Our File: 2231-27314-01

TECHNICAL MEMO

To	From
Leslie Carter, Administrator Deep Bay Improvement District	Nathan Slater E.I.T., Project Engineer
Re	**Date**
Reservoir Replacement Assessment	March 11, 2022

1. Introduction

McElhanney Ltd. (McE) is pleased to provide our assessment and recommendations for the proposed reservoir replacement. This memorandum summarizes our findings and potential replacement options.

This report was prepared in general accordance with our scope of work and fee estimate as defined in our proposal dated January 11, 2022. Written authorization to proceed was received from the Deep Bay Improvement District (the District) on January 21, 2022.

1.1. PROJECT UNDERSTANDING

McE understands the primary objective of the project is to prepare a reservoir replacement assessment, including site suitability, sizing, connection requirements, material review and a budgetary cost estimate for the proposed replacement. To complete these objectives the following scope of work has been undertaken.

- Undertook a site visit and reviewed the existing reservoir with Mr. Don Buchner on February 2nd, 2022.
- Reviewed the available siting locations for the replacement reservoir (with the intent of keeping the existing reservoir in service while a new one is being constructed).
- Determined the reservoir connections to existing infrastructure.
- Compared the most suitable reservoir material type (concrete or steel).
- Calculated the required size and capacity of the storage tank (for existing and future demand requirements).
- Reviewed operational considerations (single cell, double cell, cycling).
- Prepared Class “C” cost estimate for budgeting purposes.
- Summarized findings in a Technical Memo.

1.2. BACKGROUND

The existing concrete reservoir was built in 1975 and provides 545 cubic meters of storage. It is McE's understanding that the reservoir site is a crown land lease lot. The reservoir is now 47 years old and showing signs of age and significant deterioration. In addition, the District is experiencing water quality issues which the operator has isolated to the reservoir.

Based on the District's condition assessment of the existing reservoir, replacement is necessary.

2. Existing Reservoir Site

2.1. SITE LOCATION

The crown lease lot reservoir site is serviced by a 10.15-metre-wide by 179.72-metre-long gravel access road branching from Crosley Road. The footprint of the site minus the access road is 1207 square metres with the existing reservoir occupying 82 square metres. From an initial assessment it appears that the current land lease may not be able to accommodate a new reservoir without extending the boundaries; however, this would need to be confirmed through a site survey of the existing reservoir and land lease.

If a crown land lease boundary extension is required, an application would need to be submitted by the District through Front Counter BC.

2.2. GROUND CONDITIONS

Surface level conditions at the site are generally flat with relative grade draining north and an overflow drainage ditch established on the west perimeter. The north end of the site is fully cleared and it appears there is adequate room for a new reservoir. However, it is likely some tree and vegetation removal would be required to accommodate the new configuration.

Prior to design and construction, a full soils investigation program will need to be undertaken to develop the following:

- Site stability and ease of excavation.
- Identify site class in accordance with the BC Building Code section 4.1.8.4.
- Recommendations for foundation bearing pressures.
- Foundations and subgrade preparations.

2.3 EXISTING SITE CONNECTIONS

The existing reservoir is serviced by a 300mm diameter water main connected to the District's distribution system. There are two pipe tees entering the site that would allow the existing reservoir to stay in operation during the construction of a new reservoir.

3. Proposed Reservoir

3.1. MATERIAL TYPE

When considering a new water reservoir, there are generally two categories to consider: steel or concrete. There are several design and construction factors to be considered with both. A desktop overview of the project has been undertaken and summarized below to determine generally which material type would be suitable for the District's application.

Table 1: Steel Vs. Concrete Materials Comparison

Considerations	Material Type	
	Glass-fused-to-Steel	Concrete
Durability of Material		Preferred
Design Flexibility of Material (Single Vs Multi Cell, Size, Shape)		Preferred
Complexity of Material Design	Preferred	
Complexity of Material Construction	Preferred	
Quality Control of Material	Preferred	
Maintenance		Preferred
Size of Storage Tank Required		Preferred
Availability of Local Materials		Preferred
Capital Cost to District		Preferred
In-service Timing		Preferred
Ability to Expand for Future Demand		Preferred

Comprehensive details of the glass-fused-to-steel reservoir are included in Appendix D; however, a summary is provided below:

- Material / Coating – Glass-Fused-to-Steel
- Roof Type – Aluminum Geodesic Dome
- Base - Steel Floor
- Foundation - Reinforced Concrete

3.2. CAPACITY

The proposed reservoir will be designed to accommodate current fire, emergency, and equalization storage requirements. When sizing a reservoir, the Design Guidelines[1] consider two primary factors including the Maximum Daily Demand (MDD) on the system along with the fire flow storage requirements.

Currently the District is servicing 616[2] municipal connections which provides a MDD of 369,600 litres per day.

The fire storage requirements are based on the Fire Underwriters Survey Guide along with Section 2.5 of the MMCD Design Guidelines which outlines a minimum of 60 L/s for a two-hour time duration[3].

Combining these two factors as per the Design Guidelines provides an approximate reservoir capacity requirement of 656,000 litres or 656 m3.

3.3. RESERVOIR DIMENSIONS

Based on a minimum capacity requirement of 656 m3, approximate dimensions organized by material type and number of cells are listed below. The height of the reservoir water level is fixed at 4.95 metres to match the existing reservoir as to maintain pumping considerations.

Table 2: Approximate Dimensions of a New Reservoir

Material Type	No. Of Cells	Height (m)	Radius (m)	Length (m)	Width (m)	Square Area Required (m2)
Glass-Fused-to-Steel	1	7.2	13.6			117.5
	2	7.2	9.4			176.0
Concrete	1	6.0		9.0	14.5	142.5
	2	6.0		4.75	7.5	142.5

Both the glass-fused-to-steel and concrete tanks can be provided in a wide variety of shapes and sizes. Based on the volume required, review of the operating levels and review of the available site area, we would recommend the following tank size:

2-Cell Concrete Reservoir:

- Tank Length[4] = 9.0 m
- Tank Width = 14.5.0 m
- Tank Height = 6.0 m
- Nominal Capacity[5] = 735 cubic metres
- Useable Capacity = 660 cubic metres

[1] Master Municipal Construction Documents Design Guidelines[1] 2014 (MMCD Design Guidelines)
[2] Number of service connections as stated in the 2020 Annual Water System Report DBID
[3] Based on Residential fire flow protection
[4] Dimensions represent the exterior of tank walls
[5] Tank size is larger than useable capacity to allow for free board at top of tank, freeboard is required for overflow piping and other safety measures.

3.4. OPERATIONAL CONSIDERATIONS

Based on feedback from the District the primary considerations for operations are the maintenance requirements of the proposed reservoir with the second consideration being the security of the system, particularly the electrical components.

Maintenance of the system includes draining the reservoir for cleaning and inspection. The District has indicated that a reservoir with two cells would add the benefit of draining one cell for maintenance while allowing the other cell to stay online. A two-cell reservoir option is much easier to achieve with concrete as the number of cells can be divided and achieved with partitions; compared, to a two-cell glass-fused-to-steel option, which requires two separate reservoir tanks.

The District has also expressed consideration for security of the system. In the past the District has had difficulty with vandalism and theft of solar panels and electronic equipment used for the existing reservoirs SCADA[6] equipment. Potential solutions for these concerns can be addressed through the design process by placing this equipment in a location that limits access once in service.

3.5. COSTS

A preliminary Class “C” cost estimate has been completed for this project. This cost estimate was based on a single cell glass fused to steel reservoir as Concept 1 and a two celled concrete reservoir as Concept 2.

“Greatario” a common Canadian tank supplier has provided a preliminary cost estimate for supply and installation of the steel bolted reservoir (refer to Appendix “D” for details).

The following table summarizes the class “C” cost estimate comparing a glass-fused-to steel to a concrete reservoir.

Table 3 Summary of Cost Estimate

Initial Capital Cost (Class C Estimate)				
		Concept 1 - Single Cell Steel	**Concept 2 - Two Cell Steel**	**Concept 3 - Concrete**
SECTION 1	GENERAL CONDITIONS	$20,000	$20,000	$20,000
SECTION 2	RESERVIOR	$710,200	$972,000	$550,000
SECTION 3	CIVIL	$30,125	$30,125	$42,500
SECTION 4	WATER DISTRIBUTION	$13,750	$13,750	$13,750
TOTAL CONSTRUCTED WORKS		$774,075	$1,035,875	$626,250
CONTINGENCY (30%)		$232,223	$310,763	$187,875
ENGINEERING (10%)		$100,630	$134,664	$81,413
TOTAL PROJECT (LESS GST)		$1,106,927	$1,481,301	$895,538

[6] SCADA Supervisory control and data acquisition

It is important to note that Concept 2 the two-cell steel reservoir option requires two separate steel tanks and thus has a substantial cost increase. Also Concept 3 the concrete tank option is not separated by single and two-cell as the cost difference between the two is negligible.

Based on the preliminary details and initial cost estimate a two-cell concrete reservoir would be a more cost-effective solution for the District and provide the preferred operational considerations

CLOSING

We trust this provides the information that require currently, we would welcome any questions you may have, and we would be happy to provide any further information you deem necessary.

Sincerely,
McElhanney Ltd.

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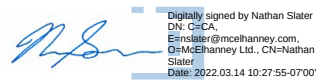

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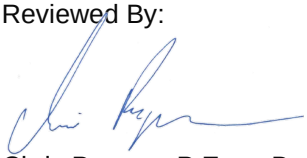

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APPENDIX A

Statement of Limitations

Statement of Limitations

Use of this Report. This report was prepared by McElhanney Ltd. ("**McElhanney**") for the particular site, design objective, development and purpose (the "**Project**") described in this report and for the exclusive use of the client identified in this report (the "**Client**"). The data, interpretations and recommendations pertain to the Project and are not applicable to any other project or site location and this report may not be reproduced, used or relied upon, in whole or in part, by a party other than the Client, without the prior written consent of McElhanney. The Client may provide copies of this report to its affiliates, contractors, subcontractors and regulatory authorities for use in relation to and in connection with the Project provided that any reliance, unauthorized use, and/or decisions made based on the information contained within this report are at the sole risk of such parties. McElhanney will not be responsible for the use of this report on projects other than the Project, where this report or the contents hereof have been modified without McElhanney's consent, to the extent that the content is in the nature of an opinion, and if the report is preliminary or draft. This is a technical report and is not a legal representation or interpretation of laws, rules, regulations, or policies of governmental agencies.

Cost Estimates and Construction Schedules. This construction cost estimate and construction schedule have been prepared using the design and technical information currently available, and without the benefit of Survey, Geotechnical, and Environmental information. Furthermore, McElhanney cannot predict the competitive environment, weather or other unforeseen conditions that will prevail at the time that contractors will prepare their bids. The cost estimate and construction schedule are therefore subject to factors over which McElhanney has no control, and McElhanney does not guarantee or warrant the accuracy of such estimate or schedule.

APPENDIX B

Reservoir Sizing

Appendix B:

Reservoir Sizing:

Per Capita Demand (MMCD Design Guidelines)		
ADD - Average Daily Demand	300	litres per capita per day (L/c/d)
MDD - Maximum Daily Demand	600	litres per capita per day (L/c/d)
PHD - Peak Hour Demand	900	litres per capita per day (L/c/d)

Number of Services (2020)*	616
*2020 Annual Water System Report DBID	

Required Volume Per Day		
	l/day	m3/day
Average Day Demand (ADD)	184800	184.8
Maximum Day Demand (MDD)	369600	369.6
Peak Hour Demand (PHD)	554400	554.4

Fire Flow Volume*	
	m3
*Based on Residential 60 l/s for two hours	432

Total Reservoir Storage Volume*:	
	m3
A = Fire Storage (From Fire Underwriters Survey Guide)	432
B = Equalization Storage (25% of Maximum Day Demand)	92
C = Emergency Storage (25% of A + B)	131
Total:	**656**
*From section 2.32.2 Capacity MMCD Design Guideline	

APPENDIX C

Detailed Class “C” Cost Estimate

Conceptual Capital Cost Estimate for Design And Construction of a Water Resesvoir

General Note:
Note, this is considered a Class "C" Estimate. This is a preliminary estimate which due to little or no design information indicates the approximate magnitude of cost of the proposed project, based on DBID requirements.

McElhanney Ltd. (2022 dollars)

DBID - WATER RESERVOIR

				Concept 1 - Single Cell Steel		Concept 2 - Dual Cell Steel		Concept 2 - Concrete	
ITEM NO.	DESCRIPTION	UNIT	UNIT PRICE	QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT
1.0	**GENERAL CONDITIONS:**								
1.1	Mobilization and Demobilization	Lump Sum	$15,000.00	1.00	$15,000	1.00	$15,000	1.00	$15,000
1.2	Environmental and Sediment Management	Lump Sum	$5,000.00	1.00	$5,000	1.00	$5,000	1.00	$5,000
	GENERAL CONDITIONS SUBTOTAL				**$20,000**		**$20,000**		**$20,000**
2.0	**RESERVIOR**								
2.1	Glass-Fused-to-Steel Design Build	Each	$613,200.00	1.00	$630,200				
2.2	Glass-Fused-to-Steel Design Build	Each	$443,500.00			2.00	$887,000		
2.3	Concrete Reservoir	Each	$460,000.00					1.00	$460,000
2.4	Mechanical Piping Misc.	Each	$35,000.00	1.00	$35,000	1.00	$40,000	1.00	$45,000
2.5	Electrical Misc. Including (SCADA)	Each	$45,000.00	1.00	$45,000	1.00	$45,000	1.00	$45,000
	CIVIL SUBTOTAL				**$710,200**		**$972,000**		**$550,000**
3.0	**Civil Works:**								
3.1	Clearing and grubbing	Square metre	$5.00	1500.00	$7,500	1500.00	$7,500	1500.00	$7,500
3.2	Common excavation (stripping) , off-site disposal	Cubic metre	$45.00	100.00	$4,500	100.00	$4,500	100.00	$4,500
3.3	Subgrade preparation	Square metre	$5.00	100.00	$500	100.00	$500	100.00	$500
3.4	Granular base - 150 mm thickness	Square metre	$55.00	75.00	$4,125	75.00	$4,125	200.00	$11,000
3.5	Granular sub-base - 250 mm thickness	Square metre	$55.00	100.00	$5,500	100.00	$5,500	200.00	$11,000
3.6	Landscaping	Square metre	$100.00	80	$8,000	80	$8,000	80	$8,000
	CIVIL SUBTOTAL				**$30,125**		**$30,125**		**$42,500**
4.0	**Water Distribution (At Reservoir)**								
4.2	Pipe - 200mm diam. PVC CL 150 C900, imported backfill. Includes joint wrapping where required.	Lineal Metre	$250.00	20	$5,000	20	$5,000	20	$5,000
4.3	Tee - 150F x 150F x 150H	Each	$900.00	3	$2,700	3	$2,700	3	$2,700
4.4	Gate Valve - 150 HxF	Each	$1,750.00	3	$5,250	3	$5,250	3	$5,250
4.5	Coupler - 200mm diam. Robar	Each	$800.00	1	$800	1	$800	1	$800
	WATER DISTIBUTION SUBTOTAL				**$13,750**		**$13,750**		**$13,750**

Notes:

1) Estimated costs are derived from recent experience on Vancouver Island, but there is no warranty that actual cost will not vary. McElhanney Ltd. accepts no liability for actual cost which may vary from the estimated construction costs provided herein.

2) Cost estimate based on conceptual design

SECTION 1	**GENERAL CONDITIONS**	**$20,000**	**$20,000**	**$20,000**
SECTION 2	**RESERVOIR**	**$710,200**	**$972,000**	**$550,000**
SECTION 3	**CIVIL**	**$30,125**	**$30,125**	**$42,500**
SECTION 5	**WATER DISTRIBUTION**	**$13,750**	**$13,750**	**$13,750**
TOTAL CONSTRUCTED WORKS		**$774,075**	**$1,035,875**	**$626,250**
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TOTAL PROJECT (LESS GST)		**$1,106,927**	**$1,481,301**	**$895,538**

APPENDIX D

Supplier “Greatario” quotation

Western Canada
Suite 300
3665 Kingsway
Vancouver, BC V5R 5W2

GREATARIO

(866) 299-3009 | GREATARIO.COM

Eastern Canada
PO Box 399
715647 Oxford Road 4
Innerkip, ON N0J 1M0

Deep Bay Potable Water Tank - McElhanney – Budget Quote

PROJECT INFORMATION

March 3, 2022

Name: **Nathan Slater B.Eng. E.I.T. C.E.T.**
Project Engineer
McElhanney – Nanaimo
250 268-1491
nslater@mcelhanney.com

Re: **45 ft. dia. x 24 ft. high Glass-Fused-to-Steel Potable Water Tank**

31 ft. dia. x 24 ft. high Glass-Fused-to-Steel Potable Water Tank

We are pleased to provide the following budget pricing for the Potable Water tank as described. Greatario would provide structural P. Eng stamped engineering design, supply and installation of tank, floor, roof and appurtenances. Greatario would also include P. Eng. Stamped foundation design and installation.

This quote can be modified to suit the needs of the project and we welcome an opportunity to discuss the tank design with you upon review of this document. Additionally, since our construction crews are based locally and our tanks are manufactured in North America, we have been and expect to continue to be able to provide exemplary support and service despite COVID related shutdowns and potential travel restrictions. We look forward to working with you to determine the best design to meet the needs of your project.

MATERIAL SCOPE OF WORK

Glass-Fused-to-Steel 45 X 24

- Tank Type: Aquastore
- Tank is quoted to store: Potable Water
- Specific Gravity: 1
- Minimum Liquid pH: 6
- Maximum Liquid pH: 9
- Inside Diameter: 44.76FT (13643mm)

- Height to eave of tank: 23.84FT (7266mm)
- Nominal Volume: 280601 Gallons - 1062 Cubic Meters
- Useable Capacity based on 91 in (2311 mm) of Freeboard: 191344 Gallons - 724 Cubic Meters
- Max. HWL: 4955mm
- Roof Type: Dome
- Floor Type: Concrete

Glass-Fused-to-Steel Tank 31 X 24

- Tank Type: Aquastore
- Tank is quoted to store: Potable Water
- Specific Gravity: 1
- Minimum Liquid pH: 6
- Maximum Liquid pH: 9
- Inside Diameter: 30.77FT (9379mm)
- Height to eave of tank: 23.84FT (7266mm)
- Nominal Volume: 132629 Gallons - 502 Cubic Meters
- Useable Capacity based on 91 in (2311 mm) of Freeboard: 90441 Gallons - 342 Cubic Meters
- Max. HWL: 4955mm
- Roof Type: Dome
- Floor Type: Concrete

Design: (Qualicum Beach BC)

- Tank Designed in Accordance with: AWWA
- Risk Category / Importance Category: IV (Post-Disaster)
- Seismic Design: Seismic Design: NBCC 2015
- Seismic Zone: NBCC 2015
- Seismic Site Class: D
- Seismic PGA: 0.395
- Seismic TL: 4
- Seismic Sa(0.2): 0.888
- Seismic Sa(0.5): 0.838
- Seismic Sa(1.0): 0.517
- Seismic Ie (importance Factor): 1.5
- Wind Default: Wind Default: NBCC 2015
- Wind Speed: 100 (MPH) - 161 (KPH)
- Wind Design: AWWA D103
- Wind Importance Factor (Iw): Essential (1.15)
- Wind q=Reference Velocity pressure (kpa): .53
- Roof Design: Roof Design: NBCC 2015 Design
- Roof Snow Load Imp. Factor (Is): 1.25
- Ground Snow Load in PSF (Pg): 2.0
- Roof Snow Load (psf): 52.2
- Roof Live Load (psf): 15 psf (73.24 kg/m2)
- Roof Snow / Live Load (psf): 52.2
- Roof Snow / Live Load (kPa): 2.5
- Roof Snow Load (Ss): 2.0

- Roof Rain Load (Sr): .4
- Roof Wind Exposure Factor (Cw): 1

Coatings:
- Coating Type: Glass-fused-to-steel
- Interior: Vitrium Glass
- Exterior Finish: Cobalt Blue (Glass)

Hardware:
- Galvanized bolts with polypropylene encapsulated heads
- Galvanized nuts, and washers

Accessories:
- 1 - 30 inch Dia. Shell Manway W/ Thick - Standard(HDG)
- 1 - Standard Manway Observation Platform
- Cathodic Protection
- 1 - Dome Step-off Platform
- 1/2" Thick Asphalt-Impregnated Fiberboard - Full Bottom Area
- Use Standard Ladder Bracket Location
- 1 - Ladder Door Assembly (Galvanized Steel)
- Ladder Extension to Grade
- Aluminum outside ladder with galvanized steel safety cage, lockable hoop entry and safety swing gate at all ladder access points
- 5 Misc. Single Flanges

Dome Accessories:
- 1 - 24 Inch Vent w/ Poly Insect Screen, AWWA Compliant w/ Pressure Relief
- 1 - 30 Inch Square Access Hatch w/ Chain Hold Open
- 1 - (2) 7 Foot Guardrails At Hatch w/ Extension To Ladder
- 1 - Walkway w/ Single-Sided Handrail and Non-Skid Tape (NFPA Compliant)
- 1 - Center Safety Support
- 1- Stainless Steel Safety Cable & Standoffs

Tentative Schedule:
- Drawings: 3 weeks
- Client Approval: 1 week
- Fabrication: 16-20 weeks
- Shipping: 1 week
- Tank erection 5 weeks
- Sealer Cure: 1 week
- Tank Fill: 1 week

BUDGET PRICING (Canadian Dollars)

45X24 Glass-Fused-to-Steel PW Tank Design/Build: $ 613,200 + taxes

31X24 Glass-Fused-to-Steel PW Tank Design/Build: $ 443,500 + taxes

ADDER: Submersible Mixer $ 17,000 + taxes

Price Includes:

- P.Eng. stamped structural submittal for all above.
- P.Eng. stamped foundation design.
- Foundation Installation
- Tank will be built in accordance with Greatario Restricted Space Procedures.
- Pricing based on typical access to the work site.
- Transportation of work crews to installation site
- All construction on site, project management, tank testing and commissioning by Greatario (fill by others).
- Construction to be completed by Greatario non-unionized crews.
- Based on a 21 days-on – 7 days-off work schedule
- PST
- Truck unloading, (maximum 10,000 lb skids).
- Greatario standard payment terms.
- Tank Flanges as Specified Above (Estimated)
- Manufacturers Standard Warranty
- O&M manuals.
- Greatario standard operation and maintenance training.
- Based on standard Greatario QC/QA procedures
- Based on standard Greatario construction safe work practices
- We have allowed up to a ½ day for worker site orientation

Price Does Not Include:

1. Overflow splash pad.
2. Site works.
3. Tank penetrations or flanges unless specified.
4. Clear 4m around tank suitable for construction purposes for building access.
5. Mechanical or electrical unless noted.
6. Taxes, building permit, fees.
7. Water supply and disposal to fill tank for testing purposes (water fill by others).
8. Winter construction.
9. Dewatering
10. Concrete or soils testing
11. Additional survey or layout of site services.
12. Site security and fencing.
13. Design supply and installation of lightening protection system.
14. Site Lighting.
15. Heaters
16. Quote is valid for only 30 days from date of receipt due to volatility in steel pricing and exchange.

Please direct any questions or comments regarding this bid to:

Mike Greig
Mequipco Inc.

Sincerely,
Pete Zimmer
Greatario Engineered Storage Systems