CE2 Engineers, Inc.

TECHNICAL MEMORANDUM

TO: Susan Randlett, Village Safe Water Project Manager - Chefornak
Robert Jimmy, City Administrator, City of Chefornak
Mike Erdman, P.E., CE2 Engineers, Inc.

FROM: Paul C. Weisner, P.E., CE2 Engineers, Inc. PCW

SUBJECT: Pump Houses 1 and 2 Issues background and discussion

DATE: October 23, 2014

Background

Designs of the proposed Pump Houses 1 and 2 are ongoing. However some issues in the design have come up that merit closer examination. In this Technical Memorandum, these issues will be discussed and recommendations made for proceeding ahead in resolving these issues.

The issues discussed in this Technical Memorandum are:

1. Well water chlorination and the issues of resulting disinfectant byproducts (DBP) in the water distribution system;
2. 2002 Water Wells W02-2 and W02-3 condition and issues;
3. Micropile discussion.

Well Water Chlorination and Resulting Disinfection Byproducts

It is very common in the United States, and certainly in southwest Alaska to add a hypochlorite solution to treated water, leaving a residual concentration of disinfectant to prevent the formation of microbial contaminants in piping and Tankage. However, potential disinfection byproducts (DBP) are produced when the hypochlorite solution reacts with the dissolved organic carbon in the water. The United States Environmental Protection Agency (EPA) explains what these DBP are:

> **Disinfection byproducts** are formed when disinfectants used in water treatment plants react with bromide and/or natural organic matter (i.e., decaying vegetation) present in the source water. Different disinfectants produce different types or amounts of disinfection byproducts.

Disinfection byproducts for which regulations have been established have been identified in drinking water, including **trihalomethanes, haloacetic acids, bromate, and chlorite.**

Trihalomethanes (THM) are a group of four chemicals that are formed along with other disinfection byproducts when chlorine or other disinfectants used to control microbial contaminants in drinking water react with naturally occurring organic and inorganic matter in water. The trihalomethanes are chloroform, bromodichloromethane, dibromochloromethane, and bromoform. EPA has published the **Stage 1 Disinfectants/Disinfection Byproducts Rule** to regulate total trihalomethanes (TTHM) at a maximum allowable annual average level of 80 parts per billion. This standard replaced the current standard of a maximum allowable annual average level of 100 parts per billion in December 2001 for large surface water public water systems. The standard became effective for the first time in December 2003 for small surface water and all ground water systems.

Haloacetic Acids (HAA5) are a group of chemicals that are formed along with other disinfection byproducts when chlorine or other disinfectants used to control microbial contaminants in drinking water react with naturally occurring organic and inorganic matter in water. The regulated haloacetic acids, known as HAA5, are: monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid. EPA has published the **Stage 1 Disinfectants/Disinfection Byproducts Rule** to regulate HAA5 at 60 parts per billion annual average. This standard became effective for large surface water public water systems in December 2001 and for small surface water and all ground water public water systems in December 2003.

Bromate is a chemical that is formed when ozone used to disinfect drinking water reacts with naturally occurring bromide found in source water. EPA has established the **Stage 1 Disinfectants/Disinfection Byproducts Rule** to regulate bromate at annual average of 10 parts per billion in drinking water. This standard became effective for large public water systems in December 2001 and for small surface water and all ground public water systems in December 2003.

Chlorite is a byproduct formed when chlorine dioxide is used to disinfect water. EPA has published the **Stage 1 Disinfectants/Disinfection Byproducts Rule** to regulate chlorite at a monthly average level of 1 part per million in drinking water. This standard became effective for large surface water public water systems in December 2001 and for small surface water and all ground water public water systems in December 2003.

Stage 2 Disinfectants and Disinfection Byproducts Rule tightens up requirements more for individual Trihalomethanes and the Five Haloacetic Acids.

The impact of these rules on the Chefornak Water Utility is that even though the water is not used for drinking, the Utility must keep DBP down below EPA maximum limits (MCL). This becomes problematic and potentially very expensive, given the organic matter (dissolved organic carbon) in the water. If a hypochlorite solution is used in the water for disinfection, then the present water as disinfected will contain DBP in excess of EPA limits.

If the water is not disinfected with a hypochlorite solution, it will not develop DBP. The water at Chefornak comes from wells that are classified true groundwater, as they go through multiple layers of silt, ash, and clay, which should provide an effective seal from microbial contaminates.

To test this hypothesis, recently the hypochlorite solution feed was shut off in the existing pump house. Next week, a Bac-T test will be performed to see if there any bacterial indicators show up in the water. If they do not show up, it will indicate that hypochlorite disinfection will not be necessary, and DBP formation will not be a concern. It is recommended for the upcoming several months that Bac-T sampling be performed once a week to show that microbial contamination is not occurring in the water distribution system.

2002 Water Wells W02-2 and W02-3 Condition and Issues

The two water wells at the south end of the community were drilled to approximately 277 ft below the surface. They found a five foot deep aquifer of fine sand, almost like beach sand, very uniform in size and shape. While drilling through the layers, there was encountered two layers of lava flow, frozen clay and silt layers, heaving fine sand, with a final layer of water bearing sand. There was adequate water, and the wells were developed into what appeared to be a good source of water. The wells were developed by the surge and bail method, followed by 24 hours of continuous pumping at 57 to 63 gpm. Well logs are attached to this technical memorandum.

In 2005, Well W02-03 was tested by continuous running for over a year to establish any changes in Total Dissolved Solids (TDS) before any pump house construction was begun for servicing these wells. It was found that by pumping the system at 10 gpm, TDS climbed to 3000 mg/l, and leveled off at that figure, except for decreases to 2000 mg/l during summer aquifer recharge. When the discharge rate was dropped to 5 gpm, TDS dropped to 1000 mg/l and stayed at that level. When the flow rate was dropped to 3 gpm, TDS again dropped, this time to 600 mg/l. These data indicated that the aquifer that was tapped by the wells was brackish, with a layer of fresh water floating atop the layer of brackish water. Based upon the data, it was hypothesized that recharge of the aquifer occurred via tundra lakes, when thawed, allowed their water to flow down to the aquifer and recharge it.

A geophysical survey was later performed to determine if there were any higher points in aquifer/frozen layers atop aquifer the vicinity that could be used to get a larger amount of fresh water all year round. Unfortunately, the interface layer was quite level, so using the wells would amount to a total of 4000 gpd to keep the TDS in the water to below 600 mg/l.

During the 15 month test of W02-3 in 2005-2006, the well did not require heat to keep it thawed when running. When the well was stopped after testing, it froze at the surface for an unknown depth.

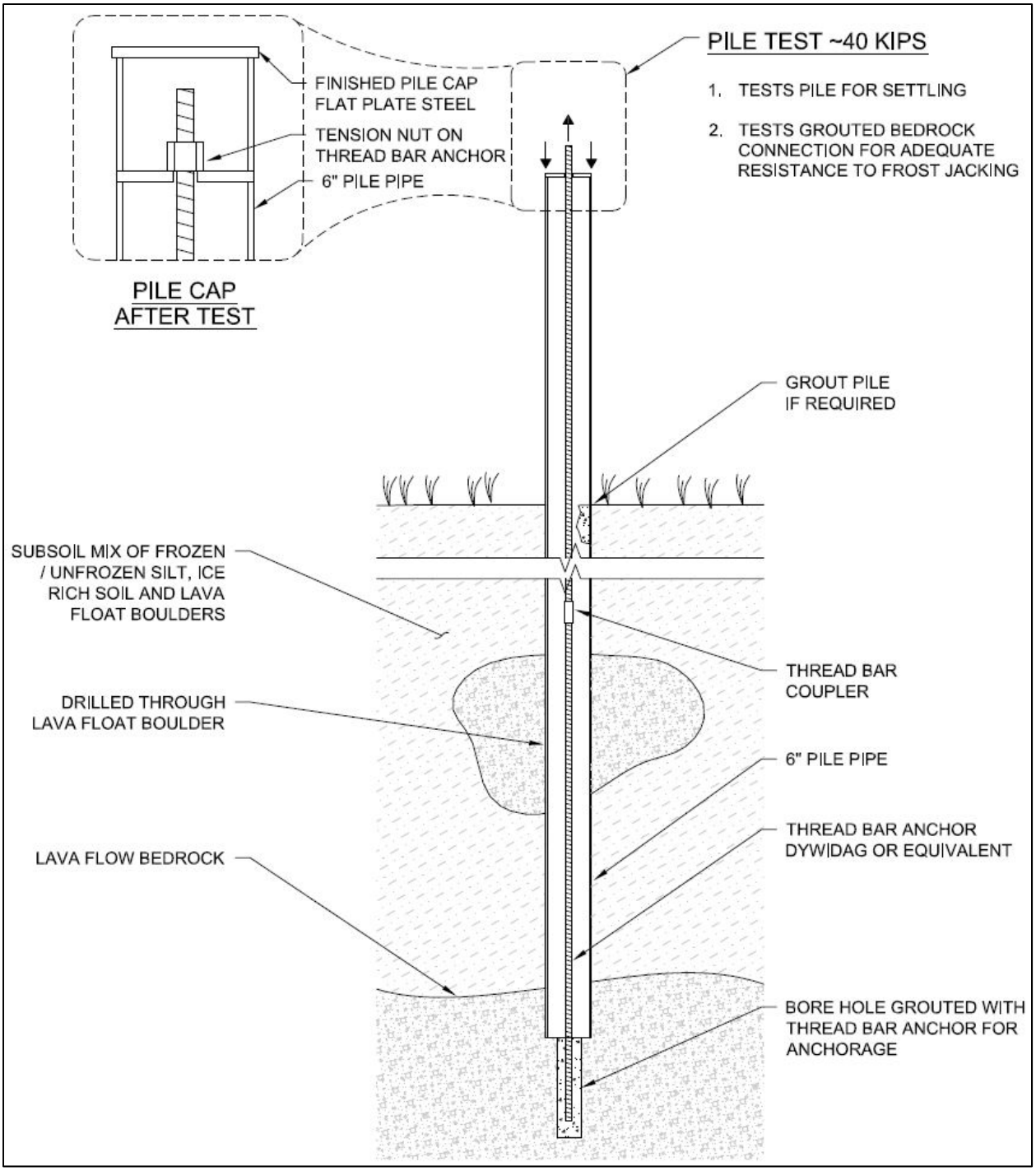
The City of Chefornak has expressed the desire to concentrate on Pump House 1 and to hold off on doing anything on Pump House 2. The well field has not been tested for 8 years. It would be my recommendation to conduct a flow test in both wells in late May of 2015 and run a flow test continuously at 3 gpm in

each well until the end of September 2015. The TDS should be monitored during that time to determine how both wells would react. This will not be a very expensive test, and would prove the viability of the well field. Regardless of whether Pump House 2 is constructed or not, it would be important to establish the well field as an alternate water source for the community.

Micropiles as a Viable Foundation Alternative

In August 2014, Golder and Associates (a geotechnical engineering firm) was hired by CE2 Engineers to examine the soils at the sites for the proposed Pump House 1 and Pump House 2 sites in Chefornak. The soil condition results found were to be used to determine the appropriate foundation for the two pump houses. Golder found that soils were frozen in some places and deeply thawed in other areas. This was found to be problematic for a foundation based on an insulated and cooled gravel pad, using thermosyphons, and a Triodetic foundation for the building. The possible results for a foundation of this type would be differential settlement, which could cause one side of the building to settle and have the whole building list toward the settled area.

Other foundation systems were considered, and the most viable one involved use of a micropile foundation. Details of the micropile system are illustrated below.



The micropile is essentially an end bearing 6-in pipe pile anchored on a lava flow approximately 20 to 40 feet below the surface, and containing a thread bar in its center that is grouted into the lava flow with cement grout. The advantages of this pile are three-fold:

- The pile is end bearing on rock, so it can support up to 40,000 lbs of load.
- The grouted bar and pipe pile can be used to proof test the pile for settlement and resistance to frost heaving. This means that the pile performance will be known.

- The micropile that is anchored in rock and proof tested will not be affected by thawed or frost heaving soil, giving an assurance of a stable foundation, despite the change in permafrost depth and quality due to change in climate.

Golder has had considerable experience with piles in Chefornak. A short distance to the east of the Pump House 1 site is located a 3-legged 120 ft high microwave tower. This tower foundation consisted of 3-ft diameter caissons set down to the top of the lava flow 40 feet below the surface. The caissons were set down several feet into the lava rock. A 1-3/4 inch diameter reinforcing bar was grouted into 20 ft of the lava rock, and each of the three foundation systems were proof tested to 170,000 lb. This has been a very stable foundation.

Golder and Associates has recommended this foundation system for many of the GCI Terra System microwave towers when lava flows or bedrock were present in southwest Alaska. The system has been very successful. In addition, Golder has recommended the use of micropiles for many clinics and housing projects in southwest Alaska with great success.

Chefornak, in the vicinity of Pump Houses 1, 2, and the proposed Washeteria, sits atop a lava flow of 20 to 53 ft in thickness, and 25 to 40 ft below the surface. The micropile would be the most stable and appropriate foundation system for the above structures. Setting the piles would be done in March or April, and construction for the buildings would commence in early summer after the barge arrives.

Attachment: 2002 well logs

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND & WATER
WATER WELL LOG

Drilling Started: 07 / 25 / 2002, Completed: 08 / 15 / 2002

City/Borough:	Subdivision:	BLOCK	LOT	Property Owner Name & Address:
Chefornak	Old Chefornak Airport	I	A	City of Chefornak, P.O. Box 29, Chefornak, AK 99561

Meridian Seward Township I N Range 86 W Section 30 , ____ 1/4 of ____ 1/4 of NE 1/4 of NW 1/4

BOREHOLE DATA: (from ground surface) Depth

Material: Type, Color & wetness	From	To
Tundra (Frozen)	0	11'
Brown Clay	11'	16'
Lava Rock	16'	55'
Black Clay (Frozen)	55'	100'
Silt w/Wood Chips and Ice	100'	135'
Silt Dark Hard Packed	135'	175'
Fine Sand (Frozen)	175'	245'
Fine Sand (Not Frozen)	245'	255' 6"
Fine Sand (Water)	255' 6"	272'
Fine Sand (No Water)	272'	276' 6"
Blue Gray Pack Sand	276' 6"	302'

Drilling method: ☐ Air rotary, ☒ Cable tool ☐ Other _____

Well use: ☒ Public supply, ☐ Domestic, ☐ Other _____

Depth of hole: 276' 8" ft, Casing stickup: 3' ft

Casing type: Steel Thickness 0.322 inches

Casing diameter: 8 inches Casing depth 255' 6" ft

Liner type: NONE Diameter: ____ inches Depth: ____ ft

Note: .....

Static water (from top of casing): 19' ft on 08 / 14 / 2002

Pumping level & yield: 34' feet after 48 hours at 68 gpm

Recovery rate: _____ gpm, Method of testing: _____

Development method: surge & bail Duration: 18 hours

Well intake opening type: ☐ Open end ☐ Open hole , Other ☐

☒ Screened; Start: 255' 6" ft, Stopped 275' 3" ft

Screen type: 10 slot Slot/mesh size 0.010

☐ Perforated; Start: _____ ft, Stopped _____ ft

Start: _____ ft, Stopped _____ ft

Gravel packed ☐ Yes ☒ No From _____ ft to _____ ft

Note: 4-5' lengths of 0.010 screen with packer

Grout type: Bentonite Volume 200 pounds

Depth; from 10 ft, to 20 ft

Pump intake depth: _____ ft

Pump size _____ hp Brand name _____

Was well disinfected upon completion? ☒ Yes ☐ No

Method of disinfection: Sodium Hypochlorite Solution

Driller comments/ disclaimers: .....

Well No. 02-2 Chefornak

Well driller name: Roy Longbotham, Jr.

Company name: R & L Drilling & Leasing

Mailing address: 18957 Avenue 318

City: Visalia State: CA Zip 93292

Phone number : (_____) _____- _____

Drillers signature:

Date: _____/_____/_____

Alaska state law requires that a copy of this well log be forwarded to the Department of Natural Resources within 45 days (AK statutes 38.05.020, 38.05.035, 41.08.020, 46.15.020 and AK regulations 11 AAC 93.140). Faxes are acceptable.

Alaska DNR, Division of Mining, Land and Water,
550 W 7th Avenue, Suite 1020
Anchorage, AK 99501-3562

Phone (907)269-8639 and fax (907)269-8947

If the well is within city limits, the City of Anchorage requires that a copy of this well log be forwarded to the city within 60 days and another copy of this log be forwarded to the owner of the property, on which the well is located, within 30 days.

City Permit Number: _____

Date of Issue: _____/____/_____

Parcel Identification Number: _____-_____-_____

Is well located at approved permit location? Yes ☐ or No ☐

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND & WATER
WATER WELL LOG

Drilling Started: 08 / 16 / 2002, Completed: 08 / 27 / 2002

City/Borough:	Subdivision:	BLOCK	LOT	Property Owner Name & Address:
Chefornak	Old Chefornak Airport	I	A	City of Chefornak, P.O. Box 29, Chefornak, AK 99561

Meridian Seward Township 1 N Range 86 W Section 30 , ____ 1/4 of ____ 1/4 of NE 1/4 of NW 1/4

BOREHOLE DATA: (from ground surface) Depth

Material: Type, Color & wetness	From	To
Clay (frozen)	0	17'
Lava Rock	17'	20'
Frozen Gray Clay	20'	30'
Lava Rock	30'	57'
Frozen Black Clay	57'	130'
Frozen Gray Silt	130'	235'
Heaving Fine Sand	235'	237'
Fine Sand (Some Water)	237'	277' 8"

Drilling method: ☐ Air rotary, ☒ Cable tool ☐ Other ____

Well use: ☒ Public supply, ☐ Domestic, ☐ Other ____

Depth of hole: 277' 8" ft, Casing stickup: 3' ft

Casing type: Steel Thickness ____ inches

Casing diameter: 6 inches Casing depth 252' 3" ft

Liner type: NONE Diameter: ____ inches Depth: ____ ft

Note: ....

Static water (from top of casing): 25" ft on 08 / 27 / 2002

Pumping level & yield: 42' 8" feet after 24 hours at 57 gpm

Recovery rate: ____ gpm, Method of testing: ____

Development method: surge & bail Duration: 12 hours

Well intake opening type: ☐ Open end ☐ Open hole , Other ☐

☒ Screened; Start: 252' 3" ft, Stopped 277' 3" ft

Screen type: 10 slot Slot/mesh size 0.010

☐ Perforated; Start: ____ ft, Stopped ____ ft

Start: ____ ft, Stopped ____ ft

Gravel packed ☐ Yes ☒ No From ____ ft to ____ ft

Note: 5-5' lengths of 0.010 screen with packer

Grout type: Bentonite Volume 200 pounds

Depth; from 10 ft, to 20 ft

Pump intake depth: ____ ft

Pump size ____ hp Brand name ____

Was well disinfected upon completion? ☒ Yes ☐ No

Method of disinfection: Sodium Hypochlorite Solution

Driller comments/ disclaimers: ....

Well No. 02-3 Chefornak

Well driller name: Roy Longbotham, Jr.

Company name: R & L Drilling & Leasing

Mailing address: 18957 Avenue 318

City: Visalia State: CA Zip 93292

Phone number : (____) ____-____

Drillers signature:

Date: ____/____/____

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Is well located at approved permit location? Yes ☐ or No ☐