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SKANA WATER SERVICE COMMITTEE

Notice of Meeting on **Tuesday, April 12, 2016 at 9:30am**
Main Conference Room, 479 Island Highway, Victoria, BC

J. Sanders (Chair) Director D. Howe B. Bovet G. Fryling

AGENDA

1. Approval of Agenda
2. Adoption of Minutes of September 21, 2015
3. Water System Operations Report – 2015 and First Quarter of 2016 (information report)
4. Water Quality Update – Skana Water System (staff report)
5. Condition Assessment of Potable Water Storage Tanks (staff report)
6. Draft Strategic Asset Management Plan for Skana Water System (staff report)
7. Review of Action List
8. New Business
9. Adjournment

To ensure quorum, advise Lorrie Siemens 250.360.3087 or lsiemens@crd.bc.ca if you cannot attend.

IWSS-928280410-4666

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Minutes of a Meeting of the Skana Water Service Committee
Held Monday, September 21, 2015 in the Main Conference Room, 479 Island Highway, Victoria, BC

PRESENT: **Committee Members**: J. Sanders (C), B. Bovet, G. DeBeer, Director D. Howe, G. Fryling
Staff: M. Cowley, Senior Manager, Infrastructure Engineering and Operations; P. Dayton, Senior Financial Analyst, D. Robson, Manager, Saanich Peninsula and Gulf Islands Operations, S. Mason, Manager, Water Engineering and Planning, L. Siemens (recorder)

The meeting was called to order at 9:30 am.

1. Approval of Agenda

MOVED by Director Howe, **SECONDED** by B. Bovet,
That the agenda be approved as distributed.

CARRIED

2. Election of Chair

Nominations were called for the election of the chair for a one-year term. Jon Sanders was nominated and agreed to stand. Nominations were called for two additional times, and hearing none, John Sanders was elected as chair of the Skana Water Service Committee.

3. Adoption of Minutes of October 9, 2014

MOVED by Director Howe, **SECONDED** by G. Debeer,
That the minutes of the Skana Water Service Committee meeting of October 9, 2014 be adopted as previously circulated.

CARRIED

4. 2016 Operating and Capital Budget

M. Cowley presented a written staff report and the 2016 Operating and Capital budget documents.

The following changes were made to the budget:

- Transfer $11,112 from LA 3090 to the Capital Reserve fund.

MOVED by B. Bovet, **SECONDED** by Director Howe,
That the Skana Water Service Committee recommend that the CRD Board:

1. Approve the 2016 operating and capital budget for the Skana Water Service as amended;

2. Authorize the Parcel Tax of $279.00 and User Charge of $813.11 for the Skana Water Service; and

3. Carry over $8,100 to 2016 as revenue and balance the 2015 revenue and expense on the 2015 transfer to capital reserve fund.

CARRIED

Staff advised that the Strategic Asset Management Plan for the Skana water system is in the process of being drafted. The draft will be sent out to the committee for review in November. A meeting will be scheduled in the spring of 2016 to review the SAMP and receive comments from the committee.

The committee discussed metering and rate structures for billing purposes. Staff provided examples of block rate structures at the meeting and noted it could be discussed further at a future meeting. Committee members advised that they will seek community input on metering and rate structures and advise staff.

5. New Business

There was no new business

6. Adjournment

MOVED by Director Howe, **SECONDED** by J. Sanders,
That the meeting be adjourned at 10:55 am.

CARRIED

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REPORT TO SKANA WATER SERVICE COMMITTEE
MEETING OF TUESDAY, APRIL 12, 2016

SUBJECT **WATER SYSTEM OPERATIONS REPORT – 2015 AND FIRST QUARTER OF 2016**

PURPOSE

The purpose of this report is to provide the Skana Water Service Committee general information only regarding operational activities carried out for the water system during 2015 and for the first few months of 2016.

BACKGROUND

Weekly operations of the Skana water system is provided by an on-island contract operator under agreement with the Capital Regional District (CRD). The contract operator performs routine scheduled activities such as system checks, water sampling for laboratory analysis and minor preventative maintenance activities all under the direction of the CRD as detailed in the operations agreement.

Additional operational support and guidance is provided by CRD personnel who typically perform more significant preventative or corrective maintenance and utility upgrade activities. Such activities include water system and reservoir flushing, hydrant/standpipe maintenance, electrical/electronic annual maintenance, water system leak detection and when requested by property owners within the service area, installation of water system connections. Other operational support provided by the CRD include emergency response and remote water system monitoring and control using the CRD's Supervisory Control and Data Acquisition (SCADA) equipment. The SCADA system is used to alert CRD standby operations staff of a potential water system fault (e.g. reservoir low water level).

REPORT

During 2015, for the most part, the Skana water system operated reliably during the year. However, a boil water advisory (BWA) was issued in late December as a result of the water system not meeting regulatory water quality standards. At the time is was concluded that the Well #13 raw water quality had been impacted and the water treatment process was not fully effective resulting in a BWA to be issued while an action plan was initiated. The action plan included removing Well #13 from service, placing Well #8 into primary operation and completely flushing and testing the water distribution system. As a result of this work and in consultation with Island Health, the BWA was lifted on December 23, 2015.

The on-island contract operator attended to regular weekly, monthly and annual operational duties as detailed in the Skana water system operating agreement. The contactor however did respond to several requests that are considered additional duties.

Table 1 below details the additional work performed by the on-island contractor at the request of the CRD:

Table 1: Additional work completed by contract operator at request of CRD.

TASK	DATE	REASON
Re-set the chlorine residual analyser	March 20, 2015	Chlorine analyser was providing unreliable information at the time.
Additional water samples requested	March 30, 2015	Requested by water quality division
Additional water samples requested	May 4, 2015	Requested by water quality division
Minor grounds maintenance	June 3, 2015	Grass and weeds growing rapidly around water system infrastructure.
Additional water samples requested	July 7, 2015	Requested by water quality
Delivery of Water Conservation Notices	July 17, 2015	Issued as a result of provincial drought level 4 conditions
Flushing and testing of Well #8	August 3, 2015	Performed due to well 13 quantity issues and requirement to have both wells online
Isolation and draining of the water storage tanks.	Nov. 15, 2015	Assistance with the condition assessment of the water reservoir storage tanks capital project.
Emergency response and the delivery of boil water advisory information	Dec. 16-23, 2015	Notifications required as a result of the boil water advisory being issued.
Daily site visit to well #8.	Dec 24-31, 2016	Well #8 does not have automatic operation and requires the operator to turn the system off and on by hand in order to fill the water reservoir.
Daily site visit to well #8.	Jan. 1 – Mar. 31 2016	Well #8 does not have automatic operation and requires the operator to turn the system off and on by hand in order to fill the water reservoir.
Island Health Site Visit	Feb. 17, 2016	Meet with Island Health and CRD Water Quality Staff at Well #13 site to investigate potential cause of surface water migrating to ground water and impacting raw water quality.

CRD operations personnel completed a number of key tasks during this period. Table 2 below details the tasks performed.

Table 2: Tasks completed by CRD operations personnel.

TASK	NOTES
Clearing of the water line easement from the water storage tanks to Waugh Road	This work is done every few years to ensure the easement remains clear of ground cover and trees in order to protect the overhead hydro lines and the watermain.
Replacement of 25mm drain line valve for water storage tank #2	The valve and piping were corroded and required replacement. This work was performed during the water storage tank condition assessment.
Water connection installation	Connection of 524 Aya Reach to the water system at the request of the property owner.
Replacement of the failed the ultra violet (UV) light sensor at Well #13	The UV sensor typically requires replacement every few years

TASK	NOTES
Replaced chlorine analyser sensor probe at Well #13.	Chlorine probe tip replaced as part of the preventative maintenance program
Replacement of a failed 50mm gate valve at Well #13.	Gate valve would not close drip tight and therefore replaced.
Stained exterior of Well #8 pump house.	Preventative maintenance performed.
Replacement of 25mm diameter pipe section and gate valve at Well #8	Gate valve was not functioning properly and piping was showing signs of significant corrosion.
Water storage tank cleaning	Tanks were drained and cleaned in conjunction with the water storage tank condition assessment.
Water system flushing, disinfection and water sample collection.	Significant amount of effort performed as a result of the boil water advisory being issued.
Emergency response to a report of a water main leak near 524 Aya Reach	Staff attended and confirmed that the leak was a result of ground water and not a water system leak.

RECOMMENDATION

That the Skana Water Service Committee receive the report for information.

Dan Robson, AScT
Manager, Saanich Peninsula and Gulf Islands Operations

Matt McCrank, MSc., P.Eng.
Senior Manager, Infrastructure Operations
Concurrence

Ted Robbins, B.Sc., C.Tech.
General Manager, Integrated Water Services
Concurrence

DR:ls:

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REPORT TO SKANA WATER SERVICE COMMITTEE
MEETING OF TUESDAY, APRIL 12, 2016

SUBJECT **Water Quality Update – Skana Water System**

ISSUE

Water quality results in the main drinking water well (#13) since October 2015 require a remediation or action plan to ensure continued potable water.

BACKGROUND

The system is supported by a main well (#13) and a backup well (#8). Well #13 has been offline due to uncharacteristic bacteriological lab test results for the untreated water and, since December 19, 2015, the system has been using Well #8 as the primary water source for the community. This well can meet the current water demand but will be insufficient for the high-use summer months.

The Capital Regional District (CRD) continues to monitor the raw water quality of Well #13. Since October, 2015, the untreated water from Well #13 has had 7 positive total coliform and 2 positive *E. coli* test results. Based on historical data, this is an unusual occurrence and seemed to coincide with the onset of heavy rainfalls in the fall. On December 15, 2015, consecutive water quality testing results confirmed the presence of total coliform bacteria at multiple locations within the water distribution system. On December 16, 2015, the Capital Regional District (CRD), in consultation with Island Health, issued a Boil Water Advisory (BWA) as a precautionary measure.

At the time the BWA was issued, the CRD proposed an action plan that included:

1. Flushing, testing and preparing the backup water source (Well #8) in the event the system needed to be placed into service.
   - Completed December 16, 2015.

2. Disinfection of Well #13 and conduct further raw water quality testing.
   - Well disinfection work completed on December 18, 2015.
   - Water quality test results were reported on December 19, 2015. Raw water quality test results indicated continued coliform bacteria presence despite well disinfection efforts. As a result the CRD removed Well #13 from service.
   - Well #8 placed into service on December 19, 2015.

3. Increase the chlorine dosage within the reservoirs in preparation for a full water system flush.
   - Chlorine dose increased from 0.9 mg/l to 1.5 mg/l on December 16, 2015.
   - Flushing plan and procedure completed and approved on December 18, 2015.
   - Water system flushing conducted on December 20, 2015.

4. Conduct additional water quality testing of the distribution system after flushing activity.
   - Water quality test results were reported on December 22, 2015. No coliform bacteria detected.

As a result of the action plan, and in consultation with Island Health, the CRD rescinded the BWA on December 23, 2015. The total coliform concentrations increased and peaked (145 CFU/100mL) in January 2016 and have since dropped to levels more in line with historical levels. No further *E. coli* positive test results have been recorded since December 2015.

Concurrent with the recent actions, Well #8 has been producing safe water. However, it typically exhibits a higher turbidity and has a smaller yield than Well #13 (0.38 L/s versus 0.98 L/s, based on the original well test records from 1971). It is anticipated that Well #8 will not be sufficient to supply the Skana Water System through the high-demand summer months. Therefore, it is imperative that every effort be made to restore the safe operation of Well #13.

CRD and Island Health met onsite on February 17, 2016 to investigate potential sources of a groundwater aquifer or well contamination. Extensive site clearing and excavation work has occurred near the well site, the closest being approximately 100 m away. While it is unlikely that this would directly impact Well #13 itself, it is conceivable that this work may have interfered with one of the many abandoned wells registered in the BC Well Log in the area and, therefore, potentially caused surface water to reach the aquifer. Also, the operator indicated the possibility that a substandard well casing and missing surface seal at Well #13 may have caused root intrusions into the well itself. This would be a plausible contaminant pathway into the well.

CRD met with Island Health again on March 4, 2016 to discuss potential actions for bringing Well #13 safely online before the summer season. It was agreed that a thorough well inspection is a logical next step in the investigation of the cause of the well contamination. Island Health is supportive of this approach. CRD Operations staff presented a cost estimate for a well inspection by a certified well driller/inspector, attached as Appendix A.

Any conclusive findings from this inspection could lead to work designed to stop pathogens from entering the well. The cost estimate for potential replacement of the surface seal and casing is also found in Appendix A.

At the March 4, 2016 meeting, Island Health agreed to the CRD's proposal to switch back to Well #13 if the next set of raw water samples showed no, or very low, indicator bacteria concentrations. Two raw water samples from Well #13 in February and March 2016 indicate that the raw water conditions are currently acceptable for Well #13 to be used again as source for the Skana Water System. A switch from Well #8 to Well #13 is anticipated for April 10, 2016.

ALTERNATIVES

Alternative 1

That the Skana Water Service Committee:

1. Approve the proposed action plan for Well #13 as presented;
2. Authorize funding of up to $6,000 from Capital Reserve Fund 1067 to conduct further investigative and potential remedial work for Well #13; and
3. Direct staff to report back on the condition and findings of the well investigation.

Alternative 2

That the Skana Water Service Committee receive this report for information and request that staff report back to the committee with additional information.

ENVIRONMENTAL IMPLICATIONS

Well #13 is the utility's only water source capable of producing sufficient water quantity during the high demand summer period. Leaving the water quality situation at Well #13 uninvestigated and unmitigated may necessitate the utility having to switch to the backup well frequently and possibly to manage more boil water advisories.

FINANCIAL IMPLICATIONS

The proposed action is to conduct investigative work to determine the cause of the well contamination. Results may indicate a requirement for rehabilitation of Well #13. The proposed inspection cost is estimated at $2,000 (taxes not included), and potential remedial work to replace the surface seal and casing is estimated at $3,200 (taxes not included). Funding for this work (approximately $6,000) is available from the Capital Reserve Fund 1067.

CONCLUSIONS

Currently, Well #8 is the primary water source for the Skana Water Service Area and it is capable of meeting the present off-peak season demands. However, Well #13 will be needed to meet the summer and long-term demands of the utility. A thorough investigation and possible rehabilitation work on Well #13 is required to ensure that this source can reliably produce good quality water for the community.

RECOMMENDATIONS

That the Skana Water Service Committee:

1. Approve the proposed action plan for the Well #13 as presented;
2. Authorize funding of up to $6,000 from Capital Reserve Fund 1067 to conduct further investigative and potential remedial work for Well #13; and
3. Direct staff to report back on the condition and findings of the well investigation

Christoph Moch
Manager, Water Quality Operations

Glenn Harris, Ph.D., R.P.Bio.
Senior Manager, Environmental Protection

Mike Walton
Acting General Manager,
Parks & Environmental Services
Concurrence

Ted Robbins, B.Sc., C.Tech.
General Manager,
Integrated Water Services
Concurrence

CM:cam
Attachment: Appendix A - Cost Estimates

Drillwell Enterprises
4994 Polkey Road
Duncan, V9L 6W3, B.C.

DRILLWELL

APPENDIX A

Phone: (800) 746-7444
Fax: (250) 746-8404
Email: drill@drillwell.com

Date: 23/02/2016

Attention: John Magi
Jmagi@crd.bc.ca

VIDEO CAMERA INSPECTION

Estimate/Quotation: For a video camera inspection on Mayne Island

Item	Item Description	Units	Est. Quantity	Price per Unit	Totals
1	Mob and Demob	hours	8	$100.00	$800.00
	Ferry	cost+15%	1.15	$65.00	$74.75
2	First well inspected (if more than 2 hours to complete, additional time charged at hourly rate)	L/S	1	$500.00	$500.00
3	Hourly for additional wells	hours		$150.00	
4	Standby or delays caused or requested by others (waiting for ferries)	hours	2	$100.00	$200.00
5	Overtime (hours over 10/day)	hours	4	$100.00	$400.00
6	Crew Subsistance	man day		$225.00	
		TOTAL ESTIMATED COST			$ 1,974.75

Prices do not include GST.

Quantities listed are estimates.

Actual cost will be determined by quantities required, multiplied by the cost per unit as above.

Terms are payment in full within 30 days of completion. 2% per month, (26.82% per annum), charged on overdue amounts.

If you wish to proceed with this project, please fill in legal address above, and sign and date below.

The undersigned agrees to pay for the work at the rates and terms outlined above.

Please sign at x and print name below

x ______________________________

print: ______________ date: ______________

Shawn Slade
DRILLWELL ENTERPRISES LTD

Drillwell Enterprises
4994 Polkey Road
Duncan, V9L 6W3, B.C.

APPENDIX A

Phone: (800) 746-7444
Fax: (250) 746-8404
Email: drill@drillwell.com

Date: 23/02/2016

Attention: John Magi
jmagi@crd.ba.ca

Estimate/Quotation: To install a liner and surface seal to approx 40 feet on Mayne Island
2 man crew

Item	Item Description	Units	Est. Quantity	Price per Unit	Totals
1	Mob and Demob	hours	8	$125.00	$1,000.00
	Ferry Charges	cost+15%	1.15	$99.40	$114.31
2	Camera onsite, if requested.	L/S		$500.00	
3	Hourly work to install Liner, set seals, etc.	hours	4	$150.00	$600.00
4	Standby or delays caused or requested by conditions or client	hours		$125.00	
5	Cement for surface seal	bags	5	$20.00	$100.00
6	Shale trap for surface seal	each	2	$60.00	$120.00
7	Grout Plant	days	1	$150.00	$150.00
8	Supply of 4inch CSA approved liner	feet	40	$5.00	$200.00
9	Overtime (hours over 10/day)	hours	4	$100.00	$400.00
10	Crew Subsistance	man day	2	$225.00	$450.00
		TOTAL ESTIMATED COST			$ 3,134.31

Prices do not include GST.

Quantities listed are estimates.

Actual cost will be determined by quantities required, multiplied by the cost per unit as above.

Terms are payment in full within 30 days of completion. 2% per month, (26.82% per annum), charged on overdue amounts.

If you wish to proceed with this project, please fill in legal address above, and sign and date below.

The undersigned agrees to pay for the work at the rates and terms outlined above.

Please sign at x and print name below

x ______________________________

print: ______________ date: ______________

Shawn Slade
DRILLWELL ENTERPRISES LTD

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REPORT TO SKANA WATER SERVICE COMMITTEE
MEETING OF TUESDAY, APRIL 12, 2016

SUBJECT CONDITION ASSESSMENT OF POTABLE WATER STORAGE TANKS

ISSUE

This report summarizes the condition assessment of the Skana Water System potable water reservoir tanks and provides recommendations for improvement.

BACKGROUND

The existing two horizontal steel storage tanks were commissioned around 1970 and provide 91 m^3 of water storage for the Skana water service area. A comprehensive review of the water system was conducted in 2003 and it was noted that the tanks were corroding and required attention. More recently, the tanks show significant corrosion and have started to leak and, therefore, at the May 13, 2015 meeting, the committee approved a capital expenditure of $10,000 to complete a condition assessment of the tanks. The intent of the assessment is to evaluate the condition of the reservoir tanks and determine if rehabilitation is possible, or if replacement is needed.

In accordance with Capital Regional District (CRD) procurement policies, Stantec Consulting Ltd. of Victoria was awarded the contract to undertake this assessment project. The scope of work included ultrasonic thickness testing of both steel tanks, a visual condition assessment of the tanks and supports, evaluation of the structures ability to withstand a seismic event, and provide a written report with conclusions, recommendations for improvements, and associated budgetary estimates.

Site investigations were performed on November 24 and 26, 2015 and on February 2, 2016, the CRD received Stantec's final report (Attachment #1). A follow up Technical Memorandum, dated March 16, 2016 was also submitted to supplement the conclusions described in the final report (Attachment #2). In summary, both tanks show signs of significant internal corrosion and the foundations and connections do not meet current seismic codes and are at risk of failure in an earthquake. Replacement of the storage tanks in the immediate future is the recommended solution.

The report and technical memo, provides both long and short term recommendations with associated probable construction cost estimates. It should be noted that the costs provided in the report do not include other project related costs which have been included in the Table 1 below. A brief description of the short term fix and long term solutions are provided as follows:

- **Short Term Fix:** The short term fix includes improvements to the supports and connections to withstand an expected seismic event, adding a new liner to the storage tanks to reduce corrosion and improve water quality, and a formal inspection program. Stantec indicates that this is only an interim solution and will not provide a significant extension to life expectancy; and as such, is not recommended. This solution will not allow for simple expansion of the water supply to accommodate any future connections within the existing water service area. The majority of this cost would not provide any value towards the eventual required tank replacement.

- **Replacement with Glass Fused to Steel Tanks:** This is the recommended solution from Stantec and involves replacement of the two tanks with a single glass fused to steel tank, similar to water storage facilities found in many other water systems. The glass fused to steel tanks will meet current seismic requirements, have a life expectancy of approximately 50 years (with regular maintenance). The glass fused to steel tanks are modular and can be expanded vertically to increase volume if, and when the community requires it. In this specific case the tanks would be designed to provide at least the current volume of $91m^3$ (to only serve the existing 46 parcels that are connected). This would minimize initial costs, but, the design would include provisions to accommodate all 73 parcels within the service area.

- **Replacement with Plastic Tanks:** Plastic tanks meet National Sanitation Foundation (NSF) requirements and are suitable for use in potable water systems. This solution involves replacement of the two tanks with two new plastic tanks. Plastic tanks are still relatively new in potable water systems and as such, life expectancy and long-term effect on water quality is not well known. Stantec has indicated that the life expectancy of plastic tanks can be predicted to be less than the glass fused to steel system. The manufacturer was contacted as part of this process and indicated that several installation in BC had been operating satisfactorily for 30 years. Stantec also indicated that potable water taste could be affected by the plastic tanks. Additional plastic tanks can be added in the future to increase system storage, but additional foundations and piping will be required. Similar to the above option, the initial two tanks would provide the current volume of $91m^3$ to minimize initial cost; however, the site design would include provisions for future additional tanks.

Table 1 – Summary of Tank Options and Project Costs

Option	Estimated Construction Cost [1]	Design and Indirect Project Costs (25%)	Project Contingency (10%)	Total Project Costs
Short Term Temp. Fix	$73,000	$18,300	$7,300	**$78,600**
Long-Term Solution A. Glass Fused Steel Tanks	$298,000	$74,500	$29,800	**$402,300**
Long-Term Solution B. Plastic Tanks	$159,000	$39,700	$15,900	**$214,600**

[1] See Stantec memo March 16, 2016

ALTERNATIVES

Alternative 1

That the Skana Water Service Committee:

1. Receive the report for information;

2. Direct staff to continue operating and patching the tanks as best as possible until they can be replaced; and

3. Direct staff to budget for the replacement of the tanks with new glass fused steel tanks, starting with a public engagement and referendum process in 2017 and to replace the tanks in 2018.

Alternative 2

That the Skana Water Service Committee:

1. Receive the report for information;

2. Direct staff to undertake the Short Term Fix as described on page 1 of this staff report; and;

3. Direct staff to budget for the replacement of the tanks with new glass fused steel tanks, starting with a public engagement and referendum process in 2017 and to replace the tanks in 2018.

Alternative 3

That the Skana Water Service Committee receive the report for information and request additional information.

IMPLICATIONS

Alternative 1 - Both storage tanks have reached their life expectancy, show signs of significant internal corrosion and are at risk of developing significant leaks and/or failing during an earthquake. Replacement with a new glass fused to steel storage tank will meet current seismic codes and additional sections can be added to increase the height of the tank in the future to accommodate all 73 parcels in the water service area.

The glass fused steel tank option has a higher initial capital cost than plastic tanks, however, Stantec has indicated that plastic tanks are still relatively new in potable water applications and there is some uncertainty on how long they might last, (will they stand up to the suns UV rays or other weather elements), they are not as robust as steel (more susceptible to vandalism, etc.), and they are uncertain on how plastic tanks may affect water temperature and taste over the long-term. The other advantage of a steel tank is that you can increase its storage capacity by adding to its height and, therefore, only one foundation is required and no piping changes are needed. Whereas to increase storage capacity using plastic tanks will require additional land, foundations, piping, and controls to interconnect multiple tanks.

There are no financial implications for this alternative in 2016, but in order plan and obtain funds for the replacement of the tanks a public engagement and referendum will have to be initiated. To give an idea of the cost impact of borrowing funds for the tank replacement, CRD Finance have indicated that for every $100,000 borrowed at a current interest rate of (2.6%) over 15 years would result in an approximate parcel tax increase of $112 dollars per taxable folio (73) per year. A number of finance options, (capital cost, amortization period, and interest rates), can be provided to the Committee and the community as part of the public engagement process.

Alternative 2 – The existing tanks have been assessed as requested by the committee and it has been confirmed that they have reached the end of their life and are at risk of developing significant leaks and/or failing during an earthquake. Undertaking the described Short Term Fix will address these issues; however, this is only an interim solution and will not provide a significant extension to life expectancy. The majority of this cost would not provide any value towards the eventual required tank replacement.

Currently the Reserve Fund is insufficient to support the Short Term Fix and additional funding through a parcel tax adjustment in 2016 will be required.

Similar to Alternative 1, in order to plan and obtain funds for the replacement of the tanks, a public engagement and referendum will have to be initiated.

<u>Alternative 3</u> – The existing tanks have been assessed as requested by the committee and it has been confirmed that they have reached the end of their life and are at risk of developing significant leaks and/or failing during an earthquake. Waiting to take action could put the water service to the community at risk.

CONCLUSION

The Skana water storage tanks were installed in the 1970's and have reached the end of their expected service life. The tanks and supports are at risk of failure in an earthquake, and internal corrosion may impair water quality. Stantec Consulting Ltd. has completed a condition assessment of the storage tanks and they have recommended that the tanks be replaced with a glass lined steel tank. This solution will provide required initial storage to serve the current 46 parcels connected to the service, improve water quality, meet current seismic codes, and can be expanded in the future to serve all 73 parcels that are in the current water service area.

The short term fix, is not recommended as it will not provide a significant extension to life expectancy, replacement of the tanks will still be required and costs expended on this fix will not provide any value towards the eventual tank replacement.

RECOMMENDATION

That the Skana Water Service Committee:

1. Receive the report for information;

2. Direct staff to continue operating and patching the tanks as best as possible until they can be replaced; and

3. Direct staff to budget for the replacement of the tanks with new glass fused steel tanks, starting with a public engagement and referendum process in 2017 and to replace the tanks in 2018.

Ian Sander, P.Eng. Manager, Capital Projects Infrastructure Engineering	Scott Mason, B.Sc., P.Eng. Manager, Water Engineering and Planning Infrastructure Engineering

Malcolm Cowley, P.Eng.
Acting Senior Manager
Infrastructure Engineering
Concurrence

Ted Robbins, B.Sc., C.Tech.
General Manager, Integrated Water Services
Concurrence

IS/SM:ls
Attachments: 2

Attachment 1

Assessment of Skana Water System Tanks, Mayne Island, BC

Stantec

Prepared for:
Capital Regional District

Prepared by:
Mr. Kenneth Jamieson, P.Eng.
Project Manager
Stantec Consulting Ltd.
400 – 655 Tyee Road
Victoria, BC V9A 6X5

February 2, 2016

Sign-off Sheet

This document entitled *Structural Assessment of Skana Water System Tanks* was prepared by Stantec Consulting Ltd. for Capital Regional District (CRD), and for the attention of Mr. Gary Pleven, AScT. The material in it reflects Stantec's best judgment in light of the information available to it at the time of preparation. Any use, which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Stantec Consulting Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Prepared by ______________________
(signature)

Kenneth Jamieson, P.Eng.

Reviewed by ______________________
(signature)

Paul Dudzinski, P.Eng., Struct.Eng, MIStructE.

Table of Contents

1.0 INTRODUCTION

The Capital Regional District (CRD) has requested that Stantec Consulting Ltd. (Stantec) review two existing above ground potable water tanks located in the Skana Water System Service Area, a CRD owned and operated small water system on Mayne Island, British Columbia. Both tanks are above grade elevation and bearing on top of a concrete saddle foundation, located each end of the tanks. No record drawings of the water tanks exist and were reported to be installed in the 1970's. The following image provides a location plan of the tanks South of Waugh Road via a service road, north of the Town Center. Road access improvements and minor upgrades to improve water circulation and operator safety were completed in 2005.

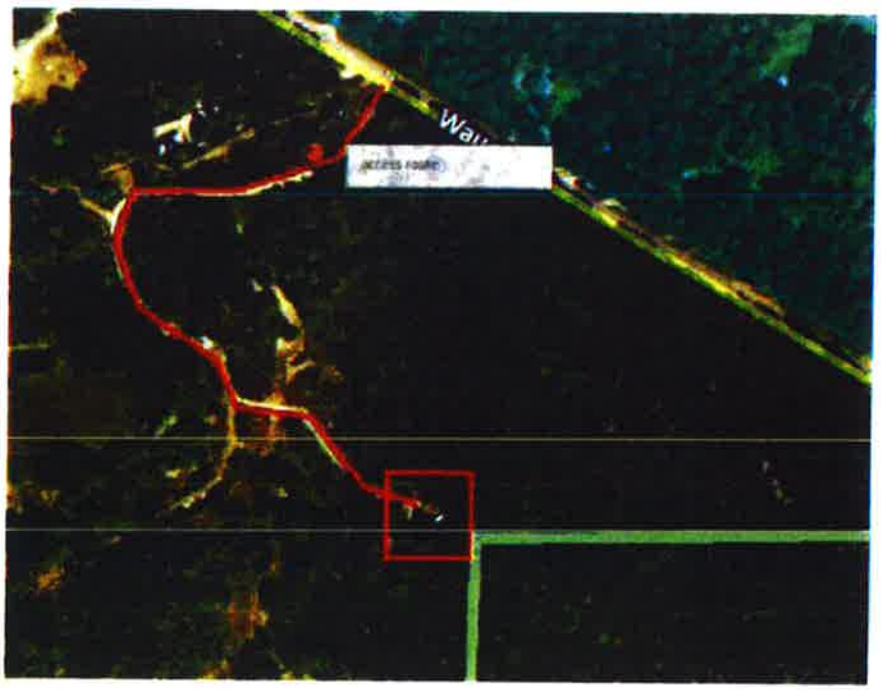

Figure 1: Tank Locations

2.0 SCOPE OF WORK

The Tank assessments were based upon:

- Onsite field observations performed by Stantec and Stasuk Testing & Inspection.
- Preliminary rational analysis calculations performed on each tank.

Our scope of work specifically excluded:

- Assessment of mechanical and electrical systems.
- Geotechnical Investigations.
- Detailed Engineering design and structural drawings.

The assessment is based, in part, on information provided by CRD and onsite visual observations documented by Stantec and Stasuk Testing & Inspection.

Unless specifically noted, we have assumed that this information is correct and have relied on it in developing our conclusions.

3.0 OBSERVATIONS

A site visit was performed on November 24, 2015 by a representative from our Victoria office and Stasuk Testing & Inspection present. A second site visit by the sub-consultant (Stasuk Testing & Inspection) was on November 26, 2015 to provide additional non-destructive testing (NDT) services of the second tank (tank #2).

Both tanks are of steel construction, located above grade elevation, supported on two concrete saddles and bearing onto a stem wall foundation system.

No existing record drawings were available and field measurements taken of the concrete support elements to determine the capacity of the storage tank to resist seismic post-disaster demand forces applied to the structure during a seismic event.

Steel reinforcing size and spacing within the concrete saddles is undetermined to verify the flexural strength capacity of the support piers during a seismic event, and only observed surface shrinkage cracking was noted at each saddle locations and is a common observation for concrete surfaces of this age. We observed past concrete patch repairs performed to the saddle supports and repairs were in good condition.

A visual walk around the exterior of the tanks indicates significant pitting to the underside of each tank and adjacent the concrete saddle platforms.

Each tank is of similar construction with similar physical properties as follows:

- Diameter: 3.0m (10 feet)
- Length: 6.5m (21.6 feet)
- Volume: 45.3m² (11,967 US gallons)
- Coated exterior cylindrical steel shell construction bearing on above ground concrete saddles each end, and supported on a concrete stem wall foundation at grade elevation
- The interior steel shell in not lined and bare steel is visible
- No physical steel clamps/connections of the tank shell to the concrete saddle support was observed

Stasuk Testing & Inspection completed non-destructive testing (NDT) thickness testing at multiple locations on each tank and findings are enclosed within their draft report enclosed within Appendix A and is further addressed in Section 4.2 – Tank Deformation.

The motivation for our analysis and review is the apparent visual pitting of the lower section of cylindrical steel shell panels adjacent to concrete saddle support locations. The pitting is evident along the bottom of each tank. The following figure details noticeable pitting of the tank wall next to the concrete saddle support.

Figure 2: Tank #1 Pitting at bottom of exterior shell at support saddle

4.0 STRUCTURAL ASSESSMENT

Stasuk Testing & Inspection performed NDT testing on the exterior shell of each tank only. WorkSafeBC confined space entry procedures were not employed, as this was not part of our scope of work services for the project, only visual observations were performed from the roof hatch location to observe the condition inside each tank.

4.1 EXISTING ROOF HATCH ASSESSMENT

As depicted in the image below, the roof hatch is in good condition, however access ladders down into the tank and visual observations from the roof hatch inside the tank (tank #1 observed) indicates significant corrosion and scaling present.

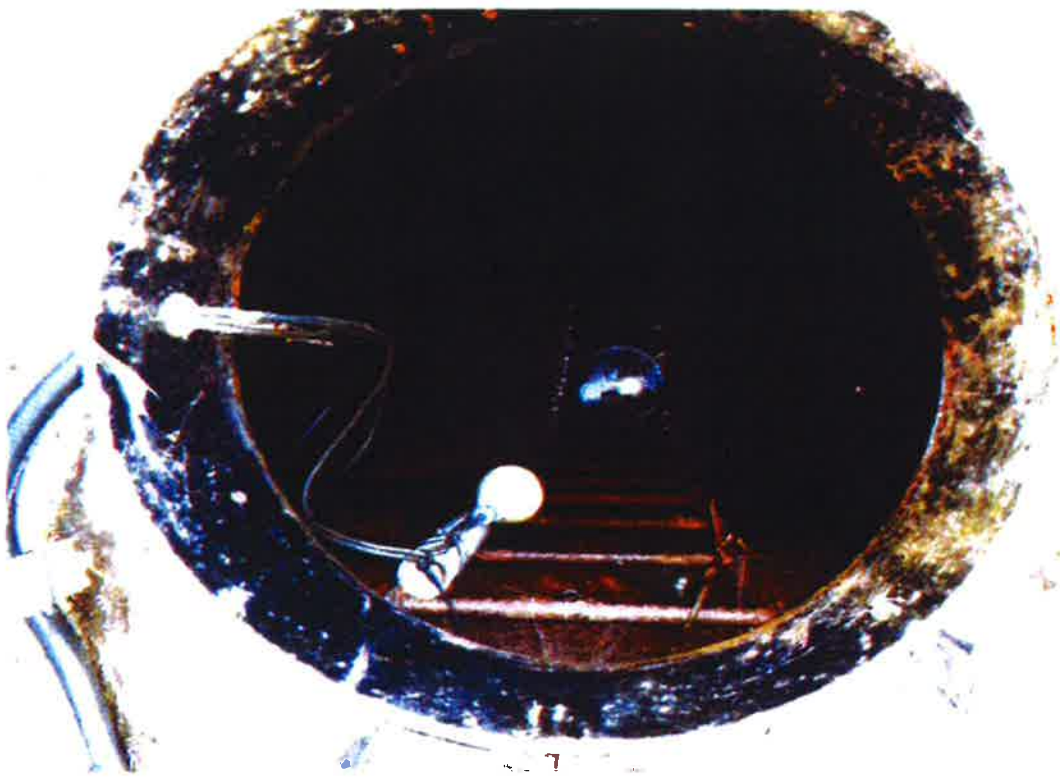

Figure 3: Roof Hatch Observation (Tank #1)

4.2 TANK DEFORMATION

Stantec conducted a review of the tank structure based on the findings from Stasuk Testing & Inspection (included in Appendix A). The two tanks, which are of similar construction, were found to have a nominal wall thickness of 6.24mm (0.25") for tank #1 and 6.29mm (0.25") for tank #2.

A stress check was performed on the steel wall plates, based on the minimum thickness measurements provided by Stasuk Testing & Inspection. The stress on the walls is within the yielding limit for steel for both tanks and acceptable.

The tank wall was also checked for susceptibility to fatigue failure. It was found that the maximum number of loading cycles (assuming the tank goes from full to empty once a day for the recommended service life of 40 years) would be below the threshold where CAN/CSA S16-09 indicates that the steel strength would start to be reduced.

A visual review of the outside of the tank observed that no deformation of the tanks was noted and not occurring locally at a panel joint seam welds which were in good condition. From the comparison of Stasuk's findings, visual review and the structural analysis performed above, Stantec concluded that no significant deformation of each tank wall was found, however significant corrosion/pitting was observed adjacent to saddle support locations.

4.3 TANK LEAKAGE

As depicted in the image below, Tank #2 had a pipe fitting failure on the second day of NDT reviews being performed by Stasuk Testing & Inspection. Due to the water leak, the tank was taken out of service. The image below indicates significant corrosion and a thread failure at the fitting was the cause of the leak. A replacement connection was installed and the tank was back online within a few days of the water leak.

Figure 4: Tank #2 East drain port nozzle pipe fitting failure

5.0 CONCLUSIONS

The tanks were constructed under building codes from the 1970's and do not meet the post-disaster seismic design requirements of the 2012 British Columbia Building Code. In addition, the tanks are beyond their operational life expectancy of 40 years and the interior shells are exposed bare steel with corrosion and visible scaling present, which can lead to water quality issues.

Without providing a foundation seismic upgrade, both tank foundations would fail during an earthquake event.

In addition to a foundation upgrade, we also recommend proposing an interior tank liner for the short-term solution to extend the present operational requirements of both tanks.

Short and long-term solutions are listed below for CRD's review and consideration with probable construction cost estimates for both options enclosed with Appendix C of the report.

6.0 RECOMMENDATIONS

6.1 SHORT TERM SOLUTION

- Provide a new cast-in-place 450mm deep (18") reinforced concrete slab at grade elevation and tied into the existing concrete saddles/footings to resist lateral post-disaster demand loading
- It may be possible to incorporate the proposed foundation seismic upgrade (short term) for the long-term solution. However this should be considered prior to pre-design/construction going forward if short term repairs are to be implemented and if replacement of the tanks in the future takes place
- Provide steel strapping/clamps are required to secure each tank to the existing concrete saddles with epoxy anchors. New steel braces anchored to the new concrete slab and located and centered each face of saddles supports to resist seismic demand loading in the long axis direction of each tank
- Both tanks have met the operational life expectancy. Providing a new internal liner for each tank will reduce further corrosion of the steel shell inner wall and improve long term water quality
- Monitoring and formalizing a tank inspection maintenance programme will extend both tanks serviceability requirements.

6.2 LONG TERM SOLUTION

- Remove the existing tanks and support foundations and replace with a proprietary glass fused to steel flat panel tank of similar volume capacity, 91 cubic meters (23,934 US gallons)
- The new tank would incorporate an aluminum geodesic dome roof, and included an elevated concrete ring beam and raft foundation designed to resist post-disaster seismic loads under the 2012 British Columbian Building Code.

6.3 PERIODIC TANK INSPECTIONS

- Removal of dirt, weeds and vegetation around the outside base of the tank
- Removal of tree limbs or bushes which may scratch the tank shell
- Check the tank interior for evidence of contamination
- Examine tank shell to foundation connection
- Examine tank for signs of corrosion, leaks, cracks or mineral streaks
- Examine exterior tank coatings for peeling, bubbling, cracking or
- corrosion
- Examine concrete saddle supports for signs of concrete deterioration (spalling, and cracking)
- Examine tank foundation for cracks, spalling, exposed reinforcing steel, crumbling, and differential settling
- Check that vents, overflows, access hatches all intact and secure

- Examine soundness of security fence and that gates and locks work properly
- Undertake coating touch-up as per the instructions of the tank distributor or manufacturer if needed
- Keep record of inspection findings

We also recommend that the CRD hire a professional cost consultant to provide an accurate Class C Cost Estimate for both short and long-term solutions. Any associated construction work should be costed by a designated professional familiar with this type of work.

Report prepared by:

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Stantec Consulting Ltd.
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PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
K. S. JAMIESON
36184
01/02/2016

Report reviewed by:

Paul Dudzinski, P.Eng, Struct.Eng. MIStructE
Associate
Stantec Consulting Ltd.
paul.dudzinski@stantec.com

Appendix A SITE PICTURES

Photo 1: View of elevated tanks from access road leading into project site. Tank#1 in foreground and Tank #2 background as noted by numbering.

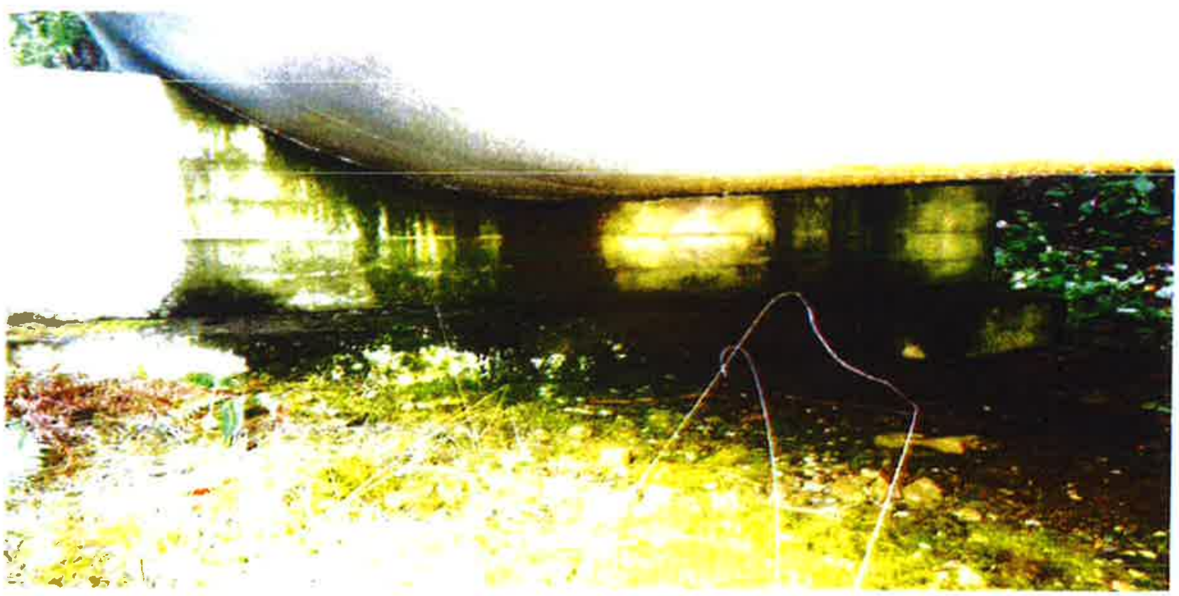


Photo 2: Typical concrete support pedestal and stem wall footing. *Note: No permanent bracket connection of tank to pedestal/footing.*

Photo 3 **Exterior access ladder in good condition for both tanks with localized corrosion present.**

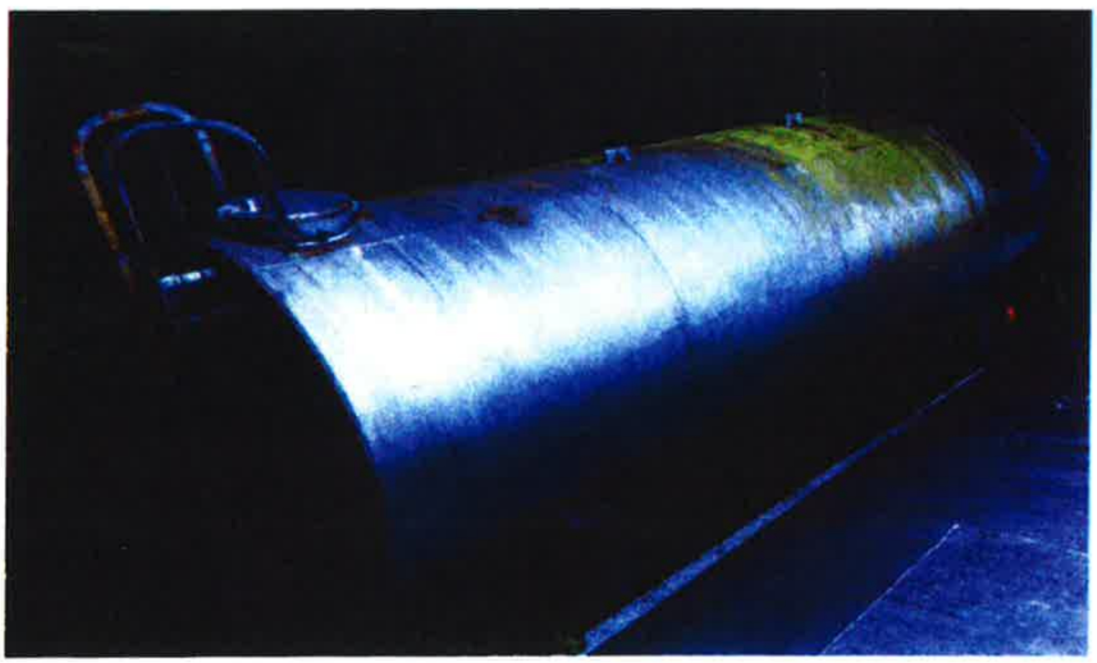


Photo 4: **View of access hatch (Tank #2).**

Photo 5: View of inside Tank #1, which shows visible rust with no interior liner.

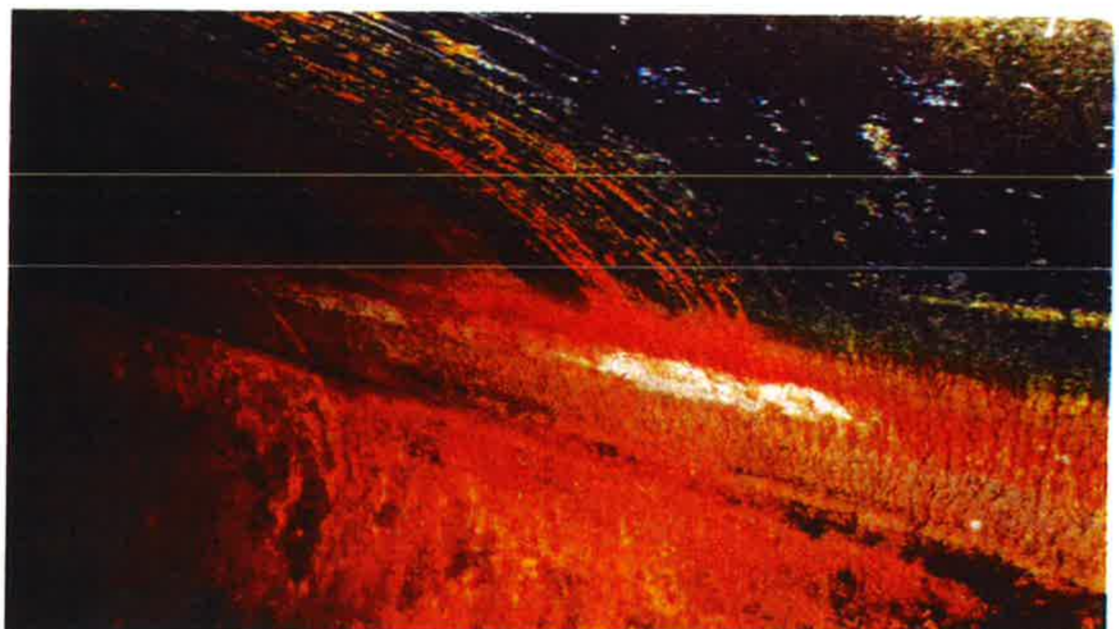


Photo 6: View of water scaling on side of Tank #1.

Appendix B STASUK TESTING & INSPECTION

Stasuk Testing & Inspection

8955 Fraserwood Court, Burnaby
British Columbia V5J 5H7
Telephone: (604) 420-4433
Fax: (604) 420-2685
www.nde.net

TANK # 1 INSPECTION REPORT

Client: Capitol Regional District
479 Island Hwy, Victoria, BC V9B 1H7

Attn: Gary Pleven

Inspection Date: November 24th, 2015
Client PO#: TBA
Stasuk WO#: TBA
Report #: 1

SUBJECT: Skana Reservoir Tank Ultrasonic Thickness Testing and Visual Inspection / Assessment
Location: Mayne Island
Specification (s): Quality Assurance – Information only/ API 653
Reference Drawings: N/A

Inspections were performed on Tank # 1, a non-API Registered tank to API 653 and client information requirements with internal and external visual inspections (no CSE performed) as tank was visually inspected through single hatch at one end of each.

All ultrasonic testing was performed after removal of coating by scraper as the coating was interfering with the testing.

The following are the inspection locations as carried out during the quality examination of tank #1. Photos are provided in the following document at each of these stages:

1. External visual inspection of tanks, documenting corrosion, coating deterioration, cracking or other issues
2. Ultrasonic thickness testing of the tank shells on a grid – a band at either end of the tanks, 2 bands equally spaced down the length of the tanks, with readings every 2' around each of the 4 bands, and a line along the bottom dead centre
3. Ultrasonic thickness testing of the end plates or heads on a 2' grid, with readings taken on the perimeter and around the clock positions (suggested).
4. Visual examination as possible, through the top manways, from the outside **without confined space entry**, after tanks are emptied, hatches are opened and ventilation is provided by testing consultant (if necessary to meet regs).
5. Visual examination of tank support saddles
6. Images from examination

Summary of Results - The area that will require attention for a significant life extension on this tank will be the 5 to 7 o'clock position down the entire length of the tank. This is due to severe corrosion attack. The external pitting has been calculated to be near through wall thickness in some areas. Considerations for an internal bladder or a doubler-plate may want to be taken to extend the life of the tank.

Submitted By: Russell W Petrie

Cert # 12374 – CWB
10214 - CGSB

Field Report Left with: No field report provided **of** N/A

1.1 External visual inspection of tank #1, documenting corrosion, coating deterioration, cracking or other issues.

1.2 Corrosion on tank # 1 was found to be generally localized to the 5 o'clock to 7 o'clock location (from the west tank end). With few corrosion colonies extending from this location. The majority of the corrosion (5 o'clock to 7 o'clock location) was found to extend down the entire length of the tank. Severe pitting was noted up to 5mm in depth on the east tank end with an average of 2.5mm pitting noted throughout the entire west to east tank bottom. See images -1 and 3.This area will require attention if significant tank life extension is desired – See ultrasonic testing results.

1.3 Minor and inconsistent corrosion was also noted around the tank saddles. See Image -2.

1.4 Severe coating degradation was noted throughout the areas of corrosion mentioned above; however the rest of the tank was noted only to be covered in mildew caused by weather with no significant recorded coating failure.

1.5 No cracking was noted on the tank in any of the following locations;

1.5.1 Tank circumferential and long seam welds
1.5.2 Inlet and outlet nozzles (West)
1.5.3 Drain port (East)
1.5.4 Breather nozzle (top east end)
1.5.5 Manway hatch / Hinges
1.5.6 Access ladder welds
1.5.7 Lifting anchors
1.5.8 Locations noted of non-concerning defects are as follows;

1.5.8.1 West end tank just below the 9 o'clock position a welding defect was noted in the tanks head. See image-4. This area is not a cause for concern.

2.0 Ultrasonic thickness testing of the tank shells was carried out on a grid as follows; One (1) band - 2.0' in from each end of the tank and one (1) bands 3.0' either side of tank centerline for a total of four (4) bands . Readings were carried out every 2' around the tank circumference. Although a line at bottom dead center was planned, it was found that the corrosion In this area was too severe to carry this out.

Reading & Clock Position	TANK # 1 Ultrasonic Thickness Findings (mm)			
	EAST END + 2 '	CL – 3'	CL + 3'	WEST END -2'
1	6.08	6.08	6.00	6.44
2	6.07	6.04	6.07	6.48
3	6.32	6.25	6.26	5.91
4 (9 o'clock)	6.36	5.75	5.75	6.31
5	6.41	5.73	5.79	5.94
6	6.16	5.64	5.73	6.16
7	6.41	6.29	6.26	6.48
8	6.11	6.32	5.44	6.31
9	6.57	6.56	5.94	6.33
10	6.07	6.47	5.95	6.28
11	6.50	6.50	6.38	6.03
12 (3 o'clock)	6.63	6.29	6.05	6.50
13	6.50	6.45	6.32	6.57
14	6.08	6.57	6.44	6.42
15	6.05	6.33	6.05	6.23

Table-1 Recorded Thickness Measurements from Tank # 1 Shell

3.0 Ultrasonic thickness testing of the end plates or heads was carried out as follows; Readings were taken around the clock positions and towards the head center at the 3, 6, 9 and 12 o'clock positions where accessible... The 6 o'clock position was not accessible for ultrasonic measurement due to the placement of the nozzle/ valve protective boxed on the west end only.

East Tank End Head (mm)				West Tank End Head (mm)			
Clock Position	1.0' in from edge	2.0' in from edge	3.0' in from edge	Clock Position	1.0' in from edge	2.0' in from edge	3.0' in from edge
1	6.0			1	6.36		
2	5.77			2	6.45		
3	6.0	5.95	5.95	3	6.31	6.32	6.60
4	5.95			4	6.23		
5	6.25			5			
6	5.97	5.63	6.03	6			
7				7	6.14	6.41	
8	5.95			8	6.72		
9	6.41	5.70	6.27	9	6.67	6.32	6.64
10	6.17			10	6.53		
11	6.03			11	6.38		
12	5.95	6.47	5.38	12	6.32	6.32	6.57

Table-2 Recorded Thickness Measurements from Tank # 1 East and West Heads

4.0 Visual examination as possible, through the top manways, from the outside <u>without confined space entry</u>, after tanks are emptied, hatches are opened.

4.1 A low level visual inspection of tank # 1 was carried out from the manway on top of the tank. No access was possible as no confined space access was set in place for the inspection. Hi levels of surface rust were noted with a distinct water settling line. Calcium build up was present on the tanks walls. These areas are highly susceptible to corrosion attack. See Images-5 & 6

4.2 An internal examination of this tank would seem redundant at this time due to the nature of the detrimental corrosion found on the external tank bottom

5.0 Visual examination of tank support saddles

5.1 It was noted that the tank saddle liners have become very brittle. It was noted also that concrete repairs have been made to the saddles in the past. Cracking was noted in areas. The determination of the usability of the saddles and whether or not code requirements are met are left to the engineer. See Image 7.

6.0 **Images from tank examination;**

	Image -1: Close-up example of the severe corrosion on the bottom of the tank
	Image -2: Another example of the severe corrosion on the bottom of the tank. This is continues along the entire bottom.

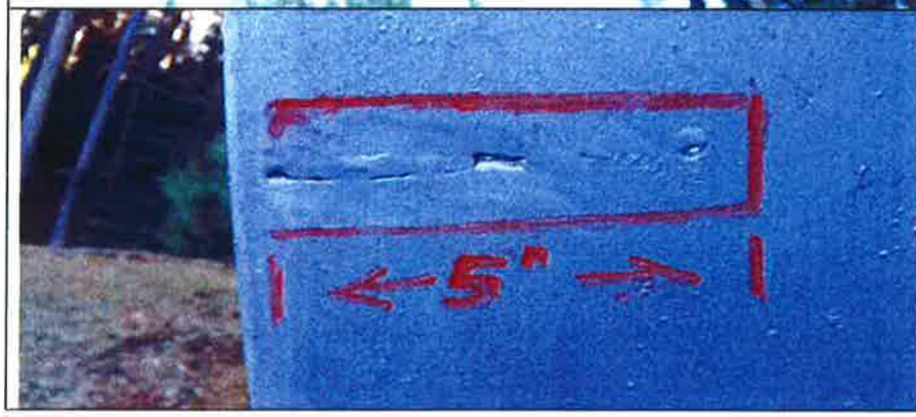
	Image -3: Corrosion colony slightly up from bottom dead center.
	Image -4: Weld defect just below the 9 o'clock position on the west end of the tank as mentioned above.

	Image-5: Example of the calcium build-up on the internal side of the tank. Note the distinct water settling lines on the right hand side of the image.
	Image -6: Example of the calcium build up found on the internal side of the tank.

	Image -7: example of the condition of the tank saddles. Note the repairs that have been made also the cracking present in the image.
	**Image -8: Example of the access ladder welds as found to be in acceptable condition. Also not eh breather nozzle found on the upper east end of the tank.**

Stasuk Testing & Inspection

8955 Fraserwood Court, Burnaby
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www.nde.net

TANK # 2 INSPECTION REPORT

Client:	Capitol Regional District 479 Island Hwy, Victoria, BC V9B 1H7	**Inspection Date:**	November 27th, 2015
		Client PO#:	TBA
		Stasuk WO#:	TBA
Attn:	Gary Pleven	**Report #:**	2

SUBJECT: Skana Reservoir Tank Ultrasonic Thickness Testing and Visual Inspection / Assessment
Location: Mayne Island
Specification (s): Quality Assurance – Information only/ API 653
Reference Drawings: N/A

Inspections were performed on Tank # 2, a non-API Registered tank to API 653 and client information requirements with internal and external visual inspections. Confined space safety was in place for an internal inspection of this tank.

All ultrasonic testing was performed after removal of coating by scraper as the coating was interfering with the testing.

The following are the inspection locations as carried out during the quality examination of tank #2. Photos are provided in the following document at each of these stages:

1. External visual inspection of tanks, documenting corrosion, coating deterioration, cracking or other issues
2. Ultrasonic thickness testing of the tank shells on a grid – a band at either end of the tanks, 2 bands equally spaced down the length of the tanks, with readings every 2' around each of the 4 bands, and a line along the bottom dead centre
3. Ultrasonic thickness testing of the end plates or heads on a 2' grid, with readings taken on the perimeter and around the clock positions (suggested).
4. Visual examination as possible, internal and external, after tanks are emptied, hatches are opened and ventilation is provided by testing consultant (if necessary to meet regulations.). Confined space was tested with an air monitor. Tank was accessed.
5. Visual examination of tank support saddles
6. Images from examination

Summary of Results – The areas that will require attention for a significant life extension on this tank will be the 5 to 7 o'clock position down the entire length of the tank and the east end drain-port nozzle.
The external pitting has been calculated to be near through wall thickness in some areas. This is due to severe corrosion attack. Considerations for an internal bladder or a doubler-plate may want to be taken to extend the life of the tank.
The drain port nozzle came completely away from the tank during examination, due to complete weld failure as a result of fatigue. This will have to be replaced before the tank can continue in service.

Submitted By: Russell W Petrie **Cert #** 12374 – CWB
10214 - CGSB

Field Report Left with: No field report provided **of** N/A

1.1 External visual inspection of tank #2, documenting corrosion, coating deterioration, cracking or other issues.

1.2 Corrosion on tank # 2 was found to be generally localized to the 5 o'clock to 7 o'clock location (from the west tank end). With noted corrosion colonies extending from this location. The majority of the corrosion (5 o'clock to 7 o'clock location) was found to extend down the entire length of the tank. Severe pitting was noted up to 5mm in depth on the tank bottom, with an average of 2.5mm pitting noted throughout the entire west to east tank areas. See image-1 below. This area will require attention if significant tank life extension is desired – See ultrasonic testing results.

1.3 Minor and inconsistent corrosion was also noted around the tank saddles

1.4 Severe coating degradation was noted throughout the areas of corrosion mentioned above; however the rest of the tank was noted only to be covered in mildew caused by weather with no significant recorded coating failure.

1.5 No cracking was noted on the tank in any of the following locations;

1.5.1 Tank circumferential and long seam welds

1.5.2 Inlet and outlet nozzles (West)

1.5.3 Drain port (East) - A minor leak was noted in the nozzle to shell weld. Under further examination the nozzle weld was found to have completely failed and nozzle came off the tank. This renders tank # 2 useless until repaired. A warning sign was hung on the pump house not to fill tank... See Images 2 &3.

1.5.4 Breather nozzle (top east end)

1.5.5 Manway hatch / Hinges

1.5.6 Access ladder welds

1.5.7 Lifting anchors

2.0 Ultrasonic thickness testing of the tank shells was carried out on a grid as follows; One (1) band - 2.0' in from each end of the tank and one (1) bands 3.0' either side of tank centerline for a total of four (4) bands . Readings were carried out every 2' around the tank circumference. Although a line at bottom dead center was planned, it was found that the corrosion in this area was too severe to carry this out.

Reading & Clock Position	TANK # 2 Ultrasonic Thickness Findings (mm)			
	WEST END + 2'	CL – 3'	CL + 3'	EAST END -2'
1	6.22	6.28	6.23	6.32
2	6.22	6.28	6.00	6.32
3	6.36	6.07	6.22	6.14
4 (9 o'clock)	6.36	6.22	5.97	5.95
5	5.95	6.03	5.94	5.83
6	6.17	6.08	6.17	5.76
7	6.51	6.35	6.03	6.44
8 (6 o'clock)	6.54	6.32	6.22	6.10
9	6.50	6.29	6.25	6.39
10	6.04	6.04	5.97	6.28
11	6.17	6.23	6.00	6.07
12 (3 o'clock)	6.19	6.03	5.24	5.50
13	6.14	6.29	5.60	6.28
14	5.95	6.05	6.22	6.29
15	6.41	6.28	5.94	6.29

Table-1 Recorded Thickness Measurements from Tank #2 Shell

3.0 Ultrasonic thickness testing of the end plates or heads was carried out as follows; Readings were taken around the clock positions and towards the head center at the 3, 6, 9 and 12 o'clock positions where accessible... The 6 o'clock position was not accessible for ultrasonic measurement due to the placement of the nozzle/ valve protective boxed on the west end only.

East Tank End Head (mm)			
Clock Position	1.0' in from edge	2.0' in from edge	3.0' in from edge
1	6.04		
2	6.31		
3	6.13	6.28	6.50
4	6.19		
5	6.18		
6	5.95	5.92	5.89
7	5.92		
8	6.00		
9	6.03	6.35	5.75
10	6.39		
11	6.31		
12	6.48	6.28	6.41

West Tank End Head(mm)			
Clock Position	1.0' in from edge	2.0' in from edge	3.0' in from edge
1	6.14		
2	6.10		
3	6.01	6.00	6.20
4	5.76		
5	6.19		
6	N/A		
7	N/A		
8	6.16		
9	6.20	5.97	6.10
10	6.41		
11	6.22		
12	6.18	6.11	6.08

Table-2 Recorded Thickness Measurements from Tank # 2 East and West Heads

4.0 Internal and external visual examination was carried out after tanks were emptied, hatches were opened and ventilation was provided by testing consultant. Confined space was tested with an air monitor. Tank was accessed.

4.1 A visual inspection of tank # 2 was carried out from the internal side of the tank. Hi levels of surface rust were noted with a distinct water settling line. Calcium build up was present on the tanks walls. These areas are highly susceptible to corrosion attack. Randomly selected areas were scraped away to reveal pitting and general material wastage of the tank walls below the water settling line. See Image-1

The welds on the internal side were noted to be severely attacked by corrosion. Pitting of up to 7mm Deep x 20 mm wide was noted on the weld reinforcement. See image -10.

Examination of the tanks nozzles was carried out from the internal tank side also. With the exception of the east end drain port, the set through nozzle on the west tank end appears to have only minor rust and calcium buildup present while the set on (external) nozzle appears to have minimal weld metal present which could be cause for concern. See images 6&7

The tank condition above the water line was found to be in fair condition with extremely minor surface rust present. The coating for the most part was intact. See image-5.

5.0 Visual examination of tank support saddles.

5.1 It was noted that the tank saddle liners have become very brittle. It was noted also that concrete repairs have been made the saddles in the past. Cracking was noted in areas. The determination of the usability of the saddles and whether or not code requirements are met are left to the engineer.

6 Images from tank examination;

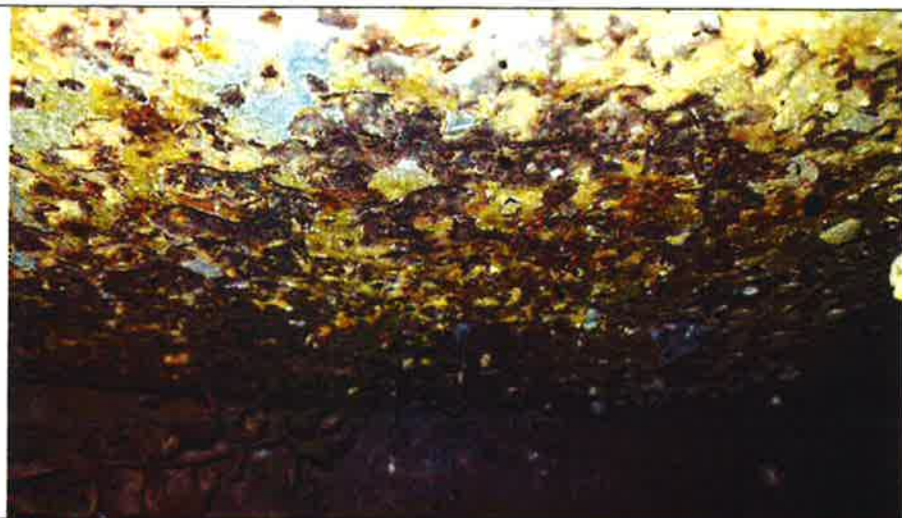	Image -1: Extreme corrosion attack on the bottom of the tank. Up to 5mm deep pitting recorded.
	Image-2: East end bottom drain port. Was found to have a minor leak. Rust removal revealed a crack around the circumference of the nozzle to shell weld. With minor pressure the nozzle came away from the shell. See next image.

	Image-3: East end drain port after nozzle came failed.
	Image -4: Example of the corrosion colonies present on the tank. The location of this image is on the south side. The circ. Weld in the image is the center line of the tank.

	Image-5: Example of the internal condition of the tank. Note the distinct water settling lines.
	Image-6: Upper nozzle on the west end of the tank. Note the lack of weld material present. Believed to be from manufacturing.

Image-7: Set through lower nozzle on the west end of the tank. Note the calcium buildup.

Image -8: Example of the general material wastage caused by the calcium build up on the shell wall of the tank.

Image-9: Example of the corrosion attack on the circumferential welds on the internal side of the shell.

Image -10: Example of the instrument used for measuring the pit depths. The pit in the image was found to have a depth of 7mm.

Appendix C PROBABLE CONSTRUCTION COST ESTIMATE

Stantec

PROBABLE CONSTRUCTION COST ESTIMATE

Project: CRD Water Tanks (91 m3)
Location: Skana Water System, Mayne Island, BC
Proj No: 115615379

By: KSJ
Date: 21-Dec-15
Total Cost: $ 73,000

Item No.	Item Description	Quan.	Unit	Unit Cost	Cost
	Structural Items-Short Term Solution				$ -
1	Steel seimic strapping	4	-	1200	$ 4,800
2	New seismic restraint reinforced concrete slab	27	m3	400	$ 10,800
3	Steel reinforcing (2 layer E/W top and bottom) 15M @ 300 o.c.	857	Kg	8	$ 6,856
4	Steel bracing at saddle supports	8	-	600	$ 4,800
5	Internal liner for each tank	2		4500	$ 9,000
6	Soil disposal off site for foundation work	18	m3	250	$ 4,500

	SUBTOTAL				$ 40,756
	GENERAL REQUIREMENTS				
1	Safety and secuirty			4%	$ 1,630
2	Temporary Services			1%	$ 408
3	Submittals			3%	$ 1,223
4	General Conditions (coordinating subs, job,super,etc)			10.0%	$ 4,076
	TOTAL GEN REQUIREMENTS				$ 7,336
	SUBTOTAL				$ 48,092
	GENERAL CONTRACTOR'S COSTS				
1	GC Home Office Overhead			8.0%	$ 3,847
2	GC Insurance,Payment &Performance Bonds			4.0%	$ 1,924
3	General Contractor's Profit			20%	$ 9,618
	TOTAL GENERAL CONTRACTOR'S COSTS				$ 15,389
	SUBTOTAL				$ 63,482
	Contingency			15%	$ 9,522
	TOTAL				$ 73,004

Note: This estimate is based on unit costs from Means Construction Cost Data.

Stantec

PROBABLE CONSTRUCTION COST ESTIMATE

Project: CRD Water Tanks (91 m3) **By:** KSJ

Location: Skana Water System, Mayne Island, BC **Date:** 1-Feb-16

Proj No: 115615379 **Total Cost:** $ 197,400

Item No.	Item Description	Quan.	Unit	Unit Cost	Cost
	Structural Items-Long Term Solution				$ -
1	Removal of exsiting tanks	2		2500	$ 5,000
2	Install new tank and foundation system	1			$ 100,000
3	Install new water tank lines	2		1800	$ 3,600

	SUBTOTAL				$ 108,600
	GENERAL REQUIREMENTS				
1	Safety and secuirty			4%	$ 4,344
2	Temporary Services				$ 3,000
3	Submittals			3%	$ 3,258
4	General Conditions (coordinating subs, job,super,etc)			10.0%	$ 10,860
	TOTAL GEN REQUIREMENTS				$ 21,462
	SUBTOTAL				$ 130,062
	GENERAL CONTRACTOR'S COSTS				
1	GC Home Office Overhead			8.0%	$ 10,405
2	GC Insurance,Payment &Performance Bonds			4.0%	$ 5,202
3	General Contractor's Profit			20%	$ 26,012
	TOTAL GENERAL CONTRACTOR'S COSTS				$ 41,620
	SUBTOTAL				$ 171,682
	Contingency			15%	$ 25,752
	TOTAL				$ 197,434

Note: This estimate is based on unit costs from Means Construction Cost Data.

Attachment 2

Stantec

Technical Memo

To:	Ian Sander, P.Eng. Capital Regional District 625 Fisgard Street Victoria, British Columbia Canada V8W 1R7	From:	Kenneth Jamieson, P.Eng. Stantec Consulting Ltd. 400 – 655 Tyee Rd. Victoria, BC
File:	115615379	Date:	March 16, 2016

Reference: Conclusions and Recommendations for Skana Water System Tanks.

Stantec have been asked to review addition information and make recommendations in reference to our Skana Water System Tank Replacement Assessment Report dated February 2nd, 2016.

This Technical Memorandum is presented to Capital Regional District to clarify and detail our conclusions and recommendations for the Skana Water System Tanks on Mayne Island. This memo is intended to provide a recommended solution, and give options and information on that recommendation.

Conclusions

The Skana Water System tanks were constructed under building codes from the 1970's and do not meet post disasters seismic design requirements.

In addition, the tanks are beyond their operational life expectancy of 40 years and the interior shells are exposed bare steel with corrosion and visible scaling preset, and this is affecting the water quality in these tanks. Major corrosion was found down the entire length of the tanks as well as severe pitting on the tanks bottoms.

The foundation of these tanks also requires replacement or significant upgrades to meet acceptable seismic standards.

Recommendations

Based on our best judgement in light of the information available to us, it is our recommendation that these tanks be replaced in the very near future. The existing tanks are now beyond the design life capacity of 40 years and they are deteriorating, resulting in the potential to impair potable water quality as well as their inability to withstand a seismic event.

In our report dated February 2nd, 2016, we proposed a short term solution that detailed immediate actions to be done if the replacement of the tanks could not be undertaken immediately. Note this was intended to be a short term fix, not the recommended solution.

Replacement of the tanks is the recommended solution because of the condition of the tanks and the seismic deficiencies.

Reference: Conclusions and Recommendations for Skana Water System Tanks.

Options for Replacement

There are two tank replacement options, polyethylene or conventional glass fused to steel tanks are available.

Our report recommended the best option for replacement to be a proprietary glass fused to steel flat panel tank of similar volume. We believe that as a long term solution this is the best replacement option for water quality, life expectancy, and cost effectiveness although the initial capital cost for this option is higher.

Our office has reviewed polyethylene tank products that are on the market and a local company, Twin Maple Industrial Tanks, located on the mainland, can supply this product.

Polyethylene tanks are designed to resist earthquake loading to the present building code and includes post-disaster seismic design load requirements. Short term benefits would include reduced costs to acquire the tanks as compared to glass fused tanks.

Polyethylene tanks have not demonstrated life capacity, which means that they may require more frequent replacement. As costs rise in the future, the cost of replacement and delivery of these tanks cannot be determined at this time.

In addition, the tanks are not lined so palatable water quality could be affected and become a concern. However, the polyethylene tanks are NSF approved and are acceptable for potable water use.

A probable cost estimate is attached for both options as well as a comparison summary table found below. The cost estimate does not include the cost of any additional exterior insulation (typically required for colder climates) for the polyethylene tanks.

To accomplish the replacement of either of these tank options, removal of each tank, support saddles and stem wall footings are required. Site Class and allowable soil bearing capacity at the project site will need to be verified by a registered geotechnical engineer in the Province of BC in order to design a new monolithic pad footing to support a replacement tank system.

Reference: Conclusions and Recommendations for Skana Water System Tanks.

Cost Comparisons of Structural Short Term Solution versus Initial Glass Fused to Steel Tank Replacement versus Polyethylene Tank Replacement

	Structural Short Term Solution	Glass Fused to Steel Tank	Polyethylene Tank (no exterior insulation)
Provide Seismic foundation, steel tank strapping and bracing saddle support upgrades with new tank liner	$40,756.00	$0.00	$0.00
Remove existing and replace with new tank, foundations and lines	$0.00	$165,600.00	$86,750.00
General requirements	$7,336.00	$31,152.00	$17,748.00
Contractors Costs	$15,389.00	$62,961.00	$33,439.00
Contingency	$9,522.00	$38,957.00	$20,691.00
Total Costs	**$73,004.00**	**$298,670.00**	**$158,627.00**

If the Capital Regional District has any further comment or questions please contact me at the number below.

STANTEC CONSULTING LTD.

Kenneth Jamieson, P. Eng.
Structural Engineer
Phone: 250-388-9161
Fax: 250-382-0514
kennethjamieson@stantec.com

Attachment: Probable Cost Estimates

Stantec

PROBABLE CONSTRUCTION COST ESTIMATE

Structural Short Term Solution

Project: CRD Water Tanks (91 m3) **By:** KSJ

Location: Skana Water System, Mayne Island, BC **Date:** 8-Apr-16

Proj No: 115615379 **Total Cost:** $ 73,000

Item No.	Item Description	Quan.	Unit	Unit Cost	Cost
	Structural Items-Short Term Solution				$ -
1	Steel seimic strapping	4	-	1200	$ 4,800
2	New seismic restraint reinforced concrete slab	27	m3	400	$ 10,800
3	Steel reinforcing (2 layer E/W top and bottom) 15M @ 300 o.c.	857	Kg	8	$ 6,856
4	Steel bracing at saddle supports	8	-	600	$ 4,800
5	Internal liner for each tank	2		4500	$ 9,000
6	Soil disposal off site for foundation work	18	m3	250	$ 4,500

	SUBTOTAL				$ 40,756
	GENERAL REQUIREMENTS				
1	Safety and secuirty			4%	$ 1,630
2	Temporary Services			1%	$ 408
3	Submittals			3%	$ 1,223
4	General Conditions (coordinating subs, job,super,etc)			10.0%	$ 4,076
	TOTAL GEN REQUIREMENTS				$ 7,336
	SUBTOTAL				$ 48,092
	GENERAL CONTRACTOR'S COSTS				
1	GC Home Office Overhead			8.0%	$ 3,847
2	GC Insurance,Payment &Performance Bonds			4.0%	$ 1,924
3	General Contractor's Profit			20%	$ 9,618
	TOTAL GENERAL CONTRACTOR'S COSTS				$ 15,389
	SUBTOTAL				$ 63,482
	Contingency			15%	$ 9,522
	TOTAL				$ 73,004

Note: This estimate is based on unit costs from Means Construction Cost Data.

Stantec

PROBABLE CONSTRUCTION COST ESTIMATE

Plastic Tank Replacement

Project: CRD Water Tanks (113,700 litres)
Location: Skana Water System, Mayne Island, BC
Proj No: 115615379

By: KSJ
Date: 16-Mar-16
Total Cost: $ 158,600

Item No.	Item Description	Quan.	Unit	Unit Cost	Cost
	Structural Items-Long Term Solution				$ -
1	Removal of exsiting tanks	2		2500	$ 5,000
2	Install tank foundation system	3		10000	$ 30,000
3	Install new water tank lines	3		750	$ 2,250
4	Supply tanks and fittings	3		16500	$ 49,500

	SUBTOTAL				$ 86,750
	GENERAL REQUIREMENTS				
1	Safety and secuirty			4%	$ 3,470
2	Temporary Services				$ 3,000
3	Submittals			3%	$ 2,603
4	General Conditions (coordinating subs, job,super,etc)			10.0%	$ 8,675
	TOTAL GEN REQUIREMENTS				$ 17,748
	SUBTOTAL				$ 104,498
	GENERAL CONTRACTOR'S COSTS				
1	GC Home Office Overhead			8.0%	$ 8,360
2	GC Insurance,Payment &Performance Bonds			4.0%	$ 4,180
3	General Contractor's Profit			20%	$ 20,900
	TOTAL GENERAL CONTRACTOR'S COSTS				$ 33,439
	SUBTOTAL				$ 137,937
	Contingency			15%	$ 20,691
	TOTAL				$ 158,627

Note: This estimate is based on unit costs from Means Construction Cost Data.

Stantec

PROBABLE CONSTRUCTION COST ESTIMATE

Steel Glass Lined Tank Replacement

Project: CRD Water Tanks (91 m3)
Location: Skana Water System, Mayne Island, BC
Proj No: 115615379

By: KSJ
Date: 1-Feb-16
Total Cost: $ 298,700

Item No.	Item Description	Quan.	Unit	Unit Cost	Cost
	Structural Items-Long Term Solution				$ -
1	Removal of exsiting tanks	2		2500	$ 5,000
2	Install new tank and foundation system	1			$ 157,000
3	Install new water tank lines	2		1800	$ 3,600

	SUBTOTAL				$ 165,600
	GENERAL REQUIREMENTS				
1	Safety and secuirty			4%	$ 6,624
2	Temporary Services				$ 3,000
3	Submittals			3%	$ 4,968
4	General Conditions (coordinating subs, job,super,etc)			10.0%	$ 16,560
	TOTAL GEN REQUIREMENTS				$ 31,152
	SUBTOTAL				$ 196,752
	GENERAL CONTRACTOR'S COSTS				
1	GC Home Office Overhead			8.0%	$ 15,740
2	GC Insurance,Payment &Performance Bonds			4.0%	$ 7,870
3	General Contractor's Profit			20%	$ 39,350
	TOTAL GENERAL CONTRACTOR'S COSTS				$ 62,961
	SUBTOTAL				$ 259,713
	Contingency			15%	$ 38,957
	TOTAL				$ 298,670

Note: This estimate is based on unit costs from Means Construction Cost Data.

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REPORT TO SKANA WATER SERVICE COMMITTEE
MEETING OF TUESDAY, APRIL 12, 2016

SUBJECT **DRAFT STRATEGIC ASSET MANAGEMENT PLAN FOR SKANA WATER SYSTEM**

ISSUE

To provide the Skana Water Service Committee a draft copy of the Strategic Asset Management Plan for the water system for its consideration.

BACKGROUND

The Skana Water Service Committee (committee) requested that the Capital Regional District (CRD) staff complete the draft Strategic Asset Management Plan (SAMP) with proposed future expenditures to inform the 2017 capital and operating budget preparation.

It should be noted that the capital reserve fund account at the beginning of 2016 was $56,453 and a new capital project of $2,000 was approved for 2016. Accounting for an estimated transfer of $1,970 from the operating budget into the capital reserve fund in 2016, the estimated capital reserve fund balance would be $56,423 at the end of 2016, should there be no unexpected expenditures. The maintenance reserve fund at the beginning of 2016 was $2,545. Accounting for an estimated transfer from the operating budget of $1,000, the estimate maintenance reserve fund balance would be $3,545 at the end of 2016 should there be no unexpected expenditures.

Draft Strategic Asset Management Plan

The scope of the draft SAMP was to identify issues related to aging infrastructure, changes in legislative obligations, level-of-service expectations, financial issues and water quality aspects of the water service. The committee may desire to pursue other issues and direct the CRD staff to review and report back to the committee.

In general, the water system performs well, however the existing storage tanks have reached the end of their service life and are recommended to be replaced. In addition, a few other capital improvements are recommended over the next few years including: well investigation, safety equipment, groundwater and water audit studies. It is also recommended to increase the transfer amount to the maintenance reserve fund and to slightly increase the water quality testing.

Operating Budget Implications (annual):

Maintenance Reserve Fund – A number of the water system valves are not functioning properly (fail to fully close). Although the long term plan is to replace the valves when the water main is scheduled for replacement, it might be necessary to replace some valves prior to the water main if the valves seize up. In addition scheduled preventive maintenance is not conducted for the wells. It is proposed that the well pump(s) and motor(s) be removed for scheduled maintenance every 5 years and at the same time the well should also be inspected. Therefore, it is recommended that the maintenance reserve fund be increased by $1,300 per year in order to fund the valve replacement (when necessary) and well inspections.

Water Quality Budget Implications (annual)
Water Quality Sampling – It is proposed to add pH, turbidity and metals testing of the water, as well as changing the external lab for analyzing disinfection by-products (for total Trihalomethanes). The proposed increase in testing will allow the water quality group to capture more data to characterize and understand the source and treated water in the Skana water system, and will bring this system in line with all of the other Local Service Area small water systems in terms of analytical tests performed. The proposed water sampling plan meets the regulatory requirements and addresses system specific risks to the drinking water quality. It is proposed to increase water quality sampling allocation in the operating budget by $100 per annum, to total $2,700 in the operating budget annually.

Capital Budget Implications

The following summarizes the proposed capital expenditures, the estimated cost and proposed year of completion:

1. Well #13 Investigation $6,000 (2016) – Due to the water quality issue encountered at well #13, CRD staff in consultation with Island Health have recommended investigative work at well #13. Further details are presented in the Skana Water Service Committee staff report "Water Quality Update – Skana Water System", dated April 12, 2016.

2. Safety Equipment $2,000 (2017) –If well #8 is to be used more frequently, than additional eyewash safety equipment and drench hose may be required at this site. To be confirmed by the CRD safety advisor.

3. Groundwater study $10,000 (2017) – Due to the varying levels in the Skana well water level, it is proposed to conduct a high-level groundwater study of the existing aquifer and identify any groundwater protection issues related to the new Water Sustainability Act of 2016. As part of this study it is proposed to conduct a water audit of the system to determine if there are any appreciable leaks in the system and further determine the condition of the PVC pipe and water service connections.

4. Public Engagement/Referendum $10,000 (2017) – A loan will be required to fund the storage tank replacement and any other capital work which will not be included under the capital reserve fund. The proposed loan will require public engagement and a referendum.

5. Storage Tank Replacement $210,000 to 400,000 (2018) - The existing storage tanks are at the end of their design life and do not meet seismic requirements. It is proposed to replace the existing tanks with a glass fused steel tank.

6. Water Quality Study $15,000 (2019) – Due to the adverse water quality event in December 2015 a groundwater study on well #13 and its connected aquifer is proposed to determine any required changes to the treatment process that may be required.

7. Well #8 Upgrade $25,000 (2020) - at present, well #8 is operated manually (requires the operator to attend the site to turn the well pump on and off to fill the reservoir) and additionally does not have SCADA remote monitoring. If the well #8 groundwater source is to be considered a long term water supply, it is recommended that this facility be upgraded to operate automatically and include remote monitoring.

The proposed 2016 and 2017 capital work as noted above totals $28,000. Should the committee decide to complete and fund the proposed 2016 and 2017 work from the capital reserve fund then the balance remaining at the end of 2017 would be approximately $29,593 (includes estimated transfer of $1,170 to capital reserve fund from operating in 2017).

The committee should consider maintaining a capital reserve fund balance using a percentage of the total asset replacement value. Considering that the estimated total replacement value of the water system is in the order of $2,400,000 and its fair condition, a reserve amount in the order of 2 to 5% of the replacement value or $48,000 to $120,000 would be reasonable at this time.

However, the CRD Finance and Technology Department will review reserve fund balances and types to determine the best strategy in order to sustain the service area. The 2017 – 2021 annual implications will be presented in the 2017 service budget. Any major future capital improvements may utilize the reserve amount solely or in combination with an increase in parcel tax and/or supplementary funding opportunities/grants.

ALTERNATIVES

Alternative 1

That the Skana Water Service Committee accept this report and draft Strategic Asset Management Plan and direct the CRD staff to amend the 2016 capital expenditure plan and include the proposed operating and capital expenditures in the draft 2017 Operating and Capital budget for the committee's consideration at the budget meeting later this year.

Alternative 2

That the Skana Water Service Committee accept this report and draft Strategic Asset Management Plan and direct the CRD staff to amend the 2016 capital expenditure plan and revise the proposed operating and capital expenditures in the draft 2017 Operating and Capital budget for the committee's consideration at the budget meeting later this year.

IMPLICATIONS

Alternative 1 – By receiving this report and directing the CRD staff to include the proposed operating and capital expenditures in the draft 2017 Operating and Capital budget the CRD staff will prepare the draft 2017 Operating and Capital budget based on the identified expenditures.

Alternative 2 – By receiving this report and directing the CRD staff to revise the proposed operating and capital expenditures in the draft 2017 Operating and Capital budget the CRD staff will prepare the draft 2017 Operating and Capital budget based on the revised items.

CONCLUSION

A draft Strategic Asset Management Plan has been prepared for the Skana Water Service Committee and overall the water system performs well, however the existing storage tanks are recommended for replacement, and some improvements are proposed over the next five years to improve and maintain the water service.

RECOMMENDATION

That the Skana Water Service Committee accept this report and draft Strategic Asset Management Plan and direct the CRD staff to amend the 2016 capital expenditure plan and include the proposed operating and capital expenditures in the draft 2017 Operating and Capital budget for the committees consideration at the budget meeting later this year.

Scott Mason, B.Sc., P.Eng.
Manager, Water Engineering and Planning
Infrastructure Engineering and Operations

Peggy Dayton
Senior Financial Advisor
Financial Services

Malcolm Cowley, P. Eng.
Senior Manager, Infrastructure Engineering
Concurrence

Ted Robbins, B.Sc., C.Tech.
General Manager, Integrated Water Services
Concurrence

JM/SM/MC:ls
Attachments: 1

SKANA WATER SYSTEM

STRATEGIC ASSET MANAGEMENT PLAN

MAYNE ISLAND, BC

SOUTHERN GULF ISLANDS ELECTORAL AREA

CAPITAL REGIONAL DISTRICT

(Draft – For Discussion with Skana Water Service Committee)

Prepared by: Capital Regional District Integrated Water Services
April 2016

TABLE OF CONTENTS

1.0 BACKGROUND

1.1 Introduction

The Capital Regional District (CRD) identified a need to develop a Strategic Asset Management Plan (SAMP) to ensure that the ability of the Skana water system to deliver water to its customers is maintained and compliant with regulatory standards. A study was approved to determine the quantity, age, condition and approximate life expectancy of the water system assets; estimate the cost to renew or replace infrastructure; and develop a long-term financial plan to fund infrastructure renewal or replacement as required to maintain an acceptable level of service and stable annual cost of service.

A feasibility study and comprehensive review was completed in January 2003 for the Skana water system. The feasibility study identified improvements that were required for the CRD to consider the conversion of ownership from the private utility owner to the CRD.

The following is summarized directly from the 2003 report entitled Skana Water System and improvements to the system are noted on the following page:

1.1.1 Proposed Improvements of 2003

a) <u>Water Source Development</u> – Additional source volume will be necessary for the future growth of the community. Provision of funding for development of this additional capacity at this time is a requirement for the CRD to assume operating responsibility for the system.

b) <u>Disinfection</u> – The existing disinfection system requires upgrading to provide redundancy in equipment and methods of disinfection, chlorine residual measurement, upgrading of control systems, provision of alarm capabilities and provision for safe storage and use of disinfection chemicals. The improvements will also be required for the development of additional sources of water for the subdivision.

c) <u>System Control</u> – Automatic control between the well pumps and the reservoir level is required to eliminate unnecessary operator time to maintain proper operating levels in the reservoirs [tanks]. The control device will permit alarms for pump failure, power outage, low reservoir level or low chlorine residual to be relayed to the operator in advance of the system running short of water.

d) <u>Storage</u> – The existing 20,000 imperial gallon storage [volume] is suitable for the present community use; however, there is limited emergency storage or storage for fire protection available. The provision of a generator for standby power to the pump, or conversely, additional storage and recirculating equipment to ensure ongoing disinfection of the increased storage volume is required. Internal surface coating recoating will likely be required.

e) <u>Pipeline Looping</u> – There would be benefit from looping mains on Waugh and Aya Roads in areas of water quality and capacity for the distribution system.

f) <u>Pipeline Replacement</u> – The system was constructed in the early 1960s with approximately 1,500 m of 100 mm PVC water mains. These mains will need replacing, however replacement when required will probably be undertaken on a section by section basis as a result of increased leakage rather than wholesale replacement of the system. *[Note the system actually includes approximately 2,000m of PVC mains installed in the 1970's]*

g) <u>Clearing Right of Way, System Maintenance</u> – The mains are generally within road allowance; however, there are a couple of areas through existing R/Ws, clearing of vegetation over the pipeline route is recommended to enable access for maintenance and to lessen the potential for future root damage to the pipeline.

A routine maintenance program should be developed to ensure that the various mechanical components operate adequately when required. As well, cleaning the system by pushing a Styrofoam pig through the pipeline to remove slime and debris from within the pipe is considered beneficial.

1.1.2 Completed Improvements Since 2003

The improvements completed to-date since the feasibility study was completed in 2003 include the following:

a) Well Upgrades - Modifications to the primary well #13 including installation of a SCADA monitoring system in 2008 to prevent over pumping to the storage tanks.

b) Water Disinfection Equipment - Addition of ultraviolet (UV) light disinfection at well #13 in 2005 and well #8 in June 2009.

c) System Monitoring - Remote monitoring equipment installed for primary well (#13) and storage tanks in 2005.

d) Storage Tank - Minor storage tank upgrades including external painting, internal flushing of the storage tanks, tank access road improvements, piping changes to improve water circulation, addition of a chlorine recirculation loop and operator safety improvements. The work was completed in 2005 and in 2011.

e) Customer Water Meters - New radio read domestic water meters with dual-check valve assemblies were installed to all properties in 2008.

f) Hydrant Maintenance - Maintenance of fire hydrants started in 2008 and is completed as budget allows.

g) Auxiliary Power Supply – A 6,500 W generator was installed at primary well (#13) in 2007.

h) General system maintenance, leak detection and equipment servicing beginning in 2004.

This SAMP serves to revisit the findings of the 2003 feasibility study, subsequent upgrades and to develop an up-to-date study to identify any system shortfalls to meet the expectations of customers. This study will consider the new legislation and regulations adopted since 2003 and discuss current and proposed level-of-service.

1.2 Regulatory Compliance

The operation and maintenance of a water utility shall be compliant with Provincial and Federal legislation, regulations, guidelines and standards as listed below, but not limited to:

a) Guidelines for Canadian Drinking Water Quality, Health Canada
b) Drinking Water Protection Act and Regulations, British Columbia
c) British Columbia Groundwater Protection Act and Regulations, B.C.(repealed), Water Sustainability Act and Groundwater Protection Regulation (2016) and
d) WorkSafe BC

The Skana water service has many bylaws related to the service including:

a) Skana Water Service Establishment Bylaw No.1, 2003, #3089
b) Southern Gulf Island and Juan de Fuca Electoral Areas Utilities and Street Lighting Fees and Charges Bylaw No. 1, 2015, #3987
c) Water Regulations Bylaw No.1, 1990, #1792

Other guidelines and standards to consider when designing or evaluating a water system may include the following:

a) Design Guidelines for Rural Residential Community Water System
b) CRD Juan de Fuca Water Distribution Engineering Specifications
c) Master Municipal Construction Document Design (MMCD) Guidelines, and
d) Fire Underwriters Survey – Water Supply for Public Fire Protection (FUS)
e) AWWA Standards
f) BC Ministry of Health: "Guidance Document for Determining Groundwater at Risk of Containing Pathogens (GARP)

1.3 Level of Service

The level-of-service that a water system should provide represents a significant factor in determining the required system configuration. The imposition of a large utility model system on smaller utilities can have significant cost implications to the users. The level-of-service can be generally categorized in a few key areas such as; water system production capacity, water quality, water storage volume, system conveyance and pressures, system reliability and fire protection.

The level-of-service to provide average per capita demands, fire protection and water quality generally have the most impact on the water system configuration and associated capital and operating and maintenance costs. There is a mandatory level of service that must be achieved to adhere to legislation and regulations such as the treatment and quality of water versus an optional level of service such as the fire protection and best management practices.

1.4 Study Area

The community of Skana is a rural residential development located on the north side of Mayne Island in the Southern Gulf Islands Electoral Area (see Figure 1.0). The Skana water system is surrounded on three sides by the Lighthouse Point Waterworks District and bounded by Waugh Road on the south. The topography of the area varies in elevation between sea level and approximately 60 m with the majority of properties at or below 30 m elevation. The climate is generally cool and dry in the summer with mild winters and an average annual rainfall of 625 mm.

The Skana water service area is made up of 73 parcels encompassing a total area of approximately 19 hectares. Of the 73 parcels only 46 were connected to the water system as of 2015, any remaining parcels are either not connected to the Skana water system or have their own wells. The service area appears to be composed of rural single family homes with no commercial or industrial areas, for the purpose of this study no proposed land use changes have been assumed. If there are any proposed land use changes then the Skana water system would need to be reassessed.

Figure 1 – Skana Water Service Area, Mayne Island (Bylaw 3089)

2.0 EXISTING WATER SYSTEM

2.1 General

The Skana water system extracts groundwater via two wells, located within CRD owned property; the primary well (#13) located approximately 200 m south of Waugh Road, and the secondary well (#8) between Oyster Bay Road and Sandy Hook Road. Chlorine and UV disinfection are provided at both wells and the secondary well water is also coarse filtered. The disinfected water from well #13 is pumped directly into two storage tanks and then distributed through the mains within the Skana water service area. Well #8, when operational, pumps disinfected water directly into the water distribution system. In addition to owning the property that the current wells are on, the CRD also owns several small parcels of land including a small parcel just west of 491 Waugh Road and two small parcels just south of 502 Bayview Drive. These small parcels may contain old wells and currently have restrictive covenants on them.

Storage tank water level, chlorine residual and water temperature are monitored remotely by way of onsite instrumentation and the CRD SCADA system.

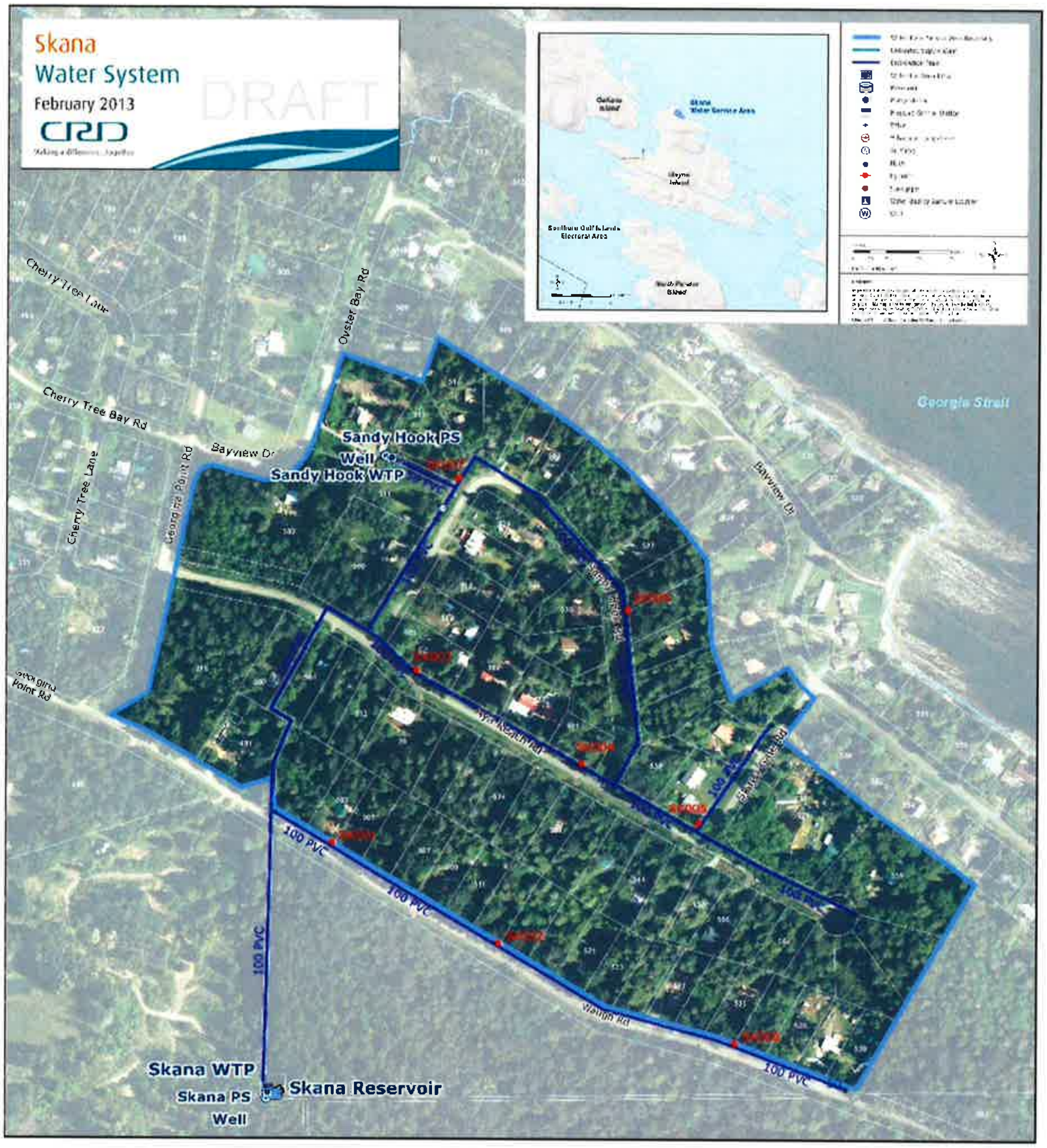

Figure 2- Skana Water System, Mayne Island

2.2 Water Supply

Water Quantity

Historical well log records and pumping test reports from the 1970's estimate that the maximum estimated well yield from primary well #13 is 1.0 liters/second (13 IGPM) and secondary well #8 is 0.4 liters/second (5 IGPM). The production rate of Skana's primary well #13 and secondary well

#8 each have a pumping capacity of approximately 0.4 liters/second (5 IGPM). Secondary well #8 historically has not been used unless water quality or operational concerns with the primary well arise. Well #8 was used due to a water quality concern at the primary well in December 2015. The daily production rate of each well running 24 hours/day is 35 m^3 or 473 litres per lot per day (based on 73 lots within the service area). The annual water production rate and metering demand varies year to year, with 3,281 m^3 produced in 2015, equivalent to an average of 11 m^3 or 232 litres per lot per day (based on 46 lots connected to the system). For a graph of the annual water production and demands for the Skana water system refer to Figure 4 - Skana Annual Water Production and Demand located in Section 3.3.

The CRD measures and records the static ground well water level of the aquifer since 2011 and the trend over the last years indicates that the static water level pattern is fairly consistent with the water level decreasing during the dry summer months and increasing during the rainy fall and winter months. Refer to Figure 3 – Skana Well #13 Static Groundwater Level.

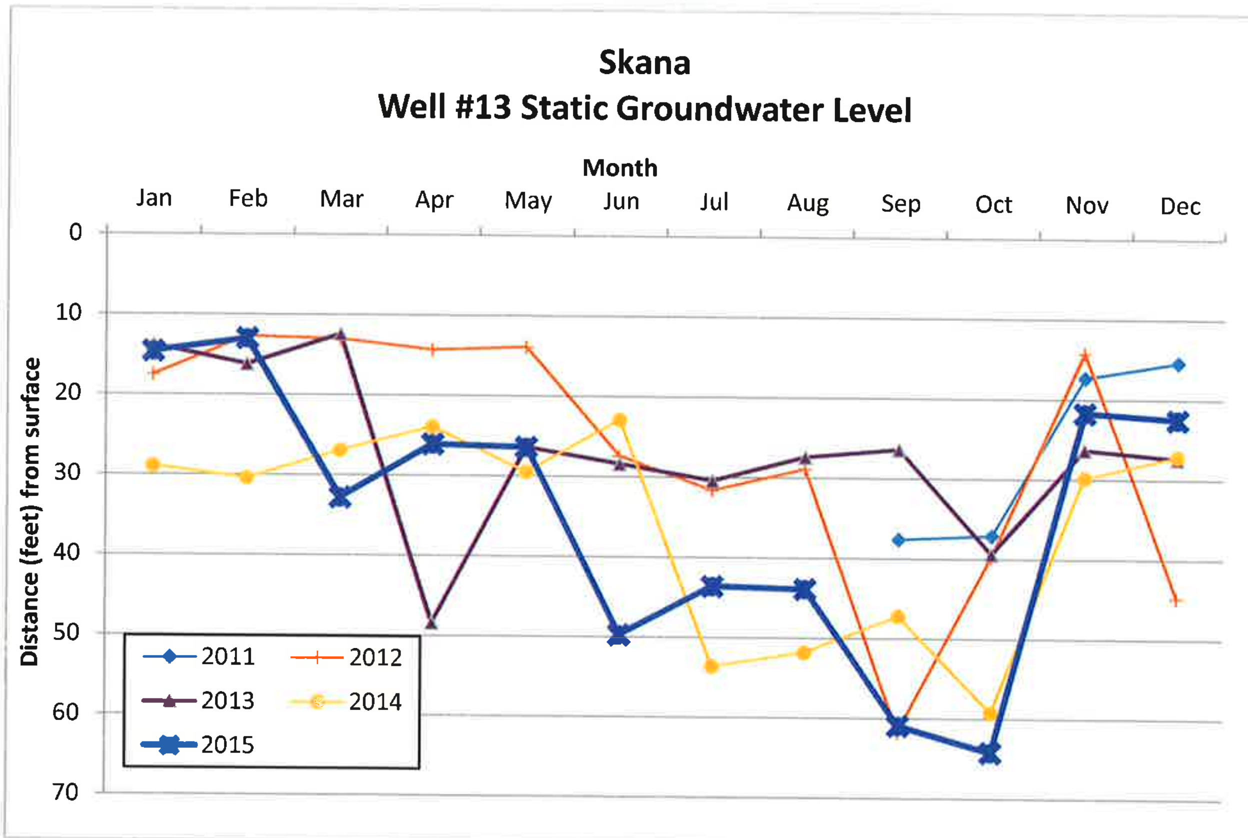

Figure 3 – Skana Well #13, Static Groundwater Level

Water Quality

For years, the well source has provided good quality raw water that typically did not contain any indicator bacteria such as total coliforms or Escherichia Coli (E. coli). The primary well #13 typically produced higher quality raw water than secondary well #8, which occasionally tested positive for indicator bacteria and generally exhibits elevated turbidity levels. However, in December 2015 adverse water quality test results on samples from well #13 and from various stations in the distribution system seem to indicate a change to the source water quality in well #13. The appearance of total coliform and E. coli bacteria in well #13 coincided with heavy rainfall events on Mayne Island. The existing disinfection equipment provided insufficient treatment during this event as evidenced by a number of positive total coliform test results in the distribution system. As a result of this event, the entire water system was temporarily put on a boil water advisory until the distribution system was flushed with highly chlorinated water and subsequently supplied from well #8, which did not experience the same symptoms as well #13. Well #13 was successfully disinfected but tested positive for indicator bacteria again shortly after. In consultation with the Island Health Authority the CRD has proposed to the Skana Water Service Committee further well investigation and possibly rehabilitation work in order ensure that well #13 produces reliably good quality water again. If the well #13 situation is not resolved, well #13 may have to be considered a GARP source with implications for the water treatment requirements based on the "Guidance Document for Determining Groundwater at Risk of Containing Pathogens (GARP)", issued by the BC Ministry of Health.

The treated water in the Skana Water System typically meets all parameters of the Guidelines for Canadian Drinking Water Quality. The modifications made to the water supply since the 2003 Feasibility Study include the addition of UV disinfection to both wells and chlorine injection at the secondary well site. If the recently observed change in raw water quality in well #13 persists, the current level of treatment needs to be assessed and reviewed. The most recent water quality annual report has been included in appendix C

2.3 Disinfection and Treatment

Water from both wells receives chlorine and UV disinfection. Water from secondary well #8 also receives another protection barrier that includes coarse filtration treatment (cartridge filter) due to higher levels of turbidity in the raw water at this location. The following summarizes the major disinfection and treatment equipment:

<u>Primary Well #13</u>
- UV disinfection system
- Sodium hypochlorite system and metering pumps
- Chlorine loop and remote monitoring at the tank site

<u>Secondary Well #8</u>
- UV disinfection system
- Sodium hypochlorite system and metering pumps
- Coarse Filtration (5 micron membrane)

2.4 Storage Tanks

The system has two cylindrical 45.4 m^3 steel storage tanks (total volume 91 m^3) mounted horizontally immediately adjacent to primary well #13. The storage tanks were installed in the early 1970s and are located at an approximate elevation of 50 m, sufficient to provide a residual pressure above 140 kPa (20 psi) to most of the water system during peak demands. In 2005, access to the reservoir site was improved and minor upgrades to the storage tanks were completed, including external cleaning, access and piping changes to improve water circulation and operator safety. The storage tanks are located on CRD owned property, and the CRD has a statutory right of way over an access road located at 492 Waugh Road for operation and maintenance of the tanks. The tanks were cleaned and inspected in 2015.

The 2003 feasibility study identified rusting in the storage tanks. In addition to these tanks being over 45 years old, they are bare steel inside. The CRD staff had proposed a condition assessment of the tanks as part of the 2015 budget which was approved by the committee at its annual general meeting on May 13, 2015. In late 2015 a capital expenditure of $10,000 was used to hire a consultant to evaluate the condition of the storage tanks and determine if rehabilitation of the storage tanks was possible. The consultant concluded that both tanks showed significant signs of internal corrosion and the foundations and connections do not meet current seismic codes and are at risk of failure in an earthquake. Replacement of the storage tanks in the immediate future is the recommended solution. (Refer to Stantec study of February 2, 2016).

2.5 Distribution Mains

The existing system consists of approximately 2,000 m of 100 mm class 160 PVC mains that were installed in the early 1970s. Table 1 – Skana Water Mains, summarizes the size material, year of installation and lengths.

Table 1 – Summary Skana Water Mains

Material	Diameter (mm)	Year Installed	Length (m)
CI(Cast Iron)	100	1970	6
160 PVC	50	1970	61
160 PVC	100	1970	1,910
Total			1,977

The distribution system generally extends from the storage tanks along Waugh Rd; through a statuary right of way to Aya Reach Road and around Sandy Hook Rd where the water mains extend to terminate at the extent of the water service area.

There is limited looping in the small system and there are three "dead end" mains. The looping of mains generally eliminates slow moving or standing water in the system which can lead to water quality issues. All of the mains are within road allowances.

The water system includes other miscellaneous appurtenances, including:

- 46 service connections c/w radio read meter and dual check backflow preventer
- 8 fire hydrants
- 3 standpipes
- 15 gate valves
- 1 air release valve

The produced water volume is metered at both well #13 and well #8 and at each customer's service connection which allows the amount of non-revenue water volume (water losses) to be quantified.

The total volume of water produced in 2015 was 3,281 m^3 and the total water demand of the customers was 2,382 m^3 resulting in a net loss of 899 m^3 or 27% which is considered high for a water system. Water loss generally can result from leakage, water main and tank flushing, illegal connections, water main breaks or use of fire hydrants and standpipes. The CRD has recently begun tracking information on water quantity used for flushing, main breaks, and the use of fire hydrants to determine the net water loss of each non-revenue component in an effort to reduce water loss.

In recent years there have been no significant system leaks observed within the Skana water system.

For a year by year comparison of the Skana annual water production versus demand refer to Figure 4 –Skana Annual Water Production and Demand in section 3.3.

2.6 Supervisory Control and Data Acquisition – (SCADA)

The Skana water service currently has a SCADA system at the well #13 water treatment plant site which includes a radio, remote terminal unit (RTU), transducers/level transmitters to continuously monitor water storage levels, pump run time indicator, BC Hydro power status and equipment monitoring. SCADA monitoring and control functioning is not available at the well #8 site.

The SCADA system transmits water system information by radio telemetry to the CRD Saanich Peninsula duty operator. In an emergency situation (when an alarm is triggered), the duty operator will attempt to contact the on island operator and alert them of the emergency issue for response. In the event the on island operator cannot be contacted, the Saanich Peninsula Duty Operator may need to respond.

2.7 Fire Protection

The Fire Underwriters Survey (FUS) sets out minimum requirements for a water system to be "recognized" for fire protection purposes, is adopted by most municipalities in Canada and is used to set insurance rates. The minimum main size recognized is 150 mm diameter.

> *"In general the gridiron of minor distributors supplying residential districts should consist of mains at least 150mm in size and arranged so that the lengths on the long sides of blocks between intersecting mains do not exceed 200 metres."* – FUS 1999

The minimum fire flow requirement for a rural residential development is 33 l/sec for one hour with a minimum residual pressure of 138 kPa (20 psi). This would require a minimum of 120 m3 to be available at all times from storage for fire protection (i.e. all of the existing volume of 91 m3, with no residual volume for balancing or emergency storage).

The present system has eight fire hydrants. However, the system is undersized to convey sufficient flow (ie., 33 l/sec) to meet fire flow requirements during normal system operation.

The present system has eight fire hydrants, located throughout the water system. However, the system is undersized to convey sufficient flow (i.e. 33 l/sec) to meet fire flow requirements during normal system operation at the minimum required pressure of 138 kPa (20 psi). The existing fire hydrant coverage spacing ranges from approximately 100m to 200m which in some cases is greater than the FUS recommended spacing of 180m for single family residential areas. Further, any fire hydrants required for fire service should be inspected, tested and maintained periodically to ensure they are ready for service.

Rural fire departments will typically be outfitted with a portable reservoir to use as an on-site storage vessel and may achieve accreditation of the superior tanker shuttle service. A fire department's tanker truck will fill the portable reservoir from available sources with the pumper truck drawing water from the portable reservoir to fight the fire. The presence of fire hydrants on a system suggests the availability of water to fight a fire and certainly are a resource in the event of an emergency.

In order to achieve a minimum level of fire protection to FUS throughout the system, a network of at least 150 mm mains would most likely be required plus additional tank storage for balancing and emergency use as indicated above, note an increase in pipe size may result in water quality problems.

If an increase in the level-of-service for fire protection is desired, then the following capital improvements may be considered:

a) Increase storage tank volume,
b) Replace undersized mains and
c) Inspection and replacement if needed of the existing fire hydrants and installation of additional fire hydrants.

2.8 Water Quality

The CRD has developed for the Skana Water System a custom water quality sampling plan that meets regulatory requirements and addresses system specific risks. This plan includes monthly testing of bacterial indicators at various locations, and less frequent testing for parameters such as metals, organic carbons and disinfection by-products and water chemistry parameters. Refer to appendix C for a copy of the latest Skana water quality sampling plan.

Unlike surface water sources, the characteristics of groundwater sources are generally less variable from season to season. Indicator bacteria such as total coliforms or E. coli rarely appear in raw water samples from groundwater wells. Generally, the detection of indicator bacteria, often following a major weather event, indicates contamination of the aquifer through common causes such as inadequate sealing of a well or improper placement of adjacent potential contamination sources.

The risk of aquifer contamination is the primary reason disinfection is provided. Historically, up until December 2015, the Skana Water System primary well #13 has been typically void of any coliform bacteria and usually has very low background bacteria concentrations. Also, specific testing during August 2015 revealed no indication of saltwater intrusion to the well during a period of drought conditions and aquifer drawdown.

Non-coliform or background bacteria are also present within the water main system. While these bacteria are not harmful to human health, when present in large numbers they have the potential to obscure other, more harmful bacteria in samples and cause error detection in the lab. For this reason, a maximum non-coliform bacteria count of 100 colony forming units (CFU) per 100 ml is a guideline the CRD strives to maintain. A residual concentration of chlorine is maintained in the system to control bacteria regrowth inside the distribution system. A periodic non-coliform bacteria count may occur in a section of water main, especially one with very little usage. In such case, the operators would flush that portion of the water main to re-establish the disinfection residual and a re-test is done to confirm the results.

The CRD is committed to deliver drinking water to the Skana water service area that is safe to drink and meets the guidelines set out in the Guidelines for Canadian Drinking Water Quality and the requirements of the BC Drinking Water Protection Act and Regulation, as administered by the Island Health Authority.

2.9 System Operations and Maintenance

At present, the regular operation and maintenance of the water system is performed by a contract operator who resides on Mayne Island. Typical duties for the contract operator include; weekly checks of the water treatment process, chlorine residual testing in the distribution system, minor water system flushing as required; monthly water sampling, minor maintenance activities as required and emergency response duties.

The CRD Operations staff, based out of the Saanich Peninsula operations facility, provide oversight and support to the Mayne Island contractor. Support includes emergency response related to water system leaks or water system operational troubleshooting assistance. Most trouble shooting assistance can be resolved through a simple telephone conversation.

Other operational support includes scheduled preventative maintenance activities including tank flushing and cleaning, hydrant/standpipe inspection/general maintenance and electrical preventative maintenance tasks. During scheduled preventative maintenance activities, corrective maintenance might be required which might lead to capital work and assistance from a variety of CRD trades or outside contractors. Currently operations works to achieve best management practices related to operation and maintenance activities based on available budget, adhering to best management practices should result in improved longevity of assets, reliability and water quality.

3.0 DESIGN CRITERIA

3.1 General

Design criteria used to evaluate the Skana water system have been taken from CRD Design Standards for the Juan de Fuca water system and from the Ministry of Water, Land and Air Protection Water Management Branch, Fire Underwriters Survey, MMCD Design Guidelines Ministry of Health, Guidelines for Canadian Drinking Water Quality in conjunction with the requirements of the Drinking Water Protection Act. The design criteria should be confirmed by the Skana water commission as per the desired level of service before any upgrades are implemented.

These design criteria values are not representative of usage in these smaller water-conscious utilities that rely on groundwater, where historical data represents consumption rates of 1/4 – 1/3 of the values. It is suggested that historical data be used to develop future demands required for the design of supply, treatment and distribution systems. However, for storage tank design it would be prudent to use standard design criteria due to the remote location of the Skana water system and the potential for prolonged power outages (mitigated with auxiliary power at well #13).

3.2 Water Supply

The British Columbia Ministry of Environment, Design Guidelines for Rural Residential Community Water Systems indicates that the dependable yield of the groundwater source must equal or exceed the maximum day demand. The groundwater source should be capable of sustaining this rate of flow continuously for 100 days without recharge by precipitation and without utilizing more than the allowable portion of the available drawdown below the lowest seasonal groundwater table.

The maximum daily well production per well is estimated as 35 m^3 or 473 litres per lot per day (based on 73 lots in service area) as outlined in Section 2.2. This production rate is more than the actual estimated 2014 maximum day demand of 27 m^3 per day or 356 litres per day per active service connection as noted in section 3.3, this demand was the highest summer demand in the last four years.

3.3 Water Demands

As previously noted, water production from both wells is measured as well as customer usage, which allows the amount of non-revenue water production to be calculated. The total production volume for 2015 was 3,281 m^3 and customer water consumption totaled 2,382 m^3. The non-revenue water was therefore 899 m^3 or 27% of total production. This is high for a small system with limited water sources. Most of this loss is likely a result of leakage, water main and tank flushing, water main breaks and use of fire hydrants and standpipes. The metering records also show that the annual water production varies from year to year. Refer to Figure 4 – Skana Annual Water Production and Demand for a graph showing the last four years.

The monthly production rates vary significantly from wintertime lows to summertime highs. As a result of this large variation, the annual production volumes should not be used to establish the average daily demand (ADD) because it may lead to insufficient tank storage design volumes. The ADD for summer provides a more appropriate value to size storage tank volume but is still considered low. It was measured at about 16.4 m^3 per day or 356 litres per day per service connection in June of 2014(highest in the last 4 years).

The estimated maximum day demand (MDD) using 2014 information (2.5 times average day demand) is approximately 27 m^3 or 575 litres per active service connection per day.

The actual water demand rates outlined above are significantly lower than those set out in most design standards. As an example, the CRD's design criteria for ADD for the Juan de Fuca water system is 1,744 litres per lot per day and the MDD is 4,360 litres per lot per day. The lower rates for the Skana water system could be a result of the awareness the community has a limited water source.

The Skana Water System should consider adoption of a water conservation plan and regulations in light of the recent dry weather, concerns of climate change and the observed lower aquifer water level. A water audit and groundwater study should be conducted as described in section 4.2.

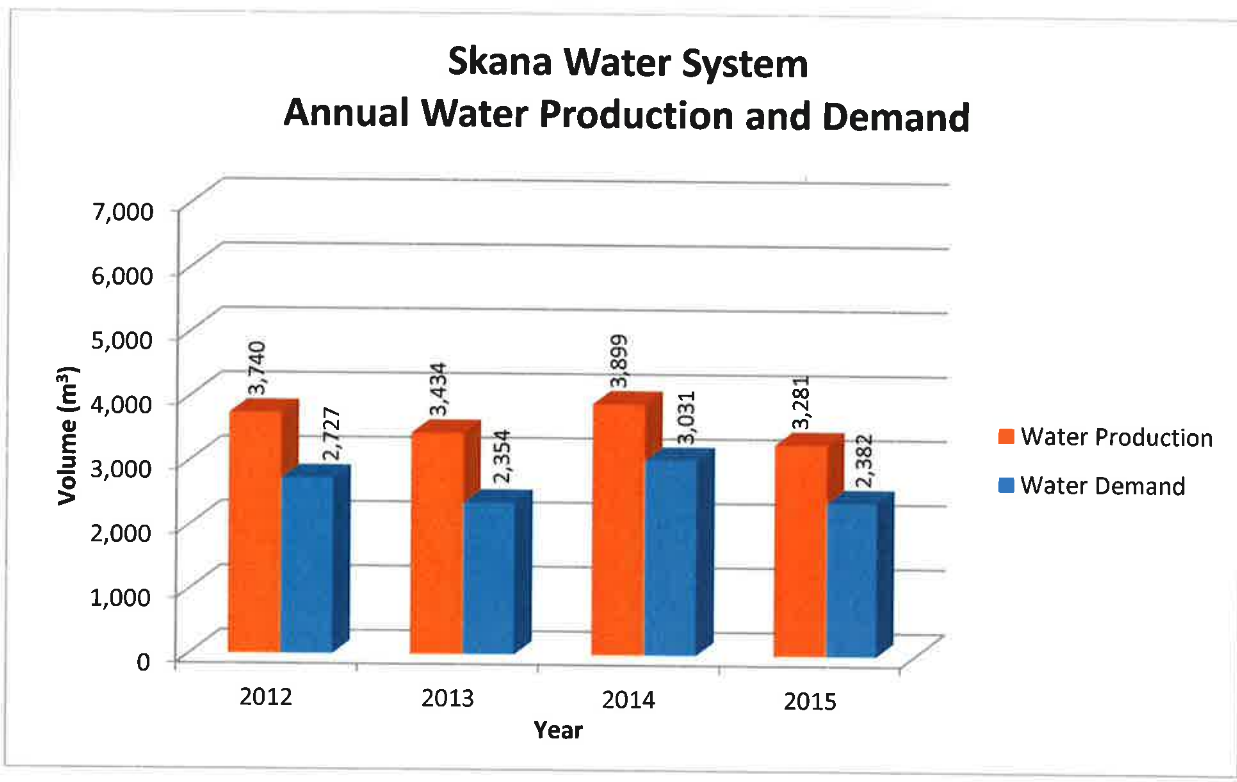

Figure 4 – Skana Annual Water Production and Demand

3.4 Multiple Barrier Approach

The *Multi-Barrier Approach* to safe drinking water is an industry wide accepted risk management approach to ensure that water suppliers provide safe water to their customers. This approach, as described by Health Canada in conjunction with the *Guidelines for Canadian Drinking Water* Quality, addresses risks to the safety of drinking water from the source to the tap. Provincial regulators have incorporated this approach in their conditions, requirements and water treatment objectives. In B.C. the Ministry of Health published in 2015 the document "Drinking Water Treatment Objectives (Microbiological) For Ground Water Supplies in B.C.". This document provides the basic, minimum framework for what is considered acceptable water treatment for ground water supply systems in B.C. based on an assessment of pathogenic risks. The CRD applies the multi-barrier approach to all its water systems and the following 'barriers' are applicable to the Skana Water System:

- **Good Water System Design.** This is the foundation for the protection of water quality and supply. Good system design matches water treatment methods to source water quality and the characteristics of the water supply system, optimizes the efficiency and safety of the water supply infrastructure, and provides for ease of operation, maintenance and monitoring. The CRD was not involved in the original Skana Water System design, but has been committed since 2003 to upgrade and improve the system infrastructure to meet industry standards and best management practices.
- **Protection of Source Water.** Both Skana Water System wells are properly capped and protected on CRD property to prevent any potential contamination through the well installations. A potential offsite groundwater aquifer contamination is however outside CRD's control.
- **Water Treatment.** Provision of treatment processes suitable for the applicable risks to ensure drinking water system meets regulatory requirements. The Skana Water System incorporates an Island Health approved dual disinfection system (UV and Chlorine) to ensure that safe water is produced and delivered to the customers.
- **Maintenance of the Water System.** A systematic maintenance management program ensures that all equipment is maintained at a high level of serviceability. This includes regular water main flushing, valve exercising, leak detection and the cleaning and disinfection of storage tanks. Certified CRD Operations staff applies best management practices to the operations of the Skana Water System.
- **Infrastructure Replacement.** Water supply infrastructure is replaced before it reaches the end of its projected lifecycle. The condition of the infrastructure is regularly assessed to determine if the replacement schedule needs to be modified.
- **Staff Certification and Training.** CRD Integrated Water Services requires its operational staff to have the appropriate levels of certification and receive regular training. The water quality testing laboratory is certified by the BC Ministry of Health.
- **Cross Connection Control.** This program works typically with industries, businesses and institutions to install measures to prevent potentially contaminated water from flowing back into the water supply system. The Skana Water System's primary cross connection risk comes from residential sources. Residential connections constitute a minor risk of introducing contaminants to the water and backflow prevention devises were installed. Due to the small number of exclusively residential water service connections in the Skana Water System, a comprehensive cross connection control program is not considered a priority at this time.
- **Water Quality Testing.** The quality of the water is regularly sampled and tested throughout the water supply and distribution system. The results are reported to the health authorities and the public. This audit ensures that the other barriers are operating in a satisfactory manner and identifies any issues that need addressing.

While some of these barriers require further consideration and improvement, the general concept of this approach enables the CRD to ensure to the public and to the regulatory authorities that the Skana water system is in a position to provide consistently safe water to its customers.

3.5 Storage Volume

The following design criteria have been used to further assess the storage volume requirements for the Skana water system:

1) Average Day Demand – CRD's design standard of 545 litre per capita per day and 3.2 people per lot or 1,744 litres per lot per day. **73 lots equates to 127 m^3** (80 m^3 for 46 lots)

2) Maximum Day Demand – CRD's design standards add a peaking factor of 2.5 to generate an MDD of 4,360 litres per lot per day. **73 lots equates to 318 m^3** (200 m^3 for 46 lots)

3) Peak Hour Demand – The peak hour demand has been used to evaluate the supply main. The peak hour demand is achieved from the storage tank draw down and is approximately three times maximum day demand.

4) Fire Flows – The minimum rural residential demand is 33 l/sec for one hour with a minimum residual pressure of 138 kPa (20 psi) in conjunction with the maximum day demand.

5) Distribution System Pressure – The generally acceptable range of pressure for a water distribution system is between 138 kPa (20 psi) and 820 kPa (120 psi).

6) Storage – There are three major components of tank storage (relates to level of service):

   a) **Equalization** – This is the volume of water required from storage to provide the difference between instantaneous system demand and maximum day demand system requirements which the pumping and treatment components are sized to provide. This amount is equal to 25% of the maximum day demand – **79.5 m^3 for Skana water system**. (50 m^3 for 46 lots)

   b) **Fire Protection** – This is a volume of water set aside in storage equal to the potential fire demand within the storage tank supply area. **The minimum FUS value for a rural residential is 120 m^3**. The Skana water system would require a substantial increase in the current storage volume, and upgrading all the 100 mm mains to 150 mm, as a minimum, in order to meet Fire Underwriters Survey recognized protection levels.

   c) **Emergency** – This is the volume of water held in storage for supply to the water system during extended power outages and is related to typical system demand and duration of outages. The amount is equal to 25% of the equalization and fire demand – **50 m^3 for the Skana Water System**. (43 m^3 for 46 lots) The Skana Water service currently has SCADA monitoring of the storage tanks and an auxiliary generator (Gen-set) hook up at well #13 in the event of a sustained power failure.

Reservoir sizing based on MMCD and rural design guidelines is usually taken as the sum of a + b + c. However, as fire protection for Skana will likely not be considered for the water system, a + c will provide the required storage tank volume. Therefore a total storage of, a + c, or 129.5 m^3 of storage is required to service all 73 lots within the service area, The total existing storage volume is 91 m^3 which does not meet the requirements for equalization and emergency storage based on all 73 lots being occupied and does not meet the requirements for fire storage (minimum rural requirement).

A total of 93 m^3 of storage is required to service the existing 46 lots, the total existing storage volume is 91 m^3 which is just under the requirements for equalization and emergency storage but does not meet the requirements for fire storage (minimum rural requirement). Any water system improvements should consider the effect of servicing all of the lots(73) within the service area.

For comparison storage tank sizing based on actual usage compared to the CRD Juan de Fuca sizing criteria would be as follows.

	Storage Tank Sizing (Volume)			
	CRD Juan de Fuca Water Sizing Criteria		Sizing Criteria based on Historical Usage at Skana(last 4 years)	
	46 Lots	73 Lots	46 Lots	73 Lots
1. Equalization Storage (m^3)	50	80	7	10
2. Emergency Storage (m^3)	43	50	32	33
Total (1+2) (m^3)	**93**	**129**	**38**	**43**
Fire Protection Storage (m^3)	120	120	120	120
Total (including Fire Storage) (m^3)	**213**	**249**	**158**	**163**

Total Existing Storage = 91 m^3

4.0 SYSTEM EVALUATION AND IMPROVEMENTS

The following section assesses the existing water system against the design criteria and standards described in the previous sections and identifies what is required to meet the desired level of service if any shortfalls are present.

4.1 General

The existing water system is approximately 45 years old and the water quality monitoring for the Skana Water System indicates that the system is generally able to produce safe drinking water. Table 4.6.1 summarizes the estimated remaining useful life for each major asset.

4.2 Water Source

In general, the groundwater sources are able to meet the current water demands based on recent metering of weekly, monthly and annual consumption and production rates. Using the present maximum well production rate of well #13 or well #8, one well must operate at least 18 hours per day to meet the current estimated actual MDD of approximately 27 m^3 per day during high summer demands as noted in Section 3.3. Based on current maximum day consumption rates per service connection, the Skana water system would require a daily production of 42 m^3 for the ultimate development (73 lots). Currently the Skana water system could theoretically operate with both well #13 and well #8 at the same time to produce an estimated 50 m^3 per day however it is unknown what the effects of pumping both wells simultaneously would do to the aquifer. Adopting CRD Juan de Fuca design criteria or a similar design criteria would require an increase in well production and may be overly conservative. Studies from the 1970's indicated that the maximum well yield of primary well #13 is 1.0 l/s or 13 IGPM which would equate to 86 m^3 per day.

Well #8, at present, is operated manually (requires the operator to attend the site to turn the well pump on and off to fill the reservoir) and additionally does not have SCADA remote monitoring. If the well #8 groundwater source is to be considered a long term water supply, it is recommended that this facility be upgraded to operate automatically and include remote monitoring

Due to the varying trend in the Skana well water level and aquifer, and the potential of requiring increased pumping capacity from either well if future lots continue to add demand, it is proposed to conduct a high-level groundwater study of the existing aquifer and identify any groundwater protection issues related to the new Water Sustainability Act of 2016. In addition a more detailed ground water study should be conducted to investigate the adverse water quality event in well #13 in December 2015. The study should review the evidence around this event and investigate the source and nature of the observed aquifer contamination and whether similar events can be expected in the future. The scope of the study should also include a well assessment in accordance with the "Guidance Document for Determining Ground Water at Risk of Containing Pathogens (GARP)" and possible implications to the required level of treatment at Skana Water System.

4.3 Disinfection and Treatment

Both production wells used for the Skana water system have chlorine and UV disinfection. The secondary well source also receives coarse filtration. The disinfection and treatment systems are about 10 years old and are in very good condition and no upgrades are required from an operational point of view, although they do require routine maintenance and replacement of consumable equipment (u.v lamps, etc.). Pending the outcome of a groundwater study on well #13 and its connected aquifer, as a result of the adverse water quality event in December 2015, it is possible that changes to the treatment process may be required. A potential change to the risk categorization of the primary well #13 needs to be investigated and any results to be considered in defining treatment objectives for the Skana Water System. If well #13 is to be considered a Groundwater at Risk of Containing Pathogens (GARP) source, then it is possible that the Island Health Authority requires water treatment equivalent to a surface water system which would most likely require additional treatment processes.

Due to the water quality issues encountered at well #13 CRD staff in consultation with Island Health are recommended investigative work at well #13 be undertaken. Further details can be found in the Skana Water Service Committee staff report "Water Quality Update – Skana Water System", dated April 12, 2016.

Related to disinfection process, the CRD's safety advisor had undertaken a review of the facility in consultation with the Worksafe BC officer and had determined that additional emergency eyewash safety equipment and drench hose was required for the safety of the workers at primary well site #13. This work is budgeted and scheduled to be completed in 2016 at a cost of $2,000. If well #8 is to be used more frequently, than additional eyewash safety equipment and drench hose may be required at this site, which will be confirmed by the CRD safety advisor.

In regard to Water Quality Sampling – It is proposed to add pH, turbidity and metals testing of the water, as well as changing the external lab for analyzing disinfection by-products (for total Trihalomethanes). The proposed increase in testing will allow the water quality group to capture more data to characterize and understand the source and treated water in the Skana water system, and will bring this system in line with all of the other Local Service Area small water systems in terms of analytical tests performed. The proposed water sampling plan meets the regulatory requirements and addresses system specific risks to the drinking water quality.

4.4 Storage Tanks

The existing storage capacity of 91 m^3 with the two existing steel tanks is just under the required 93 m^3 design value calculated in Section 3.5 and should be considered sufficient for current users (46 lots), with no fire protection, however at the ultimate development (72 lots) of the Skana water service area the tanks may be considered undersized for emergency and balancing storage as well as having no fire protection.

The recent storage tank assessment undertaken by a consultant (Stantec) concluded that both tanks show significant signs of internal and external corrosion and the foundations and connections do not meet current seismic codes and are at risk of failure in an earthquake. Replacement of the storage tanks in the immediate future is the recommended solution. The proposed temporary fix and long term solutions are as follows:

1. **Temporary Fix:** The temporary fix includes improvements to the supports and connections to withstand an expected seismic event, adding a new liner to the storage tanks to reduce corrosion and improve water quality, and a formal inspection program. Stantec indicates that this is only a temporary fix and will not provide a significant extension to life expectancy; and as such, is not recommended. This solution will not allow for simple expansion of the water supply to accommodate any future connections within the existing water service area. The majority of this cost would not provide any value towards the eventual required tank replacement. The cost for this fix is expected to be in the order of $100,000 including construction, CRD staff time, engineering and contingencies.

2. **Replacement with Glass Fused to Steel Tanks** (Long Term Solution): This is the recommended solution from Stantec and involves replacement of the two tanks with a single glass fused to steel tank, similar to water storage facilities found in many other water systems. The glass fused to steel tanks will meet current seismic requirements, have a life expectancy of approximately 50 years (with regular maintenance). The glass fused to steel tanks are modular and can be expanded vertically to increase volume if, and when the community requires it. In this specific case the tanks would be designed to provide at least the current volume of 91m^3 (to only serve the existing 46 parcels that are connected). This would minimize initial costs, but, the design would include provisions to accommodate all 73 parcels within the service area. The cost for this solution is expected to be in the order of $400,000 including construction, CRD staff time, engineering and contingencies.

3. **Replacement with Polyethylene (Plastic) Tanks** (Long Term Solution): Plastic tanks meet National Sanitation Foundation (NSF) requirements and are suitable for use in potable water systems. This solution involves replacement of the two tanks with two new plastic tanks. The plastic tanks have a reduced capital cost as opposed to a steel or concrete structure and can be designed to meet current seismic requirements. Plastic tanks are still relatively new in potable water systems and as such, life expectancy and long-term effect on water quality is not well known. Stantec has indicated that the life expectancy of plastic tanks can be predicted to be less than the glass fused to steel system. The manufacturer was contacted as part of this process and indicated that several installation in BC had been operating satisfactorily for 30 years. Stantec also indicated that potable water taste could be affected by the plastic tanks. Additional plastic tanks can be added in the future to increase system storage, but additional foundations and piping will be required. Similar to the above option, the initial two tanks would provide the current volume of 91m^3 to minimize initial cost; however, the site design would include provisions for future additional tanks. The cost for this solution is expected to be in the order of $210,000 including construction, CRD staff time, engineering and contingencies.

The per capita flow and number of lots to be ultimately served should be confirmed as part of the preliminary design of the tanks. The tanks should be designed with sufficient capacity to provide peak balancing, emergency storage and if desired, fire protection.

The capital costs allow for replacing the existing tanks with the same volume. An additional 160 m^3 of storage volume would be required in order to provide fire protection for the system and the ultimate development of the Skana Water System in addition to upgrading distribution mains to 150 mm and the installation of additional fire hydrants.

4.5 Distribution System

The existing distribution system currently meets the domestic needs of the community but has 27% unaccounted for, which is considered high for a water system. The distribution system is not designed to provide fire protection to FUS standards. The mains are PVC and reported to have been constructed in the early 1970s, making them almost 45 years old.

Replacement of the distribution system may be necessary over the next 15 to 20 years as unaccounted water is significant. It is proposed to undertake a water audit study to determine if there are any appreciable leaks in the system and further determine the condition of the PVC material.

The system contains a number of dead-end mains that could be interconnected with the rest of the system to improve water flow, remove dead spots and improve water quality, however new water main and statutory right of ways would be required. Routine flushing these dead-end mains is required to ensure chlorine residual and to maintain water quality.

The other distribution components as listed in Section 2.5 should be replaced as part of a main replacement program. Many of these components are as old as the mains. The valves need to be located and those that operate should be exercised regularly. A number of system valves do not fully close and have been identified. The valves that do not work will only be replaced if they are critical to the operation of the distribution system.

The water mains would need to be upgraded to a minimum 150 mm in order to provide fire protection to FUS standards. Negative water quality issues are expected to arise with larger mains and storage volume.

4.6 Prioritization Summary and Recommended Improvements

The following summarizes the recommended strategy for improvements to the Skana Water system that should be considered for implementation in order to ensure that the capacity of the water system to deliver water is maintained, compliant with regulatory standards and financially sustainable. Table 4.6.1 summarizes the estimated remaining useful life for each major asset.

Operating

Maintenance Reserve Fund – A number of the water system valves are not functioning properly (fail to fully close). Although the long term plan is to replace the valves when the water main is scheduled for replacement, it might be necessary to replace some valves prior to the water main if the valves seize up. In addition scheduled preventive maintenance (PM) is not conducted for the wells. It is proposed that the well pump(s) and motor(s) be removed for scheduled maintenance every 5 years and at the same time the well should also be inspected. Therefore, it is recommended that the maintenance reserve fund be increased by $1,300 per year in order to fund the valve replacement (when necessary) and well inspections.

Water Quality Sampling

Water Quality Sampling – It is proposed to add pH, turbidity and metals testing of the water, as well as changing the external lab for analyzing disinfection by-products (for total Trihalomethanes). The proposed increase in testing will allow the water quality group to capture more data to characterize and understand the source and treated water in the Skana water system, and will bring this system in line with all of the other Local Service Area small water systems in terms of analytical tests performed. The proposed water sampling plan meets the regulatory requirements and addresses system specific risks to the drinking water quality. It is proposed to increase water quality sampling allocation in the operating budget by $100 per annum, to total $2,700 in the operating budget annually.

Capital

The following is a summary of proposed capital expenditures in the next five years:

1) Well #13 Investigation $6,000 (2016) – Due to the water quality issue encountered at well #13, CRD staff in consultation with Island Health have recommended investigative work at well #13. Further details are presented in the Skana Water Service Committee staff report "Water Quality Update – Skana Water System", dated April 12, 2016.

2) Safety Equipment $2,000 (2017) – If well #8 is to be used more frequently, than additional eyewash safety equipment and drench hose may be required at this site. To be confirmed by the CRD safety advisor.

3) Ground water study $10,000 (2017) – Due to the varying levels in the Skana well water level, it is proposed to conduct a high-level ground water study of the existing aquifer and identify any groundwater protection issues related to the new Water Sustainability Act of 2016. As part of this study it is proposed to conduct a water audit of the system to determine if there are any appreciable leaks in the system and further determine the condition of the PVC pipe and water service connections.

4) Public Engagement/Referendum $10,000 (2017) – A loan will be required to fund the storage tank replacement and any other capital work which will not be included under the capital reserve fund. The proposed loan will require public engagement and a referendum.

5) Storage Tank Replacement $200,000-$400,000 (2018) - The existing storage tanks are at the end of their design life and do not meet seismic requirements. It is proposed to replace the existing tanks in the immediate future with a glass fused steel tank. Alternatively polyethylene (plastic) tanks could also be utilized, although the consultant does not recommend them because there is little information on their performance over the long term.

6) Water Quality Study $15,000 (2019) – Due to the adverse water quality event in December 2015 a ground water study on well #13 and its connected aquifer is proposed to determine any required changes to the treatment process that may be required.

7) Well #8 Upgrade $25,000 (2020) - at present, well #8 is operated manually (requires the operator to attend the site to turn the well pump on and off to fill the reservoir) and additionally does not have SCADA remote monitoring. If the Well #8 ground water source is to be considered a long term water supply, it is recommended that this facility be upgraded to operate automatically and include remote monitoring.

Item	Capital Cost (year)
• Well #13 Investigation	$6,000 (2016)
• Safety Equipment *	$2,000 (2017)
• Groundwater Study	$10,000(2017)
• Public Engagement/Referendum	$10,000(2017)
• Storage Tank Replacement(steel)	$400,000(2018)
• Water Quality Study	$15,000(2019)
• Well #8 Upgrade	$25,000(2020)
TOTAL	**$468,000**

*To be confirmed by CRD safety officer.

The capital costs are based on estimated costs in 2016 dollars, and includes supply and installation of materials and equipment, engineering, contingency, and indirect costs.

Capital Reserve Account

The replacement cost of the overall Skana including wells, water treatment plants, storage tanks, distribution pipes and appurtenances is estimated to be in the order of 2.4 million dollars.

Summary of estimated replacement costs:

Well Infrastructure (2 wells)	$500,000
Water Treatment Plant(2 plants)	$500,000
Storage Tank(s)	$400,000
Distribution System and Appurtenances	$1,000,000
Total	$2,400,000

The Skana Water Service Committee should consider maintaining a capital reserve fund balance using a percentage of the total asset replacement value. Considering that the estimated total replacement value of the water system is in the order of $2,400,000 and its fair condition, a reserve amount in the order of 2 to 5% of the replacement value or $48,000 to $120,000 would be reasonable at this time.

However, the CRD Finance Department will review reserve fund balances and types to determine the best strategy in order to sustain the service area. Any major future capital improvements such as the storage tank replacement may utilize the reserve amount solely or in combination with an increase in parcel tax and/or supplementary funding opportunities/grants. For consideration, for every $100,000 borrowed at current rates (2.6%) over 15 years there would be an increase in parcel tax of approximately 112 dollars per taxable folio (73) per year.

Table 4.6.1 – Prioritization Summary

Asset	Remaining Useful Life (Years)	Importance	Redundancy	Priority (1 is high)
Well #13	unknown	Needed for service	Well #8	1
Well #13 pump/motor	15	Needed for service		1
WTP/Pump house #13	15	Needed for service	WTP/Pump house #8	1
Well #13 electrical components	15	Needed for control		1
Well #13 Chlorinator	10	Mandatory		1
Well #13 UV	10	Mandatory		1
Well #8	unknown		Well #13	2
Well #8 pump/motor	15			2
WTP/Pump house #8	15	Needed for service	WTP/Pump house #13	2
Well #8 electrical components	15	Needed for control		2
Well #8 Chlorinator	10	Mandatory		2
Well #8 UV	10	Mandatory		2
Well #8 coarse filter	2	Mandatory		2
Storage tank 1	1	Need for demand		2
Storage tank 2	1	Need for demand		2
Distribution System				
Hydrants (8)	20	Needed for public safety	Other hydrants	5
Standpipes (3)	20	Needed for public safety and maintenance		5
Valves (15)	20	Needed for isolation	Other valves, some out of service	4
Water Meters (46)	18(25 total)	Needed for operating information(not used for billing)		5
Watermains and water service lines				
100 mm (PVC)	20	Needed for delivery	No redundancy	2
100 mm (CI)	10	Needed for delivery	No redundancy	2
50 mm (PVC)	20	Needed for delivery	No redundancy	2

Appendix A

SUMMARY OF WATER SERVICE COMMITTEE BYLAWS

- Water Regulations Bylaw No.1, 1792
- Skana Water Service Establishment Bylaw No.1, 2003, 3089
- Southern Gulf Island and Juan de Fuca Electoral Areas Utilities and Street Lighting Fees and Charges Bylaw No. 1, 3987

Appendix B

SUMMARY OF BACKGROUND INFORMATION

- Skana Water System – CRD, January 2003
- Pump Testing of Wells 5, 6 and 8 at Skana Subdivision – E. Livingston, P. Eng, June 1971
- Pump Test of Well #13 – E. Livingston, P. Eng, July 1971
- Island Health Letter of Support – Skana Water System Well #13, Waugh Road Mayne Island, BC, March 17, 2016
- Assessment of Skana Water System Tanks, Mayne Island, BC,- Stantec, February 2, 2016
- Technical Memo – Conclusion and Recommendations for Skana Water System Tanks – Stantec, March 16, 2016

Appendix C

SUMMARY OF WATER QUALITY INFORMATION

- 2014 Untreated(Raw) Water Quality of Skana Well Water
- 2016 Skana Water Sampling Plan – CRD, April 4, 2016

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SKANA WATER SERVICE COMMITTEE
TASK LIST

	TASK	ACTION	STATUS
September 21, 2015 (Budget)			
1.	Bring draft SAMP to committee for review.		
2.	Seek community input on metering and rate structures.	Committee Members	