CITY OF McBAIN
MISSAUKEE COUNTY, MICHIGAN

USDA – Rural Development
Preliminary Engineering Report
Water System Improvements

January 2020

Project No. 839140

STATE OF MICHIGAN
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FLEIS&VANDENBRINK
603 BAY ST, FIRST FLOOR, TRAVERSE CITY, MI 49684

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PROJECT PLANNING AREA

Project Planning Area

The project planning area is the current water distribution service area in the City of McBain. The City currently serves municipal water to 224 customers. The median household income for the City is $31,875. See attached map of the existing water distribution area (Figure 1).

The City of McBain had Fleis and VandenBrink perform a Water System Review in 2019. This report is in the appendix and is part of this preliminary engineering report. The report identified and recommended a number of distribution system improvements throughout the City.

Environmental Resources Present

A separate Environmental Report was prepared by Michigan Community Action Agency Association - Rural Community Assistance Provider, which evaluated the potential environmental impacts of the proposed water system improvements included in this report. Implementation of recommended improvements will follow recommendations included in the Environmental Report to minimize environmental impact of the project.

Population Trends

The projected 20-year water demand for the City was estimated using the past population numbers obtained from the U.S. Census Bureau. The population of McBain is estimated to grow at approximately 0.4% per year. This growth rate of 0.4% per year was used to project the future population of the City. The table below shows the past and projected populations for the City.

POPULATION PROJECTIONS

Year	Population
1950	506
1960	551
1970	520
1980	519
1990	694
2000	584
2010	656
*2019 (est.)	635
2039 (est.)	691

*Based on population estimate data from US Census Bureau for 2017

Community Engagement

The City has published a public notice informing the community of the intent to pursue funding for improvements to the City's water system. The notices encourage public comment within designated times for this project. The City will consider input from the community while planning for the water system improvements.

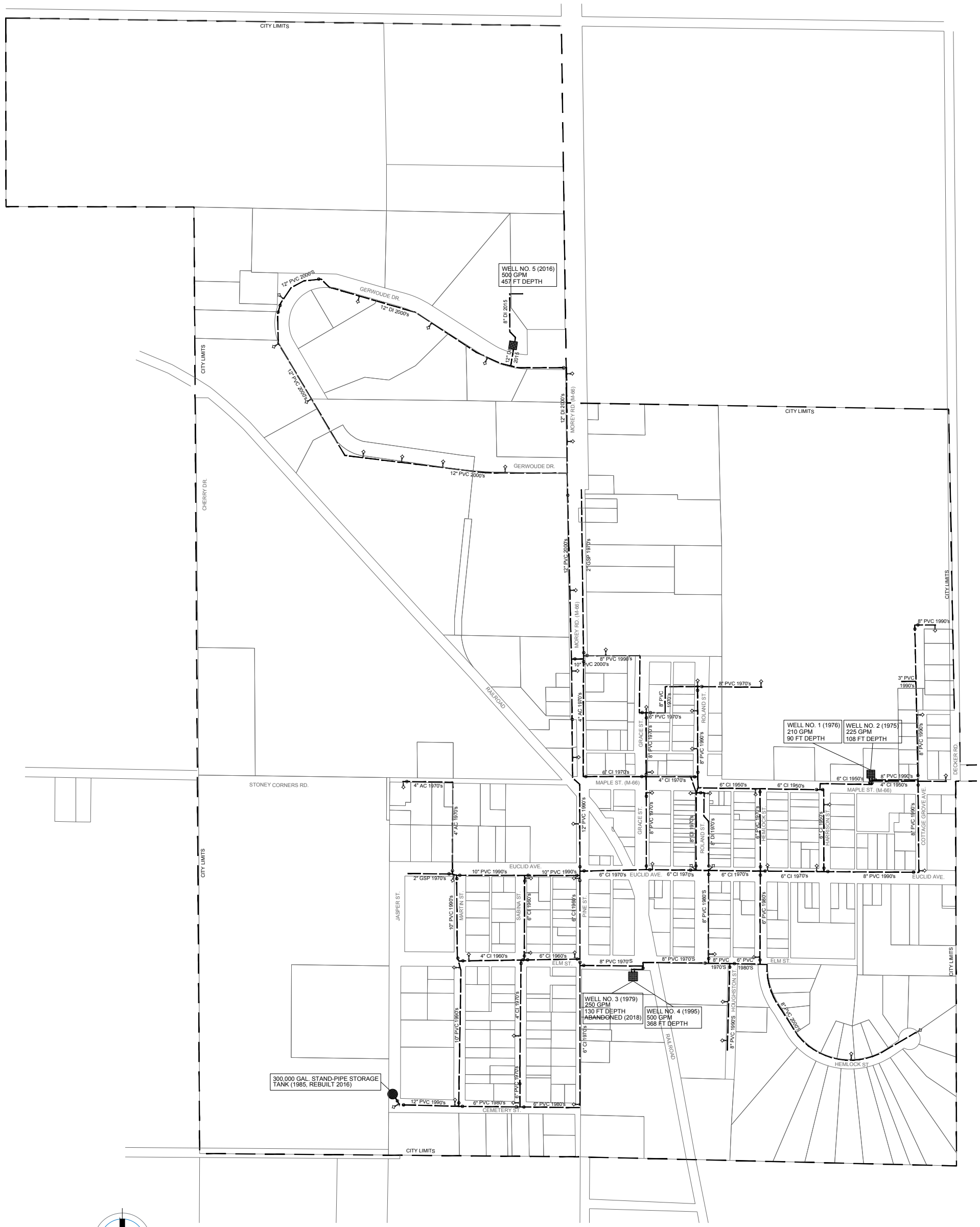
EXISTING FACILITIES

Existing Facilities

The City of McBain water system consists of four wells designated as Well No. 1, Well No. 2, Well No. 4, and Well No. 5; a 300,000-gallon stand-pipe style storage tank, watermain, hydrants, valves, water services and appurtenances. The water system serves 224 customers, comprised of both residential and commercial users.

The existing water system has the following deficiencies:

- Well No. 1 is aged and approaching the end of its useful life
- Well No. 2 is aged and approaching the end of its useful life
- Well No. 4 has high iron concentrations
- Well No. 5 has high iron concentrations
- The water tower does not contain enough operating volume to provide fire protection flows or have an appropriate way to clean and is conducive to sediment buildup
- 6-inch, 4-inch, and 2-inch watermain needs to be replaced. They are aged and undersized to provide fire protection flows. Many of these water mains are cast iron.
- The system does not have water service meters. Meters need to be installed for accurate billing and leakage monitoring.



NORTH
SCALE : NONE

LEGEND

- WATERMAIN WITH PIPE SIZE
- FIRE HYDRANT
- VALVES

CITY OF McBAIN
MISSAUKEE COUNTY, MI
EXISTING WATER SYSTEM

FIGURE 1 - EXISTING SYSTEM

F&V PROJECT NO. 839140

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kenm/M:\Proj839001-841000\839140 McBain - USDA RD Water App\Cad\Fig\839140 FIGURE 1 EXISTING SYSTEM.dwg

PURPOSE & NEED FOR PROJECT

Purpose and Need for Project

Need for the project was in part established through water quality issues experienced in the distribution system. Further, the Water System Review completed in 2019 identified additional needs of the system including:

1. Water quality issues pertaining to iron concentrations and sedimentation concerns
2. No mud valve on the storage tank
3. More than ½ of the storage tank capacity is unusable in order to maintain system pressures
4. Storage volume in the operating range of the tank is too small to maintain required flows, and water customers near the storage tank complain of low water pressure.
5. Well No.1 and No. 2 are beyond their useful lives and should be replaced to maintain recommended water system capacity.
6. The existing 6-inch and 4-inch watermains are not adequately sized to provide fire protection flows.
7. The distribution system contains approximately 14,000 feet of cast iron piping which may be leaching additional iron into the system and is a likely location to find lead goosenecks for service connections which pose health risks.
8. The system does not have water service meters. Meters need to be installed for accurate billing and leakage monitoring.

The City of McBain has experienced water quality issues for the past several years. The City receives complaints from water customers about discolored water. At certain times, the water in the distribution system has a rust-like color. The City performs frequent flushing to try and improve the water quality and aesthetics. It is believed that this phenomenon is caused by water with high iron concentrations that endures long detention times in the stand-pipe style water tank which increases sedimentation. This sediment accumulates at the bottom of the tank and is drawn into the water distribution system and potentially causes the discoloration of the water. There does not seem to be a trend associated with the discolored water, the City's water quality seems to be generally unreliable. The City installed a new well in 2016 in hopes that it would improve water quality, however, this well also produces water with high iron concentration and due to this, the well has not been in regular service since it's installation. The City decided to further investigate these water quality issues and worked with F&V to perform a review of the City's entire water system.

As part of the Water System Review, the annual water sampling results for the wells in service were analyzed in depth for iron and hardness. Generally, wells No. 1 and No. 2 contain hardness levels notably higher than wells No. 4 and No. 5. Wells No. 1, No. 2, and No. 4 are showing increasing levels of iron concentrations based on historical trends. The iron concentrations in well No. 4 have consistently been near or above the EPA guideline threshold of 0.3mg/l where iron frequently becomes an aesthetic concern for communities. In 2018 the samples from well No. 5 were at or above the 0.3 mg/l EPA threshold, and iron concentration is prior to 2018 were considerably higher that 0.3 mg/l. The iron concentrations experienced in Well No. 4 are generally acceptable for successful iron treatment through sequestration by addition of polyphosphate at the well house. The water from well No. 5 should be treated through an iron removal plant to maintain water quality.

As noted above, Wells No. 1 and No. 2 are aged beyond their useful life. The City is not reliant in the capacity of these wells for regular water consumption demands, however, they would like to maintain the capacity for fire fighting purposes. The City is planning to replace the capacity of these aged wells with a new well(s) near the site of Well No. 5.

In a report dated December 21, 2015, Insurance Services Office, Inc. (ISO) recommends a basic fire flow of 3,000 gpm for the City of McBain. This basic fire flow is chosen based on the fifth largest needed fire flow for the building types in the community. For a basic fire flow of 3,000 gpm, the ultimate water system capacity goal is to be able to provide this flow rate for three hours. The table below shows the City of McBain's current water system capacity as it relates to the ISO recommendation for residential, commercial, industrial (ISO recommendation for McBain), and institutional fire fighting capacity classifications:

Required Water System Capacity for Fire Fighting									
Classification	Desired Flow (gpm)	Duration (hr)	Ex Max Day (gpm)	Total Flow (gpm)	Well Capacity (gpm)	Net Flow (gpm)	Total Storage Needed (gal)	Ex Storage (gal)	Add'l Capacity Needed (gal)
Residential	1,000	2	244	1,244	1,435	-191	0	113,830	0
Commercial	2,000	2	244	2,244	1,435	809	97,080	113,830	0
Industrial	3,000	3	244	3,244	1,435	1,809	325,620	113,830	211,790
Institutional	3,500	3	244	3,744	1,435	2,309	415,620	113,830	301,790

The well capacity shown in the table above is total existing well capacity, and existing storage is based on the upper portion of the standpipe water storage tank that is capable of providing adequate system pressures.

As shown in the table above, the City's water system has just enough capacity to meet commercial fire-fighting capacity (provide 2,000 gpm for 2 hours). The City desires to at least maintain the current water system capacity as part of the proposed project.

The project goals are:

1. Improve water quality
2. Improve distribution system capacity and reliability
3. Replace aged wells which will reduce maintenance costs, maintain reliable water supply, and maintain current water system capacity.
4. Reduce water detention time at the water storage tank and facilitate purging of sediment from the tank

The planned improvements will address the water system in the following ways:

1. Iron treatment through sequestration for well No. 4, an iron removal plant for well No. 5 (the iron removal plant would also treat water from new new well(s) mentioned below).
2. Construct a new 200,000-gallon elevated water storage tank to maximize use of stored water, reduce detention time, and allow for sediment purging.

   OR

   A lower cost storage alternative – install a sump drain in the existing tank to purge sediment and make other modifications to minimize impact of sediment on the City's stored water.
3. Install new well(s) to replace the aged wells (No. 1 and No. 2) and improve water quality.
4. Replace existing cast iron water mains with new and larger diameter watermains in various sections of the City to improve residual pressures, increase available flows, including fire flows, and improve water quality.

ALTERNATIVES CONSIDERED

Alternatives Considered

Three alternatives were considered for this proposed project.

1. The first alternative is the "No Action Alternative".
2. The second alternative is to complete the most urgent replacements to improve flows/quality/reliability. These priorities include:
    - Well No. 1 and No. 2 abandonment
    - Installation of a new well(s) at the site of well No. 5 providing capacity in the 500-800 gpm range.
    - Iron removal plant to treat water from well No. 5 and new well(s) installed at this location.
    - Modifications to well No. 4 to remove iron through sequestration
    - Construct a new 200,000 gallon water storage tank
    - Replace aged 4-inch and 6-inch water main with 8-inch
    - Water service meters installation
3. The third alternative includes all water supply and distribution system improvements included in the second alternative, with a reduced scope water storage component that will complete modifications to the existing water storage tank in lieu of tank replacement.

    The revised water storage improvement scope includes the following:
    - Install a drain sump in the existing water tank floor/foundation with a valve located outside the tank. This valve can be operated periodically to purge sediment from the water tank floor.
    - Install drainage facilities (pipe, ditching, retention area, etc.) for water release from the tank (for purging sediment).
    - Increase the elevation of the inlet pipe to the existing water tank to reduce impact of sediment on the stored water.
    - Increase elevation of mixer to circulate water while not disturbing sediment on the tank floor.
    - Cathodic projection system improvements.

    The water supply and distribution system scope remains the same as the second alternative:

    - Well No. 1 and No. 2 abandonment
    - Installation of a new well(s) at the site of well No. 5 providing capacity in the 500-800 gpm range.
    - Iron removal plant to treat water from well No. 5 and new well(s) installed at this location.
    - Modifications to well No. 4 to remove iron through sequestration
    - Replace aged 4-inch and 6-inch water main with 8-inch
    - Water service meters installation

Table 1 - List of the Alternatives

Alternative	Estimated Costs	Beneficial Environmental Impacts	Potential Adverse Environmental Impacts
Alt. 1 - No Action Alternative	$0.00	None	Risk of system reliability and water quality may become urgent.
Alt. 2 – Water Supply, Water Storage, and Distribution System Improvements	$7,333,000	• Maintain a sustainable quality drinking water supply for the City. • Reduced maintenance • Increase fire flows	Temporary disruption of surface vegetation in some areas.
Alt. 3 – Water Supply, Distribution System, and reduced scope Water Storage Improvements	$6,492,000	• Maintain a sustainable quality drinking water supply for the City. • Reduced maintenance • Increase fire flows	Temporary disruption of surface vegetation in some areas.

Alternative 1: No Action

Regarding the No Action alternative, it is not feasible for the City of McBain to do nothing with their water distribution and water supply system. Optimizing the current facilities is not a feasible alternative since the City needs to perform improvements to improve water quality.

If “no action” was performed, it would leave the City water system in a continuing state of disrepair and will increase maintenance and utility costs yearly to repair watermains. No Action would also mean the City’s water quality would remain marginal and unreliable with high iron and sedimentation issues. With this Alternative, repairs are made only as necessary and on an emergency basis only, resulting in expected system failures and significantly increased operating and repair costs.

Alternative 2: Recommended Water Distribution System, Water Supply, and Water Storage Improvements

This alternative will address the major needs of the City's water system by performing necessary improvements to improve water quality. The proposed improvements are as follows:

- construct a new 200,000-gallon elevated water storage tank to reduce overall water

storage and detention time, however, provide more usable storage situated at an appropriate elevation to provide water system pressure.

- Construct an 800 gpm iron removal plant to remove iron from water supply, this capacity will match the rated capacity for well No. 5 and the new well(s) at the well No. 5 site.
- Install additional well(s) at well No. 5 so aged wells No. 1 and No. 2 can be abandoned.
- Add iron sequestration at Well No. 4 to remove iron
- Replace aged and undersized cast iron watermains that may be contributing to discoloration of the City's water.
- Install water service meters.

Alternative 3: Recommended Water Distribution System, Water Supply, and Reduced Scope Water Storage Improvements.

This alternative will address the major needs of the City's water distribution system and water supply system and will make modifications to the existing water storage tank to improve water quality.

The water storage tank improvements will include installation of a sump drain in the existing water tank floor/foundation. This sump drain will be plumbed to a water discharge system that may consist piping, ditching, or water retention ponds. This new sump drain will be controlled by a valve located outside the tank. This sump will allow the water operators to periodically purge sediment from the tank to reduce the overall sediment that ends up in the stored water.

The tank inlet pipe will also be raised inside the tank. The pipe currently extends 10" above the tank floor which provided potential for sediment on the tank floor to drawn-out of the tank and into the distribution system. Raising the inlet will provide more separation between accumulated sediments and the water being drawn from the tank which may reduce sediment throughout the distribution system.

The existing mixer that was installed as part of the tank rehab project in 2016 will be raised. The intent of the mixer was to keep water circulating to minimize ice build-up. The mixer was installed very close to the tank floor and it stirred-up sediment when in operation. This suspended sediment was drawn into the distribution system. The mixer was taken offline shortly after installation due to it's negative impact on water quality. This alternative proposed to raise the mixer to an elevation where it can operate without disturbing accumulated sediments on the tank floor and restore the ability of the mixer to reduce ice accumulation in the tank.

The final tank modification will be to make improvements to the cathodic protection system for the existing water storage tank to ensure that it is protected from corrosion for years to come.

The reduced scope water storage system improvements may result in a slight increase in operation and maintenance cost due to purging water from the tank and operation of the mixer, however, the overall capital cost for the modification will be lower than the tank replacement option.

Alternative No. 3 maintains the same water distribution system and water supply improvements included in Alternative No. 2

Design Criteria used for the Project

The design criteria to be used for the project will comply with RUS design policies (7 CFR 1780.57), the State of Michigan PA 399 and its administrative rules, AWWA guidelines, and the recommended standards for Water Works.

Water System Project Map

A copy of the water system map showing the recommended improvements can be found at the end of this section (Figure 2 – Selected Alternative).

Land Requirements

The proposed watermain improvements and storage tank improvements will be located within the street right-of-ways or property owned by the City. The new wells and iron treatment plant may be installed on property owned by the City. The well installation may require deed restrictions on adjacent properties to maintain the EGLE required isolation perimeter around the new wells.

Permits will be acquired per the EGLE regulations for water systems.

Construction Problems

There are no known construction problems at this time. Soil borings and a geotechnical analysis of the borings will be completed as part of the design process.

Compliance with EGLE Lead and Copper Rules

The water distribution system improvements include replacement of the City's oldest cast iron watermains that were installed in the 1950's. It is possible that there are lead and galvanized services connected to these old watermains. The water service material will be confirmed either by the City prior to construction (in the design phase) or confirmed by the Contractor during construction. Coordination with property owners for potential water service replacements will occur during the design phase.

Water services found with materials in violation will be addressed in accordance with the EGLE lead and copper rules. This will involve water service replacement on private property. The City will apply to EGLE's DWRF program for funding to complete the portion of the water service replacement that will occur on private property. All improvements within City right-of-way (including water service replacement from the new wateramin to right-of-way line) is included in the USDA project scope.

The private property water service replacement work will include installation of new water service from the right-of-way line to 18" inside the foundation of the house or structure. There are 150 existing water service replacements included with the proposed project. The estimated cost for the private property portion of the water service replacements is $520,000. This estimated cost includes construction, bond counsel services, and engineering. The cost of this private property water service work is not included in the USDA project cost estimates listed below.

Project Cost Estimates

Project cost estimates for each alternative are as follows:

Alternative No. 1 - No Action:

Total Project Cost $ 0

Alternative No. 2 - Recommended Water System Improvements

Construction Costs	$ 5,586,000
Project Contingencies	$ 558,600
Design & Construction Engineering	$ 1,073,900
Bond Council, Interim Financing, Legal, and Administrative Expenses	$ 114,500
Total Project Cost	**$ 7,333,000**

Alternative No. 3 - Recommended Water System Improvements with Reduced Scope Water Storage Improvements.

Construction Costs	$ 5,017,000
Project Contingencies	$ 501,700
Design & Construction Engineering	$ 849,700
Bond Council, Interim Financing, Legal, and Administrative Expenses	$ 123,600
Total Project Cost	**$ 6,492,000**

Advantages/Disadvantages

Alternative No. 2:

Alternative 2 meets the City's most urgent water distribution system needs by replacing aged and undersized watermains, replacing aged wells No. 1 and No. 2, providing iron treatment, constructing a new water storage tank, and looping the distribution system.

Alternative 2 will cause the Village to incur costs to perform improvements to their water system.

Alternative No. 3:

Alternative 3 meets the City's most urgent water distribution and water supply system needs by replacing aged and undersized watermains, replacing aged wells No. 1 and No. 2, and making modification to the existing storage tank. This alternative will accomplish the project goals of improving water quality and available flow at a lower capital cost than Alternative No. 2.

Alternative No. 3 will require higher operation and maintenance costs than Alternative No. 2 due to increased effort by operators to purge sediment from the existing water tank and due to operation of the mixer.

LOCATION OF NEW IRON REMOVAL PLANT AND NEW WELL(S)

WELL NO. 5 (2016)
500 GPM
457 FT DEPTH

ABANDONMENT OF WELL NO. 1 AND WELL NO. 2

WELL NO. 1 (1976)
210 GPM
90 FT DEPTH

WELL NO. 2 (1975)
225 GPM
108 FT DEPTH

PROPOSED WATER STORAGE TANK IMPROVEMENTS

300,000 GAL. STAND-PIPE STORAGE TANK (1985, REBUILT 2016)

WELL NO. 3 (1979)
250 GPM
130 FT DEPTH
~~ABANDONED (2018)~~

WELL NO. 4 (1995)
500 GPM
368 FT DEPTH

LOCATION OF WELL NO. 4 IMPROVEMENTS

NORTH
SCALE : NONE

LEGEND

- WATERMAIN WITH PIPE SIZE
- FIRE HYDRANT
- VALVES
- PROJECT AREA

CITY OF McBAIN
MISSAUKEE COUNTY, MI
EXISTING WATER SYSTEM
FIGURE 2 - SELECTED ALT.

F&V PROJECT NO. 839140

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kenm/M:\Proj839001-841000\839140 McBain - USDA RD Water App\Cad\Fig\839140 FIGURE 2 SELECTED ALTERNATIVE.dwg

SELECTION OF AN ALTERNATIVE

PROPOSED PROJECT
(RECOMMENDED ALTERNATIVE)

Selection of an Alternative

Need for the project was in part established through water quality issues experienced in the distribution system. Further, the Water System Review completed in 2019 identified additional needs of the system. Three alternatives were considered for McBain:

- Alternative No. 1: No action
- Alternative No. 2: Completion of all recommended water system improvements in priority areas.
- Alternative No. 3: Completion of recommended water system improvements with a reduced scope water storage option that performs modifications to the existing water storage tank in lieu of tank replacement.

Alternative 3 – has been determined to be the best option for the proposed project due to the reduced capital cost vs. Alternative No. 2.

Proposed Project Design

The proposed project will consist of existing watermain replacement, Modifications to the existing water storage tank, a new 800 gpm iron removal plant, a new well(s), improvements at Well No. 4, abandonment of Well No.1 and Well No. 2, and installation of water meters and remote reading system. The scope of the watermain improvements can be seen on Figure No. 2 (Selected Alternative) attached to the previous section of this report.

An estimate for Alternative No. 2 (Selected Alternative) is included in the Appendix.

Proposed Project Schedule

Milestone	Date
Rural Development Application Submittal	January 2020
Rural Development Application Approved	March 2020
Project Design	April 2020
Permits	March 2021
Advertisement for Bids	April 2021
Loan Closing	May 2021
Contract Award	May 2021
Initiation of Construction	June 2021
Substantial Completion	June 2022
Final Completion	August 2022

Permit Requirements

The permits required for this project include a Soil Erosion and Sedimentation Control permit, an MDEQ Act 399 Water permit, and an MDOT permit.

Operation and Maintenance Cost

Projected operation and maintenances costs, present worth analysis and bond schedules for the proposed project can be seen in the Appendix.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions and Recommendations

The recommended water system improvements are a result of water quality issues experienced in the distribution system and the Water System Review completed in 2019.

The proposed improvements included in Alternative No. 3 (the selected alternative) will improve quality, flow and reliability of the distribution system, reduce maintenance, reduce leakage, and reduce energy consumption from pumping the City water supply. The estimated cost of these improvements is $6,492,000.

APPENDIX

CITY OF McBAIN

USDA WATER SYSTEM IMPROVEMENTS APPLICATION

PROJECT ESTIMATES

Date 1/28/2020
PM KCM
Project No. 830920

Engineer's Estimate of Probable Construction Cost

Watermain Improvements					
Item No.	**Item Description**	**Unit**	**Est Qty**	**Unit Price**	**Est Price**
1	General Conditions, Bonds, Insurance and Mobilization	Lsum	1	$91,900.00	$91,900.00
2	Construction Signing and Barricades	Lsum	1	$15,000.00	$15,000.00
3	Soil Erosion /Sedimentation Control	Lsum	1	$5,000.00	$5,000.00
4	Above Ground Video Survey	Lsum	1	$2,200.00	$2,200.00
5	Dewatering	Lsum	1	$20,000.00	$20,000.00
6	Pavement Removal	Syd	19,820	$3.00	$59,460.00
7	Concrete Sidewalk Removal	Syd	1,740	$4.00	$6,960.00
8	Concrete Drive Removal	Syd	840	$6.00	$5,040.00
9	Concrete Curb and Gutter Removal	Lft	2,340	$6.00	$14,040.00
10	Hydrant Remove, Salv	Ea	30	$500.00	$15,000.00
11	Abandon Ex. Valve and Box	Ea	50	$250.00	$12,500.00
12	Cut and Plug Ex. Watermain	Ea	50	$300.00	$15,000.00
13	Flowable Fill of Ex. Watermain	Lft	4,410	$2.00	$8,820.00
14	Sidewalk, Conc. 4"	Sft	15,630	$4.00	$62,520.00
15	Sidewalk Ramp, Conc. 6"	Sft	600	$6.00	$3,600.00
16	Concrete Drive, 6"	Sft	7,560	$5.00	$37,800.00
17	Sand Subbase, CIP	Cyd	1,300	$8.00	$10,400.00
18	Trench Undercutting and backfill, CIP	Cyd	1,300	$20.00	$26,000.00
19	Aggregate Base 22A, 8", CIP	Syd	12,160	$7.25	$88,160.00
20	Aggregate Base 21AA, 8", CIP	Syd	7,660	$8.00	$61,280.00
21	Aggregate Surface 23A, 6", CIP	Syd	890	$6.00	$5,340.00
22	Concrete Curb and Gutter, Match Existing	Lft	2,340	$18.00	$42,120.00
23	HMA 13A, Base	Syd	11,230	$6.00	$67,380.00
24	HMA 36A, Surfacing	Syd	19,990	$6.00	$119,940.00
25	HMA 36A, Driveway	Syd	1,980	$15.00	$29,700.00
26	HMA 3E3, Base	Syd	6,630	$9.50	$62,990.00
27	HMA 4E3, Leveling	Syd	6,630	$5.50	$36,470.00
28	HMA 4E3, Surface	Syd	6,630	$5.50	$36,470.00
29	8" Watermain	Ft	9,680	$40.00	$387,200.00
30	8" Watermain Directional Drill	Ft	150	$70.00	$10,500.00
31	18" Jack and Bore	Ft	70	$260.00	$18,200.00
32	8" Valve and Box	Ea	50	$1,300.00	$65,000.00
33	Hydrant Assembly	Ea	30	$4,000.00	$120,000.00
34	Connect to Ex WM	Ea	50	$1,500.00	$75,000.00
35	1" Water Service	Ft	4,800	$15.00	$72,000.00
36	1" Water Service Directional Drill	Ea	80	$600.00	$48,000.00
37	1" Corporation, Curb Stop & Box	Ea	150	$650.00	$97,500.00
38	Reconnect Ex. Water Service	Ea	150	$225.00	$33,750.00
39	Pavement Marking 6", White, Waterborne (include 2 applications)	Ft	3,550	$0.40	$1,420.00
40	Pavement Marking 4" Yellow, Waterborne (include 2 applications)	Ft	3,550	$0.40	$1,420.00
41	Pavement Marking, Railroad Crossing, Ovly Cold Plastic	Ea	10	$340.00	$3,400.00
42	Pavement Marking Stop Bar, Polyurea	Ft	60	$13.00	$780.00
43	Mulch Blanket	Syd	1,030	$1.00	$1,030.00
44	Surface Restoration	Syd	10,320	$3.25	$33,540.00
				Subtotal	**$1,930,000.00**

Iron Removal Plant, Well Improvements, Water Meters, Water Storage Tank Improvements

Item No.	Item Description	Unit	Est Qty	Unit Price	Est Price
1	Iron Removal Plant	Lsum	1	$2,122,000.00	$2,122,000.00
2	Add Iron Sequestration to Well No. 4	Lsum	1	$24,000.00	$24,000.00
3	Install an Additional Municipal Well	Lsum	1	$326,000.00	$326,000.00
4	Abandonment of Well No. 1 and Well No. 2	Lsum	1	$40,000.00	$40,000.00
5	Modifications to Existing Water Storage Tank	Lsum	1	$150,000.00	$150,000.00
6	Water Meters for City Water Customers	Lsum	1	$425,000.00	$425,000.00
				Subtotal	**$3,087,000.00**

Total Cost of Recommended Improvements	**$5,017,000.00**
Project Contingencies	**$501,700.00**
Design & Construction Engineering	**$849,700.00**
Legal, Bond Council, Interim Financing & Administrative Expenses(publications, lead and asbestos survey, testing, etc.)	**$123,600.00**
Total Project Cost	**$6,492,000.00**

Existing Water System Summary

(add or delete cells or rows as necessary)

Community Name: City of McBain

MDEQ Water Supply Number (WSSN): 4190

Well	Rated Capacity (gpm)	Date of Completion	Date of Last Maint.	Depth	Water Quality
Well 1	210	1976	2010	90ft	Acceptable
Well 2	225	1975	2010	103ft	Acceptable
Well 4	500	1995	2017	368ft	Acceptable
Well 5	500	2016	2016	457ft	Acceptable

Water Demand (MGD)

Firm Capacity:	1.35	MGD
Avg. Day Demand:	0.137	MGD
Max Day Demand:	0.351	MGD
Avg Monthly Billing	3.59	MG
Avy Monthly Pumpage	3.59	MG

Storage

Elevated Tank or Ground Storage		
Volume:	300,000	Gal
Construction:	Elevated - Bolted Steel	
Const Date:	2016	
Last paint:	2016	
Low Service Pumps	N/A	(gpm, ea.)
High Service Pumps	N/A	(gpm, ea.)

Distribution System:

	Material	Footage	Age
2" watermain	Galvanized	1472	49
3" watermain	Galvanized	102	29
4" watermain	Cast Iron/Asbetos Cement	3607	59-49
6: watermain	PVC/Cast Iron	8239	69-39
8" watermain	PVC/Ductile Iron	11668	49-19
10" watermain	PVC	2564	29
12" watermain	PVC/Ductile Iron	8978	29-4

Number of Hydrants	Brand
56	Various

Number of Valves: 79

Water Customer Information:

	No. of Existing Customers	Monthly Usage (gallons)	No. of Users after Project	Projected Total Usage
Residential Dwellings	172	860,000	172	860,000
Other Users	52	2,146,751	52	2,146,751
Totals	224	3,006,751	224	3,006,751

Existing Rate Structure:

REUs	Base Rate	Per:
1	$73.00	3 Mo.

Average Monthly Billing at Current Rates (all customers)

$14,633

Yearly O & M Cost Before Improvements: $85,083 **Yearly O & M Cost After:** $135,123

Operating Budget
For First Full Year After Construction

(add or delete rows as necessary)

Community Name: City of McBain **County:** Missaukee

Address: P.O.Box 95
McBain, MI 49657

A. Applicant Fiscal Year: **From:** Feb-22 **To:** Jan-23

B. Operating Income:	**From Water Sales or Sewer Rates & Charges:**	$287,664
	Other (e.g. Water Tank Antenna Rental, etc)	
	Total Operating Income:	$287,664
C. Operating Expenses:		
	Contractual Services	$24,709
	Office Supplies	$5,013
	Public Utilities	$17,334
	Repairs and Maintenance	$18,016
	Labor and Equipment Rental	$67,916
	Miscellaneous	$2,135
D.	**Total Operating Expenses:**	$135,123
	Net Operating Income:	$152,541
E. Non Operating Income:		
	Interest Income:	$207
	Capital Contribution	$10,000
	Total Non Operating Income:	$10,207
F.	**Net Income**	$162,748
G. Expenditures/Transfers		
	Repair, Replacement & Improvement Fund	$20,920
	Bond Reserve	$6,716
	Payment to USDA Loan	$67,158
	Payment to Other Loans:	
	2016 GO Bond	$67,950
	Total Expenditures/Transfers:	$162,744
	Excess/Deficit over net income:	$4

Present Worth Analysis & Short Lived Depreciation

(add or delete rows or cells as necessary)

Community Name: City of McBain

Federal Discount Rate for Water Resources Planning (Interest Rate) i = 0.04875

Number of Years, n = 20 years

Alternative 1:		**Alternative 2:**		**Alternative 3:**	
Initial Capital Costs =	$0	**Initial Capital Costs =**	$7,333,000	**Initial Capital Costs =**	$6,492,000
Annual Operations & Maintenance Costs =	$85,083	**Annual Operations & Maintenance Costs =**	$135,123	**Annual Operations & Maintenance Costs =**	$135,123
Future Salvage Value =	$695,888	**Future Salvage Value =**	$3,115,778	**Future Salvage Value =**	$2,838,248
Present Worth of 20 years of O & M =	$1,071,651	**Present Worth of 20 years of O & M =**	$1,701,923	**Present Worth of 20 years of O & M =**	$1,701,923
PW = Annual OM *(1+i)^n-1 / i*(1+i)^n					
Present Worth of 20 yr Salvage Value =	$268,596	**Present Worth of 20 yr Salvage Value =**	$1,202,616	**Present Worth of 20 yr Salvage Value =**	$1,095,496
PW = FSV* 1 / (1 + i)^n					
Alternate 1 Total Present Worth =	$803,055	**Alternative 2 Total Present Worth =**	$7,832,307	Alternative 3 **Total Present Worth =**	$7,098,427

Short Lived Depreciated Assets

(items listed, life expectancy, are just examples, use your own data)

Item	Years of Life Expectancy	Number of Units	Replacement Cost	Funds to Set Aside Yearly
Tank Rehab	15	1	$100,000.00	$6,667
Well inspection and cleaning (I	10	3	$10,000.00	$3,000
Well Pump and Motor	15	3	$12,000.00	$2,400
Well Control Panel/SCADA	15	3	$10,000.00	$2,000
Chemical Feed Equipment	10	4	$5,000.00	$2,000
Valve Actuators	10	18	$1,400.00	$2,520
IRP Filter Media	15	1	$35,000.00	$2,333
				$20,920

Note:
This is not intended to include every piece of equipment in the system. It is to itemize the critical equipment or maintenance items that money should be set aside for via rates and charges.

No short lived assets with more than 15 years of life expectancy

CITY OF MCBAIN

MISSAUKEE COUNTY, MI

WATER SYSTEM REVIEW

January 2019
Project No. 837200

FLEIS&VANDENBRINK
DESIGN. BUILD. OPERATE.

Bond Schedule

Date: ***01/28/20***

Borrower Name: **City of McBain** ***Type of Bond:*** **Revenue**
Interest Rate: 1.625%
Yrs Deferred Principle 0
Principal: **$1,964,000** (round to nearest $1000)
Ammort. Factor 0.0342
Ammortized Payment: $67,158

Year	1st Interest	2nd Interest	Principal Paid	Total Year Payment	Loan Balance
					1,964,000
1	15,958	15,958	35,000	66,915	1,929,000
2	15,673	15,673	36,000	67,346	1,893,000
3	15,381	15,381	36,000	66,761	1,857,000
4	15,088	15,088	37,000	67,176	1,820,000
5	14,788	14,788	38,000	67,575	1,782,000
6	14,479	14,479	38,000	66,958	1,744,000
7	14,170	14,170	39,000	67,340	1,705,000
8	13,853	13,853	39,000	66,706	1,666,000
9	13,536	13,536	40,000	67,073	1,626,000
10	13,211	13,211	41,000	67,423	1,585,000
11	12,878	12,878	41,000	66,756	1,544,000
12	12,545	12,545	42,000	67,090	1,502,000
13	12,204	12,204	43,000	67,408	1,459,000
14	11,854	11,854	43,000	66,709	1,416,000
15	11,505	11,505	44,000	67,010	1,372,000
16	11,148	11,148	45,000	67,295	1,327,000
17	10,782	10,782	46,000	67,564	1,281,000
18	10,408	10,408	46,000	66,816	1,235,000
19	10,034	10,034	47,000	67,069	1,188,000
20	9,653	9,653	48,000	67,305	1,140,000
21	9,263	9,263	49,000	67,525	1,091,000
22	8,864	8,864	49,000	66,729	1,042,000
23	8,466	8,466	50,000	66,933	992,000
24	8,060	8,060	51,000	67,120	941,000
25	7,646	7,646	52,000	67,291	889,000
26	7,223	7,223	53,000	67,446	836,000
27	6,793	6,793	54,000	67,585	782,000
28	6,354	6,354	54,000	66,708	728,000
29	5,915	5,915	55,000	66,830	673,000
30	5,468	5,468	56,000	66,936	617,000
31	5,013	5,013	57,000	67,026	560,000
32	4,550	4,550	58,000	67,100	502,000
33	4,079	4,079	59,000	67,158	443,000
34	3,599	3,599	60,000	67,199	383,000
35	3,112	3,112	61,000	67,224	322,000
36	2,616	2,616	62,000	67,233	260,000
37	2,113	2,113	63,000	67,225	197,000
38	1,601	1,601	64,000	67,201	133,000
39	1,081	1,081	65,000	67,161	68,000
40	553	553	68,000	69,105	0

I. BACKGROUND AND PURPOSE

The City of McBain is located in the south western part of Missaukee County in Northern Michigan. McBain has a type 1 (public) water supply and distribution system with five water production wells and one Aquastore storage tank.

The purpose of this review is to examine the City's water infrastructure, water chemistry, and chemical application in order to provide the City with recommendations to remedy the issue the City has been experiencing with orange colored water. To gain an in-depth understanding of the situation and make recommendations, the review of the following areas is intended:

1. Review historical water system operating records including water use and pump records. Review known problem areas in the water distribution system.

2. Review existing water system components including pump and tank data, well capacity, well houses and treatment.

3. Review available information on the water distribution system and its overall condition, known deficiencies, age of water lines and type of pipe materials.

4. Review prior studies completed by the City including the most recent Water System Reliability Study, Water System Asset Management Plan (if completed), well test data, and MDEQ Sanitary Survey.

5. Review chemical analysis of the water based on City test records.

6. Review chemical feed systems, rates and dosages, and evaluate options to optimize chemical treatment.

Once available data has been reviewed, recommendations for next steps, both short term and long term, to allow for a reliable quality water supply will be given.

The study and service area include the City of McBain. The service area is located in sections 24 and 25 of Township 21 N, Range 8 W and sections 19 and 30 of Township 21 N, Range 7 W.

II. EXISTING WATER SYSTEM

A. WATER SUPPLY

1. Wells

The City of McBain water supply system currently consists of five wells. The wells are designated as Wells No. 1, 2, 4 and 5. Well No. 3 was recently abandoned. Wells No. 1 & 2 are located towards the east side of town, along the north side of Maple St., south of the High School's football field. Well No. 4 is located on the south side of town at the City park east of the Elm St. and Pine St. intersection. Well No. 5 in located on the north side of town, north of Gerwoude Dr. and west of M-66, located between the two baseball fields. Table 1 summarizes selected data of each well and pump.

Wells 1 & 2 were inspected by Pearson Drilling Company in 2010. Well 4 was rebuilt in 2017. Well 5 was installed in 2015.

TABLE 1
WELL SUMMARY

Well Number	Year Drilled	Diameter (inch)	Depth (feet)	Rated Capacity @ TDH
1	1976	8	90	210 gpm @ 185 ft.
2	1975	10	108	225 gpm @ 200 ft.
4	1995	12	368	500 gpm
5	2016			500 gpm

General

Firm capacity is calculated by removing the capacity of the largest pump from the system. The pumping capacity that remains is the firm capacity. The City of McBain has a rated firm capacity of 935 gpm. Current well performance data was not provided as part of the review, so it is unknown how the wells are actually performing at this time.

Well No. 1

Well No.1 was installed in 1938. New well pipe, casing and pump were installed in 1976. The well was cleaned in 2010 and another new pump was installed. Well No. 1 is currently active. MDEQ has noted that the well is near the end of its life and has requested annual inspection by a professional to ascertain capacity and operational condition of the well.

Location of Well No. 1 south of McBain High School's football field.

Well No. 2

Well No. 2 was installed in 1975 at 130 feet deep. The well was cleaned in 2010 and the pump and drop pipe were replaced. Well No. 2 is currently active. MDEQ has noted that due to the well's age, annual inspection by a professional to ascertain capacity and operational condition of the well is requested.

Well No. 3

Well No. 3 was taken out of service at the end of 2014 because of high levels of nitrates. This well was abandoned in the fall of 2018.

Well No. 4

Well No. 4 is a 12" diameter well installed in 1995 at 375 feet deep. It was cleaned and rebuilt in 2017. Well No. 4 is currently active. MDEQ has requested annual inspection by a professional to ascertain capacity and operational condition of the well.

Location of Well No. 4 at the City park north of the tennis courts.

Well No. 5

Well No. 5 was built in 2015 but is now inactive due to high iron levels.

2. Well Houses

The Well House that serves wells No. 1 & 2 is masonry block construction and is very old. To access the piping and chemical feed areas, the operator must descend into a lower level. Electrical equipment is accessed via a narrow walkway. As both well 1 and 2 are located outside the building, this wellhouse only contains electrical, controls, and piping. MDEQ has recommended the City begin active planning to replace or rehabilitate the wellhouse, as the safety and conditions for the operators are less than optimal.

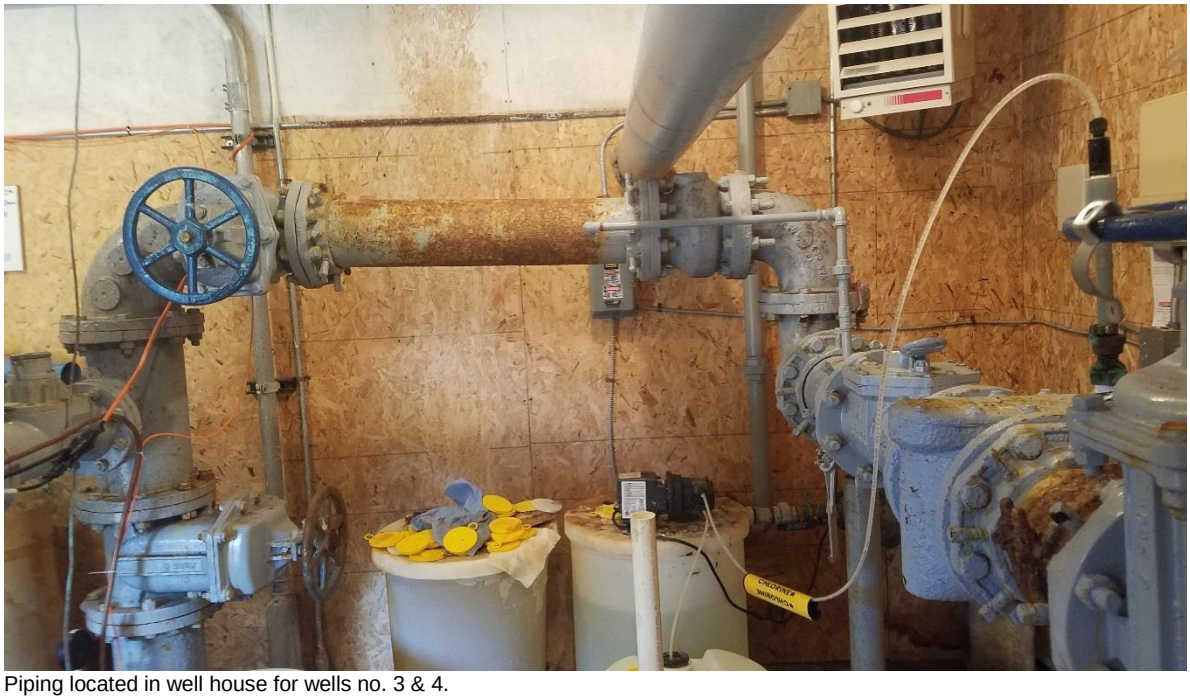
The masonry block well house for Well No. 4 is in good condition. The process piping inside the wellhouse is showing corrosion, especially around the chlorine injection quills. Since Well No. 3 has been abandoned, the City should consider investing in removing it's associated piping and equipment, and cleaning and repainting the well 4 piping. Another consideration would be whether a new well at the site could be served by the wellhouse and the piping for Well No. 3 could be reused for this new well.

The wellhouse for well 5 is very new and in excellent condition. The building contains space and pipe penetrations to allow an additional well to be served through the wellhouse.

Inside well house for wells no. 1 & 2.

Inside well house for wells no. 1 & 2.

Piping located in well house for wells no. 3 & 4.



Piping located in well house for wells no. 3 & 4.

Piping located in new well house for well no. 5.

3. Water Treatment & Quality

The City treats raw water with chlorine for disinfection at each well house. The City has chlorine supply and chlorine pumps in each wellhouse.

The City regularly tests the water quality of its wells and throughout the system per MDEQ requirements. There is testing done monthly for bacteria, yearly for partial chemical and every 3 years for metals analysis. The tests taken at the wells from 2010 to 2018 reported that the contaminant levels were below the state requirements in all wells except nitrate at Well no. 3. The water quality tests reviewed reported that the water met the State drinking water standards. It should be noted that iron is a secondary contaminant and is not regulated by the State.

The City tests for lead and copper on a triennial basis. Lead/copper levels in 2017 were well below the MDEQ action levels. The City is in compliance with the next round of testing due in 2020. During our review of the City's water test results, we noted that although below the legal limits, the lead levels have been gradually increasing. We recommend additional sampling to determine whether corrosive action within the City's piping could be causing this increase.

Following is a summary of well contaminant lab data for each well based on City records back to 2010:

TABLE 2
PARTIAL CHEMISTRY RECORDS – WELL 1

Date	Chloride*	Fluoride*	Hardness*	Iron*	Nitrate*	Nitrite*	Sodium*	Sulfate*
28-Jan-10	178	0	420	0	0.9	0	91	30
19-Apr-11	181	0	408	0.5	1.2	0	78	29
23-Jan-13	147	0	386	0.4	1.3	0	58	27
18-May-16	105	0.11	354	1.9	0	0	47	20
29-Aug-17	103	0	366	0.2	1.2	0	47	26
27-Jun-18	85	0	356	0.2	1.2	0	36	21
28-Nov-18	77	-	371	0.29	-	-	-	31

*All units are mg/L.

TABLE 3
PARTIAL CHEMISTRY RECORDS – WELL 2

Date	Chloride*	Fluoride*	Hardness*	Iron*	Nitrate*	Nitrite*	Sodium*	Sulfate*
11-Jan-05	30	0.1	331	0	0	0	19	27
9-Feb-06	41	0	363	0	0	0	22	32
20-Feb-07	43	0	334	0	0	0	20	29
27-Feb-08	37	0	327	0	0	0	17	30
28-Jan-10	39	0	337	0	0	0	16	31
19-Apr-11	41	0	327	0.1	0	0	11	29
22-Feb-12	38	0	342	0	0	0	12	28
18-Mar-14	51	0	349	0	0.6	0	16	27
26-Feb-15	99	0	382	1	1.2	0	38	31
18-May-16	105	0.11	354	1.9	0	0	47	20
27-Jun-17	154	0	378	0.2	0.6	0	59	25
29-Aug-17	62	0	333	0.1	0	0	21	23
20-Dec-17	61	0	334	0.1	0	0	21	16
27-Jun-18	58	0	310	0.6	0	0	23	16
28-Nov-18	77	-	371	0.09	-	-	-	27

*All units are mg/L.

TABLE 4
PARTIAL CHEMISTRY RECORDS – WELL 3

Date	Chloride*	Fluoride*	Hardness*	Iron*	Nitrate*	Nitrite*	Sodium*	Sulfate*
16-Jan-13	15	0	274	0	8.0	0	0	14
14-Feb-13	14	0	271	0	8.8	0	0	12
27-Mar-13	15	0	281	0	8.6	0	5	11
9-Apr-13	14	0	278	0	8.9	0	6	14
9-May-13	14	0	309	0	8.9	0	5	13
7-Aug-13	15	0	288	0	8.3	0	5	11
11-Oct-13	14	0	265	0	9.1	0	0	17
12-Nov-13	14	0	281	0	9.6	0	0	15
12-Dec-13	14	0	280	0	11.0	0	5	15
29-Aug-17	0	0.17	210	0.3	0	0	0	0

*All units are mg/L.

TABLE 5
PARTIAL CHEMISTRY RECORDS – WELL 4

Date	Chloride*	Fluoride*	Hardness*	Iron*	Nitrate*	Nitrite*	Sodium*	Sulfate*
11-Jan-05	0	0.20	205	0.3	0	0	6	9
9-Feb-06	0	0.13	223	0.3	0	0	0	10
20-Feb-07	0	0.13	203	0.2	0	0	5	0
27-Feb-08	0	0.14	206	0.2	0	0	0	0
28-Jan-10	0	0.13	202	0	0	0	0	12
19-Apr-11	0	0.15	206	0.4	0	0	0	0
22-Feb-12	0	0.14	222	0.4	0	0	0	0
23-Jan-13	0	0.14	207	0.4	0	0	6	0
18-Mar-14	0	0.12	226	0.2	0	0	0	0
26-Feb-15	4	0.17	231	0.3	0	0	8	0
18-May-16	0	0.15	229	0.2	0	0	0	0
28-Mar-18	0	0.14	221	0.4	0	0	0	0
27-Jun-18	0	0.13	217	0.5	0	0	0	0
28-Nov-18	4	-	202	0.26	-	-	-	12

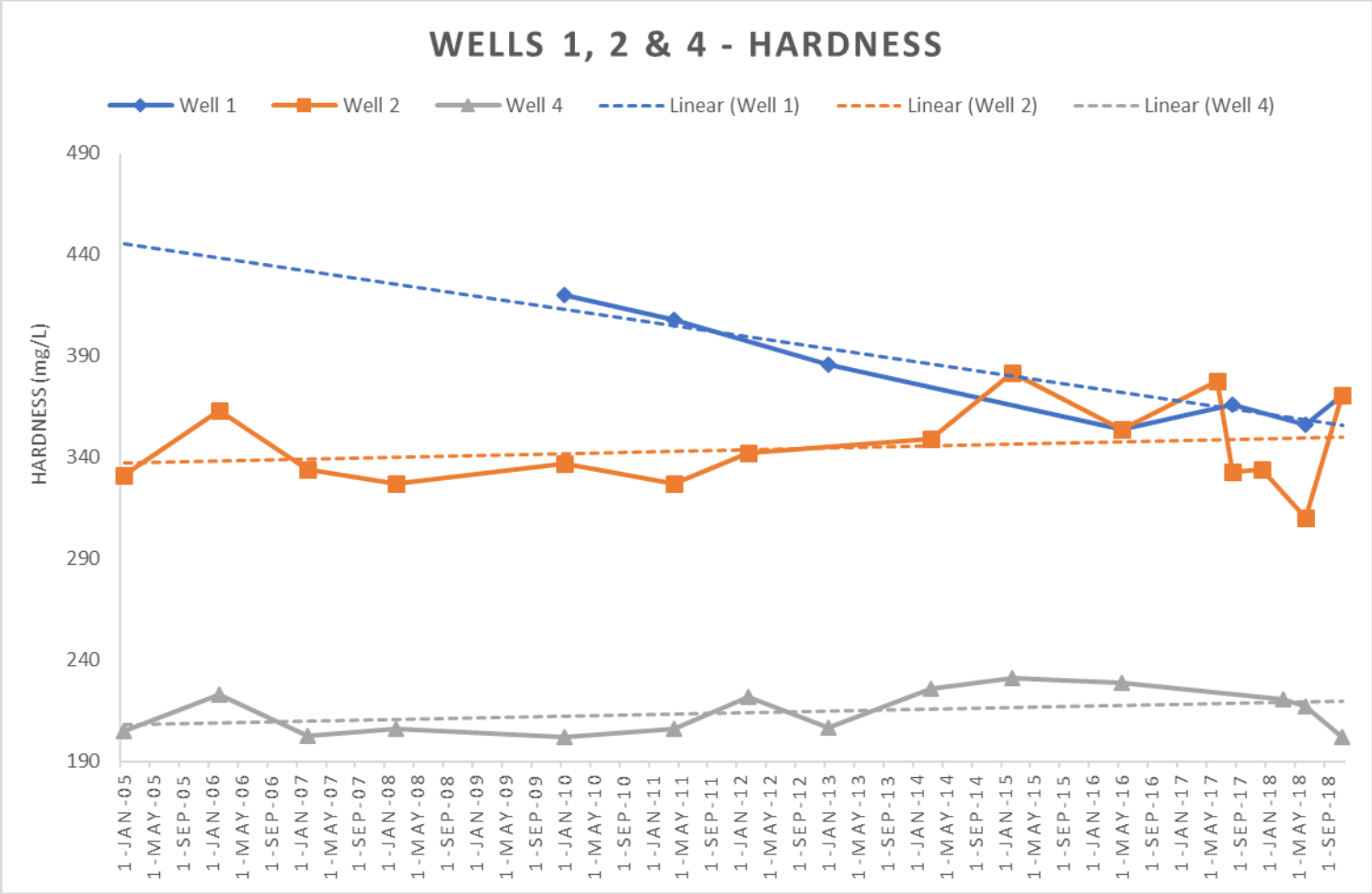
*All units are mg/L.

TABLE 6
PARTIAL CHEMISTRY RECORDS – WELL 5

Date	Chloride*	Fluoride*	Hardness*	Iron*	Nitrate*	Nitrite*	Sodium*	Sulfate*
28-Mar-18	0	0.14	179	0.5	0	0	0	0
17-May-18	0	0.11	171	0.3	0	0	0	0
27-Jun-18	0	0.12	175	0.8	0	0	0	0
28-Nov-18	2	-	160	0.3	-	-	-	5

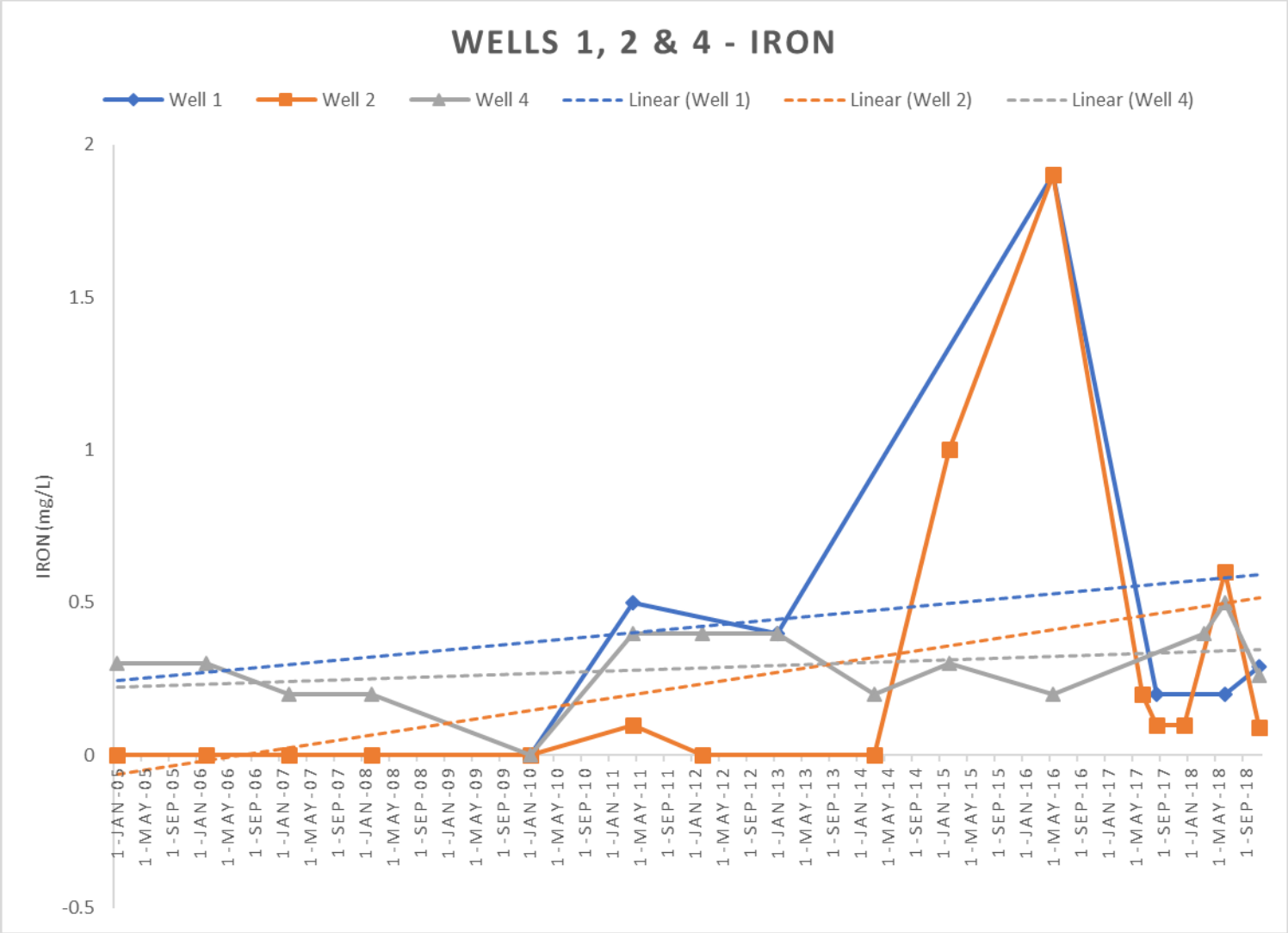
*All units are mg/L.

FIGURE 1
HARDNESS COMPARISON – WELLS 1, 2 & 4



Above you can see the hardness levels of the City's water. Hardness is typically a function of the geology of the ground where the wells are drilled. Environmental factors and aquifer use and strain can cause hardness values to change over time. Wells 1 & 2 are at levels notably higher in hardness than well 4 or 5. Interestingly, well 1 is trending downward, while well 2 has trended upward since 2010.

FIGURE 2
IRON COMPARISON – WELLS 1, 2 & 4



There are several tests for iron that deviate from historical averages for the City wells. In 2015, well 2 showed a very high iron test and in 2016, both wells 1 and 2 showed high iron tests. In 2017, the levels for both wells came back down to historical averages. It is impossible to know whether there was something that happened during collection of the sample, analysis at the lab, or whether the water really did exhibit very high iron at that time. All 3 of the City's older wells are showing a trend of increasing iron levels. The EPA has set a guideline of 0.3 mg/L as a threshold where iron frequently becomes an aesthetic concern for communities. Iron within these levels are not known to cause health concerns, but can stain fixtures, discolor clothing, and have an unpleasant taste.

B. DISTRIBUTION SYSTEM

1. Pipe Condition

McBain's water distribution system is composed of PVC, Cast Iron, Ductile Iron, and Asbestos Cement pipe. Table 3 provides an approximate breakdown of the water distribution system's watermain inventory by material.

TABLE 7
WATERMAIN INVENTORY

Watermain Material	Length (feet)	Percent of Total (%)
PVC	18,015	50%
Cast Iron	14,410	40%
Ductile Iron	1,800	5%
Asbestos-Cement	1,800	5%
Total:	**36,025**	

As part of this review, we have considered whether iron in the distribution pipe materials may be leaching into the water, contributing to the water quality concerns. The newer construction in the City has been of PVC watermain, which will not contribute to the iron problem. What we have specifically looked for is cast iron or older ductile iron piping in the system. There appears to be enough of this pipe to warrant further study of the corrosive nature of the water.

Low flows can also pose a concern with regard to maintaining water quality. Flushing is a regular system maintenance activity that clears sediment and stagnant water from the lines. In order to be effective, flushing velocities of 3 ft/sec must be achieved. Required flow to achieve this velocity varies depending on the size of the watermain; larger watermains require higher flows to achieve minimum flushing velocities. On larger pipes, it is sometimes necessary to open multiple hydrants to achieve adequate velocity. Also, operators often will need to close key valves to direct flow where needed to reach adequate velocity.

It is recommended that flushing occur twice per year, or more frequently if water quality concerns are present. It has been reported that the water quality seems to improve, at least temporarily, after flushing, so it would appear the City is achieving some success with this practice.

The MDEQ notes that valve exercising was last performed in 2013. Valve exercising is an important maintenance activity, and it is recommended all valves be exercised at least annually, usually as part of the flushing program.

C. WATER STORAGE

The City of McBain currently has one 300,000-gallon Aquastore stand-pipe style storage tank that supplies water storage for the system. The tank is located in the southwest part of the City at the northwest corner of the Jasper St. and Cemetery Rd. intersection. The following paragraphs address the specifications and maintenance for the tower.

City water tank.

1. Specifications

The tank is 25 feet in diameter and 90 feet tall with an overflow elevation of 82.5 feet. Due to the design of a stand-pipe style tank, much of the tank's height is needed to store water just to maintain system pressures. Only a portion of the water is actually usable to the water customers. In the case of the City's tank, the water must maintain a height of 41 feet above ground level just to maintain system operating pressures, leaving only 31 feet, or 113,830 gallons, of working capacity.

TABLE 8
WATER STORAGE TANK OPERATING RANGES

Operating Range	Head Range (feet)	Storage Volume (gallons)
Max Usable	41-82.5	152,388
Normal Usable	41-72	113,832
Normal Operating	69-72	11,016

2. Tank Maintenance/Repair

The tank was constructed in 1985 and was rebuilt in 2016. The repairs included removing and replacing several panels that were damaged due to ice loading.

MDEQ has recommended several other repairs to the tank including:

- Raising the overflow drain to at least 12" above ground level
- Install screen mesh over vents to keep insects out
- Install a flap on overflow to keep cold air drafts out
- Improve drainage at tank to accommodate overflow water
- Remove old communications control equipment

3. Mixer

Because the tank is large in relation to the daily water use of the City, and because the water enters and exits the tank at the bottom, there is not a lot of natural water circulation within the tank. As a result, during the recent rehabilitation project, the City installed a tank mixer at the bottom of the tank.

Sediment will settle out of water as it sits in a storage tank. At the time the tank was taken out of service for repairs in 2016, photographs indicate there was approximately 10" of sediment in the bottom of the tank. In many tanks, there is what is called a mud valve at the bottom of the tank that allows the operators to periodically remove this material by opening the valve and flushing the material out. The City's ground tank does not have that capability. Sediment must be vacuumed or manually removed, and the tank must be taken out of service and drained to do that.

As a consequence, when the mixer was installed at the bottom of the tank, it regurgitates the solids that have settled from the tank back into the water column. In the short term, the mixer should be raised or adjusted to fix this problem.

4. Drainage

The configuration of the site drainage and water supply valving at the tank location pose constraints for draining or maintaining the tank. There are two primary concerns. First is that the water that drains from the tank is not well managed and does not have a good place to drain. Second is that due to the configuration of the valves and hydrant at the site, it is not possible to utilize the site as a pressure relief location while still having a water supply for tank cleaning purposes.

Mr. Fisher has proposed a plan to add some drainage improvements to allow for easier draining of the tank. The water would be captured in a drainage structure and routed to ditching and culverts to the south and would flow through the tree farm. This plan warrants development of final details and implementation. Some factors to consider are obtaining written permission, or even a drainage easement, over the tree farm property. Also, sizing and grading of the new storm sewer structure and piping, as well as ditches and culverts should be pursued. The drainage should be planned to accommodate year round use for draining the tank and to provide drainage so the tank location can be used as a pressure relief blowoff location.

Also part of Mr. Fisher's plan is to reconfigure the valving and hydrant at the tank site to allow for ability to drain the tank, provide for a blowoff location and provide a water supply to be able to clean the tank.

IV. WATER USE AND FIRE PROTECTION

A. WATER USE

1. Customers

The City of McBain water system currently serves 135 customers, consisting of roughly 51 commercial/industrial and 84 residential. Past water pumpage data is presented in Table 4 below. Peak hour demands are estimated based on a peaking factor of 4.0 times the average day demand. As there are no water service meters, there is no available information for water loss.

TABLE 9
WATER USAGE

Year***	Total Water Pumped (gal)	Average Day Demand (gpd)	Maximum Day Demand* (gpd)	Average Day Demand (gpm)	Maximum Day Demand* (gpm)	Maximum Day Peaking Factor
2007	61,124,000	167,000	482,000	116	335	2.9
2008	54,734,000	150,000	323,000	104	224	2.2
2009	49,038,000	134,000	387,000	93	269	2.9
2010	44,673,000	122,000	323,000	85	224	2.6
2011	43,000,000	125,000	314,000	87	218	2.5
2012	46,073,000	126,000	324,000	88	225	2.6
2013	51,998,000	142,000	313,000	99	217	2.2
2014	50,108,000	137,000	352,000	95	244	3.6
2015		128,000	230,000	89	160	1.8
2016	56,506,000	155,000	n/a**	108	n/a**	n/a**
2017	43,061,000	118,000	303,000	82	210	2.6
Average	50,031,500	136,900	350,875	95	244	2.56

* Includes high usage days caused by hydrant flushing, tower outages, etc.
** Recorded data was removed because it does not match the historical trend.
*** Record data was not provided for 2015.

B. FIRE PROTECTION

1. ISO Rating System

The Insurance Services Office (ISO) establishes suggested fire flow protection standards based on various factors including building construction type, area, height, type of development and density. The level of protection the City chooses to adopt will dictate a level of performance of the system, in terms of water supply, storage volume, and distribution piping.

2. Recommended Fire Flows

Table 11 below presents the suggested ISO fire flows and recommended target fire flow values. These recommended target fire flows were obtained from tabular values presented in the *"Fire Protection Handbook'*, the *"2015 International Fire Code"*, and the AWWA's Manual of Water Supply Practices – *"Distribution System Requirements for Fire Protection"*.

TABLE 10
ISO SUGGESTED AND RECOMMENDED TARGET FIRE FLOW VALUES AND DURATIONS

Classification	ISO Suggested Fire Flows @ 20 psi	Recommended Target Fire Flows @ 20 psi	Duration (Hours)
Residential	1,000 - 1,500	1,000	2
Commercial	2,000 - 2,500	2,000	2
Industrial	3,000	3,000	3
Institutional	3,500	3,500	3

V. EVALUATION OF SYSTEM CAPACITY

A. WATER SUPPLY

The MDEQ recommends the firm capacity of a community's water supply be greater than the maximum day demand. Currently, the firm capacity of City's water system is 935 gpm and the maximum day demand for the past five years is 244 gpm. Therefore, the existing firm capacity is sufficient for the current demands of the system.

B. WATER STORAGE

The recommended target fire flow for commercial areas is 2,000 gpm for two hours. To provide the required volume of water to combat a fire of this duration, 240,000 gallons of water would be used. Table 15 compares the volume of available water using current firm well capacity and the existing storage volume for each of the classifications of recommended target fire flows and fire flow durations for the existing maximum day demand.

TABLE 11
REQUIRED STORAGE CAPACITY FOR FIRE FIGHTING
(EXISTING MAXIMUM DAY DEMAND)

Classification	Desired Fire Flow @ 20 psi (gpm)	Duration (hr)	Existing Maximum Day Demand (gpm)	Total Flow Required (system outflow) (gpm)	Firm Well Flow (system inflow) (gpm)	Net System Outflow (gpm)	Total Storage Required (gallons)	Existing Storage (gallons)	Addt'l Storage Required (gallons)
Residential	1,000	2	244	1,244	935	309	37,080	113,830	0
Commercial	2,000	2	244	2,244	935	1,309	157,080	113,830	43,250
Industrial	3,000	3	244	3,244	935	2,309	415,620	113,830	301,790
Institutional	3,500	3	244	3,744	935	2,809	505,620	113,830	391,790

As the data in Table 15 shows, the City has sufficient storage to meet only the residential requirements. Due to the amount of non-usable water storage within the existing tank, additional storage is needed to meet the recommended commercial (2,000 gpm for 2-hour duration), industrial (3,000 gpm for 3-hour duration) and institutional fire flow requirements (3,500 gpm for 3-hour duration). The level of fire protection desired within the City should be determined.

VI. RECOMMENDATIONS

We understand that the City's primary goal is to improve the water quality and aesthetics, and after our initial review of the water system, we offer the following recommendations:

Water Treatment:

The main water quality issue to address is removal of iron from the City's water. The common options for iron removal are 1) sequestration through injection of polyphosphate chemical at each well, or 2) construction of an iron removal plant with a sand/carbon filter to remove iron from the water.

Sequestration of Iron in Drinking Water:

Sequestration is a relatively cost effective and simple option for iron removal and it also provides corrosion control by forming a protective coating on the inside of watermains. The water quality testing performed in November 2018 showed iron levels at the City wells are within a range that sequestration can be an effective method of treatment. It should be noted that some of the prior tests, particularly on well 5, exceeded generally acceptable ranges for successful sequestration. Therefore, we are recommending that the City initiate polyphosphate addition on a trial, or pilot basis, while water quality is monitored frequently. Our concern is that as the aquifer is pumped more frequently, water quality could change.

Based on test results, the water produced by well 4 is within the range where polyphosphate addition should yield an improvement in delivered water quality.

There is a notable complication to sequestration of iron – the sequestration process binds the iron particles together and these iron particles can settle-out of the water if the water is allowed too much time to sit in a stagnant state. This means that the sequestration process may actually increase the sedimentation at the water tank. If the City chooses to implement sequestration, we recommend that City address the storage tank through one of the options below to allow for efficient removal of sediment from the tank.

It is recommended that quarterly flushing of the storage tank and distribution system be implemented with sequestration. It is also recommended that the distribution system be flushed using a uni-directional flushing process at least once per year.

Estimated cost for sequestration for City wells: $48,000

Iron Removal Plant:

An iron removal plant would involve installation of an iron filtration system, associated building, controls, and support systems. The benefit to an iron removal plant is it is more adaptable than sequestration for removal of high iron content. Therefore, there is higher reliability that an iron removal plant will be successful at resolving the City's iron problems. Also, an iron filtration system will not increase sedimentation in the water system because the iron particles are filtered out and retained in the filter.

Despite the higher confidence that an iron filter will be able to remove adequate iron from the City water, there are challenges. . Iron treatment plants are expensive, and for that reason, we would not recommend the City install a plant at each well location. It would be much more cost effective to install a plant near a well field that contains

multiple wells, so a single plant would treat water pumped from multiple wells. This scenario would require reconfiguration of the Village's well locations. The site of Well No. 4 or 5 may be an adequate site for an iron removal plant and installation of an additional well.

Estimated cost for Iron Removal Plant: $2,500,000 (includes iron removal plant only – no additional wells)

A secondary concern regarding the City's water quality is the low-level presence of iron and sulphur reducing bacteria in all of the wells. The testing showed that at the levels present, approximately 6 days of detention time was needed for the bacteria to grow to problematic levels. Given the size and detention time in the City's water tank, it is probable that some of the complaints over time could have been the result of bacteria "flare-ups".

As a first step, the City should consider a cleaning and flushing of each production well that will involve mechanical and chemical cleaning, followed by heavy, extended flushing, which will reduce bacteria present in the well.

Estimated cost for Well Cleaning: $15,000 per well ($60,000)

Water Storage:

There are three separate concerns with the water tank. 1) The water storage tank does not have a mud valve or similar mechanism to easily remove sediment that accumulates at the bottom of the tank. 2) The bottom 41' of water, or 150,750 gallons, is unusable and creates a long detention time for water in the tank. 3) The amount of water in the operating range of elevations that will provide optimal system pressures is too low.

This sediment accumulation was found to be significant when the tank was last serviced and sedimentation will likely increase if sequestration is used.

In order to address all three concerns a new tank is needed. If the City would like to pursue a lower cost option, we have developed a retrofit option that will address only the sedimentation issue.

Basic Storage Improvements – Retrofit Existing Tank
In order to facilitate sediment removal, the existing tank could be retrofitted with an improvised mud valve to purge sediment. This would require installation of a thickened concrete floor that is contoured to direct sediment to a constructed sump and mud valve. The mud valve could be periodically purged to remove sediment from the tank floor. There are a lot of engineering details to work out for this option, however, initial conversations with the tank supplier indicates this alternative could be feasible. This option would also require site grading and piping to dispose of the purged water.

Estimated cost to retrofit existing water tank with a mud valve: $50,000 (ball park estimate, awaiting feedback from a tank supplier to firm-up this budget)

Tank Replacement Option:

A factor that contributes to sedimentation that accumulates in the existing storage tank which is potentially recirculated into the distribution system is the lengthy water

detention time in the tank. A new elevated storage tank may reduce sediment accumulation by reducing detention time as well as be constructed with a proper mud valve that is easy to service at whatever frequency is needed. With an elevated storage tank, the entire storage volume would be situated at the elevation to supply adequate pressure to the water system. This would reduce the overall storage volume in comparison to the existing stand-pipe style. With less storage, detention time (and the resulting sedimentation) would be reduced.

Estimated cost to install a new elevated tank: $800,000

Water Supply:

Wells No. 1 and No. 2 are approaching the end of their useful life and the City should begin planning for replacement. It may be possible to replace the capacity of both wells with a single new higher-capacity well. The area near Well No. 4 or near Well No. 5 may be a good location for a new well as it would situate two City wells on the same site and could accommodate an iron removal plant.

Estimated cost to install and new high capacity well and abandon Well No. 1 and No. 2: $350,000.

Water Distribution:

The City has over 14,000 feet of cast iron piping in the water system. This pipe should be looked at more closely for replacement. The immediate concerns are that the cast iron pipe may be leaching additional iron into the water between the time it leaves the wellhouses and before it reaches the homes. Second, cast iron pipe is the most likely location to find lead goosenecks, which pose health risks and are subject to the newly passed lead and copper rules from the MDEQ. Third, most if this pipe is likely undersized to provide adequate flows, possibly for normal use and especially for fire protection.

In order to prioritize replacement of this pipe, we recommend preparing a hydraulic model as part of a Reliability Study and Master Plan update. Based on the model, we can help you prioritize pipe based on flow conditions, although for the first and second reasons described above, the City should be looking to replace all of the cast iron pipe.

Estimated cost for cast iron pipe replacement: $3,200,000

Water Meters:

Water meters should be installed for all services in the City. Installing water services will allow the City to analyze the amount of water being pumped compared to the amount of water being used by the customers. Having this information will allow the City to identify potential leaks within their system more easily. Installing water meters also provides the City with the option to bill their customers based on water usage. If funding is secured through USDA, meters will be required.

Estimated cost to is water meters: $500,000