WILLIAMS ENGINEERING CANADA

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Project Name
Kugluktuk Water Treatment Plant

Type of Project
Raw Water Pipeline Assessment

Project Location
Kugluktuk, NU

Prepared For
Government of Nunavut, CGS

Prepared By
Williams Engineering Canada Inc.

Date Prepared
March 3, 2020

WE File No. 13655.11

P.O. Box 1529, 2nd floor, 4902 - 49 Street | Yellowknife, NT | X1A 2P2

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Appendices

1.0 General

1.1 Facility

The Kugluktuk water treatment system consists of two water treatment plants and a network of pumphouses and pipelines. The old water treatment plant has had most processes superseded by the new plant which was commissioned on March 15, 2018 but there are still functions which rely on it. The raw water pipeline was constructed in 2000 and a branch was added in 2014. The new branch is intended to be the primary supply. The old branch is maintained for redundancy and to support the 'ice shack' function which involves putting a portable shack on the ice to pump water from a hole in the ice.

1.2 Scope of Work

The assessment performed at the site was generally based on American Society for Testing and Materials (ASTM) Standard E2018-08, "Standard Guide for Property Condition Assessments: Baseline Property Condition Assessment Process", and the scope of services outlined in Williams Engineering Canada's proposal dated August 7, 2019.

Our professional evaluation consulting services included trips to the site to collect site-specific data through a visual assessment of major system components. Additionally, we held discussions with plant operators and representatives of the owner. The major components and systems observed include:

- Pipeline **Mechanical Components**, pipelines, pipe materials, fittings, valves, jackets and casings, and insulation.
- Pipeline **Electrical Components**, including heat tracing, and electrical and control wiring installed alongside the pipeline.
- Pipeline **Structural Components**, including pipeline foundations and supports.

Non-destructive testing of pipeline material thickness was made using a Dakota Ultrasonics MX-1 ultrasonic thickness gauge.

Non-destructive electrical testing of heat trace elements was conducted using standard field equipment provided by Ryfan Electric.

It is assumed that the existing building and site development was reviewed and approved by local authorities at the time of construction, and during any subsequent renovations and inspections.

The evaluation identifies conditions that are indicators of distress or equipment operation concern but did not involve detailed examination or specialized testing of components. This report is not intended to warrant the future performance of the building or its systems.

1.3 Field Review

Site reviews were conducted on September 30, 2019 by the following personnel:

Glen Sibbeston, BSc., E.I.T.	WEC	Mechanical
Brandyn Lemoine, E.E.T.	Ryfan	Electrical

Average prevailing weather conditions during the site review were approximately +5°C and clear.

2.0 Reference Material

In this report, reference is made to the “reported” condition of particular systems and/or components, which pertains to information provided by the building’s operations and maintenance personnel or tenants. Reference may also be made to, or Williams Engineering Canada Inc. may have referred to, the following reference material.

Based on the best-available information, the following drawings were accessible for review:

Historical Drawings

- Drawing Set, Water Supply Pump House and River Intake (1984 Modifications,) Record Drawings, prepared by Underwood McLellan Ltd.;
- Water Supply Treatment Plant and Minor Renovations to the Existing Water Supply System 2002, prepared by Ferguson, Simek and Clark Architects and Engineers;
- Drawing Set, Water Supply Improvements – Phase 1 – New Intake and Pumphouse, Record Drawings, Williams Engineering Canada, 2014.

3.0 Method of Evaluation

The development of opinions on the condition of the components or systems comprising this facility are based on our site visit, visual review of selected features, and not on all areas of the facility. The report is based on the conditions present and viewed during the review to obtain a representative impression of the system.

The evaluation was conducted in a manner that incorporated the following:

- Review of the available documentation.
- Visual review of site conditions during one site visit.

- Interviews with operations staff and owner input.

The review occurred during prevailing weather conditions and did not test the capabilities of seasonally operated equipment during climatic extremes. During the site review, photographs of selected representative conditions of the project were made, some of which may have been included for your reference. Destructive testing or exposure of hidden components was not undertaken.

4.0 Definitions

4.1 Opinions of Probable Costs

Opinions of probable costs for repair and/or replacement of components and/or additional investigation of the conditions identified in this report are based on the noted method of evaluation. These opinions are only for general budgeting purposes, since they are based on historical costing information and our experience with similar systems in other facilities.

A detailed or exhaustive examination of quantities/costs of equipment, materials, or labour required for the remedial work has not been performed. Unless otherwise stated, engineering costs for remedial work have not been included in this report.

4.2 Condition Ratings and Site Observations

The physical condition of major systems and/or assets is dependent on whether a physical deficiency is associated with that asset and/or system. The physical condition of the assets and/or systems noted in this report have been rated as either “Good”, “Fair”, or “Poor”. Definitions for these ratings are provided below.

GOOD: The highest level condition rating. No immediate concerns are evident. The components are new and/or recently installed and are adequately maintained.

FAIR: The medium level condition rating. Generally, the components are existing and are adequately maintained. Some minor issues may be noted, and repair/replacement is recommended.

POOR: The lowest level condition rating. Generally, components may have failed, and/or may be at or near the end of their service life, and/or may exhibit evidence of deterioration or insufficient maintenance. Health and safety issues may be items of concern. Recommendations may include urgent repair, replacement or upgrades.

5.0 Expected Service Life of Pipeline Components

5.1 Pipe

The pipeline is mainly constructed of HDPE pipe to ASTM D1248 and with a PPI designation of PE3408. The pipeline system has runs of Dimension Ratio DR-11[1] and DR-9[2] pipe. The DR-11 pipe has a working rating of 160 psi and an allowable surge pressure of an additional 80 psi. The DR-9 pipe has a working rating of 200 psi and an allowable surge pressure of an additional 100 psi. The raw water pumps have a cut-off pressure of 165 psi and should generally operate below 150 psi with further reductions as the pipeline gains in elevation. The operating condition is within the pipe specifications and the pipeline generally sees one pressure cycle per day. Under these conditions HDPE pipes have been shown to endure 10,000,000 pressure cycles so they are not expected to fail due to fatigue. The life expectancy for HDPE pipe of this type, used in this service, is conservatively 100 years[3].

5.2 Insulation

Polyurethane foam insulation has an expected service life of 60 years[4], although the range varies greatly depending on service conditions. In pipeline applications where the jacket protects the insulation from light, weather, and wildlife the insulation may last 100 years. Where the jacket is compromised the insulation deteriorates rapidly and the inner pipe can be exposed in a single season. The insulation is easy to maintain using spray foam which bonds well to the original foam and will last so long as the jacket is also maintained.

5.3 Electrical Service

Metal Clad (MC) cable with PVC jacket is expected to have a “useful life” of 50 years[5] under the conditions found on site.

5.4 Heat Trace

Self-regulating heat trace of the type installed has a “useful life” of 20 years[6]. Heat trace in original (1990) sections of the pipeline which are now 30 years old have mostly failed. In the last 3 years

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1 Dimension Ratio 1:11, nominal 150 mm (6-inch) HDPE DR-11 Pipe has a diameter of 168 mm and wall thickness of 15.3 mm
2 Dimension Ratio 1:9, nominal 150 mm (6-inch) HDPE DR-9 Pipe has a diameter of 168 mm and wall thickness of 18.7 mm
3 https://plasticpipe.org/pdf/tn-27-faq-hdpe-water-transmission.pdf
4 http://www.sprayfoam.org/files/docs/SPFA%20LCA%20Long%20Summary%20New.pdf
5 https://www.chromalox.com/-/media/files/catalog/resources/en-us/dg-pj33.pdf
6 https://www.chromalox.com/-/media/files/catalog/resources/en-us/dg-pj33.pdf

there have been fires caused by the failed heat trace indicating they have remained in service past their service life.

6.0 Pipeline Descriptions

The original pipeline was steel and was built around 1980. There was a pipeline realignment project circa 2000 where the pipeline was replaced with the current HDPE pipe system which we refer to herein as the 'original branch'. A new pumphouse and intake was added further downstream in 2014 which we refer to as the 'new branch.'

The pipeline has three sections: the original branch (2000) runs 382 meters from the old Water Treatment Plant (WTP) to an inlet screen submersed in the Coppermine River, with meter 0 being at the old WTP. There is a 20-meter tee from the Old Pumphouse to Access Vault 1 which is used with the ice shack. The new branch (2014) joins the original at Access Vault 3 (meter 228) and continues for another 243 meters to a pair of intakes in the Coppermine River. There is an interconnect between the old WTP and the new WTP which consists of three pipes (150 mm raw water, 100 mm treated water, 50 mm recirc) and is 153 meters long. The network therefore consists of 798 meters of pipeline, some of which is duplexed or triplexed. A plan drawing of the facility is included as Appendix A.

The 2014 upgrade project was meant to replace the original branch. To date, the new branch intakes have not had access to fresh river water year around. As a result, the original branch has been used every winter with an 'ice shack.' Both branches must remain in operation for year around supply of fresh river water to the community.

6.1 Original Branch

6.1.1 <u>Original Branch Construction</u>

The original branch raw water pipeline consists of a 150 mm (6") HDPE pipe encased in 100 mm (4") rigid foam insulation. The insulation is jacketed in 3 mm (1/8") poly shell. The assembly is contained in a 550 mm (22") corrugated steel culvert which is split and has bolt fasteners at 100 mm (4") intervals. A chase containing the heat trace element is cast in the foam insulation just below the HDPE pipe. The chase appears to be 50 mm (2") PVC pipe, thermo-formed into a rough oval which gives better thermal contact with the HDPE pipe than if it was left round. See Figure 1.

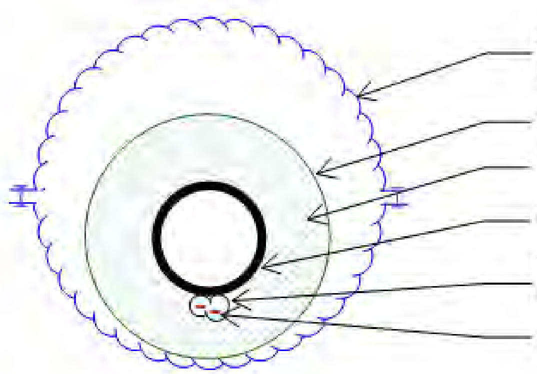


Figure 1: Raw Water Pipeline Cross Section (2000 branch)

6.1.2 Original Branch Condition

The original branch is now 20 years old, the remaining life with ongoing maintenance should be 80 years as detailed in section 5.1. Notwithstanding the following, it should be noted that most of the original branch is in good condition.

Thickness measurements were taken, and it was found that wall thickness exceeds the new specification. This is interpreted to mean that the pipe was manufactured slightly thicker than specified and that the service conditions are not causing any reduction in thickness. Thickness measurement data is included as Appendix B.

	
Photo 1: Burned tee to old pumphouse.	Photo 2: Tee removed, original pipeline now terminates only at the Old Access Vault 1.

The corrugated steel culvert case is in good condition and the granular cover is consistent and adequate.

A short section of pipeline was destroyed by fire; the fire was caused by failure of the heat trace. Fire is a risk whenever heat trace is water damaged or kept in service longer than the manufacturer recommends. A tee and short branch of pipeline to the old pumphouse is not currently connected to the pipeline as a result (Photo 1.) The tee has been replaced with a straight piece of pipeline and now terminates only at the Old Access Vault 1 near the Coppermine River (Photo 2.) This branch is currently used with the 'ice shack' to pump fresh water when the new intakes are suffused with sea water. The Old Pumphouse is not usable with this configuration so a new tee should be installed.

	
Photo 3: Elevated pipeline is supported on columns and concrete pads.	Photo 4: Frost action has caused supports to become uneven.

The culvert emerges from the granular cover about 30 meters up from the old pumphouse; there is a steep rock outcrop which necessitates a change from buried to overhead support. There are steel columns supporting the pipeline for this portion, two are resting on concrete columns and two on concrete pads (Photo 3.) The concrete pads have moved through frost action and support of the pipeline is not straight and even (Photo 4.) The pipeline appears not to have suffered ill effects from this but some of the supports are overloaded and straightening is required. The supports have height adjustment holes and pins so straightening should not be time-consuming or difficult. The concrete pads are losing granular support on the downhill side so granular should be added (Photo 5.) The pads still appear to be level.

	
Photo 5: Concrete pads are losing granular support.	Photo 6: Steel casing and jackets damaged at the road crossing.

The intake lines from the Old Pumphouse to the Coppermine River are not currently serviceable as they are fouled with silt. They could be returned to service by clearing the intakes which may be as simple as reverse-flowing them. The steel casing and poly jackets have been damaged by heavy equipment where the road crosses just downhill from the Old Pumphouse (Photo 6.)

6.2 New Branch

6.2.1 New Branch Construction

The new raw water branch (2014) has three variants of pipeline. The run from the branch to the New Pumphouse is a manufactured product called 'Spiwrap' by Urecon (Photo 7.) There is a 150 mm (6") DR-9 HDPE pipe encased in polyurethane foam insulation and jacketed in 22-gauge galvanized steel. The jacket has an outward dimension of 279 mm (11") and provides 55 mm (2.188") insulation thickness. There is a heat trace chase with a roughly square section about 25 mm on a side which is cast with one side touching the outer pipe surface. See Appendix C for product submittal information.

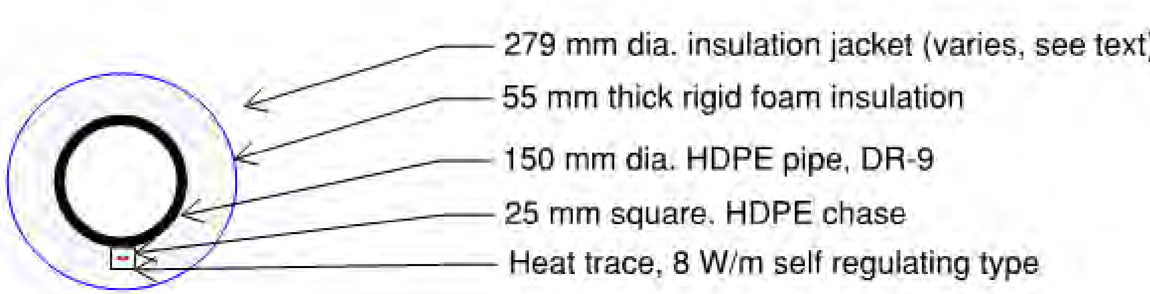


Figure 2: Raw Water Pipeline Cross Section (2014 branch)

The run from the New Pumphouse to Access Vault 2 is a similar product but with a spiral poly tape wrap over the insulation instead of steel (Photo 8.) From the New Pumphouse to the river intakes the pipelines are accompanied by compressed air lines (blue jacket) for intake screen blowout.

Photo 7: Pipeline uphill of the New Pumphouse.

Photo 8: Pipeline downhill of the New Pumphouse. Compressed air line with light blue jacket.

The two parallel runs from Access Vault 2 to the river are 355 mm (14") casing pipe with 50 mm (2") insulation. The casings contain 100 mm (4") HDPE pipes with pumps mounted on the wet ends where the river depth first reaches 3.5 meters. The 355 mm casing pipes continue approximately another 20 meters where they terminate with intakes. There is no chase, but the heat trace is wrapped around the inner pipes.

6.2.2 New Branch Condition

The new branch is 6 years old, the remaining life with ongoing maintenance should be 94 years as detailed in section 5.1. The corrugated steel culvert case is in good condition and the granular cover is consistent and adequate. The new branch is generally in good condition, with exceptions noted below.

Thickness measurements were taken, and it was found that wall thickness exceeds the new specification. This is interpreted to mean that the pipe was manufactured slightly thicker than specified and that the service conditions are not causing any change in thickness. Thickness measurement data is included as Appendix B.

There is a wide-flange steel beam segment used as a support for the pipeline just outside the New Pumphouse in the uphill direction (Photo 7.) The beam appears to be frostjacking and is exerting upward force on the pipeline. The support should be removed, and a surface support should be installed in its place which would stop the frostjacking. Damage to the jacket and insulation should be repaired.

The segment from the New Pumphouse to Access Vault 2 is in good condition and no action is required Photo.

	
Photo 9: Pipeline uphill of Vault 2 is in good condition.	Photo 10: Pipeline downhill of Vault 2 has split insulation at the exit.

The segment downhill from Access Vault 2 is in good condition except for immediately at the exit from the vault. Both lines have a split in the insulation on the top half of the pipe. This may be caused by differential movement of the vault relative to the pipeline so the vault should be monitored for level and potential frostjacking. The split insulation and jacket should be repaired.

6.3 Description of Raw Water Pipeline Electrical

Electrical service is installed alongside the original branch and new branch pipelines. The interconnect pipeline does not have electrical service associated with it as the new water treatment plant has overhead electrical service.

The pipelines have electric heat trace freeze protection. The heat trace is self-regulating type, generally 8 Watts per meter. WEC hired Ryfan Electric to inspect and test the heat trace system. Their report is attached as Appendix D. WEC has reviewed the report and agrees with the conclusions regarding the condition of each heat trace string.

6.3.1 Condition of Original Branch Electrical

There is 600 Volt service installed alongside the original branch pipeline which runs between the old water treatment plant and the old pumphouse. There is also a bundle of control wires which run along this route and buried alongside the service. The service and control wires are Metal Clad (MC) type which has an expected service life of 50 years and should last for another 30 years. Heat trace along the original branch is in poor to unserviceable condition. The condition of the heat trace has caused at least three fires, with one of them requiring replacement of a tee and length of pipe. All the heat trace requires immediate replacement. See Appendix D for details.

Heat trace in the original branch runs in an irregular chase (see section 6.1.1 and Figure 1) which will likely cause trouble for an electrician installing new heat trace. The old heat trace may prove difficult or impossible to remove by pulling on one end. It may also be difficult to thread a new strand just using fish tape. Replacement may involve unearthing, opening the steel casing, cutting through the insulation and cutting opening the plastic chase to clear obstructions. A considerable contingency amount should be allowed for when budgeting this item. A note should be made on construction documents to alert contractors.

6.3.2 Condition of New Branch Electrical

There is 600 Volt service installed alongside the new branch pipeline which runs from Access Vault 3 to the new pumphouse. Pump feeds continue to Access Vault 2. The MC wiring has an expected service life of 50 years and should not require replacement for another 44 years.

Heat trace along the new branch is in good condition with the following exceptions: One string uphill from the New Pumphouse was water-logged and the controller was also damaged by water; this string and controller requires replacement. Heat trace installed on the 100 mm (4") pump mounting pipes have been exposed to the elements and mechanical damage and should be replaced.

6.4 Old Pumphouse

The Old Pumphouse was constructed in 1980 with upgrades in 1984. The New Pumphouse was intended to replace this pumphouse when it was completed in 2014, but to date it has not been decommissioned due to problems with sea water at the new intakes and because it feeds electrical power to Access Vault 1 which is still used with the 'ice shack.' The Old Pumphouse is not currently connected to the pipeline system due to the fire noted in section 6.1.2.

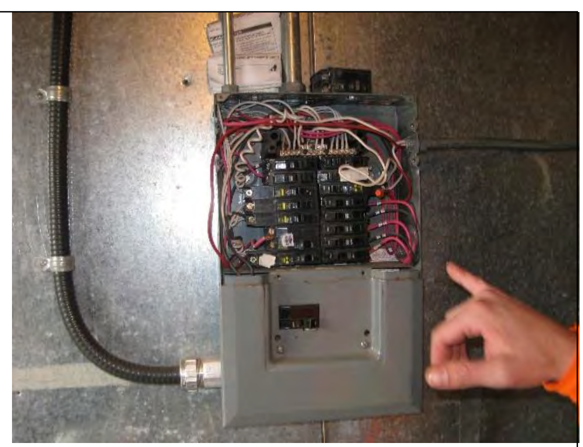
6.4.1 Condition of Old Pumphouse Mechanical

Mechanical components consist of pipeline connections, valves and pumps and are generally in fair condition. One of the pumps has been removed to be used with the ‘ice shack’ and should be replaced if the Old Pumphouse is to be retained for redundancy.

	
Photo 11: Old Pumphouse is in fair condition.	Photo 12: Mechanical equipment in the Old Pumphouse is in fair condition. One of the pumps has been removed.

6.4.2 Condition of Old Pumphouse Electrical

The Old Pumphouse has 600V service from the Old Water Treatment Plant. The raw water pumps are fed from the building as well as a 240V panel which serves lighting, outlets and heat tracing. The electrical equipment is in fair to poor condition with several items not meeting current code.

	
Photo 13: 600V equipment for raw water pumps.	Photo 14: 240V panel needs front cabinet.

6.5 Old Access Vault #1

The Old Pumphouse was constructed circa 1984 And is generally in poor condition. This pumphouse was intended to be replaced by the New Pumphouse when it was completed in 2014, but to date has not been decommissioned due to problems with sea water at the new intakes and because it feeds electrical power to Access Vault 1 which is still used with the 'ice shack.' The Old Pumphouse is not currently connected to the pipeline system due to the fire noted in section 6.1.2.

	
Photo 13: 600V equipment for raw water pumps.	Photo 14: 240V panel needs front cabinet.

6.5.1 <u>Condition of Access Vault #1 Electrical</u>

The Old Pumphouse has 600V service from the Old Water Treatment Plant. The raw water pumps are fed from the building as well as a 240V panel which serves lighting, outlets and heat tracing. The electrical equipment is in fair to poor condition with several items not meeting current code.

6.6 Access Vaults #4 and #5

Access vault #4 is part of the original pipeline and contains valves and a tee for directing flow to the old water storage pond. Access vault #5 is part of the new interconnect pipeline and contains elbows and shut-off valves. Heat trace running along each of the pipes is evident in vault #5.

	
Photo 15: Vault 4 (center) and Vault 5 (top left).	Photo 16: Vault 5 contains elbows and shut-off valves. Note heat trace.

6.6.1 Condition of Access Vaults #4 and #5

Vault #4 is in fair condition; no action is required.

Vault #5 is in good condition; no action is required.

6.6.2 Possible Interconnect of Vaults #4 and #5

It would be straightforward to connect the 150 mm raw water pipeline from vault 4 directly to vault 5. Approximately 5-8 meters of new pipeline would be needed. This would allow the Old Plant to be decommissioned and frozen with no impact on raw water delivery to the New Plant.

Changes to the electrical service and controls would be necessary before fully decommissioning the Old Plant and they could be done at the same time or later.

7.0 Recommendations

Due to an accumulation of defects to the pipeline and associated systems, WEC recommends a restoration project to effect repairs and upgrades. The construction tasks are listed in these recommendations. A construction opinion of probable cost is also included. Additional engineering would be required to produce construction documents suitable for a construction contract.

7.1 List of Construction Tasks

7.1.1 Replace Heat Trace

Heat trace that is damaged or has been in service for more than 20 years should be replaced immediately. All observations of heat trace failures made in the Ryfan report (Appendix D) are recommended for replacement.

7.1.2 Repairs to Fire Damaged Tee at the Old Pumphouse

The damaged Tee at the Old Pumphouse should be replaced with a new tee fitting and new pipe to the extent of the damaged area.

7.1.3 Adjustment and Maintenance of Pipe Supports

Pipe supports just uphill of the Old Pumphouse should have granular added to prevent further erosion. Height adjustments should be made to straighten the elevated section of the pipeline.

7.1.4 Replace Pipe Support Just Uphill of New Pumphouse

The pipe support noted in section 6.1.2 is frost jacking and damaging the pipeline. This should be removed and replaced with a new grade-supported arrangement. The jacket and insulation should be repaired where it has been damaged.

7.1.5 Old Pumphouse Pump and River Pipeline Repairs

One of the pumps from the old pumphouse has been removed for use in the Ice Shack. Since the Ice Shack has proven to be an operational necessity a new pump should be provide for the old pumphouse. The River Pipeline cases should be repaired to prevent damage to the pipeline.

7.1.6 Old Pumphouse Electrical

The 208V electrical panel in the Old Pumphouse should be replaced. An outlet with switching should be provided to Access Vault 1 for operation of the Ice Shack pump.

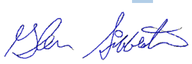
7.1.7 Interconnect of Access Vaults #4 and #5

The interconnect of vaults #4 and #5 would allow decommissioning of the old Water Treatment Plant. Connecting the vaults with a new length (about 8 m) of HDPE pipe would allow water to pump directly to the New Plant. Relocating the 600 Volt electrical service to the New Plant or establishing a new outdoor 600 Volt service would also be necessary. Redirecting the pump controls would be the costliest aspect but this would make complete operation of the plant including raw water pumps possible from the New Plant. This is recommended, with low priority, since it simplifies the system and eliminates the need to heat the Old Plant.

8.0 Closure

This report has been prepared based upon the information referenced herein. It has been prepared in a manner consistent with good engineering judgement. Should new information come to light, Williams Engineering Canada Inc. requests the opportunity to review this information and our conclusions contained in this report. This report has been prepared for the exclusive use of Government of Nunavut, CGS, and there are no representations made by Williams Engineering Canada Inc. to any other party. Any use that a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties.

Prepared by,



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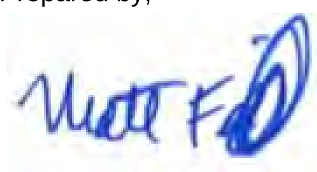

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Appendix A

Drawing C100 Kugluktuk Water Treatment Plant

Raw Water Pipeline Assessment

KEYNOTES:

1. OLD WATER TREATMENT PLANT
2. OLD RAW WATER STORAGE POND
3. OLD TREATED WATER STORAGE (TWS-1, TWS-2)
4. NEW WATER TREATMENT PLANT
5. INTERCONNECT PIPELINE (150 mm RAW WATER FILL, 100 mm TWS, 50 mm TREATED WATER RECIRC)
6. ACCESS VAULT 1, CONNECTION FOR ICE SHACK
7. ACCESS VAULT 2
8. ACCESS VAULT 3, TEE CONNECTION BETWEEN ORIGINAL BRANCH AND NEW BRANCH
9. ACCESS VAULT 4, ORIGINAL PIPELINE
10. ACCESS VAULT 5, INTERCONNECT PIPELINE
11. OLD PUMPHOUSE
12. OLD RAW WATER INTAKE WITH SCREEN
13. NEW PUMPHOUSE
14. NEW RAW WATER INTAKES WITH SCREENS

CONNECTION LOCATION DATA

CONNECTION	COORDINATES	STATION
1	N: 7524383.32 E: 580600.34	0+000 3+000
9	N: 7524332.35 E: 580592.50	0+051.50
CP1	N: 7524323.81 E: 580591.38	0+060.11
CP2	N: 7524281.97 E: 580615.19	0+108.25
CP3	N: 7524236.00 E: 580613.83	0+154.25
CP4	N: 7524173.30 E: 580652.11	0+227.45 1+000
CP5	N: 7524084.84 E: 580666.23	0+317.28 2+000
11	N: 7524083.35 E: 580658.94	0+324.72
12	N: 7524028.27 E: 580673.74	0+381.75
13	N: 7524150.36 E: 580679.92	1+036.62
7	N: 7524114.01 E: 580785.26	1+151.90
14	N: 7524072.00 E: 580841.00	1+243.26
6	N: 7524075.17 E: 580683.43	2+019.73
10	N: 7524328.99 E: 580597.21	3+054.47
4	N: 7524318.55 E: 580693.94	3+153.04

COORDINATES SHOWN ARE IN UNIVERSAL TRANSVERSE MERCATOR (UTM) ZONE 11W, CENTRAL MERIDIAN 117° WEST (NAD83), SYSTEM

REVISIONS

NO.	DESCRIPTION	YYYY.MM.DD	BY	APP.
0	ISSUED FOR REPORT	2020.02.28	HB	GS

REFERENCE DRAWINGS

DRAWING NO.	DESCRIPTOR

FOR BEST PLOTTING RESULTS, BE SURE TO USE WILLIAMS ENGINEERING CANADA AUTOCAD PLOT CONFIGURATION FILES AVAILABLE FROM: www.williamsengineering.com

LEGEND

SECTION # / SOURCE / REFERENCE DWG. — DETAIL # / SOURCE / REFERENCE DWG.

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WILLIAMS ENGINEERING CANADA

CLIENT: Nunavut

JOB. TITLE:

KUGLUKTUK WATER TREATMENT PLANT RAW WATER PIPELINE ASSESSMENT

KUGLUKTUK, NU

DWG. TITLE:

APPENDIX A

DWN. BY: MP	DES. BY: SC	PROJ. MGR.: S.C.
PEER REVIEW: EP	DATE: (YY-MM-DD) 2019.10.03	SCALE: 1:750
CLIENT PROJ. #		WEC PROJ. # 13655.11
DWG # C100	OF 1	REV # 0

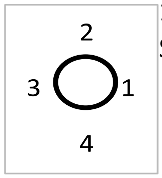
Appendix B

Pipeline Thickness Measurement Data

Kugluktuk Water Treatment Plant
Ultrasonic Thickness Gauge Measurements
Corrections to HDPE material due to instrument calibrated for steel

Speed of Sound in material

V-steel	V-HDPE	
5920	2388	m/s

No.	Location	Material	Diagram	Description	Position	T-measured	T-calculated	T-nominal	Variance
1	Old WTP	Steel		100 mm	1	6.13	6.13	6.02	0.11
				Sch. 40	2	6.00	6.00	6.02	-0.02
					3	5.98	5.98	6.02	-0.04
					4	6.02	6.02	6.02	0.00
2	Vault 1	HDPE	as above	150 mm	1	38.28	15.44	15.3	0.14
				DR-11	2	37.85	15.27	15.3	-0.03
				Inlet	3	38.08	15.36	15.3	0.06
					4	38.07	15.36	15.3	0.06
		HDPE	as above	Outlet	1	38.18	15.40	15.3	0.10
					2	37.51	15.13	15.3	-0.17
					3	37.72	15.22	15.3	-0.08
					4	38.35	15.47	15.3	0.17
3	Vault Tee	HDPE	as above	150 mm	1	40.67	16.41	15.3	1.11
				DR-11	2	40.95	16.52	15.3	1.22
				Uphill	3	40.96	16.52	15.3	1.22
					4	41.17	16.61	15.3	1.31
4	Old Pumphouse	HDPE	as above	150 mm	1	39.13	15.78	15.3	0.48
				DR-11	2	39.49	15.93	15.3	0.63
				Uphill	3	38.56	15.55	15.3	0.25
					4	39.10	15.77	15.3	0.47
		HDPE	as above	Downhill	1	42.40	17.10	15.3	1.80
					2	40.88	16.49	15.3	1.19
					3	40.80	16.46	15.3	1.16
					4	41.08	16.57	15.3	1.27

*field notes held on file by WEC

Appendix C

Pipeline Construction Submittal Data

Submittal Data

High Density Polyethylene Pipe (I.P.S. dims)

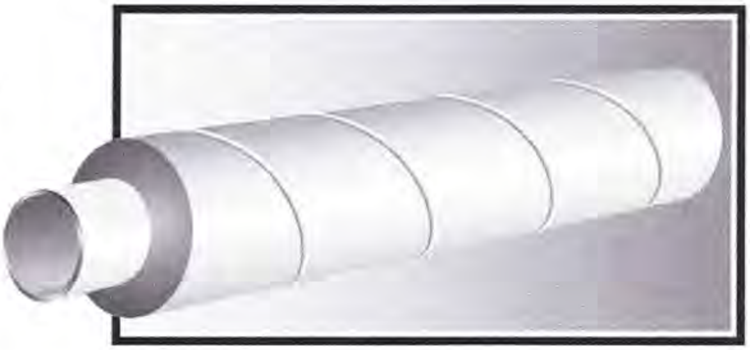
General
Pipe shall be high density polyethylene manufactured of PE 3408 materials as per ASTM F-714. The product shall comply with AWWA Standard C-901 (12mm-75mm *(1 ½ in.-3 in.)*) and C906 (100mm-1600mm *(4 in.-63 in.)*). The product shall also comply with NSF Standard 61 and/or Standard 14, and must be certified by the NSF for portable water.

Material
Materials used for the manufacture of high density polyethylene pipe and fittings shall comply with all requirements for Type III, Class C, Category 5, Grade P34 according to ASTM D1248, and have a PPI recommended designation of PE3408. Pipe shall further meet ASTM D3350 General Cell Classification of 345444C. The raw material shall contain a minimum of 2%, well dispersed, carbon black. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification and from the same raw material supplier. The pipe manufacturer shall provide, upon request, an outline of quality control procedures performed on polyethylene system components. The pipe shall have product traceability; this shall be accomplished by the inclusion of a product code into the printline of all products.

The printline shall notate the manufacturer, the date of manufacture, the lot and supplier of raw material, the location of manufacture, and the production shift on which the product was produced.

Joining Methods
Wherever possible the polyethylene pipe should be joined by the method of thermal butt-fusion, as outlined in ASTM-D2657, Heat Joining Polyolefin Pipe and Fittings. Butt-fusion joining of pipe and fittings shall be performed in accordance with the procedures recommended by the manufacturer. The polyethylene pipe may be adapted to fittings or other systems by means of an assembly consisting of a polyethylene stub-end butt-fused to the pipe, a back up flange of ductile iron made to Class 150, ANSI B16.5 dimensional standards with bolts of compatible material and suitable gasket. In all cases, the bolts shall be drawn up evenly and in line. No pipe or fittings shall be joined by fusion by any contractor unless he/she is adequately trained and qualified in the techniques involved. Polyethylene pipes of the same outside diameter but different wall thickness shall be joined by means of a flange assembly as designated above. Mechanical fittings acceptable for use with polyethylene pipe shall follow the recommendations of the mechanical fittings manufacturer.

Submittal Data



Standard
Spiwrap® system
for pipe with plain ends

Urecon's "U.I.P."® factory insulation piping process and related ISO-9000 quality control procedures assure you of the highest quality product on the market today. A galvanized steel, aluminum or stainless steel locked seam metal jacket protects the system once the "U.I.P."® foam has cured.

Application:
Urecon's Spiwrap® pre-insulated piping system is suitable for
- Above ground chilled water lines in warmer climates
- Above ground lines for freeze protection of bridge crossings, mining and industrial lines.

Core Pipe:
All types of plain end pipe may be factory insulated with the "U.I.P."® process; refer to the attached pipe manufacturer's data sheet for information on the core pipe(s) chosen for this project.

Pipe Preparation:
Pipe and jacket interior shall be cleaned of surface dust and dirt to insure a positive bond of the foam to the entire pipe surface. The pipe and jacket may be treated by sand blasting, steam cleaning or the application of a chemical foam-bonding compound if deemed necessary by Urecon.

Insulation:
- Material, rigid polyurethane foam, factory applied.
- Thickness: as required, refer to accompanying thickness chart.
- Density: (ASTM D 1622) 35 to 46 kg/m^3 *(2.2 to 3.0 lbs/ft^3)*.
- Closed cell content: (ASTM D 2856) 90%,minimum.
- Water absorption: (ASTM D 2842) 4.0% by volume .
- Thermal conductivity: (ASTM C518) 0,020 to 0,026 W/m ^{0}C *(0.14 to 0.17 Btu • in/ft^2 •hr • ^{0}F)*.

System Properties:
- System compressive strength: (modified ASTM D 1621 with locked seam jacket) approximately 1379 kPa *(200 lbs/in^2)*, varies with gauge, type of jacket material and pipe diameter.
- Temperature limitations:
  - in service*, -45^0 to 85^{0}C*(-49^0 to 185^{0}F)*

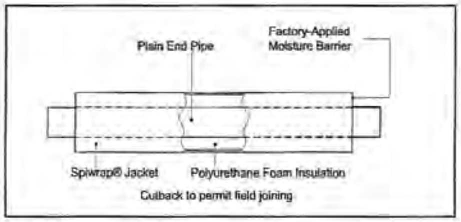
Outer Jacket:
The outer protective jacket shall be supplied with 4-ply lock seam as indicated on the following chart:

Jacket Material	Gauge*				
	18	20	22	24	26
Galvanized Steel			X		
Aluminum					
Stainless Steel					

Plain End Joints:
The pipe is provided with the appropriate cut-backs to allow for joining in the field. These are typically:
- Butt-welded steel @ 150mm *(6 in.)*
- Butt-fused HDPE @ 225mm *(9 in.)*
- Soldered copper @ 75mm 150mm *(6 in.)* for up to 37mm *(1 ½ in.)*, and 225mm *(9 in.)* for 50mm *(2 in.)* and larger.

Joint insulation kits consist of a preformed set of urethane or polyisocyanurate foam half shells and metal jacket consistent with the pipe jacket secured with stainless steel straps and Band-it® clips to suit. All metal overlaps shall be 50mm (2 in.) minimum and shall be field positioned in such a way as to shed water.

Fittings:
Refer to the accompanying data sheet 'Insulation Kits for Spi-wrap® system' for details.



Spiwrap® System*													
		25mm *(1")*				35mm *(1 ½")*				50mm *(2")*			
Pipe Size		Jacket Size		Foam		Jacket Size		Foam		Jacket Size		Foam	
in	mm	*in*	mm	*in*	mm	*in*	mm	*in*	mm	*in*	mm	*in*	mm
1/2"	12	*x*	x	*x*	x	*4.0*	100	*1.580*	40	*5.0*	127	*2.080*	53
3/4"	19	*x*	x	*x*	x	*4.0*	100	*1.475*	37	*5.0*	127	*1.975*	50
1"	25	*4.0*	100	*1.343*	34	*5.0*	127	*1.843*	47	*6.0*	152	*2.343*	60
1 1/4"	32	*4.0*	100	*1.170*	30	*5.0*	127	*1.670*	42	*6.0*	152	*2.170*	55
1 1/2"	38	*4.0*	100	*1.050*	26	*5.0*	127	*1.550*	39	*6.0*	152	*2.050*	52
2"	50	*5.0*	127	*1.313*	33	*6.0*	152	*1.813*	46	*7.0*	178	*2.313*	59
2 1/2"	64	*5.0*	127	*1.063*	27	*6.0*	152	*1.563*	40	*7.0*	178	*2.063*	52
3"	76	*6.0*	152	*1.250*	32	*7.0*	178	*1.750*	44	*8.0*	203	*2.250*	57
4"	100	*7.0*	178	*1.250*	32	*8.0*	203	*1.750*	44	*9.0*	229	*2.250*	57
5"	127	*8.0*	203	*1.219*	31	*9.0*	229	*1.719*	44	*10.0*	254	*2.219*	56
6"	150	*9.0*	229	*1.188*	30	*10.0*	254	*1.688*	43	*11.0*	279	*2.188*	55
8"	200	*11.0*	279	*1.188*	30	*12.0*	305	*1.688*	43	*13.0*	330	*2.188*	55
10"	254	*13.0*	330	*1.125*	29	*14.0*	356	*1.625*	41	*15.0*	381	*2.125*	54
12"	305	*15.0*	381	*1.125*	29	*16.0*	406	*1.625*	41	*17.0*	432	*2.625*	67
14"	14.0	*16.0*	406	*1.000*	25	*x*	x	*x*	x	*18.0*	457	*2.000*	51
16"	16.0	*18.0*	457	*1.000*	25	*x*	x	*x*	x	*20.0*	508	*2.000*	51
18"	457	*20.0*	508	*1.000*	25	*x*	x	*x*	x	*22.0*	559	*2.000*	51
20"	508	*22.0*	559	*1.000*	25	*x*	x	*x*	x	*24.0*	607	*2.000*	51
22"	559	*24.0*	607	*1.000*	25	*x*	x	*x*	x	*26.0*	660	*2.000*	51
24"	607	*26.0*	660	*1.000*	25	*x*	x	*x*	x	*28.00*	711	*2.000*	51

*Highlighted areas indicate product submitted for this project.

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HIGH DENSITY POLYETHYLENE PIPE

Nom. Pipe Size	Nom. Outside Diam.	DR 32.5			DR 26			DR 21			DR 17			DR 15.5		
		Nom. Inside Diam.	Min. Wall Thick.	Nom. Weight (lb./ft.)	Nom. Inside Diam.	Min. Wall Thick.	Nom. Weight (lb./ft.)	Nom. Inside Diam.	Min. Wall Thick.	Nom. Weight (lb./ft.)	Nom. Inside Diam.	Min. Wall Thick.	Nom. Weight (lb./ft.)	Nom. Inside Diam.	Min. Wall Thick.	Nom. Weight (lb./ft.)
3	3.500				3.214	0.135	0.62	3.146	0.167	0.76	3.063	0.206	0.93	3.021	0.226	1.01
4	4.500				4.133	0.173	1.03	4.046	0.214	1.26	3.938	0.265	1.54	3.885	0.290	1.67
5	5.563				5.109	0.214	1.57	5.001	0.265	1.93	4.870	0.327	2.35	4.802	0.359	2.56
6	6.625	6.193	0.204	1.80	6.084	0.255	2.23	5.957	0.315	2.73	5.798	0.390	3.33	5.720	0.427	3.63
7	7.125	6.661	0.219	2.08	6.544	0.274	2.58	6.406	0.339	3.16	6.237	0.419	3.85	6.150	0.460	4.20
8	8.625	8.063	0.265	3.05	7.921	0.332	3.78	7.754	0.411	4.63	7.550	0.507	5.65	7.446	0.556	6.15
10	10.750	10.048	0.331	4.73	9.874	0.413	5.87	9.665	0.512	7.19	9.410	0.632	8.77	9.279	0.694	9.56
12	12.750	11.919	0.392	6.66	11.711	0.490	8.26	11.463	0.607	10.11	11.160	0.750	12.34	11.005	0.823	13.44
13	13.375	12.502	0.412	7.33	12.285	0.514	9.08	12.025	0.637	11.13	11.707	0.787	13.57	11.545	0.863	14.80
14	14.000	13.086	0.431	8.03	12.859	0.538	9.95	12.586	0.667	12.19	12.253	0.824	14.88	12.086	0.903	16.21
16	16.000	14.957	0.492	10.48	14.696	0.615	13.00	14.385	0.762	15.93	14.005	0.941	19.43	13.812	1.032	21.17
18	18.000	16.826	0.554	13.27	16.533	0.692	16.44	16.183	0.857	20.16	15.755	1.059	24.59	15.539	1.161	26.80
20	20.000	18.696	0.615	16.39	18.370	0.769	20.31	17.982	0.952	24.89	17.507	1.176	30.36	17.265	1.290	33.08
22	22.000	20.565	0.677	19.82	20.206	0.846	24.57	19.778	1.048	30.11	19.257	1.294	36.73	18.992	1.419	40.03
24	24.000	22.435	0.738	23.60	22.043	0.923	29.24	21.577	1.143	35.84	21.007	1.412	43.72	20.718	1.548	47.64
28	28.000	26.173	0.862	32.11	25.717	1.077	39.80	25.174	1.333	48.78	24.508	1.647	59.51	24.171	1.806	64.84
32	31.594	29.541	0.969	40.74	29.024	1.213	50.58	28.415	1.500	61.93	27.663	1.854	75.60	27.288	2.031	82.30
36	36.000	33.651	1.108	53.09	33.064	1.385	65.80	32.366	1.714	80.63	31.510	2.118	98.36			
40	39.469	36.898	1.213	63.72	36.255	1.516	78.97	35.496	1.874	96.66						
42	42.000	39.261	1.292	72.24	38.576	1.615	89.55	37.760	2.000	109.76						
48	47.382	44.302	1.453	91.64	43.526	1.819	113.76	42.616	2.248	139.20						
55	55.295	51.698	1.697	124.91	50.805	2.118	154.63	49.728	2.626	189.75						
63	63.209	59.102	1.937	163.00	58.076	2.421	202.05									

Nom. Pipe Size	Nom. Outside Diam.	DR 13.5			DR 11			DR 9			DR 7.3			DR 6.3		
		Nom. Inside Diam.	Min. Wall Thick.	Nom. Weight (lb./ft.)	Nom. Inside Diam.	Min. Wall Thick.	Nom. Weight (lb./ft.)	Nom. Inside Diam.	Min. Wall Thick.	Nom. Weight (lb./ft.)	Nom. Inside Diam.	Min. Wall Thick.	Nom. Weight (lb./ft.)	Nom. Inside Diam.	Min. Wall Thick.	Nom. Weight (lb./ft.)
3	3.500	2.951	0.259	1.15	2.826	0.318	1.38	2.675	0.389	1.65	2.485	0.479	1.97			
4	4.500	3.794	0.333	1.90	3.633	0.409	2.29	3.440	0.500	2.73	3.194	0.616	3.26	2.986	0.714	3.68
5	5.563	4.690	0.412	2.91	4.490	0.506	3.50	4.253	0.618	4.17	3.948	0.762	4.99	3.691	0.883	5.62
6	6.625	5.584	0.491	4.12	5.349	0.602	4.96	5.065	0.736	5.92	4.700	0.908	7.07	4.395	1.052	7.97
7	7.125	6.006	0.528	4.77	5.751	0.648	5.74	5.446	0.792	6.85	5.056	0.976	8.18	4.727	1.131	9.22
8	8.625	7.270	0.639	6.99	6.963	0.784	8.41	6.594	0.958	10.03	6.119	1.182	11.99	5.723	1.369	13.51
10	10.750	9.062	0.796	10.86	8.679	0.977	13.06	8.219	1.194	15.59	7.627	1.473	18.62	7.133	1.706	20.99
12	12.750	10.749	0.944	15.27	10.293	1.159	18.38	9.746	1.417	21.93	9.046	1.747	26.19	8.459	2.024	29.53
13	13.375	11.274	0.991	16.80	10.797	1.216	20.22	10.225	1.486	24.13	9.491	1.832	28.83			
14	14.000	11.802	1.037	18.41	11.301	1.273	22.16	10.701	1.556	26.44	9.934	1.918	31.58			
16	16.000	13.488	1.185	24.04	12.915	1.455	28.94	12.231	1.778	34.53	11.353	2.192	41.25			
18	18.000	15.174	1.333	30.43	14.532	1.636	36.62	13.760	2.000	43.71						
20	20.000	16.860	1.481	37.57	16.146	1.818	45.21	15.289	2.222	53.95						
22	22.000	18.544	1.630	45.46	17.760	2.000	54.71									
24	24.000	20.231	1.778	54.11	19.374	2.182	65.11									
28	28.000	23.603	2.074	73.64	22.605	2.545	88.62									
32																
36																
40																
42																
48																
55																
63																

NPS and Metric Dimensions are in accordance with ASTM F714-85 and ISO 161.

Nominal Weight calculations are based on Plastic Pipe Institute (PPI) Report #TR-7.

Other diameters and DR's are available upon request.

Fittings

Both pipe and fittings shall carry the same pressure rating. All fittings shall be pressure rated to match the system piping to which they are joined. At the fusion, the outside diameter and minimum wall thickness of the fitting shall meet the outside diameter and minimum wall thickness specifications of ASTM F714 for the same size of pipe. All fittings shall be properly derated according to manufacturers written recommendations, and clearly labeled on the fitting as such. Manufacturer shall have a written specification for all standard fittings which establishes Quality Control criteria and tolerances.

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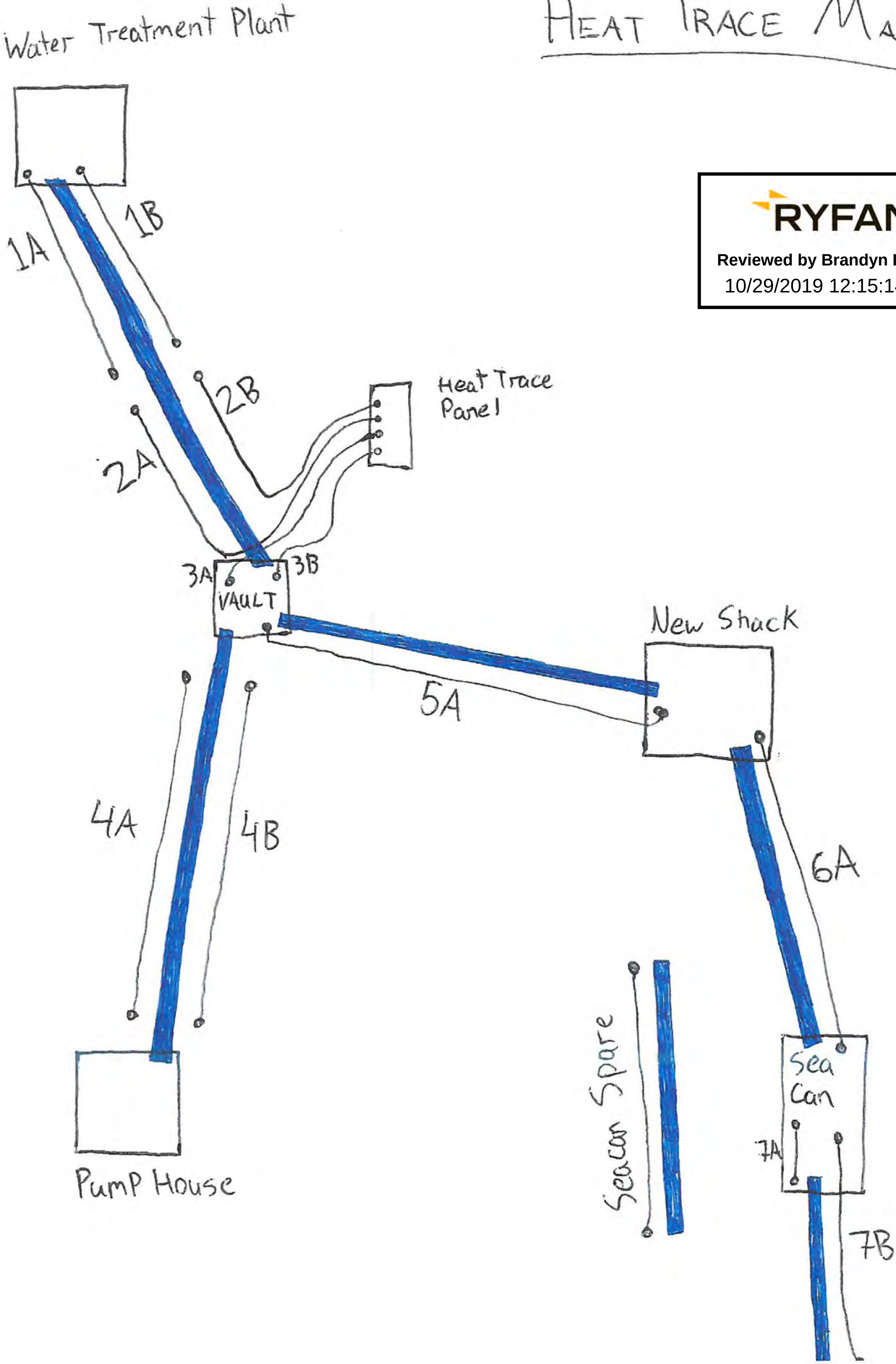
Appendix D

Heat Trace Condition Report

Heat Trace Map



RYFAN
Reviewed by Brandyn Lemoine
10/29/2019 12:15:14 PM

Heat Trace Review - Kugluktuk WTP

Heat Trace Run #	Recommend Replace Y/N	Length (ft)	Replace Controller Y/N	Comments
1A	Y	345	N	
1B	Y	345	Y	
2A	Y	295	N	
2B	Y	295	N	
3A	Y	15	N	
3B	Y	15	N	Unknown Fault - may be at splice
4A	Y	175	N	Cable is water logged, and cut due to fire
4B	Y	175	N	Cable is water logged, and cut due to fire
5A	Y (Inconclusive)	130	Y	Controller filled with water, circuit was damaged
6A	N	410	N	
7A	N	8	N	
7B	N	30+	N	
7A (Spare)	Y (Inconclusive)	325	N	Doesn't seem to be installed correctly on its own circuit, inconclusive readings
	Total Required Length (FT):	**2327**	**Total Required Controllers:**	**2**

Recommend replacing cable

11 Installation and Inspection Records

nVent Heat-Tracing Installation and Inspection Record

Facility	Water Treatment Plant 1A
Circuit number	28, 30
Heating cable type	
Circuit length	345 Ft.

		Commission
Inspection date:		Oct. 1, 2019
Visual Inspection		
Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.		Water Damage in Junction box
Proper electrical connection, ground, and bus wires insulated over full length.		
Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.		Damaged, Worn Heat trace cable @ JB
Covered end seals, splices, and tees properly labeled on insulation cladding.		
Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.		
Insulation resistance (Megger) test		**Ohms**
Test A	500 Vdc	O.L
(bus to braid)	1000 Vdc	6.13GΩ
	2500 Vdc	4.63GΩ
Test B	500 Vdc	N/A
(braid to pipe)	1000 Vdc	N/A
	2500 Vdc	N/A
Power check		
Circuit voltage		
Panel	(Vac)	206.2V
Circuit end*	(Vac)	—
Circuit amps after 10 min	(Amps)	14.4A
Pipe temperature	(°F)	—
Power = Volts x amps/ft	(watts/ft)	8.6 W/Ft

* Commissioning only

Recommend replacing cable and controller

11 Installation and Inspection Records

nVent Heat-Tracing Installation and Inspection Record

Facility	Water Treatment Plant 1B
Circuit number	28, 30
Heating cable type	
Circuit length	345 Ft.

	Commission
Inspection date:	Oct. 1, 2019
Visual Inspection	
Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.	Water damage in junction box
Proper electrical connection, ground, and bus wires insulated over full length.	
Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.	Damaged worn heat trace cable @ JB
Covered end seals, splices, and tees properly labeled on insulation cladding.	
Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.	

Insulation resistance (Megger) test		**Ohms**
Test A	500 Vdc	N/A Megger would not supply proper volta[ge]
(bus to braid)	1000 Vdc	N/A
	2500 Vdc	N/A
Test B	500 Vdc	N/A
(braid to pipe)	1000 Vdc	N/A
	2500 Vdc	N/A

Power check		
Circuit voltage		
Panel	(Vac)	206.2V
Circuit end*	(Vac)	
Circuit amps after 10 min	(Amps)	N/A
Pipe temperature	(°F)	
Power = Volts x amps/ft	(watts/ft)	N/A

Damaged controller, unable to turn on heat trace

* Commissioning only

Recommend replacing cable

11 Installation and Inspection Records

nVent Heat-Tracing Installation and Inspection Record

Facility	Heat Trace Panel 2A
Circuit number	1,3
Heating cable type	
Circuit length	295 Ft.

	Commission
Inspection date:	Oct. 1, 2019
Visual Inspection	
Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.	Water damage in Junction box
Proper electrical connection, ground, and bus wires insulated over full length.	Braid not insulated
Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.	Worn Heat trace
Covered end seals, splices, and tees properly labeled on insulation cladding.	
Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.	

Insulation resistance (Megger) test		Ohms
Test A	500 Vdc	4.45 GΩ
(bus to braid)	1000 Vdc	4.19 GΩ
	2500 Vdc	3.76 GΩ
Test B	500 Vdc	N/A
(braid to pipe)	1000 Vdc	N/A
	2500 Vdc	N/A

Power check		
Circuit voltage		
Panel	(Vac)	239.3V
Circuit end*	(Vac)	—
Circuit amps after 10 min	(Amps)	11.2 A
Pipe temperature	(°F)	—
Power = Volts x amps/ft	(watts/ft)	9.1 W/Ft

* Commissioning only

Recommend replacing cable

11 Installation and Inspection Records

nVent Heat-Tracing Installation and Inspection Record

Facility	Heat trace Panel 2B
Circuit number	1,3
Heating cable type	
Circuit length	295 Ft.

	Commission
Inspection date:	Oct. 1, 2019
Visual Inspection	
Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.	Water damage in Junction Box
Proper electrical connection, ground, and bus wires insulated over full length.	
Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.	Worn Heat trace
Covered end seals, splices, and tees properly labeled on insulation cladding.	
Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.	

Insulation resistance (Megger) test		**Ohms**
Test A	500 Vdc	4.47 GΩ
(bus to braid)	1000 Vdc	4.16 GΩ
	2500 Vdc	3.87 GΩ
Test B	500 Vdc	N/A
(braid to pipe)	1000 Vdc	N/A
	2500 Vdc	N/A

Power check		
Circuit voltage		
Panel	(Vac)	239.3 V
Circuit end*	(Vac)	—
Circuit amps after 10 min	(Amps)	9.7 A
Pipe temperature	(°F)	—
Power = Volts x amps/ft	(watts/ft)	7.9 W/Ft.

* Commissioning only

Recommend replacing cable

11 Installation and Inspection Records

nVent Heat-Tracing **Installation and Inspection Record**

Facility	Heat Trace Panel 3A
Circuit number	2, 4
Heating cable type	
Circuit length	15 Ft

	Commission
Inspection date:	Oct. 1, 2019

Visual Inspection

Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.	Water Damage in Junction Box
Proper electrical connection, ground, and bus wires insulated over full length.	
Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.	Worn Heat trace
Covered end seals, splices, and tees properly labeled on insulation cladding.	Spliced Heat trace
Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.	

Insulation resistance (Megger) test		Ohms
Test A	500 Vdc	136.2 MΩ
(bus to braid)	1000 Vdc	89.6 MΩ
	2500 Vdc	N/A Megger wouldn't supply proper voltage
Test B	500 Vdc	N/A
(braid to pipe)	1000 Vdc	N/A
	2500 Vdc	N/A

Power check

Circuit voltage		
Panel	(Vac)	239.8V
Circuit end*	(Vac)	—
Circuit amps after 10 min	(Amps)	0.4A
Pipe temperature	(°F)	
Power = Volts x amps/ft	(watts/ft)	6.4 W/Ft.

* Commissioning only

Recommend replacing cable

11 Installation and Inspection Records

nVent Heat-Tracing Installation and Inspection Record

Facility	Heat Trace Panel 3B
Circuit number	2,4
Heating cable type	
Circuit length	15 Ft.

	Commission
Inspection date:	Oct. 1, 2019
Visual Inspection	
Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.	Water Damage in Junction Box
Proper electrical connection, ground, and bus wires insulated over full length.	
Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.	Worn Heat trace
Covered end seals, splices, and tees properly labeled on insulation cladding.	Spliced Heat trace
Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.	

Insulation resistance (Megger) test		**Ohms**
Test A	500 Vdc	4.7 MΩ
(bus to braid)	1000 Vdc	3.2 MΩ
	2500 Vdc	2.5 MΩ
Test B	500 Vdc	N/A
(braid to pipe)	1000 Vdc	N/A
	2500 Vdc	N/A
Power check		
Circuit voltage		
Panel	(Vac)	239.8V
Circuit end*	(Vac)	—
Circuit amps after 10 min	(Amps)	N/A
Pipe temperature	(°F)	—
Power = Volts x amps/ft	(watts/ft)	N/A

* Commissioning only

Heater tripping when turned on. Heat trace cable to be replaced in near future. Unable to locate fault Most likely at splice.

Recommend replacing cable

11 Installation and Inspection Records

nVent Heat-Tracing Installation and Inspection Record

Facility	Pump House 4A
Circuit number	N/A
Heating cable type	
Circuit length	175 Ft.

		Commission
Inspection date:	Oct. 1, 2019	
Visual Inspection		
Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.		
Proper electrical connection, ground, and bus wires insulated over full length.		
Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.	Damaged and worn cable Water Filled heat trace Cable	
Covered end seals, splices, and tees properly labeled on insulation cladding.		
Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.	* Heat trace cable cut off at both ends due to Fire	

Insulation resistance (Megger) test		**Ohms**
Test A	500 Vdc	2.6 MΩ
(bus to braid)	1000 Vdc	34.5 MΩ
	2500 Vdc	62.3 MΩ
Test B	500 Vdc	N/A
(braid to pipe)	1000 Vdc	N/A
	2500 Vdc	N/A

Power check

Circuit voltage		
Panel	(Vac)	N/A
Circuit end*	(Vac)	/
Circuit amps after 10 min	(Amps)	N/A
Pipe temperature	(°F)	/
Power = Volts x amps/ft	(watts/ft)	N/A

* Commissioning only

Recommend replacing cable

11 Installation and Inspection Records

nVent Heat-Tracing Installation and Inspection Record

Facility	Pump House 4B
Circuit number	N/A
Heating cable type	
Circuit length	175 Ft.

	Commission
Inspection date:	Oct. 1, 2019
Visual Inspection	
Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.	
Proper electrical connection, ground, and bus wires insulated over full length.	
Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.	Damaged, worn cable Water Filled cable
Covered end seals, splices, and tees properly labeled on insulation cladding.	
Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.	* Heat trace cut off at both end due to fire

Insulation resistance (Megger) test		**Ohms**
Test A	500 Vdc	2.85 GΩ
(bus to braid)	1000 Vdc	2.29 GΩ
	2500 Vdc	N/A Megger would not supply proper voltage
Test B	500 Vdc	N/A
(braid to pipe)	1000 Vdc	N/A
	2500 Vdc	N/A

Power check		
Circuit voltage		
Panel	(Vac)	N/A
Circuit end*	(Vac)	—
Circuit amps after 10 min	(Amps)	N/A
Pipe temperature	(°F)	/
Power = Volts x amps/ft	(watts/ft)	N/A

* Commissioning only

Recommend replacing cable, assumed to be water damaged (inconclusive)

11 Installation and Inspection Records

nVent Heat-Tracing **Installation and Inspection Record**

Facility	New Shack 5A		
Circuit number	10.12		
Heating cable type			
Circuit length	130 Ft.		
		Commission	
Inspection date:	Oct. 1, 2019		
Visual Inspection			
Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.			
Proper electrical connection, ground, and bus wires insulated over full length.			
Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.			
Covered end seals, splices, and tees properly labeled on insulation cladding.			
Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.		Heat trace controller completely Filled with water	
Insulation resistance (Megger) test		**Ohms**	
Test A	500 Vdc	O.L	
(bus to braid)	1000 Vdc	O.L	
	2500 Vdc	18.6GΩ	
Test B	500 Vdc	N/A	
(braid to pipe)	1000 Vdc	N/A	
	2500 Vdc	N/A	
Power check			
Circuit voltage			
Panel	(Vac)	N/A	couldn't turn cct on due to water damage. controller to be replaced
Circuit end*	(Vac)	/	
Circuit amps after 10 min	(Amps)	N/A	
Pipe temperature	(°F)	/	
Power = Volts x amps/ft	(watts/ft)	N/A	

* Commissioning only

Replacement not required

11 Installation and Inspection Records

nVent Heat-Tracing Installation and Inspection Record

Facility	New Shack 6A
Circuit number	14, 16
Heating cable type	
Circuit length	410 Ft.

	Commission
Inspection date:	Oct. 1, 2019
Visual Inspection	
Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.	
Proper electrical connection, ground, and bus wires insulated over full length.	
Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.	
Covered end seals, splices, and tees properly labeled on insulation cladding.	
Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.	

Insulation resistance (Megger) test		**Ohms**
Test A	500 Vdc	15.46 MΩ
(bus to braid)	1000 Vdc	48.2 MΩ
	2500 Vdc	N/A Megger not putting out proper voltage
Test B	500 Vdc	N/A
(braid to pipe)	1000 Vdc	N/A
	2500 Vdc	N/A

Power check		
Circuit voltage		
Panel	(Vac)	202.1 V
Circuit end*	(Vac)	/
Circuit amps after 10 min	(Amps)	9.9 A
Pipe temperature	(°F)	/
Power = Volts x amps/ft	(watts/ft)	4.9 W/Ft

* Commissioning only

Replacement not required

11 Installation and Inspection Records

nVent Heat-Tracing Installation and Inspection Record

Facility	Sea Can 7A
Circuit number	20, 22
Heating cable type	
Circuit length	8 ft.

	Commission
Inspection date:	Oct. 1, 2019
Visual Inspection	
Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.	
Proper electrical connection, ground, and bus wires insulated over full length.	
Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.	
Covered end seals, splices, and tees properly labeled on insulation cladding.	
Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.	

Insulation resistance (Megger) test		**Ohms**
Test A	500 Vdc	O.L
(bus to braid)	1000 Vdc	O.L
	2500 Vdc	14.7 GΩ
Test B	500 Vdc	N/A
(braid to pipe)	1000 Vdc	N/A
	2500 Vdc	N/A

Power check		
Circuit voltage		
Panel	(Vac)	198.2 V
Circuit end*	(Vac)	/
Circuit amps after 10 min	(Amps)	1A
Pipe temperature	(°F)	
Power = Volts x amps/ft	(watts/ft)	24.8 W/Ft

* Commissioning only

Replacement not required

[Note: unknown run length]

11 Installation and Inspection Records

nVent Heat-Tracing Installation and Inspection Record

Facility	Sea Can 7B
Circuit number	20,22
Heating cable type	
Circuit length	N/A *Unable to measure length in water (30m to water)
	Commission
Inspection date:	Oct. 1, 2019

Visual Inspection

Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.

Proper electrical connection, ground, and bus wires insulated over full length.

Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.

Covered end seals, splices, and tees properly labeled on insulation cladding.

Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.

Insulation resistance (Megger) test		**Ohms**
Test A	500 Vdc	1.59 GΩ
(bus to braid)	1000 Vdc	1.04 GΩ
	2500 Vdc	593.1 MΩ
Test B	500 Vdc	N/A
(braid to pipe)	1000 Vdc	N/A
	2500 Vdc	N/A

Power check

Circuit voltage		
Panel	(Vac)	198.2 V
Circuit end*	(Vac)	/
Circuit amps after 10 min	(Amps)	13.9 A
Pipe temperature	(°F)	/
Power = Volts x amps/ft	(watts/ft)	N/A

* Commissioning only

Recommend replacement, doesn't seem to have its own circuit (inconclusive results)

(Note: Unknown run #]

11 Installation and Inspection Records

nVent Heat-Tracing Installation and Inspection Record

Facility	Sea Con Spare (attaches to 7A)
Circuit number	N/A
Heating cable type	
Circuit length	325 Ft.

	Commission
Inspection date:	Oct. 1, 2019
Visual Inspection	
Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections and other problems.	
Proper electrical connection, ground, and bus wires insulated over full length.	
Damaged or wet thermal insulation; damaged, missing, cracked lagging or weather-proofing; gaps in caulking.	
Covered end seals, splices, and tees properly labeled on insulation cladding.	
Control and Monitoring system checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.	

Insulation resistance (Megger) test		**Ohms**
Test A	500 Vdc	5.89 GΩ
(bus to braid)	1000 Vdc	5.75 GΩ
	2500 Vdc	5.07 GΩ
Test B	500 Vdc	N/A
(braid to pipe)	1000 Vdc	N/A
	2500 Vdc	N/A

Power check		
Circuit voltage		
Panel	(Vac)	N/A
Circuit end*	(Vac)	/
Circuit amps after 10 min	(Amps)	N/A
Pipe temperature	(°F)	/
Power = Volts x amps/ft	(watts/ft)	N/A

* Commissioning only