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Technical Memorandum

To: Jean Keely, City of Blaine
From: Michelle Stockness, Lisa Andrews, and Brian LeMon
Subject: Responses to City Council questions on WTP4 from April 14, 2016 Workshop
Date: June 22, 2016
Project: WTP4 Pre-Feasibility Study, 23021037.01

The purpose of this technical memorandum is to answer and discuss the questions that Blaine City Council asked during the Council Workshop on April 14, 2016 regarding proposed Water Treatment Plant No. 4 (WTP4). The following is the list of questions that will be addressed:

- **Question 1** - What is the cost estimate of a pressure plant for WTP4?
- **Question 2** - What is the cost comparison of pressure plant vs. gravity plant – construction and future maintenance?
- **Question 3** - What is the rough cost estimate to add Well 22 and have the capacity of WTP4 increased to 8,000 gpm?

Background

Barr submitted a final WTP4 pre-feasibility study on April 8, 2016 providing details for a 6,000 gpm gravity filtration plant design and a class 5 cost estimate.[1] The report also included discussion on the main differences between gravity and pressure filtration. The results of this study were among the items presented to the council during the workshop on April 14th. Prior to completing the pre-feasibility study report, the City of Blaine chose to proceed with estimating the capital cost of a gravity filtration water treatment plant based on the following design decisions. The total cost of a gravity plant is estimated at $21.9 million and includes the following major elements:

- Gravity filters with dual media (4 ea 20'x25' gravity filters)
- Lamella clarifier system for backwash water recovery
- Water storage, below grade, outside of the building (clear well)
- High-service pumping to the distribution system
- Disinfection chemical feed from onsite sodium hypochlorite generation (OSHG)
- Fluoride and Sodium permanganate chemical feed
- Miscellaneous piping and valves
- Lab and storage space
- Backup generator
- Two story building construction (20,000 SF) and associated site work

[1] Class 5 estimate based on the Cost Estimate Classification System with an expected accuracy range of -20% to -50% (low) and +30% to +100% (high) (AACE, 2005).

The questions from the city council workshop are answered below:

Question 1: What is the cost estimate of a pressure plant for WTP4?

Question 1 Response:

The cost estimate for a pressure filter plant with traditional media for WTP4 is $20.7 million compared to the estimate of $21.9 million for a gravity plant; a difference of $1.2 million (accuracy range of -20% to -50% (low) and +30% to +100% (high) (AACE, 2005)). The main difference in cost is the lower building height and the deletion of high service pumping and the clear well. A pressure plant building would only require a single story building instead of a two-story building.

The main components of a traditional pressure plant used for the cost estimate include:

- Larger well pump and motor sizing to provide higher influent pressure
- Pressure filters with traditional media (not high rate loading) (4 ea 10'x50' pressure filters)
- Lamella clarifier system for backwash water recovery
- Disinfection chemical feed from onsite sodium hypochlorite generation (OSHG)
- Fluoride and Sodium permanganate chemical feed
- Miscellaneous piping and valves
- Lab and storage space
- Backup generator
- One story building construction (20,000 SF) and associated site work

For the pressure plant estimate, the well pumps and motors would need to be redesigned to provide a higher water supply pressure into the plant since pressure filters operate at a higher pressure than the gravity filters the current well motors were designed to feed. Pressure from a WTP to the distribution system is typically provided either by high service pumping or by increasing the size of the well pump and motor again to provide enough pressure to deliver water through the plant to the distribution system. High service pumping is typically not included with traditional pressure plants since it duplicates pumping energy, although it would keep the well pumps smaller. Eliminating the high service pumping and clear well with a pressure plant would require large well pumps and motors, which may not advisable given the resultant large motor size. More detailed design calculations should be performed before making this decision. The cost estimate for the pressure plant assumes upgrades to the well pumps and the elimination of high service pumping. Table 1 provides a summary of the construction cost differences.

Table 1 – Capital cost comparison between gravity and pressure filtration (Class 5 estimate)

WTP4 as proposed	**6,000 gpm gravity filtration plant**	$	17,900,000	Construction cost
		$	4,000,000	Engineering, legal, & admin
		$	**21,900,000**	**Total project cost**
WTP4 as pressure	**6,000 gpm pressure filtration plant**	$	16,900,000	Construction cost
		$	3,800,000	Engineering, legal, & admin
		$	**20,700,000**	**Total project cost**

Table 2 provides qualitative illustration of the potential relative construction cost differences between a new pressure filter plant and a gravity filter plant. Gravity plants are more common at design flows above 3,000 gpm.

Table 2 – Qualitative construction cost difference comparison of a pressure filter plant

Design and Construction elements	**Item**	**Cost impact compared to proposed gravity filtration**
	Single-story building	↓
	Elimination of high service pumping and clear well	↓
	Pumping energy	same

Question 2: What is the cost comparison of pressure plant vs. gravity plant – construction and future maintenance?

Question 2 Response:

The construction costs of the two types of filtration plants are described in the response to the first question above.

The costs of operation and maintenance for any water plant are tied to many different things, not just whether the plant is a gravity or pressure plants. The main differences between the types of filters are the size, ability for visual inspection, and the pumping requirements.

Gravity filters use a difference in elevation to provide the pressure needed to transfer water through the filter media bed, whereas pressure filters use pumping to transfer the water through a media bed. Building height must accommodate the elevation change needed to transfer the water using gravity filtration. Gravity filters require extensive structural concrete and installation of filter internals including underdrain piping, troughs, and media supports. This increases installation cost compared to pressure filters.

On the operations side, traditional gravity filters have similar operations and maintenance to pressure filters. The main difference is that gravity filters are open to the atmosphere, so the operator can view the water flowing through the filter bed and can view the backwash cycle. If there is an issue with inadequate backwash or a maintenance issue with the filter structure, it is easier for an operator to troubleshoot based on visual indication. Pressure filters are enclosed vessels, so in order to inspect the filter components or media, the filter must be taken out of service and entered using confined space entry protocol.

The estimated maintenance costs for gravity and pressure filters at this level of detail cannot be easily quantified, however, it can be stated that, in general, operation and maintenance of a traditional gravity plant are similar to a traditional pressure plant. Gravity plants will have slightly higher pumping costs with the use of high service pumping, and thus replacement pump costs. Pressure plants have more valves, which can add maintenance and replacement costs. Pressure plants can be designed to backwash in-service, eliminating the need for a backwash pump, which saves construction cost and maintenance. Gravity plants will typically have a longer service, approximately 40-60 years, versus the service life of a traditional pressure plant which is approximately 20-40 years. A life cycle assessment could be helpful to compare maintenance and replacement costs and the service life of the two types of plants.

Table 3 qualitatively compares a typical pressure filter plant operation and maintenance to a typical gravity filter plant.

Table 3 – Qualitative operation and maintenance cost difference comparison

Item	Comparative Cost of Pressure Plant	Comparative Cost of proposed gravity filtration	Comments
Filter operation and troubleshooting	Enclosed vessel is harder to troubleshoot without visual inspection. Visual inspection requires shutdown and opening of vessel and confined space entry.	Gravity are open and can be viewed for troubleshooting without shutting down	Viewing operation of backwash cycles can help troubleshoot filter performance issues. Viewing backwash cycles provides valuable information for troubleshooting filter performance issues
Pumping energy	Higher influent pressure required from supply wells.	Lower influent pressure required from supply wells, but need high service pumping.	Similar pumping energy.
Equipment repair/maintenance	More valves and valve maintenance. Shorter pressure filter service life with higher vessel replacement cost. Filters could be backwashed in service which would eliminate backwash pumps.	More pumps and pump maintenance. Longer gravity filter service life.	Differences are hard to quantify into operations and maintenance costs at this level. A life cycle assessment could be helpful to compare replacement costs and the service life of the two types of plants.

Question 3: What is the rough cost estimate to add Well 22 and have the capacity of WTP4 expanded to treat 8,000 gpm?

Question 3 Response:

If the treatment plant capacity was increased from 6,000 gpm to 8,000 gpm with the addition of another water supply well, the cost of an 8,000 gpm gravity plant would be $24.3 million[2] compared to the 6,000 gpm plant at $21.9 million. The cost increase includes the following:

- Larger filter system
- Larger pumping capacity
- Larger clear well capacity
- Larger Lamella clarifier system
- Larger chemical feed system capacity
- Larger building footprint

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[2] Class 5 estimate based on the Cost Estimate Classification System with an expected accuracy range of -20% to -50% (low) and +30% to +100% (high) (AACE, 2005).

Although the addition of another well would provide increased capacity, the city should review whether this increased capacity is worth the additional cost, and whether the city needs the additional capacity to meet future water demands. The current DNR water appropriations permit includes four future Wells No. 18-21, and does not include a 5^{th} future well, Well 22.

The concepts for future Water Treatment Plant No. 4 should be discussed and further refined during a Feasibility Study. The feasibility study would refine the conceptual design proposed in the Pre-Feasibility Study Report based on the further feedback from the City, the actual water quality from the wells that will be constructed this summer, and onsite pilot testing of the proposed treatment system.

Certification

I hereby certify that this memo was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Michelle Stockness — June 22, 2016

Michelle A. Stockness — Date

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