Engineering Evaluation

Water Treatment Pilot Study

Village of Kronenwetter
Marathon County, WI

January 2017

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BECHER HOPPE

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1.0 INTRODUCTION

The Village of Kronenwetter water supply system consists of two 700 GPM wells, 58 miles of 6 to 14 inch watermain, and a 300,000 gallon elevated water tower. The average daily water use is 0.30 MGD. The maximum daily water use over the last five years was 1.0 MGD. At average daily conditions, the retention time of water in the water supply system is 4 days. Well operation is approximately 7.1 hours per day.

The water of Well No. 1 contains negligible concentrations of iron and 0.03 mg/l of manganese. The water of Well No. 2 presently contains 0.55 mg/l iron and 0.25 mg/l manganese. These levels exceed the secondary standards of the Safe Water Drinking Act of 0.3 mg/l and 0.05 mg/l respectively. As a result, there are numerous colored water complaints. The history of the deterioration of the water quality is documented in the project Request for Proposals, included as an attachment to this report.

Tonka Water conducted a pilot study, under the supervision of Becher-Hoppe Associates, between the 17th and 28th of October, 2016 to demonstrate a process for the effective and efficient removal of iron and manganese from the groundwater of Well No. 2.

Pilot testing of Well No. 2 water indicated that sodium hypochlorite and potassium permanganate performed equally well in oxidizing the soluble iron and manganese in the water. Likewise, anthracite capped GreensandPlus media and pyrolusite media performed equally well in filtering the precipitated materials.

The Wisconsin Department of Natural Resources has established filtration rates for gravity filters (NR 811.49) as follows:

Filtration Rates	Filter Media Type
2 gpm/ft^2	Single Media
3 gpm/ft^2	Dual Media
4 gpm/ft^2	Tri Media

However, NR 811 also states the determination of the filtration rate of filters can be based on “consideration of factors such as raw water quality, degree of pretreatment provided, filter media, water quality control parameters, competency of operating personnel, and other factors required by the department.”

Based on the pilot performance, construction costs and estimated annual O&M costs, we recommend utilizing a 700 GPM pressure filter with anthracite / GreensandPlus filter media and sodium hypochlorite as the oxidant at an application rate of 6 GPM per square feet. A horizontal filter with 3 or 4 symmetrical cells in one unit is less costly than an equal number of separate vertical filters.

2.0 CHEMICAL USAGE

Using sodium hypochlorite, approximately 3.75 pounds of chlorine per day are required to treat the water of Well No. 2. Sodium hypochlorite is available in solution and costs approximately $3.85 per gallon. Chemical cost per year is estimated at $4,500.

Potassium permanganate is available in granular form and must be made into a solution for use with standard chemical feed pumps. Potassium permanganate costs $3.65 per pound. Approximately 2.5 pounds of potassium permanganate are required per day. Chemical cost per year is estimated at $3,600.

When using potassium permanganate, it is also necessary to carry a chlorine residual throughout the depth of the filter media. Sodium hypochlorite would be used at an additional cost of $600 per year.

3.0 BACKWASH

The filter cells are backwashed individually. Backwash rates can vary from 3 to 15 GPM per square foot (130 GPM to 680 GPM), dependent on whether air scour or surface wash is provided during the backwash sequence. The total backwash volume for all cells of the filter is estimated at 20,000 gallons. The pilot test exhibited good potential for backwash solids settling.

The pilot testing demonstrated that backwash of a pressure filter would be required after 30 hours of operation when filter loading rate is 6 GPM per square foot, and after 40 to 50 hours of operation when filter loading rate is 3 GPM per square foot.

It is projected that a gravity filter operating at 6 GPM per square foot would require backwashing after 10 to 15 hours of operation, and a gravity filter operating at 3 GPM per square feet would require backwashing after 40 to 50 hours of operation.

For a pressure filter operating at 6 GPM per square foot, backwashing would be required after 4.2 days of operation under average day demand conditions. The peak backwash rate (680 GPM) exceeds the capacity of the sanitary sewer system at the existing well field. It is recommended to install equalization facilities to contain one complete backwash volume (20,000 gallons) and slowly discharge to the sewer system.

The equalization basin could also be used as a backwash recycle basin. To provide this function, two 60 GPM recycle pumps, one 50 GPM drain pump, one floating decanter, piping, control valves, and electric controls would be required. These items have an opinion of probable project cost of $45,000. The annual cost to discharge all of the backwash to the sanitary sewer system has a projected cost of $1,250 which has a 20-year total present worth value of $16,400. It is cost effective to discharge all of the backwash, after equalization, to the sanitary sewer system

4.0 OPERATION AND MAINTENANCE COSTS

The filter equipment can be designed to provide automatic control of the backwash process based on hours of operation or head loss across the media.

The annual operation and maintenance costs are projected to be as follows:

ITEM	ANNUAL COST
Chemicals	$ 6,100
Labor (2 hours per day)	$ 51,100
Backwash disposal	$ 1,300
Heating and electric	$ 6,000
Media Replacement (avg. 15 years)	$ 3,000
Materials	$ 20,000
TOTAL	**$ 87,500**

The annual cost per an equivalent residential water user is estimated at $42 per year.

5.0 OPINION OF PROBABLE COST

The opinion of probable costs for three filter alternates are provided in Tables 1, 2 and 3, and summarized as follows:

ALTERNATE	PROJECT COST
Table 1 - Horizontal Pressure Filter (6 GPM/sq. ft.)	$ 1,720,000
Table 2 - Horizontal Pressure Filter (3 GPM/sq. ft.)	$ 2,070,000
Table 3 - Gravity Filter (3 GPM/sq. ft.)	$ 2,400,000

Because of the projected frequent backwash frequency, a gravity filter operating at 6 GPM/square feet is not practical. The cost of vertical pressure filtering equipment is approximately 10% more than horizontal pressure filtering equipment. A schematic of the typical filtration options is provided in Figure 1. At average day conditions, the filter will be in operation seven hours per day. If adequate treated water storage is provided, a single pressure filter unit could provide an additional volume of treated water up to 2.0 MGD if one well (700 GPM) at a time operation is utilized.

6.0 FINANCING COSTS

If the Safe Drinking Water Fund is used for financing, the 6 GPM per square foot pressure filter alternate has an annual debt retirement of approximately $105,200 per year. The annual debt retirement cost per an equivalent residential water user for the project is estimated at $50 per year.

7.0 USER COSTS

A typical residential customer uses 42,300 gallons of water per year and pays $ 356 per year for water. After the filtration project is operational, the user costs for a residential water user will increase by approximately $92 per year. The total residential user cost for water is estimated to be $448 per year. The median household income for the Village of Kronenwetter is $74,000 per year. The projected residential water user rates are 0.67% of the median household income.

8.0 PROJECT SCHEDULE

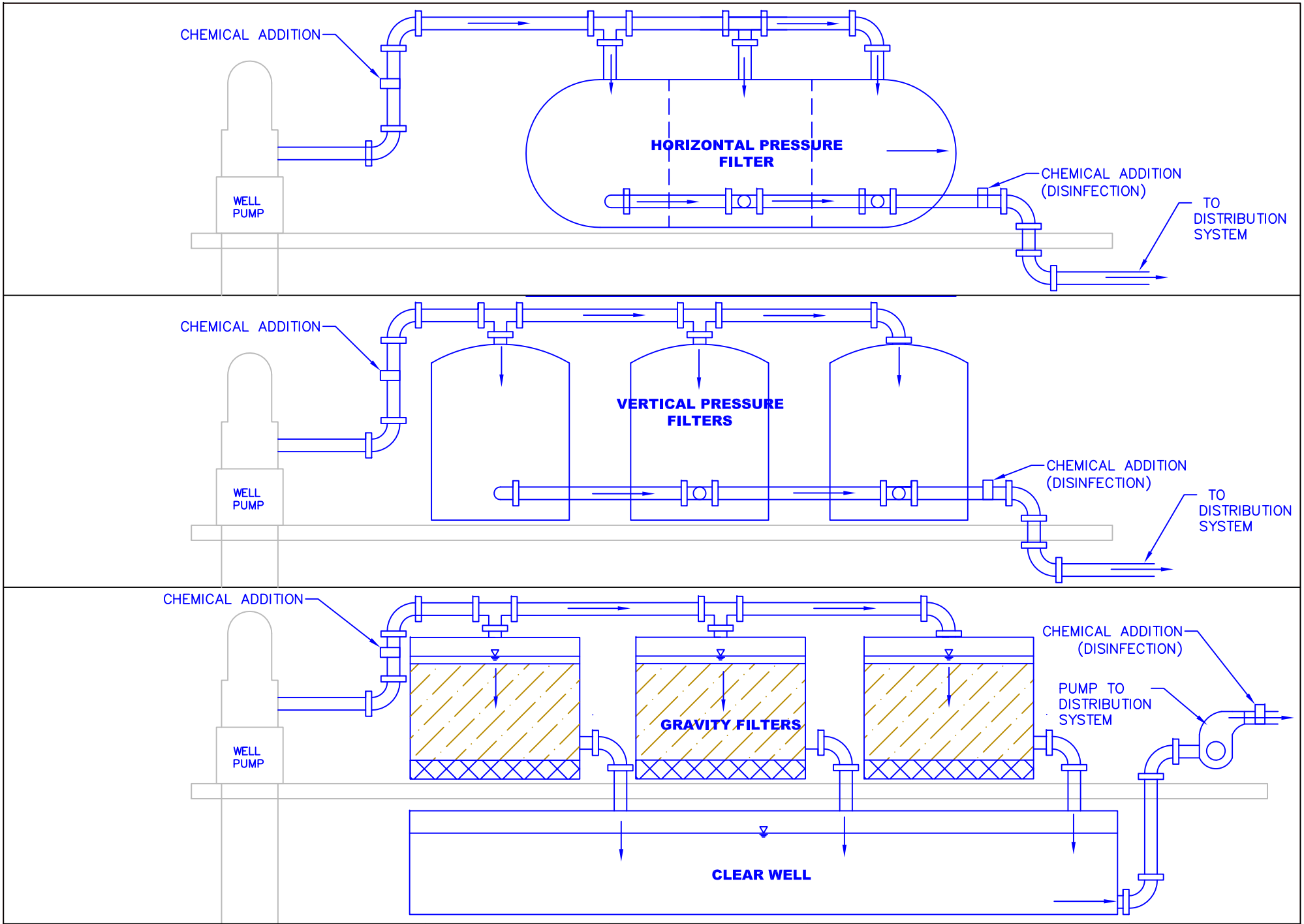
The project schedule is typically controlled by the funding agency requirements. The median household income of the Village of Kronenwetter is larger than most communities in the state, and it is unlikely that grant funding will be available for this project. It is likely that this project will be financed by a low-interest loan from the Wisconsin Safe Drinking Water Loan Program. The project requires Wisconsin Public Service Commission authorization and Wisconsin Department of Natural Resources report and plan approval.

The first order of work is to provide a Preliminary Engineering Report to accompany the Pilot Study Report. The Preliminary Engineering Report should address existing facilities, proposed growth, capacity of existing facilities to meet future demands, health or sanitary hazards, impact on environmental and endangered resources, impact on historic or archaeological sites, water / waste/ energy efficiency, financing, and user costs.

The Preliminary Engineering Report should address all proposed water system improvements. After review and approval / authorization to proceed by regulating agencies, the design of the project can proceed.

For the Wisconsin Safe Drinking Water fund program, the controlling timetable item is submittal of approval plans and specifications by June 30 of the fiscal year in which funding is anticipated. A typical schedule is as follows:

Submit Preliminary Engineering Report and Engineering Evaluation of Water Treatment Pilot Study to PSC and DNR.	January 1, Year 1
Prepare design plans.	April 1 – June 30, Year 1
Submit biddable design plans and specifications to DNR.	June 30, Year 1
Submit SDRFL application.	June 30, Year 1
Bid project.	Sep 1 – Dec 30, Year 1
Complete project construction.	June 1, Year 2
Loan closing.	June 30, Year 2



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DRAWN BY: JRK CHECKED BY: SMO	SCALE: NONE	VILLAGE OF KRONENWETTER	SHEET TITLE:
DATE: 01/16/2017	REV. DATES:	ALTERNATE FILTER SYSTEMS	FIGURE 1

Table 1

Horizontal Pressure Filter - 6 GPM/sq. ft.

Opinion of Probable Project Cost
Village of Kronenwetter

1.	General Conditions / Project Administration	$	60,000
2.	Sitework	$	50,000
3.	Block Building (1,200 s.f.)	$	300,000
4.	Pressure Filter (installed)	$	480,000
5.	Mechanical - piping and pumps	$	100,000
6.	HVAC	$	50,000
7.	Chemical Feed	$	50,000
8.	Electrical	$	100,000
9.	SCADA	$	50,000
10.	Well Pump Modification	$	40,000
11.	Backwash Equalization	$	40,000
12.	Land	$	0
	Construction	$	1,320,000
	Contingency	$	130,000
	Technical Services	$	200,000
	DNR and PSC Applications	$	10,000
	Interim Interest during construction	$	50,000
	Legal and Administrative	$	10,000
	TOTAL PROJECT COST	$	1,720,000

Table 2

Horizontal Pressure Filter - 3 GPM/sq. ft.

Opinion of Probable Project Cost
Village of Kronenwetter

1.	General Conditions / Project Administration	$	70,000
2.	Sitework	$	50,000
3.	Block Building (1,560 s.f.)	$	390,000
4.	Pressure Filter (installed)	$	630,000
5.	Mechanical - piping and pumps	$	100,000
6.	HVAC	$	50,000
7.	Chemical Feed	$	50,000
8.	Electrical	$	110,000
9.	SCADA	$	50,000
10.	Well Pump Modification	$	40,000
11.	Backwash Equalization	$	40,000
12.	Land	$	0
	Construction	$	1,580,000
	Contingency	$	160,000
	Technical Services	$	240,000
	DNR and PSC Applications	$	10,000
	Interim Interest (during construction)	$	70,000
	Legal and Administrative	$	10,000
	TOTAL PROJECT COST	$	2,070,000

Table 3
Gravity Filter - 3 GPM/sq. ft.

Opinion of Probable Project Cost
Village of Kronenwetter

1.	General Conditions / Project Administration	$	90,000
2.	Sitework	$	50,000
3.	Block Building (1,700 s.f.)	$	425,000
4.	Gravity Filter (installed)	$	660,000
5.	Clear Well	$	45,000
6.	Mechanical - piping and pumps	$	140,000
7.	HVAC	$	70,000
8.	Chemical Feed	$	50,000
9.	Electrical	$	150,000
10.	SCADA	$	60,000
11.	Well Pump Modification	$	40,000
12.	Backwash Equalization	$	60,000
13.	Land	$	0
	Construction	$	1,840,000
	Contingency	$	184,000
	Technical Services	$	276,000
	DNR and PSC Applications	$	10,000
	Interim Interest (during construction)	$	80,000
	Legal and Administrative	$	10,000
	TOTAL PROJECT COST	$	2,400,000

Attachment Reports

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To be added to final copy