2.4.1 Land Use

The area surrounding Shelby is mainly agricultural with livestock grazing and grain production the prevalent use. A small percentage of the agricultural land surrounding Shelby is irrigated. The proposed project is within the urbanized area of Shelby.

2.4.2 Biological Resources

The proposed project is within the urbanized area of Shelby with the work to be accomplished on City owned property, public rights-of-way or negotiated easements. Construction of the recommended improvements is not expected to impact any threatened or endangered species. Comments from the Fish, Wildlife and Parks have been requested and included in Appendix x.

2.4.3 Water Resources

Surface water in the area consists of a small reservoir, the Marias River and an irrigation system. Ground water is present at various depths in the area. No adverse impacts to water resources are anticipated as a result of the proposed project.

2.4.4 Floodplains

Shelby is not located within a FEMA identified floodplain. The City of Shelby public water supply wells are located along the Marias River five miles south of town in order to find water of satisfactory quality and quantity to meet the City' s needs. The wells are most likely located within the 100 year floodplain of the Marias River; however that section of the Marias River has not been delineated by FEMA. The proposed project will not result in any impact to existing floodplains.

2.4.5 Cultural Resources

The project will not impact any known historical or archeological resources. The project will not have any disproportionate effects on low-income or minority members of the community.

2.4.6 Socio - economic Issues

Shelby is not considered a minority or low-income community according to the Department of Commerce. It is expected that the improvements will affect the entire community equally and will have no disproportionate effects.

2.5 Population Trends

The 2010 US Census indicates a population of 3,376, with 1,245 households. The median Household income is $40,464.00.

Primary area industries and employers include: agriculture and livestock production, oil and natural gas development, retail trade, transportation and warehousing, education, health and social services. The City is actively pursuing growth and development opportunities. Areas available for residential as well as commercial development are available within the city. The potential residential growth areas are generally on the north and south areas of town. On the north side of town there is an existing platted area just across the road from Lake Shel-oole that currently has no water lines. On the south side there is another area of platted, yet undeveloped lots adjacent to the extension of 13th street. The main industrial/commercial areas of potential growth are northwest and southeast of town. One growth area is west of the interstate, off the interstate ramp, adjacent to the highway and

the railroad. This area is in the general vicinity of the existing Shopko store and Best Western hotel. On the southeast side of Shelby there is potential commercial/industrial growth around the fairgrounds and adjacent to the highway and the railroad. On the southeast side of town adjacent to the railroad is the Port of Northern Montana Energy Park. It is anticipated that the city will experience modest growth, approximately 1% annually, over the 20 year planning period. The 2036 population of Shelby would be expected to be 4,373 persons.

Table 1: Historic Population Trends

	Year	Population	Percent Change	Percent Change per Year
US CENSUS	1950	3,058	NA	NA
	1960	4,017	31.4%	3.1%
	1970	3,111	-22.6%	-2.3%
	1980	3,142	1.0%	0.1%
	1990	2,763	-12.1%	-1.2%
	2000	3,216	16.4%	1.6%
	2010	3,376	5.0%	0.5%
			AVERAGE	**0.3%**
PROJECTED	2016	3,584	6.2%	1.0%
	2026	3,959	10.5%	1.0%
	2036	4,373	10.5%	1.0%

The privately owned Crossroads Correctional Facility has increased the population (inmates and staff) served by the water distribution system. The facility currently houses approximately 600 inmates. The 2010 Census data includes the inmates housed at the correctional facility. Therefore, our growth projections for 2036 will include the population at the facility.

2.6 Community Engagement

The City of Shelby conducted a general needs assessment public meeting on August 31, 2015 to obtain public comments regarding community development needs and priorities for economic development, housing and community revitalization, and public facilities. On April 18, 2016 the City of Shelby hosted a second public meeting to discuss any public comments regarding the Water System PER and the Environmental Assessment. On May 2, 2016 the City of Shelby hosted a public meeting to formally adopt the PER and Environmental Document.

3 Existing Facilities

3.1 Location Map

A schematic layout of the system components is located in Appendix D.

3.2 History

The existing water supply system for Shelby consists of a series of thirteen groundwater wells of which 11 are currently being used, a combination UV/Chlorination unit treatment facility, four water storage tanks, and the distribution system.

The oldest well was drilled in 1940 and the last constructed in 2005. The City's water supply well field is located adjacent to the Marias River approximately 5 miles south of town and according to City officials is flooded on average of once every 5 years. Past droughts have caused lower than average flows in the Marias River during the summer and fall months of the year. In 1983, the low flows in the Marias River lowered the water table thus reducing the recharge ability of the wells. During those low flows the wells could only be used sporadically which greatly limited the city's water supply. In 1983 the city's water supply consisted of only eight wells. Now there are twelve wells producing water in the same area.

In 2003, Montana Department of Environmental Quality (DEQ) required that well number 4 no longer be used because it was determined that it was under the direct influence of surface water. In 2005, a new well number 13 was constructed and was placed into operation in 2006. Also in 2005, a new treatment facility was constructed housing the chlorination unit and a new ultraviolet (UV) disinfection component. The new treatment facility is currently performing the disinfection duties. The old transmission lines located within the well field were replaced in 2006. In 2004, a bank stabilization project was completed to protect the well field from the meandering Marias River.

The oldest portions of the distribution system date from the late 1940's. Numerous improvements have been implemented over the past several years. A booster station, 500,000 gallon elevated steel tank, and several thousand feet of distribution mains were constructed in 2001 in conjunction with the Crossroads Correctional Facility. Several more thousand feet of distribution mains were constructed in 2004, 2008 and 2013.

3.3 Water Demands

The water demand for a typical city varies from hour to hour, day to day, and month to month. Due to these changes an average demand is calculated over an entire year compensating for the fluctuations throughout the varying seasons of the year.

Table 2 below provides a summary of the total water pumped from the source for 2013 through 2015 broken down per month. Dividing the total water usage for the year by 365.25 days gives average day demands of 574,919 gpd in 2013, 623,351 gpd in 2014, and 608,088 gpd in 2015. The large amount of fluctuation in the water usage is most likely do to a factor of weather. Annual precipitation for the city of Shelby as recorded by the NRCS was 16.25 inches in 2013, 12.95 inches in 2014, and 11.85 inches in 2015. The decrease in precipitation in 2015 was likely the cause of the larger water usage for the year as residents were using

more water for irrigating lawns. Irrigation is typically the cause of peak day demands during the summer months.

To project what future water demands will be it is important to understand how much water is used per person. Based on population estimates presented in Table 1, a per capita water demand has been calculated and included in Table 2.

Table 2: Average Day Water Usage

MONTH	TOTAL WATER USAGE (gallons)		
	2013	2014	2015
January	12,469,000	11,597,000	10,864,000
February	9,995,000	11,139,000	9,524,000
March	11,080,000	12,206,000	10,689,000
April	11,452,000	11,490,000	14,855,000
May	20,812,000	19,432,000	24,795,000
June	21,253,000	27,381,000	29,715,000
July	34,425,000	41,217,000	35,274,000
August	30,273,000	33,136,000	32,531,000
September	20,302,600	21,909,000	18,761,000
October	14,004,000	14,177,000	13,098,000
November	11,928,000	10,975,000	10,537,000
December	11,852,000	12,864,000	11,309,000
Yearly Total	209,845,600	227,523,000	221,952,000
Average Day Demand(gpd)	574,919	623,351	608,088
Population	3,478	3,513	3,548
Average Day Demand (gpcd)	165	177	171

Using the average of the per capita day demand of 171 gpcd and the projected populations summarized in Table 1, the projected demand through the year 2036 has been calculated and summarized in Table 3.

Table 3: Projected Average Day Demand

YEAR	POPULATION OF SHELBY	AVERAGE DAY DEMAND		
		GPCD	GPD	GPM
2016	3,584	171	612,864	426
2026	3,959	171	676,989	470
2036	4,373	171	747,783	519

It is important to consider the peak day demands as water demand fluctuates from day to day and month to month. In accordance with Montana Department of Environmental Quality (DEQ) Circular 1, the source must be adequate to meet or exceed the design maximum day demand for the service area with the largest well out of service. To ensure that the source can accommodate the future demands a peak day factor is used to estimate peak day, or maximum day, demands. The water supply should produce the peak day demands without using stored water. A peak day factor is used to estimate peak day demands. The peaking factor is defined as the ratio of the peak day demand to the average day demand. Based on records kept by the City the peak days for 2013 through 2015 have been included in Table 4. The peaking factors have been summarized in Table 4.

Table 4. Peaking Factors

DEMAND	TOTAL WATER USAGE		
	2013	2014	2015
YEAR TOTAL	209,845,600	227,523,000	221,952,000
AVG. DAY DEMAND (GPD)	574,919	623,351	608,088
PEAK DAY DEMAND (GPD)	1,435,000	1,862,000	1,594,000
PEAKIING FACTOR	2.50	2.99	2.62

An average of the peaking factors equal to 2.7 will be used to estimate future peak day demands. Projected peak day demands are summarized in Table 5. The projected peak day demands were calculated by multiplying the average day demand by the peaking factor, or:

Peak Day Demand = Average Day Demand x Peaking Factor

= 171 gpcd x 2.7

= 462 gpcd

Table 5. Projected Peak Day Demands

YEAR	POPULATION OF SHELBY	PEAK DAY DEMAND		
		GPCD	GPD	GPM
2016	3,584	462	1,655,808	1,150
2026	3,959	462	1,829,058	1,270
2036	4,373	462	2,020,326	1,403

Similar to the peak day demands, the peak hour demand represents the hour with the highest usage. The peak hour factor is defined in a similar way as the peak day factor, the ratio of the peak hour demand to the average day demand. Since there is no available data to calculate the hour demands a peak hour factor must be estimated. The peak hour factors generally range from 1.6 to 2 times the peak day demand. A peak hour factor of 2 times the peak day demand will be used for the purpose of this report. The peak hour projected demands are summarized in Table 6.

Table 6: Projected Peak Hour Demands

YEAR	POPULATION OF SHELBY	PEAK DAY DEMAND			PEAK HOUR DEMAND
		GPCD	GPD	GPM	GPM
2016	3,584	462	1,655,808	1,150	2,300
2026	3,959	462	1,829,058	1,270	2,540
2036	4,373	462	2,020,326	1,403	2,806

The water from the peak hour demand is not needed on a continual basis; any demand above the peak day demand is typically supplied by the storage facilities. As will be discussed later, the City has adequate capacity in their storage facility to meet the projected peak day demands.

The City of Shelby is in the process of constructing a pipeline connecting Shelby and Cut Bank to provide supplemental water. It is expected that the system will be operational by the end of 2016. The agreement for Shelby to provide water to Cut Bank indicates a minimum capacity of 400,000 gpd and a maximum of 750,000 gpd.

In 2014, Devon also requested connection to the Shelby system. Devon has not yet received DEQ approval to move forward with their construction project but it is expected in the near future. There has been some recent discussion about Devon and Devon's capacities. When discussing Devon's proposed system capacity it is important to understand that a portion of the proposed Devon system will provide water to residents of Shelby that are currently connected to Shelby's existing system. The total additional demand that will be placed on Shelby's system by Devon is estimated to be 83,088 gpd. The contract between Devon and Shelby indicates that Shelby will provide "a rate not to exceed 120,000 gallons per day." A copy of this contract can be found in Appendix X.

The total system demands used to evaluate the City of Shelby's water system are shown in Table 7 below:

Table 7: Projected Total System Water Demands

Community	Average Day Demand (Gallons)	Peak Day Demand (Gallons)
Shelby	747,783	2,020,326
Cut Bank	400,000	750,000
Devon	55,392	83,088
Total	1,203,175	2,853,414

3.4 Evaluation of Existing Supply

All of the water for the City of Shelby is supplied from 13 wells of which 11 are currently being used. The well field is located approximately 5 miles south of the city near the Marias River. The wells vary in depth from 31 to 50 feet. Well logs are included in Appendix F. The majority of the well pumps are sized to provide a total dynamic head of 450 feet with the remaining well pumps acting as feeder pumps. Well No. 11 pumps into Well No. 5; and Well No. 12 pumps into Well No. 7, these two feeder wells have smaller pumps. Well No. 6 is currently not operational and well No, 4 is anticipated to be reconnected in the summer of 2016.

It should be noted that Wells #11 and #12 are typically used only during the summer, and Wells #9 and #10 are not frequently used. Some of the City of Shelby's wells are operated only during the spring, summer and fall because they have exposed piping that is susceptible to freezing during winter conditions. The City is working on heated well enclosures eventually allowing all of the wells to be operational year-round.

The available GWIC records are included in Appendix F. The last well log included in Appendix F is the well log for Well No. 13. Well No. 13 was drilled to replace Well No. 4.

A Source Water Protection Plan (SWPP) was developed for the City of Shelby in 2003 and is included in Appendix G. To prevent duplication, only a summary of the findings will be included in the text of this report.

The following information was taken from the SWPP:

> "In general terms, the primary aquifer in the Marias River valley (around the well field) is found within the following materials: sedimentary rocks of the Cretaceous age, which completely underlie the area and make up the bedrock; and the younger Quaternary alluvium and possible glacial outwash deposits...Wells in and around the Marias River valley almost exclusively draw water from the river valley-fill sediments, primarily alluvium, but other deeper bedrock wells are common. The shallow aquifer undoubtedly... exchanges water with the river and is subject to seasonal and yearly water level fluctuations."

For each of the PWS wells, a 100 foot radius was used to delineate the exclusion zone or control zone. The majority of Williamson Park is within the exclusion zone. Within the boundaries of the exclusion zone, careful management is critical to protect a PWS as human activity can have an immediate impact on water quality. The inventory region is defined as the zone of contribution to the well, which can approximate a three-year groundwater time-of-travel or approximately a 1-mile radius around the wellhead. Contaminant releases in the Inventory Region have the potential to reach a PWS well in a period approximately less than 3 years. If there appears to be interaction between surface water and the groundwater in the Inventory Region, a surface water buffer is delineated. The surface water buffer is defined as an area consisting of 0.5 miles on either side of the river and about 10 miles upstream along the primary channels. The recharge region is defined as the entire aquifer or an area that contributes water to the local aquifer. This large region is sometimes defined as the entire watershed. Long term water quality at a PWS is affected by large contaminant sources, accidental chemical releases, or extensive land use activities in the Recharge Region.

The SWPP indicates the susceptibility of the wells to contamination during a flood event on the Marias River, especially in the areas immediately adjacent to the wellheads. The SWPP also identifies several significant potential contaminant sources. "They include a large capacity septic system at Williamson Park, Highway 15 and 3 bridges that cross the Marias River just upstream of the well field, and the 18-hole golf course (Marias Valley Golf and Country Club). The Shelby PWS well field has a very high susceptibility to the large capacity septic system in Williamson Park. The PWS well field has a high susceptibility to spills along the highway or on the bridges. It has a moderate susceptibility to contaminants originating at the 18 hole golf course located upstream and within the Inventory Region."

A bank stabilization project was completed along the Marias River adjacent to the well field in 2004. The purpose of the stabilization project was to discourage bank erosion.

Other groundwater sources have been evaluated in the past to no avail. The groundwater table in the low parts of town is seasonally close to the surface. Wells in this area are typically poor producers. Deep wells have been drilled in search of oil and gas but limited information of the water encountered is available. Typically water quality in these types of wells is poor. The geology of the area is not likely to produce the quantity or quality of water required to supply the town. The Marias River is the most likely location to find the geology required to provide the transmissivity necessary to supply the quantity and quality of water essential to the city of Shelby. "The water pumped from the well field located at the Marias River is generally of good quality with the exception of high iron and manganese values. The iron and manganese pose no health risks, but can cause taste and staining problems" (from the 2006 PER). As the city grows, additional water sources will likely need to be considered south of the Marias River.

The City of Shelby is also in the process of assessing the place of use for their water rights with the Department of Natural Resources & Conservation (DNRC).

3.4.1 Capacity Assessment

All of the existing wells were test pumped on October 2-3, 2013 to determine the available capacity of the existing system during a period of relatively low groundwater levels. During periods of highest demands on the water system, the wells would probably have increased capacity due to higher groundwater levels. The wells pump water to a ground storage tank that was constructed near the well field in 2011. The test pumping was conducted with water discharge to the ground surface at the well, so the capacity of each well needs to be adjusted to account for the elevation difference between the ground surface at the well and at the storage tank. The ground storage tank has a minimum elevation of 3116.5 feet, a maximum elevation of 3131.5 feet, and an average elevation of about 3124 feet. All of the wells are located at a ground elevation between 3100 feet and 3103 feet, resulting in about 10 psi of elevation head to overcome, in addition to friction head, while pumping to the ground storage tank. Table 1 shows the test flow rates from each well at a discharge pressure of about 10 psi. Where wells operate in combination, as noted above, the test flow rate shown for the upstream well is combined with the flow from the downstream well to obtain a single value. See Table 8 for individual well capacities:

Well No.	Test Flow Rate (GPM)
1	241
2	73
3	158
4	300
5 / 11	508
7 / 12	240
8	111
9	160
10	140
11	175[1]
12	130[1]
13	340
Total	2271

[1]Flowrate was added to downstream well.

This quantity includes the capacity of Well No. 4 which is planned to be reconnected to the system in the summer of 2016. The capacity of the system with the largest well out of service (Well No. 13) is approximately 1,931 gpm or 2,780,640 gpd. The City currently has adequate water supply to meet the peak day demand for the City of Shelby, City of Cut Bank and Devon with an excess of 291,744 gpd. However, as discussed in Section 3.3, the well field capacity cannot meet the projected 2036 peak day demand of 2,853,414 gpd for the City of Shelby, City of Cut Bank and Devon.

3.4.2 Condition Assessment

The City plans on utilizing the well field until the North Central Montana Regional Water Authority (NCMRWA) pipe line carrying water from Tiber Dam to many North Central Montana communities is operational. The City of Shelby has signed an agreement to participate in the NCMRWA. Once the pipe line is in place and is distributing treated water, the City of Shelby will connect to the system and will use the NCMRWA water as its main water supply source. Construction has begun on key components of the core line. Federal and state funding availability will dictate the progress of the construction. The City of Shelby connection may or may not be made during the planning period therefore the City needs to be proactive in protecting and upgrading its existing water supply.

"It is not possible to verify that eight of the water supply wells were constructed with a proper annular seal. Over the last ten years, a number of samples taken at the well sites have tested positive for coliform. These positive samples have resulted in boil orders as recently as July of 2002. It is thought that the contamination is due to flood waters percolating along the well casings. Although the new disinfection facility is treating the water supply, City officials believe that sealing the wells will add another layer of

protection." (from 2006 PER). The City completed a project to seal the wells by placing a 1' lift of bentonite clay cap around each of the wells to provide a seal.

Wells No. 9 - No. 12 are only operated during the spring, summer and fall because they have exposed piping that is susceptible to freezing during the winter months. The City is working on heated well enclosures eventually allowing all of the wells to be operational year-round. In addition to the heated enclosures, the water main from the well to the water main feeding the clear well need to be lowered to 6.5' of bury for frost protection.

Only Well No. 13 currently has a flow meter installed in the well house. All flow tests that have been conducted for each individual well, the water has been pumped to waste. To accurately measure the quantity of water derived from each well, flow meters should be installed in each individual well and a flow meter installed outside the Well Field Booster Station to monitor the total quantity of water.

The City of Shelby has recently completed the installation of an in-place auxiliary power source for the well field. The auxiliary power source is a diesel powered Cummins generator that is equipped with an automatic transfer switch in the event of a power outage.

3.4.3 Regulatory Assessment (if applicable)

At this time Montana DEQ is reviewing a report that the City of Shelby submitted to bring Well No. 4 back online.

3.5 Evaluation of Existing Pumping Facilities

3.5.1 Description of Existing System

The City of Shelby water system utilizes two water pumping facilities (booster stations). They are located near the water treatment plant and at the Prison storage tank.

- Well Field Booster Station
  Adjacent to the clear well near the well field is a booster station that was constructed in 2011. This booster station moves water from the storage tank, through a treatment unit that provides UV disinfection and into a ground storage tank at the south end of the City of Shelby. The booster station is equipped with four pumps that operate in parallel. The rated capacity varies slightly depending on the number of pumps running simultaneously. The static head represents about 80 percent of the total head of the pump system; therefore, the flow rate does not vary significantly with parallel pump operation.

- Prison Tank Booster Station
  Adjacent to the ground storage tank at the south end of the City of Shelby is a booster pump station. This pump station moves water from the ground storage tank to a 500,000 gallon elevated tank near the Shelby Prison. The pump station initiates operation when the water in the elevated tank drops to an elevation of 3609.6 feet. The pump station ceases operation when the water level in the elevated tank reaches an elevation of 3612.1 feet. The overflow elevation of the elevated tank is 3616.6 feet. The elevation set points that dictate pump operation can be adjusted by the system operator.

3.5.2 *Capacity Assessment*

- Well Field Booster Station

  The booster station is equipped with four pumps that operate in parallel. The pumps were tested in the Spring of 2015. With one of the four pumps out of service the test results are shown in Table 9 below.

Table 9: Booster Pump Testing Well Field Booster Station

Number of operating pumps	Total Flow Rate, gpm	Total Flow Rate, MGD	Flow Rate, each pump, gpm
0	0	0	0
1	1040	1.5	1040
2	1440	2.07	720
3	1470	2.12	490

Given this value, the pump station does not have adequate capacity to provide the current and projected 2036 peak day demands of the City of Shelby, along with providing 0.75 MGD to the City of Cut Bank and 83,088 gpd to Devon with one of the pumps out of service.

Currently, a project is planned to be completed in 2017 of installing a parallel 20" water main from the booster station to the existing treatment plant and then to the existing South tank. Given this additional water main, the booster station output is shown in the table below:

Table 10: Proposed Booster Pump Output Well Field Booster Station

Number of operating pumps	Total Flow Rate, gpm	Total Flow Rate, MGD	Flow Rate, each pump, gpm
0	0	0	0
1	1290	1.86	1290
2	1990	2.86	995
3	2280	3.28	760

Given the updated values for the booster station, will have 3.28 MGD maximum output with one of the four pumps out of service. This new output will exceed the current and projected 2036 peak day demand of the City of Shelby, City of Cut Bank and Devon.

- Prison Tank Booster Station

  Flow records from the prison tank booster pumps were reviewed to determine system demands associated with this zone of the distribution system. For the period from October 2012 through September 2013, the peak month was July 2013, with a total monthly demand of 8.984 million gallons, or about 0.29 MGD. The peak day was July 3, 2013, with a total demand of 0.43 million gallons. However, the total demand for the

week when the peak day demand was experienced was only 1.968 million gallons, corresponding to an average day demand of about 0.281 MGD.

A pump capacity test was conducted in September 2013 on the prison tank booster pumps to determine their capacity. There are three pumps in this booster pump station. The results of the pump test are shown in Table 11.

Table 11: Booster Pump Testing Elevated Storage Tank System

Number of operating pumps	Downstream pressure reading, psi	Total Flow Rate, gpm	Total Flow Rate, MGD	Flow Rate, each pump, gpm
0	89	0	0	0
1	91	365	0.53	365
2	93	650	0.94	325
3	95	820	1.18	273

The capacity based on one of the three booster pumps is out of service, the flow rate would reduce to 0.94 MGD, and the peak monthly demand for the City of Shelby area served by the prison tank pump system is 0.29 MGD, about 0.65 MGD would generally be available to the City of Cut Bank during the peak month. If the peak day demand from the area served by the prison tank pump system is 0.43 MGD, the minimum flow available to the City of Cut Bank is approximately 0.51 MGD.

Based on the projected 2036 peak day demand, the area served by the Prison Tank Booster Station is approximately 0.52 MGD. With the existing pumps in place, the minimum flow to the City of Cut Bank would be approximately 0.42 MGD.

3.5.3 Condition Assessment

- Well Field Booster Station
  This booster station was constructed in 2011 and is in good working order.

- Prison Tank Booster Station
  This booster station was constructed in 2000 and is in good working order. However, the control system is very outdated. The current system is OPTO 22 by Tetragenics, this system is a Windows 95 based operating system and is very outdated. At this time City staff do not have access to replacement parts for the system, and the OPTO 22 telemetry system does not correspond with the telemetry system for the remaining components in the water system. Also, if additional pumps are needed as a result of the proposed project. The existing building may need to be updated to accommodate larger pumps or more pumps.

3.5.4 Regulatory Assessment (if applicable)

3.6 Evaluation of Existing Treatment Facility

3.6.1 Description of Existing System

In 2003, the City of Shelby requested permission from the Montana Department of Environmental Quality (MDEQ) to consider allowing the City to implement Ultraviolet (UV)

disinfection for drinking water without the requirement of chlorine residual. On July 30, 2003 MDEQ sent a letter to the City of Shelby indicating they would give conditional consideration to the use of an UV system without chlorine residual. As one of the conditions to consideration and eventual approval, the City would have to disconnect Well #4 from the system. Well #4 had been shown to be influenced by surface water, while the remaining wells supplying the City were determined to not be under the direct influence of surface water.

In November 2003, Thomas, Dean & Hoskins, Inc. (TD&H) submitted plans, specifications, and a design report for an UV disinfection system with chlorine gas backup proposed for the City of Shelby. As part of the project, Well #4 would be abandoned and a new well drilled. The MDEQ approved implementation of the proposed UV and chlorine gas backup system. The UV system was constructed in accordance with the MDEQ approved plans and specifications, with the deviations as noted on the August 2005 record drawings submitted to MDEQ by TD&H. The 2003 system included a single medium pressure UV disinfection train.

In March of 2010, KLJ submitted plans, specifications, and a design report for an expansion to the UV disinfection system to double the UV disinfection capacity and to allow for the City to have redundancy with the UV disinfection. The proposal included adding an additional medium pressure UV disinfection train and maintaining the chlorine gas system for backup. The MDEQ approved implementation of the second medium pressure UV disinfection train. The installation of the second UV system did not impact any of the conditions outlined in the July 30, 2003 letter from MDEQ, and modeled the 2003 UV system as closely as possible.

The medium pressure Trojan 4L24 UV reactor installed in 2005, operated in series (Shelby has operated in series since 2011) with the Trojan 4L24 UV reactor installed in 2011 provide 4-log virus inactivation per the UVDGM as required by DEQ 1 3.2.5.2.d.

According to City public works, the UV units are controlled by system telemetry that will shut down the units and send a warning notification to the City's operators if either unit is not providing adequate treatment. If the UV units malfunction, the treatment plant is equipped with a backup chlorine gas injection unit that is designed to automatically begin treatment as soon as the UV unit's shutdown.

The treatment facility is located on top of the plateau above the Marias River approximately one half mile from the well field. The treatment facility is fed from the well field by two 12" diameter pipelines that combine into one 16" diameter pipeline just outside of the treatment facility.

3.6.2 Capacity Assessment

The medium pressure Trojan 4L24 UV reactor installed in 2005, operated in series (Shelby has operated in series since 2011) with the Trojan 4L24 UV reactor installed in 2011 provide 4-log virus inactivation per the UVDGM as required by DEQ 1 3.2.5.2.d. The two 4L24 reactors are capable of providing 4-log inactivation up to 1,750 gpm or 2,520,000 gpd. The maximum output from the well field with the largest well out of service is 1,931 gpm. Therefore, the existing treatment plant does not have adequate capacity to maintain the 4-log virus inactivation rule.

3.6.3 *Condition Assessment*

The two Trojan 4L24 UV reactors are in good working order and have the capability to be expanded to treat 6,320 gpm.

3.7 Evaluation of Existing Storage Facilities

3.7.1 *Description of Existing System*

The City has four finished water storage tanks and one raw water storage tank providing a combined capacity of 3.1 million gallons of finished water and 3.2 million gallons total. The five tanks provide storage in excess of the peak day and fire flow demands for the City as long as the distribution system can deliver the water. The storage system supplements the supply system during short duration periods when demand exceeds the supply. The five storage tanks that make up the storage facilities for the system include:

- South Tank
  A 1 million gallon partially buried concrete storage tank that is located on the south side of town. The south tank is located at an approximate ground elevation of 3,460 feet with the bottom of the tank located approximately 3 feet below ground level. The South Tank is the first tank on the system. A booster pump supplies water from the South Tank to the 500,000 gallon prison tank.

- Prison Tank
  A new 500,000 gallon elevated tank located near the Crossroads Correctional Facility. The ground elevation at the Prison Tank is approximately 3,490 feet and the tank is elevated approximately 190' measured to the top of the tank. The booster station maintains a water level in the Prison Tank of 3,671 to 3,678 feet. The Prison Tank serves the high and middle pressure zones on the south and west sides of town and is the only tank in those districts. This tank provides storage for approximately one-fourth of the City. The elevation of this tank in conjunction with a pressure reducing valve would provide adequate pressure for the north side of town near the border patrol station and the airport.

- City Shop Tank
  A 1.5 million gallon above ground steel tank that is located on the northeast side of town near the City shops. The ground elevation at the City Shop Tank is 3,441 feet. The water in this tank equalizes at the same elevation as the water in the South Tank. The overflow elevations of these two tanks are about the same. This tank controls the operations of the well field and the elevations of the tank are:

  - High Water Level: 3,478.5 feet (pump shutoff elevation)
  - Low Water Level: 3,476.5 feet (pump start elevation)
  - Bottom: 3,441.0 feet

  This tank primarily serves the low pressure zone north of the highway and the railroad. Water to the north side of town was dependent upon only two crossings beneath the railroad and the highway. With the 2008 distribution improvements an additional 12" pipe has been constructed beneath the highway and railroad helping to

minimize the dependency on the tank in the event that one of these crossings in disrupted.

- Airport Tank
  A 100,000 gallon elevated tank that is located on the northwest side of town near the border patrol station and the airport. The ground elevation at the Airport Tank is approximately 3,428 feet and the tank is elevated approximately 26 feet measured to the bottom of the tank, with the high water elevation of the tank at 3,478.5 feet. The Airport Tank floats on the low pressure zone and is dependent upon the flow of water under the railroad and highway. "...The tank was constructed by the Great Northern Railway near 4th Avenue North , and was moved to the present site by the City" (from 2006 PER). The north area of Shelby is experiencing some growth with the addition of the border patrol station, a significant potential for growth exists near the airport and Lake Shel-oole. This tank cannot provide adequate volume or pressure in the area near the tank. The border patrol station was constructed in 2005 and had to install a booster pump for their fire suppression sprinkler system because of the low pressure. According to City officials, the fire hydrant located near the tank will not supply adequate pressure to fill the fire truck.

- Well Field Clear Well
  A 100,000 gallon steel tank that is located near the water treatment plant approximately 5 miles south of the City. The finish floor elevation is approximately 3,116.50 feet, the high water elevation of the tank is at 3,131.50 feet. The tank was constructed in 2011. The tank primarily serves as storage to serve the well field water booster station.

3.7.2 *Capacity Assessment*

According to DEQ-1, 7.0.1, "The minimum allowable storage must be equal to the average daily demand for a 24-hour period plus fire flow demand where fire protection is provided. A Storage Sizing Engineering Analysis must support any deviation requests from this standard."

In order to properly address the storage capacity of the existing system, each pressure zone should be examined for its ability to provide for domestic and fire flow demands.

According to ISO the fire flow is typically based on size and type of building construction, use of the building, and distance between adjacent buildings.

High and Middle Pressure Zones

The high and middle pressure zones, as defined on the water system map included in Appendix D, are currently supplied with water from the South Water tank by an 820 gpm booster station. The population of the high and middle pressure zones is made up of 663 people (from 2006 PER), or approximately 19% of the City's population, a portion of those 663 people make up the Ethridge Water Users Association. The 500,000 gallon Prison Tank provides storage for these zones. The majority of this pressure zone is comprised of residential homes with the largest building being a 500 bed prison which is sprinkled. The O'Haire Blvd area contains the densest area of residential homes requiring the largest fire demand. Based on ISO recommendations, the needed fire flow for the O'Haire Blvd area is

estimated at 2,000 gpm. The fire flow calculations have been included in Appendix H. To calculate the actual gallons of storage needed, the duration of the fire event must be determined. The durations associated with their corresponding fire flows according to the Uniform Fire Code are presented in Table 12 below.

Table 12: Duration of Fire Event

DURATION (hr)	UNIFORM FIRE CODE-NEEDED FIRE FLOW (GPM)
2	Less than 2,875
3	2,875 - 3,875
4	More than 3,875

According to the Uniform Fire Code the duration of a 2,000 gpm fire would be 2 hours. The total needed fire volume for a 2,000 gpm fire with a duration of 2 hours is calculated as follows:

Fire Volume = 2,000 gpm x 2 hours x 60min/hour

= 240,000 gallons

During a fire event the demand is high therefore the booster pumps would be operational. With one of the three booster pumps offline the booster station will provide 650 gpm for two hours. The booster pumps will supply:

Booster Pumps = 650 gpm x 2 hours x 60min/hour

= 78,000 gallons

The total amount of fire flow storage is then calculated by subtracting the available fire flow from the booster station from the total needed fire volume. The calculation follows:

Fire Flow Storage = 240,000 gallons - 78,000 gallons

= 162,000 gallons

The Montana DEQ requires storage in the amount of fire flow plus the average day demand. For the high and middle pressure zones the storage needed for fire flow is 163,200 gallons. The projected average day demand in 2036 is estimated at 747,783 gallons for the entire City, therefore the projected average day demand for these two pressure zones is 19% of 747,783 or 142,079 gallons.

Total Required Storage = 162,000 gallons + 142,079 gallons

= 304,079 gallons

The 500,000 gallon Prison Tank has sufficient capacity to supply the average daily demand and fire flows to the high and middle pressure zones through the year 2036 with excess

capacity of 195,921 gallons. The 100,000 gallon Airport Tank could be eliminated with the area served by this tank being fed by the Prison Tank.

Low Pressure Zone

The low pressure zone, as defined on the water system map included in Appendix D, currently has 2,600,000 gallons of storage, not including the water that can also be supplied to this zone from the Prison Tank through a pressure reducing valve by the intersection of 1st Street South and 9th Avenue South. The 2,600,000 gallons of storage is supplied by three tanks including the 1,000,000 gallon South Tank, the 1,500,000 gallon City Shop Tank, and the 100,000 gallon Airport Tank. This pressure zone is comprised of residential homes with small businesses located in the downtown area. The largest building is a k-12 school which is sprinkled. The downtown area along Main Street contains the densest area of small businesses requiring the largest fire demand. Based on ISO recommendations, the needed fire flow for the Main Street downtown area is estimated at 3,000 gpm. The fire flow calculations have been included in Appendix H. To calculate the actual gallons of storage needed, the duration of the fire event must be determined. The durations associated with their corresponding fire flows according to the Uniform Fire Code are presented in Table 12 on page 23.

According to the Uniform Fire Code the duration of a 3,000 gpm fire would be 3 hours. The total needed fire volume for a 3,000 gpm fire with a duration of 3 hours is calculated as follows:

Fire Volume = 3,000 gpm x 3 hours x 60min/hour

= 540,000 gallons

For the purpose of this report we will assume that the well field and the well field clear well will not provide flow to the system during a fire.

The Montana DEQ requires storage in the amount of fire flow plus the average day demand. For the low pressure zone the storage needed for fire flow is 540,000 gallons. The projected average day demand in 2036 is estimated at 747,783 gallons for the entire City, therefore the projected average day demand for this pressure zone is 81% of 747,783 or 605,704 gallons.

Total Required Storage = 540,000 gallons + 605,704 gallons

= 1,145,704 gallons

The 2,600,000 gallons of existing storage exceeds the needed storage by enough that during low flow time care has to be taken to allow enough flow through the tanks to keep the water fresh. The low pressure zone has sufficient capacity to supply the average daily demand and fire flows through the year 2036 with excess capacity of 1,454,296 gallons. There is enough excess storage capacity in this zone to eliminate the Airport Tank.

Well Field Clear Well

After analyzing the capacity of the clear well, we understand that the clear well is undersized to keep up with the well field booster station. However, the well field itself has sufficient capacity to supply the booster station on its own.