm	19 m	118 m	84 m	53 m	28 m

The above results indicate that adjacent infrastructure, equipment, and buildings located within 610 m from the hydrogen plant could be not exposed to a thermal heat radiation exceeding 37.5 kW/m^2 which implies that the proposed location of the hydrogen (production) building is at a safe separation distance.

6.2 Toxic Ammonia release events

Toxic impact assessments are evaluated in terms of the Emergency Response Planning Guidelines (ERPG) according to the American Industrial Hygiene Association standards.

Table 6-3 provide the toxic consequence impact results in terms of an ammonia release at the process facility.

Table 6-3: Ammonia Consequence Hazard Zones

Hazard Scenario	Distance from Ammonia release Point (Weather 1.5 m/s Weather Classification F)		
	ERPG-1 (25 ppm)	ERPG-2 (200 ppm)	ERPG-3 (1000 ppm)
Scenario 1 - Appendix A: A 25 mm leak on the vapour side of the Ammonia Storage tank	9277 m	2793 m	774 m
Scenario 2 - Appendix B: A full bore 28" leak on the NH_3 transfer pipeline result in a liquid release	1053 m	162 m	89 m
Scenario 3 - Appendix C: A large leak 10% cross sectional failure of the 505 mm (20") diameter loading arm at harbour result in a liquid release	762 m	218 m	97 m
Scenario 4 - Appendix D: A 25 mm leak due to flange gasket opening or PSV opening is considered to be on the vapour side of the NH_3 storage compartment on the ship vessel	15922 m	3371 m	784 m

The above results indicate that adjacent infrastructure, equipment and buildings located within 3400 m from the ammonia off-loading facility at the harbour could be exposed to an ERPG-2 level (200 ppm).

7. Conclusions and Proposed Recommendations

Despite a best effort to investigate multiple potential scenarios as part of the consequence impact assessment, experience has demonstrated that the consequential outcomes of most industrial incidents have been difficult to accurately predict. It is important to bear in mind that a scenario different than the ones investigated herein might occur.

The result of the report is preliminary based on the engineering developed at the time of this assessment. A new version of this report will be produced at the next engineering phase once the sizing of the major equipment and layout is fixed.

7.1 Explosion and Fire Impact

With regards to explosion scenarios, projectiles are typically part of explosion events and could significantly impact infrastructure or the integrity of process buildings which may compromise the safety of the personnel. The assessment of projectiles as well as the impact on personnel outside occupied buildings did not form part of this scope. Operational and maintenance personnel may be exposed to an explosion or fire event while working outside on the plant. These situations are considered to be occupational hazards, as workers are performing activities in a hazardous area.

Non of the explosion or fire risk which could occur at the prosed NH_3 and H_2 facility will have an impact of concerns due to the safe separation distance between the facilities.

7.2 Toxic Impact

With regards to toxic ammonia scenarios, natural weather and wind conditions may differ from the generic values which was considered for this risk assessment.

Operational and maintenance personnel may be exposed to an ammonia cloud or hydrogen explosion or fire event during normal activities while working on the plant. These situations are considered to be occupational hazards as workers are performing activities in a hazardous area and need to be trained accordingly. In terms of a frequency of events, the proposed NH_3 and H_2 facilities should apply maintenance strategies, integrity evaluations and safe operation procedures to minimize and maintain a very low probability of loss of containment of an ammonia release or ignition of flammable gas clouds.

Further to the above it is recommended that the project team assist the client with the establishment or update of the emergency procedures, which needs to include the potential hazards of an NH_3 release event. This emergency procedure must support the operational requirements in terms of an on-site and off-site actions which should be communicated to the local municipality who is responsible for the effective execution of the emergency response plan.

For future expansion, the location of operational buildings (facilities that reasonably require that personnel need to be in the hazard zone to conduct their normal duties) should be located at a safe separation distance of at least 150 m from the hydrogen facility to ensure they are outside the 7 kPa blast zone.

In order to minimise the consequence of potential ammonia gas release the following mitigations should be considered:

- The activation for closure of the shut-off valve on the connection point of the NH_3 transfer gas pipeline feeding needs to be automated from a signal on pressure loss or leak detection, in order to minimise the volume of the gas cloud if a leak occurs.
- Ensure that critical equipment is located outside the heat radiation of concern (e.g., electrical and instrument cables to be located outside the 12.5 kW/m^2 zone) or the provision of passive fire protection should be included in the design requirements.
- Ensure that the selection of pumps, motors, instrumentation, and other electrical components comply with the applicable electrical hazard zone, which will minimise the probability of ignition at the hydrogen plant.
- Ensure that the NH_3 tank are locate outside the 20 kPa explosion zone (not closer than 60 m) from the hydrogen plant to minimise secondary risks and domino events.

Appendix A
Phast Modeling – Ammonia Storage Vessel

Consequence Summary Report - Workspace: PTGA Project

Study: Ammonia Storage Vessel

Discharge Results (after atmospheric expansion)

INPUT DATA

Volume in Storage Tank	**51573**	m^3
Initial temperature	**-33**	^0C
Initial pressure (gauge)	**4**	kPa
Hole diameter	**25**	mm

OUTPUT DATA

Mass flow rate (vapour release)	6.06394	kg/s

Distance downwind to defined concentrations

Scenario	Weather	Concentration of interest [ppm]	Distance downwind to concentration of interest [m]
Leak on NH3 Storage Tank *The scenario is from a two-phase vessel where the releases material is from the vapour side through a 25mm hole due to flange gasket or relief valve opening.*	Category 1.5/F *Stable atmosphere clear calm night with low wind conditions*	ERPG 1 - (25 ppm)	9277.02
	Category 1.5/D *Neutral atmosphere (day/night) with moderate winds and overcast conditions*	ERPG 1 - (25 ppm)	3273.53
	Category 5/D *Neutral atmosphere (day/night) with strong winds and overcast conditions*	ERPG 1 - (25 ppm)	2019.61

Distance downwind to defined concentrations

Scenario	Weather	Concentration of interest [ppm]	Distance downwind to concentration of interest [m]
Leak on NH3 Storage Tank *The scenario is from a two-phase vessel where the releases material is from the vapour side through a 25mm hole due to flange gasket or relief valve opening.*	Category 1.5/F *Stable atmosphere clear calm night with low wind conditions*	ERPG 2 - (200 ppm)	2793.15
	Category 1.5/D *Neutral atmosphere (day/night) with moderate winds and overcast conditions*	ERPG 2 - (200 ppm)	874.58
	Category 5/D *Neutral atmosphere (day/night) with strong winds and overcast conditions*	ERPG 2 - (200 ppm)	652.43

Distance downwind to defined concentrations

Scenario	Weather	Concentration of interest [ppm]	Distance downwind to concentration of interest [m]
Leak on NH3 Storage Tank *The scenario is from a two-phase vessel where the releases material is from the vapour side through a 25mm hole due to flange gasket or relief valve opening.*	Category 1.5/F *Stable atmosphere clear calm night with low wind conditions*	ERPG 3 - (1000 ppm)	773.07
	Category 1.5/D *Neutral atmosphere (day/night) with moderate winds and overcast conditions*	ERPG 3 - (1000 ppm)	323.68
	Category 5/D *Neutral atmosphere (day/night) with strong winds and overcast conditions*	ERPG 3 - (1000 ppm)	243.54

Aerial Map Overlay – NH_3 Storage Vessel

(1.5/D Neutral atmosphere day/night event)

Release of NH_3 from the vessel vapour side through a 25 mm hole

Note: The consequence impact from a vapour release will be higher under weather class "F" than weather class "D" due to at lower wind speeds the dispersion rate is less.

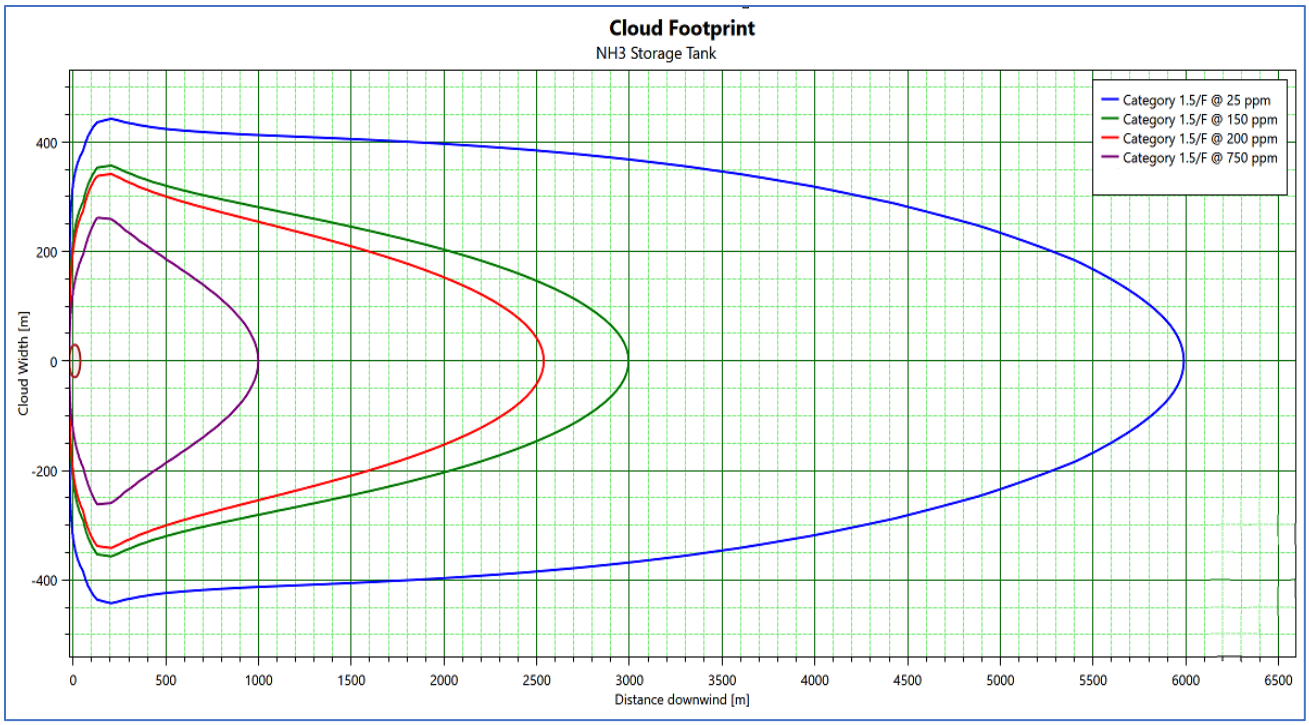
Aerial Map Overlay –NH_3 Storage Vessel

(1.5/F Stable atmosphere clear calm night with low wind conditions)

Release of NH_3 from the vessel vapour side through a 25mm hole

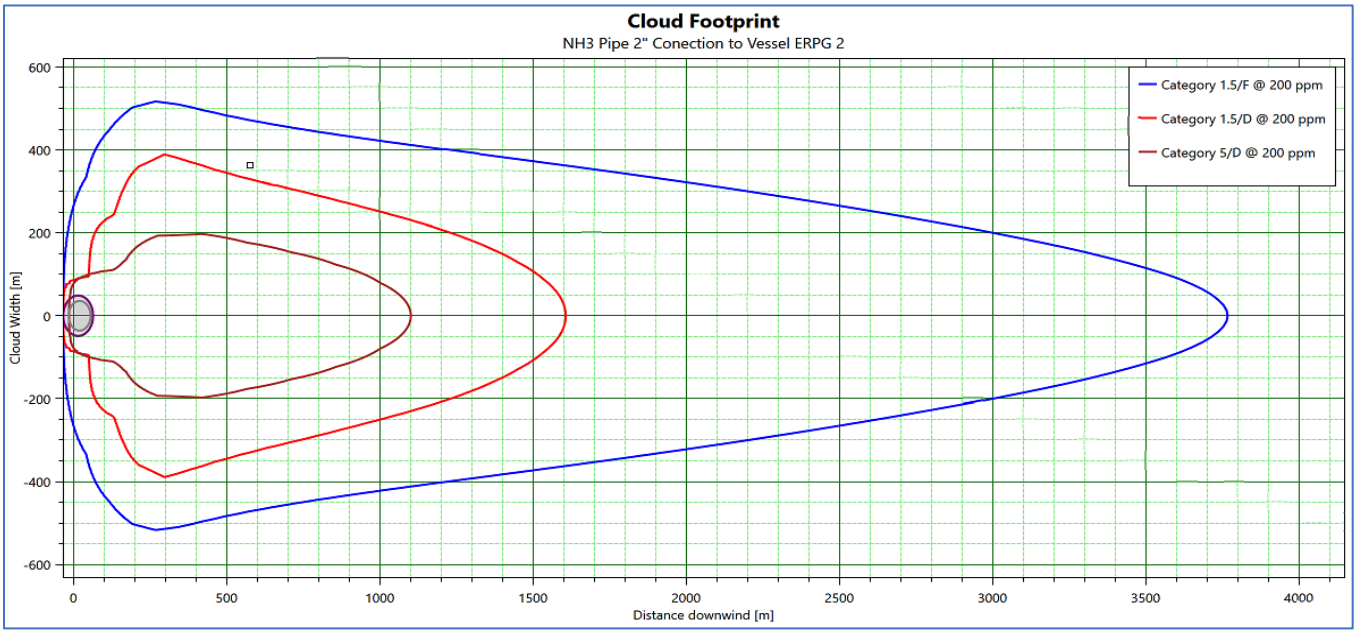
Cloud Footprint – NH_3 Storage Vessel (Vapour Side 25 mm hole)

The scenario is from two-phase vessel where the releases material is from the vapour side through a 25 mm hole due to flange gasket or relief valve opening.



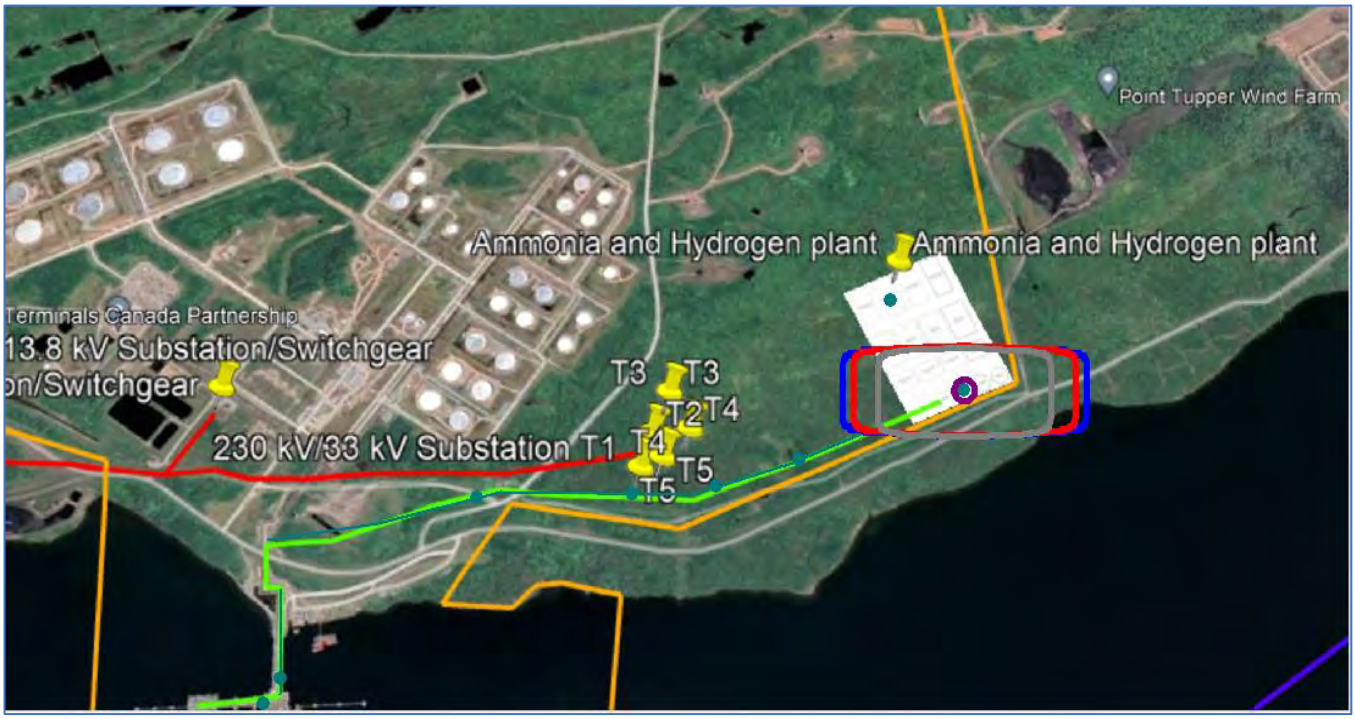
Cloud Footprint – NH_3 Storage Vessel (Liquid release 2” Pipe Connection)

Full-bore line rupture of a short 2" pipe of 10m length attached to the liquid side of the storage vessel. The cloud moves downwind, and it is modeled until the cloud concentration drops below harmful toxic thresholds. The concentration in the cloud is converted to lethality levels using probit values stored in the materials database.

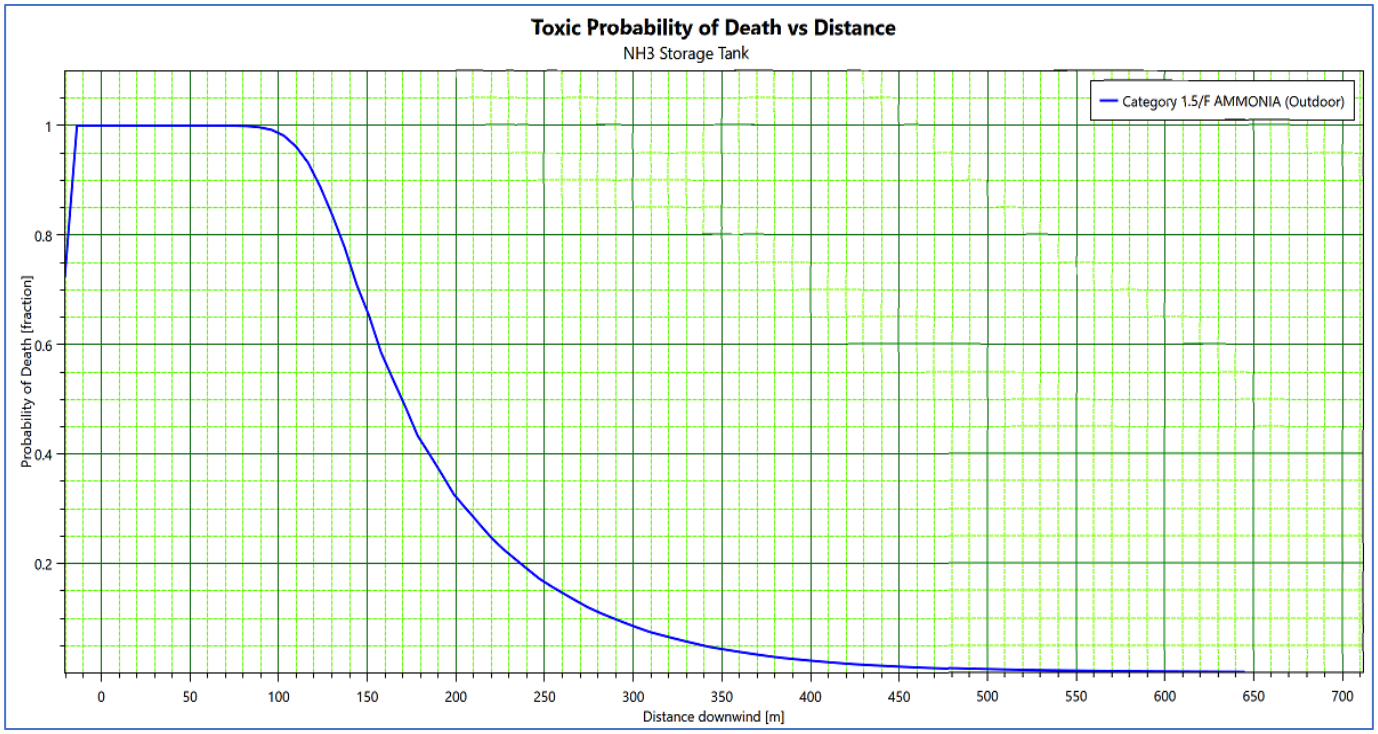


Aerial Map Overlay – NH_3 Storage Vessel Catastrophic Rupture

During a Catastrophic failure of the vessel the release is instantaneously, and a liquid pool will be formed. The cloud formation is determined by the evaporation rate from the liquid pool and no cloud drift is considered.



Probability of Death – Outdoor Release from NH_3 Storage Vessel



Appendix B
Phast Modeling – Ammonia Transfer Line

DNV

Consequence Summary Report - Workspace: PTGA Project

Study: Ammonia Transfer Pipeline

Discharge Results (after atmospheric expansion)

INPUT DATA

Distance between isolation valves	**1200**	m
Initial temperature	**-33**	^{0}C
Initial pressure (gauge)	**400**	kPa
Hole diameter	711.2	mm

OUTPUT DATA

Mass flow rate (liquid release pumped)	472.22	kg/s

Distance downwind to defined concentrations

Scenario	Weather	Concentration of interest [ppm]	Distance downwind to concentration of interest [m]
Leak from NH_3 Transfer Pipeline *The scenario is a full bore 28" pipeline failure. The release will initially form a liquid pool. The NH_3 cloud mass is based on the evaporation rate from the liquid pool*	Category 1.5/F *Stable atmosphere clear calm night with low wind conditions*	ERPG 1 - (25 ppm)	1052.75
	Category 1.5/D *Neutral atmosphere (day/night) with moderate winds and overcast conditions*	ERPG 1 - (25 ppm)	1094.07
	Category 5/D *Neutral atmosphere (day/night) with strong winds and overcast conditions*	ERPG 1 - (25 ppm)	2544.18

Distance downwind to defined concentrations

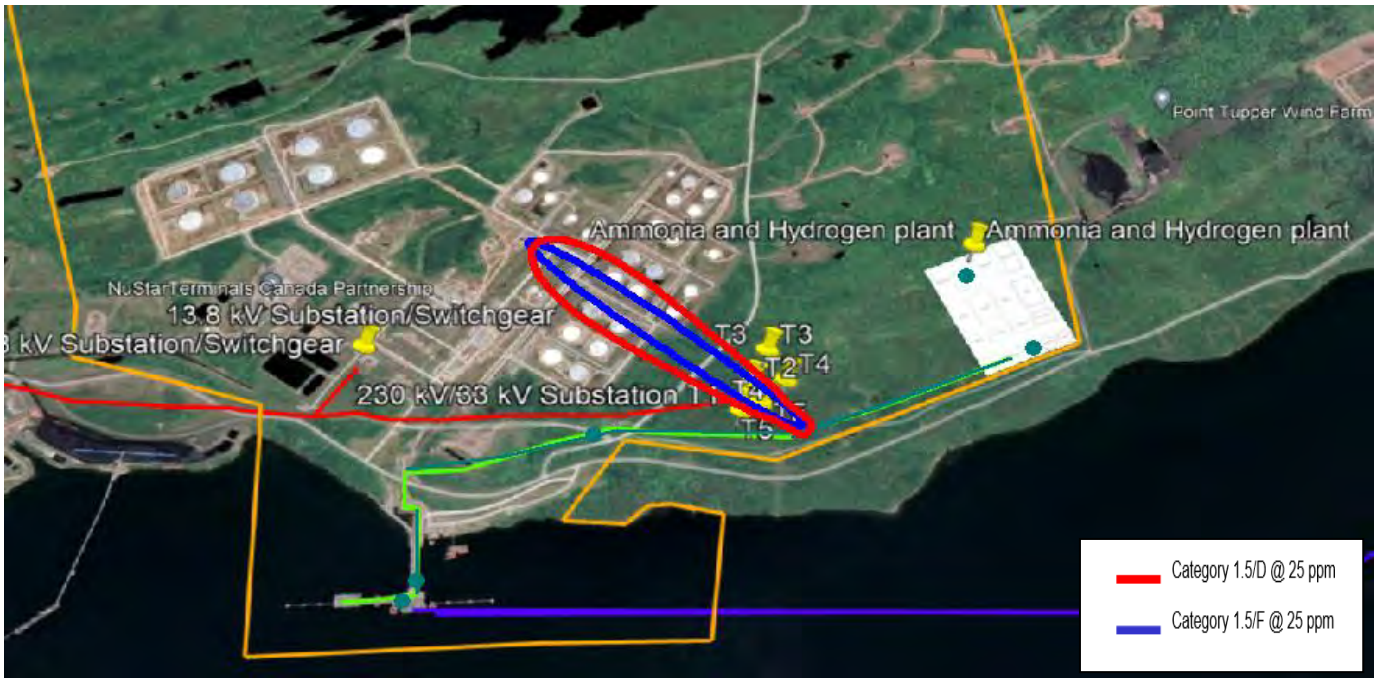
Scenario	Weather	Concentration of interest [ppm]	Distance downwind to concentration of interest [m]
Leak from NH_3 Transfer Pipeline *The scenario is a full bore 28" pipeline failure. The release will initially form a liquid pool. The NH_3 cloud mass is based on the evaporation rate from the liquid pool*	Category 1.5/F *Stable atmosphere clear calm night with low wind conditions*	ERPG 2 - (200 ppm)	161.44
	Category 1.5/D *Neutral atmosphere (day/night) with moderate winds and overcast conditions*	ERPG 2 - (200 ppm)	315.73
	Category 5/D *Neutral atmosphere (day/night) with strong winds and overcast conditions*	ERPG 2 - (200 ppm)	606.10

Distance downwind to defined concentrations

Scenario	Weather	Concentration of interest [ppm]	Distance downwind to concentration of interest [m]
Leak from NH_3 Transfer Pipeline *The scenario is a full bore 28" pipeline failure. The release will initially form a liquid pool. The NH_3 cloud mass is based on the evaporation rate from the liquid pool*	Category 1.5/F *Stable atmosphere clear calm night with low wind conditions*	ERPG 3 - (1000 ppm)	89.93
	Category 1.5/D *Neutral atmosphere (day/night) with moderate winds and overcast conditions*	ERPG 3 - (1000 ppm)	121.53
	Category 5/D *Neutral atmosphere (day/night) with strong winds and overcast conditions*	ERPG 3 - (1000 ppm)	196.38

Aerial Map Overlay – NH_3 Transfer Pipeline ERPG 1

Release of NH_3 from a 28" Transfer Pipeline (full bore rupture scenario at bend near road)
The results indicate the NH_3 Cloud for a 1.5/D "Neutral atmosphere Day event" and 1.5/F "Stable atmosphere Calm Night Event"
Note: The consequence impact from a liquid pool will be higher under weather class "D" than weather class "F" due to at higher wind speeds the evaporation rate is higher.

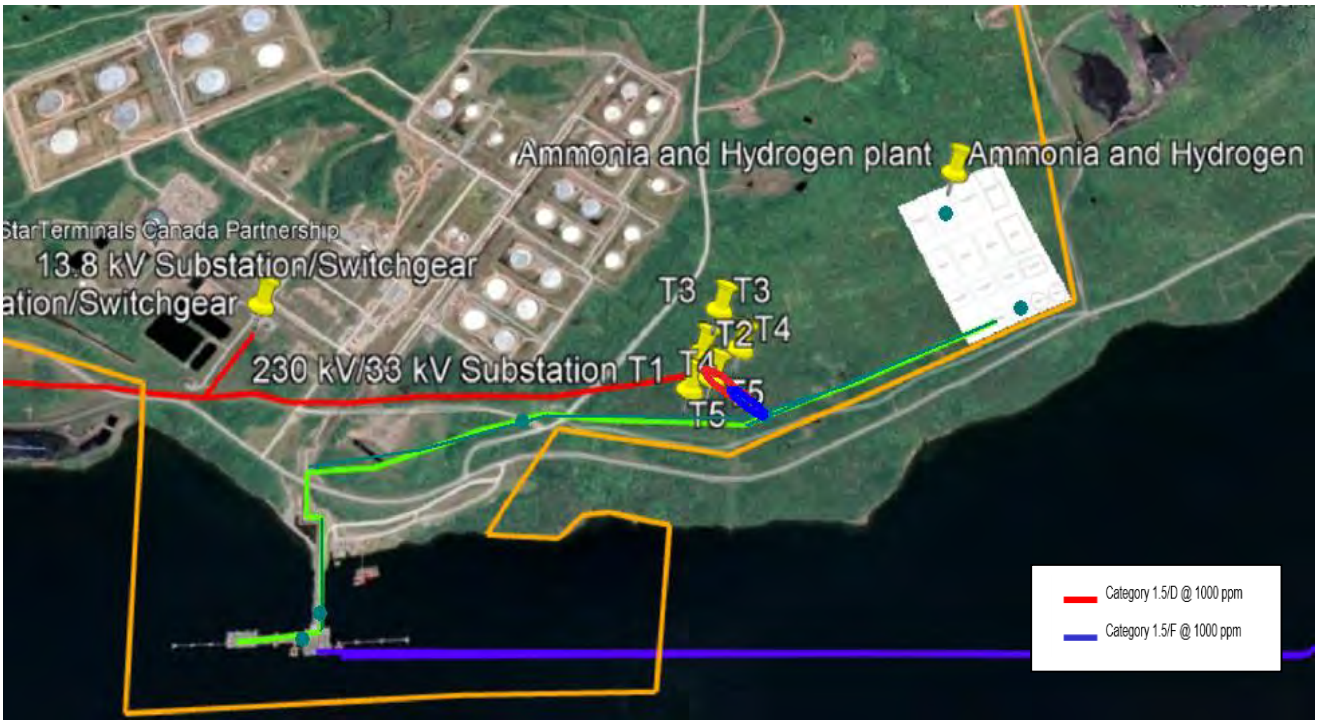


Aerial Map Overlay – NH_3 Transfer Pipeline ERPG 2

Release of NH_3 from a 28" Transfer Pipeline (full bore rupture scenario at bend near road)
The results indicate the NH_3 Cloud for a 1.5/D "Neutral atmosphere Day event" and 1.5/F "Stable Calm Night Event"

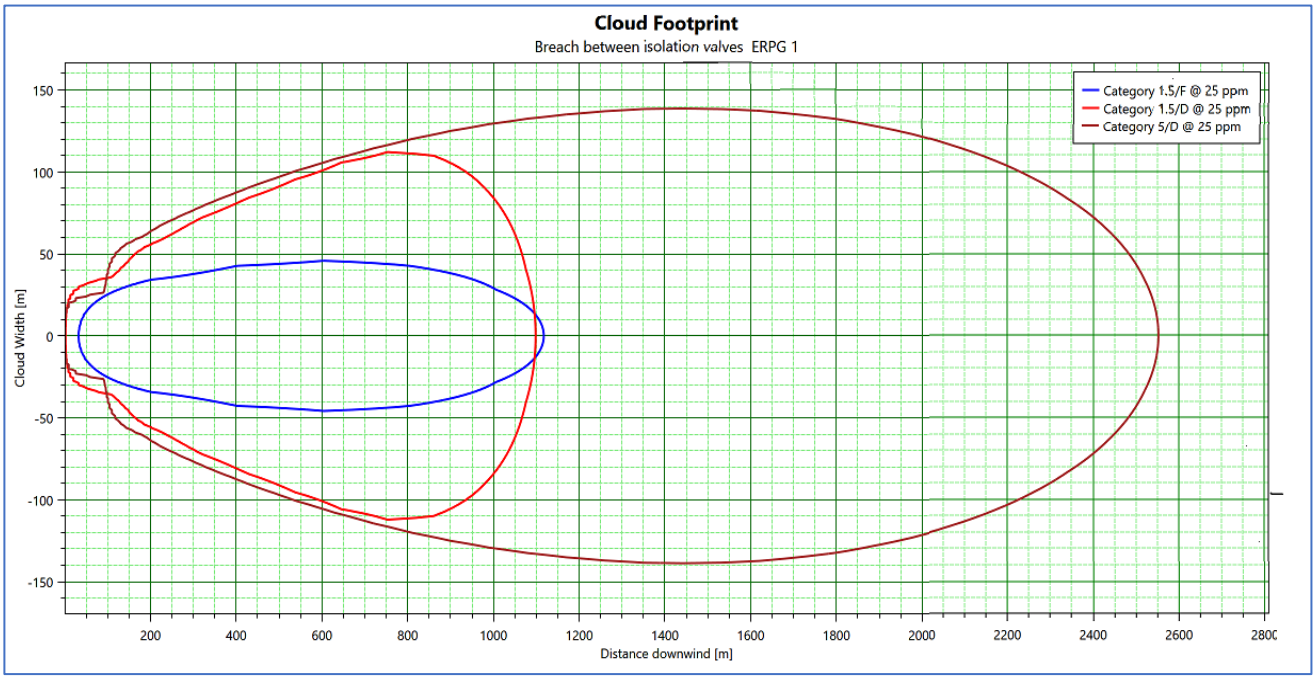
Aerial Map Overlay – NH_3 Transfer Pipeline ERPG 3

Release of NH_3 from a 28" Transfer Pipeline (full bore rupture scenario at bend near road)
The results indicate the NH_3 Cloud for a 1.5/D "Neutral atmosphere Day event" and 1.5/F "Stable Calm Night Event"



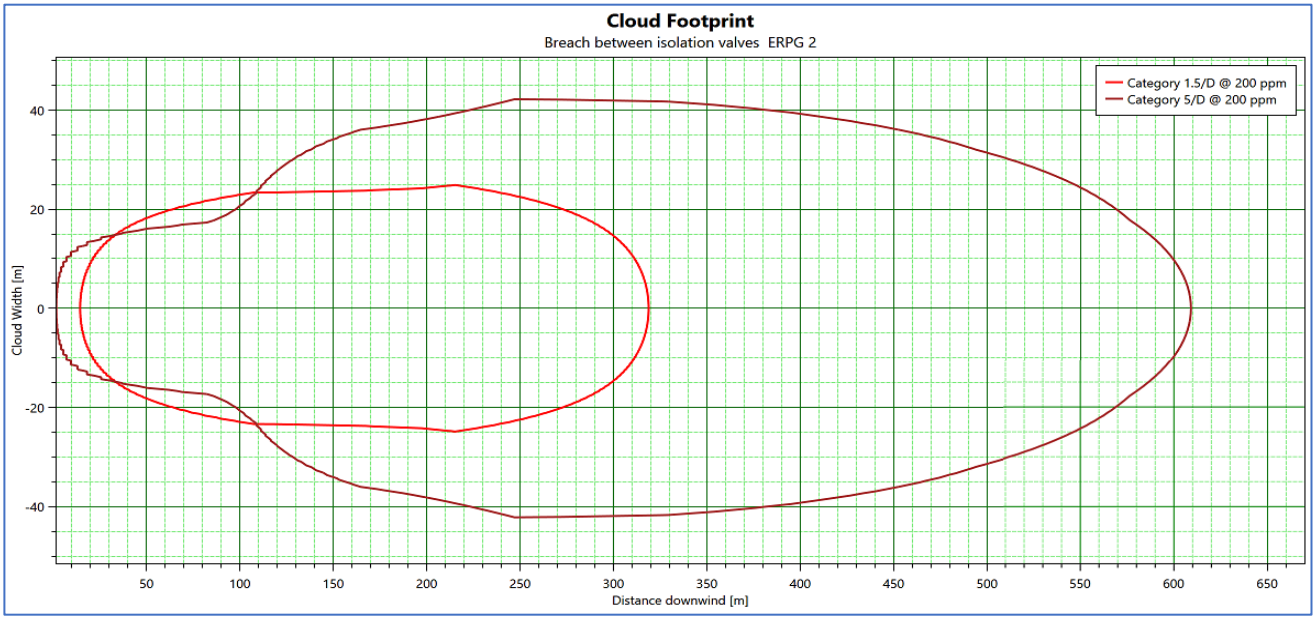
Cloud Footprint – NH_3 Transfer Pipeline (ERPG 1)

Full-bore line rupture of a 28" pipeline releasing approximately 476.71 m^3. The pipeline is 1200 m in length which is the distance between isolation valves. The cloud moves downwind, and it is modeled until the cloud concentration drops below harmful toxic thresholds. The concentration in the cloud is converted to lethality levels using probit values stored in the materials database.



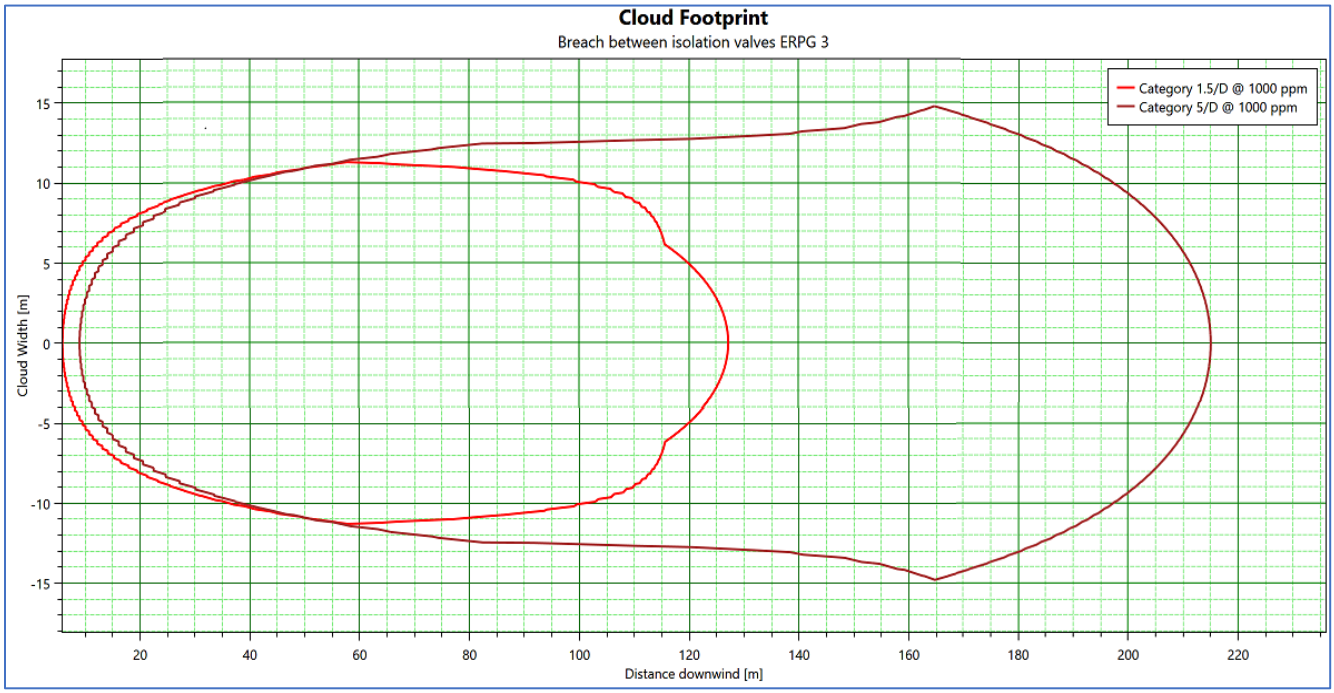
Cloud Footprint – NH_3 Transfer Pipeline (ERPG 2)

Full-bore line rupture of a 28" pipeline releasing approximately 476.71 m^3. The pipeline is 1200 m in length which is the distance between isolation valves. The cloud moves downwind, and it is modeled until the cloud concentration drops below harmful toxic thresholds. The concentration in the cloud is converted to lethality levels using probit values stored in the materials database.

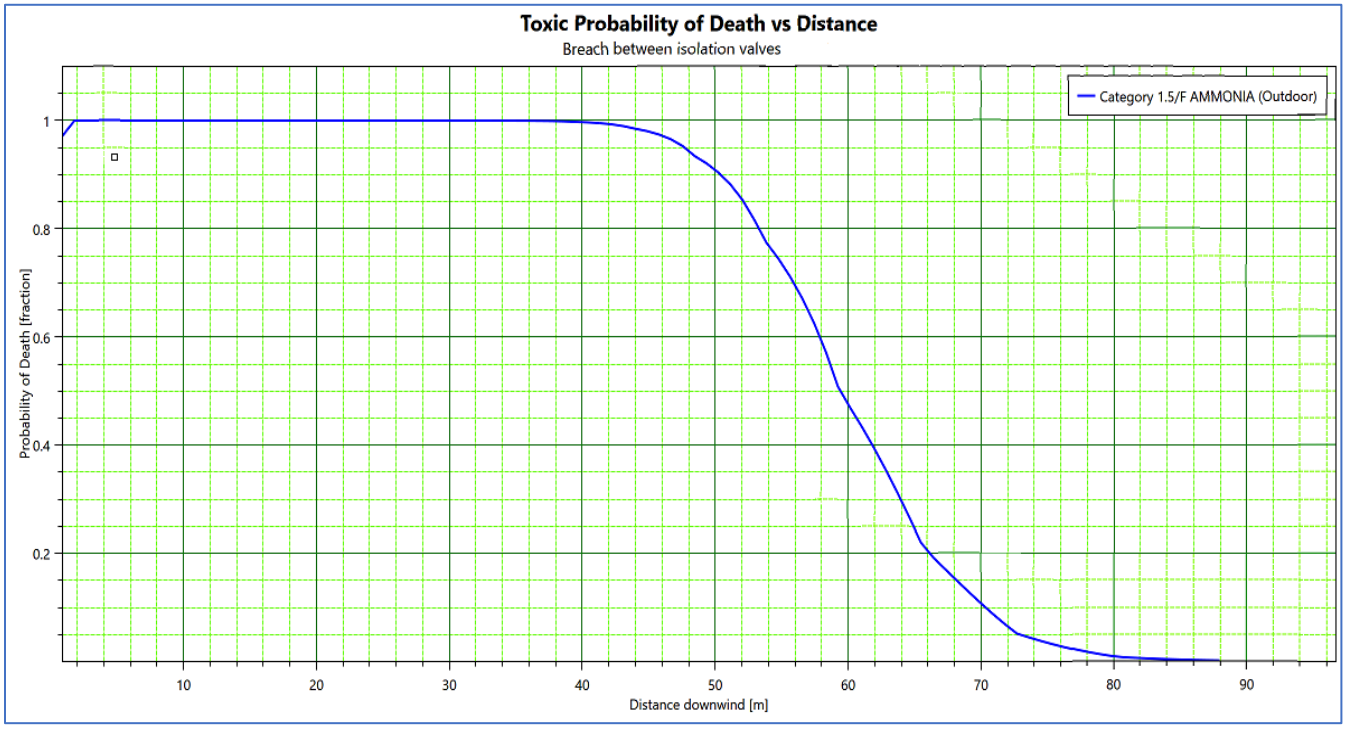


Cloud Footprint – NH_3 Transfer Pipeline (ERPG 3)

Full-bore line rupture of a 28" pipeline releasing approximately 476.71 m^3. The pipeline is 1200 m in length which is the distance between isolation valves. The cloud moves downwind, and it is modeled until the cloud concentration drops below harmful toxic thresholds. The concentration in the cloud is converted to lethality levels using probit values stored in the materials database.



Probability of Death – Outdoor Release from NH_3 Transfer Pipeline



Appendix C
Phast Modeling – Ammonia Loading Arm

DNV

Consequence Summary Report - Workspace: PTGA Project

Study: Ammonia Ship Loading Arm at Harbour

Discharge Results (after atmospheric expansion)

INPUT DATA

Volume in Loading Arm pipe section	30.41	m^3
Initial temperature	**-33**	^0C
Initial pressure (gauge)	**400**	kPa
Hole diameter (line rupture)	505	mm

OUTPUT DATA

Mass flow rate (liquid release pumped)	472.22	kg/s

Distance downwind to defined concentrations

Scenario	Weather	Concentration of interest [ppm]	Distance downwind to concentration of interest [m]
Leak on NH3 Loading Arm *Liquid Ammonia release which considers a leak from the Ship Loading Arm which is 505 mm (20") in diameter and ± 150 m in length. The NH_3 cloud mass is based on the evaporation rate from the liquid pool*	Category 1.5/F *Stable atmosphere clear calm night with low wind conditions*	ERPG 1 - (25 ppm)	726.61
	Category 1.5/D *Neutral atmosphere (day/night) with moderate winds and overcast conditions*	ERPG 1 - (25 ppm)	803.12
	Category 5/D *Neutral atmosphere (day/night) with strong winds and overcast conditions*	ERPG 1 - (25 ppm)	2184.82

Distance downwind to defined concentrations

Scenario	Weather	Concentration of interest [ppm]	Distance downwind to concentration of interest [m]
Leak on NH3 Loading Arm *Liquid Ammonia release which considers a leak from the Ship Loading Arm which is 505 mm (20") in diameter and ± 150 m in length. The NH_3 cloud mass is based on the evaporation rate from the liquid pool*	Category 1.5/F *Stable atmosphere clear calm night with low wind conditions*	ERPG 2 - (200 ppm)	218.15
	Category 1.5/D *Neutral atmosphere (day/night) with moderate winds and overcast conditions*	ERPG 2 - (200 ppm)	360.23
	Category 5/D *Neutral atmosphere (day/night) with strong winds and overcast conditions*	ERPG 2 - (200 ppm)	657.36

Distance downwind to defined concentrations

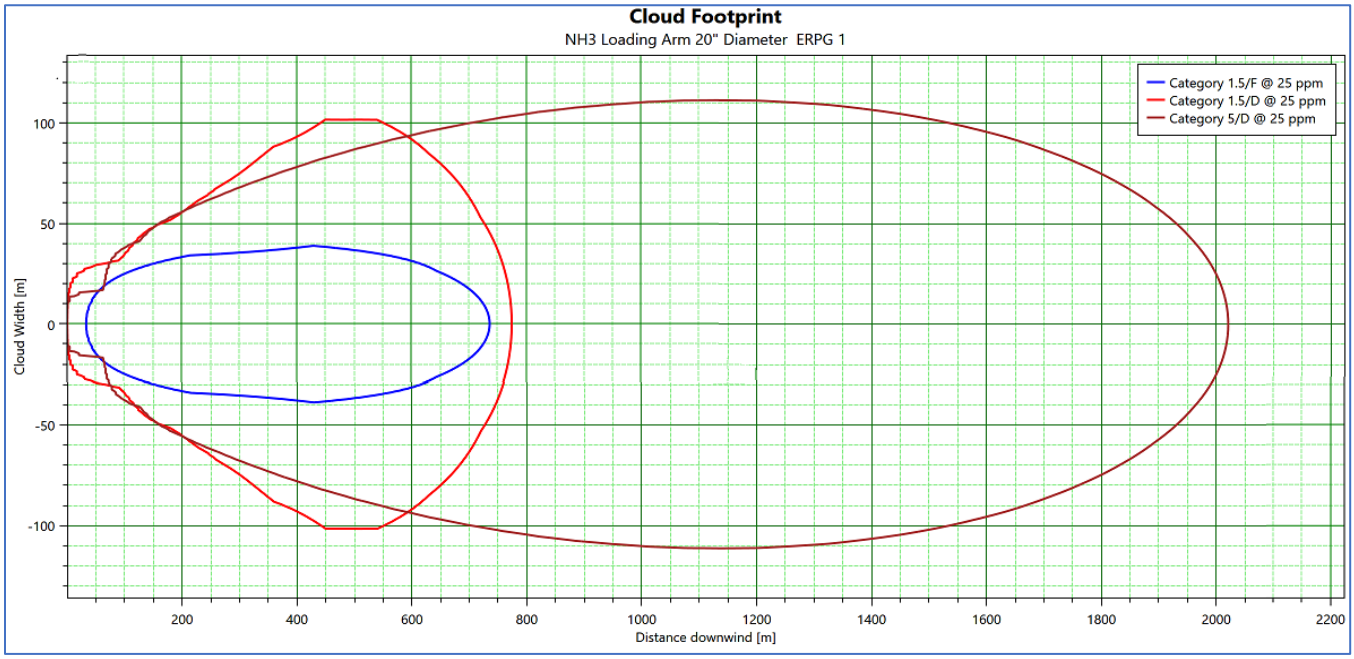
Scenario	Weather	Concentration of interest [ppm]	Distance downwind to concentration of interest [m]
Leak on NH3 Loading Arm *Liquid Ammonia release which considers a leak from the Ship Loading Arm which is 505 mm (20") in diameter and ± 150 m in length. The NH_3 cloud mass is based on the evaporation rate from the liquid pool*	Category 1.5/F *Stable atmosphere clear calm night with low wind conditions*	ERPG 3 - (1000 ppm)	97.47
	Category 1.5/D *Neutral atmosphere (day/night) with moderate winds and overcast conditions*	ERPG 3 - (1000 ppm)	145.91
	Category 5/D *Neutral atmosphere (day/night) with strong winds and overcast conditions*	ERPG 3 - (1000 ppm)	197.31

Aerial Map Overlay – Release from NH_3 Loading Arm (ERPG 1)

Release of NH_3 from Loading Arm at Ship (a 20" diameter line rupture result in liquid release)
Note: The consequence impact from a liquid pool will be higher under weather class "D" than weather class "F" due to at higher wind speeds the evaporation rate is higher.

Cloud Footprint – NH_3 from 20" Loading Arm (ERPG 1)

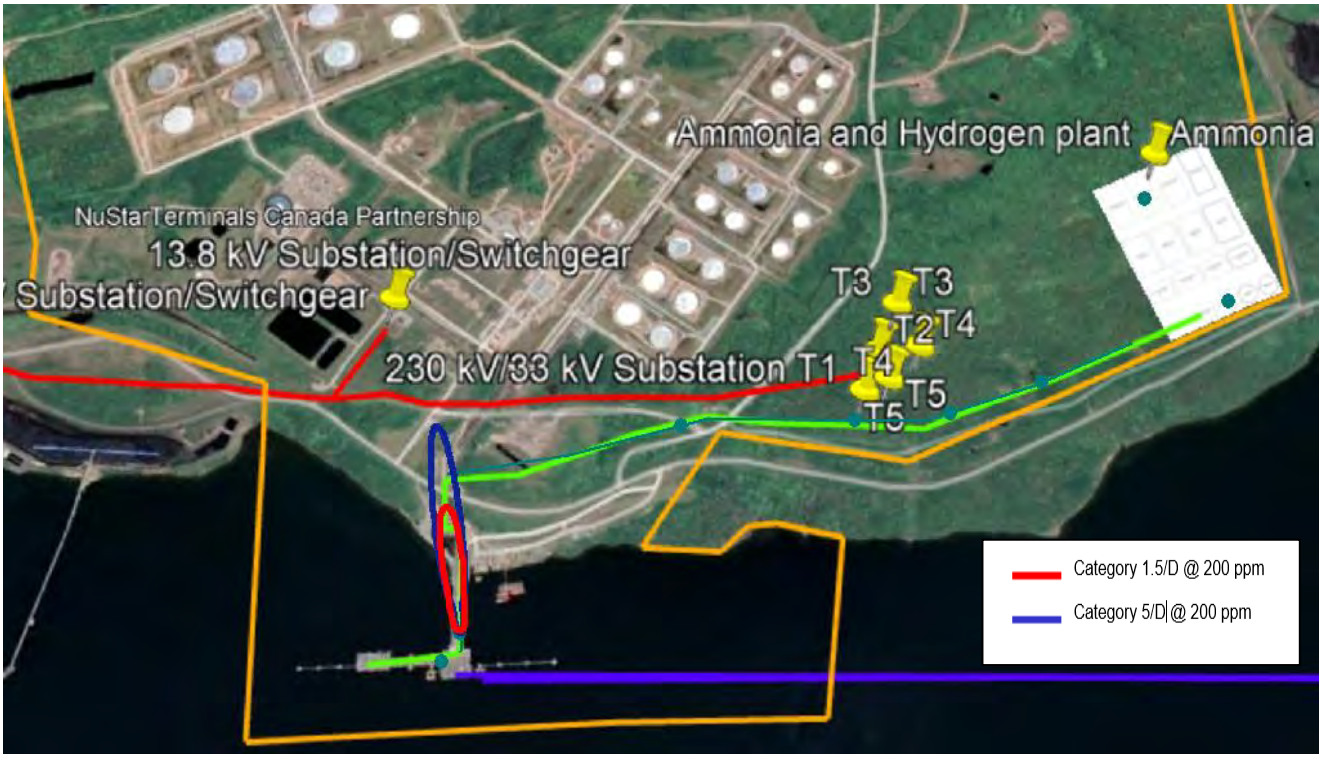
Full-bore line rupture of a 20" Loading Arm attached to Ship vessel. The cloud moves downwind, and it is modeled until the cloud concentration drops below harmful toxic thresholds. The concentration in the cloud is converted to lethality levels using probit values stored in the materials database



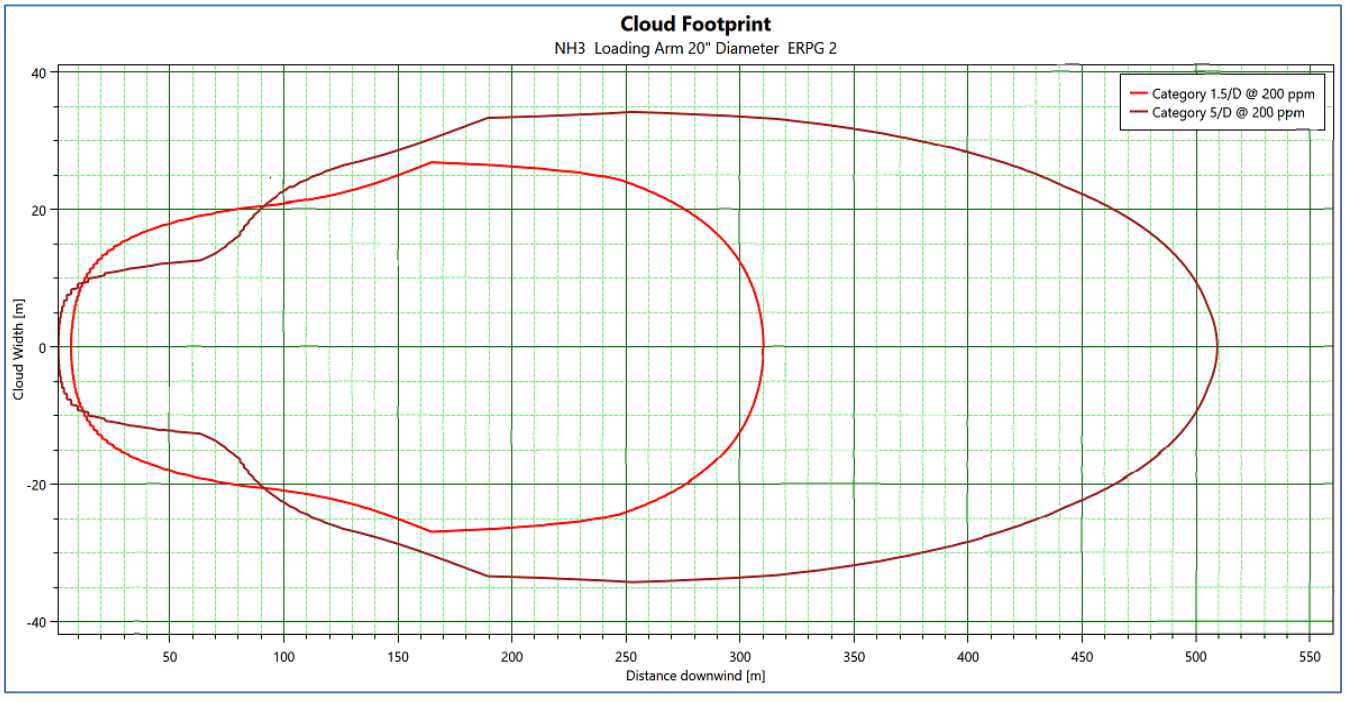
Audit Number: 1792
Date: 5/6/2022 Time: 8:31 PM

Aerial Map Overlay – Release from NH_3 Loading Arm (ERPG 2)

Release of NH_3 from Loading Arm at Ship (a 20" diameter line rupture)



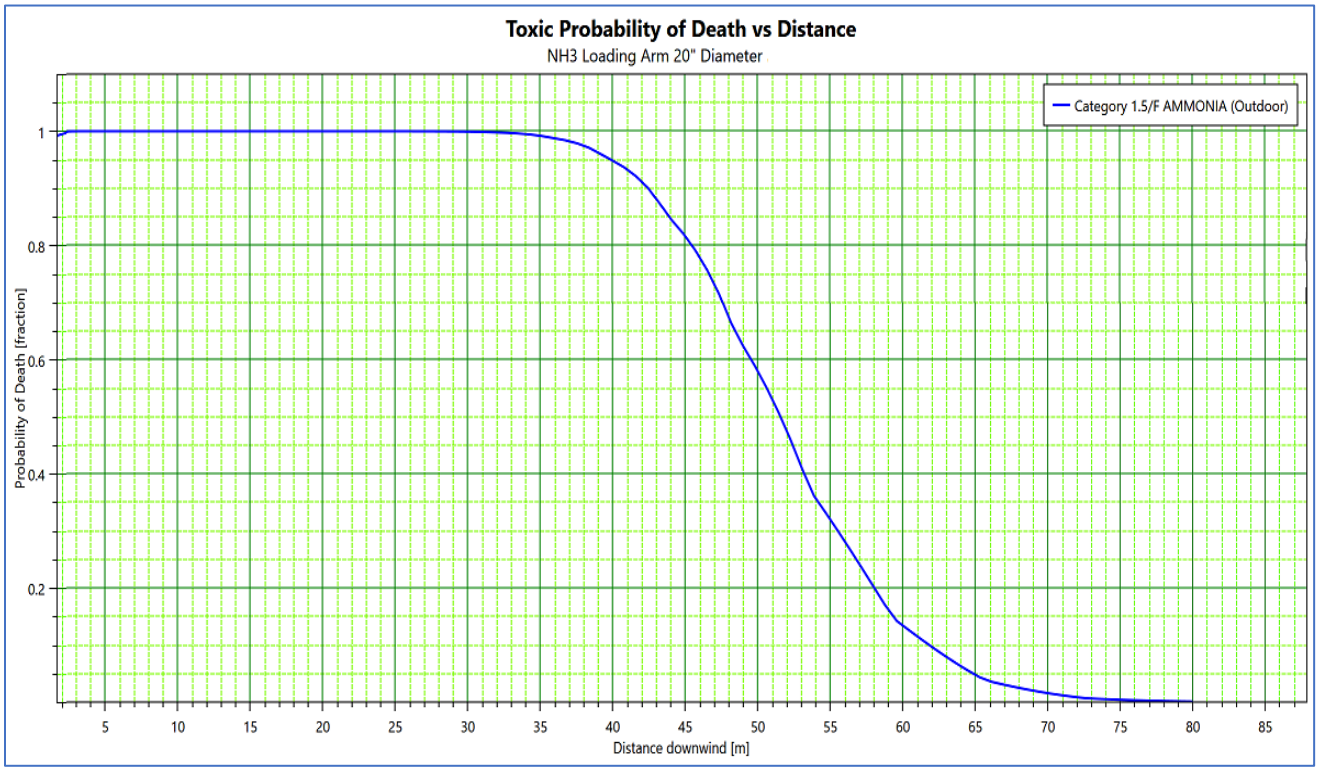
Full-bore line rupture of a 20" Loading Arm attached to Ship vessel. The cloud moves downwind, and it is modeled until the cloud concentration drops below harmful toxic thresholds. The concentration in the cloud is converted to lethality levels using probit values stored in the materials database



Aerial Map Overlay – Release from NH_3 Loading Arm (ERPG 3)

Release of NH_3 from Loading Arm at Ship (a 20" diameter line rupture)

Probability of Death – Outdoor Release from NH_3 Loading Arm



Appendix D
Phast Modeling – Ammonia Ship Vessel

DNV

Consequence Summary Report - Workspace: PTGA Project

Study: Ammonia Vessel (ship)

Discharge Results (after atmospheric expansion)

INPUT DATA

Mass in Vessel (Ship)	**5e+007**	kg
Release duration	**3600**	s
Initial temperature	**-33**	^{0}C
Initial pressure (gauge)	**400**	kPa
Hole diameter on Vessel (Ship)	**25**	mm

OUTPUT DATA

Mass flow rate (vapour release)	9.23	kg/s

Distance downwind to defined concentrations

Scenario	Weather	Concentration of interest [ppm]	Distance downwind to concentration of interest [m]
Leak on NH_3 Vessel (ship) *The scenario is from two-phase vessel where the releases material is from the vapour side of the ship vessel through a 25 mm hole due to flange gasket opening.*	Category 1.5/F *Stable atmosphere clear calm night with low wind conditions*	ERPG 1 - (25 ppm)	15922.80
	Category 1.5/D *Neutral atmosphere (day/night) with moderate winds and overcast conditions*	ERPG 1 - (25 ppm)	6002.30
	Category 5/D *Neutral atmosphere (day/night) with strong winds and overcast conditions*	ERPG 1 - (25 ppm)	3220.32

Distance downwind to defined concentrations

Scenario	Weather	Concentration of interest [ppm]	Distance downwind to concentration of interest [m]
Leak on NH_3 Vessel (ship) *The scenario is from two-phase vessel where the releases material is from the vapour side of the ship vessel through a 25 mm hole due to flange gasket opening.*	Category 1.5/F *Stable atmosphere clear calm night with low wind conditions*	ERPG 2 - (200 ppm)	3371.72
	Category 1.5/D *Neutral atmosphere (day/night) with moderate winds and overcast conditions*	ERPG 2 - (200 ppm)	1377.92
	Category 5/D *Neutral atmosphere (day/night) with strong winds and overcast conditions*	ERPG 2 - (200 ppm)	828.82

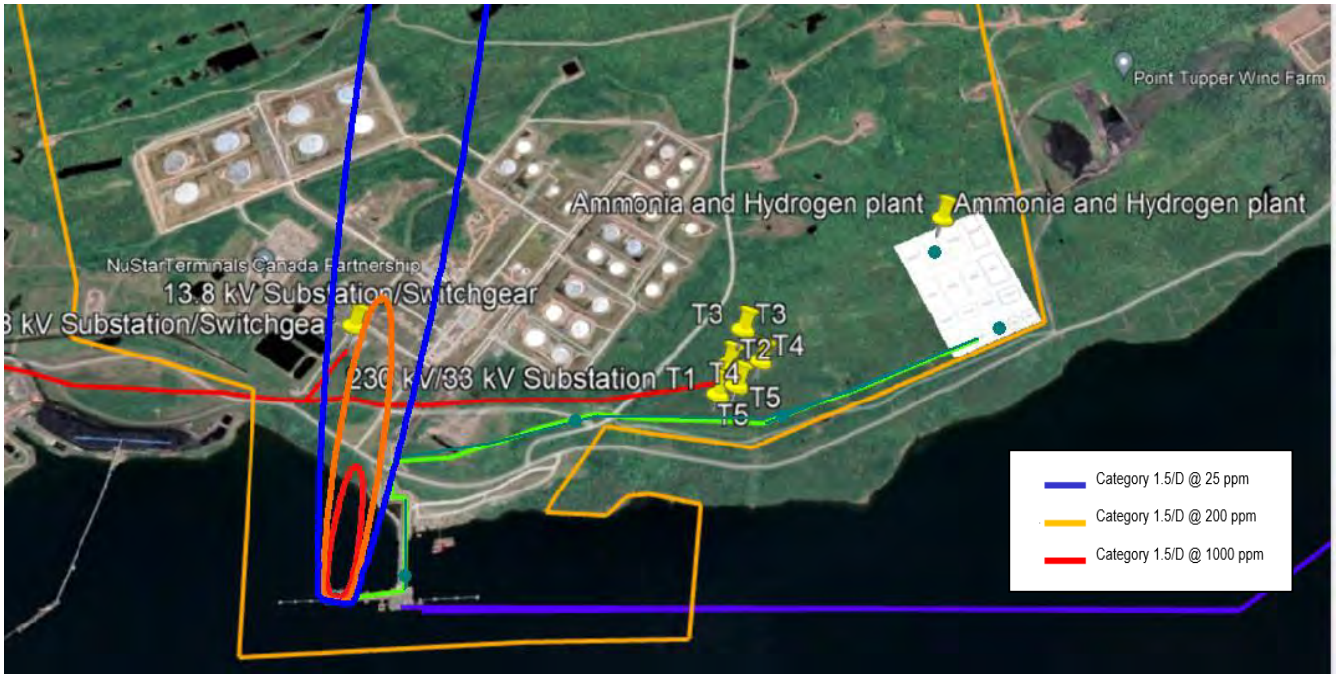
Distance downwind to defined concentrations

Scenario	Weather	Concentration of interest [ppm]	Distance downwind to concentration of interest [m]
Leak on NH_3 Vessel (ship) *The scenario is from two-phase vessel where the releases material is from the vapour side of the ship vessel through a 25 mm hole due to flange gasket opening.*	Category 1.5/F *Stable atmosphere clear calm night with low wind conditions*	ERPG 3 - (1000 ppm)	784.15
	Category 1.5/D *Neutral atmosphere (day/night) with moderate winds and overcast conditions*	ERPG 3 - (1000 ppm)	519.20
	Category 5/D *Neutral atmosphere (day/night) with strong winds and overcast conditions*	ERPG 3 - (1000 ppm)	253.12

Aerial Map Overlay – NH_3 Vessel (Ship) (1.5/D Moderate Wind Day Event)

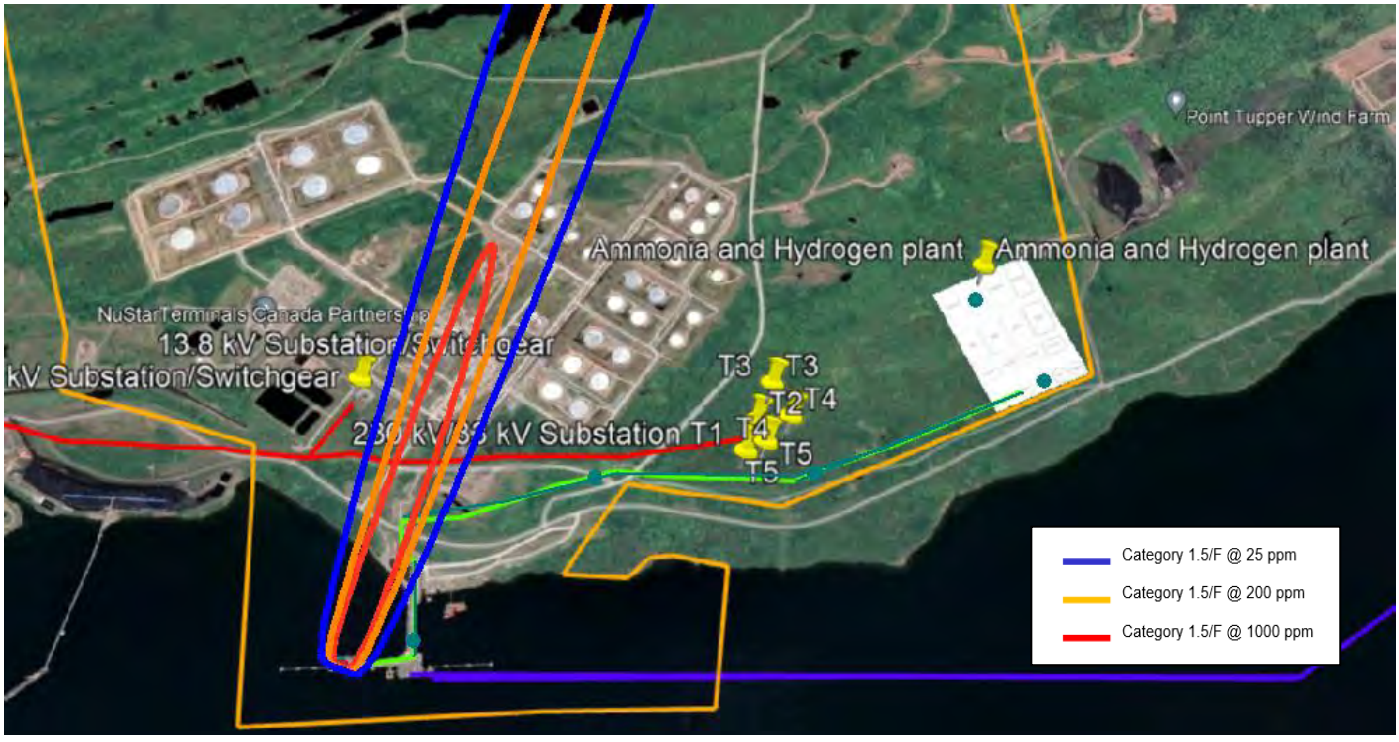
Release of NH_3 from the vessel vapour side through a 25mm hole

Note: The consequence impact from a vapour release will be higher under weather class "F" than weather class "D" due to at lower wind speeds the dispersion rate is less



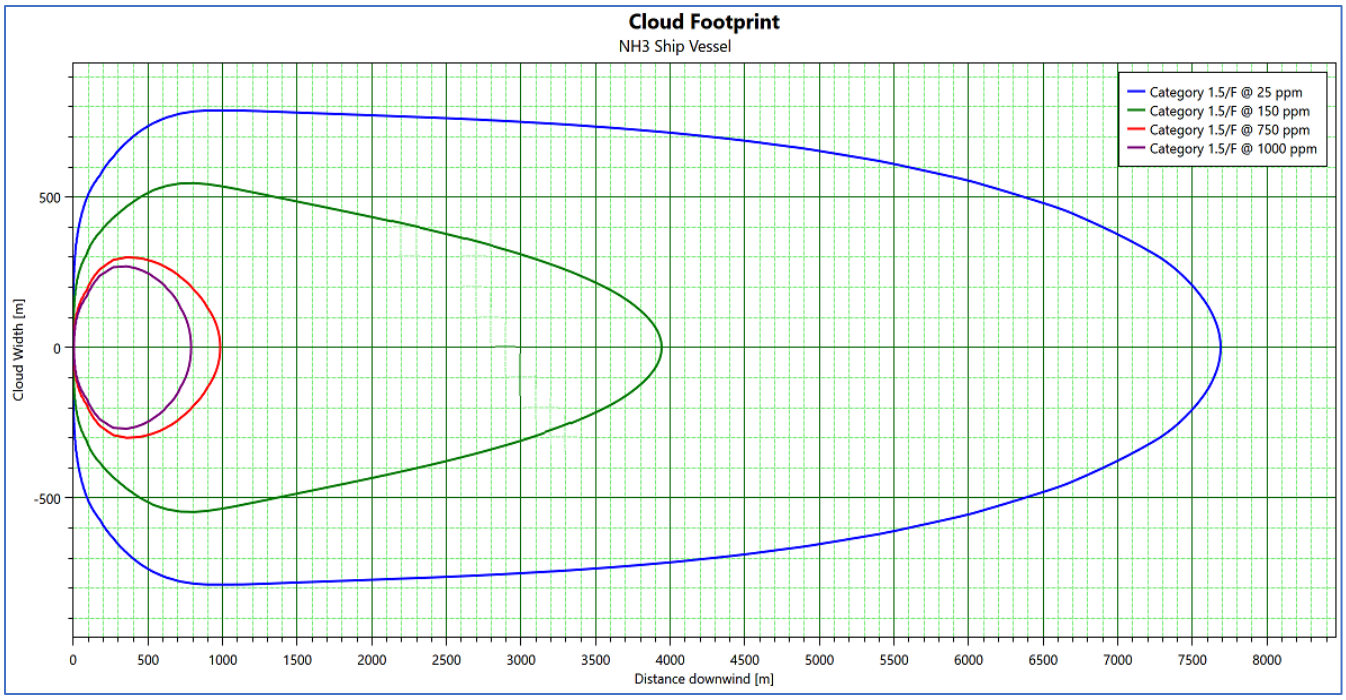
Aerial Map Overlay –NH_3 Vessel (Ship) (1.5/F Calm Wind Night Event)

Release of NH_3 from the vessel vapour side through a 25mm hole

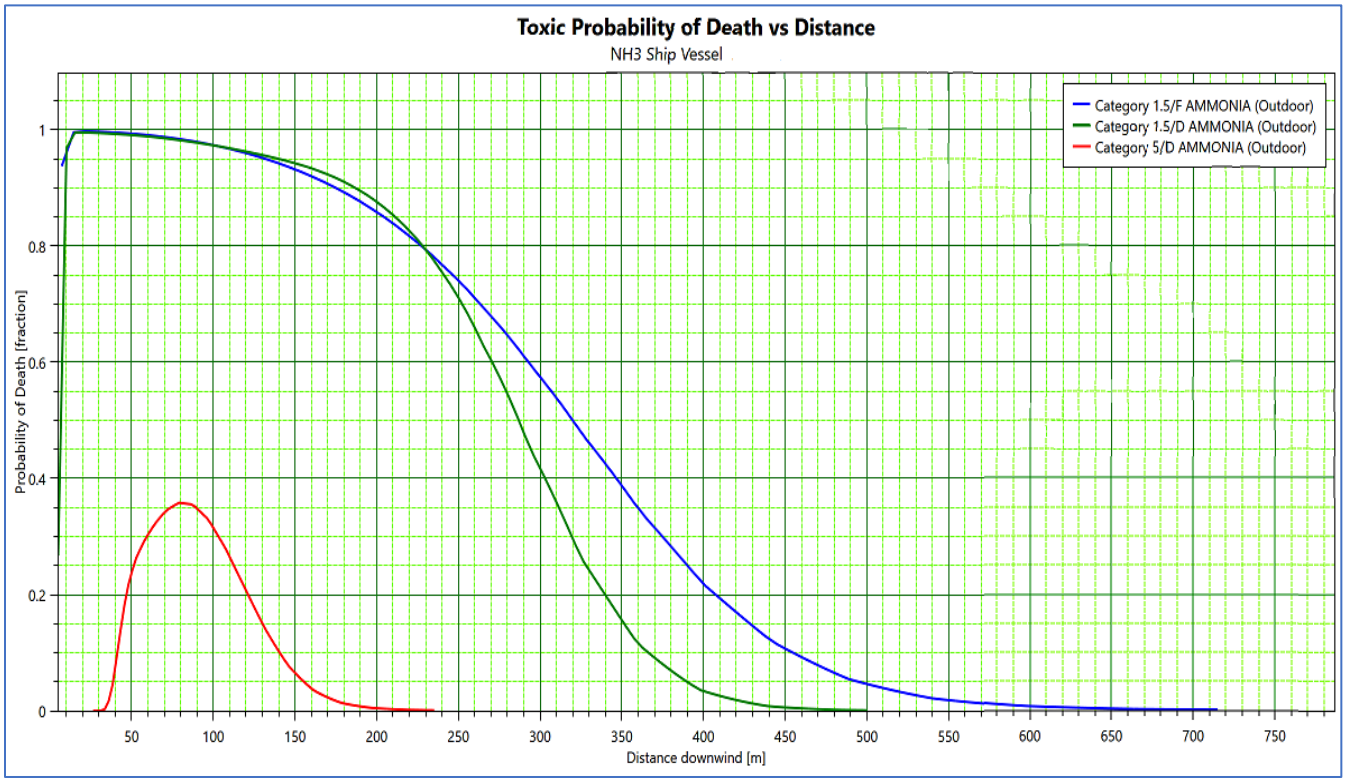


Cloud Footprint – NH_3 Vessel (Ship) (Vapour Side 25 mm hole)

The scenario is from two-phase vessel where the releases material is from the vapour side through a 25 mm hole due to flange gasket opening.



Probability of Death – Outdoor Release from NH_3 Vessel (Ship)



Appendix E
Phast Modeling – Hydrogen Electrolyser

Consequence Summary Report

Hydrogen Electrolyser Stack

TNO Multi-Energy Explosion Results

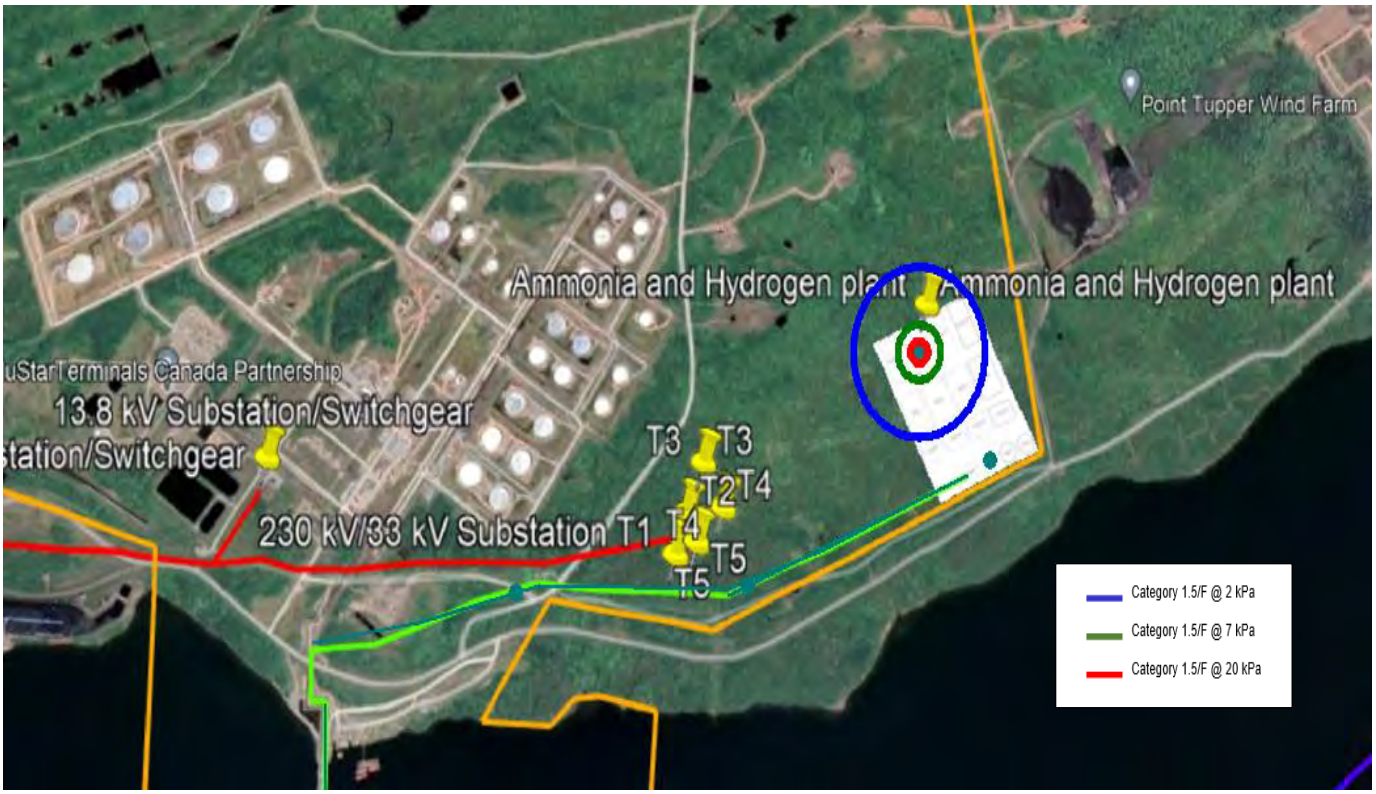
Material	HYDROGEN	
Pasquil stability	Class F - Stable atmosphere clear calm night with low wind conditions	
Flammable mass in cloud	154.27	kg
Confined explosion strength	6	
Unconfined explosion strength	4	
Volume of unconfined cloud	1871	m^3

OUTPUT DATA

Unconfined explosion energy	1.70836E+07	kJ
Confined explosion energy	474099	kJ

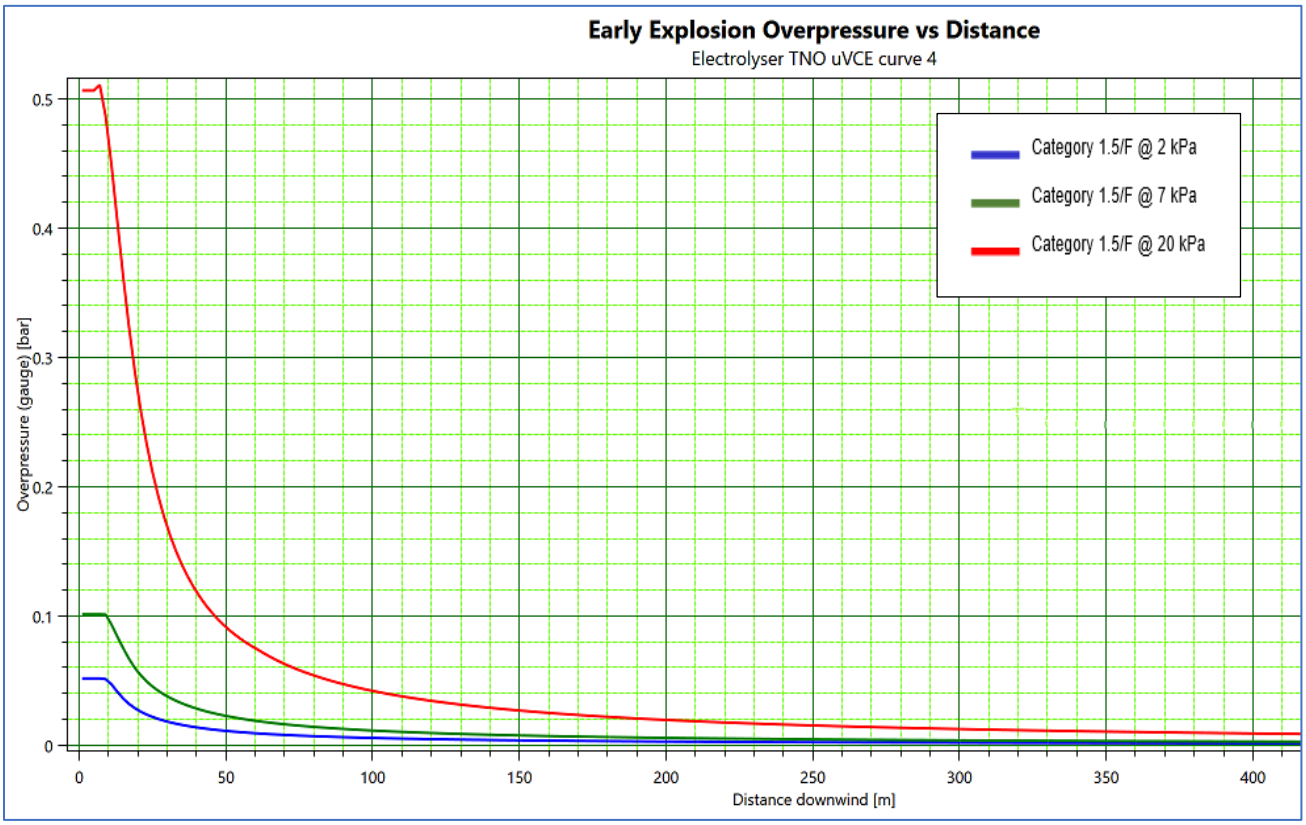
Scenario	Weather	Distance [m] to reached 2 kPa	Distance [m] to reached 7 kPa	Distance [m] to reached 20 kPa
TNO Volume Blockage Ration (VBR 55%) TNO Unconfined Vapour Cloud Explosion (uVCE curve 4)	uVCE - 1.5m/s (F) Stable atmosphere clear calm night with low wind conditions	195.81	63.77	28.33
TNO Confined Vapour Cloud Explosion (cVCE curve 6)	cVCE 1.5m/s (F) Stable atmosphere clear calm night with low wind conditions	450.31	146.58	60.08

TNO Unconfined Vapour Cloud Explosion (uVCE curve 4)

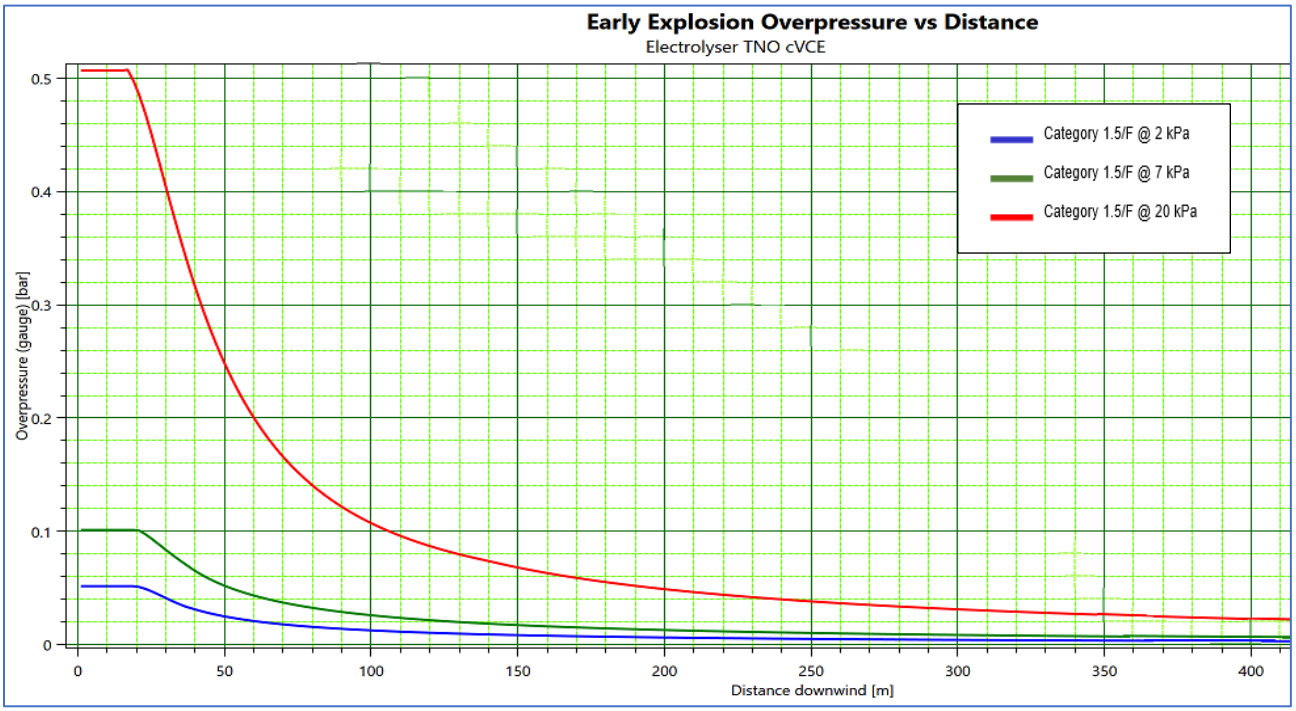


TNO Confined Vapour Cloud Explosion (uVCE curve 6)

TNO Unconfined Vapour Cloud Explosion (uVCE curve 4) Overpressure versus Distance



TNO Confined Vapour Cloud Explosion (uVCE curve 6) Overpressure versus Distance



Appendix F
Phast Modeling – Hydrogen Compressor

Consequence Summary Report

Hydrogen Compressor

TNO Multi-Energy Explosion Results

Material	HYDROGEN	
Pasquil stability	Class - Stable atmosphere clear calm night with low wind conditions	
Flammable mass in cloud	87.26	kg
Confined explosion strength	6	
Unconfined explosion strength	4	
Volume of unconfined cloud	1176	m^3

OUTPUT DATA

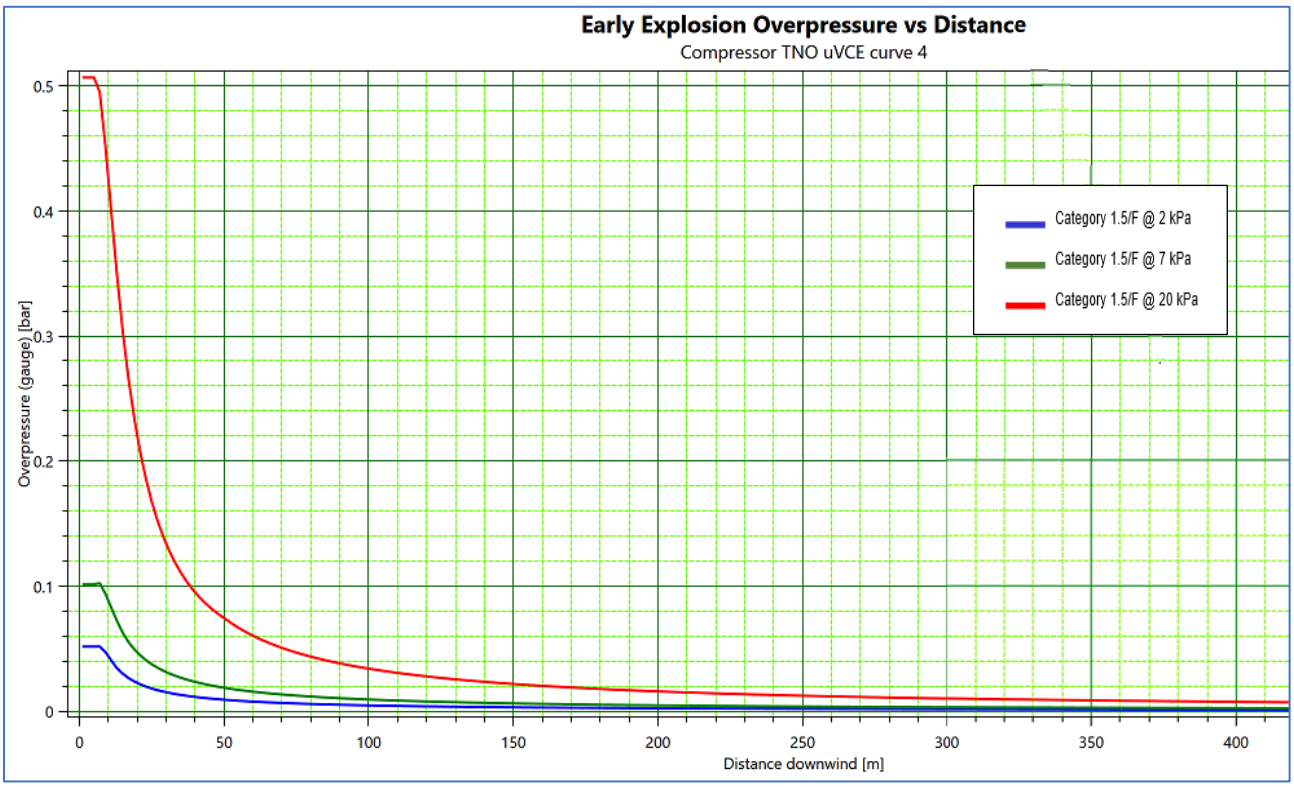
Unconfined explosion energy	9.66159E+06	kJ
Confined explosion energy	268636	kJ

Scenario	Weather	Distance [m] to reached 2 kPa	Distance [m] to reached 7 kPa	Distance [m] to reached 20 kPa
TNO Volume Blockage Ration (VBR 10%) TNO Unconfined Vapour Cloud Explosion (uVCE curve 4)	uVCE - 1.5m/s (F) Stable atmosphere clear calm night with low wind conditions	162.09	52.76	21.62
TNO Confined Vapour Cloud Explosion (cVCE curve 6)	cVCE - 1.5m/s (F) Stable atmosphere clear calm night with low wind conditions	385.74	125.65	51.46

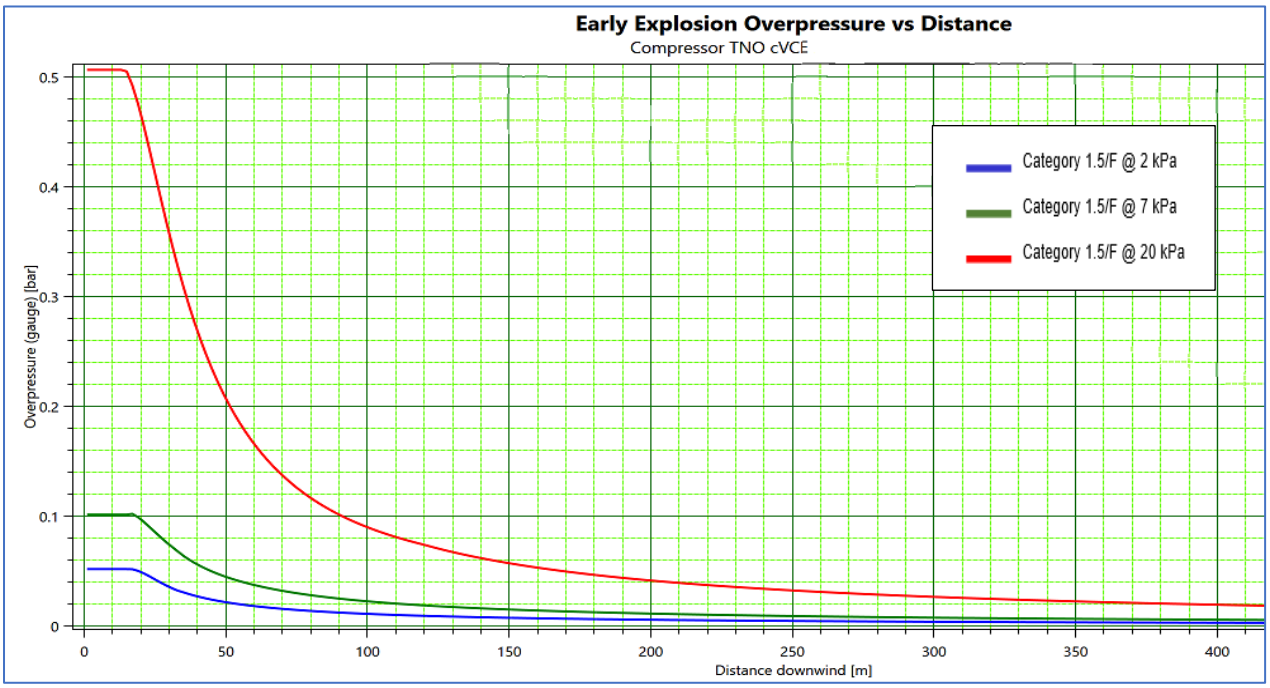
TNO Unconfined Vapour Cloud Explosion (uVCE curve 4)

TNO Confined Vapour Cloud Explosion (uVCE curve 6)

TNO Unconfined Vapour Cloud Explosion (uVCE curve 4) Overpressure versus Distance



TNO Confined Vapour Cloud Explosion (uVCE curve 6) Overpressure versus Distance



Appendix G
Phast Modeling – Hydrogen Main Header

Consequence Summary Report

Hydrogen Main Header

Fireball Impact

INPUT DATA

Fireball model	Martinsen and Marx	
Fireball Radius	18.71	m
Burst pressure - gauge	101.325E+03	Pa
Flame surface emissive power	1.4E+05	W/m2
Fireball duration (Phast maximum input value)	100	S

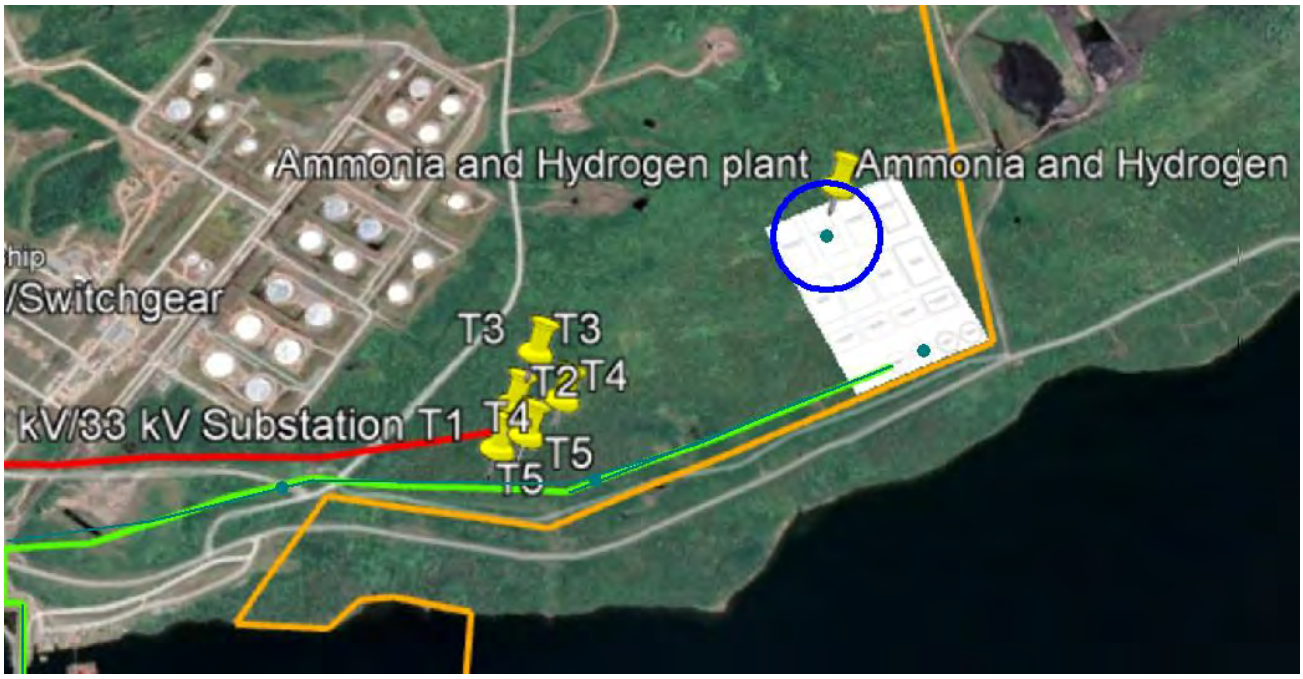
Weather: Category 1.5/F

Wind speed [m/s]	1.5
Pasquill stability	Class F - Stable atmosphere clear calm night with low wind conditions
Atmospheric temperature [degK]	288
Relative humidity [fraction]	0.55
Flame surface emissive power [W/m2]	140

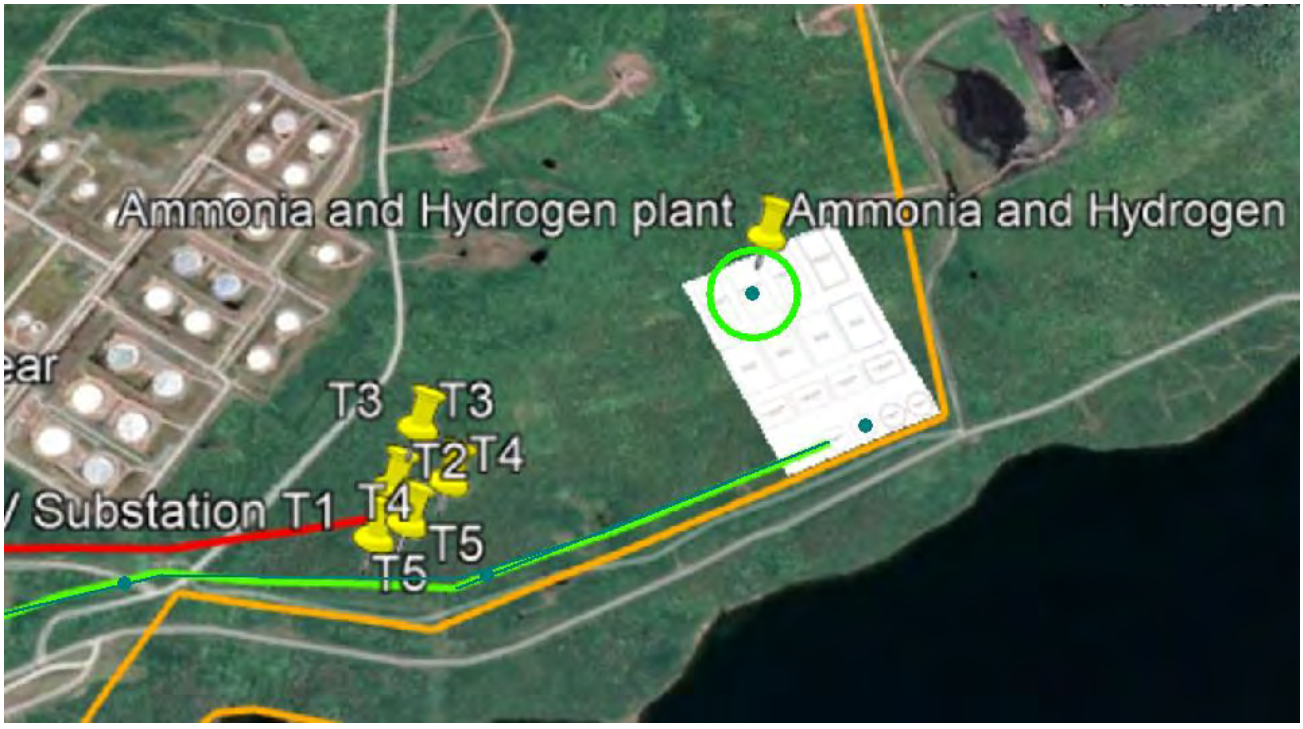
Output DATA

Scenario	Heat Radiation Level	Weather	Fireball Diameter [m]	Distance downwind to specified heat radiation intensity level [m]
The H_2 is fed to the gas scrubber. The fireball event is considered ignition of a gas cloud caused by a 25 mm hole in the main H_2 header which is 1100 mm in diameter.	Fireball 2.5 kW/m^2	Category 1.5/F	37.42	117.55
	Fireball 5 kW/m^2	Category 1.5/F	37.42	83.72
	Fireball 12.5 kW/m^2	Category 1.5/F	37.42	52.41
	Fireball 37.5 kW/m^2	Category 1.5/F	37.42	27.42

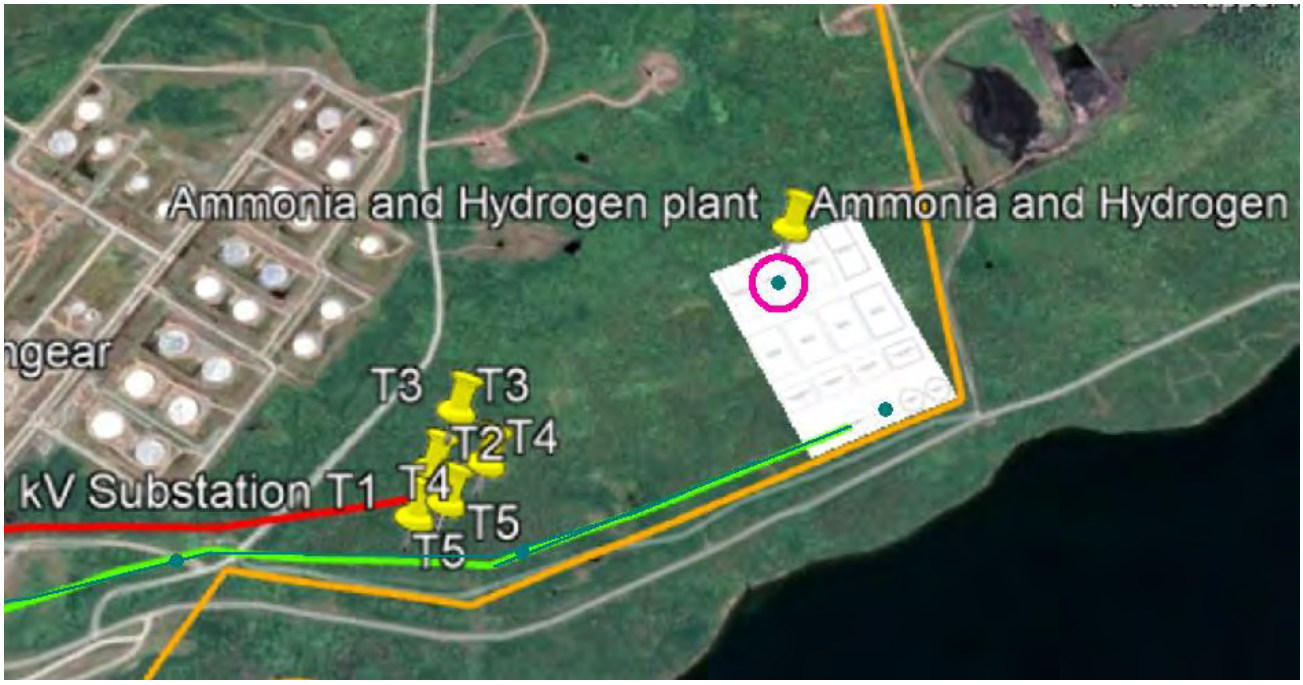
Aerial Map View - Fireball Impact 2.5 kW/m^2



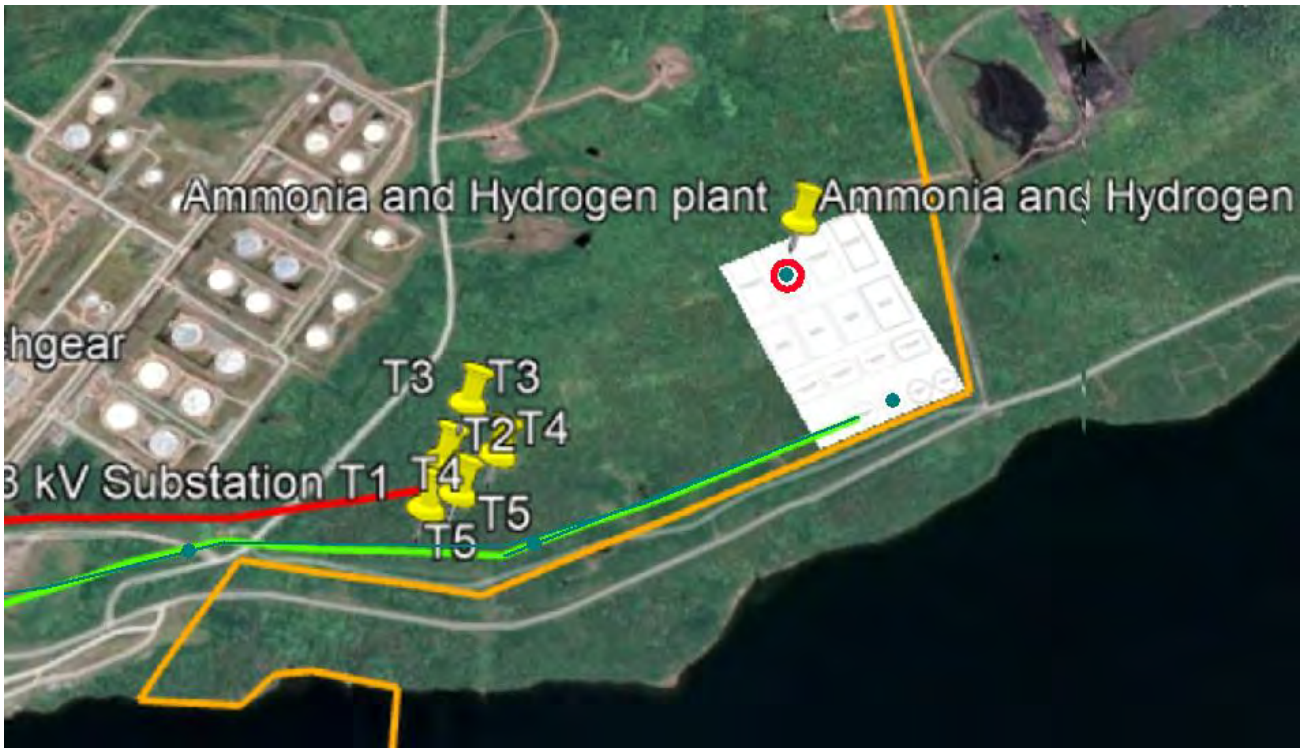
Aerial Map View - Fireball Impact 5 kW/m^2



Aerial Map View - Fireball Impact 12.5 kW/m^2



Aerial Map View - Fireball Impact 37.5 kW/m^2



APPENDIX H
GROUNDWATER WELL DETAILS

Wells within 2 km of the Project Boundary *Project # 22-8516*

Well ID	Address	Community	County	Depth (m)	Casing (m)	Bedrock (m)	Static (m)	Yield (Lpm)	Elevation (masl)	Type	Water Use	Easting	Northing	Date Installed
1913	PORT HASTINGS	CRANDALL ROAD	INVERNESS	22.23	12.18	2.13	3.04	68.1	105	DRILLED	Domestic	627500	5056500	7/18/2000
1928	PLEASANT ROAD	CRANDALL ROAD	INVERNESS	29.84	12.18	1.83	3.04	113.5	122	DRILLED	Domestic	628500	5056500	10/16/2000
11107	815 QUEEN STREET, PORT HAWKESBURY, HIGHWAY #4	MACINTYRE LAKE	INVERNESS	44.76	24.36	22.84	13.7	22.7	22	DRILLED	Domestic	628650	5052195	5/21/2001
31901	44 HATCHER ROAD	ASKILTON	INVERNESS	37.76	12.18	2.13	2.44	18.16	85	DRILLED	Domestic	629995	5058889	11/26/2003
32699	PLEASANT HILL	PORT HASTINGS	INVERNESS	38.06	12.18	4.26		26.1	5	DRILLED	Domestic	627500	5053500	11/27/2003
41749	PORT HAWKESBURY	CRANDALL ROAD	INVERNESS	37.76	6.09		3.04	45.4	94	DRILLED	Domestic	629418	5057693	9/15/2004
52636	67 Heavy Water (P) Road	POINT TUPPER	RICHMOND	42.63	12.18	6.09		408.6	29	DRILLED	Commercial	629075	5050462	4/19/2005
171033	571 CRANDALL ROAD	PORT HAWKESBURY	INVERNESS	44.15	6.09	2.44	3.04	136.2	105	DRILLED	Domestic	629160	5055215	12/11/2017
430025	BLACK & WHITE INN	PORT HAWKESBURY	INVERNESS	26.49					45	DRILLED		629500	5052500	7/31/1943
440063	PORT HAWKESBURY	PORT HAWKESBURY	INVERNESS	36.54	3.04	2.13	5.48	22.7	32	DRILLED	Domestic	628127	5054161	5/24/1944
590017		PORT HAWKESBURY	INVERNESS	15.22	2.74		0	27.24	5	DRILLED	Domestic	627500	5053500	6/30/1959
590020		PORT HAWKESBURY	INVERNESS	17.36	4.26	3.96	0	27.24	5	DRILLED	Domestic	627500	5053500	7/31/1959
600012		PORT HAWKESBURY	INVERNESS	30.45	8.22		0	22.7	56	DRILLED	Domestic	629500	5053500	12/31/1960
600050	PLEASANT HILL SCHOOL	PLEASANT HILL	INVERNESS	14.01	2.44		0	18.16	117	DRILLED	Municipal	627853	5056227	10/31/1960
610007		PORT HAWKESBURY	INVERNESS	19.79	3.96		0	36.32	56	DRILLED	Domestic	629500	5053500	4/30/1961
610031		PORT HAWKESBURY	INVERNESS	19.49	5.18		0	27.24	45	DRILLED	Commercial	629500	5052500	8/31/1961
620111		PORT HAWKESBURY	INVERNESS	21.32	9.14	8.53	3.04	36.32	9	DRILLED	Domestic	628954	5051443	12/31/1962
650008		PORT HAWKESBURY	INVERNESS	121.8	6.09	5.18		136.2	36	DRILLED	Municipal	628500	5052500	11/23/1965
650020		PORT HAWKESBURY	INVERNESS	45.68	10.05	4.57		22.7	36	DRILLED		628500	5052500	8/16/1965
650031	RINK	PORT HAWKESBURY	INVERNESS	45.68	13.7	13.09		45.4	36	DRILLED		628500	5052500	11/25/1965
650106		PORT HAWKESBURY	INVERNESS	30.45	9.44	6.09	6.09	22.7	8	DRILLED	Domestic	627456	5053587	5/8/1965
650107		PORT HAWKESBURY	INVERNESS	39.58	26.19	4.57	2.44	90.8	36	DRILLED	Industrial	628500	5052500	4/15/1965
660680		PORT HAWKESBURY	INVERNESS	48.72	5.48	4.57	12.18	6.81	36	DRILLED	Domestic	628500	5052500	7/6/1966
660686		PORT HAWKESBURY	INVERNESS	22.84	13.4	12.79	6.7	13.62	36	DRILLED	Domestic	628500	5052500	1/1/1966
660687		PORT HAWKESBURY	INVERNESS	24.36	6.09	4.57	3.65	45.4	36	DRILLED	Domestic	628500	5052500	8/11/1966
660705		PORT HAWKESBURY	INVERNESS	27.4	5.48	1.83	9.14	18.16	36	DRILLED	Domestic	628500	5052500	11/7/1966
660719		PORT HAWKESBURY	INVERNESS	27.4	6.09	4.57	4.57	227	36	DRILLED	Domestic	628500	5052500	8/25/1966
660726		PORT HAWKESBURY	INVERNESS	16.75		1.83	3.96	13.62	36	DRILLED	Domestic	628500	5052500	6/10/1966
660732		PORT HAWKESBURY	INVERNESS	35.02	6.09	3.04	6.09	9.08	36	DRILLED	Domestic	628500	5052500	8/17/1966
660733		PORT HAWKESBURY	INVERNESS	33.5			1.52	22.7	36	DRILLED	Domestic	628500	5052500	6/30/1966
660735		PORT HAWKESBURY	INVERNESS	48.72	4.57	2.44	3.04	4.54	36	DRILLED	Domestic	628500	5052500	7/5/1966
660742		PORT HAWKESBURY	INVERNESS	38.06	12.79	10.66	7.31	9.08	36	DRILLED	Domestic	628500	5052500	8/10/1966
670116		POINT TUPPER	RICHMOND	25.88	8.83	8.22	8.53	22.7	28	DRILLED	Domestic	628435	5051410	4/27/1967
670175		PORT HAWKESBURY	INVERNESS	35.02	9.74	6.39		27.24	36	DRILLED	Domestic	628500	5052500	3/4/1967
670609		PORT HAWKESBURY	INVERNESS	91.35	4.57		1.83	454	36	DRILLED	Municipal	628500	5052500	11/18/1967
670610		PORT HAWKESBURY	INVERNESS						36	DRILLED		628500	5052500	9/4/1967
670616		POINT TUPPER	RICHMOND	60.9	12.79	9.14	6.09	227	7	DRILLED	Industrial	628892	5049452	6/19/1967
670629		PORT HAWKESBURY	INVERNESS	60.9	6.39	3.04	2.44	227	36	DRILLED	Industrial	628500	5052500	5/29/1967
670630		PORT HAWKESBURY	INVERNESS	66.08	6.09	1.52	2.44	217.92	36	DRILLED	Industrial	628500	5052500	11/8/1967
670631		PORT HAWKESBURY	INVERNESS	62.42	7.31	3.04	3.04	263.32	36	DRILLED	Industrial	628500	5052500	11/3/1967
670632		PORT HAWKESBURY	INVERNESS	91.35	6.09	1.52	4.87	227	36	DRILLED	Industrial	628500	5052500	6/23/1967
670647		PORT HAWKESBURY	INVERNESS	30.45	5.79	3.04	9.14	13.62	36	DRILLED	Domestic	628500	5052500	8/3/1967
670648		PORT HAWKESBURY	INVERNESS	36.54	4.57	3.04	9.14	13.62	36	DRILLED	Domestic	628500	5052500	10/2/1967
670649		PORT HAWKESBURY	INVERNESS	36.54	4.57	2.44	7.31	18.16	36	DRILLED	Domestic	628500	5052500	10/4/1967
670650		PORT HAWKESBURY	INVERNESS	51.76	3.35	2.44	12.18	45.4	36	DRILLED	Domestic	628500	5052500	9/28/1967
671052		PORT HAWKESBURY	INVERNESS	11.27				9.08	36	DRILLED	Domestic	628500	5052500	9/19/1967
671056		PORT HAWKESBURY	INVERNESS	17.05	6.39	5.48		22.7	27	DRILLED	Domestic	628663	5052249	1/1/1967
680024		PORT HAWKESBURY	INVERNESS	24.36	4.57	3.04		13.62	36	DRILLED	Domestic	628500	5052500	7/1/1968
680125		POINT TUPPER	RICHMOND	36.84	12.79	9.74		22.7	32	DRILLED		628209	5051455	11/16/1968
680737		POINT TUPPER	RICHMOND	16.75	6.09	3.04	4.57	22.7	14	DRILLED	Domestic	632901	5048609	2/22/1968
681214		PORT HAWKESBURY	INVERNESS	35.02		16.14			36	DRILLED		628500	5052500	5/27/1968
681215		PORT HAWKESBURY	INVERNESS	57.86		6.7			36	DRILLED		628500	5052500	5/21/1968
681216		PORT HAWKESBURY	INVERNESS	24.36	12.48	9.14		18.16	36	DRILLED	Domestic	628500	5052500	10/21/1968
681219		PORT HAWKESBURY	INVERNESS	10.66	7.31	6.09		22.7	36	DRILLED		628500	5052500	6/28/1968
690113		PORT HAWKESBURY	INVERNESS	49.33	6.09	3.04	4.57	27.24	5	DRILLED	Domestic	632753	5048424	4/3/1969
690124		PORT HAWKESBURY	INVERNESS	29.54	19.18	4.87	4.26	45.4	67	DRILLED	Domestic	631146	5054565	10/15/1969
690189		PORT HAWKESBURY	INVERNESS	21.62	19.18	6.39	2.44	340.5	74	DRILLED	Domestic	631118	5054691	10/4/1969
691180		PORT HAWKESBURY	INVERNESS	33.5	33.5	12.18		18.16	36	DRILLED	Domestic	628500	5052500	12/20/1969
691182		PORT HAWKESBURY	INVERNESS	19.49	5.48	3.04	4.57	18.16	38	DRILLED	Domestic	632431	5055683	11/7/1969
700092		PORT HAWKESBURY	INVERNESS	29.54	23.75	3.04	3.04	136.2	79	DRILLED	Domestic	630726	5054463	7/4/1970
700154		POINT TUPPER	RICHMOND	36.84	12.79	11.57	3.04	54.48	29	DRILLED	Domestic	628174	5051263	11/12/1970
710145		POINT TUPPER	RICHMOND	48.72	6.7	3.65	11.57	31.78	40	DRILLED	Domestic	628416	5051314	9/20/1971
710202		PORT HAWKESBURY	INVERNESS	35.32	16.44	2.44	6.09	54.48	5	DRILLED	Domestic	627775	5053465	5/21/1971
711090		PORT HAWKESBURY	INVERNESS	36.54	5.48	4.26		18.16	85	DRILLED	Domestic	628702	5059503	4/2/1971
720150	PORT HAWKESBURY	PORT HAWKESBURY	RICHMOND	33.5	13.09	8.53	5.79	31.78	41	DRILLED	Domestic	628503	5052758	4/6/1972
720222		MACINTYRE LAKE	INVERNESS	82.22	27.1	33.5	9.14	2.27	35	DRILLED	Domestic	632566	5055786	7/31/1972
730259		PORT HAWKESBURY	INVERNESS	52.68	6.09	4.26	2.74	68.1	36	DRILLED	Domestic	628500	5052500	4/13/1973
731659		PORT HAWKESBURY	INVERNESS	20.1	6.39	4.87		18.16	2	DRILLED	Domestic	627758	5053409	11/29/1973
740199	LANDRIE LAKE	PORT HAWKESBURY	INVERNESS	90.13	13.09	11.57	3.96	13.62	18	DRILLED	Domestic	632499	5048438	8/21/1974
740249		PORT HAWKESBURY	INVERNESS	29.84	7.61	2.44	1.52	18.16	36	DRILLED	Domestic	628500	5052500	10/28/1974
740281		POINT TUPPER	RICHMOND	44.76	6.39	5.48	4.57	15.89	35	DRILLED	Domestic	628277	5051366	8/9/1974
741475		POINT TUPPER	RICHMOND	22.84	5.48	3.65		22.7	37	DRILLED	Domestic	628315	5051319	9/5/1974
741488		PORT HAWKESBURY	INVERNESS	19.79	6.7	5.79		18.16	36	DRILLED	Domestic	628500	5052500	3/16/1974
741504		PORT HAWKESBURY	INVERNESS	22.84	12.79	6.7		22.7	36	DRILLED	Domestic	628500	5052500	6/14/1974
741505		PORT HAWKESBURY	INVERNESS	22.84	12.79	7.31		18.16	36	DRILLED	Domestic	628500	5052500	6/15/1974
750221		L'ARDOISE	RICHMOND	29.54	6.39	4.26	4.57	22.7	119	DRILLED	Domestic	629057	5055611	10/13/1975
750244		POINT TUPPER	RICHMOND	22.23	12.18	0.91	0.91	68.1	37	DRILLED	Industrial	630224	5048363	10/8/1975
750246		POINT TUPPER	RICHMOND	29.54	13.4	1.52	3.04	45.4	51	DRILLED	Industrial	630614	5048189	10/9/1975
751640		PORT HAWKESBURY	INVERNESS	30.15	5.79	3.04		18.16	36	DRILLED	Domestic	628500	5052500	4/25/1975

Well ID	Address	Community	County	Depth (m)	Casing (m)	Bedrock (m)	Static (m)	Yield (Lpm)	Elevation (masl)	Type	Water Use	Easting	Northing	Date Installed
751651		PORT HAWKESBURY	INVERNESS	15.22	6.7	5.79		22.7	36	DRILLED	Domestic	628500	5052500	3/14/1975
751661		PORT HAWKESBURY	INVERNESS	22.84	8.53	3.04		18.16	36	DRILLED	Domestic	628500	5052500	10/30/1975
760188		PORT HAWKESBURY	INVERNESS	45.07	13.7	10.96	3.65	81.72	45	DRILLED	Domestic	629931	5052291	1/22/1976
761064		POINT TUPPER	RICHMOND	22.84	24.36	1.22	6.09	68.1	34	DRILLED	Domestic	628268	5051441	11/18/1976
761595		PORT HAWKESBURY	INVERNESS	33.5	6.09	1.52		13.62	36	DRILLED		628500	5052500	10/11/1976
771278		Macdale	INVERNESS	21.32	5.48			22.7	81	DRILLED	Domestic	628197	5059142	5/16/1977
771280		MACKDALE	INVERNESS	14.01	6.09	3.65		22.7	75	DRILLED	Domestic	628300	5059292	6/17/1977
771286		POINT TUPPER	RICHMOND	13.4	6.7	4.87		36.32	28	DRILLED	Domestic	628259	5051253	2/2/1977
780761		PORT HAWKESBURY	INVERNESS	9.44	7	0.91	0.91	36.32	18	DRILLED	Domestic	629190	5049860	12/31/1978
780763		POINT TUPPER	RICHMOND	24.36	13.4		1.22	31.78	7	DRILLED	Domestic	629158	5051403	12/31/1978
780765		PORT HAWKESBURY	INVERNESS	29.54	6.7	3.65	4.57	40.86	78	DRILLED	Domestic	630718	5054523	12/31/1978
780770		PORT HASTINGS	INVERNESS	15.22	6.09		0.91	54.48	116	DRILLED	Domestic	627408	5057542	12/31/1978
790127	PORT HAWKESBURY	PORT HASTINGS	INVERNESS	37.15	6.39		3.04	18.16	111	DRILLED	Domestic	629031	5057575	5/2/1979
790137		PORT HAWKESBURY	INVERNESS	37.15	13.09	12.18	2.13	31.78	7	DRILLED	Domestic	629158	5051403	9/28/1979
790198		POINT TUPPER	RICHMOND	23.45	6.7		0.61	54.48	7	DRILLED	Domestic	629158	5051403	7/24/1979
791404		BARRA HEAD	RICHMOND	16.14	7	4.26	3.65	36.32	103	DRILLED	Domestic	629249	5057007	1/1/1979
791432	PLEASANT HILL	PORT HASTINGS	INVERNESS	22.84	6.7	4.57	9.14	22.7	133	DRILLED	Domestic	628368	5056096	7/14/1979
800116		PORT HAWKESBURY	INVERNESS	21.92		3.04	7.61	27.24	34	DRILLED	Domestic	629126	5052946	8/26/1980
800157	PORT HASTINGS	PORT HAWKESBURY	INVERNESS	37.15	12.18	8.83	4.57	13.62	60	DRILLED	Domestic	630751	5052980	10/24/1980
800191	PORT HAWKESBURY	CRANDALL ROAD	INVERNESS	33.5	6.7	3.35	6.09	13.62	118	DRILLED	Domestic	629063	5056032	8/7/1980
801262		PORT HAWKESBURY	INVERNESS	13.7	7	1.83	3.35	27.24	80	DRILLED	Domestic	629095	5054489	5/23/1980
801266		MACKDALE	INVERNESS	22.84	7	4.26	3.04	18.16	80	DRILLED	Domestic	628302	5059142	9/19/1980
810110		PORT HAWKESBURY	INVERNESS	21.92	6.7	5.18	3.04	36.32	7	DRILLED	Domestic	629158	5051403	12/11/1981
810863		PORT HAWKESBURY	INVERNESS	10.96	6.7	4.57	2.44	18.16	53	DRILLED	Domestic	627471	5054456	8/11/1981
810913		PORT HASTINGS	INVERNESS	26.8	25.27	24.97	16.14	27.24	78	DRILLED	Domestic	628999	5059118	1/7/1981
820758		PORT HASTINGS	INVERNESS	17.36	6.09	3.65	3.04	13.62	116	DRILLED	Domestic	627408	5057542	10/28/1982
830018		CRANDALL ROAD	INVERNESS	24.36	6.39		6.09	36.32	88	DRILLED	Domestic	630025	5058819	5/14/1983
830036	DAVIS DRIVE	CRANDALL ROAD	INVERNESS	29.84	7	4.26	3.65	18.16	118	DRILLED	Domestic	629063	5056032	8/15/1983
830037	DAVIS DRIVE	CRANDALL ROAD	INVERNESS	40.19	6.7	3.04	3.04	45.4	118	DRILLED	Domestic	629063	5056032	8/16/1983
830066		CRANDALL ROAD	INVERNESS	21.92	7	1.52	4.57	13.62	118	DRILLED	Domestic	629063	5056032	10/12/1983
840004	PORT HAWKESBURY	CRANDALL ROAD	INVERNESS	31.36	6.39	3.65	4.57	49.94	118	DRILLED		629063	5056032	7/5/1984
840044	PORT HASTINGS	CRANDALL ROAD	INVERNESS	37.15	7.61	5.18	4.57	36.32	118	DRILLED	Domestic	629063	5056032	11/29/1984
850802		PORT HAWKESBURY	INVERNESS	25.88	6.09	3.65	4.57	27.24	53	DRILLED	Domestic	627471	5054456	6/12/1985
860001	PLEASANT HILL	PORT HAWKESBURY	INVERNESS	37.15	6.39	3.04	3.65	22.7	5	DRILLED	Domestic	627500	5053500	6/11/1986
861545		PORT HAWKESBURY	INVERNESS	19.49	13.4	0.91	6.09	18.16	55	DRILLED	Domestic	628500	5054500	11/17/1986
870961	PLEASANT HILL	PORT HAWKESBURY	INVERNESS	26.19	7.61	1.52	1.83	31.78	50	DRILLED	Domestic	627500	5054500	8/3/1987
871030		PORT HAWKESBURY	INVERNESS	21.01	5.48	3.04	3.96	54.48	50	DRILLED	Domestic	627500	5054500	8/20/1987
872122		MACKDALE	INVERNESS	18.27	17.97	4.26	7.61	68.1	82	DRILLED	Domestic	628500	5059500	3/13/1987
872140	DAVIS DRIVE (HILL TOP)	PORT HASTINGS	INVERNESS	29.54	12.18	7.92	9.14	27.24	88	DRILLED	Domestic	629500	5054500	7/20/1987
872143		PORT HAWKESBURY	INVERNESS	60.29	6.09	3.04	3.04	181.6	25	DRILLED	Heat Pump (source or dis)	630500	5051500	7/30/1987
872176	PORT HAWKESBURY	CRANDALL ROAD	INVERNESS	29.54	6.7	3.65	6.09	36.32	98	DRILLED	Domestic	629500	5057500	12/14/1987
882066		MACINTYRE LAKE	INVERNESS	54.2	42.63		21.32	11.35	39	DRILLED	Domestic	632500	5055500	10/27/1988
882099	AT DAVIES DRIVE	PORT HAWKESBURY	INVERNESS	44.76	13.4	2.44	6.09	18.16	5	DRILLED	Domestic	627500	5053500	4/28/1988
882104		PORT HAWKESBURY	INVERNESS	37.15	6.7	0.61	10.66	31.78	36	DRILLED	Domestic	628500	5053500	6/1/1988
882126		PORT HAWKESBURY	INVERNESS	29.54	6.09	2.13	3.04	45.4	88	DRILLED	Domestic	629500	5054500	7/20/1988
882128	PLEASANT HILL	PORT HAWKESBURY	INVERNESS	29.54	6.09	3.35	19.79	22.7	89	DRILLED	Domestic	629500	5056500	7/26/1988
882160		PORT HAWKESBURY	INVERNESS	37.45	12.18	3.35	25.88	27.24	36	DRILLED	Domestic	628500	5053500	10/5/1988
882345	CRANDAL ROAD	PORT HAWKESBURY	INVERNESS	36.54	6.09	3.65	5.48	18.16	36	DRILLED	Domestic	628903	5052452	7/11/1988
892028	RCMP PORT HAWKESBURY	PORT HAWKESBURY	INVERNESS	39.58	12.18	2.44	2.44	68.1	88	DRILLED		629500	5054500	4/3/1989
892042	DAVIS DRIVE, RR#1 CLEVELAND	PORT HAWKESBURY	INVERNESS	29.84	12.18	2.74	6.09	22.7	88	DRILLED		629500	5054500	5/27/1989
892046	DAVIS DRIVE	PORT HAWKESBURY	INVERNESS	22.23	12.18			18.16	88	DRILLED		629500	5054500	6/9/1989
892078		POINT TUPPER	RICHMOND	52.37	7	5.48	5.48	22.7	20	DRILLED		628500	5051500	8/9/1989
892109	CRANDAL ROAD	PORT HAWKESBURY	INVERNESS	37.15	10.35	1.22	3.04	54.48	36	DRILLED		628500	5052500	10/23/1989
902167	PORT HAWKESBURY	PORT HASTINGS	INVERNESS	37.15	12.18	4.26	3.04	113.5	122	DRILLED		628500	5056500	2/22/1990
902170	DAVID DRIVE	PORT HAWKESBURY	INVERNESS	44.76	8.53	3.35	4.57	45.4	55	DRILLED		628500	5054500	3/20/1990
902171		PORT HAWKESBURY	INVERNESS	44.76	12.18		3.04	68.1	77	DRILLED		631500	5054500	3/26/1990
902214	CRANDALL ROAD	PORT HASTINGS	INVERNESS	37.15	12.18	2.44	3.04	27.24	122	DRILLED		628500	5056500	9/17/1990
902635	LONG STRETCH ROAD	PORT HASTINGS	INVERNESS	43.85	12.18	1.83		18.16	100	DRILLED		627500	5058500	12/13/1990
910118	TINA MACLELLAN	MACKDALE	INVERNESS	31.97	12.18	4.57	6.09	45.4	100	DRILLED		627500	5058500	4/30/1991
942517	105 HIRAM, PORT HAWKESBURY	PORT HASTINGS	INVERNESS	37.15	12.18	4.57	4.57	31.78	32	DRILLED	Domestic	627700	5053098	7/20/1994
942900		POINT TUPPER	RICHMOND	27.4	6.09		6.39	5.45	21	DRILLED	Industrial	628500	5050500	4/21/1994
952372	PORT PLEASANT HILL	PORT HAWKESBURY	INVERNESS	44.76	12.18	10.66	3.04	18.16	36	DRILLED	Domestic	628500	5052500	1/17/1995
952385		PORT HAWKESBURY	INVERNESS	37.15	12.18	5.18	4.26	18.16	20	DRILLED	Domestic	628500	5051500	8/17/1995
952394	SUGAR CAMP	CRANDALL ROAD	INVERNESS	37.15	18.27	3.04	25.88	36.32	75	DRILLED	Domestic	629503	5057952	9/22/1995
952430		MACINTYRE LAKE	INVERNESS	3.2	3.2		2.44		77	DUG	Domestic	631500	5054500	6/16/1995
972705	HILLTOP	PORT HAWKESBURY	INVERNESS	37.15	12.18	2.44	3.04	18.16	88	DRILLED	Domestic	629500	5054500	6/27/1997
972739	CRANDALL ROAD	CRANDALL ROAD	INVERNESS	29.54	12.18	5.18	3.04	18.16	105	DRILLED	Domestic	627500	5056500	8/22/1997
980101		PORT HAWKESBURY	INVERNESS	29.54	12.18	6.09	0.61	36.32	36	DRILLED	Domestic	628500	5053500	6/8/1998
980545	POINT TUPPER	PORT HAWKESBURY	INVERNESS	92.57	12.18	2.44		68.1	39	DRILLED		629500	5050500	10/27/1998
981912		POINT TUPPER	RICHMOND	92.57	12.18		12.18	68.1	39	DRILLED		629500	5050500	10/27/1998
982219		PORT HAWKESBURY	INVERNESS	29.54	12.18	3.65	3.04	22.7	55	DRILLED	Domestic	628500	5054500	9/10/1998
982262		CRANDALL ROAD	INVERNESS	37.15	12.18	3.04	4.57	22.7	87	DRILLED	Domestic	629913	5058869	12/15/1998
982267		PORT HAWKESBURY	INVERNESS	29.54	12.18	6.09	0.61	36.32	36	DRILLED	Domestic	628500	5053500	1/8/1998
991210		MACKDALE	INVERNESS	44.76	12.18	6.7	3.65	4.54	100	DRILLED	Domestic	627500	5058500	6/3/1999
992693	LONG STRETCH ROAD	MACKDALE	INVERNESS	43.85	12.18	3.65	6.09	27.24	100	DRILLED	Domestic	627500	5058500	11/1/1999
993185		MACKDALE	INVERNESS	42.63	7	5.48	5.48	13.62	82	DRILLED	Domestic	628500	5059500	6/25/1999
			AVERAGE	**34.60**	**9.91**	**5.11**	**5.14**	**49.21**	**53**					
			MIN	**3.20**	**2.44**	**0.61**	**0.00**	**2.27**	**2**					
			MAX	**121.80**	**42.63**	**33.50**	**25.88**	**454.00**	**133**					

Source: NSECC(2020)

APPENDIX I
FIELD SURVEY METHODOLOGY

Watercourse Surveys

Watercourse surveys were completed during the months of August, September, and October 2022 within the Project Boundary (along with previous layout iterations for the Transmission Interconnection Line and Industrial Facility). Watercourse surveys included the delineation of all watercourses within the Project Boundary along with an assessment of physical and habitat characteristics. Watercourse surveys were completed by qualified biologists with past experience in watercourse delineation and evaluation.

The following parameters were recorded as part of the watercourse surveys:

- Watercourse Type (permanent, intermittent, etc.)
- Width (channel and wetted)
- Depth (bank, water, and pool)
- Velocity
- Substrate composition
- Habitat characteristics (riffle, run, etc.)
- Instream cover
- Riparian habitat description
- Evidence of erosion and siltation
- Fish presence/habitat

During the survey, GPS waypoints and photos were also collected if notable habitat and/or Species of Conservation Interest (SOCI) were observed.

Wetland Surveys

Wetland surveys were completed during the months of August, September, and October, 2022 within the Project Boundary (along with previous layout iterations for the Transmission Interconnection Line and Industrial Facility). Wetland surveys included wetland delineation of all wetlands within the Project Boundary along with functional assessments for select representative wetlands. Wetland delineations and functional assessments were completed by qualified biologists with past experience in wetland identification, delineation, and WESP-AC assessment.

One wetland delineation was completed out of season (after September 30) along a section of the Transmission Interconnection Line located within the fence line of the existing Point Tupper Terminal. Strum received approval/permission from NS Environment and Climate Change (NSECC) to complete out of season wetland delineations on September 27, 2022. Conditions were also adequate for an out of season wetland delineation as no snow was present on the ground and the area had undergone previous assessment during the growing season (August to September) for incidental SOCI and significant habitat.

Wetland Delineation Surveys

Wetland delineation surveys adhered to the protocol outlined in the US Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory, 1987). To be considered a wetland, the following three criteria need to be present and were assessed in the field:

- Presence of hydrophytic (water loving) vegetation
- Presence of hydrologic conditions that result in periods of flooding, ponding, or saturation during the growing season
- Presence of hydric soils (anaerobic conditions in upper part)

Identification of Hydrophytic Vegetation

Hydrophytic vegetation is defined as the sum total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanent or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present (Environmental Laboratory, 1987).

An inventory of dominant vegetation (herbaceous, graminoids, shrubs, and trees) was recorded during wetland delineation surveys, which included photos, upland habitat descriptions, and observances of any SOCI.

Identification of Hydric Soils

A hydric soil is a soil that has formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (USDA-NRCS, 2010). Indicators of the presence of a hydric soil include soil colour (gleyed soils and soils with bright mottles and/or low matrix chroma), aquic or preaquic moisture regime, reducing soil conditions, sulfidic material (odour), soils listed on the hydric soils list, iron and manganese concretions, organic soils (histosols), histic epipedon, high organic content in surface layer in sandy soils, and organic streaking in sandy soils.

Soil pits were excavated to a maximum depth of 40 cm or refusal. The soil in each pit was then examined for hydric soil indicators. The matrix colour and mottle colour (if present) of the soil were determined using the Munsell Soil Colour Charts.

Determination of Wetland Hydrology

Wetland habitat, by definition, either periodically or permanently, has a water table at, near, or above the land surface or that is saturated with water. To be classified as a wetland, it should have at least one primary indicator or two secondary indicators of wetland hydrology. Primary indicators include water marks, drift lines, sediment deposition, drainage patterns, water-stained leaves, and visual observations of saturated soils or inundation. Secondary indicators include oxidized root channels, dry season water table, and stressed/stunned plants.

During the surveys, wetland habitat was assessed for signs of hydrology, via visual observations across the area and through assessment of soil pits.

Fish & Fish Habitat

Fish presence and existing habitat were documented as part of the watercourse assessment surveys conducted within the Project Boundary and alternative layouts/routes. During each watercourse assessment, notes on the visual observance of fish were recorded along with any habitat characteristics that may influence fish presence such as pool/rifle sequences, barriers to fish passage, and substrate composition. This information, along with results of the desktop review, was then used to select ideal watercourses for qualitative electrofishing.

The fish and fish habitat assessments were completed in September 2022 and included several components:

- An analysis of in-situ water chemistry
- A physical analysis of the watercourse including bank characteristics and substrate composition
- An assessment of fish habitat potential across various life stages (i.e., spawning, rearing, and overwintering)
- Qualitative electrofishing

Electrofishing was conducted over 200 m stretches along the watercourse, where the assessments of chemical/physical characteristics and fish habitat were conducted at 0 m, 100 m, and 200 m (heading upstream). Notes were taken any points of concern such as obstructions to fish passage (e.g., elevated culvert).

Terrestrial Habitat, Flora, and Fauna

Incidental observations (informed by the results of the desktop assessment) of terrestrial SOCI and significant habitat (e.g., old growth) were recorded during watercourse, wetland, and fish/fish habitat surveys completed between August and October 2022. Any SOCI or significant habitat found during the aforementioned surveys were documented via photographs, notes, and a GPS waypoint was taken.

APPENDIX J
DESKTOP IDENTIFIED WATERCOURSES

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
Industrial Facility				
River - Single Line		379049	406.48	222.74
River - Single Line Indefinite		407099	391.38	306.97
River - Single Line		376681	466.00	377.23
River - Single Line		377322	316.30	430.27
River - Single Line Indefinite		405022	311.60	549.68
River - Single Line		368267	543.38	622.88
River - Single Line		383203	253.90	630.06
River - Single Line Indefinite		410040	158.00	641.23
River - Single Line		366372	30.53	659.95
River - Single Line		391504	172.33	678.42
River - Single Line		391379	1,072.32	787.83
River - Single Line		368742	477.64	824.79
River - Single Line		376483	1,255.77	897.43
River - Single Line		371159	490.92	947.81
River - Single Line		377458	58.37	1,036.43
River - Single Line		391616	19.34	1,038.24
River - Single Line		369442	351.37	1,044.54
River - Single Line		389409	196.61	1,091.19
River - Single Line Indefinite		409206	87.93	1,104.95
River - Single Line Indefinite		404548	27.51	1,131.58
River - Single Line Indefinite		406426	105.26	1,155.16
River - Single Line		380144	189.30	1,183.62
River - Single Line		352965	19.98	1,361.61
River - Single Line		393081	239.60	1,434.64
River - Single Line		372772	130.38	1,438.51
River - Single Line		352964	95.66	1,454.00
River - Single Line		364921	9.62	1,493.02
River - Single Line		372377	15.22	1,502.46
River - Single Line Indefinite		406973	193.13	1,514.88
River - Single Line		370709	12.06	1,564.74
River - Single Line	Seacoal Brook	400498	89.53	1,575.47
River - Single Line	Seacoal Brook	400499	273.10	1,575.47
River - Single Line		364906	5.73	1,590.01
River - Single Line		380984	33.93	1,590.53
River - Single Line		392846	23.00	1,593.07
River - Single Line		374225	39.88	1,647.37
River - Single Line Indefinite		407498	25.70	1,678.36
River - Single Line		384052	479.87	1,763.89
River - Single Line		391278	324.78	1,856.15
River - Single Line		385260	273.56	1,885.28
River - Single Line		379001	718.43	1,936.50
River - Single Line		375215	719.88	1,950.26
River - Single Line		377359	582.55	2,097.72
River - Single Line		364264	1,384.81	2,107.34
River - Single Line		389894	642.66	2,122.13
River - Single Line		363776	372.36	2,130.24
River - Single Line		375135	408.97	2,171.58
River - Single Line		352675	127.05	2,367.51
River - Single Line		388843	295.41	2,423.45
River - Single Line		376663	969.41	2,451.76

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
River - Single Line		371038	465.71	2,487.97
River - Single Line Indefinite		409232	783.81	2,521.16
River - Single Line		351997	14.81	2,560.29
River - Single Line		378989	60.40	2,572.44
River - Single Line		372673	402.68	2,673.36
River - Single Line		389898	519.52	2,725.49
River - Single Line		380487	1,020.65	2,738.49
River - Single Line Indefinite		404990	808.84	2,762.07
River - Single Line	Seacoal Brook	400501	71.93	3,052.64
River - Single Line		371462	374.70	3,062.30
River - Single Line	Seacoal Brook	400500	499.37	3,110.71
River - Single Line Indefinite		407818	381.19	3,110.71
River - Single Line		382280	28.07	3,231.78
River - Single Line		391375	1,295.93	3,255.69
River - Single Line		365316	818.33	3,278.77
River - Single Line Indefinite		404972	166.01	3,341.95
River - Single Line Indefinite		411503	111.16	3,341.95
River - Single Line		368232	351.57	3,455.91
River - Single Line		371845	146.33	3,475.57
River - Single Line Indefinite	Seacoal Brook	412685	1,092.89	3,475.57
River - Single Line		390539	142.00	3,475.98
River - Single Line		379871	632.96	3,486.42
River - Single Line		387228	453.69	3,490.02
River - Single Line		378702	756.78	3,534.60
River - Single Line		364080	233.84	3,541.44
River - Single Line		370210	714.73	3,635.16
River - Single Line		391244	27.34	3,635.16
River - Single Line		376451	96.32	3,654.90
River - Single Line		352978	170.31	3,684.71
River - Single Line		375741	1,055.26	3,693.84
River - Single Line		381222	57.91	3,708.57
River - Single Line		390234	34.94	3,815.34
River - Single Line		387899	109.97	3,842.18
River - Single Line		368723	36.07	3,849.97
River - Single Line		384500	455.66	3,874.21
River - Single Line		374825	183.42	3,881.12
River - Single Line		353401	169.23	3,882.74
River - Single Line		364589	120.74	3,884.51
River - Single Line Indefinite		404803	399.36	3,885.04
River - Single Line		384659	470.72	3,893.88
River - Single Line		381342	473.94	3,939.27
River - Single Line		369451	919.46	3,964.39
River - Single Line		352987	19.33	4,030.09
River - Single Line	Seacoal Brook	400497	1,141.79	4,042.21
River - Single Line		352287	105.14	4,042.42
River - Single Line		352284	51.11	4,145.31
River - Single Line		363906	169.64	4,145.31
River - Single Line		389621	861.63	4,146.62
River - Single Line		381888	1,518.15	4,146.72
River - Single Line		390079	182.12	4,146.72
River - Single Line Indefinite		408556	328.46	4,152.47
River - Single Line		352189	36.89	4,163.52

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
River - Single Line		386793	36.18	4,174.69
River - Single Line Indefinite		405246	437.14	4,305.39
River - Single Line		376129	173.93	4,322.74
River - Single Line		372662	256.72	4,338.29
River - Single Line		385406	205.59	4,370.59
River - Single Line Indefinite		407748	677.33	4,427.13
River - Single Line		375977	16.02	4,495.33
River - Single Line		352958	389.87	4,525.66
River - Single Line		366585	461.50	4,543.18
River - Single Line		385608	12.99	4,585.10
River - Single Line Indefinite		409161	525.15	4,586.14
River - Single Line		352180	260.94	4,630.87
River - Single Line		382728	243.91	4,630.87
River - Single Line		366514	31.41	4,683.77
River - Single Line		388882	102.09	4,759.37
River - Single Line Indefinite		410555	366.95	4,807.24
River - Single Line		364870	56.38	4,846.58
River - Single Line		369590	368.23	4,859.42
River - Single Line		376522	287.17	4,888.52
River - Single Line		383836	645.32	4,892.54
River - Single Line		383261	15.69	4,900.93
River - Single Line	Little River	397239	15.81	4,927.86
Transmission Interconnection Line				
River - Single Line Indefinite	Seacoal Brook	412685	1,092.89	0.00
River - Single Line		363776	372.36	0.00
River - Single Line		369442	351.37	0.00
River - Single Line		368267	543.38	0.00
River - Single Line		371159	490.92	0.00
River - Single Line		370838	522.93	0.00
River - Single Line		375985	569.99	0.00
River - Single Line		379001	718.43	0.00
River - Single Line		385249	439.92	0.00
River - Single Line		391278	324.78	0.00
River - Single Line Indefinite		404990	808.84	0.00
River - Single Line Indefinite		409232	783.81	10.43
River - Single Line		381888	1,518.15	11.91
River - Single Line Indefinite		407498	25.70	25.68
River - Single Line		374225	39.88	31.29
River - Single Line Indefinite		406973	193.13	46.93
River - Single Line	Seacoal Brook	400497	1,141.79	58.02
River - Single Line		372377	15.22	139.30
River - Single Line		352964	95.66	140.12
River - Single Line		364921	9.62	140.12
River - Single Line		391616	19.34	149.97
River - Single Line		378068	556.01	161.35
River - Single Line		382588	269.78	161.36
River - Single Line		377458	58.37	180.61
River - Single Line		383203	253.90	194.18
River - Single Line		384659	470.72	225.70
River - Single Line		379049	406.48	234.81
River - Single Line		364126	540.61	248.21

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
River - Single Line		366617	488.63	248.21
River - Single Line	Little River	397235	2,298.42	254.10
River - Single Line		369152	962.58	269.29
River - Single Line Indefinite		412177	1,131.68	270.05
River - Single Line		382280	28.07	280.34
River - Single Line		352965	19.98	284.70
River - Single Line		370210	714.73	314.74
River - Single Line		383800	67.76	368.66
River - Single Line		383381	859.27	378.55
River - Single Line		354309	3.16	381.15
River - Single Line Indefinite		405966	703.98	421.17
River - Single Line		366255	862.42	436.08
River - Single Line		368423	1,076.61	445.78
River - Single Line		385912	597.73	482.42
River - Single Line Indefinite		407099	391.38	557.77
River - Single Line		377322	316.30	560.46
River - Single Line		380487	1,020.65	564.76
River - Single Line Indefinite		404972	166.01	565.17
River - Single Line Indefinite		411503	111.16	565.17
River - Single Line		381351	492.83	580.61
River - Single Line		390539	142.00	605.63
River - Single Line		378702	756.78	605.69
River - Single Line	North Little River	399476	1,097.61	631.71
River - Single Line		390079	182.12	640.72
River - Single Line Indefinite		407818	381.19	651.93
River - Single Line		387228	453.69	681.47
River - Single Line		366053	299.63	703.40
River - Single Line		390041	120.92	703.40
River - Single Line		368232	351.57	717.91
River - Single Line Indefinite		408556	328.46	740.38
River - Single Line	Seacoal Brook	400501	71.93	781.19
River - Single Line		372939	827.21	796.50
River - Single Line		354439	152.09	811.80
River - Single Line	Seacoal Brook	400500	499.37	814.10
River - Single Line		388720	917.76	817.40
River - Single Line Indefinite		405022	311.60	836.97
River - Single Line	North Little River	399482	1,734.42	843.40
River - Single Line		366372	30.53	857.06
River - Single Line	North Little River	354234	445.99	865.78
River - Single Line	North Little River	399478	1,208.69	879.61
River - Single Line		371845	146.33	880.41
River - Single Line		391504	172.33	883.82
River - Single Line	North Little River	354178	9.80	890.64
River - Single Line		389778	607.99	896.82
River - Single Line	North Little River	399481	130.75	899.08
River - Single Line		372338	155.83	909.34
River - Single Line		377781	432.78	909.34
River - Single Line		376451	96.32	911.54
River - Single Line		376681	466.00	911.95
River - Single Line		368938	233.07	916.59
River - Single Line		391137	789.55	918.52
River - Single Line		364080	233.84	919.09

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
River - Single Line		372418	530.04	938.22
River - Single Line		391244	27.34	959.69
River - Single Line Indefinite		408425	288.94	963.13
River - Single Line Indefinite		410706	239.77	963.13
River - Single Line		383967	117.34	967.08
River - Single Line		375905	358.38	970.22
River - Single Line		371462	374.70	984.21
River - Single Line		387757	263.64	1,003.27
River - Single Line		365742	389.73	1,008.05
River - Single Line	North Little River	399480	613.89	1,018.70
River - Single Line		391375	1,295.93	1,023.12
River - Single Line		354452	55.11	1,023.81
River - Single Line		380674	45.19	1,023.81
River - Single Line		381222	57.91	1,035.29
River - Single Line		368742	477.64	1,040.41
River - Single Line		372871	273.29	1,045.30
River - Single Line Indefinite		408926	232.49	1,057.93
River - Single Line		392413	604.31	1,107.99
River - Single Line		393081	239.60	1,112.72
River - Single Line Indefinite		410040	158.00	1,160.08
River - Single Line		369590	368.23	1,163.25
River - Single Line	North Little River	399479	639.13	1,176.41
River - Single Line		364906	5.73	1,189.05
River - Single Line		380984	33.93	1,194.66
River - Single Line		387288	1,912.37	1,199.61
River - Single Line	North Little River	399475	2,476.46	1,212.28
River - Single Line		373938	200.27	1,248.75
River - Single Line		389007	524.95	1,248.75
River - Single Line Indefinite		408163	15.17	1,276.79
River - Single Line	Little River	397236	376.71	1,290.85
River - Single Line		384646	424.09	1,290.91
River - Single Line		363738	829.84	1,300.59
River - Single Line		391379	1,072.32	1,303.36
River - Single Line	Embrees Brook	395627	368.75	1,330.21
River - Single Line		384175	597.77	1,346.01
River - Single Line Indefinite		409161	525.15	1,357.01
River - Single Line	Embrees Brook	395628	342.10	1,363.82
River - Single Line	Embrees Brook	395630	397.00	1,410.58
River - Single Line Indefinite		409206	87.93	1,419.24
River - Single Line Indefinite		404548	27.51	1,437.75
River - Single Line		352287	105.14	1,444.77
River - Single Line	Little River	397241	172.34	1,448.70
River - Single Line		369022	90.76	1,448.70
River - Single Line Indefinite		406426	105.26	1,461.22
River - Single Line		391032	120.61	1,463.48
River - Single Line		380144	189.30	1,463.76
River - Single Line Indefinite	Little River	412518	408.76	1,467.46
River - Single Line		369870	464.51	1,477.21
River - Single Line		368409	494.98	1,485.80
River - Single Line		352284	51.11	1,539.13
River - Single Line		363906	169.64	1,539.13
River - Single Line		376483	1,255.77	1,542.03

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
River - Single Line		402325	103.80	1,544.57
River - Single Line	Embrees Brook	395626	43.29	1,554.86
River - Single Line		387946	347.22	1,556.66
River - Single Line		369217	424.50	1,569.03
River - Single Line		353380	96.12	1,570.27
River - Single Line		383881	78.65	1,576.98
River - Single Line		379466	203.37	1,577.53
River - Single Line		393438	2,470.51	1,594.81
River - Single Line		393436	753.28	1,596.26
River - Single Line		354493	31.41	1,599.02
River - Single Line		372662	256.72	1,599.64
River - Single Line		380927	578.80	1,613.44
River - Single Line	Embrees Brook	395629	1,179.89	1,617.53
River - Single Line		364293	301.68	1,617.53
River - Single Line		383131	619.14	1,642.17
River - Single Line	North Little River	353409	7.12	1,666.30
River - Single Line Indefinite		410278	411.28	1,668.77
River - Single Line	North Little River	399474	219.57	1,673.08
River Split - Single Line		422022	206.85	1,673.08
River - Single Line Indefinite		407748	677.33	1,680.09
River - Single Line	Seacoal Brook	400498	89.53	1,747.37
River - Single Line Indefinite	Little River	412519	581.09	1,747.68
River - Single Line Indefinite		405665	1,233.61	1,747.68
River - Single Line		370709	12.06	1,756.65
River - Single Line	Seacoal Brook	400499	273.10	1,768.37
River - Single Line		374825	183.42	1,793.47
River - Single Line		376663	969.41	1,807.90
River - Single Line		372772	130.38	1,809.05
River - Single Line	North Little River	399472	565.65	1,823.14
River - Single Line		389409	196.61	1,825.50
River - Single Line		370836	970.49	1,851.54
River - Single Line		385406	205.59	1,861.39
River - Single Line Indefinite	Little River	412520	381.21	1,865.50
River - Single Line		381304	144.26	1,873.77
River - Single Line Indefinite		405246	437.14	1,921.66
River - Single Line		384227	13.29	1,935.40
River - Single Line		377436	1,201.96	1,955.12
River - Single Line		392846	23.00	1,959.76
River - Single Line		372100	126.65	1,962.31
River - Single Line		353401	169.23	1,971.95
River - Single Line		371422	434.83	1,979.42
River - Single Line		389906	51.09	1,980.33
River - Single Line		374896	1,662.01	1,992.64
River - Single Line		384052	479.87	2,005.76
River - Single Line		379282	362.63	2,008.15
River - Single Line		402336	98.59	2,010.98
River - Single Line Indefinite		410555	366.95	2,011.31
River - Single Line		354444	19.32	2,027.90
River - Single Line		354443	98.77	2,031.09
River - Single Line		368991	1,557.30	2,054.44
River - Single Line		363896	1,008.87	2,059.69
River - Single Line		393437	213.49	2,111.04

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
River - Single Line		364589	120.74	2,140.38
River - Single Line		377359	582.55	2,141.14
River - Single Line		374386	944.89	2,141.62
River - Single Line	Little River	397234	228.03	2,186.85
River - Single Line		392180	1,086.70	2,210.81
River - Single Line		387949	741.76	2,211.22
River - Single Line Indefinite		406970	477.46	2,214.69
River - Single Line		376770	129.95	2,237.34
River - Single Line Indefinite		411581	564.11	2,237.34
River - Single Line		352958	389.87	2,243.61
River - Single Line		385260	273.56	2,257.29
River - Single Line Indefinite		404803	399.36	2,259.01
River - Single Line		368723	36.07	2,260.17
River - Single Line		372673	402.68	2,260.47
River - Single Line		390234	34.94	2,268.04
River - Single Line		386182	259.33	2,271.55
River - Single Line		393429	366.78	2,271.55
River - Single Line Indefinite		410966	563.42	2,277.31
River - Single Line		378824	866.53	2,287.53
River - Single Line		374627	221.67	2,304.33
River - Single Line		364264	1,384.81	2,311.90
River - Single Line	North Little River	399473	1,231.58	2,337.19
River - Single Line		393441	234.94	2,347.16
River - Single Line		389834	243.65	2,349.95
River - Single Line Indefinite		409283	461.65	2,349.95
River - Single Line		354218	40.29	2,355.59
River - Single Line	North Little River	399477	1,901.03	2,368.95
River - Single Line		372391	1,700.26	2,382.66
River - Single Line		367902	483.17	2,400.98
River - Single Line Indefinite		402666	5.40	2,430.55
River - Single Line Indefinite		407503	529.09	2,432.27
River - Single Line Indefinite		407786	390.30	2,476.64
River - Single Line		353647	14.44	2,481.45
River - Single Line		393430	1,678.41	2,495.70
River - Single Line		379160	388.64	2,535.20
River - Single Line		385822	377.29	2,538.08
River - Single Line		389621	861.63	2,540.89
River - Single Line		388311	148.73	2,542.75
River - Single Line		384782	1,497.81	2,554.08
River - Single Line		375135	408.97	2,566.29
River - Single Line		353789	62.93	2,572.78
River - Single Line		354226	175.16	2,579.44
River - Single Line		389898	519.52	2,583.87
River - Single Line		375215	719.88	2,592.46
River - Single Line Indefinite		409546	1,358.11	2,609.00
River - Single Line		385608	12.99	2,624.55
River - Single Line		352675	127.05	2,627.92
River - Single Line		379169	212.41	2,634.27
River - Single Line		389894	642.66	2,636.61
River - Single Line		388843	295.41	2,639.98
River - Single Line		390084	754.44	2,641.44
River - Single Line		393440	1,731.20	2,687.13

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
River - Single Line		354380	407.44	2,692.31
River - Single Line Indefinite		404519	1,270.53	2,698.03
River - Single Line		388616	820.22	2,699.94
River - Single Line		354381	18.84	2,707.65
River - Single Line		380340	342.00	2,710.92
River - Single Line		375916	894.49	2,715.99
River - Single Line Indefinite		406356	794.76	2,724.20
River - Single Line		370677	549.03	2,737.76
River - Single Line		371038	465.71	2,742.14
River - Single Line		377913	131.80	2,743.89
River - Single Line		368372	101.03	2,783.17
River - Single Line Indefinite	Steep Creek	412726	131.22	2,789.83
River - Single Line		387825	285.36	2,820.05
River - Single Line		380078	798.39	2,820.96
River - Single Line		383780	503.42	2,823.39
River - Single Line		393068	380.40	2,823.39
River - Single Line		354400	29.06	2,851.28
River - Single Line		378253	457.00	2,857.34
River - Single Line		354378	167.31	2,859.72
River - Single Line		354411	8.24	2,861.28
River - Single Line		375006	7.58	2,868.69
River - Single Line Indefinite		407729	785.58	2,875.28
River - Single Line		354410	16.92	2,875.92
River - Single Line		391198	1,338.35	2,879.29
River - Single Line		391870	1,122.92	2,880.08
River - Single Line		382892	1,001.96	2,890.86
River - Single Line		354174	3.44	2,893.63
River - Single Line	North Little River	399471	444.34	2,907.05
River - Single Line Indefinite	Steep Creek	412725	222.73	2,907.59
River - Single Line		368414	932.00	2,921.92
River - Single Line		354379	133.87	2,922.96
River - Single Line		368330	578.43	2,968.04
River - Single Line		387916	1,351.08	2,970.71
River - Single Line		370476	700.79	2,986.42
River - Single Line		391059	1,258.60	3,015.42
River - Single Line		373794	248.80	3,039.17
River - Single Line		402365	154.13	3,039.17
River - Single Line		367663	519.47	3,039.67
River - Single Line		386981	270.15	3,039.94
River - Single Line Indefinite	Black Brook	412325	1,131.22	3,067.87
River - Single Line		365316	818.33	3,072.78
River - Single Line	Byers Brook	394645	436.14	3,086.34
River - Single Line		402424	137.56	3,090.29
River - Single Line		383261	15.69	3,108.56
River - Single Line	Little River	397239	15.81	3,123.56
River - Single Line		353607	43.04	3,145.38
River - Single Line		353609	48.56	3,145.38
River - Single Line		382595	266.60	3,164.60
River - Single Line		379598	735.49	3,170.96
River - Single Line		351972	27.44	3,172.34
River - Single Line		386606	1,104.89	3,181.58
River - Single Line		378989	60.40	3,207.70

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
River - Single Line		351997	14.81	3,220.75
River - Single Line		378771	273.53	3,221.14
River - Single Line		383303	397.99	3,231.57
River - Single Line		369118	281.98	3,243.49
River - Single Line		357337	4.32	3,249.59
River - Single Line		360459	31.14	3,253.16
River - Single Line		385850	7.64	3,298.50
River - Single Line		353865	154.50	3,303.37
River - Single Line		384500	455.66	3,344.18
River - Single Line		383438	35.81	3,344.56
River - Single Line		388578	89.53	3,380.01
River - Single Line Indefinite		406260	431.08	3,388.62
River - Single Line Indefinite		404329	601.22	3,420.55
River - Single Line		388687	766.86	3,421.99
River - Single Line	East Brook	395467	2,480.69	3,438.15
River - Single Line		392419	907.71	3,486.43
River - Single Line		391750	476.73	3,502.39
River - Single Line		388404	654.80	3,510.15
River - Single Line		354366	11.18	3,513.63
River - Single Line		380231	116.98	3,524.76
River - Single Line Indefinite		410893	419.95	3,531.98
River - Single Line		386219	198.47	3,542.27
River - Single Line		393432	197.51	3,547.34
River - Single Line		379871	632.96	3,568.58
River - Single Line Indefinite		410019	443.94	3,582.88
River - Single Line Indefinite		402967	1,258.41	3,585.52
River - Single Line		388703	471.40	3,611.94
River - Single Line		354364	187.37	3,625.59
River - Single Line		354363	30.00	3,684.87
River - Single Line		352978	170.31	3,710.24
River - Single Line		375129	367.28	3,711.58
River - Single Line		393448	792.48	3,711.70
River - Single Line		381956	175.15	3,717.89
River - Single Line	Black Brook	394377	119.67	3,733.01
River - Single Line		365000	21.56	3,734.00
River - Single Line		368532	1,026.78	3,738.29
River - Single Line		392151	385.48	3,738.29
River - Single Line	Black Brook	353700	1.41	3,746.38
River - Single Line	Black Brook	394373	358.80	3,746.51
River - Single Line		352987	19.33	3,750.06
River - Single Line Indefinite		406643	60.69	3,773.48
River - Single Line		387899	109.97	3,773.79
River - Single Line	Sugar Camp Brook	402242	2,277.12	3,785.23
River - Single Line		374268	193.68	3,788.75
River - Single Line	Sugar Camp Brook	402245	487.27	3,806.45
River - Single Line Indefinite		411734	2,544.24	3,824.93
River - Single Line		370376	1,255.64	3,833.78
River - Single Line	Mill Brook	398668	472.89	3,862.45
River - Single Line Indefinite		405483	632.97	3,870.71
River - Single Line		385799	561.70	3,878.68
River - Single Line		365062	304.24	3,893.93
River - Single Line	West Brook	401631	320.36	3,898.10

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
River - Single Line		381019	736.78	3,908.80
River - Single Line		390159	179.44	3,921.64
River - Single Line		375741	1,055.26	3,954.84
River - Single Line		373639	332.68	3,981.24
River - Single Line Indefinite		408292	594.76	3,982.49
River - Single Line		381276	689.83	3,984.94
River - Single Line		365935	211.71	3,986.19
River - Single Line Indefinite		405430	228.14	3,999.30
River - Single Line	Black Brook	394372	92.41	4,002.81
River - Single Line Indefinite		408526	164.96	4,022.05
River - Single Line		392880	12.20	4,027.78
River - Single Line		381950	1,274.32	4,035.00
River - Single Line		353549	9.00	4,039.82
River - Single Line	Brown Brook	394610	1,291.62	4,052.77
River - Single Line		393439	749.88	4,052.77
River - Single Line	Mill Brook	398670	1,682.09	4,055.60
River - Single Line		353548	121.03	4,066.27
River - Single Line	Black Brook	394384	146.36	4,076.16
River - Single Line		376881	850.83	4,077.38
River - Single Line		389710	289.30	4,080.46
River - Single Line	Sugar Camp Brook	353021	98.72	4,087.77
River - Single Line		390077	128.80	4,087.77
River - Single Line		369451	919.46	4,090.69
River - Single Line		376522	287.17	4,101.07
River - Single Line	Sugar Camp Brook	402244	272.48	4,102.76
River - Single Line		366585	461.50	4,112.52
River - Single Line		353020	168.15	4,116.07
River - Single Line		380363	500.98	4,142.07
River - Single Line	Little River	397240	216.02	4,152.14
River - Single Line		381342	473.94	4,153.71
River - Single Line		377471	522.27	4,155.26
River - Single Line		378939	5.82	4,158.65
River - Single Line		387076	110.11	4,163.83
River - Single Line		383356	195.12	4,169.03
River - Single Line	Little River	397238	753.37	4,169.18
River - Single Line	Little River	397237	58.01	4,175.27
River - Single Line		392140	543.40	4,176.49
River - Single Line Indefinite		408296	213.07	4,181.89
River - Single Line		380370	423.81	4,184.13
River - Single Line	West Brook	401626	42.98	4,185.02
River - Single Line		393442	352.28	4,190.47
River - Single Line Indefinite		407746	210.53	4,197.47
River - Single Line		353547	31.20	4,204.98
River - Single Line		374771	285.14	4,211.46
River - Single Line	Black Brook	394375	501.73	4,214.40
River - Single Line		376827	284.11	4,216.46
River Split - Single Line		421499	82.61	4,220.42
River - Single Line		353369	3.00	4,224.51
River - Single Line	Little River	352435	120.53	4,224.69
River - Single Line		387590	315.91	4,224.83
River - Single Line	West Brook	401632	44.22	4,227.53
River - Single Line Indefinite		406653	1,091.65	4,227.53

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
River - Single Line Indefinite		402968	181.84	4,243.63
River - Single Line		367917	309.66	4,251.14
River - Single Line	West Brook	401628	167.32	4,265.60
River - Single Line		390681	66.86	4,279.49
River - Single Line		389920	192.27	4,283.01
River - Single Line		390926	260.83	4,284.07
River - Single Line		354122	4.16	4,291.21
River - Single Line		381965	222.07	4,295.28
River - Single Line Indefinite		402612	2.91	4,302.26
River - Single Line Indefinite		410305	297.25	4,303.77
River - Single Line Indefinite		409542	347.36	4,318.54
River - Single Line		376609	6.35	4,322.12
River - Single Line		368359	7.00	4,326.65
River - Single Line		352158	1.49	4,330.33
River - Single Line Indefinite		407953	9.20	4,331.16
River - Single Line		378325	477.03	4,333.41
River - Single Line		383836	645.32	4,335.40
River - Single Line		380964	836.56	4,337.44
River - Single Line Indefinite		407215	89.79	4,339.24
River - Single Line		381393	208.18	4,350.97
River - Single Line		388416	2,310.49	4,356.90
River - Single Line	McNairs Brook	398447	2,057.34	4,361.49
River - Single Line	Murray Brook	399057	79.90	4,367.92
River - Single Line		382067	104.33	4,390.42
River - Single Line		393433	433.11	4,408.80
River - Single Line		385315	40.93	4,417.25
River - Single Line	West Brook	401629	1,363.41	4,424.79
River - Single Line		382247	1,946.09	4,424.79
River - Single Line Indefinite		410601	44.65	4,427.02
River - Single Line		367395	377.56	4,428.45
River - Single Line		370694	243.26	4,432.93
River - Single Line		391534	1,470.60	4,434.47
River - Single Line		352189	36.89	4,443.48
River - Single Line Indefinite		410075	293.56	4,448.10
River - Single Line Indefinite		408907	246.25	4,452.97
River - Single Line Indefinite		405628	81.33	4,455.82
River - Single Line		386793	36.18	4,457.05
River Split - Single Line		421529	183.43	4,458.89
River - Single Line	Sugar Camp Brook	402243	727.35	4,461.81
River - Single Line		353045	103.58	4,466.22
River - Single Line		373388	1,192.47	4,468.87
River - Single Line		376343	69.16	4,469.96
River - Single Line Indefinite		407484	7.52	4,469.96
River - Single Line Indefinite		411005	353.66	4,471.38
River - Single Line		387019	264.12	4,474.48
River - Single Line		381902	916.83	4,502.28
River - Single Line		393449	656.68	4,502.28
River - Single Line	Murray Brook	399061	259.23	4,504.88
River - Single Line	Melford Brook	398552	550.72	4,505.87
River - Single Line		382585	333.55	4,512.99
River - Single Line		385570	517.42	4,512.99
River - Single Line		372054	596.38	4,518.49

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
River - Single Line		376326	34.04	4,532.46
River - Single Line		383032	98.65	4,536.06
River - Single Line		381671	22.21	4,537.68
River - Single Line		355875	1,265.57	4,542.31
River - Single Line		382965	47.86	4,542.55
River - Single Line		354623	165.22	4,545.15
River - Single Line		376129	173.93	4,557.83
River - Single Line		388832	267.01	4,558.61
River - Single Line Indefinite		409071	512.58	4,559.90
River - Single Line		378613	688.44	4,574.63
River - Single Line		354577	1.35	4,580.76
River - Single Line		393443	177.95	4,581.70
River - Single Line		365685	15.92	4,581.95
River - Single Line		354572	2.83	4,594.92
River - Single Line		382637	61.64	4,597.51
River - Single Line Indefinite		407427	381.95	4,598.36
River - Single Line Indefinite		404748	93.84	4,603.96
River - Single Line		373328	642.83	4,616.69
River - Single Line Indefinite		409504	304.03	4,618.69
River - Single Line		353107	2.00	4,622.52
River - Single Line		393163	797.85	4,624.33
River - Single Line	Murray Brook	399055	679.72	4,625.27
River - Single Line	Black Brook	394380	425.12	4,632.43
River - Single Line		392420	426.65	4,632.43
River - Single Line Indefinite		402587	6.40	4,636.12
River - Single Line Indefinite		407274	524.59	4,642.25
River - Single Line		382248	1,544.53	4,651.11
River - Single Line		377380	223.10	4,656.31
River - Single Line Indefinite		402783	17.80	4,661.18
River - Single Line		353114	372.70	4,662.00
River - Single Line		352828	127.65	4,675.90
River - Single Line	Black Brook	394371	188.11	4,717.57
River - Single Line		393434	1,871.80	4,731.50
River - Single Line		371076	283.92	4,737.82
River - Single Line		375977	16.02	4,739.42
River - Single Line	Black Brook	394383	319.06	4,754.01
River - Single Line		382559	534.57	4,765.54
River - Single Line		353154	1.00	4,765.95
River - Single Line		382728	243.91	4,784.37
River - Single Line		380204	433.10	4,791.00
River - Single Line		383346	391.29	4,791.00
River - Single Line		369404	488.69	4,798.61
River - Single Line		366980	375.28	4,813.39
River - Single Line		352180	260.94	4,839.41
River - Single Line		353115	60.02	4,848.90
River - Single Line Indefinite		405004	461.09	4,853.39
River - Single Line		371700	422.19	4,858.04
River - Single Line		390604	402.82	4,866.00
River - Single Line		384467	250.51	4,869.57
River - Single Line		372242	1,432.58	4,888.64
River - Single Line		355873	951.75	4,893.86
River - Single Line	Black Brook	394381	239.99	4,900.40

Feature Description	Name (if provided)	Feature ID	Length (m)	Distance to Project (m)
River - Single Line		364784	732.14	4,902.65
River - Single Line		382727	469.31	4,906.10
River - Single Line		366514	31.41	4,926.65
River - Single Line		354490	98.80	4,930.87
River - Single Line		393446	622.04	4,955.61
River - Single Line Indefinite	Horton Brook	412464	583.20	4,960.72
River - Single Line		388955	296.01	4,960.86
River - Single Line		374082	423.02	4,971.07
River - Single Line	Melford Brook	398551	269.16	4,971.31
River - Single Line		385302	1,273.81	4,971.31
River - Single Line		388882	102.09	4,981.30
River - Single Line		391921	144.30	4,984.99

APPENDIX K
ALTERNATIVE LAYOUT FIELD RESULTS

ALTERNATIVE INDUSTRIAL FACILITY LAYOUTS

Watercourse Survey Results

Seven watercourses were identified within considered alternative layouts of the Industrial Facility. The locations and drainage directions of these watercourses have been presented on Drawing 2. The watercourses identified consist of small permanent (five) and intermittent features (two) all located within the 1FA-SD7 Secondary Watershed, draining west/south into the Strait of Canso. Watercourses here are fed primarily by overland flow and associated small drainage features, with several additionally fed by various wetlands.

All of the identified watercourses flow through various culvert systems underneath the LNG pipeline and Bear Island Road which travel perpendicular to the topographic direction of drainage. This has resulted in altered channelization and flow of these watercourses. Further, the culvert passing underneath the LNG pipeline is elevated on the downstream side (Figure 1).

Figure 1: LNG pipeline culvert looking upstream (left) and Bear Island Road culvert looking downstream (right) along WC-V and WC-VI (watercourses merge and flow through same culvert).

Detailed physical characteristics of the seven watercourses identified are presented in Table K.1. Note that constructed drainage ditches that were identified during field studies were not considered natural watercourses, and therefore, are not included as part of the freshwater field survey/assessment.

Wetland Survey Results

Nine wetlands were identified within considered alternative layouts of the Industrial Facility, see summary below (Table 1). The locations of these wetlands have been presented on Drawing 2.

Table 1: Field Identified Wetlands within the Alternative Industrial Facility Layouts

Wetland Type[1]	# of Wetlands	Wetland ID(s)	WSS[2]
Marsh	1	WL-G	None
Floodplain / Fringe	1	WL-F	None
Shrub Swamp	3	WL-A*, WL-B, WL-D	None
Treed Swamp	4	WL-C, WL-E, WL-H, WL-I	None

[1]If multiple wetland types exist (i.e., mosaics), the wetland was categorized according to its most dominant type.
[2]Wetlands that overlap (partially or completely) with WSS identified in the WSS Database (NSNRR, 2014).
*Desktop identified wetland – not field verified.

The majority of wetlands within the considered alternative Industrial Facility layouts consisted of treed swamps. Dominant tree species identified during wetland assessments include: black spruce, eastern tamarack, red maple, white pine, and yellow birch. In the shrub layer, species such as red maple, balsam fir, and sheep laurel were identified. The herbaceous layer consisted primarily of bunchberry, cinnamon fern, and New York fern. Soils within the treed swamps were hydric, mostly histosol ranging in depth between 0.20 m to 0.60 m. Hydrological features observed across the treed swamps included saturation, high water table, drainage patterns, water-stained leaves, and surface water.

The second most commonly encountered wetland within considered alternative Industrial Facility layouts were shrub swamps dominated by species such as speckled alder, balsam fir, and red maple. At the herbaceous level, species such as small cranberry, tawny cottongrass, and broad-leaved cattail were frequently observed. Soils within the shrub swamps were identified as histosol (hydric) ranging in depth between 0.40 m to >1.00 m. Hydrologic indicators encountered during wetland assessments consisted of high water table, saturation, and surface water.

Other wetland types observed include a floodplain/fringe wetland and a marsh. The floodplain/fringe wetland contained <0.20 m of histosol (to refusal at bedrock) and was dominated by tree species including white ash, yellow birch, red spruce, and balsam fir. The marsh contained 0.40 m to 0.60 m of histosol (with a hydrogen sulfide odor) and was dominated by species such as broad-leaved cattail, tawny cottongrass, bristly dewberry, sheep laurel, and speckled alder.

Detailed characteristics of the surveyed wetlands have been presented below in Table K.2. No WSS were identified within considered alternative layouts of the Industrial Facility.

Photos of the watercourse and wetland features identified within alternative Industrial Facility layouts have been presented below.

ALTERNATIVE TRANSMISSION INTERCONNECTION LINE ROUTE

Watercourse Survey Results

Three watercourses were identified within the considered alternative route of the Transmission Interconnection Line. The locations and drainage directions of these watercourses have been presented on Drawing 3. The watercourses identified all consisted of small permanent features located within the Landrie Lake Secondary Watershed (1FD-SD6), draining north/east towards Landrie Lake. Watercourses here are fed primarily by surrounding overland flow and wetland habitat.

Detailed physical characteristics of the three watercourses are presented in Table K.3.

Wetland Survey Results

Six wetlands were identified within the considered alternative route of the Transmission Interconnection Line, see summary below (Table 2). The locations of these wetlands have been presented on Drawing 3.

Table 2: Field Identified Wetlands within the Alternative Transmission Interconnection Line Route

Wetland Type[1]	# of Wetlands	Wetland ID(s)	WSS[2]
Treed Swamp	6	ATWL1, ATWL2, ATWL3, ATWL4, ATWL5, ATWL6	ATWL2

[1]If multiple wetland types exist (i.e., mosaics), the wetland was categorized according to its most dominant type.
[2]Wetlands that overlap (partially or completely) with WSS identified in the WSS Database (NSNRR, 2014).

All of the wetlands identified within the considered alternative Transmission Interconnection Line route consisted of treed swamps. Dominant species identified during wetland assessments include: eastern tamarack, black spruce, red maple, and balsam fir. Soils within the wetlands were hydric (histosol and/or histic epipedon), ranging in depth between <0.20 m and 1.00 m. The most frequently observed hydrological features across the wetlands were saturation, high water table, water marks, and water-stained leaves.

Detailed characteristics of the surveyed wetlands have been presented below in Table K.4. Of the six wetlands within considered alternative routes of the Transmission Interconnection Line, one (ATWL2) is a WSS.

Photos of the watercourse and wetland features identified within the alternative Transmission Interconnection Line route have been presented below.

Photo 1: WC-I

Photo 2: WC-II

Photo 3: WC-III

Photo 4: WC-IV

Photo 5: WC-V

Photo 6: WC-VI

Photo 7: WC-VII

Photo 8: WL-B

Photo 9: WL-C

Photo 10: WL-D

Photo 11: WL-E

Photo 12: WL-F

Photo 13: WL-G

Photo 14: WL-H

Photo 15: WL-I

Table K.1: Alternative Industrial Facility Layouts Watercourse Survey Results *Project #22-8516*

Watercourse ID	Primary Watershed	Secondary Watershed	Watercourse Class	Habitat	Flow Direction	General Characteristics (m)					Substrate Composition (%)							Instream Cover (Trace, Moderate, Abundant)							Bank Description	Fish Bearing?	Riparian Area		Additional Notes
						Channel Depth	Water depth	Channel Width	Water Width	Pool Depth	Bedrock	Boulder	Rubble	Cobble	Gravel	Sand	Fines/Muck	Boulders	Overhanging Vegetation	Large Woody Debris	Small Woody Debris	Deep Pools	Undercut Banks	Instream Vegetation			Habitat Types Present	Dominant Habitat	
WC-I	River Inhabitants (1FA)	1FA-SD7	Small Permanent	Pool, Riffle, Run	North	0.05	0.05	0.40	0.35	0.10	0	0	10	40	40	10	0	None	Moderate	None	Moderate	None	None	Trace	Vegetated, Sloped	No - Barrier to Fish Passage Observed	Herbaceous, Graminoids, Shrub, Softwood, Hardwood	Shrub	
WC-II	River Inhabitants (1FA)	1FA-SD7	Small Permanent	Riffle, Run	West	0.05	0.08	0.20	0.20	n/a	0	80	0	0	0	0	20	Abundant	Abundant	Abundant	Moderate	None	None	Trace	Vegetated, Eroded	Possible	Herbaceous, Graminoids, Shrub	Shrub	
WC-III	River Inhabitants (1FA)	1FA-SD7	Intermittent	Run	South	0.05	0.20	0.15	0.16	n/a	0	0	0	10	0	0	90	None	Abundant	Abundant	Moderate	None	Trace	Abundant	Undercut, Vegetated, Eroded ,Muddy	Possible	Herbaceous, Graminoids, Shrub, Softwood, Hardwood	Herbaceous	
WC-IV	River Inhabitants (1FA)	1FA-SD7	Small Permanent	Cascade, Riffle, Run	West	0.12	0.10	2.00	1.70	0.20	40	0	10	10	20	20	0	None	Abundant	Trace	Moderate	None	None	None	Eroded	No - Barrier to Fish Passage Observed	Shrub, Softwood, Hardwood	Shrub	Remnant flow from hurricane (Fiona). Drains west from a large forested area, dispersing into large basin-wetland.
WC-V	River Inhabitants (1FA)	1FA-SD7	Small Permanent	Run, Riffle	East	0.25	0.05	1.20	1.00	n/a	0	0	10	40	0	20	30	None	Abundant	None	Moderate	None	None	None	Vegetated, Well defined, Good Condition, Muddy	Possible	Shrub, Graminoids, Herbaceous	Shrub	
WC-VI	River Inhabitants (1FA)	1FA-SD7	Intermittent	Riffle, Run, Cascade	West	0.05	0.25	1.40	1.00	0.30	0	0	0	20	0	10	70	None	Abundant	Trace	Moderate	None	Moderate	Abundant	Vegetated, Undercut	Possible	Herbaceous, Graminoids, Shrub, Softwood, Hardwood	Mixedwood	Ends upstream in wetland. High water levels likely resulting from recent rainfall.
WC-VII	River Inhabitants (1FA)	1FA-SD7	Small Permanent	Riffle, Run	South	0.30	0.15	1.50	1.60	0.25	0	5	50	0	0	45	0	None	Moderate	Moderate	Abundant	None	Abundant	Moderate	Well defined, Muddy, Vegetated, Undercut	Possible	Herbaceous, Graminoids, Shrub, Softwood, Hardwood	Mixedwood	

Wetland ID	Upland Characteristics and Habitat						Wetland Characteristics and Habitat										Full or Partia Delineation	Mapped WSS
	Dominant Habitat	Habitat Notes	Soils Types	Herbaceous Layer	Shrub Layer	Tree Layer	Landform	Wetland Type (dominant, other)	Soil Types	Soil Notes	Substrate depth (m)	Waterflow	Hydrological Indicators	Herbaceous Layer	Shrub Layer	Tree Layer		
WL-A*	Softwood	Mature. Adjacent to LNG pipeline and Port Malcolm Road	*Upland soils (details not available)*	*Details not available*	*Details not available*	white spruce, eastern tamarack, red maple	Basin	Shrub Swamp	*Hydric soils (details not available)*	None	n/a	West	*Details not available*	*Details not available*	*Details not available*	Eed maple, black spruce	Desktop	No
WL-B	Mixedwood	Even growth-mostly one canopy layer, mossy bottom	0-8cm organic 9-12 cm 7.5yr-4/6 13-25cm 7.5yr - 5/6 refusal	Bunchberry, northern starflower	Red maple, northern wild raisin	Balsam fir, red spruce, yellow birch, white birch, gray birch	Basin	Shrub Swamp	Histosol (40cm) (A1), Hydrogen Sulfide (A4)	Organic no refusal	>1.00	West	High Water Table, Saturation, Surface Water	Broad-leaved cattail, small cranberry, bunchberry, Canada rush, bluejoint reed grass, Canada manna grass	Hairy flat-top white aster, red maple, speckled alder	Speckled alder, red maple, black spruce, mountain holly	Full	No
WL-C	Softwood	Young even aged softwood stand, moss covered hummocks with some needle cover. High water table	1-5 organic 5-40cm 7.5yr -5/6. Then refusal of sandy/rocks	Bunchberry, northern starflower, wild lily-of-the-valley	None	White birch, red spruce, gray birch	Basin	Treed Swamp	Histosol (40cm) (A1), Hydrogen Sulfide (A4)	Refusal at 50cm	0.40-0.60	West	Saturation, High Water Table, Drainage Patterns	Bunchberry, small cranberry, cinnamon fern	Sheep laurel, common labrador tea, black spruce	Common winterberry, black spruce, eastern tamarack, white pine, white birch	Full	No
WL-D	Softwood	Sloped extensive ground cover	7.5 YR-5/4	Bunchberry, wild lily-of-the-valley	Late lowbush blueberry, red maple, red spruce	Red spruce, yellow birch, red maple, balsam fir	Basin	Shrub Swamp	Histosol (40cm) (A1)	0-20 organic 20-60 7.5yr-4/1	0.40-0.60	West	High Water Table, Saturation, Surface Water	Small cranberry, Canada manna grass, tawny cottongrass, bog aster, cinnamon fern	Leatherleaf, eastern tamarack, black spruce, red maple	Eastern tamarack, red maple, black spruce	Full	No
WL-E	Mixedwood	Extensive leaf litter	7.5 YR 4/6	Bunchberry, northern beech fern, wild sarsaparilla	Red spruce, balsam fir, red maple	Yellow birch, American mountain ash, balsam fir	Basin	Treed Swamp	Sandy Mucky Mineral (S1)	7.5 yr-4/2	0.20-0.40	None apparent	Water Stained Leaves, Saturation	Goldthread, large false solomon's seal, hairy flat-top white aster, cinnamon fern	Balsam fir, red maple, red spruce	Yellow birch, red maple, white ash, white pine	Full	No
WL-F	Softwood	Mature	0-10cm organic 10-20cm 7.5YR 5/4	New York fern, bunchberry, wild lily-of-the-valley, whorled wood aster, cinnamon fern	Red maple, red spruce, highbush blueberry	White birch, balsam fir, red spruce, red maple	Floodplain	Floodplain, Treed Swamp	Histosol (40cm) (A1)	0-20cm organic , refusal	0.20-0.40	West	Saturation, Water Marks, Drainage Patterns, Water Stained Leaves, Sparsely Vegetated Concave Surface	Cinnamon fern, creeping bugleweed, bristly dewberry, hairy flat-top white aster	White ash, red maple, balsam fir	White ash, yellow birch, red spruce, balsam fir	Full	No
WL-G	Hardwood	Sloping towards wetland	0-10 organic, 10-30 7.5YR 5/4	Bunchberry, northern starflower, New York fern, cinnamon fern	Sheep laurel, balsam fir, red spruce, late lowbush blueberry,	Yellow birch, red spruce, balsam fir, red maple, white pine	Basin	Marsh, Treed Swamp	Histosol (40cm) (A1)	100% organic	0.40-0.60	West	Surface Water, High Water Table, Saturation, Hydrogen Sulfide Odor	Cinnamon fern, tawny cottongrass, broad-leaved cattail, bristly dewberry	Speckled alder, red maple, eastern tamarack, sheep laurel	Red maple, white pine, black spruce, eastern tamarack	Full	No
WL-H	Softwood	Mixed growth, mossy	0-5cm organic, 5-20cm 7.5yr-5/3, 20-50cm 90% 7.5yr-4/4 10%	Bunchberry, late lowbush blueberry, creeping snowberry, wild lily-of-the-valley, yellow bluebead lily,	Balsam fir, red spruce	Yellow birch, red spruce, balsam fir, red maple	Floodplain	Treed Swamp	Histosol (40cm) (A1)	30cm organic then refusal	0.20-0.40	West	Surface Water, High Water Table, Saturation	Cinnamon fern, whorled wood aster, bunchberry, three-seeded sedge, New York fern	Striped maple, red maple	Black spruce, red spruce, white ash, red maple, mountain holly, yellow	Full	No
WL-I	Mixedwood	Needle and moss cover, sloped into wetland.	0-5 cm organic, 5-25 cm 7.5 YR 4/4	Twinflower, wild lily-of-the-valley, Canada goldenrod, hairy flat-top white aster	Red maple, red spruce, balsam fir, striped maple	Balsam fir, red spruce, white pine, red maple, yellow birch, striped maple	Basin	Treed Swamp	Histosol (40cm) (A1)	Organic to 50 cm then refusal, water table 20 cm deep	0.40-0.60	Northwest	Saturation, High Water Table, Drainage Patterns, Water Stained Leaves	Cinnamon fern, bunchberry, New York fern	Red maple, balsam fir, black spruce	Black spruce, red maple, white pine, norhern wild raisin	Full	No

**WL-A was desktop identified, attributes provided were pulled from the Provincial Landscape Viewer and other provincial databases.*

Photo 1: ATWC1

Photo 2: ATWC2

Photo 3: ATWC3

Photo 4: ATWL1

Photo 5: ATWL2

Photo 6: ATWL3

Photo 7: ATWL4

Photo 8: ATWL5

Photo 9: ATWL6

Table K.3: Alternative Transmission Interconnection Line Route Watercourse Survey Results *Project #22-8516*

Watercourse ID	Primary Watershed	Secondary Watershed	Watercourse Class	Habitat	Flow Direction	General Characteristics (m)					Substrate Composition (%)							Instream Cover (Trace, Moderate, Abundant)							Bank Description	Fish Bearing?	Riparian Area		Additional Notes
						Channel Depth	Water Depth	Channel Width	Water Width	Pool Depth	Bedrock	Boulder	Rubble	Cobble	Gravel	Sand	Fines/Muck	Boulders	Overhanging Vegetation	Large Woody Debris	Small Woody Debris	Deep Pools	Undercut Banks	Instream Vegetation			Habitat Types Present	Dominant Habitat	
ATWC1	River Inhabitants 1FA	1FD-SD6 (Landrie Lake)	Small Permanent	Run	North	0.5	0.08	1.00	0.55	n/a	0	0	0	0	10	45	45	None	Abundant	Trace	Trace	None	None	None	Eroded, Vegetated, Well defined, Good Condition	No - Barrier to Fish Passage Observed	Herbaceous, Graminoids, Hardwood, Softwood	Graminoids	None
ATWC2	River Inhabitants 1FA	1FD-SD6 (Landrie Lake)	Small Permanent	Riffle	North	0.75	0.75	1.20	1.20	n/a	0	0	0	5	10	80	5	None	Trace	None	Trace	None	None	Trace	Vegetated, Well defined, Sloped, Good Condition	Possible	Herbaceous, Graminoids, Shrub, Softwood, Hardwood	Graminoids	None
ATWC3	River Inhabitants 1FA	1FD-SD6 (Landrie Lake)	Small Permanent	Riffle	East	0.60	0.35	0.90	0.75	n/a	0	0	0	0	0	10	90	None	Moderate	None	None	None	None	Moderate	Vegetated, Sloped	No - Barrier to Fish Passage Observed	Herbaceous, Graminoids, Softwood, Hardwood	Herbaceous	None

Table K.4: AlternativeTransmission Interconnection Line Route Wetand Survey Results *Project # 22-8516*

Wetland ID	Upland Characteristics and Habitat						Wetland Characteristics and Habitat										Full or Partial Delineation	Mapped WSS
	Dominant Habitat	Habitat Notes	Soils Types	Herbaceous Layer	Shrub Layer	Tree Layer	Landform	Wetland Type (dominant, other)	Soil Types	Soil Notes	Substrate depth (m)	Waterflow	Hydrological Indicators	Herbaceous Layer	Shrub Layer	Tree Layer		
ATWL1	Mixedwood	Sloped topography, young. Very sparse understory.	0-20cm organic. Refusal at 24cm	Wild lily-of-the-valley, bracken fern	None	Balsam fir, red maple	Flat	Treed Swamp	Histosol (40cm) (A1)	100% organic 39cm	0.20-0.40	None apparent	Saturation, High Water Table	Tawny cottongras, cinnamon fern, wild lily-of-the-valley, bog aster, New York fern	Northern wild raisin	Black spruce, red maple, eastern tamarack	Partial	No
ATWL2	Softwood	Mixed aged stand. thin organic layer.	5cm organic	Bunchberry	Common labrador tea, sheep laurel, highbush blueberry, bracken fern	Red spruce, balsam fir, white birch	Flat	Treed Swamp	Histosol (40cm) (A1)	100% organic muck	0.80-1.00	None apparent	High Water Table	None	Leatherleaf, common labrador tea, sweet gale, northern wild raisin, mountain holly	Eastern tamarack, black spruce	Partial	Yes
ATWL3	Hardwood	Hilly topography with various drainage channels leading into wetland.	Thin organic layer underlain by large boulders and bedrock	Bracken fern, cinnamon fern, wild lily-of-the-valley, highbush blueberry, bristly dewberry	None	Red maple, red spruce, balsam fir	Floodplain	Treed Swamp	Histosol (40cm) (A1), Histic epipedon (20cm) (A2	0-5cm organic, 5-20cm 7.5yr 5/4	<0.20	None apparent	Surface Water, Water Stained Leaves, Drainage Patterns	Bracken fern, cinnamon fern	None	Balsam fir, red maple, red spruce	Partial	No
ATWL4	Softwood	Open understory. A lot of snags	0-10cm organic.10-20cm 7.5yr 5/4	Yellow bluebead lilly, bunchberry	Balsam fir, red spruce, white birch	Eastern tamarack, black spruce	Basin	Treed Swamp	Histosol (40cm) (A1)	0-10cm organic, 10-24cm 7.5yr 6/2, No refusal	0.20-0.40	None apparent	Saturation, High Water Table, Water Marks, Water Stained Leaves	Bunchberry	Bracken fern, balsam fir, red spruce, sheep laurel	Red spruce, eastern tamarack, balsam fir	Partial	No
ATWL5	Mixedwood	Lots of pitches and mounds in topography. Sparse understory.	Thin organic layer. Refusal 10cm.	Twinflower, bunchberry	Red maple, red spruce	Red maple, white pine, balsam fir, red spruce, white birch	Floodplain	Treed Swamp	Histosol (40cm) (A1)	Muck followed by refusal 20cm	<0.20	None apparent	Surface Water, High Water Table, Saturation, Water Stained Leaves, Drainage Patterns	Red raspberry, hairy flat-top white aster, cinnamon fern	Broad-leaved cattail, mountain holly, red spruce, white birch	Red maple, white pine, Black spruce, red spruce, eastern tamarack	Partial	No
ATWL6	Mixedwood	Steeply sloped into wetland rocky with thin soil.	Organic layer 15cm followed by refusal.	Creeping snowberry	Sheep laurel, balsam fir	Balsam fir, black spruce, eastern tamarack, white birch, white pine	Fringe	Treed Swamp	Histosol (40cm) (A1)	30cm organic muck.	0.20-0.40	None apparent	Surface Water, High Water Table, Saturation, Water Marks, Water Stained Leaves, Drainage Patterns	None	Red spruce, sheep laurel, eastern tamarack	Eastern tamarack, red spruc, black spruce	Partial	No