City of Chefornak

Design Analysis Report

Chefornak Pump House 2

Chefornak, Alaska

Prepared by:

CE2 Engineers, Inc.

Draft

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I. Executive Summary

The Design Analysis Report (DAR) for the proposed Pump House 2 project is the next to final step in design of this facility. The proposed Pump House 2 at Chefornak is being designed to incorporate the two water wells in the south end of the community to supply water to the existing water distribution loop. This loop supplies water to:

- Watering Points
- School
- Clinic
- Fish Processing during the fishing season
- Temporary Washeteria

This project was the third priority of improvements to the Chefornak Water and Sewer System.

The proposed Pump House 2 will be 24-ft wide x 24-ft long x 8-ft high sidewalls, placed atop a 6-in steel micropile foundation. Plan View and Elevations of the proposed facility are shown on Sheets A1.0 and A2.0 of the 35% Plan Set (Appendix A).

The building will contain one each 2,500-gallon HDPE water storage tank, cartridge filters and well controls. It will also contain a pressure pump system, water distribution loop circulation system, and a building and water distribution backup heat exchanger and controls, used if the waste heat recovery system at the City Power Plant is not available for any reason.

Geotechnical considerations necessitated a steel pipe micropile-type foundation, due to the widely varying areas of frozen and thawed subsoil that prevented the use of a passively cooled gravel fill foundation and Triodetic foundation space frame. Fortunately, the building site has an ancient lava flow underlying the soil at a depth of 30 feet that has supported a number of structures in the area using piles driven or drilled to this bedrock layer.

A tentative construction schedule is envisioned as follows:

- The micropile foundation grid would be installed March-April 2015 while the ground surface is still frozen. This operation would be performed in conjunction with the Washeteria/Water Tank, and Pump House 1 micropile foundation projects to minimize mobilization and demobilization costs for each project by combining them to one overall project.
- The building shell and internals would be constructed in summer-fall 2016 as soon as materials arrive on the first barge to Chefornak. This construction

timeframe will be scheduled after the Washeteria and Pump House 1 are completed and when grant funding is in place to finance the project.

- The well field will be connected to Pump House 2 with an arctic pipe duct set on helical piers.
- The existing water distribution loop will be connected to Pump House 2 through a junction box and an aluminum utilidor set on treated wood sleepers.

Capital costs for Pump House 2 improvements are estimated at **$1,323,405**. This assumes cartridge filtration of the well water. Details of the capital cost estimate, including the multimedia option, are found in Section VI Cost Estimates of this DAR.

Annual operating costs for Pump House 2 improvements are estimated at **$38,697 per year**. Details of the operating cost estimate using multimedia filtration are found in Section VI Cost Estimates.

II. Introduction/Purpose/Background

The proposed Pump House 2 in Chefornak is being designed to connect the two wells, drilled in 2002, to the existing water distribution loop. The pump house will provide filtration and chlorination of raw water, heating for the raw water lines between the well field and the pump house, storage of 2500 gallons of filtered and chlorinated water, pressurization of water, and backup circulation pumping of the existing water distribution loop.

The proposed Pump House 2 will be 24 ft wide x 24 ft long x 8 ft high at the end walls. It will have a gable roof with a 4:12 pitch. Engineered wood floor joists and rafters will be used for floor and roof, respectively. Floor and ridge beams with be glued-laminated beams. Walls will be structural insulated panels (SIP).The foundation will be 6 in pipe micropiles.

Plan view and elevations of the proposed facility are seen in Plan Sheets A1.0 and A2.0, respectively of the 35% plan set in Appendix A.

A. Location

The site is situated in the south area of the built-up community. The site for proposed Pump House 2 is located on Lot 4, Block 18, Plat 97-3 (South Chefornak Subdivision). It is presently a vacant lot owned by the City of Chefornak. A copy of the original Trustee Deed, as well as the Bethel Recorder's Office Document Display of information pertaining to this Deed will be found in Appendix B after final land transfer documents are sent to the Recorder's Office.

B. Existing Site Conditions

The existing site is on a relatively flat area, covered in local grasses, with some standing water on about 5 percent of the lot. The lot slopes down to the north, but there is adequate room for the building on the flat area of the lot. The area between the proposed Pump House 2 site and the well field 650 feet to the south consists of tundra and hummocks. A small shallow drainage ravine, about 150 ft wide and two-thirds the way from the proposed pump house site to the well field, consists of swampy ground with some standing water with a very slow eastward flow.

C. Existing Facilities

As Pump House 2 will be a new building, there are no existing facilities on Lot 4. There are presently two each 6-in wells 277 feet deep at the well field area, along with a power pole with a temporary 240/120 single phase service.

D. Water Source

The existing water source consists of two each 6" pipe cased wells drilled down through 277 feet of silt, ash, and lava to a five foot thick aquifer. After initial well development (surging and pumping) an extensive test pumping program was performed on Well W02-3 to gain knowledge of long term water quality, with respect to Total Dissolved Solids (TDS). Pumping of this well began around May 25, 2005 to August 11, 2006, a period of 15 months. Initial pumping was performed at 10 gpm, and TDS climbed to 3000 mg/l, a high value. Sea water is 36,000 mg/l, as a comparison. After 12 months of pumping, a flow limiter was placed on the discharge line from the well and flow was limited to 5 gpm. TDS dropped to 1,000 mg/l. The flow limiter was changed to 3 gpm, and TDS dropped and stabilized at 600 mg/l.

It became apparent that a layer of fresh water was sitting on a layer of brackish water, and that maintaining a low discharge flow rate from a well would enable the City to keep the TDS levels down to 600 mg/l. It was also noted that seasonal recharge of the aquifer occurred from June through August of each year. Well logs, well pumping graph showing TDS versus time, and well water quality data is shown in Appendix C.

The raw water quality parameters are shown below for the two wells with results from samples taken in September 2002.

Water Parameter	MCL*	Well W02-2	Well W02-3
Total Organic Carbon, dissolved		5.82 mg/l	5.60 mg/l
Total Organic Carbon		5.38 mg/l	5.26 mg/l
UV254		n/m	n/m
Total Dissolved Solids	500 mg/l	390 mg/l	435 mg/l
Turbidity	0.5 NTU	01.16 NTU	2.21 NTU
True Color	15 PCU	80 PCU	80 PCU
CO_3 Alkalinity		20 mg/l	15 mg/l
HCO_3 Alkalinity		250 mg/l	246 mg/l
Hardness as $CaCO_3$		10.0 mg/l U	10.2 mg/l U
pH	6.5 to 8.5	8.80	8.70
Aluminum	0.05 to 0.2	n/m	n/m
Calcium		0.556 mg/l	1.01 mg/l
Magnesium		3.06 mg/l	0.91 mg/l
Silver	0.1 mg/l	n/m	n/m
Nitrate-N (measured as nitrogen)	10.0 mg/l	0.208 mg/l	0.200 mg/l
Nitrite-N (measured as nitrogen)	1.0 mg/l	0.200 mg/l U	0.200 mg/l U

Water Parameter	MCL*	Well W02-2	Well W02-3
Bromide	0.1 mg/l	n/m	n/m
Antimony	6 µg/l	ND	ND
Arsenic	10 µg/l	2.00 µg/l U	2.00 µg/l U
Barium	2000 µg/l	9.84 µg/l	29.0 µg/l
Beryllium	4 µg/l	0.40 µg/l U	0.40 µg/l U
Cadmium	5 µg/l	ND	ND
Chromium	100 µg/l	ND	ND
Copper	1000 µg/l	1.9µg/l	1.52µg/l
Cyanide	0.2 µg/l	ND	ND
Fluoride	2 mg/l	ND	ND
Mercury by Cold Vapor	0.2 µg/l	ND	ND
Nickel	100 µg/l	ND	ND
Selenium	50 µg/l	ND	ND
Thallium	2 µg/l	ND	ND
Chloride	250 mg/l	18.8 mg/l	64.5 mg/l
Langlier Index @40F		-0.33	-0.07
Langlier Index @140F		-0.75	1.01
Iron	0.3 mg/l	0.134 mg/l	0.340 mg/l
Odor (TON)	3 TON	ND	ND
Manganese	0.05 mg/l	0.013 mg/l	0.032 mg/l
Sodium	250 mg/l	123 mg/l	139 mg/l
Sulfate	250 mg/l	ND	ND
Zinc	500 mg/l	2.33 µg/l	2.00µg/l U
Total Potential	80 µg/l	n/m	n/m
Total Potential HAA5	60 µg/l	n/m	n/m
Ammonia (as nitrogen)		n/m	n/m
Dissolved oxygen		n/m	n/m
Hydrogen sulfide		n/m	n/m
Carbon dioxide		n/m	n/m

n/m not measured ND not detected

* MCL Maximum Contaminant Level, as set by the Environmental Protection Agency (EPA

The water from the existing City well source, as well as the water from the pair of 2002 wells to the south of the community, has a problem with treatment using conventional methods of coagulation and multimedia filtration because of the high levels of TDS, which interferes with the coagulation process. However, for the past 30 years, minimal treatment has been performed on the City well source, which is similar to this well field for Pump House 2. There has been some multimedia filtration, but aside from chlorination and the above mentioned filtration, no other treatment steps were taken.

The water has been used for bathing, clothes washing, hand washing, and steam baths, but not for drinking.

E. Site Plan

The location of the proposed Pump House 2 is shown below in Figure 1 below. It is located on Lot 4, Block 18, Plat 97-3 (South Chefornak Subdivision). The full site plan is shown in sheet C2 of the 35% Plan Set presented in Appendix A.

Figure 1—Proposed Location: Pump House 2

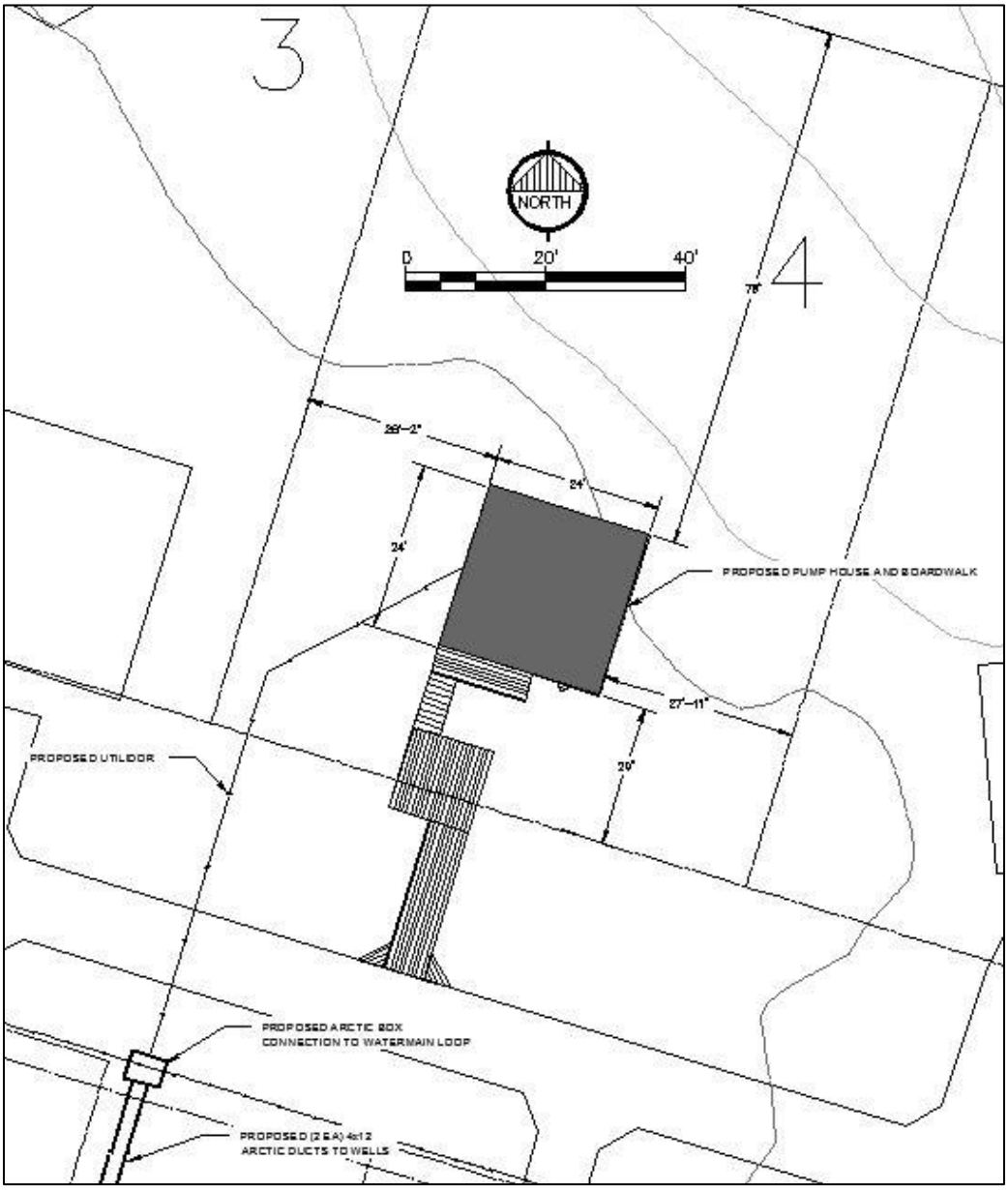
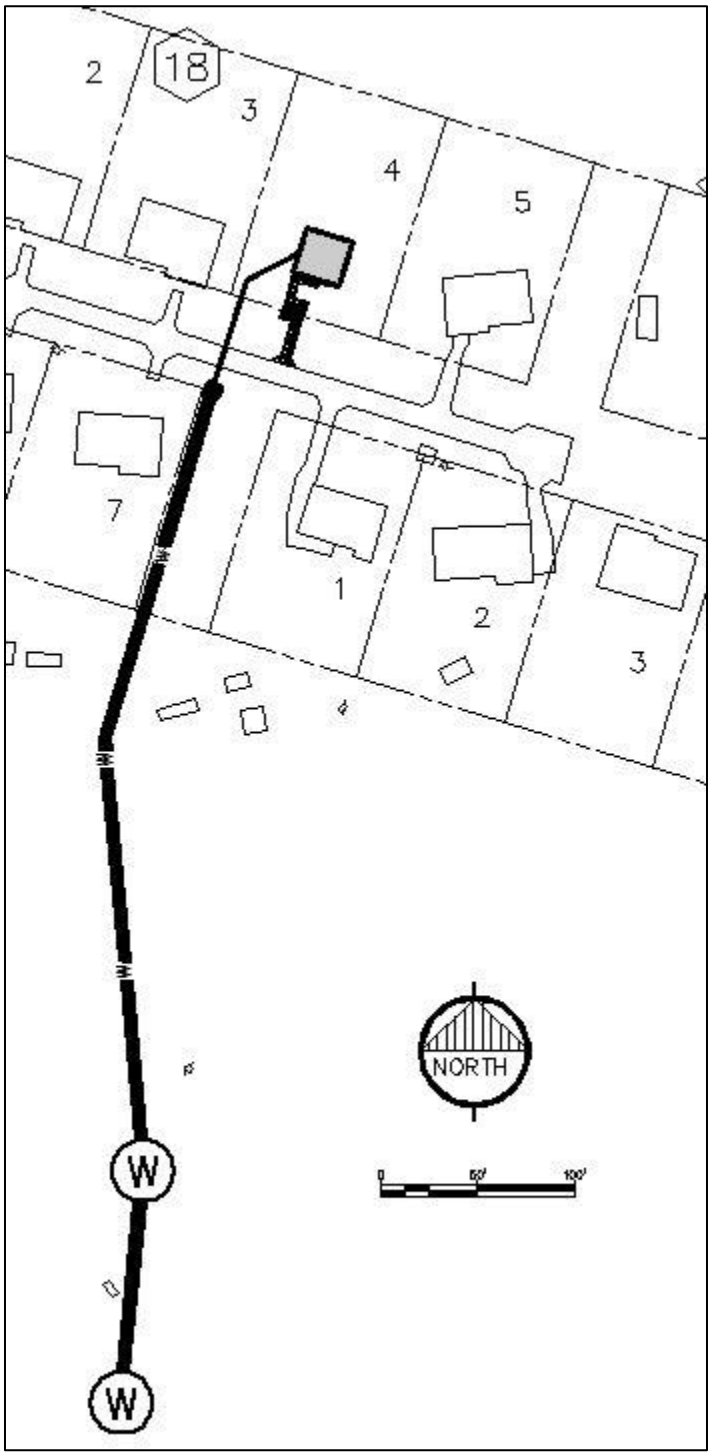


Figure 2 below shows a site plan of proposed Pump House 2 with the connecting Utilidor, junction boxes, water transmission line, and well field.

Figure 2—Vicinity Map of Pump House 2, Connecting Pipelines, and Well Field



III. Design Requirements and Considerations

A. Population/Design Life

Based upon U.S. Census Data for Census Years 1990, 2000, and 2010, and a 2012 population estimate, population is shown in tabular form below.

Year	Population	Difference	Annual Pct Increase Equivalent
1990	320	-	-
2000	394	79	2.1%
2010	418	24	0.6%
2012	434	16	0.4%
2034 (projected)	*458*	*24*	*0.5% (assumed)*

As seen from the above figures, the population growth rate has been steadily dropping in the last 30 years. A conservative estimate for an annual growth rate in the next 20 years (assuming a design life of 20 years) is 0.5%. With this in mind, the 20 year design horizon population figure is estimated at 458.

B. Soil Conditions

Chefornak is located on the south bank of the Kinia River, about 6 miles east of Etolin Strait. It lies near the present coastal margin of the Yukon-Kuskokwim Delta, which is comprised of thick unconsolidated alluvial, deltaic, and Aeolian deposits of silts and fine sands, with some gravelly sands. Sediments in this area are at least 237 ft thick. Basaltic flows from Tern Mountain, about 5.5 miles to the south, extend northward to beneath the City of Chefornak. The City well drilled in Chefornak lies on a recent volcanic sequence within about 30 feet of the surface. This lava flow is about 27 ft thick. Soil conditions around the existing City pump house consist of about 1 ft of organics, followed by about 16 ft of areas of frozen or thawed silt, fractured basalt, and hard basalt.

C. Regulatory Requirements

- Applicable Codes: Title 13 of the Alaska Administrative Code, Chapters 50 through 55, was adopted and amended to the 2009 International Building, Fire, and Mechanical Codes, as adopted and amended by the State of Alaska.
- Design Minimum Temperature: -45°F
- Design Degree-Days for heating to 65°F: 13,200 °F*Days / year

- Design Degree-Days for heating to 50°F: 7,900 °F*Days / year
- Design ground snow load: 40 lb/sf. Note that snow drifting is a significant factor in Chefornak. The structural engineer must take drifting into account during design.
- Maximum Wind, 3-second gust: 130 MPH, Exposure C.
- Seismic Design: Site Class D, Spectral response acceleration at short period--- S_{DS} = 0.15, for long period--- S_{D1} = 0.07

D. Pump House 2 Design Criteria

1. Geotechnical Considerations

Soil sampling was performed for the site of Pump House 2 on August 20-21, 2014, by Golder and Associates (Golder). A Hilti impact hammer was used to sample soils down to about the 6 ft level. Their report will be placed in the Appendix as soon as it is issued, which will be at the end of September, 2014. Preliminary findings indicate a seasonal thawed layer from 2 ft to 3 ft below the surface. Soil conditions indicate frozen soil in irregular areas.

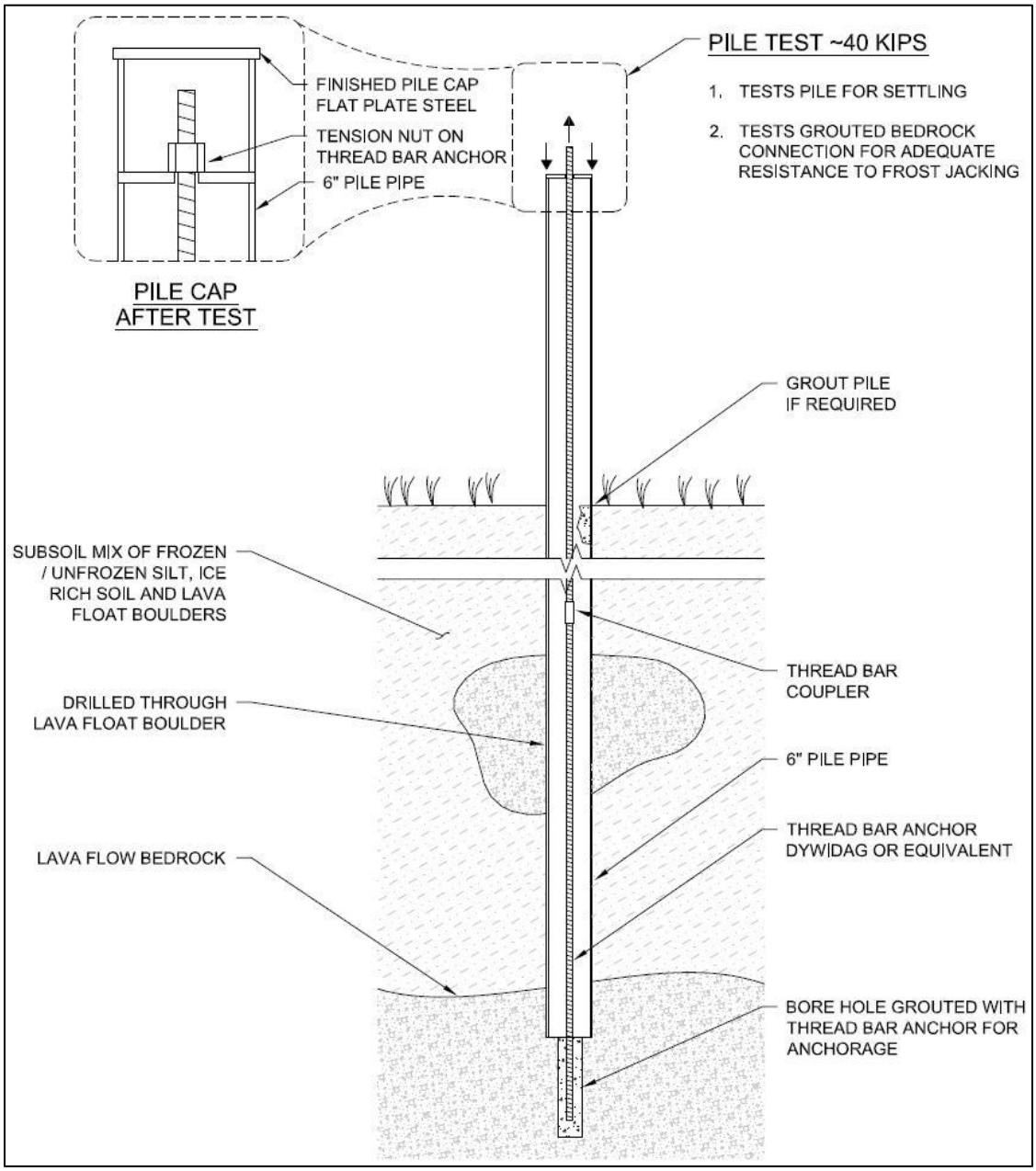
Golder's recommendation is to use a 6-in pipe micropile, end bearing, in bedrock (ancient lava flow), for a foundation. There are now portable drill rigs that can be flown in with small air freighters into Chefornak. This work can be done in spring before thaw, so a foundation would be ready for building construction when the first barge comes to Chefornak in June.

The foundation design is to drive the piling down to an obstruction (lava boulder floating in matrix of silt and ash), and then the obstruction is drilled about 2 ft. If soil is encountered after going through the obstruction, then the pile is continued until bedrock, where further drilling of about 1.5 ft depth is done to seat the pile. See **Error! Reference source not found.** below, for a section of a typical micropile, as envisioned for Chefornak.

A Technical Memorandum of Preliminary Geotechnical Findings – Chefornak Pump House is presented in Appendix D. The final report will be available later in October 2014.

General loadings on piles will range from 7 to 14 kips. Uplift from frost heave will require that these micropiles be rated for uplift in excess of the static loading, due to 40 psi ice adhesion along the pile perimeter through the expected active layer for frost uplift. This ice adhesion translates to almost 10,000 lb per foot of 6-in pipe. It will be necessary to have a tension bar grouted into the bedrock at each pile to resist this frost uplift in the soil active layer.

Figure 3—Typical Foundation Micropile



2. Building Shell and Foundation Structural Design

a. Building Form

The building will be a one story rectangular structure, 24-ft wide x 24-ft long, with a gross area of 672 sq ft. with an open ceiling. The roof will consist of a ridge beam and columns embedded in structural insulated wall panels (SIP), supporting engineered wood beam rafters with a clear span between the ridge and the exterior side walls. The ends of the roof beams will be configured in gable fashion.

The floor will be standard wood joist construction (BCI or LVL type joists) sitting on glu-lam beams, which in turn are supported on a 6-in micropile pipe foundation.

Partition walls will be non-structural and will be 2x4, or 2x6 framing, as required.

Building outside walls will be 8 in thick SIP panels, and the roof will be constructed of engineered joists (BCI's) with treated OSB or plywood sheathing.

Wind will be the governing factor in designing the structure to resist wind pressures and the resulting overturning moment on Pump House 2 when the 2500-gal water tank is empty (worst case).

b. Exterior and Interior Materials

Exterior materials for the roof and walls will be treated OSB or plywood, sheathed with metal roofing and siding. The soffit on the underside of the floor will be plywood. The area under the foundation will be secured with chain link fencing to prevent unauthorized entry under the building.

Interior materials will be OSB or plywood on the walls and ceiling, with vapor barrier and 5/8" gypsum wall board bonded to white FRP panels on the surface for cleanliness. Structural subfloor will be 3/4" thick plywood covered with 3/8" thick underlayment and an epoxy floor.

3. Internal Water Storage Tank

a. Design Criteria

The following design criteria govern the parameters of the City well pump and Pump House 2 water storage tank:

- Continuous water demand is greatest when the school is pumping water continuously to feed its UF/RO process, about 10 gpm, or about 14,000 gallons per day. Most of this demand will be handled by the 22,000 gal storage tank at the future Washeteria.
- Pumping well water from the 2002 well field is limited by experience to 6 gallons per minute (gpm) when the two wells are pumping together. Continuous demand for Pump House 2 would be 3.2 gpm or 53% duty cycle. The design goal is to minimize the level of total dissolved solids (TDS) in the pumping of water from the two wells. To accomplish this goal, the closer the well is pumped to the average daily flow rate, the lower the TDS will be relative to higher pumping rates with higher well draw downs (with possible up-coning of higher saline water below the well pump. In the case of the two wells, it has been

shown by well pump test data that TDS should be around 600 mg/liter with continuous pumping at 3 gpm per well.

- Water storage in Pump House 2 should be 2,500 gallons, as this will allow about 7 hours continuous demand at 6 gpm without running the two well pumps.
- A TDS meter should be installed on the well water line to the water storage tanks, downstream from the cartridge filter. The meter should be calibrated to the actual TDS periodically, determined by gravimetric methods by evaporating a known volume of sample water and weighing the residual solid material. The TDS meter sample water will have to be further filtered to 2 microns.
- Tankage should be 1 ea 2500 gallon HDPE vertical upright tank, approximately 8 ft dia x 7.5 ft high, NSF 61 listed, and a floor pressure not to exceed 500 lb/sf on the floor of Pump House 2.
- There must be two ports: one for drawing water out of the tank (tank suction), and another for filling the tank on the top of the tank. An air gap should be provided above the top of the tank with a standpipe extended down to the bottom of the tank interior to minimize splashing and disturbing of the water surface. This will maximize accuracy of the ultrasonic tank level sensing unit.

b. Foundation

The tanks will sit on the finished floor of Pump House 2 atop a lined basin that will catch condensation from the tank walls, preventing water from accumulating on the Pump House floor. The loads on the floor area supporting the water storage tanks will be additional micropiles, as determined by the Structural Engineer.

4. Building Shell Thermal Design

The thermal envelope of Pump House 2 is designed to provide exceptionally low heat loss. The walls will be 8-inch rigid Styrofoam in SIP panels, so the insulation value of the walls will approximately be R-30. The roof will consist of 14 in deep BCI type rafters and 12 in of fiberglass insulation for an approximate R-40 insulation value. The floor would be BCI type joist construction with 12 in of fiberglass insulation for an approximate R-40 insulation value.

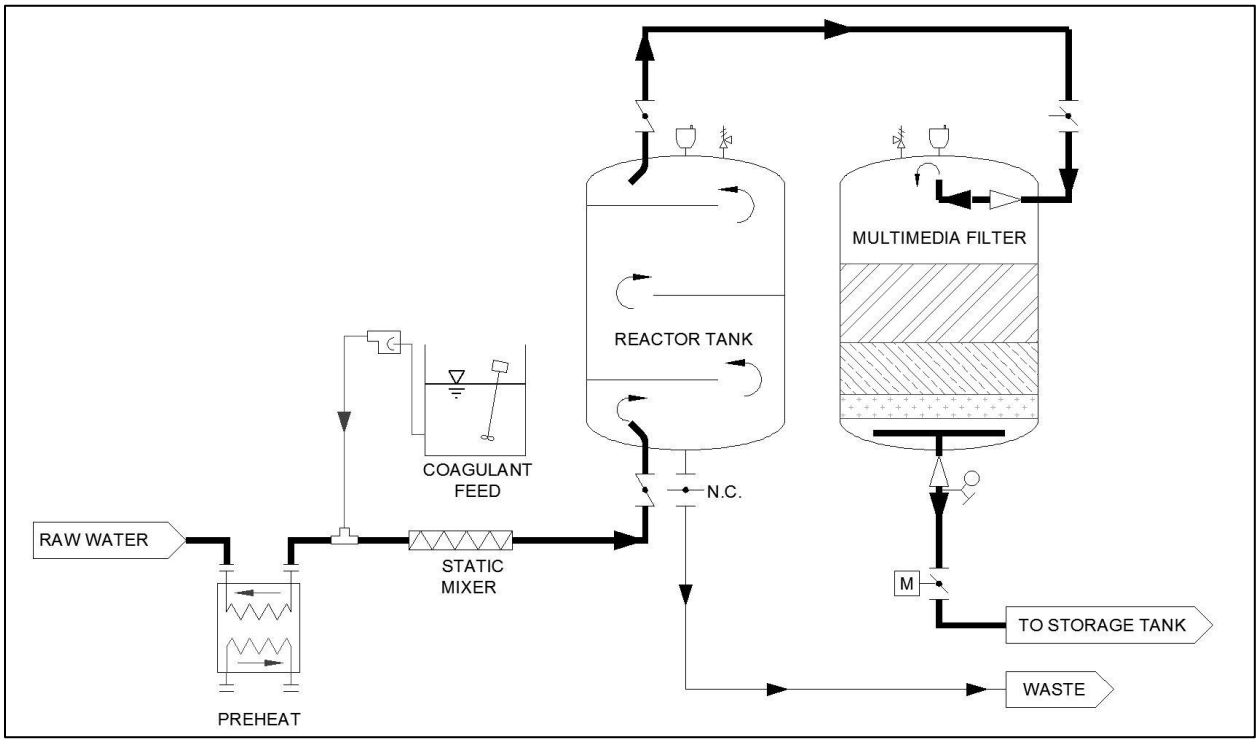
5. Water Treatment

Water used for the past thirty years in Chefornak from the existing PHS well has had minimal treatment, mainly consisting of filtration with multimedia filters, generally without coagulant, and chlorination. The water produced is not used for drinking, due to higher levels of total dissolved solids (TDS) up to 1000 mg/liter. This water is

instead considered "utility" water for hand washing, bathing, steam baths, and laundry. There are two practical possibilities for treatment:

Treatment Alternative 1: Treatment by multimedia filtration and a coagulant is generally better at removing color from the water than by most other common means. It consists of preheating the water from 35°F well water to 50°F, injection of a coagulant into the process stream, mixing it, and letting the water through a reactor vessel to give the coagulation 30 minutes of process time to form adequately sized floc. After that, the floc-laden water flows through a multimedia filter to trap the contaminants. Figure 4 below illustrates the process.

Figure 4—Multimedia filtration process flow diagram



Advantages: Produces more aesthetically pleasing water, a slightly better product for utility use: bathing, hand washing, clothes washing. Also saves on the cost of cartridge filters in Treatment Alternative 2.

Disadvantages: Capital costs for multimedia filtration are about $40,000 higher than cartridge filter systems. To optimize the system, raw water to be filtered must be heated from 35°F well water to 50°F before filtration to make the process work, which adds an additional $5.25 per hour of oil for water preheat, or $0.01 per gallon to the price of water to cover heating cost. Operator knowledge of the

multimedia process is most important to have the system work, or the system will fail to filter the raw water.

Treatment Alternative 2: A simplified filtration system would consist of two stainless filter housings in series: the first one containing a 10-micron pleated filter, and the second one containing a 5-micron filter. This simplified filtration system will keep the water tanks and water lines cleaner and will minimize sediment in the water distribution loop.

Advantages: This process is a simple flow-through type with no preheat, addition of chemicals, chemical injection equipment. No special training is needed, other than the careful change out or cleaning of the filter elements. Capital costs are relatively low, about $10,000.

Disadvantages: Removal of color in water is not as nearly effective as multimedia filtration and coagulant. Cleaning of cartridge filters takes more effort than backwashing a multimedia filter.

A typical stainless steel filter housing is shown in Figure 5, below.

Figure 5—Cartridge Water Filter Housing

Disinfection of Water. Disinfection of the water used in the distribution loop is optional, as this water comes from true groundwater, and the water is not used for drinking. Disinfection can be accomplished by injecting well water after filtration with a calcium hypochlorite solution with a peristaltic pump. The calcium hypochlorite solution would be prepared in a separate mixing tank, using calcium hypochlorite powder. The solution would then be allowed to settle to drop out the clay binders in the powder, and then the clear solution pumped to the hypochlorite vat. A separate chlorine room with ventilation would be set aside for chemical mixing and pumping.

A serious problem with chlorination in this type of water is the formation of disinfectant byproducts (DBP) from contact of the organic carbon with dissolved hypochlorite in the water. The EPA has set limits on DBP, and exceeding these limits will cause violations. Unless there is an overriding reason to chlorinate, it should not be used. The school UltraFiltration/reverse osmosis (UF/RO) water treatment process has issues with chlorinated water. Also, a relatively long residence time of water in the proposed 22,000 gallon Washeteria water storage tank could promote additional DBP. So for the time being, it is recommended that a separate room be set aside for chlorination, UV disinfection, or other process during the construction of Pump House 2, but equipment not be installed at this time.

6. Distribution System Water Use and Design Considerations

It is critical to have adequate water available in the existing water distribution system:

- The watering points require adequate water to operate so the public can obtain water for bathing and washing clothes;
- To maintain circulation in winter, and to prevent freezing of the water distribution, it is necessary to have water from the 2002 well field available to pump into the system;
- It is necessary to have an adequate flow of water to supply the school UltraFiltration/Reverse Osmosis (UF/RO) water treatment system with adequate water to fill their potable water tanks without interruption.
- It is necessary to have a continuous flow of water through the 3-in HDPE water loop piping of 35 to 40 gpm to keep enough heat in the far reaches of the 10,000 LF water loop.
- Pump House 1 would be the primary water supply (2/3 of demand), with Pump House 2 being secondary supply (1/3 of demand).
- Pump House 1 would run the distribution system loop pumps, with Pump House 2 being the backup circulation pump system.
- The distribution water loop would be heated from waste heat off generators in the City Power Plant. Pump House 1 would provide backup heat for the

distribution system, with Pump House 2 being the secondary backup heat source for this critical function.

7. Wastewater Generation

Wastewater generation must be minimal in this facility. The only economical solution to the disposal of wastewater is to haul it away by the existing wastewater vacuum tank trailer or sled. This limitation on wastewater generated affects the choices of equipment in design. For example, a multimedia filter would be one option in the filtration of the well water, but backwash water would require a settling pond and a place to dispose of decanted waste water after the filter sludge is settled in this pond. There is no room for a settling pond on the property, and there is no place to drain out the clarified water, except for hauling it away in the City's vacuum tank trailer. However, there is a possible alternative for disposing of backwash water, and that is to recycle the decanted backwash water back into the process stream, and to dispose of the settled sludge in the honeybucket dump site using tank haul. Sludge from backwashing would probably be hauled every 4 to 6 backwash operations.

If a cartridge filtration system is used, then the only wastewater generated would be the contents of the filter housings.

Condensate from the water tanks sweating also needs to be accommodated, as well as incidental uses generating wastewater, such as mopping and cleaning.

To accommodate this wastewater, a central rectangular HDPE sump of 50 to 100 gallons should be designed into the building floor to store this generated wastewater. When the sump becomes full, it would be pumped by hose and sump pump into the City vacuum trailer for disposal.

8. Drainage, Waste, and Vent Piping Requirements

Drainage, Waste, and Vent (DWV) piping will be minimal with this low wastewater generating system in Pump House 2. If the sump opening is sealed with a water trap, then a single air vent will have to be run to the roof ridge area to allow any gases, or difference of pressure, to vent to the outside.

9. Distribution System Piping Connections

The existing water distribution system for the watering points, school, Washeteria, clinic, or other load is an 8 in inner pipe duct x 15 in OD arctic pipe carrying two each 3 in SDR11 HDPE water pipes. These two water pipes form a circulating water loop that circulates heated water through the arctic pipe duct that keeps the distribution system warm. Connections to this water distribution piping at the building will be

done through an insulated Utilidor from the distribution system junction box on the south side of the boardwalk to the building, designed to allow for movement of the Utilidor meeting the building wall without undue stresses.

10. Heat Loads and Air Requirements

The heating system in Pump House 2 will be a simple 2-pipe hydronic system, with the following heat loads and preliminary heat estimates for 65°F inside temperature and -45°F outside temperature:

- Heating building envelope using unit heaters: 8,700 BTU/hr
- Heating building make-up air for ventilation: 13,100 BTU/hr
  1 air change per hour;
- Providing heat for well field and arctic pipe transmission: 16,500 BTU/hr
- Providing backup heat for water distribution loop: 150,000 BTU/hr
- Heating arctic entrance to building and chlorination room: 6,000 BTU/hr

  Total Estimated Worst Case Heat Load at -45°F outside temp: **194,300 BTU/hr**

The heating boilers will be two ea 172,000 BTU/hour input high efficiency oil-fired cast iron units, using a 50% propylene glycol/deionized water mixture of heat transfer fluid. It is important to not use local water in the mix, as it may be too high in total dissolved solids.

The intent of the heating system design is to minimize the amount of heat production required for Pump House 2 by utilizing waste heat from the City power plant to keep the water distribution loop heated to 50°F. If the water distribution loop is heated by recovered waste heat, then the maximum heat load at -45°F outside temperature would be about 44,300 BTU/hr.

The temperature differential between hydronic supply and return will be 20°F. One hydronic pump with backup will be required for the hydronic heating system. The pump will be a canned rotor type with internal variable speed control to provide a constant pressure head as loads come on and off the heating system.

All piping, boilers, and appurtenances will be well insulated to minimize standby losses, thus saving heat energy. Coils will be operated by thermal or motorized valves to put the heat where it is needed, and not wasted in standby losses.

Pump House 2 is a low occupancy building, so ventilation requirements will be minimal: 0.5 air changes per hour for unoccupied space, and 1.0 air changes per hour for an occupied building (usually one operator for a limited time. This translates to 50 cfm for unoccupied and 100 cfm for an occupied building.

11. Ventilation and Air Makeup System

The ventilation and air make up system will consist of a motorized damper and arctic air intake hood, coupled with an exhaust fan, rated to 200 cfm with speed control, and a motorized damper in the exhaust duct with weatherproof exhaust hood.

12. Electrical

Electric power will come directly from the nearby City electrical distribution system. It will go through a 100 amp meter/main with a 100-amp circuit breaker on the outside of the building. See one-line diagram on Sheet E4.1 of the 35% Plan Set (Appendix A).

To minimize electrical power use in this high cost area, high efficiency motors will be used and run time minimized or run speeds reduced by variable speed drives where appropriate. Interior lighting will be accomplished using LED wraparound tube type lamps with prismatic lenses. Outside lighting will consist of LED fixtures on photocells.

E. Pump House 2 Well Field Design Criteria

The existing wells W02-2 and W02-3 were drilled in 2002 and flow tested for 15 months, starting in May 2005. It was found that if the flow rate of each well was limited to 3 gpm, then the total dissolved solids (TDS) would not climb higher than 600 mg/liter. With this in mind, it was decided to use this well field as a backup to the existing City well, and to supplement the present flow of the City well.

1. Geotechnical

Well W02-2 was drilled down to 278 foot depth, and well W02-3 was drilled to 302 foot depth. The wells passed through multiple clay, lava flow, and silt layers before encountering the water bearing sand layer. Well drilling logs can be found in Appendix C.

2. Well Heads

The well heads will have to be shortened to keep the height of the bases of the arctic pipe transmission lines connecting the well head arctic boxes limited to 2 ft above the surface of the ground at the well field. The exposed well pipe above the ground will be insulated with a piece of 8 in x 15 in arctic pipe slipped over the 6 in steel well casing. The well head arctic box on the top of the well casing will be constructed of 1/8 in thick aluminum, with 4 in of extruded rigid Styrofoam insulation around all sides, bottom, and top of the box.

The well will have a sanitary seal on top, with a pitless adaptor on the side of the well for the drop pipe. All this will be inside the well head arctic box.

A method for hoisting out the well pump and HDPE drop pipe will be provided so that the well pump and drop can be hoisted out by hand or by use of a small portable electric winch.

3. Well Connection to Pump House 2

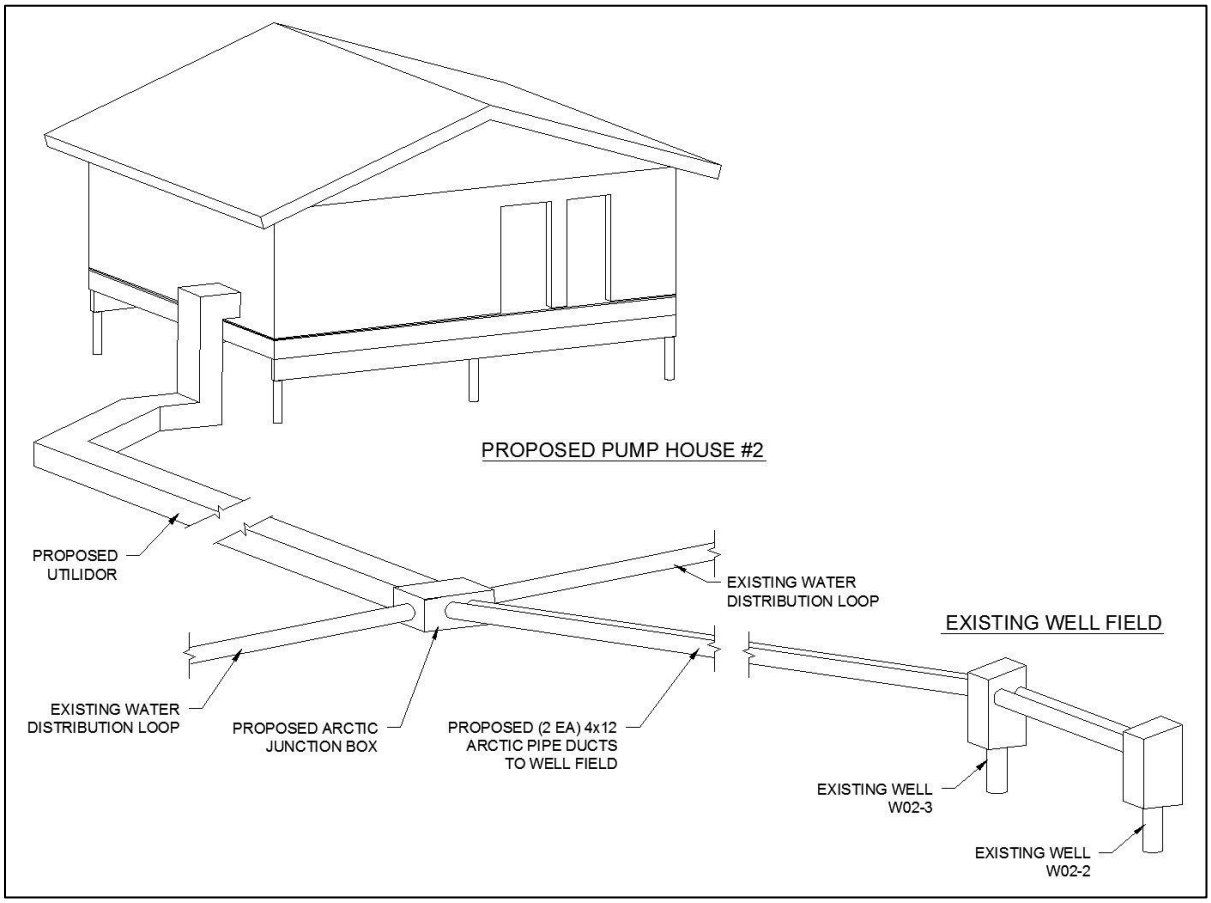
The well drop pipe will be connected to the side of the well casing inside the well with a 1 in pitless adaptor for easy connection to the HDPE pipe connecting the well to Pump House 2. Two each 4 in HDPE by 12 in outside diameter (OD) arctic pipes will be used to connect the well head box to the water distribution system box on the outside of the Pump House. After that, a Utilidor will run from the water distribution box to Pump House 2 that will carry both 3" HDPE water distribution pipes and the well HDPE pipes. The two arctic pipes will serve as a transmission line duct to house:

- Two well water 1" HDPE delivery pipes running to the Pump House;
- Two well water 1" HDPE delivery pipes running to the Pump House;
- A hydronic loop to keep both arctic pipe transmission ducts warm, using 1" PEX,

An electrical conduit outside the arctic pipe will house control wiring for the well pumps and emergency thawing heat tapes for each well.

Below is a conceptual view of the well and connecting piping to the proposed Pump House 2.

Figure 6—Conceptual drawing of Pump House 2 Utilidor and Well Field arctic pipe connections



4. Well Line Heating

The well transmission ducts will be heated with a 1 in PEX hydronic heating loop, using a propylene glycol mix as the heating medium. Heating using oil-fired hydronic heat costs one-third of the cost of electric heat, so over a year, savings are substantial.

Backup electric self-limiting heat trace of 8 watts per foot will be provided to thaw out the well and connecting lines in an emergency.

5. Tank Fill and Draw

The single 2,500 gallon water storage tank will be filled from the top. The tank will have a 2-in FIPT draw fitting with suction elbow inside the tank for connecting to the pressure pumps, or for draining down the tank during cleaning or other maintenance functions.

IV. Land Status/Site Control

A. Land Status

The site for the proposed Pump House 2 facility is Lot 4, Block 18, Plat 97-3 (South Chefornak Subdivision). This lot was recently transferred over to the City of Chefornak as part of a large land transfer by the Chefornrmute Village Corporation under the terms of the Alaska Claims Settlement Act. The transfer is in the process of being recorded at the Bethel Recording District.

B. Site Control

The City of Chefornak owns the lot on where the proposed Pump House 2 will be located. Site control documents for this property, as described in section A above, will be placed in Appendix B after they are recorded.

V. Environmental Determinations and Permit Requirements

An Environmental Assessment is required for all of Chefornak Indian Health Service grants for water and sewer improvements. An Environmental Assessment document is now being prepared for all Chefornak projects by State of Alaska, Village Safe Water, under contract with a private firm.

There also will be a requirement for getting an archaeological clearance from the State Historic Preservation Office. The Association of Village Council Presidents (AVCP) has had archaeological investigations conducted in the area, and may well have clearances in place for their work that could apply to the existing site.

An approval to construct and operate may be required by Alaska Department of Environmental Conservation, Drinking Water Division.

An Approval to Construct will be required after plan review from the State of Alaska, Department of Public Safety, State Fire Marshal, Plan Review Bureau, Anchorage office.

VI. Cost Estimates

A. Conceptual Budget

1. Capital Costs

CHEFORNAK PUMP HOUSE 2 --- 35% CAPITAL COST ESTIMATE					
Line No.	Cost Description	Unit Cost	Unit	Quantity	Extended Cost
1	Pile Foundation	$ 5,750	EA	9	$ 51,750
2	Foundation Beams	$ 500	EA	3	$ 1,500
3	Building Shell	$ 140,829	Lot	1	$ 140,829
4	Mechanical	$ 52,500	Lot	1	$ 52,500
5	Electrical and Controls	$ 45,000	Lot	1	$ 45,000
6	Well Field Improvements and Transmission Line	$ 183,600	Lot	1	$ 183,600
7	Labor	$ 3,000	Day	152	$ 455,143
8	Equipment Rental	$ 3,500	Month	10	$ 35,000
9	Freight	$ 65,000	Lot	1	$ 65,000
10	Support	$ 20,000	Lot	1	$ 20,000
11				**SUBTOTAL**	**$ 1,050,321**
12	Engineering @10%				$ 105,032
13	Construction Management @16%				$ 168,051
14				**TOTAL**	**$ 1,323,405**

Note: This capital cost estimate is based upon the installation of a cartridge type filtration system. If a multimedia filtration system is desired, add $60,000 for equipment and heat exchanger. The capital cost of this option would be **$1,383,405**. If utilizing waste heat recovery from the distribution system for well water preheat, add $12,000. The capital cost with multimedia filtration and heat recovery for well water preheat would be **$1,395,405.**

2. Operation and Maintenance (O&M) Costs

The following O&M budget has been developed using values calculated from estimated performance of the plant, coupled with an estimated amount for City administrative

tasks. Repair and replacement of equipment, as well as annual capital replacement cost over the estimated life of the building have been included.

Expense Category	Annual Estimate	
Administration	$	3,000
Labor	$	8,000
Miscellaneous Materials	$	300
Electricity	$	12,174
Heating Fuel	$	4,200
Water Treatment	$	1,600
Sewage Treatment	$	-
Insurance	$	1,000
Repair and Replacement Account	$	4,025
Other	$	750
Capital Replacement Account	$	3,649
Total Annual Expenses	**$**	**38,697**

Administration		
Administrator	$	1,000
Clerk	$	300
Office Supplies	$	100
Postage	$	100
Occupancy Costs	$	100
Other		
Total Administration	**$**	**1,600**

Labor		
Operator I	$	5,000
Operator II	$	2,500
Training	$	500
Other	$	-
Other	$	-
Total Labor	**$**	**8,000**

Miscellaneous Materials		
Cleaning Supplies	$	300
Other	$	-
Other	$	-
Total Miscellaneous Materials	**$**	**300**

Electricity		
Electricity (17,391 kwh/yr)	$	12,174
$0.70/kwh	$	-
Total Electricity	**$**	**12,174**

Heating Fuel		
Fuel (600gal/yr, $7.00/gal)	$	4,200
Other	$	-
Total Fuel	$	4,200

Water or Water Treatment		
Chemicals	$	-
Testing	$	1,500
Postage/Freight	$	100
Filter elements	$	1,500
Total Water/Water Tmt	$	1,600

Sewer or Sewage Treatment		
Chemicals	$	-
Other		
Other		
Total Sewer/Sewer Tmt	$	-

Insurance		
Building Insurance	$	680
Liability Insurance	$	320
Other	$	-
Total Insurance	$	1,000

Other		
Vehicle Expense	$	500
Gasoline	$	250
	$	-
Total Other	$	750

This O&M cost estimate assumes a cartridge type filtration system. If a multimedia filtration system is desired, well water will have to be preheated to 50°F for effective color removal. For a Pump House 2 average flow rate of 3 gpm of water supplied to the water distribution, this would take 2,000 gallons of fuel oil per year to supply preheat for well water. Pump House 2 is about 2500 feet from the City Power Plant, which is too far to run heat recovery lines directly for well water preheat. However, the water distribution loop could carry recovered heat from the Power Plant to Pump House 2 for preheating the well water. The disadvantage of this scheme is that the whole system becomes more complex and a challenge to operate and maintain. With oil heat, the

additional O&M cost for multimedia filtration would be $15,000 per year. With waste heat recovery, the additional O&M cost is estimated at $5,000 per year, primarily for electricity.

VII. Recommendations

1. The foundation for the building should be micropiles anchored to bedrock, for resistance to settlement and frost heave.
2. To be cost effective, all micropiles should be placed in the spring (March and April) for Pump House 1, Pump House 2, and the Washeteria to minimize mobilization and demobilization costs for each project (estimated 70 piles total).
3. The design should be completed and approved for construction by February 1, to meet material procurement for the summer barge.
4. The pile foundation designs for Pump House 1, Pump House 2, and Washeteria should be completed by the end of this year for early January bids to enable March-April construction.
5. The Pump House 2 building shell should be engineered wood joists for the floor, with SIP walls and engineered wood rafters for most rapid erection of the shell. Roofing and wall siding should be standard 3 ft wide ribbed roofing for ease of installation and maintenance.
6. Clearance under Pump House 2 should be a minimum of 4 ft to allow for wind to be unobstructed to the maximum extent to prevent snow drifting around building. If possible, metal wire perimeter fencing should be 4-inch square mesh to minimize obstruction to winds.
7. An adequate amount of shelving and cabinet space should be allowed for water testing, recordkeeping, and spare filters and parts.
8. The multimedia filtration option should be evaluated with the following facts in mind:
    - It is an optional process for filtering water that will not be used as drinking water;
    - An additional capital cost will be incurred ($60,000 to $72,000).
    - Annual O&M costs will be increased ($5000 to $15,000).

    This option should be evaluated by the City and Village Safe Water for affordability, both in capital costs and O&M costs.