Akiak Water and Sewer Design

Date:	May 13, 2022
To:	Akiak Native Community
Thru:	Joel Neimeyer, P.E. - Akiak Tribal Consultant
From:	Matt Edge, P.E. – CRW Engineering Group, LLC
Project:	Task 5 Water and Sewer Design
Subject:	Water and Sewer Design Analysis & Recommendations,

1. Introduction

This technical memorandum is amended to address comments provided by ANTHC on April 28, 2022, pertaining to the original memorandum dated March 11, 2022.

The Akiak Native Community (ANC) is threatened by riverine erosion along approximately 2,600 feet of the Kuskokwim River. Streambank revetment projects to mitigate erosion have been found to be too expensive and unlikely to be funded by Federal or State agencies. The only viable option available is for the community to retreat from the advancing river. This involves relocating homes and other structures to new locations in the community, including the construction of a new subdivision on the western side of the village, away from the river.

This memorandum summarizes the design analysis of a proposed water and sewer extension to serve the new subdivision being developed west of the existing honey bucket lagoon. The analysis includes evaluation and sizing of new water and sewer mains and a new lift station and force main to serve the subdivision. It also analyzes the effects of the system expansion on the operations of the existing water treatment plant (WTP) and the capacity of existing wastewater lift stations downstream of the proposed subdivision.

2. Water and Wastewater Design Criteria

Water demand was estimated based on information found in past sanitation projects in Akiak and confirmed in an interview with the WTP operator. The population growth projections, water usage, wastewater flows, and lift station design criteria were based on the following sanitation projects dating back to 2001:

- The 1999 Gravity Sewer, Lift Station, Force Main, Lagoon Project (AN 97-L76, 99-P39, 01-Q28, 02-M98) which provided a gravity sewer system to Lift Station #1 on Pork Street and a force main to the wastewater lagoon.
- The 2001 Water Treatment and Distribution project (AN 94-A35, AN 96-L50, and AN 97-L76) which provided a new water source, water treatment plant, storage tank, and filter backwash lagoon, as well as a two water distribution loops (Loops #1 & 2).
- The Akiak 2008 Water and Sanitary Sewer Improvements which extended the water distribution Loop #2 (Loop Extension A), gravity sewer system, and Lift Station #2 on Dummocks Street with a force main connecting to the existing gravity sewer system.
- The 2011 Water and Sewer Improvements which further extended the water distribution Loop Extension #A (Loop Extension B), and sewer mains to unserved houses along Dummocks Street.

- The 2021 Water and Sewer Main Extensions to 6 Homes which again further extended the water distribution Loop Extension B (Loop Extension C), and sewer mains along Dummocks Street.

Akiak's population grew from 299 people in 1999 (DCRA) to 420 in 2019 (DCRA). When the WTP was first built in 2001, the design was based on a population growth rate of 0.6% between 1995 and 2015 which was an underestimate of the 1% growth rate that actually occurred. Later, the Akiak 2008 Water and Sanitary Sewer Improvements design projected a 1.5% population growth rate from 2000 to 2020, which was an overestimation of the 1% population growth rate that occurred. Therefore, based on historical growth, the project at hand will assume a 1% population growth rate to determine future population and calculate associated water demand and wastewater flows. 2019 data indicated a population of 420 and reflects the highest recent population prior to a 7% decrease in population (to 391) reported in 2020. It unknown whether the decrease was associated with COVID-19 pandemic and if it is indicative of future population trends.

Previous design criteria assumed an average of 4 to 5 residents per household. This project assumes 4 residents per home, consistent with the most recent design projects. Akiak's sanitation system has been designed for 60 gallons per capita per day (gpcd) for the average water use. Past design criteria have consistently used peaking factors of 2 and 5 for peak daily and hourly water demand, respectively. The WTP operator indicated that the community typically uses 11,000-12,000 gallons per day (gpd), approximately 32 gpcd.

For all past projects, average per capita wastewater flow was estimated to be equal to the average per capita water demand. Peak hourly wastewater flow was estimated to be 3.5 times the average daily wastewater flow in the 1999 Gravity Sewer, Lift Station, Force Main, and Lagoon Project. The Akiak 2008 Water and Sanitary Sewer Improvements increased their projected peak hourly wastewater flow to 5 times the average daily wastewater flow. The peaking factor was again increased to 6 for the most recent project 2021 Water and Sewer Main Extensions to 6 Homes. The proposed project will similarly set the design peak hourly wastewater flow to 6 times the average daily wastewater flow.

Table 1 summarizes the existing demand, past project design criteria, and selected design criteria for the proposed project.

Table 1 - Design Criteria

	WTP Operator (Actual Demand)	**2021 Project[1] (Design Criteria)**	**Selected Design Criteria**
Design Population (Year)	420 (2019, DCRA)	455 (2032) (18 yrs @~1%)	512 (2039) (20 yrs @~1%)
Residents per Home	n/a	4	4
Water System Details			
Avg per Capita Water Demand (gpcd)	32	60	60
Avg Daily Demand (gpd)	12,000	28,700	30,720
Design Peak Hourly Demand (gpm)	42[2]	100[2]	107[2]
Wastewater System Details			

Avg per Capita Wastewater Flow (gpcd)	32	60	60
Avg Daily Wastewater Flow (gpd)	12,000	28,700	30,720
Design Peak Hourly Wastewater Flow (gpm)	50[3]	120[3]	128[3]

1. 2021 Water and Sewer Main Extensions to 6 Homes
2. Assumed 5 x Avg water use
3. Assumed 6 x Avg influent

The anticipated river erosion will require homes on the eastern side of the community (served by Loop 1) to be relocated or replaced with new homes on the western side of Akiak (served by Loop 2). Table 2 identifies the number of homes that are currently connected to the piped water system and the estimated number of homes that will be connected in the future. This information determines flows in the proposed sewer mains and sizes the lift station serving the new subdivision (Lift Station #3).

Table 2 – Estimated Homes Served With Piped Water

	Existing Served Homes (Current Residents)	**Relocated or New Served Homes (Current Residents)[1]**	**Future Served Homes (Community Growth)[2]**	**Total Served Homes (Design Population)[3]**
Water Loop #2 + Loop Extensions A, B and C	50	29	0	79
2021 Water Main Extension	0	6	23	29
Subtotal (Loop #2)	**50**	**35**	**23**	**108**
Water Loop #1	37	-17[4]	0	20
Total (Loops #1 & 2)	**87**	**35**	**23**	**149**

1. Relocated or New Served Homes quantifies total vacant lots less Future Served Homes. Available lots exceed actual demand for relocated and new homes.
2. Future Served Homes reflects community growth over 20 years assuming 4 residents per home.
3. Total Served Homes quantifies total vacant lots less approximate abandoned lots adjacent to Water Loop #1. Available lots exceed actual demand for relocated, new, and future homes.
4. Approximate quantity of homes relocated from Water Loop #1.

The proposed Lift Station #3 will serve 32 homes. Average daily and design peak hourly wastewater influent used to size pumps for the proposed Lift Station #3 are listed in Table 3. Note that three of the lots currently served by water Loop Extension C will be served by the proposed gravity sewer main and Lift Station #3.

Table 3 Lift Station #3 Influent

Homes from New Subdivision Served by Lift Station #3	Residents from New Subdivision	Avg Per Capita Wastewater Influent (gpcd)	Avg Daily Wastewater Influent (gpm)	Design Peak Hourly Wastewater Influent (6 x Avg) (gpm)
32	128	60	5.3	32

3. Water System Preliminary Design

The proposed water main extension will be located in Sara Street and Station Way and along the back lot easement between Sara Street and Dummocks Street and between Sara Street and Michael Street (see Attached Drawings). The extension will connect to Loop Extension C and will be constructed with the same pipe: 12-inch arctic pipe with a 16-gauge aluminum SPIR-L-OK jacket and a 6-inch diameter, SDR 11 HDPE core pipe with polyurethane insulation and a heat trace channel. The water main Loop Extension C is buried a minimum of 2 feet below ground plus an additional 6 inches due to the mounded trench fill.

Proposed water services will be constructed with the same pipe used for the Loop Extension C services: 12-inch arctic pipe with a 16-gauge aluminum SPIR-L-OK jacket and 4-inch diameter, SDR 17 HDPE core pipe with polyurethane insulation and a heat trace channel. Past projects have installed home circulation pumps for water service lines. Homes served by distribution Loops #1 & 2 (69 homes) have a Grundfos UPS15-42F, 115V or equal circulation pump in each home. The homes on Loop Extension A with service lines longer than 100 feet have an unknown type of internal circulation pump, and all homes on Loops B and C have Grundfos Alpha 15-55 SF/LC circulation pumps. The homes along the new Distribution Loop Extension will likely need to have internal circulation pumps.

4. Existing WTP and Distribution System Impacts

The relocated homes and population growth will increase demand on the water system. The capacity of the water treatment plant was evaluated to confirm that it can support this growth. The existing WTP was designed with a capacity of 56,000 gpd, approximately 38 gallons per minute (gpm). The existing water storage tank (WST) has a volume of 150,000 gallons and was built in 1999. The WTP typically operates at about 25 gpm for 12 hours per day to meet the current average system demand of 12,000 gpd. The WTP is able to meet the needs of the new subdivision because the 20-yr future average day demand is 30,720 gpd, significantly less than the WTP capacity of 56,000 gpd. The conclusion of this analysis is that the existing WTP can accommodate the proposed growth.

The distribution pressure pump, circulation pumps, and fire suppression pump were evaluated to determine if the pumps require replacement to serve the expanded system. The general configuration of the Akiak distribution system consists of distribution Loops #1 and #2. The loops are served by two 3-HP, 3-phase, Burks model 330GA7-1.25 pressure pumps which operate in a lead/lag configuration. The pump pressure set points range from 35 to 50 psi. Each distribution loop has a dedicated circulation pump for freeze protection. The circulation pumps are both 1.5-HP, 3-phase Grundfos model 50-160 circulation pumps. The system was expanded in recent years with three extensions (A, B, and C) to distribution Loop #2. The new water main extension will extend from Loop Extension C.

A. Pressure Pumps

The pressure pump performance was analyzed based on the system geometry, and a peak-hourly flow of 106 gpm. The existing pressure pumps have a combined capacity of 90 gpm, less than the design

peak hourly flowrate of 106 gpm. Further analysis indicates that the pump will be adequate until the population grows to approximately 430 people with the current per person water use, or the average water demand increases to 25,000 gal/day. Because most of the growth in the new subdivision is homes relocated from elsewhere in the system, upgrading the pump is not recommended at this time. New pressure pumps should be installed when the community grows, complaints of low pressure during high demand times occur, or when a rehabilitation project is completed at the WTP.

B. Circulation Pumps

The circulation pumps were evaluated to confirm that the additional head loss from the new water distribution loop was within the capabilities of the existing Loop #2 circulation pump. Given the Loop #2 system curve, the existing circulation pump would operate at around 110 gpm. While 110 gpm is less than the previous design flowrate design of 144 gpm, it results in a flow velocity of 1.5 ft/s which is adequate to prevent freezing. To confirm this, the increased distribution loop length was analyzed to determine the temperature drop at the lower circulation rate. The predicted loop return temperatures are 2 degrees colder than the supply temperature, confirming the adequacy of the lower circulation flow rate. No upgrades are recommended to the existing circulation pump.

C. High Demand Pump

The existing high demand pump was evaluated with the distribution expansion. The increased length of the distribution system would incur an additional 4 psi pressure drop at the end of the system. The existing pump is rated to supply 280 gpm at 40 psi. A reduction of 4 psi meets minimum fire flow requirements of 20 psi, so no improvements are recommended to the high demand pump.

Table 4 summarizes the water system capacitates detailed above.

Table 4 – Water System Capacities

	Existing Design	Current Use	Future Design
WTP Capacity (gpd)	56,000		
Water Demand (Avg gpd)	56,000	12,000	30,720
Pressure Pump Flow (gpm)	0-62	0-62	0-62
Pressure Pump Setpoint Range (psi)	35-50	35-50	35-50
Circulation Pump Design Flow (gpm)	144	144	110[2]
Circulation Target Velocity (ft/s)	2	2	1.5[2]
Water System Peaking Factor (Hourly Peak)	5	5	5
Water Storage [1]	4.3 days	5.5 days	4 days

1. 150,000 gallon tank with 28,000 gallons reserved for fire protection
2. Reduction in target velocity minimizes the need for upgrades with the water main extension.

5. Wastewater System Preliminary Design

The gravity sewer serving the new subdivision will run along Sara Street and Station Way and along the back lot easement between Sara Street and Dummocks Street and between Sara Street and Michael Street (see attached Drawings). The new gravity sewer main and service lines will be constructed with the same

pipe as the previous project: 15-inch arctic pipe with a 16-gauge aluminum SPIR-L-OK jacket and an 8-inch diameter, SDR 7 HDPE core pipe with polyurethane insulation and 12-inch arctic pipe with a 16-gauge aluminum SPIR-L-OK jacket and a 4-inch diameter, SDR 17 HDPE core pipe with polyurethane insulation. Gravity sewer will be buried a minimum of 1 foot below existing ground and will eventually flow into the proposed Lift Station (LS) #3 at an elevation of 20.0'.

The preliminary design for Lift Station #3 is summarized below in Table 5. The proposed bottom of wet well elevation is set to match groundwater elevation (16.7' feet) as measured in fall of 2021. The pumps used for conceptual design are two Flygt MP3069 3.8 HP submersible grinder pumps with a 2-inch discharge pipe. While the size of the discharge pipe is appropriate for gravity sewer flows and force main head loss, use of a smaller diameter than the sewer services may allow larger objects to enter the wet well and therefore require the use of a submersible grinder pump.

Table 5 – Lift Station #3 Preliminary Design

Lift Station Design Parameter	Value	Comment
Homes Served by Gravity Sewer	32	
Residents per Home	4	
Avg Wastewater Influent (gpcd)	60	
Total Avg Wastewater Influent (gpm)	5.3	
Peak Hourly Wastewater Influent (gpm)	32	6 x Avg
Wet Well Diameter (ft)	6	
Groundwater Elevation (ft)	16.7	
Minimum Pump Operating Depth (ft)	0.8	
Pump Output (gpm)	63	Pump output sized for maintaining a minimum of 3.5 ft/s in the force main.
Min. Operating Volume (Gal)	427	
Min. Pump Run Time with No Flow (min)	6.8	Based on clearing entire force main in one pump cycle to avoid freezing issues.
Bottom Inside Elevation (ft)	16.7	
Pump Off Elevation (ft)	17.5	
Lead Pump On Elevation (ft)	19.75	
Lag Pump On Elevation (ft)	20.0	
High Water Alarm Elevation (ft)	20.0	
Gravity Inlet Elevation (ft)	20.0	
Discharge Pipe Elevation (ft)	20.0	
Operating Volume (Gal)	476	
Pump Run Time with No Flow (min)	7.6	
Pump Run Time with Avg Flow (min)	8.3	
Pump Run Time with Peak Flow (min)	15.4	
Cycle Time with Avg Flow (min)	97.5	
Cycle Time with Peak Flow (min)	30.2	

D. Force Main

The new force main will be constructed with 12-inch arctic pipe with a 16-gauge aluminum SPIR-L-OK jacket and a 3-inch diameter, SDR 9 HDPE core pipe and polyurethane insulation. Force main will be constructed in two phases, with the first phase connecting to the gravity sewer system at its terminus south of the existing landfill on Sara Street. A future force main extension is proposed to bypass this gravity line and connect downstream of Lift Station #2 on Dummocks Street (see discussion in Section 6 below regarding Lift Station #2 capacity).

E. Time to Freeze

It is critical for the viability of the wastewater system that extended periods of no flow be avoided. The time for the pipe to freeze was calculated using heat loss formulas for insulated pipe, above ground, with no flow. Given the shallow bury and variable soil conditions, calculating for above ground is simpler and more conservative. Air temperature used is slightly lower than the 20-year low recorded in Bethel. Time to freeze for the Phase 1 force main was calculated based on the values in Table 6 and resulted in 317.4 minutes (5.29 hours):

Table 6 – Time to Freeze Calculations, 3”x12” Arctic Pipe

Assumption	Value
Air Temperature	-40 °F
Temperature of Wastewater	45 °F
Minimum Temperature Desired	35 °F
Pump Run Time with Peak Flow (min)	0.0139 BTU/(hr * ft* °F)

Electric heat trace is proposed for the force main to keep it from freezing during winter months and in the event of stagnation in the pipe. Once full build out is achieved, pump cycles in Lift Station #3 will discharge enough volume to clear the force main constructed in Phase 1 before the wastewater freezes. However, until full buildout is achieved, flow into the lift station may not trigger enough pump cycles and freezing is a concern. Furthermore, once the future force main extension is installed, the volume of wastewater that will need to be pumped to keep the force main from freezing will increase, which will likely require incorporating electric heat trace into the extension.

6. Existing Wastewater System Impacts

The capacity of the downstream Lift Station #2 was reviewed to confirm it had the capacity for the additional concentrated flow from the proposed Lift Station #3. With 28 existing and proposed homes connected to the existing gravity main, the downstream lift station on Dummocks Street has estimated average and peak wastewater flows of 4.67 gpm and 28 gpm respectively. The additional flow of 63.0 gpm from the proposed force main is nearly equivalent to the pump output for both pumps operating at 3.5 fps. Furthermore the 476-gallon operating volume of the proposed manhole is 6 times the operating volume depicted on the Dummocks Street lift station as-built.

7. Project Phasing and Cost Estimates

The following phased construction is recommended:

- Phase 1 – Construct lift station and force main, connecting to gravity sewer main on Sara Street. This will drain into Lift Station #2. The controls for Lift Station #3 will include an interim operation that will reduce the pump output to approximately half of the maximum output through the use

of a Variable Frequency Drive (VFD). The VFD will provide an initial high velocity scour phase and then throttle the flow to approximately match the downstream capacity of Lift Station #2.

- Phase 2 – Extend the force main to tie into the gravity main downstream of Lift Station #2 near Dummocks Street. This should occur before full buildout of the new subdivision. Once the force main is completed, the controls on Lift Station #3 will be adjusted to provide full pump capacity during operations.

Project funding for Phases 1 and 2 may occur separately. The Akiak Native Community has identified its preference in support of Phase 1 (see Appendix B) and has approved the Phase 1 cost estimate below. Phase 2 funding can occur when the community commits to full buildout of the new subdivision. The costs of the required infrastructure are summarized below and detailed in Appendix C.

Table 7 – Construction Phasing and Costs

Phase 1	
Water	$ 150,450
Sewer	$ 1,007,185
Sewer Lift Stations	$ 1,007,490
Construction Management, Contingency, and Engineering	$ 1,769,784
Total Phase 1	$ 3,934,909
Phase 2	
Water	$ 638,375
Sewer	$ 778,800
Construction Management, Contingency, and Engineering	$ 1,246,600
Total Phase 2	$ 2,663,775
Total Santation Improvements	
Phase 1 + Phase 2	$ 6,598,684

End of Memo

Water and Sewer Design
Design Analysis & Recommendations

Appendix A:
35% Design Drawings

August 14, 2022 Notes:

1. 35% Design Drawings (37 pages total) removed from this 5-13-2022 memo - to limit file size.

2. 95% Design Drawings for the proposed sanitation improvements were submitted to A-DEC for review in August 2022. Inquire with the Akiak Native Community for a copy of these documents.

Appendix B:
Akiak Native Community
Preference Letter

Akiak Native Community

Akiak IRA Council
P.O. Box 52127
Akiak, Alaska 99552
Phone: (907) 765-7112 Fax: (907) 765-7512

May 6, 2022

Matt Edge
CRW Engineering Group
3940 Arctic Blvd., Ste 300
Anchorage, AK 99503

Dear Matt:

RE: Akiak Native Community Preference for Sanitation Infrastructure in the Expanded Housing Subdivision

This letter is to confirm the Tribe's preference for Phase 1 as identified in recent cost estimates that support the CRW Engineering Group March 11, 2022 Memo entitled: Water and Sewer Design Analysis & Recommendations.

The Tribe previously provided your firm with instructions for identifying phases for sanitation development with the first phase including only the necessary sanitation improvements to serve the six new homes that are currently under construction by the Association of Village Council Presidents - Regional Housing Authority. As we understand it, Phase 1 total cost is $3.93M.

If you have questions regarding the points in this letter, please contact me at 907-765-7112.

Sincerely,

Michael P. Williams, Sr.
Tribal Chief
Akiak Native Community

Appendix C:
Cost Estimates

8450105 Akiak Sanitation Improvements

Work Description	Qty	Unit	Unit Cost	Total Cost
Water				
6"x12" Arctic water distribution main, temporary on timber sleepers	605	LF	$90	$54,450
4"x12" Water services, below ground (75 ft ea) (on Dummock Street)	6	EA	$16,000	$96,000
includes class B pipe bedding, local backfill, test and disinfect				
arctic insulated pipe w hdpe supply and return, circ pump connect				
			Water Subtotal	*$150,450*
Sewer				
8"x15" Sewer gravity mains, buried, w trench	903	LF	$300	$270,900
includes class B pipe bedding, local backfill, pressure test, connections				
Manholes	6	EA	$27,000	$162,000
4"x 15" Sewer force mains, buried, w trench	1,405	LF	$325	$456,625
includes class B pipe bedding, local backfill, pressure test, connections				
4"x12" Sewer services, below ground (75 ft ea) (Dummock Street)	6	EA	$18,000	$108,000
includes class B pipe bedding, local backfill, pressure test, fittings				
Force Main Clean Out	2	EA	$4,000	$8,000
Bollard	2	EA	$830	$1,660
			Sewer Subtotal	*$1,007,185*
Sewer Lift Stations				
Lift Station	1	LS	$925,000	$925,000
Earthwork, gravel pad, culvert	1	EA	$30,000	$30,000
Bollard	3	EA	$830	$2,490
Electrical Panel	1	EA	$50,000	$50,000
			Sewer Lift Stations Subtotal	*$1,007,490*
General Construction Costs				
Mobilization, Supplies, Per Diem	1	EA	$275,000	$275,000
Construction Survey	1	EA	$15,000	$15,000
Erosion and Pollution Control Plan and Materials	1	EA	$15,000	$15,000
			GENERAL CONSTRUCTION SUBTOTAL	*$305,000*

Construction Subtotal		$2,470,125
Construction Contingency	25%	$617,531
Construction Total		$3,087,656
Engineering and Construction Management		
Design and Permitting (Primary, Subs, & Specialists)	10%	$308,766
Construction Management	8%	$247,013
Design & Construction Management Total		$555,778
Project Management/Admin	8%	$291,475
Estimated Total Cost		**$3,934,909**

8450105 Akiak Sanitation Improvements

Work Description	Qty	Unit	Unit Cost	Total Cost
Water				
6"x12" Arctic water distribution main, buried, w trench	1,820	LF	$275	$500,500
includes class B pipe bedding, local backfill, test and disinfect				
arctic insulated pipe w fittings, curbstops				
Relocate temporary water main to permanent, incl service connection	605	LF	$175	$105,875
Water Main Gate Valve w riser	4	EA	$3,500	$14,000
Arctic Flush Hydrant	4	EA	$4,500	$18,000
			Water Subtotal	*$638,375*
Sewer				
8"x15" Sewer gravity mains, buried, w trench	1,786	LF	$300	$535,800
includes class B pipe bedding, local backfill, pressure test, connections				
Manholes	9	EA	$27,000	$243,000
			Sewer Subtotal	*$778,800*
General Construction Costs				
Mobilization, Supplies, Per Diem	1	EA	$225,000	$225,000
Construction Survey	1	EA	$15,000	$15,000
Erosion and Pollution Control Plan and Materials	1	EA	$15,000	$15,000
			GENERAL CONSTRUCTION SUBTOTAL	*$255,000*
			Construction Subtotal	$1,672,175
			Construction Contingency 25%	$418,044
			Construction Total	$2,090,219
			Engineering and Construction Management	
			Design and Permitting (Primary, Subs, & Specialists) 10%	$209,022
			Construction Management 8%	$167,218
			Design & Construction Management Total	$376,239
			Project Management/Admin 8%	$197,317
			Estimated Total Cost	**$2,663,775**