April 8, 2021 Our File: 346-361

District of Barriere
4936 Barriere Town Road
Box 219
Barriere, BC V0E 1E0

Attn: Bob Payette, CAO

Dear Sir:

RE: *Louis Creek Industrial Park – Reservoir Improvement Options*

The District of Barriere recently completed a series of improvements to the Louis Creek Industrial Park Water System in 2019 and 2020. The improvements generally consisted of the following:

- Water supply well completion
- Pumphouse construction
- Chlorination system
- Dual distribution piping consisting of:
  - Non-potable fire suppression system
  - Potable water supply system
- Electrical and controls systems

Due to budget constraints, a dual (potable / non-potable) water distribution system was designed and constructed. The potable water system comprises a 100mm distribution main with 50mm services provided to each lot. The potable system is controlled based on system pressure as measured in the pumphouse building. The capacity of the potable system is limited to the capacity of the well source, which has been determined by BC Groundwater Consulting Services Ltd. to be 50 USgpm (3.2 L/s).

The fire suppression system consists of large diameter (250mm) distribution mains and fire hydrants, which extend from the existing open-air concrete reservoir. This reservoir is the former fire suppression reservoir as was utilized by the Tolko Mill for industrial purposes prior to the 2003 wildfires. Crack sealing of the reservoir was undertaken in 2020 to ensure that storage of non-potable water for fire suppression purposes could be achieved. The existing open-air concrete reservoir provides sufficient volumes for fire-fighting purposes. It is filled as needed from the potable supply system. Due to the fact that the reservoir is not covered, the water quality is considered non-potable from this system.

The dual piping system (potable / non-potable) was considered to be a temporary solution at the Louis Creek Industrial Park due to budget constraints. Once sufficient funding was available, it was planned to improve the reservoir to allow it to be connected to the potable water system. Several benefits would be realized by connecting the reservoir to the potable system, including:

- Water quality would be improved and would be considered potable
- Maintenance obligations associated with poor water quality in the open-air reservoir would be eliminated
- The capacity of the system to supply potable water to the Industrial Park would be increased as the reservoir would provide a buffer during periods of high demand, reducing the reliance on the well to keep up with system demands

At minimum, a reservoir roof would be required in order to connect the reservoir to the potable water system. The reservoir roof must be tightly sealed to the existing concrete walls in order to achieve potability requirements and to receive construction approvals from Interior Health Authority. Once reservoir improvements are completed, the existing 100mm potable main would become a dedicated supply main to the reservoir and the existing 250mm main would become the distribution main servicing each lot. This letter has been prepared to provide the District with an assessment of the options that are available related to the improvement of the water storage reservoir such that it could be connected to the potable water system.

The existing reservoir consists of a 24m wide by 24m long by 2.75m deep cast in place concrete structure. The reservoir walls are approximately 240mm thick and the slab appears to consist of a raft slab. The slab thickness is unknown. Field observations suggest that the reservoir was formerly fitted with a wooden roof structure which was destroyed during the 2003 fires. West Edge Engineering Ltd completed an inspection of the existing reservoir in 2014 and did not observe any settlement, tilting, bending, major cracks or surface deterioration. It was determined that the reservoir was structurally sound, but leakage repair was required. The District subsequently retained Newport Structures to complete the recommended leakage repairs in 2020.

The primary challenge associated with the existing concrete reservoir is the fact that any improvement to the existing structure will be considered a retrofit project. With any retrofit project, there will be risks associated with the project. Risks associated with the existing structure include unknown thickness of the raft slab, unknown rebar specification in the slab and walls, and unknown rebar spacing in the slab and walls. Consequently, the ability of the structure to carry loads as applied through the retrofit construction will be considered a significant unknown.

TRUE Consulting has considered six (6) options for the establishment of a potable water storage reservoir for the consideration of the District of Barriere. Of the six options that were considered, four of the options involve retrofit improvements to the existing structure, whereas the remaining two options comprise construction of a new reservoir at this location. A general description of the six options, together with advantages and disadvantages, is provided following.

Option #1: Precast Concrete Roof

Option 1 is illustrated in Figure 1 attached. As shown, this option comprises the placement of 300mm thick precast concrete roof panels on the existing reservoir. A preliminary design has been completed for this improvement option. It has been determined that two 600mm deep beams would be required to support the new roof panels. Each of these beams would be supported by approximately four new concrete columns (8 columns in total) that would have to be constructed within the reservoir to support the new roof. Each of the concrete columns would need to be supported by concrete footing pads. The precast footing pads would be placed directly on to the existing raft slab. The preliminary design places columns next to the reservoir walls to avoid using the existing walls as a bearing surface to the greatest extent possible. All end-to-end joints would be welded and grouted solid, other joints would be caulked with silicone. It is likely that low points will be formed on the precast panels, thereby creating the potential for maintenance obligations. As such, a torch-on roof membrane system has been included in the preliminary cost estimate to ensure that potability can be ensured.

Risks associated with this option include: unknown wall and raft slab structural details and subgrade details / unknown impacts of weight bearing on existing reservoir structure through footing pads and wall loading; challenges related to creating a potable seal between precast roof panels and existing reservoir walls; and membrane maintenance over time due to ponding at low points.

Disadvantages associated with this option include: the reservoir must be taken offline during construction; and the number of available contractors is limited due the pre-cast nature of the works.

Option #2: Cast-in-Place Concrete Roof

Option 2 is illustrated in Figure 2 attached. As shown, this option comprises the construction of a cast-in-place concrete roof structure on the existing reservoir. A preliminary design has been completed for this improvement option. It has been determined that approximately sixteen (16) cast-in-place concrete columns would be required inside of the reservoir to support the construction of a new cast-in-place roof structure. Each of the concrete columns would need to be supported by cast-in-place concrete footings. For this option, the column footings would be constructed by cutting away the reservoir raft slab such that thickened concrete footings could be poured in place.

It has been determined that a cast-in-place roof system has some advantages in comparison to the pre-cast concrete option described above (Option 1) as it relates to a roof retrofit. The cast-in-place system can be poured to form a sound connection with the existing reservoir walls, thereby ensuring a potable seal. In addition, a cast-in-place option will not result in cold joints between panels, thereby eliminating the requirement for a torch-on roof membrane system. Consequently, the cast-in-place roof will require reduced long term maintenance in comparison with Option 1. Further, the cast-in-place construction methods allow for more competitive construction since the construction methods are more “typical”.

Risks associated with this option include: unknown subgrade conditions below raft slab / unknown ability for subgrade soils to support new footing placement; and unknown impacts of weight bearing on existing reservoir structure through increased wall loading**.**

Disadvantages associated with this option include: the reservoir must be taken offline during construction.

Option #3: Aluminum Roof System

Option 3 is illustrated in Figure 3 attached. As shown, this option comprises the installation of an aluminum clear-span, low-profile potable water dome roof. The aluminum dome roof is corrosion resistant, UV resistant and weather tight. Preliminary design suggests that an aluminum dome roof can be installed as a clear span, thereby eliminating the requirement to retrofit the existing structure with support columns.

Risks associated with this option include: unknown impacts of weight bearing on existing reservoir structure through increased wall loading**;** and potential complexities creating a potable seal between aluminum roof and existing concrete walls.

Disadvantages associated with this option include: the reservoir must be taken offline during construction.

Option #4 Glass-fused-to-steel bolted reservoir

The construction of a new reservoir has been considered as an option. Option 4 is illustrated in Figures 4A and 4B attached. As shown, this option comprises the construction of a new reservoir, completely independent from the existing concrete structure. The new reservoir would consist of a glass-fused bolted steel reservoir designed and constructed to potable standards. The new reservoir would likely be placed to the south of the existing reservoir on the same bench, as illustrated on Figure 4B. The construction of a new bolted-steel reservoir mitigates the risks associated with altering/retrofitting the existing reservoir. The new reservoir dimensions would be approximately 12m in diameter and approximately 11.6m tall. The added reservoir height would increase the service pressure in the distribution system by approximately 12 psi. The location of the new reservoir would be such that it could be constructed independent of the existing structure, thereby allowing the existing structure to remain in operation during construction of the new reservoir.

Risks associated with this option include: unknown soil conditions south of the existing reservoir.

Option #5 – Box Girder Supported Membrane Roof

Option 5 is illustrated in Figures 5A and 5B attached. As shown, this option comprises the installation of steel piling along the north and south walls of the existing reservoir. The steel piling would provide opportunity for the roof loading to be distributed to the soil profile through the piles rather than by way of increased loading on the existing structure. Cast-in-place concrete pier caps would be poured on top of the steel piling paralleling the north and south walls of the existing structure. Concrete box girders would be placed on the cast-in-place pier caps. The box girders

would be clear-span and would not require column supports within the existing structure. A torch-on roof membrane system would be required over the box girder to provide a water-tight seal.

A preliminary design has been completed for this improvement option. It has been determined that twenty (20) concrete box girders would be required to form the new roof panels. The box girders would provide a clear-span structure over the existing reservoir structure. The girders would be supported by steel piling and cast-in-place pier caps. Preliminary design suggests that approximately eleven (11) steel piles would be required along both the north and south reservoir walls (22 piles total).

Risks associated with this option include: challenges associated with putting down piles in close proximity to the existing structure; challenges related to creating a potable seal between roof panels and existing reservoir walls; and membrane maintenance over time due to ponding at low points.

Disadvantages associated with this option include: the reservoir must be taken offline during construction.

Option #6 Cast-in-place concrete reservoir

Similar to Option 4, this option also considers construction of a new reservoir as an option. Option 6 is illustrated in Figure 6 attached. As shown, this option comprises the construction of a new reservoir, but within the same footprint as the existing concrete structure. The new reservoir would consist of cast-in-place concrete construction which would be designed and constructed to potable standards. Due to its dimensions, the new reservoir would be constructed within the same footprint of the existing reservoir. The construction of a new cast-in-place reservoir mitigates the risks associated with altering/retrofitting the existing reservoir. The new reservoir length and width dimensions would be approximately equal to the existing reservoir. Wall heights could be increased by approximately 2.1m. The added reservoir height would increase the service pressure in the distribution system by approximately 3 psi.

Risks associated with this option are minimal and would comprise unknown soil conditions under the existing reservoir.

Disadvantages associated with this option include: the reservoir must be taken offline during construction.

Cost Summary

A summary of the Class D costs associated with each of the options described above is included in the table below. A more detailed breakdown of each cost estimate is included as Appendix A of this document.

	Option #1	Option #2	Option #3	Option #4	Option #5	Option #6
Item	**Precast Concrete Roof System**	**Cast-in-Place Concrete Roof System**	**Aluminum Roof System**	**Glass-Fused-to-Steel Bolted Reservoir**	**Box Girder Membrane Roof System**	**Cast-In Place Reservoir**
General	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000
Structural	$445,000	$480,000	$900,000	$630,000	$941,500	$842,000
Mechanical	$35,000	$35,000	$35,000	-	$35,000	$35,000
Civil	$30,000	$30,000	$30,000	$85,000	$30,000	$30,000
Electrical	$50,000	$50,000	$50,000	$55,000	$55,000	$55,000
Subtotal	$610,000	$645,000	$1,065,000	$820,000	$1,111,500	$1,012,000
Engineering	$61,000	$96,750	$159,750	$123,000	$166,725	$151,800
Contingencies	$91,500	$96,750	$159,750	$123,000	$166,725	$151,8000
TOTAL PROJECT	**$762,500**	**$838,500**	**$1,384,500**	**$1,066,000**	**$1,444,950**	**$1,315,600**

Conclusions and Recommendations

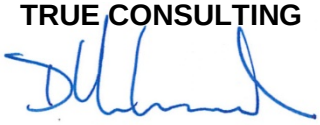
TRUE Consulting has assessed six (6) reservoir improvement options for the Louis Creek Industrial Park water system on behalf of the District of Barriere. The uncertainties associated with the existing reservoir structure present significant unknowns and risks in terms of the retrofit options that have been considered. The lowest cost option that has been considered is a pre-cast concrete roof structure (Option 1). Unfortunately, there are considerable risks associated with this approach. Option 4 (bolted-steel reservoir) comprises the option with the least amount of risk and the cost associated with this option is approximately “middle of the pack” in terms of the options that have been assessed. Option 4 has the added benefit of increasing the service pressure in this subdivision by approximately 12 psi.

Given the risks and uncertainties associated with retrofit of the existing structure, TRUE Consulting recommends that the District proceed with the construction of a new glass-fused bolted steel reservoir to provide potable water storage at the Louis Creek Industrial Park.

If there are questions or should you wish to discuss, please do not hesitate to contact the undersigned.

Yours truly,

TRUE CONSULTING



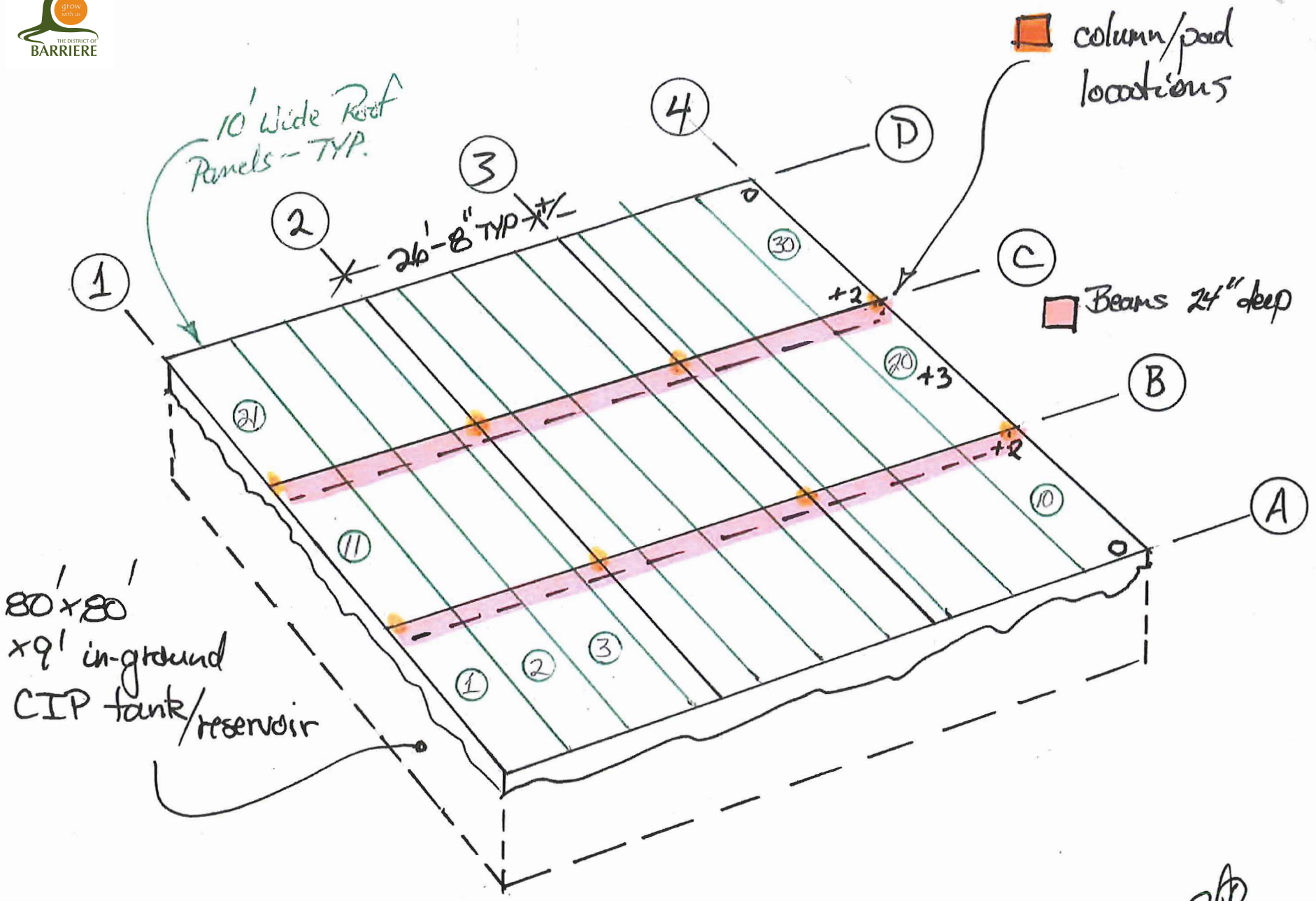
Dave Underwood, P. Eng.

Enclosures

District of Barriere
Louis Creek Industrial Park - Reservoir Upgrade
Precast Concrete Roof - Option #1
Cost Estimate - Class "D"

ITEM NO.	DESCRIPTION	UNIT	ESTIMATE
1.0	**GENERAL**		
	Insurance and Bonding, Mobilization, Restoration, Demobilization	allow	$50,000
2.0	**STRUCTURAL**		
	Precast Concrete Roof System c/w Support Columns	allow	$300,000
	Roof Membrane System	allow	$100,000
	Precast Structural Engineering	allow	$45,000
3.0	**MECHANICAL**		
	Stainless Steel 100mm Inlet, 250mm Outlet and 250mm Overflow pipe	allow	$35,000
	Air Vents, Access Hatches, Access Ladders		
4.0	**CIVIL**		
	100mm SS/PVC Inlet Piping, Bend, Pipe Couplings and Tie-ins	allow	$30,000
	250mm SS/PVC Outlet Piping, Bends, Pipe Couplings and Tie-ins		
	200mm SS/PVC Overflow Piping, Bends, Pipe Couplings and Tie-ins		
	Overflow Outfall Structure c/w Rip-Rap and Flap Gate		
	250mm Tank Drain c/w Valves		
5.0	**ELECTRICAL**		
	BC Hydro Service	allow	$50,000
	Metering Pole c/w Service Dip to Kiosk		
	Electrical Service Kiosk		
	Fiber Optic Cable Connection to Kiosk		
	Instrumentation		
	Programming and Controls		
6.0	**COST ESTIMATE SUMMARY**		
		Subtotal	$610,000
	Engineering - Allow (10%)		$61,000
	Contingencies - Allow (15%)		$91,500
	TOTAL PROJECT		**$762,500**

Louis Creek Industrial Park Water System



Precast Concrete Roof - Option #1

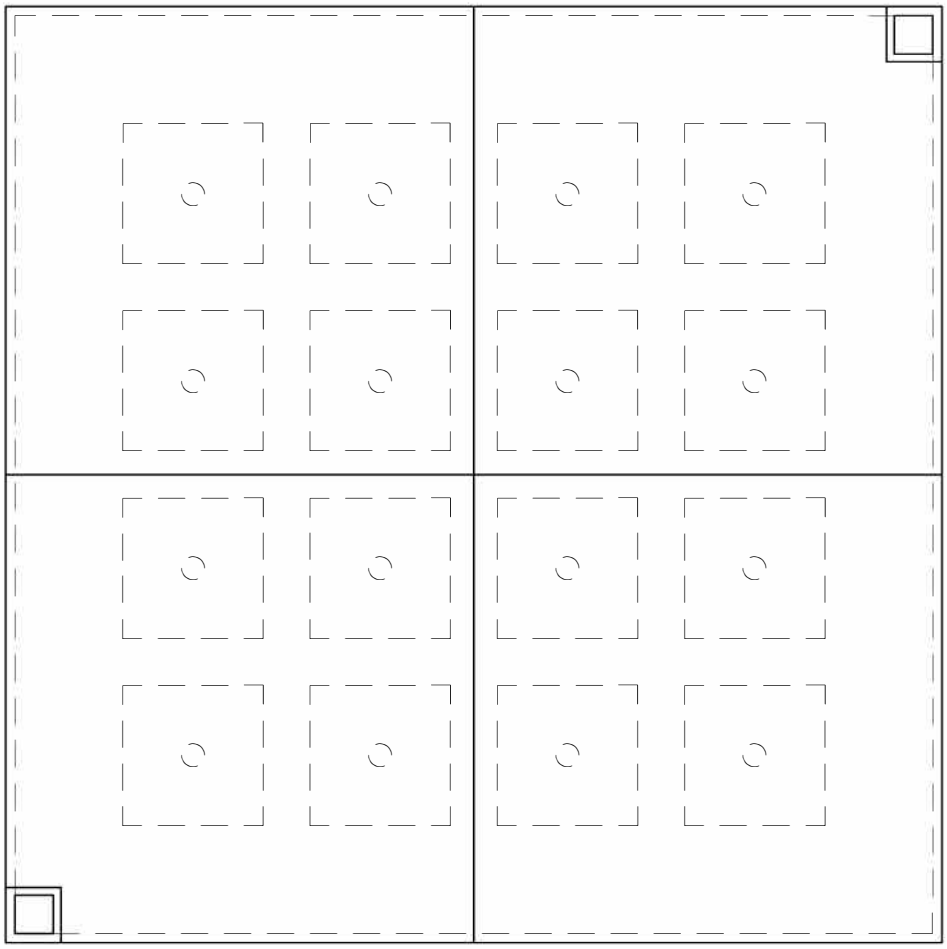
Figure 1

Barrière Aug 24/2020

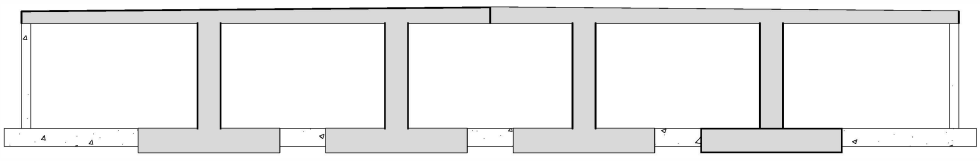
District of Barriere
Louis Creek Industrial Park - Reservoir Upgrade
Cast-In-Place Concrete Roof - Option #2
Cost Estimate - Class "D"

ITEM NO.	DESCRIPTION	UNIT	ESTIMATE
1.0	**GENERAL**		
	Insurance and Bonding, Mobilization, Restoration, Demobilization	allow	$50,000
2.0	**STRUCTURAL**		
	Cast-In-Place Concrete Roof System	allow	$480,000
3.0	**MECHANICAL**		
	Stainless Steel 100mm Inlet, 250mm Outlet and 250mm Overflow pipe	allow	$35,000
	Air Vents, Access Hatches, Access Ladders		
4.0	**CIVIL**		
	100mm SS/PVC Inlet Piping, Bend, Pipe Couplings and Tie-ins	allow	$30,000
	250mm SS/PVC Outlet Piping, Bends, Pipe Couplings and Tie-ins		
	200mm SS/PVC Overflow Piping, Bends, Pipe Couplings and Tie-ins		
	Overflow Outfall Structure c/w Rip-Rap and Flap Gate		
	250mm Tank Drain c/w Valves		
5.0	**ELECTRICAL**		
	BC Hydro Service	allow	$50,000
	Metering Pole c/w Service Dip to Kiosk		
	Electrical Service Kiosk		
	Fiber Optic Cable Connection to Kiosk		
	Instrumentation		
	Programming and Controls		
6.0	**COST ESTIMATE SUMMARY**		
		Subtotal	$645,000
	Engineering - Allow (15%)		$96,750
	Contingencies - Allow (15%)		$96,750
	TOTAL PROJECT		**$838,500**

Louis Creek Industrial Park Water System



Plan View



Section

Cast-in-place concrete Reservoir Roof - Option #2

Figure 2

District of Barriere
Louis Creek Industrial Park - Reservoir Upgrade
Aluminum Roof System - Option #3
Cost Estimate - Class "D"

ITEM NO.	DESCRIPTION	UNIT	ESTIMATE
1.0	**GENERAL**		
	Insurance and Bonding, Mobilization, Restoration, Demobilization	allow	$50,000
2.0	**STRUCTURAL**		
	Aluminum Roof System	allow	$900,000
3.0	**MECHANICAL**		
	Stainless Steel 100mm Inlet, 250mm Outlet and 250mm Overflow pipe	allow	$35,000
	Air Vents, Access Hatches, Access Ladders		
4.0	**CIVIL**		
	100mm SS/PVC Inlet Piping, Bend, Pipe Couplings and Tie-ins	allow	$30,000
	250mm SS/PVC Outlet Piping, Bends, Pipe Couplings and Tie-ins		
	200mm SS/PVC Overflow Piping, Bends, Pipe Couplings and Tie-ins		
	Overflow Outfall Structure c/w Rip-Rap and Flap Gate		
	250mm Tank Drain c/w Valves		
5.0	**ELECTRICAL**		
	BC Hydro Service	allow	$50,000
	Metering Pole c/w Service Dip to Kiosk		
	Electrical Service Kiosk		
	Fiber Optic Cable Connection to Kiosk		
	Instrumentation		
	Programming and Controls		
6.0	**COST ESTIMATE SUMMARY**		
		Subtotal	$1,065,000
	Engineering - Allow (15%)		$159,750
	Contingencies - Allow (15%)		$159,750
	TOTAL PROJECT		**$1,384,500**

Louis Creek Industrial Park Water System

Aluminum Roof System - Option #3

Figure 3

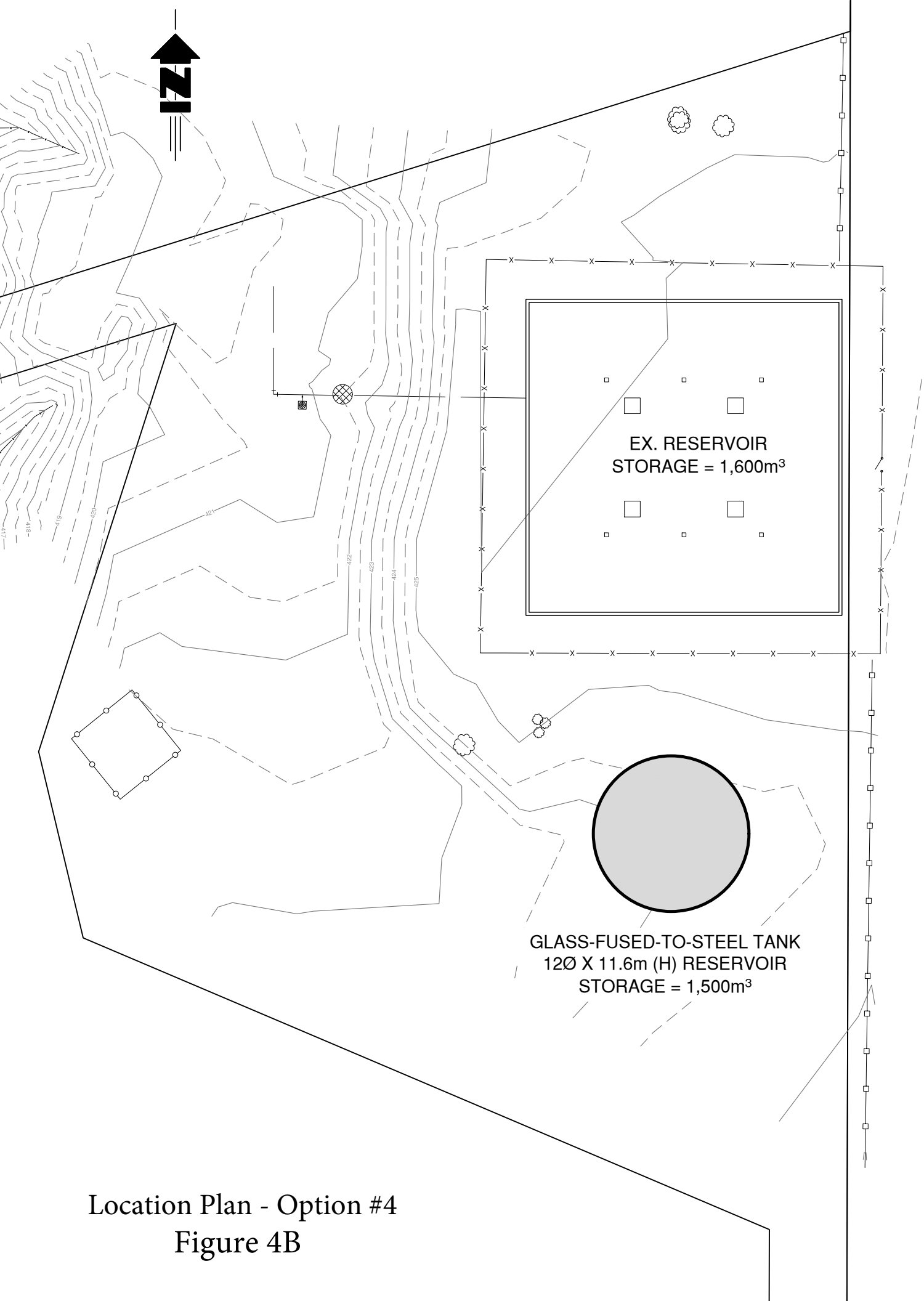
District of Barriere
Louis Creek Industrial Park - Reservoir Upgrade
Glass-Fused-to-Steel Bolted Reservoir - Option #4
Cost Estimate - Class "D"

ITEM NO.	DESCRIPTION	UNIT	ESTIMATE
1.0	**GENERAL**		
	Insurance and Bonding, Mobilization, Restoration, Demobilization	allow	$50,000
2.0	**STRUCTURAL**		
	Glass-Fused-to-Steel Bolted Reservoir c/w Access Ladder & Hatch, Insulation, Mixer	allow	$630,000
	Size: 12.8mØ x 11.6m(H) - Volume: 1421m^3 (375,500 USgal)		
3.0	**CIVIL**		
	100mm SS/PVC Inlet Piping, Bend, Pipe Couplings and Tie-ins	allow	$25,000
	250mm SS/PVC Outlet Piping, Bends, Pipe Couplings and Tie-ins		
	200mm SS/PVC Overflow Piping, Bends, Pipe Couplings and Tie-ins		
	250mm SS Drain c/w gate valve		
	Overflow Outfall Structure c/w Rip-Rap and Flap Gate		
	Site preparation includes, clearing and grubbing, excavation, crush gravel,	allow	$60,000
	compaction and backfill		
4.0	**ELECTRICAL**		
	BC Hydro Service	allow	$55,000
	Metering Pole c/w Service Dip to Kiosk		
	Electrical Service Kiosk		
	Fiber Optic Cable Connection to Kiosk		
	Instrumentation		
	Programming and Controls		
	Reservoir mixer connection		
5.0	**COST ESTIMATE SUMMARY**		
	Subtotal		$820,000
	Engineering - Allow (15%)		$123,000
	Contingencies - Allow (15%)		$123,000
	TOTAL PROJECT		**$1,066,000**

Louis Creek Industrial Park Water System

Glass-Fused-to-Steel-Bolted Reservoir - Option #4

Figure 4A

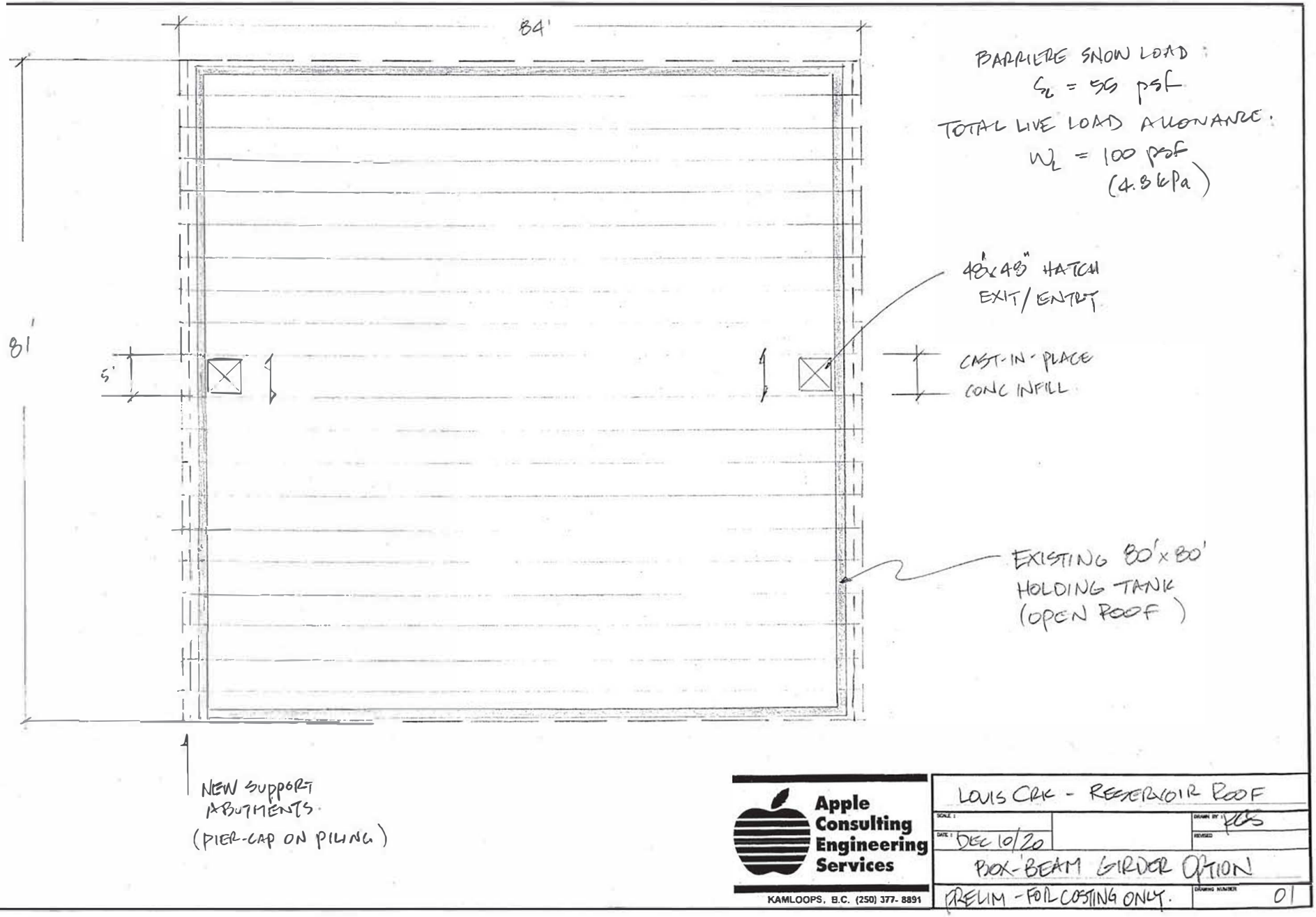


Location Plan - Option #4
Figure 4B

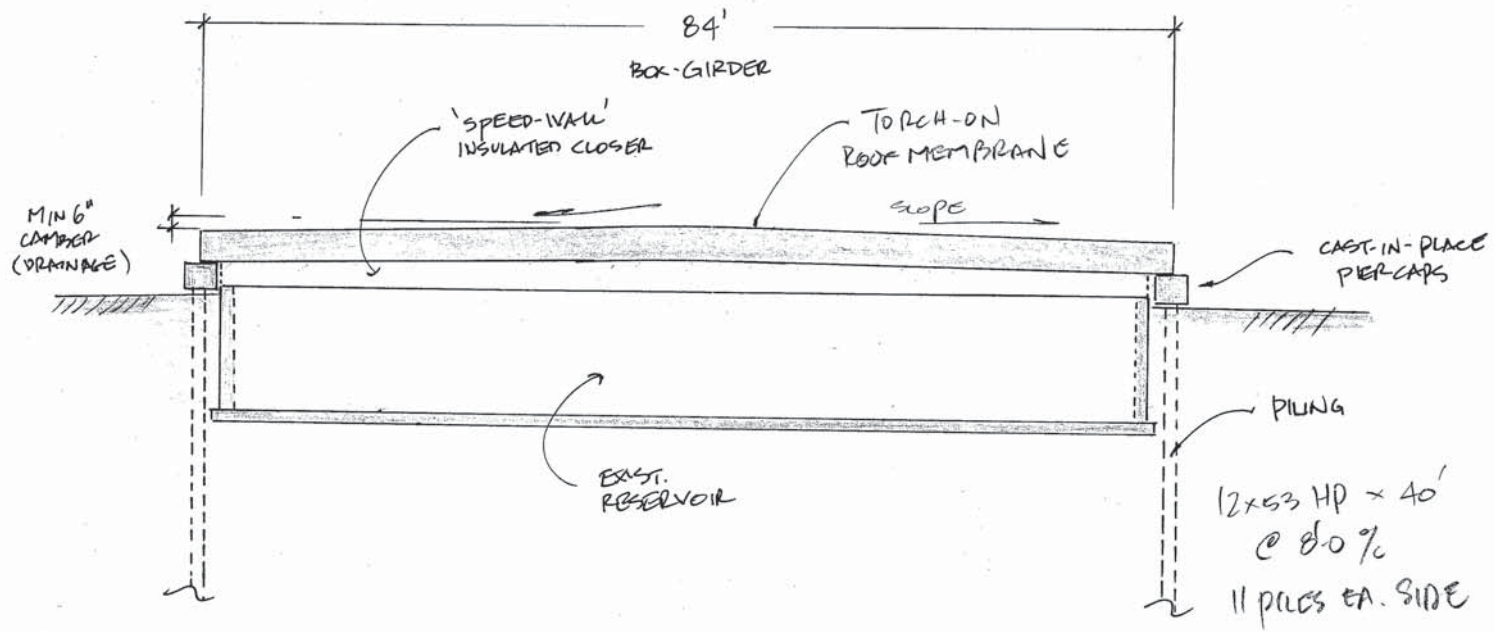
District of Barriere
Louis Creek Industrial Park - Reservoir Upgrade
Box Girder Supported Membrane Roof - Option #5
Cost Estimate - Class "D"

ITEM NO.	DESCRIPTION	UNIT	ESTIMATE
1.0	**GENERAL**		
	Insurance and Bonding, Mobilization, Restoration, Demobilization	allow	$50,000
2.0	**STRUCTURAL**		
	Pile Driving - 11 piles per side x 2 x HP12 x 53 x 50 ft	allow	$166,000
	Concrete Pier Cap	allow	$64,500
	Precast Box Girder Roof	allow	$546,000
	Roof Slab Finish c/w Infill Concrete	allow	$31,000
	Torch-on Roof Membrane	allow	$107,000
	Close in Tank Sides	allow	$27,000
3.0	**MECHANICAL**		
	Stainless Steel 100mm Inlet, 250mm Outlet and 250mm Overflow pipe	allow	$35,000
	Air Vents, Access Hatches, Access Ladders		
3.0	**CIVIL**		
	100mm SS/PVC Inlet Piping, Bend, Pipe Couplings and Tie-ins	allow	$30,000
	250mm SS/PVC Outlet Piping, Bends, Pipe Couplings and Tie-ins		
	200mm SS/PVC Overflow Piping, Bends, Pipe Couplings and Tie-ins		
	Overflow Outfall Structure c/w Rip-Rap and Flap Gate		
	250mm Tank Drain c/w Valves		
4.0	**ELECTRICAL**		
	BC Hydro Service	allow	$55,000
	Metering Pole c/w Service Dip to Kiosk		
	Electrical Service Kiosk		
	Fiber Optic Cable Connection to Kiosk		
	Instrumentation		
	Programming and Controls		
	Reservoir mixer connection		
5.0	**COST ESTIMATE SUMMARY**		
	Subtotal		$1,111,500
	Engineering - Allow (15%)		$166,725
	Contingencies - Allow (15%)		$166,725
	TOTAL PROJECT		**$1,444,950**

Louis Creek Industrial Park Water System



Box-Beam Girder - Option #5
Figure 5A



Apple Consulting Engineering Services
KAMLOOPS, B.C. (250) 377-8891

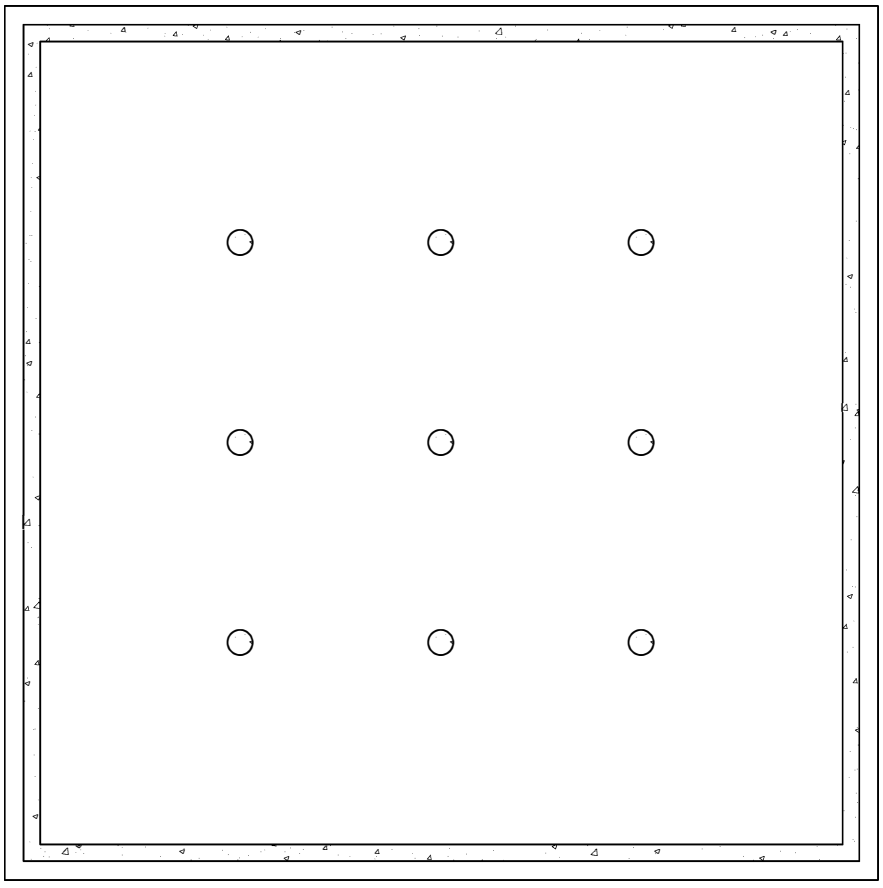
LOUIS CRK - RESERVOIR ROOF
SCALE : DEC 11/20
DATE :
DRAWN BY : KS
REVISED
BOX BEAM GIRDER OPTION
PRELIM - FOR COSTING ONLY
DRAWING NUMBER 02

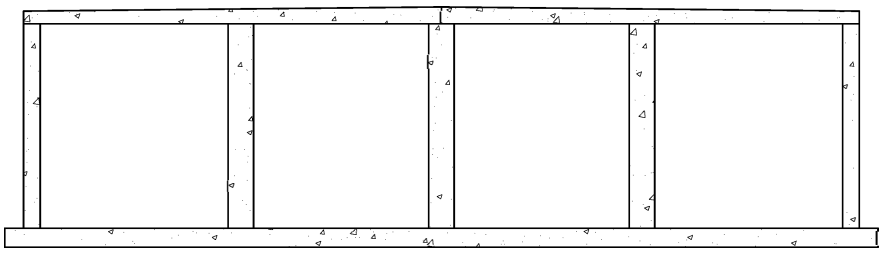
Figure 5B

District of Barriere
Louis Creek Industrial Park - Reservoir Upgrade
Cast-In Place Reservoir - Option #6
Cost Estimate - Class "D"

ITEM NO.	DESCRIPTION	UNIT	ESTIMATE
1.0	**GENERAL**		
	Insurance and Bonding, Mobilization, Restoration, Demobilization	allow	$50,000
2.0	**STRUCTURAL**		
	Removals of old concrete reservoir	allow	$10,000
	Reservoir subbase gravels	allow	$14,500
	Cast-in-place concrete reservoir	allow	$800,000
	Backfill	allow	$17,500
3.0	**MECHANICAL**		
	Stainless Steel 100mm Inlet, 250mm Outlet and 250mm Overflow pipe	allow	$35,000
	Air Vents, Access Hatches, Access Ladders		
3.0	**CIVIL**		
	100mm SS/PVC Inlet Piping, Bend, Pipe Couplings and Tie-ins	allow	$30,000
	250mm SS/PVC Outlet Piping, Bends, Pipe Couplings and Tie-ins		
	200mm SS/PVC Overflow Piping, Bends, Pipe Couplings and Tie-ins		
	Overflow Outfall Structure c/w Rip-Rap and Flap Gate		
	250mm Tank Drain c/w Valves		
4.0	**ELECTRICAL**		
	BC Hydro Service	allow	$55,000
	Metering Pole c/w Service Dip to Kiosk		
	Electrical Service Kiosk		
	Fiber Optic Cable Connection to Kiosk		
	Instrumentation		
	Programming and Controls		
	Reservoir mixer connection		
5.0	**COST ESTIMATE SUMMARY**		
	Subtotal		$1,012,000
	Engineering - Allow (15%)		$151,800
	Contingencies - Allow (15%)		$151,800
	TOTAL PROJECT		**$1,315,600**

Louis Creek Industrial Park Water System





Cast-in-Place Concrete Reservoir - Option #6

Figure 6