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Queensway Carleton Hospital

Back-up Fuel Heating System Review

DRAFT

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1. Executive Summary

TO BE ADDED AFTER DRAFT REVIEW MEETING

2. Background Information

Queensway Carlton Hospital (QCH) central heating water and steam plants currently operate on natural gas as the primary fuel source. *CSA Z317.2 - Special requirements for heating, ventilation, and air-conditioning (HVAC) systems in health care facilities)* standard requires a standby fuel requirement for health care facilities (HCFs) under Clauses 6.2.6 and 6.2.7 noted below:

6.2.6 Secondary fuel requirements

6.2.6.1 Combustible fuel sources

Where the primary heating unit is dependent on a combustible fuel source (whether supplied by a utility or stored on site), a standby fuel supply shall be stored on site. Dual fuel burners shall be provided if necessary to accommodate the standby fuel source.

Notes:

1) *The intent of this clause is to ensure that failure of the primary fuel supply does not cause a shut-down of the facility.*
2) *Burners that require physical modifications or recertification when changing fuels do not meet the intent of this clause.*

6.2.7 Standby fuel

Standby fuel or other means shall be available on site at all times to allow for continued operation of the HCF in accordance with the requirements in CSA Z8000 for maintenance of essential services during any event that threatens to disrupt business continuity.

Notes:

1) *The type and quantity of standby fuel will be determined by local conditions.*
2) *The standby fuel system should be designed to facilitate cycling of fuel to avoid fouling of the fuel in unused tanks.*

The CSA Z317.2 does not itself specify a required backup duration, quantity and type of standby fuel are left to local conditions and to the requirements of *CSA Z8000 – Canadian Health Care Facilities*. For the purpose of this report and in line with preliminary sizing summary issued in 2024 (included in the appendix A), a 72-hour backup duration as established requirement for emergency generators per CSA C:282.24 – Emergency Electrical Power Supply for Buildings is used as the most-conservative sizing basis for the heating back-up fuel system.

7.3.2 Health care facilities

In addition to Clause 7.3.1, where the emergency electrical power supply system supplies essential electrical systems in conformance with CSA Z32, a fuel supply shall be maintained on site at all times that is sufficient for operating the engine under full load for at least

a) 72 h for Class A HCF;
b) 24 h for Class B HCF; and
c) 24 h for Class C HCF.

The HCF retains the ability to reduce this duration if warranted based on their requirements and overall risk assessment under emergency situations as described in CSA Z8000.

The current set up at QCH to meet the above-referenced secondary fuel requirements is to use Synthetic Natural Gas (SNG). SNG as used throughout this report, refers to a propane-air mixture (vapourized propane blended with compressed air to closely replicate the heating value and combustion characteristics of natural gas). Because it is compatible with equipment designed for natural gas, SNG can be burned in existing gas-fired boilers with no change to the combustion equipment or dual-fuel burners. The use of SNG is a proven approach already in use at the facility and in our professional opinion the preferred solution should be going forward as discussed within the later sections of this report.

The alternate secondary fuel options such as diesel/type 2 fuel oil is being evaluated here due to specific regulatory questions/concerns associated with large quantities of propane storage required. As per afore-referenced 2024 study done by V&R (see Appendix A), the volume of propane required to meet the 72-hour requirement for this facility, including planned future expansions under Part 4 and Part 5, is approximately 90,000 US gallons, a quantity that exceeds the standard container clearance/separation-distance tables published in *CSA B149.2 -The propane storage and handling code*. Above that listed capacity, the code does not provide a straightforward table lookup for required setbacks, and it is unclear what TSSA (Ontario's regulator for fuel storage) will require by way of additional engineering justification.

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Table 7.4
Location of above-ground tanks for consumer applications
(See Clauses 7.10.2, 7.10.3, and 9.3.2 and Annex M.)

Total aggregate water capacity, USWG (L)	Minimum distance, ft (m), between tank and property line; adjacent concrete or masonry building wall with no building openings within the specified clearances; or source of ignition*	Minimum distance, ft (m), between tank and building wall of other than concrete or masonry construction	Minimum distance, ft (m), between tank and building opening	Minimum distance, ft (m), between tank and adjacent tank†
Up to and including 125 (475)	None‡	None	3 (0.9)	None
Over 125 (475) up to and including 1000 (3800)	10 (3)	10 (3)	10 (3)	3 (0.9)
Over 1000 (3800) up to and including 2000 (7800)	10 (3)	25 (7.6)	25 (7.6)	3 (0.9)
Over 2000 (7800) up to and including 5000 (19 000)	15 (5)	25 (7.6)	25 (7.6)	3 (0.9)
Over 5000 (19 000) up to and including 10 000 (38 000)	25 (7.6)	25 (7.6)	25 (7.6)	3 (0.9)
Over 10 000 (38 000) up to and including 30 000 (113 500)	50 (15.2)	50 (15.2)	50 (15.2)	5 (1.5)
Over 30 000 (113 500)	§	§	§	§

* *Distances to property lines may be amended by the authority having jurisdiction.*
† *If tanks of a multiple tank installation are installed on a common concrete/steel base or pier, the clearances may be reduced to a 1/4 of the sum of diameters of the adjacent container.*
‡ *10 ft (3 m) from any source of ignition.*
§ *At the discretion of the authority having jurisdiction.*

3. Existing System – SNG

Several factors make SNG the most cost-effective and least disruption option as a backup fuel choice for gas-fired heating water and steam equipment:

Simplified System and Piping Distribution. SNG is blended to match natural gas' combustion characteristics closely enough that it burns in the same burners as natural gas. Although technically two sources of fuel are provided, the heating boilers are provided with single gas train and burners designed for natural gas combustion. Switchover from primary gas to backup SNG occurs at the main heating plant and the same natural gas piping is utilized to deliver SNG to the heating equipment.

Existing System Servicing. Because the same burner handles both fuels, there is only one piece of combustion equipment per boiler to install, maintain, and eventually replace over the life of the equipment rather than maintaining two parallel fuel-train systems.

Established methods and reliability. SNG backup is currently used in the hospital as back-up fuel source. The system has been in service for many years with proven track record and overall reliability.

Precedent on this site. The facilities already operate SNG backup, meaning operational familiarity, existing maintenance procedures, and staff training are already in place — a real advantage over introducing an entirely new fuel-handling procedure for the first time. Although there is some familiarity with diesel due to emergency generators using diesel, the switch over system and equipment familiarity and maintenacance procedures would have to be considered.

No changes to existing distribution piping. Because SNG utilizes the same natural gas piping (downstream of switch-over station), the piping distribution already serving the boilers remains unchanged. There is no need to install parallel fuel lines to each unit, unlike a diesel conversion.

No changes to the existing switchover station. The existing switchover infrastructure that transitions the plant from primary natural gas to backup SNG remains as-is, avoiding the cost and disruption of commissioning new transfer/switchover equipment. The switchover station is located in the existing plant along the wall facing the existing propane tank located in the courtyard.

Better long-term environmental profile. Over a multi-decade outlook, propane looks as a more future-proof option as it burns cleaner (lower emission per unit of heat delivered) than diesel (Type 2 fuel oil). It's unclear what the future regulations will be but with the continuous drive towards cleaner energy and lower emissions, it is our opinion that propane is a better alternative in terms of futureproofing.

4. Projected Propane Storage Sizing

Storage sizing for the SNG system was developed through a coordinated assessment of estimated current and proposed future heating and steam loads and propane demand sizing by Vanderwesten & Rutherford and Sleegers Engineered Products. Potential storage locations were reviewed for both the current and immediate renovation loads, as well as the more distant future expansion plans. The complete report can be found in Appendix A.

The resulting 90,000 US gallon requirement reflects this combined current, near-term renovations (Part 4 and Part 5). With long-term expansion load (Part 6 and Part 7) the proposed storage would increase to 130,000 US gallons.

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It is also worth noting that the facility's existing propane storage, a single, 18.025 US Gallon tank, was installed without the 72-hour backup factor or future expansion considerations associated with Part 4 and Part 5.

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5. Propane Storage Regulatory Requirements Overview

CSA B149.2 - Propane storage and handling code provides prescriptive clearance/separation-distance tables governing how far propane storage containers must be sited from property lines, buildings, ignition sources, and public ways. These tables are structured by container water capacity, with required distances increasing in steps as capacity increases. The tables are built around a defined maximum listed capacity (eg. Table 7.4 Location of Above-ground Tanks for Consumer Application). The table sets out the required separation distances by tank water capacity. At proposed 90,000 US gallons exceeds the largest capacity addressed in Table 7.4.

Table 7.4
Location of above-ground tanks for consumer applications
(See Clauses 7.10.2, 7.10.3, and 9.3.2 and Annex M.)

Total aggregate water capacity, USWG (L)	Minimum distance, ft (m), between tank and property line; adjacent concrete or masonry building wall with no building openings within the specified clearances; or source of ignition*	Minimum distance, ft (m), between tank and building wall of other than concrete or masonry construction	Minimum distance, ft (m), between tank and building opening	Minimum distance, ft (m), between tank and adjacent tank†
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Over 10 000 (38 000) up to and including 30 000 (113 500)	50 (15.2)	50 (15.2)	50 (15.2)	5 (1.5)
Over 30 000 (113 500)	§	§	§	§

* *Distances to property lines may be amended by the authority having jurisdiction.*
† *If tanks of a multiple tank installation are installed on a common concrete/steel base or pier, the clearances may be reduced to a 1/4 of the sum of diameters of the adjacent container.*
‡ *10 ft (3 m) from any source of ignition.*
§ *At the discretion of the authority having jurisdiction.*

Above that threshold, the code does not provide a direct table lookup for required setbacks. This creates a regulatory gap/unknown rather than a simple non-compliance. In the absence of a prescriptive answer from the table, the approval would fall to TSSA's discretion. At present, it is not established how TSSA would exercise its discretion for a volume above the table's scope.

6. Potential Path Forward for TSSA Approach

Under Ontario Regulation 211/01 - Propane Storage and Handling, TSSA requires a formal Risk and Safety Management Plan (RSMP) for facilities classified as non-consumers. The sites consisting only of propane tanks or cylinders connected to a heating system are considered "consumer applications" and do not require a formal RSMP and do not require a formal RSMP ad not fall under Ontario Regulation 211/01. That said, the RSMP framework could be used to answer the underlying question on how to demonstrate an acceptable level of risk for a propane installation whose scale falls outside routine compliance. The assessment would provide hazard analysis, risk assessment, risk mitigation/control plan and emergency response. Rather than asking TSSA to exercise their discretion with minimal supporting documentation, the facility would proactively provide the same category of hazard analysis, worst-case scenario modeling, mitigation plan, and emergency response plan that TSSA already relies on for non-consumer facilities. The risk assessment approach could also use guidelines established in MIACC (Major Industrial Accidents Council of Canada) as it is typically done for non-consumer industrial facilities.

As another point to consider, the risk assessment also has value beyond TSSA approval alone. A storage volume of this scale may also have implications for the facility's property and liability insurance, which reinforce the case for carrying out this assessment:

7. Diesel (No.2 Fuel Oil) Option Considerations

Dual Gas Train. Because diesel cannot be burned in the existing gas burners without modification, each of the existing boilers (both steam and heating waters) would have to be retrofitted or replaced to add a secondary (oil) gas train and potentially burner replacement. This would require continuous maintenance of two combustion trains per boiler over the service life of the equipment, rather than the single shared combustion train with SNG option. It would increase the amount of equipment (at boiler level) that must be installed, maintained, and eventually replaced.

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Fuel Delivery Infrastructure. Bulk fuel storage, whether propane or diesel, is proposed to be located approximately 500 ft from the hospital and the neighboring residential area as per latest site plan. For SNG, this distance is an asset as it makes the large volume storage workable against setback expectations. For diesel, the same distance becomes a design challenge. It is worth noting that diesel's own setback requirements (governed by *CSA B139 - Installation Code for Oil Burning Equipment*) are generally less restrictive than propane's, meaning a diesel tank could, in principle, be sited closer to the facility than propane can although it is not clear if there would be an opportunity to do so. If assumed that the diesel tanks would most likely end up in the same location as the propane storage, the advantage of less restrictive clearances would not be realized.

New supply and return piping. New supply and return oil piping would need to be run from the diesel storage tank to both plants. Assuming the new transfer station is located near the existing natural gas/SNG transfer station, the diesel option would require new oil piping from that location to all four boilers in the existing plant, plus an additional set of lines to the James Beach mechanical room. This routing is likely feasible, following the same path as the natural gas piping, across the link roof, through the existing mechanical room, and up into the James Beach mechanical room but it does require an entirely new piping run that would not be needed if the SNG option is chosen instead. Piping of this length also carries the standard considerations for long outdoor fuel oil runs such as pressure drops, potential heat tracing for any exposed long piping sections, additional considerations for weatherproofing, structural support, roof penetrations, and spill containment.

New pumping station. Pumping system would be required to move diesel fuel from the remote diesel storage tanks to each plant along with day tank, transfer pumps and new piping infrastructure.

Long-Term Fuel Storage Considerations. Diesel does not store indefinitely the way propane does. Fuel sitting in bulk storage for extended periods as an emergency reserve is subject to a recurring maintenance cost and a real reliability risk if the fuel has degraded by the time it is actually needed in an emergency. Propane carries no equivalent degradation-in-storage concern.

Environmental and Emissions Profile. As noted in earlier sections, propane burns cleaner than diesel (Type 2 fuel oil) which favors SNG as air-emissions regulations tend to become more stringent over long term (multi-decade) period.

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8. Final Recommendations

Primary path. Proceed with SNG at the full 90,000-gallon sizing basis, supported by a voluntary RSMP-style, MIACC-informed risk assessment (hazard analysis, worst-case scenario modeling, risk mitigation/land-use plan, and emergency response plan), prepared by Sleegers and submitted proactively to TSSA to address the CSA B149.2 Table 7.4 gap. The facility's insurance (FM Global should be engaged in parallel so the same risk assessment plan supports both regulatory approval and insurance underwriting.

Contingency: Diesel option could be pursued only if the above path proves genuinely unworkable with TSSA. As detailed within the body of this report, this option carries substantially higher cost and disruption and should be treated as a fallback.

Option: A hybrid on-site/off-site propane storage model. Under this approach, on-site propane storage would be reduced to limits within Table 7.4 with the remaining propane storage, required for 72 hour service, held in leased ISO-certified propane containers stored off-site (e.g., at a supplier's yard) and transported to site and connected as required. *Consider reducing the sizing below 72 hours as discussed in Section 2 of this report.*

This option could add some value because it could substantially reduce or eliminate special TSSA approval, reduce overall on site footprint and associated risk, and potentially ease the insurance conversation. Further study would need to be conducted to address the following concerns:

Ongoing operating cost vs. upfront capital cost: Unlike the full on-site storage option (a larger upfront capital cost with somewhat smaller ongoing fuel/maintenacance expense), the hybrid model would carry a recurring lease and logistics cost for the off-site containers and their transport for the entire services life of the system which could be less favourable to the hospital in terms of funding.

Delivery/transport reliability: The off-site containers must reach site and be connected during the same severe weather or emergency conditions that may have caused the natural gas service interruption in the first place. This requires contractual guaranteed-response terms with the supplier and realistic worst-case transport time assumptions.

On-site receiving infrastructure and training: Connecting delivered ISO containers under emergency conditions requires dedicated connection points and new facility staff procedures.

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9. Appendices

Appendix A – QCH Early Works – Propane Storage Relocation/Replacement (July 31, 2024)

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Attention: Peter Thompson, Capital Project Manager - Planning

RE: QCH EARLY WORKS – PROPANE STORAGE RELOCATION/REPLACEMENT

Introduction

To facilitate the upcoming Part 4 Expansions at the Queensway Carleton Hospital, relocation of the existing propane storage assembly is required. Vanderwesten & Rutherford have coordinated estimated future loads with Sleegers Engineered Products Inc. (retained by Parkin Architects Ltd.) and have reviewed potential locations for future storage for both the current and immediate renovation loads (Part 4 and 5) as well as the more distant expansion plans (part 6 and 7). Condition of the existing storage assembly was reviewed with Superior Propane, the supplier of propane to the facility.

Compliance with CSA B149.2 has been used for this review.

Executive Summary

Three (3) 30,000 USWG tanks are required to store 72 hrs of propane storage on site to serve the current, Part 4 and Part 5 loads. Sleegers have provided two layouts for planning purposes (see attached sketches).

These layouts show two (2) future tanks for Part 6 and 7, for a total of five (5) 30,000 USWG of storage; however, given how distant those expansions are in the future (20-30 years), and given that storage requirements trigger TSSA approval of the work, it is recommended that Part 6 and 7 storage be planned for on the south side of campus (location to be determined during Part 6 design phase).

It should be noted that although CSA B149.2 indicates a setback clearance of 50 ft., TSSA may require more depending on the outcome of their review. The consultant team shall work with TSSA in design to ensure all requirements are met.

Existing Conditions

The existing propane tank is located west of the existing main power plant, at grade on concrete supports. The tank has a storage capacity of 18,025 USWG and was constructed in 1975 (nameplate date 5-5-75). Tank dimensions are 84in. diameter x 766.25in. (63.85ft.) long.

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The tank is owned by QCH, appears to be in fair condition and has not expired; however, in review with Superior Propane, the following items were noted:

- Relief valves are due to be replaced (existing are dated 2011, replacement cycle is every 10 years).
- Surface corrosion is present on some areas of tank and piping
- Tank piers and bollards no longer meet current code

Based on historic natural gas consumption data and high-level estimation of future expansion loads, the following heating loads have been calculated for a 72-hour period (as mandated by CSA):

- Current Load: 3,466,447,660.59 BTUs

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- Part 4 + 5 load: 3,086,665,992 BTUs
- Part 6 load: 1,457,768,448.00 BTUs
- Part 7 load: 1,933,114,608.00 BTUs

Design Considerations

Tank size

Based on the existing plant sizing and run/standby configurations of the systems, Sleegers has calculated a required storage capacity for current conditions at 44,328 USWG. This takes into account the requirement for 72 hours of on-site fuel storage. The value exceeds the existing tank's capacity.

Although the existing tank has not failed inspection, it is recommended to be replaced with new. This removes the risk of potential damage during relocation and potential red-tagging of system if failure was to occur in the short term.

A summary of storage requirements, calculated by Sleegers per planned hospital expansion, is as follows:

Load	Propane Req'd (USWG)	Container Capacity Req'd (USWG)
Current	37,679	44,328
Current + 4 to 5	71,230	83,799
Current + 4 to 6	87,075	102,441
Current + 4 to 7	108,087	127,161

It should be noted that the above storage accounts for operation of the Cancer Centre, which was not previously incorporated into backup loads.

Site Location & Code Compliance

The most feasible location for the new propane storage for Part 4 & 5 is indicated below. A new "island" has been planned for north of the existing location.

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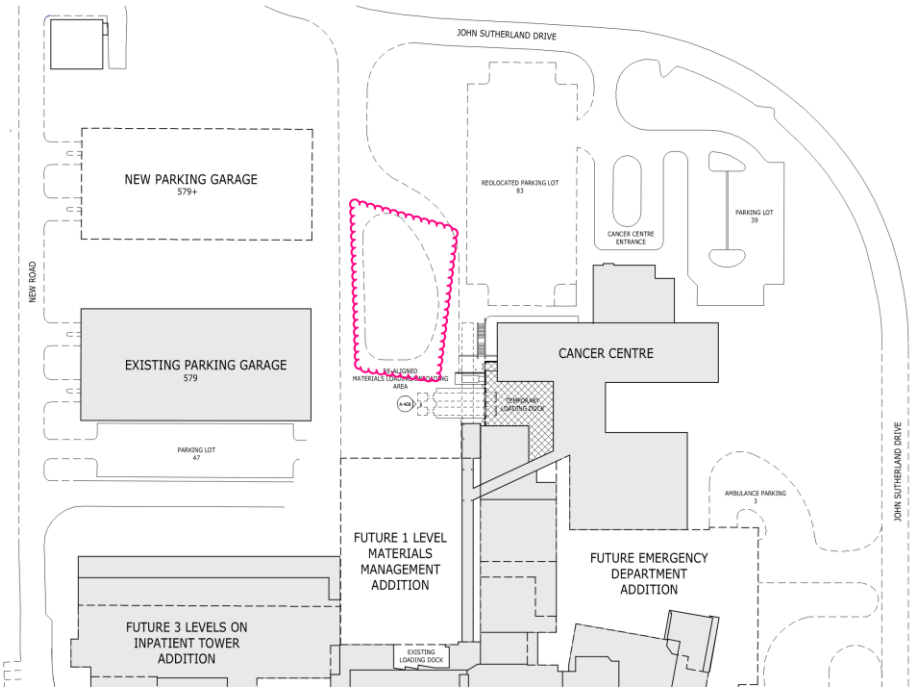

CSA B149.2, clause 6.5.1.8 outlines clearances to be maintained when planning outdoor propane storage:

6.5.1.8

Except as permitted in Clauses 6.5.2.6.1 for cylinder exchange cages, an outdoor cylinder storage area, special cylinder storage room, or a cylinder storage building described in Clause 6 shall be located in accordance with Table 6.3 with respect to

a) the nearest building or group of buildings;
b) the line of adjoining property that may be built upon;
c) public thoroughfares or sidewalks; and
d) the line of adjoining property occupied by schools, churches, hospitals, athletic fields, or other points of public gathering.

Table 6.3
Cylinder storage clearances
(See Clauses 6.5.1.8, 6.5.2.6.1, and 6.5.3.2.)

Quantity of propane stored, lb (kg)	Distance, ft (m), from cylinder storage to Items a) and b) of Clause 6.5.1.8	Distance, ft (m), from cylinder storage to Items c) and d) of Clause 6.5.1.8
Up to and including 500 (225)	0*†	10 (3)
501 (225) to 2500 (1135)	15 (4.5)	25 (7.6)
2501 (1135) to 5000 (2270)	25 (7.6)	25 (7.6)
Over 5000 (2270)	25 (7.6)	50 (15.2)

* *3 ft (0.9 m) from any building opening.*
† *10 ft (3 m) from any mechanical air intake.*

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Given the proposed storage sizing, this system falls under the "Over 5000 (2270)" line above. Through consultation with TSSA, required setbacks will be reviewed and optimized for overall planning of expansions where possible.

Clause 7.1.5 in CSA also outlines necessary coordination with electrical site services:

7.1.5

A tank with a capacity in excess of 2000 USWG (7500 L) shall not be installed

a) under an electrical transmission line and shall be located a minimum horizontal distance from any such line equal to the property clearance requirements of Clauses 7.10.2 and 7.16;

b) under an electrical distribution line and shall be located not less than 25 ft (7.6 m) in any direction from any such line; and

c) over an underground electrical distribution line and shall be located not less than 5 ft (1.5 m) from any such line.

New duct bank routing will be coordinated to ensure a minimum of 5 ft clearance is maintained.

Table 7.4 from CSA indicates that TSSA approval shall be required for proposed tank layout due to storage volume required:

Table 7.4
Location of above-ground tanks for consumer applications
(See Clauses 7.10.2, 7.10.3, and 9.3.2 and Annex M.)

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Over 1000 (3800) up to and including 2000 (7800)	10 (3)	25 (7.6)	25 (7.6)	3 (0.9)
Over 2000 (7800) up to and including 5000 (19 000)	15 (5)	25 (7.6)	25 (7.6)	3 (0.9)
Over 5000 (19 000) up to and including 10 000 (38 000)	25 (7.6)	25 (7.6)	25 (7.6)	3 (0.9)
Over 10 000 (38 000) up to and including 30 000 (113 500)	50 (15.2)	50 (15.2)	50 (15.2)	5 (1.5)
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‡ 10 ft (3 m) from any source of ignition.
§ At the discretion of the authority having jurisdiction.

Proposed Work

Sleegers have indicated that a standard tank size is 30,000 USWG. Three (3) tanks are required to serve the current load, in addition to the immediate Part 4 and Part 5 Expansion loads.

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Two tank configurations have been provided for preliminary planning. See attached sketches for reference.

Option No. 1 footprint: 45 ft x 61 ft

Option No. 2 footprint: 38 ft x 79 ft

Future tanks may be added on to this assembly for Part 6 and 7; however, it is strongly recommended that the storage be broken into two separate locations on campus. This will result in less complications with TSSA approval and allows for shorter runs to future equipment.

Maintaining a smaller footprint with the three (3) tanks versus adding more to the assembly in the future will also ensure code required clearances are maintained. In addition, Part 6 and 7 are planned for much farther in the future (20-30 years); therefore, there is no value in designing for storage now, as requirements are bound to change.

If you should require any further information or clarification, please do not hesitate to contact this office.

Sincerely,

VANDERWESTEN & RUTHERFORD ASSOCIATES INC.
Mechanical & Electrical Consulting Engineers

Isabelle Fernandez, P.Eng., LEED AP
Associate, Senior Mechanical Engineer

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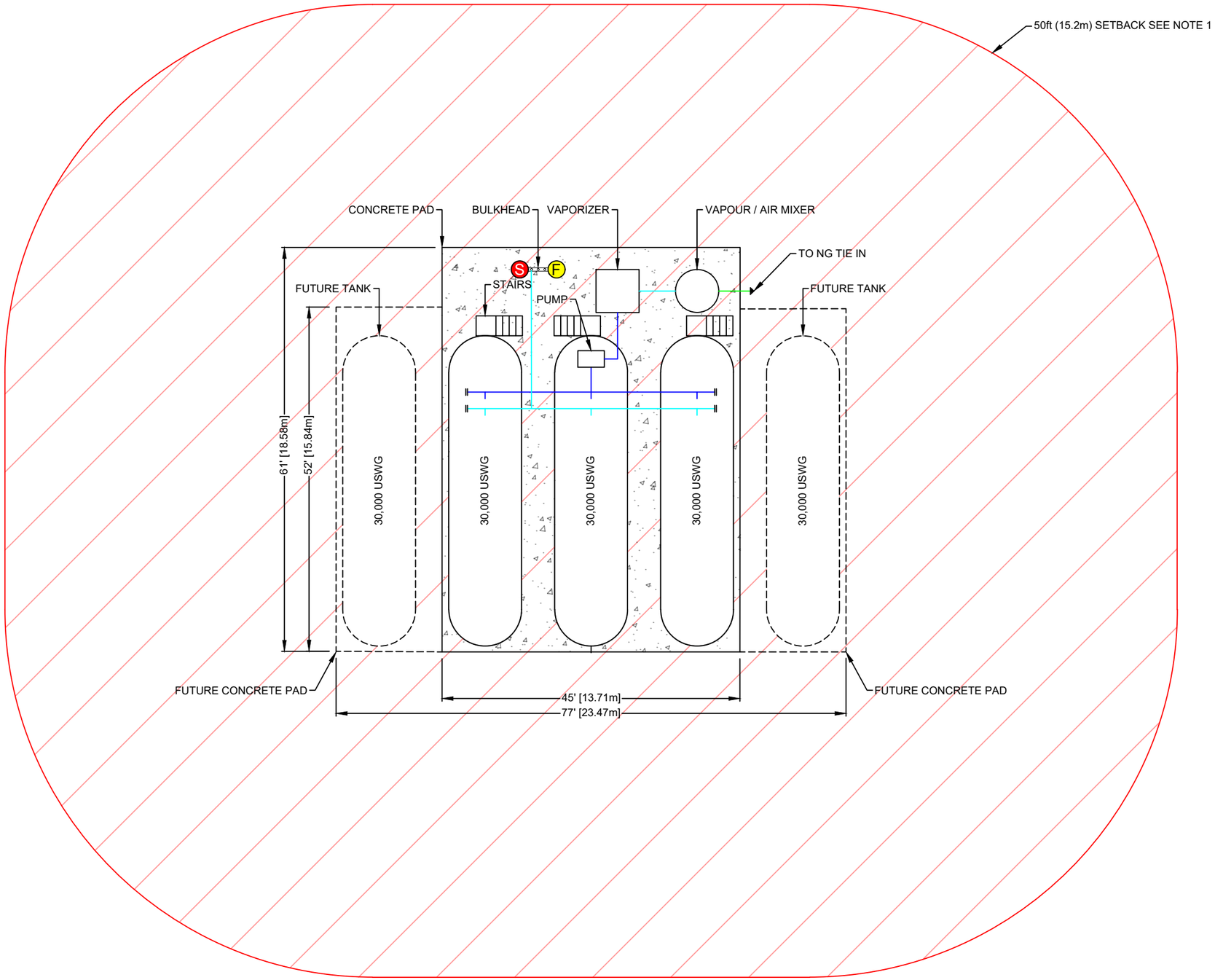
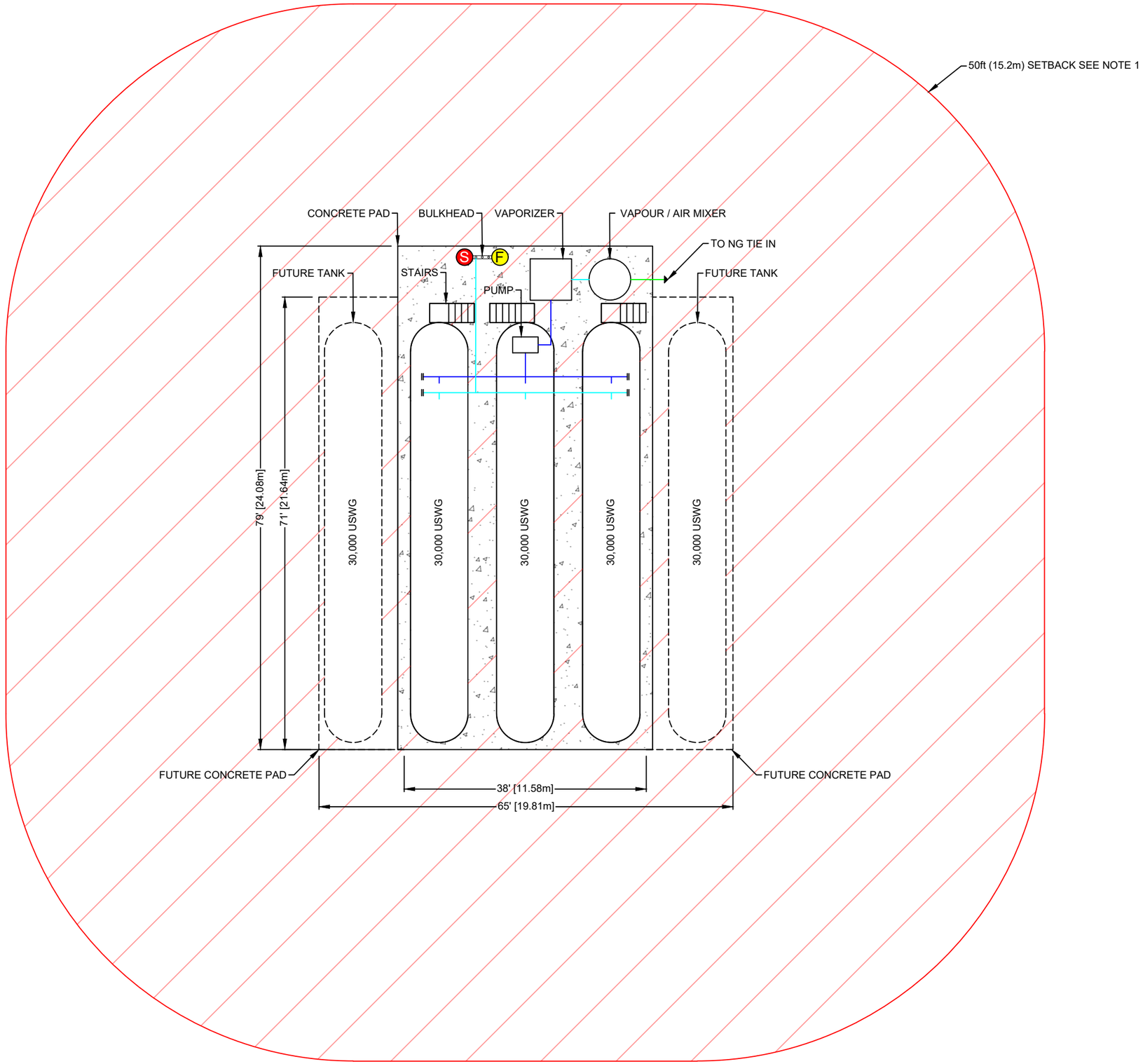


NOTES

1. 50ft (15.2m) SETBACK TO STORAGE TANKS FOR PROPERTY LINES, BUILDINGS, SOURCES OF IGNITION AND ELECTRICAL POWER LINES. THIS SETBACK IS SUBJECT TO APPROVAL BY THE TSSA.
2. AREA MUST HAVE VEHICULAR PROTECTION ADHERING TO CSA B149.2.
3. VAPORIZERS TO BE PROTECTED FROM TAMPERING AND DAMAGE.
4. ELECTRICAL INSTALLATIONS TO FOLLOW CANADIAN ELECTRICAL CODE

LEGEND

- S — EMERGENCY SHUTOFF
- F — FIRE EXTINGUISHER
- FLANGES (PROVISION FOR FUTURE TANKS)
- LIQUID PROPANE PIPING
- VAPOUR PROPANE PIPING
- SNG PIPING



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