

WATER TREATMENT PLANT FEASIBILITY STUDY

Bullock Pen Water District

June 24, 2021



HMB Professional Engineers, Inc.

Frankfort, Kentucky

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- A Bullock Pen Lake Withdrawal Correspondence from Kentucky Department of Fish & Wildlife Resources and Kentucky Division of Water
- B Opinion of Probable Project Costs 2.0 MGD and 1.5 MGD Water Treatment Plants

WATER TREATMENT PLANT FEASIBILITY STUDY

A. Introduction

A Water Treatment Plant (WTP) Feasibility Study is being prepared as a means of an evaluation of the water treatment system, to improve water treatment and increase water capacity at the Bullock Pen Water Treatment Plant located in Grant County, Kentucky. The WTP study describes the water treatment system operated by the Bullock Pen Water District (WD) and the water improvements needed to achieve the WD goals. The report also describes the potential for additional water treated versus water purchased.

B. Project Area

Bullock Pen Water District is in the northern Kentucky area. The WD began operation in 1961, which included progressively extending water service, and constructing of water storage and treatment facilities. The initial water treatment plant was constructed in 1977 and expanded in 1986. The WD serves a large portion of Grant County and portions of Boone, Kenton, Pendleton, and Gallatin Counties. The WD serves the rural areas of these counties outside the cities of Williamstown, Dry Ridge, and Walton except for the City of Crittenden. The main areas of customer concentrations are in and around the City of Crittenden and are scattered throughout the remaining service area. Presently, there are about 7,400 customers served by seven elevated storage tanks, three booster pump stations, and 356 miles of water lines.

Grant County's estimated population growth through the planning period (next 20 years) is a slight decrease in population (about 700 persons), however, the northern Kentucky area is expected to increase over the same period. The WD provides service to the entire service area with only very small areas unserved. Therefore, growth is not expected based on the extension of water service within the service area. The WD could grow based on infill or customers and new commercial and industrial growth of customers. It is assumed that the WD customer base will remain steady or have a slight increase. For this study, the water treatment needs will be considered based on No Growth and 20% Growth, throughout the study period.

C. Existing Water Treatment Plant

The WD owns and operates a conventional water plant that is located on the west side of I-75 along Violet Road next to Bullock Pen Lake. The current plant was originally constructed in 1977 and expanded in 1986 with a design capacity of 0.8 million gallons per day (MGD). The WD wishes to continue operation of the Bullock Water Treatment Plant (WTP). The 35-year-old facility is permitted for 0.8 MGD but due to design and age constraints can only produce an average daily flow of approximately 0.4 to 0.5 MGD while meeting permit requirement standards of the Safe Drinking Water Act. The WTP must be upgraded or replaced to continue operation and meet current and future water treatment standards.

The following are the major components of the water treatment plant:

Raw Water Intake

Raw Water Pump Station/Building

Chemical Feed System

Flash Mix

Flocculation Basins

Settling Basin

Filters

Clear Wells

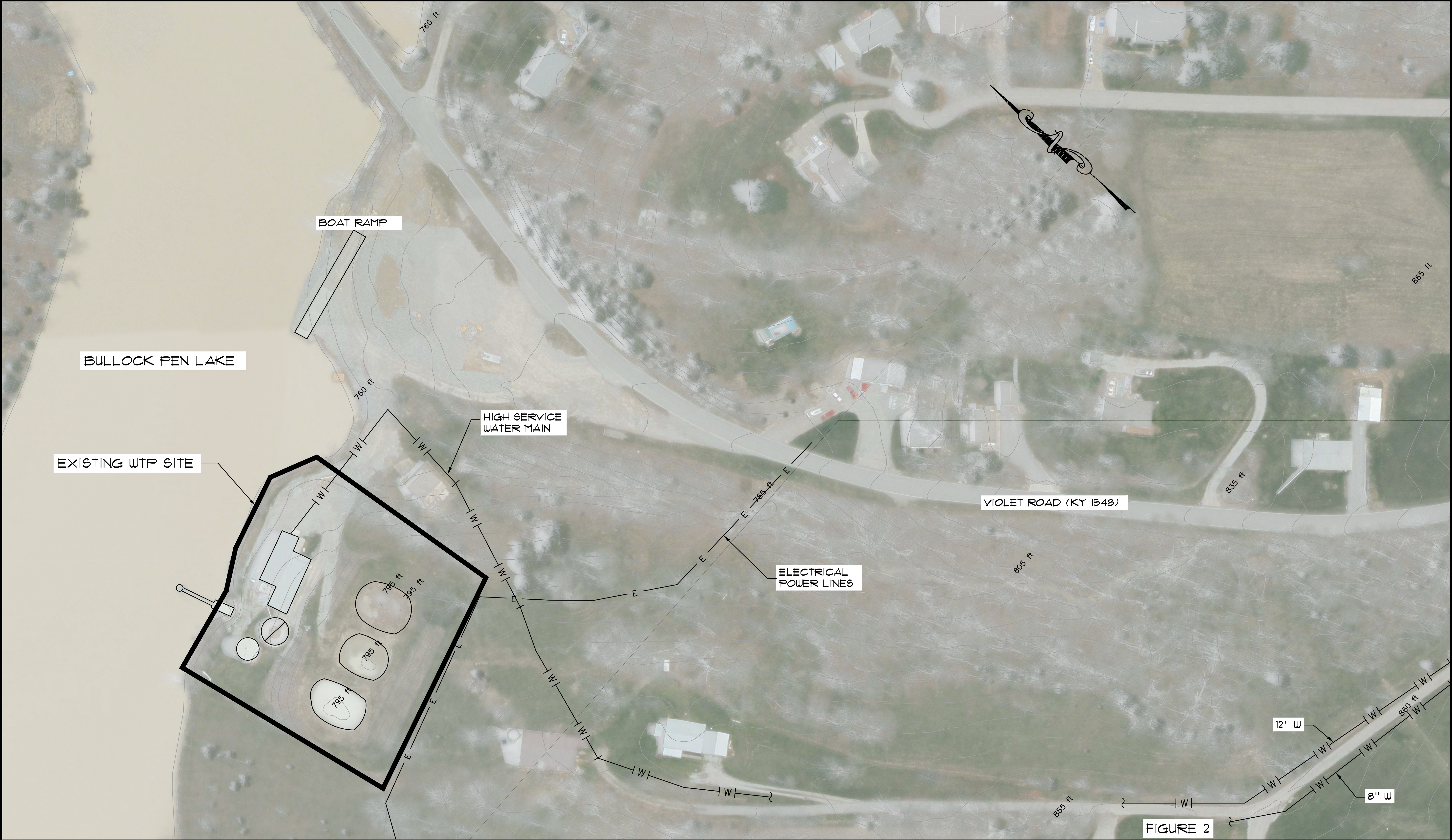
High Service Pumps

Electrical/ Instrumentation

Miscellaneous

A schematic of the existing water treatment plant facility is shown in Figure 1 with a location map of the WTP provided in Figure 2.

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NO.	DATE	REVISIONS	CHK'D	APPR'D	DATE

PROJECT: 4222.01 DATE: APR 2021
SCALE: 1"=50' (22x36 SHEET)

DESIGNED BY	NAME	DATE
DRAWN BY		
CHECKED BY		
RECORD DUGS.		



3 HMB CIRCLE
FRANKFORT, KENTUCKY
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(502) 695-9810 FAX

**WATER TREATMENT PLANT
BULLOCK PEN WATER DISTRICT
GRANT COUNTY, KENTUCKY**

EXISTING WTP LOCATION MAP

SHEET
4

Pictures and descriptions of the water treatment plant processes can be seen as follows:

Raw Water Intake

The raw water intake pipe extends into the Bullock Pen Lake. The intake can be adjusted to various withdrawal elevations depending on the water level. A screen is provided on the inlet pipe to prevent large debris from being sucked into the raw water pumps. The condition of the screen is not known. The walkway must be used for access to adjust the level and currently, the handrail system does not meet safety standards. When there are low water levels in Bullock Pen Lake additional adjustment of intake level is required. The limited depth of the lake at the intake location prevents the necessary adjustment. If an extended drought occurred, the water treatment plant maybe required to shut down based on low water levels in combination with poor water quality.



Walkway to Raw Water Intake

Raw Water Pump Station/ Building

The raw water pumps are in a building located up against the shoreline of Bullock Pen Lake on one side and a retaining wall on the other. This location makes it difficult to perform maintenance and replace materials. Two vertical turbine pumps are provided each with a capacity to provide water to the treatment system. Based on a visual inspection, the pumps, discharge piping, and valves, are in poor condition. Due to age and degradation, each piece of equipment, piping, and valves has the potential for failure, which could result in early maintenance. Currently, the handrail system does not meet safety standards.



Vertical Turbine Raw Water Pumps

Chemical Feed

Hydrogen peroxide is fed at the Raw Water Pump Station with ferric chloride and potassium permanganate feed systems that inject in the line leading to the Flash Mix. Except for the metering pumps, most of the chemical feed system is nearing the end of its useful life. Inlet piping and valves, that are below the floor level, are in poor condition due to age and corrosion that has occurred.



Chemical Feed System



Raw Water Piping and Valves w/Chemical Feed Connection

Flash Mix

The flash mix chamber, below the upper floor has been replaced over the past few years, with the mixing system being rebuilt, with a non-standard mechanical drive. The HVAC system is in the same, lower level, room as the flash mix. It is elevated approximately 6 feet off the floor in a very tight space with a small access doorway for access. It requires maintenance or replacement every few years based on being in a high moisture area. A polymer feed system, with updated pumps, is located on the upper floor where it is fed into the flash mix. Currently, the flash mix and polymer feed are in good operating order at a reduced flow rate.



Lower Flash Mix Chamber



HVAC System



Upper Flash Mix and Polymer Feed System

Flocculation Basins

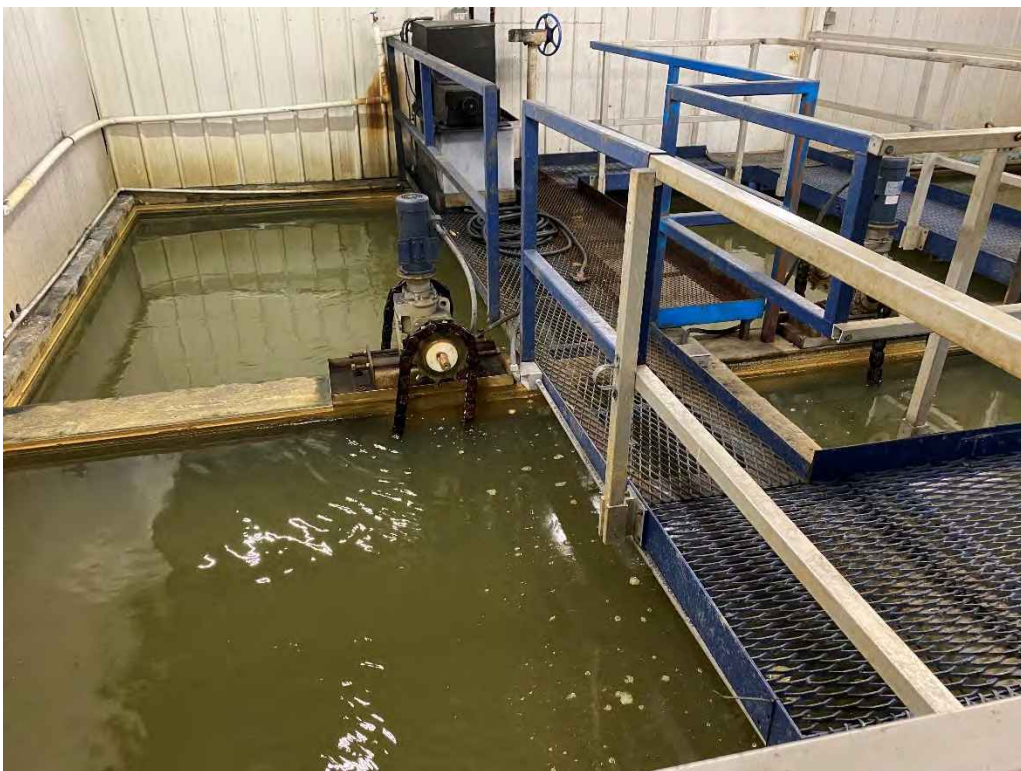
The flocculation basins consist of three basins with chain driven baffles, each with variable frequency drives (VFD's). In the 1986 upgrade, the flocculation/settling basins were converted to function as just flocculation basins. The basins are configured so the first basin is taken out of service, flow can be diverted to the second and third basins with water treatment continuing. However, the second or third basins cannot be by-passed, and the water treatment kept in service. Chlorine can be fed at the end of the first flocculation basin. The chlorination feed system equipment has been replaced and is adequate, but not ideal. Chlorine gas is a very hazardous chemical to handle. The existing system that is used to lift the 150 lb. chlorine cylinders into the chlorine room can be dangerous due to the small and elevated platform that the cylinders are loaded on to move into the chlorine room. Space is limited around the flocculation basins due to the building being constructed on top of the basin walls with very little free board or head space. Bags of powder activated carbon must be carried across a walkway to get to the carbon feeder. Currently with all basins in operation, treatment is good but operates at a reduced flow rate.



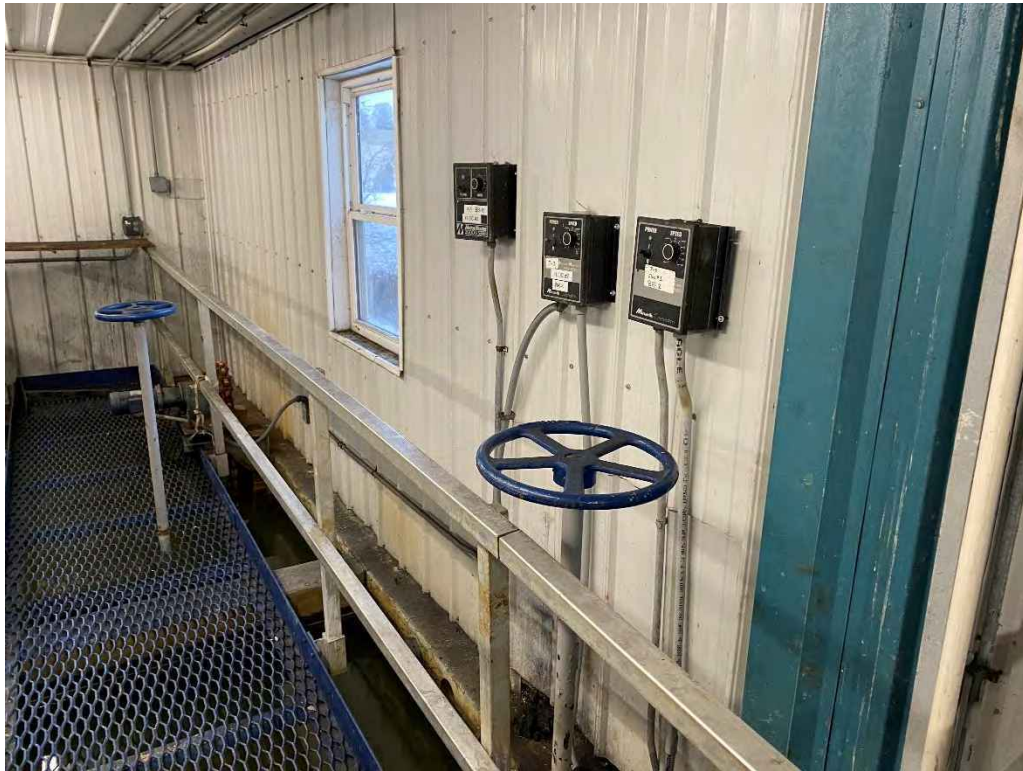
Chlorination Feed System



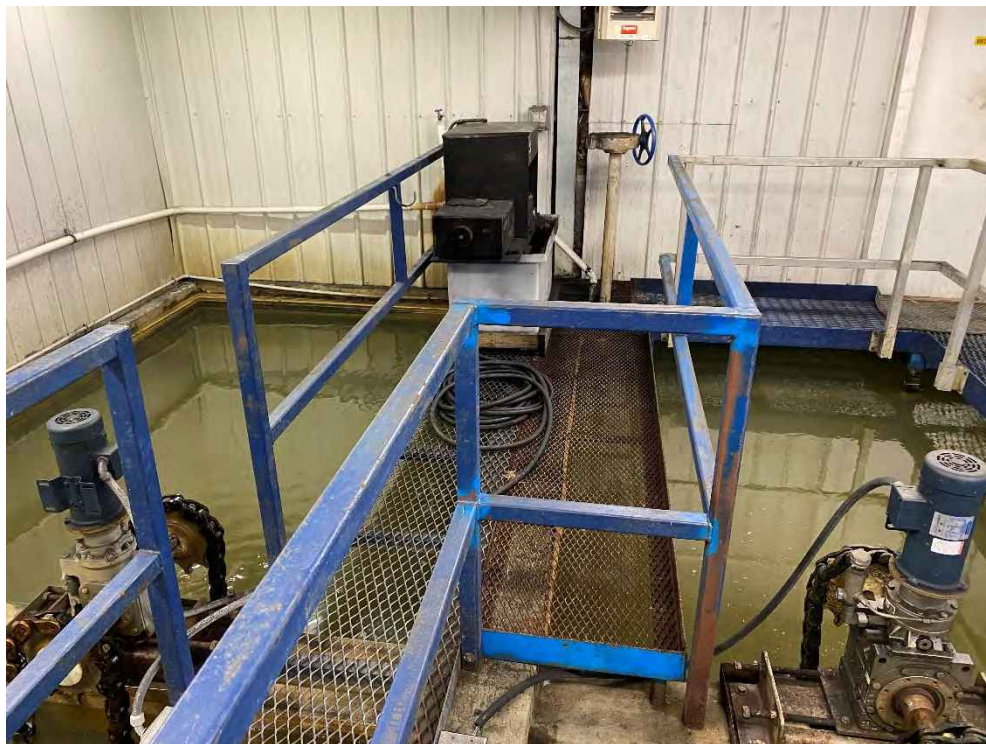
Chlorine Cylinder Lift and Access to Bldg.



Flocculation Basin No. 1



Flocculation Basin VFD Control and Chlorine Feed



Powered Activated Carbon Feed into Flocculation Basin

Settling Basin

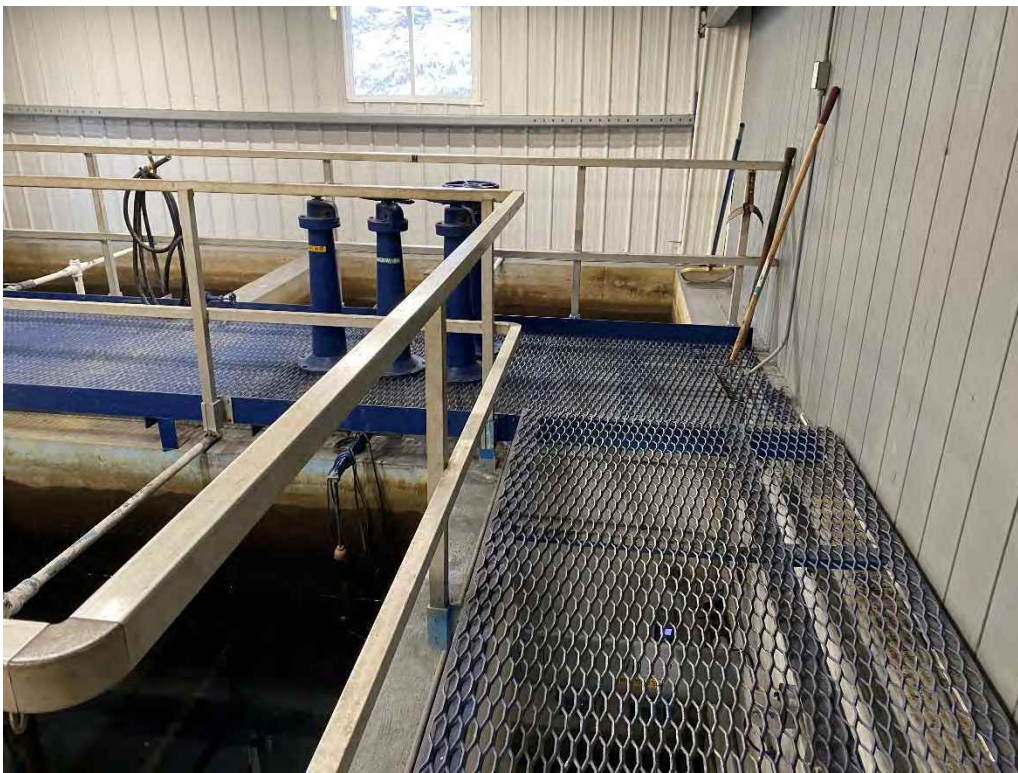
The settling basin was constructed during the 1986 upgrade and is located outside. The basin consists of tube settlers, which provide a quiet zone for solids to settle, and scraper arms to remove solids from the bottom of the basin and dispose in the Solids Lagoons. The settling basin appears to be in good condition. Due to the location on the site, some areas may be difficult to access, and the lack of a handrail system on one side does not meet safety standards. Currently, treatment is good but operates at a reduced flow rate.



Settling Basin

Filters

The filters consist of four basins. The original water plant had two filters and two additional filters were constructed in 1986. All filters are conventional gravity filters with dual media, which is a very forgiving filtration system. The piping for the two newest filters is located around the corner in a separate pipe gallery making maintenance and replacement of piping and valves more difficult. All valve operations are manually driven. The building is set on top of the walls along three sides with low ceiling clearance. Based on the location and age, piping, and valves for filtration operation from the original water plant constructed in 1977 are between good to poor condition. All pipe or valves located in the pipe trench "below other piping" are in poor condition, and if required to take off-line for replacement/maintenance, may shut down the entire water treatment plant for days or longer. Some pipe and valves, if moved, may not be able to be reused based on condition at pipe joints and tapped locations. Currently treatment is good but operates at a reduced flow rate.



Filter Basin Upper Access



Upper Filter Basin



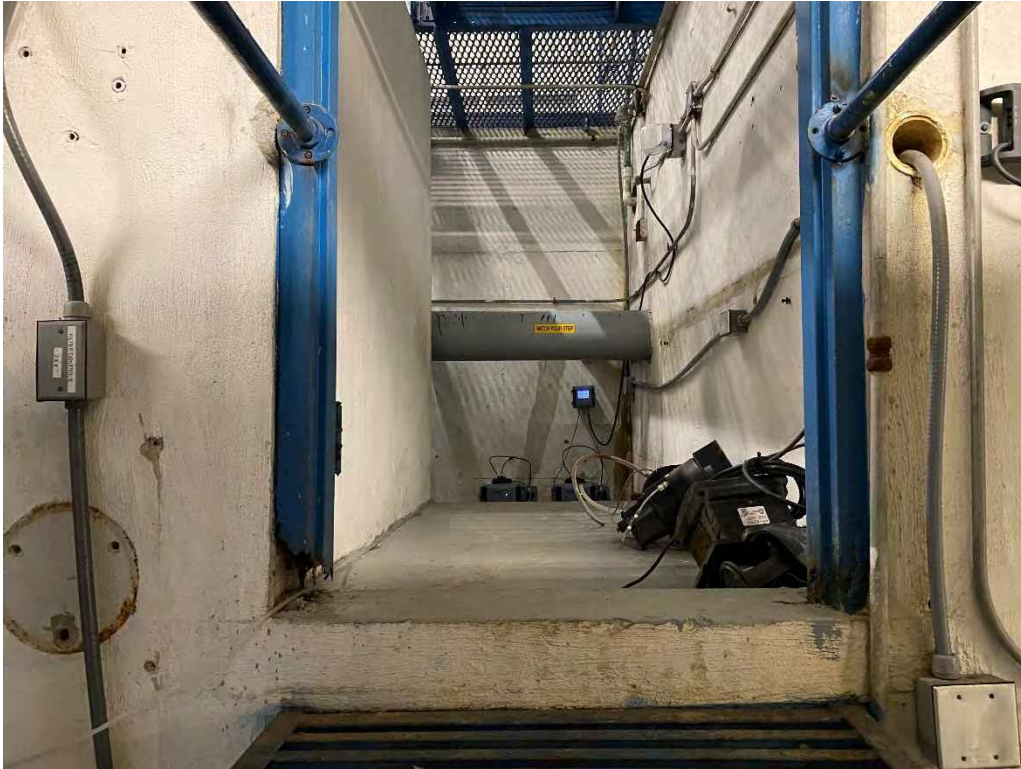
Filter Valve Operators



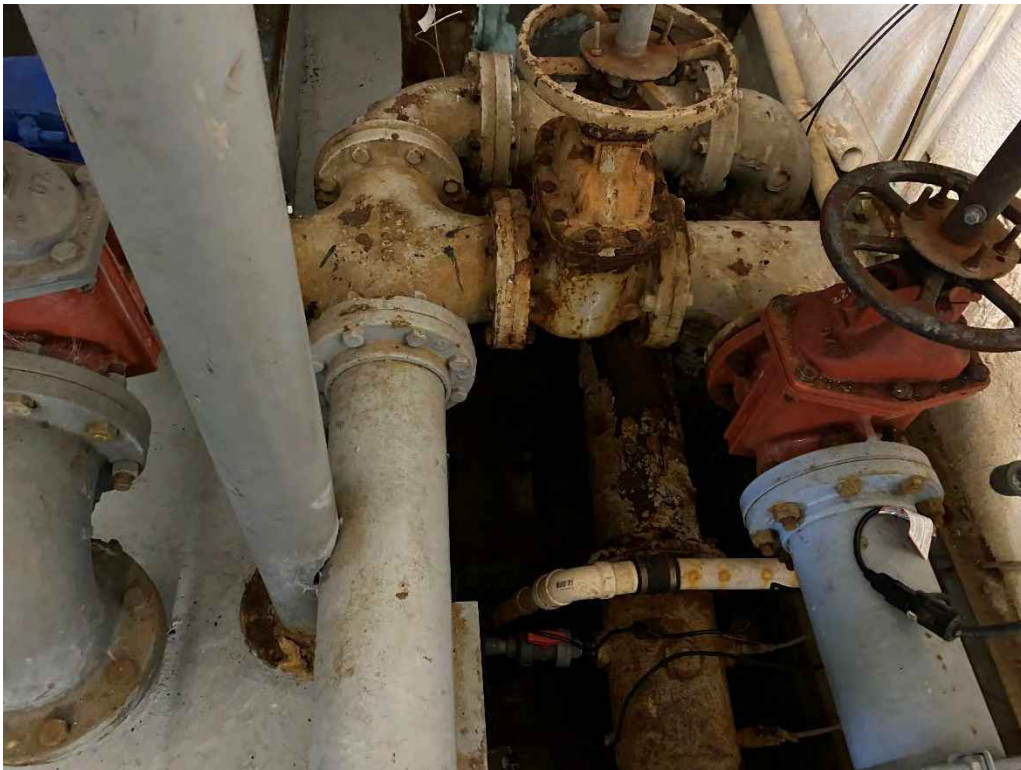
Walkway Above Filter Basins



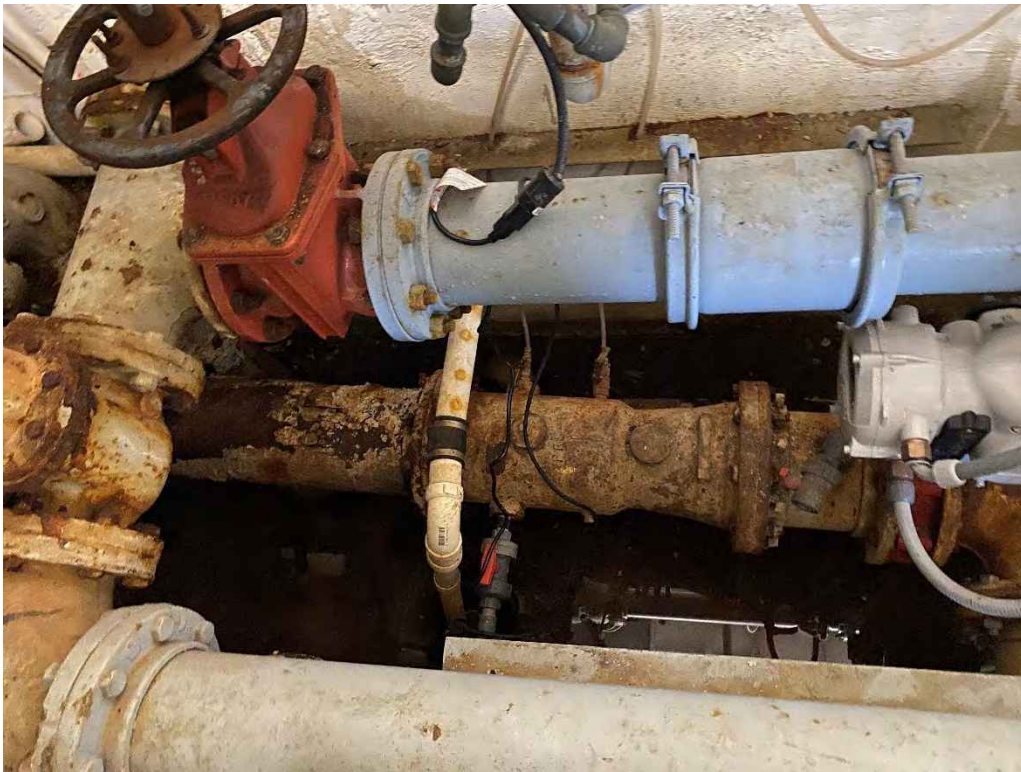
Filter Piping



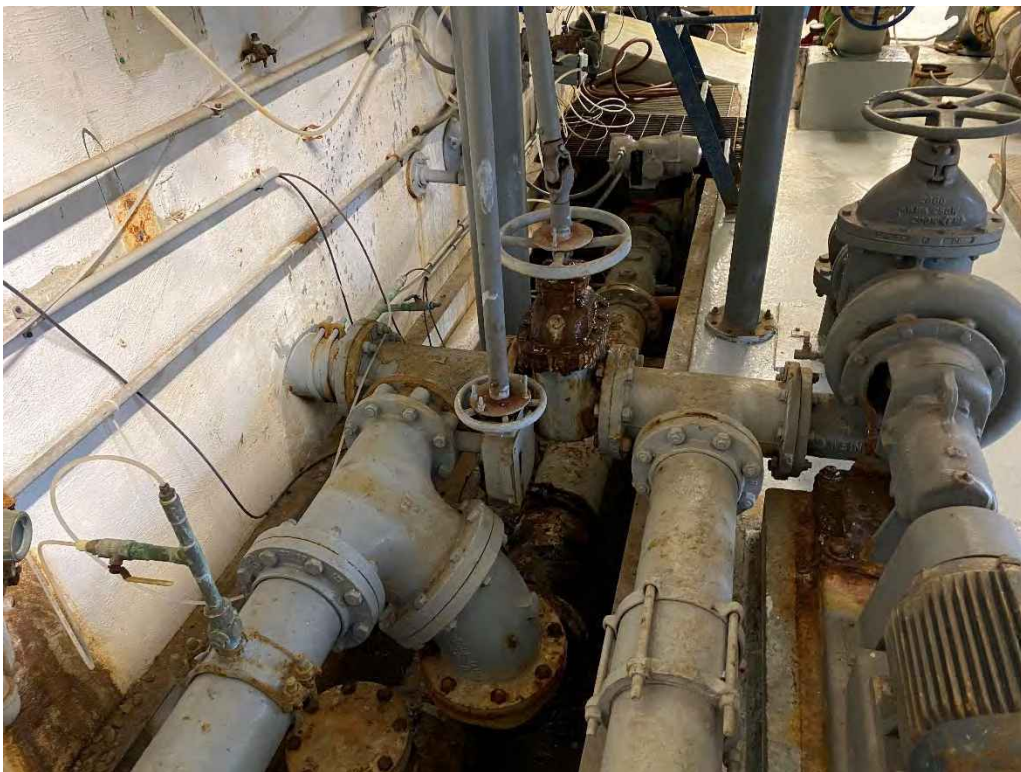
Filter Piping Between Basins



Filter Valves and Piping



Filter Valves and Piping



Filter Valves and Piping

High Service Pumps

Two high service pumps are provided, each with capacity to pump into the water distribution system. One backwash pump is also provided. These pumps, piping, and valves appear to be in good condition.



High Service Pumps and Valves

Clear Well

Water flows by gravity from the filters into the clear wells, which are located below the floor next to the filters. The condition of the clear well is unknown.

Electrical and Instrumentation

The electrical and instrumentation system is generally not in good condition. There are no plans of how and where all electrical and instrumentation is run or in some cases connected. Some old wiring was left from the original treatment plant from the 1970's which may not be in operation. If a major issue occurred, with loss of power to any process, the WTP would be shut down for days or more.

D. Need for Project

The WD has been operating a water treatment system to provide finished water to their customers since the 1970's. In addition, the WD also purchases finished water from four other water providers (wholesalers). These include the City of Williamstown, City of Walton, Northern Kentucky Water District, and Boone County Water. The WD wants to continue to provide finished water but increase the amount of water produced at the Bullock Pen WTP thereby reducing the amount purchased. To be able to do this, improvements to the water treatment system are needed. The existing WTP cannot continue operation as is or by replacement of equipment based on the below key factors:

- Issues with much of the process piping, valves, electrical, and equipment, based on 35 - 45 years old system
- Safety risk to personnel due to operational requirements
- Risk of pipe or electrical failures taking the entire water treatment plant out of service for unknown lengths of time
- Due to changing regulations, being out of compliance with permit regulations
- Risking continued reduction in water treatment capacity.

Based on these factors, and the limited space available at the existing site for expansion, it is recommended that a new water treatment plant be provided on a new site.

Water Treatment Plant Feasibility Study | Bullock Pen Water District**E. Alternatives Considered**Existing Water Usage

Current water produced by the WD and purchased from the four water wholesalers are summarized for FY 2018, FY 2019, and FY 2020 in Tables 1, 2, and 3.

Table 1 Water Produced / Purchased¹ (FY 2018)							
Month	City of Williamstown	City of Walton	Northern KY WD	Boone Co. Water	Bullock Pen WD	Total	Average Daily
January	13.29	4.67	19.28	5.79	12.60	55.63	1.79
February	12.03	3.92	6.43	2.70	10.76	35.84	1.28
March	12.55	4.44	10.74	1.57	12.28	41.58	1.34
April	14.68	4.99	12.19	1.43	11.88	45.17	1.51
May	13.32	4.64	20.76	0.88	9.46	49.06	1.58
June	14.11	4.45	17.35	1.45	8.29	45.65	1.52
July	15.09	1.84	18.49	6.26	10.75	52.43	1.69
August	13.36	0.36	14.21	5.21	12.70	45.84	1.48
September	14.10	0.11	17.13	5.45	13.32	50.11	1.67
October	12.12	0.006	13.48	5.43	13.90	44.94	1.45
November	13.45	0.03	11.42	4.33	11.96	41.19	1.37
December	14.66	0.19	11.99	5.60	12.02	44.46	1.43
Total	162.76	29.65	173.47	46.10	139.92	551.90	
Water Prod.	29.5%	5.4%	31.4%	8.3%	25.4%	100%	
							Avg. Daily
							1.51
							Avg. Daily Max. Month
							1.79
							Avg. Produced by BPWD
							0.38
							Avg. Purchased
							1.13

Note: ¹ All flows are expressed in million gallons

Water Treatment Plant Feasibility Study | Bullock Pen Water District

Table 2 Water Produced / Purchased¹ (FY 2019)							
Month	City of Williamstown	City of Walton	Northern KY WD	Boone Co. Water	Bullock Pen WD	Total	Average Daily
January	14.10	0.33	14.78	3.81	12.12	45.14	1.46
February	14.59	0.58	22.72	4.65	9.84	52.38	1.87
March	13.85	0.31	14.58	3.93	14.01	46.68	1.51
April	14.51	0.30	14.73	4.53	14.04	48.11	1.60
May	13.79	0.21	14.94	3.65	14.47	47.06	1.52
June	13.80	1.24	16.87	4.01	11.30	47.22	1.57
July	13.00	2.80	20.44	4.38	11.44	52.06	1.68
August	12.57	2.90	16.62	3.91	12.40	48.40	1.56
September	14.34	3.89	16.07	3.77	12.04	50.11	1.67
October	14.34	2.89	14.17	3.97	11.78	47.15	1.52
November	15.53	0.37	10.80	4.34	11.55	42.59	1.42
December	12.09	0.39	14.08	4.63	11.36	42.55	1.37
Total	166.51	16.21	190.80	49.58	146.35	569.45	
Water Prod.	29.2%	2.9%	33.5%	8.7%	25.7%	100%	
				Avg. Daily			1.56
				Avg. Daily Max. Month			1.87
				Avg. Produced by BPWD			0.40
				Avg. Purchased			1.16

Note: ¹ All flows are expressed in million gallons

Water Treatment Plant Feasibility Study | Bullock Pen Water District

Table 3 Water Produced / Purchased¹ (FY 2020)							
Month	City of Williamstown	City of Walton	Northern KY WD	Boone Co. Water	Bullock Pen WD	Total	Average Daily
January	11.26	0.41	13.01	4.34	10.70	39.72	1.28
February	11.57	0.42	11.53	4.26	12.74	40.52	1.45
March	12.72	0.38	13.28	4.07	13.56	44.01	1.42
April	12.58	0.08	12.35	4.82	11.30	41.13	1.37
May	12.52	0.55	11.60	4.71	13.17	42.55	1.37
June	13.37	1.59	16.93	4.62	12.71	49.22	1.64
July	13.84	1.69	17.28	5.38	12.51	50.70	1.64
August	15.23	0.58	17.53	5.82	11.01	50.17	1.62
September	12.29	0.38	19.94	4.92	9.72	47.25	1.58
October	10.98	0.81	19.09	4.90	9.71	45.49	1.47
November	13.84	0.48	14.05	3.96	12.30	44.63	1.49
December	12.81	0.37	16.72	4.83	11.95	46.68	1.51
Total	153.01	7.74	183.31	56.63	141.38	542.07	
Water Prod.	28.2%	1.4%	33.8%	10.5%	26.1%	100%	
							Avg. Daily
							1.49
							Avg. Daily Max. Month
							1.64
							Avg. Produced by BPWD
							0.39
							Avg. Purchased
							1.10

Note: ¹ All flows are expressed in million gallons

Looking at these years for this study, FY 2019 is a good year to use as a basis for existing and projected future water usage. Currently the WD serves all cost-effective areas, within the WD boundaries, with no future growth expected due to expansion. Existing water usage by current customers average about 1.56 million gallons per day (MGD) with an average maximum monthly usage of 1.87 MGD. The WD provides about 0.40 MGD or about 26% of all water produced versus purchased. The other water providers sell on the average to the WD the following amounts:

Wholesalers	Water Purchased	Percent of Total
City of Williamstown	0.46	29
City of Walton	0.04	3
Northern KY WD	0.52	33
Boone County Water	0.14	9

As can be seen, the City of Williamstown and Northern KY WD together, provide about 62% of all water needs serving WD customers.

The amount of water billed to customers in FY2019 averaged 0.96 MGD as shown in Table 4. This indicates that only about 62% of all water that enters the water distribution system is billed. Most of the water loss “not billed” is due to flushing of the distribution system to keep water fresh and meet current regulatory requirements at the ends of the water distribution system. Reasoning can be made that, with a new WTP, the frequency and amount of flushing could be reduced, but until a new WTP is online and operating for several months, this cannot be determined or assessed for the purposes of the study.

Table 4 Water Billed¹ (FY 2018 – 2020)			
Month	FY 2018 Billed Amount	FY 2019 Billed Amount	FY 2020 Billed Amount
January	33.84²	28.51	29.98
February	27.59	28.98	25.08
March	22.17	28.98	25.92
April	27.99	26.06	28.69
May	29.01	28.65	25.71
June	32.28	30.54	37.46²
July	29.68	30.73	37.17
August	32.01	32.29	31.67
September	29.60	36.11²	31.68
October	25.60	26.88	27.56
November	27.09	27.14	27.60
December	31.85	25.01	26.59
Total	348.71	349.85	355.11
Avg. Daily	0.96	0.96	0.97
Avg. Daily Max. Month	1.09	1.20	1.25

Notes: ¹ All flows are expressed in million gallons

² Maximum monthly billed

Raw Water Supply

Kentucky Division of Water (KDOW) developed a model of the Bullock Pen Lake’s ability to provide water for the new Bullock Pen Water Treatment Plant. Based on data from 2001 through 2019, the model indicated that up to 2.0 MGD could be provided by the lake. However, Kentucky Department of Fish and Wildlife Service (KDFWS) owns the lake. A request to KDFWS was made to get approval for a withdrawal rate of 2.0 MGD, with a reduction to 1.5 MGD, when water reaches a critical elevation. The critical elevation was determined by KDFWS based on the bottom elevation of the boat ramp. The WD has requested from KDFWS that these flow withdrawals be granted. At the time of the study, KDFWS has not provide their final

determination. Included in appendix A, is the correspondence with KDFWS along with potential withdrawal rates as calculated by Kentucky Division of Water.

Future Water Needs

The WD customer base is not expected to increase except through infill of new customers. Currently the water distribution system serves all cost-effective areas throughout the service area. Two scenarios were used to project the average daily flow. One is based on No Growth and the other based on 20% Growth over the 20-year planning period. The No Growth scenario is based on a continued average daily water usage of 1.56 MGD. This would be maintained through reduced water loss, and less usage by current customers. Thus, allowing some increase in the customer base. The 20% Growth scenario is based on average daily water usage increase of 0.31 MGD from 1.56 MGD to 1.87 MGD over the 20-year planning period. This growth is based on infill customers outpacing the reductions in water loss and usage by current customers. It may also be possible to add commercial and light industrial customers.

Water Treatment Plant Size Determination

In determining the size, a new water treatment plant must be, other than population or service area increases, several additional factors must be considered. These include the requirements of the existing purchase agreements with current providers "Wholesalers", flexibility to meet existing average water usage of both 1.56 MGD and 1.87 MGD with varying amounts of actual purchased water from the Wholesales, and WTP hours of operation within an acceptable operational range. The operational range would typically be within 10 to 16 hours per day. The existing purchase agreements require a minimum from the current Wholesalers of 0.50 MGD total. This is summarized in Table 5 with monthly and daily minimums, wholesale purchase price per 1000 gallons, and the current purchase agreement expiration date, when wholesale rates or conditions may change.

Table 5 Purchase Agreement Summaries					
Item	City of Williamstown	City of Walton	Northern KY WD	Boone Co. Water	Total
Monthly Minimum (MG)	3.04	0	9.125	3.04	15.21
Avg. Daily Minimum (MGD)	0.10	0	0.30	0.10	0.50
Wholesale Purchase Rate per 1,000 Gal.	\$3.39	\$4.64	\$3.98	\$4.11	- -
Current Purchase Agreement Expiration Date	FY 2026	No Agreement	FY 2040	FY 2028	- -

Water Treatment Plant Feasibility Study | Bullock Pen Water District

Based on above factors, the WTP recommended size base on No Growth and 0.5 MGD purchased could be either 2.0 MGD or 2.5 MGD as shaded in Table 6. For 20% Growth and 0.50 MGD purchased, the WTP size could be either 2.0 MGD or 2.5 MGD also, as shaded in Table 7.

Table 6 Projected Water Treatment Plant Capacity¹ (No Growth) (0.50 MGD Purchased)					
Daily Demand	Water Produced / Purchased (MGD)	Purchased Min. (MGD)	Produced by BPWD (MGD)	WTP Capacity (MGD)	WTP Hours of Operation per day
Average	1.56	0.50	1.06	1.5	17.0
Maximum	1.87	0.50	1.37	1.5	21.9
Average	1.56	0.50	1.06	2.0	12.7
Maximum	1.87	0.50	1.37	2.0	16.4
Average	1.56	0.50	1.06	2.5	10.2
Maximum	1.87	0.50	1.37	2.5	13.2
Average	1.56	0.50	1.06	3.0	8.5
Maximum	1.87	0.50	1.37	3.0	11.0

Note: ¹ Water produced / purchased based on FY 2019 information

Shaded areas represent acceptable WTP sizes based on hours of operation per day to produce amount required from the BP WTP.

Table 7 Projected Water Treatment Plant Capacity¹ (20% Growth) (0.50 MGD Purchased)					
Daily Demand	Water Produced / Purchased (MGD)	Purchased Min. (MGD)	Produced by BPWD (MGD)	WTP Capacity (MGD)	WTP Hours of Operation per day
Average	1.87	0.50	1.37	1.5	21.9
Maximum	2.24	0.50	1.50	1.5	24.0
Average	1.87	0.50	1.37	2.0	16.4
Maximum	2.24	0.50	1.74	2.0	20.9
Average	1.87	0.50	1.37	2.5	13.2
Maximum	2.24	0.50	1.74	2.5	16.7
Average	1.87	0.50	1.37	3.0	11.0
Maximum	2.24	0.50	1.74	3.0	13.9

Note: ¹ Water produced / purchased based on FY 2019 information

Shaded areas represent acceptable WTP sizes based on hours of operation per day to produce amount required from the BP WTP.

Water Treatment Plant Feasibility Study | Bullock Pen Water District

However, it would be more conservative if No Growth and 20% Growth were evaluated based on the water wholesalers providing 150% of the minimum amounts of 0.75 MGD. The WTP recommended size would be 1.5 MGD or 2.0 MGD as shaded in Table 8 for No Growth, and 2.0 MGD or 2.5 MGD as shaded in Table 9 for 20% Growth.

Table 8 Projected Water Treatment Plant Capacity¹ (No Growth) (0.75 MGD Purchased)					
Daily Demand	Water Produced / Purchased (MGD)	Purchased 150% of Min. (MGD)	Produced by BPWD (MGD)	WTP Capacity (MGD)	WTP Hours of Operation per day
Average	1.56	0.75	0.81	1.5	13.0
Maximum	1.87	0.75	1.12	1.5	17.9
Average	1.56	0.75	0.81	2.0	9.7
Maximum	1.87	0.75	1.12	2.0	13.4
Average	1.56	0.75	0.81	2.5	7.8
Maximum	1.87	0.75	1.12	2.5	10.8
Average	1.56	0.75	0.81	3.0	6.5
Maximum	1.87	0.75	1.12	3.0	9.0

Note: ¹ Water produced / purchased based on FY 2019 information

Shaded areas represent acceptable WTP sizes based on hours of operation per day to produce amount required from the BP WTP.

Table 9 Projected Water Treatment Plant Capacity¹ (20% Growth) (0.75 MGD Purchased)					
Daily Demand	Water Produced / Purchased (MGD)	Purchased 150% of Min. (MGD)	Produced by BPWD (MGD)	WTP Capacity (MGD)	WTP Hours of Operation per day
Average	1.87	0.75	1.12	1.5	17.9
Maximum	2.24	0.75	1.49	1.5	23.8
Average	1.87	0.75	1.12	2.0	13.4
Maximum	2.24	0.75	1.49	2.0	17.9
Average	1.87	0.75	1.12	2.5	10.8
Maximum	2.24	0.75	1.49	2.5	14.3
Average	1.87	0.75	1.12	3.0	9.0
Maximum	2.24	0.75	1.49	3.0	11.9

Note: ¹ Water produced / purchased based on FY 2019 information

Shaded areas represent acceptable WTP sizes based on hours of operation per day to produce amount required from the BP WTP.

The Pros and Cons of varying purchased amounts should be evaluated based on the existing distribution system and how water is moved through and regulated from Wholesalers in the service area, including flushing requirements. This is not included in the scope of the WTP study.

Based on Tables 6 through 9, it is recommended that the WTP be based on a 2.0 MGD design. This size best fits the varying growth scenarios and the range of possible water purchase amounts (0.50 to 0.75 MGD). For this study, a cost for the 1.5 MGD WTP will also be developed. This size WTP might come into play, depending on the limitations that KDFWR might impose on withdrawal rates from Bullock Pen Lake.

F. Recommended Alternative

In considering the type of treatment processes that could treat surface impoundments like the Bullock Pen Lake, the WD visited four water treatment plants that had varying treatment processes to consider. These included a conventional type, Actiflo, and dissolved air flotation basins. The treatment processes were in both concrete and steel tanks, all with gravity multi-media filters. Based on observations and conversations with operators at the water treatment plants, for this study, a conventional treatment process with concrete basins will be assumed for a 2.0 MGD water treatment plant. The general design criteria for all types of water treatment systems are summarized in Table 10 for Surface and Ground Water Supplies. As indicated, some criteria are required, and others are recommended. The criteria will be used to size treatment processes through the WTP. Figure 3 is a potential WTP layout based on conventional treatment, including space for a future granular activated carbon system, all located within a building. The building provides security for the plant, and a consistent environment for water treatment.

Table 10 General Design Criteria Surface and Ground Water Supplies (Kentucky Division of Water Requirements)		
Process	Requirements	Recommendations
A. Raw Water Source	Raw water source able to supply rated design capacity of proposed WTP	
B. Raw Water Intake	- Multilevel withdrawal - Screen at intake - Entrance velocity $\leq 0.5\text{ft/sec}^1$ - Backflush cleaning of screen - Provisions for pretreatment chemical addition - Provisions for maintenance of equipment	 X X

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5. Ballasted Flocculation 6. Dissolved Air Flotation 7. Filters (granular media) 8. Filters (membrane) 9. Clear Well 10. High Service Pumps	• Surface overflow rate < 0.75 gpm/ft² with raw water turbidity at any time during the year • Minimum of 2 basins and at least 50% of WTP design capacity with one basin out of service • Sludge collection and removal equipment • Minimum of 2 units and at least 50% of WTP design capacity with one unit out of service • Pilot testing required if conventional gravity, granular media filters are not used • Design based on manufacturer's recommendations • Approval requires demonstrating satisfactory performance with on-site plant testing under all operating conditions. Protocol shall be submitted for DOW approval • Minimum of 2 units and 50% of WTP design capacity with one unit out of service • Gravity or pressure filtration (pressure filtration not allowed for surface water supply) • Filter rate of < 2 gpm/ft² (sand / single media), < 5 gpm/ft² (multimedia) • Minimum 2 filters and 100% of WTP design capacity with one filter unit out of service • Backwash rate of 15 gpm/ft² min. to 20 gpm/ft² recommended to provide 50% expansion of filter bed • No air piping penetrations or within filter media bed, no short circuiting between unfiltered and filtered water • Not applicable for this study • Volume ≥ 15% of WTP capacity • Two separate compartments or two separate clear wells with access to high service pumps to allow maintenance with one chamber / clear well out of service without interruption of service	
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11. Chemical Feed System	• Minimum 2 pumps and 100% of WTP design capacity with (largest) pump out of service • Surge control for normal pump start and stopping • Chlorination • Fluoridation • Ability to feed powered activated carbon • Offer chemicals used as determined necessary	
12. Disinfection	• Disinfection treatment sufficient to ensure compliance	
13. UV Disinfectant	• Not applicable for this process	
14. Standby Electric Power	• Dedicated standby power or alternate electric power source to meet the average day demand	X
15. Security System	• Door and window locks • Security fencing • Security monitoring system	X

Notes: ¹ ft/sec – feet per second

² min. – minimum

³ sec. – second

⁴ ft/min – feet per minute

⁵ gpm – gallons per minute

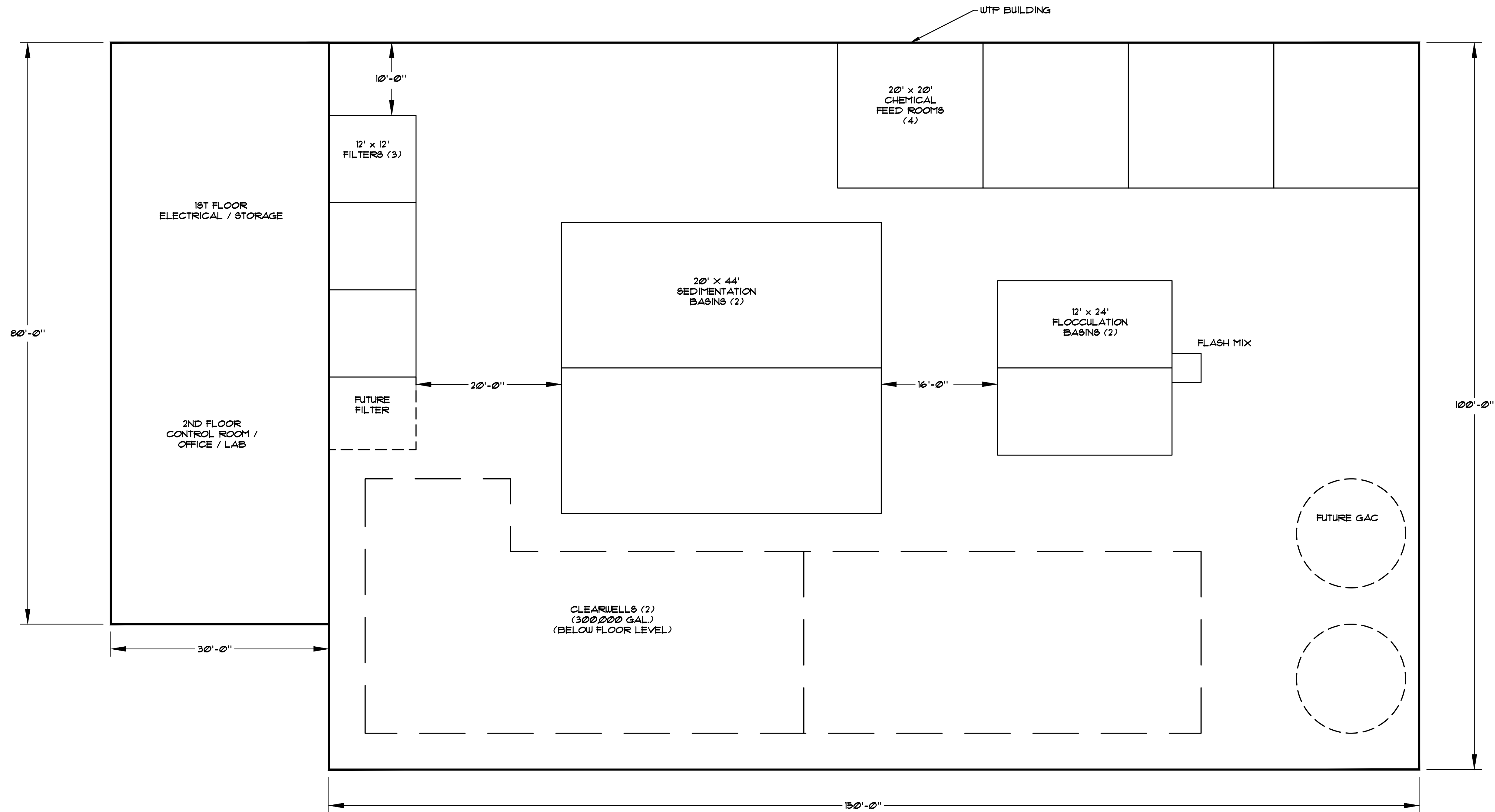


FIGURE 3

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Opinion of probable construction costs and project costs were developed for both a 2.0 and 1.5 MGD treatment plant rated capacity. The opinion of probable project costs is \$13.5 million(M), and \$13.1M for a 2.0 MGD, and 1.5 MGD WTP, respectively. Detailed cost breakdowns for each are provided in Appendix B. For the remaining study it will be assumed that a 2.0 MGD plant is constructed at a cost of \$13.5M.

The existing water treatment plant property does not have available land to construct a new water treatment plant. Therefore, alternative property locations were considered close to the existing plant with access to Bullock Pen Lake, and connection to the existing water distribution system. These project sites are located on the same property as shown in Figures 4, 5, and 6. Site 1 provides the most space without obstructions at approximately 3.8 acres. Site 2 overlays the same piece of property as Site 1 but is limited in size. The 1.6 acres would require a temporary construction easement adjacent to the property, to provide a staging and storage site area during construction. Site 3 is located adjacent to the existing WTP but is restricted by how the property is access by larger vehicles, and a power line that runs through the middle of the property. Therefore, Site 1 as shown in Figure 4 is the recommended size and location for a new WTP.