CITY OF SHELBY

CITY OF
SHELBY
MONTANA

CAPITAL IMPROVEMENTS PLAN

Revised: 12/2017

WATER SYSTEM

CHAPTER 1 – EXISTING SYSTEM

Existing Facilities

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 five miles south of town and according to City officials is flooded on average of once every five 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.

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. The City has adequate capacity in their storage facility to meet the projected peak day demands.

The city of Shelby has completed a pipeline connecting Shelby and Cut Bank to provide supplemental water. 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."

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

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 five miles south of the city near the Marias River. The wells vary in depth from 31 to 50 feet. 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.

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.

A Source Water Protection Plan (SWPP) was developed for the city of Shelby in 2003. 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 one-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 three 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 ten 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).

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:

Table 8: Well Field 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.

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.

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

Evaluation of Existing Pumping Facilities
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.

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 cty of Cut Bank would be approximately 0.42 MGD.

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.

Evaluation of Existing Treatment Facility

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.

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.
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.

Evaluation of Existing Storage Facilities
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.

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 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. 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. 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 three 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, 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.

Condition Assessment

The City has 5 storage tanks providing a combined capacity of 3.2 million gallons. 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 4 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 tank is generally in good condition.
- Prison Tank
  A relatively new 500,000 gallon elevated tank located near the Crossroads Correctional Facility. The tank is in good condition.
- 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. In 2005 the steel water main that supplies that tank suffered a major leak. "The foundation for this tank is an oiled sand bed, a common type of foundation at the time of the tank construction. The City needs to study this foundation to ensure the leak did not wash too much of the sand away and that the foundation will be adequate to support this tank in the long term" (from the 2006 PER). Regular maintenance of a steel tank requires periodic recoating on the outside and in.
- 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. Lab tests of the paint that is flaking off of the exterior of the tank show that the paint used to coat the tank was lead based. This tank should be removed from service and properly disposed of. "This area of town should be connected to the current high pressure zone in the near future" (from the 2006 PER). A new tank could also be constructed to serve this area of town but would require a booster station. Storage requirements for this area could be provided by the prison tank.
- 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. This tank is in good condition. Regular maintenance of a steel tank requires periodic recoating on the outside and in.

Evaluation of Existing Distribution Facilities

Description of Existing System

The original water distribution system was installed in the late 1930's and early 1940's. Most of the original pipe has been replaced with asbestos concrete pipe with the more recent improvements utilizing PVC. The distribution system within the City is composed primarily of 6 inch to 16 inch diameter mains. Only a few 4 inch diameter mains remain. Soils in the area are highly corrosive to cast iron and steel pipes therefore almost all of these pipes have deteriorated and have been replaced.

The distribution system is fed by a 16" asbestos cement main line extending from the treatment building (located approximately 5 miles south) to the south tank. This particular water main is very vital to the City, as it is the only main to deliver water from the well field to the City. If this main were to break, the City would be without water until the main was repaired. Due to this, a project is planned for completion in 2017 of installing a parallel 20" water main from the Well Field booster station to the existing treatment plant and then to the South storage tank. This project will provide redundancy and additional capacity to the existing 16" water main.

The distribution system is made up of the three pressure zones . The low pressure district is fed directly by the South Tank with storage provided by the South Tank, the City Shop Tank, and the

Airport Tank. The high and middle pressure zones are fed directly by the new booster station located adjacent to the South Tank with storage provided by the Prison Tank. When the booster station was constructed, two PRV's were installed to reduce excessive pressures, therefore separating part of the existing system from the low pressure zone.

Since the 2010 PER the city of Shelby completed water distribution projects that have looped several areas. Water becomes stagnant in long dead end mains and to improve water quality it is recommended that the mains be looped. Looping the mains not only limits the length of dead end mains improving water quality, but also provides alternate paths for the water to reach the same destination. This allows flexibility for the operator to isolate specific areas for repairs while limiting service interruptions. Other benefits of looping include increased fire flow through smaller mains.

The City has completed numerous distribution system improvements throughout the years that include replacing old and deteriorating pipe, looping mains, and increasing fire flows to key areas of town.

The city of Shelby is almost entirely metered with the exception of a small park. The impact of this park is relatively small with minimal usage. The City currently hires Shelby Gas to read the water meters at the same time that they read their gas meters. The meter reading process works well but the City may want to eventually consider options for more efficient meter reading. There are many options available for converting to a radio-read system, which would eliminate nearly all time to read the meters.

Table 13: Summary of Distribution Pipe

Size (in)	Pipe Type	Quantity (ft)
16	AC	10,797
16	PVC	16,720
12	AC	131,451
10	AC	22,519
8	AC	7,682
8	PVC	2,777
6	AC	49,668
6	PVC	12,586
4	AC	9,327
Total		263,527 (49.91 Miles)

Capacity Assessment

A computer model was developed for the water system based on water system maps provided by the City. The model was constructed using WaterCad V8i by Haestad Methods with topographic maps superimposed over the Shelby water system map to determine elevations. The purpose of the computer model is to analyze the adequacy of the existing system and to develop alternatives for providing peak day demands along with fire protection to the different areas of the City.
The high pressure zone of the existing water system operates at a hydraulic grade of approximately 3,671feet to 3,679 feet. The high pressure zone operates above 75 psi during the peak day. The

middle pressure zone of the existing water system operates at a hydraulic grade of approximately 3,582 feet to 3,583 feet. The middle pressure zone operates above 62 psi during the peak day. The low pressure zone of the existing water system operates at a hydraulic grade of approximately 3,476 feet to 3,482 feet. Some of the higher areas are as low as 22.7 psi during the peak day. The area north of town near the Border Patrol Station operates at 25.9 psi and the area near the City Shop tank operates near 30 psi on the peak day. The 22.7 psi occurs on the west side of town in an unpopulated area that could experience some growth during the planning period.

The existing distribution system provides generally provides adequate fire protection. There are inadequate fire protection in the areas near the South storage tank. However, these areas have nearby hydrants that could also be connected to provide adequate fire flows.

Condition Assessment

Generally the water distribution system in good working order. However, the existing 16" AC pipe that connects to the South Tank has been exposed to the elements at existing vaults and is beginning to deteriorate. This main is also very close to the existing foundation of the South tank. The City has shared concern of how to adequately repair this water main. The City has also shared concern regarding the two 12" water mains that deliver water from the wellfield booster station to the treatment plant. These mains are dated and were installed on a steep slope from the well field booster station to the treatment plant. However, a project has been proposed to supplement these mains with a new 20" main.

Table 13: Summary of Distribution Pipe

Size (in)	Pipe Type	Quantity (ft)
16	AC	10,797
16	PVC	16,720
12	AC	131,451
10	AC	22,519
8	AC	7,682
8	PVC	2,777
6	AC	49,668
6	PVC	12,586
4	AC	9,327
Total		263,527 (49.91 Miles)

Table 15: Hydraulic Model Calibration

Capacity Assessment

A computer model was developed for the water system based on water system maps provided by the City. The model was constructed using WaterCad V8i by Haestad Methods with topographic maps superimposed over the Shelby water system map to determine elevations.

The purpose of the computer model is to analyze the adequacy of the existing system and to develop alternatives for providing peak day demands along with fire protection to the different areas of the City.

The high pressure zone of the existing water system operates at a hydraulic grade of approximately 3,671feet to 3,679 feet. The high pressure zone operates above 75 psi during the peak day.

The middle pressure zone of the existing water system operates at a hydraulic grade of approximately 3,582 feet to 3,583 feet. The middle pressure zone operates above 62 psi during the peak day.

The low pressure zone of the existing water system operates at a hydraulic grade of approximately 3,476 feet to 3,482 feet. Some of the higher areas are as low as 22.7 psi during the peak day. The area north of town near the Border Patrol Station operates at 25.9 psi and the area near the City Shop tank operates near 30 psi on the peak day. The 22.7 psi occurs on the west side of town in an unpopulated area that could experience some growth during the planning period.

The existing distribution system provides generally provides adequate fire protection. There are inadequate fire protection in the areas near the South storage tank. However, these areas have nearby hydrants that could also be connected to provide adequate fire flows.

Condition Assessment

Generally the water distribution system in good working order. However, the existing 16" AC pipe that connects to the South Tank has been exposed to the elements at existing vaults and is beginning to deteriorate. This main is also very close to the existing foundation of the South tank. The City has shared concern of how to adequately repair this water main. The City has also shared concern regarding the two 12" water mains that deliver water from the wellfield booster station to the treatment plant. These mains are dated and were installed on a steep slope from the well field booster station to the treatment plant. However, a project has been proposed to supplement these mains with a new 20" main.

Financial Status of Existing Facilities

A summary of the City's income and expenditures for the last three fiscal years is provided in the following table.

Table 14: Summary of Expenses and Revenues

Year	Water		Sewer	
	Revenues	Expenditures	Revenues	Expenditures
2012-2013	$1,003,302.00	$764,321.00	$476,048.00	$378,212.00
2013-2014	$954,020.00	$761,690.00	$454,465.00	$380,052.00
2014-2015	$1,052,446.00	$998,033.00	$518,546.00	$667,202.00

* Does not include expenses nor revenues incurred from loans.

The current water rates for the City of Shelby are established at a base rate of $43.00/month (for a ¾" service), and increases based on the size of the service and the quantity of water used. The current residential and commercial sewer rates for the City are established at a base rate $25.40 per month and increases based on the size of the sewer service and the quantity of sewage. The target rate is a user rate that is established for each municipality across the state. The target rate is used to determine if the municipality is paying its fair share of a project's cost. In order to apply

for grant funding from the Montana Department of Commerce, the user rates after completion of the project must meet or exceed the target rates.

The target rates are calculated as a percentage of the median income for the municipality. The percentages of median income are approximately 0.9 percent of the median household income for wastewater only, 1.4 percent of the median household income for water only, or 2.3 percent of the median household income for water and wastewater combined. The median household income for Shelby according to the 2010 census was $40,464. According to the Montana Department of Commerce for the City of Shelby, the final target rates for the 2017 biennium are as follows:

Table 15: Target Rates

System	Median Household Income	Percentage	Target Rate	
			Annual	Monthly
Water Only	$40,464.00	1.4%	$566.50	$47.21
Wastewater Only	$40,464.00	0.9%	$364.18	$30.35
Water and Wastewater Combined	$40,464.00	2.3%	$930.67	$77.56

The water target rates are based on residential equivalent dwelling units (EDUs), therefore it is necessary to calculate the City's existing rates based on EDUs. A 3/4 inch water service is a typical residential water service and is considered to be 1 EDU. The EDUs for each water service line are calculated by comparing the area of the service line to the area of a ¾ inch service line. The calculation assumes that the 5/8 inch services are roughly equivalent to the ¾ inch services and the 1 ¼ inch services are roughly equivalent to the 1 inch services. The total Residential EDUs for the City of Shelby are summarized in the following table.

Table 16: Equivalent Dwelling Units

Hookup Size	Number of Hookups	EDUs per hookup	EDUs
3/4" or smaller	1060	1.00	1060
1"	137	1.79	245
1-1/2"	15	4.00	60
2"	21	7.14	150
3"	4	16.00	64
4"	7	28.57	200
6"	1	64.29	64
TOTALS	1245		1843

According to City officials the 2015 revenue from residential metered sales was $949,010 giving an average monthly residential metered water charge in 2015 of $79,084/month. The total residential EDUs in 2015 were 1,843 therefore the 2015 rate per EDU was $42.91/EDU/month. According to City officials the 2015 revenue from residential sewer sales was $719,584 (reference Appendix M) giving an average monthly residential metered water charge in 2013 of

$59,965/month. There were a total of 1245 residential sewer connections in 2015; therefore, the 2015 sewer only rate per connection was $48.16/Connection/month or $32.53/EDU/month.
The combined water and waste water rate in 2015 was $75.44/EDU/month. The City does not currently exceed the target rate ($77.56/EDU/month). However, after the improvements from this PER are in place the combined monthly water/sewer rate will be above the target rate; therefore, the City will be eligible to apply for grant funding through the Montana Department of Commerce.
Water/Energy/Waste Audits
A Sanitary Survey Inspection of the City of Shelby Public Water Supply System was conducted on August 13, 2015 by the Montana Department of Environmental Quality (DEQ).

PROPOSED IMPROVEMENTS

NEEDS ASSESSMENT

Health and Safety

The following list of problems has been experienced by the City of Shelby in the recent past and will need to be solved in the future.

- Coliform Present. Over the last ten years a number of samples taken at the well sites have tested positive for coliform. These positive samples have required the water system to be under a "boil order" a number of times. The most recent boil order was in June 2002.
- Disinfection Required. The Montana Department of Environmental Quality (DEQ) has required the City of Shelby to provide full time disinfection of the public water supply. This requirement is based on two factors. One of the city's wells has been identified as being under the influence of surface water during the initial assessment of the water supply wells for "Groundwater Under the Direct Influence of Surface Water". The rest of the wells have been determined to *not* be under the direct influence of surface water. Another factor in the disinfection requirement is a provision in the Administrative Rules of Montana, Section 17.38.229 that gives the DEQ authority to require disinfection of a water system when the source water is a "...poorly protected groundwater source."

System O&M

The maintenance and operation of the Shelby water system is accomplished by the three certified operators on the city crew. Some of their concerns are:

- The city crew has been working diligently on eliminating the worst of the maintenance headaches caused by the poor condition of the iron water mains. This old main must be replaced in order to control maintenance needs and cost as well as the conservation of water.
- The existing control system consists of a variety of different vendor products. The existing control system is in the break room at the city shop in a dust-free environment.
- Areas of town need better fire flows. Increasing main sizes and providing loops in the existing lines will be required to allow the needed system capacity.
- Parts of Shelby are platted, but do not have utilities installed to serve the existing lots. In order to provide a logical and consistent water distribution system, water mains need to be extended to serve these areas.

Priority #1 - 13th Street Loop (New 12" Looping Line South)

Description

This project consists of providing a new 12-inch main from the south tank to the industrial area and fairgrounds southeast of the city in order to supply greater flows and pressures under fire and maximum day demands. The proposed new main will connect to an existing 12-inch main on 13th Street and to an existing 8-inch main on Santa Fe Trail.

Costs

The estimated cost associated with this improvement as it is described above is $3,735,693. Following is a breakdown of the estimated costs associated with the project.

Table 6 – Cost Estimate

Item	Unit	Quantity	Unit Cost	Total
Mobilization	LS	1	$200,000	$200,000
Common Excavation	CY	150,000	$8	$1,200,000
Water Line ROW Development	LS	1	$369,800	$369,800
Overhead Power Relocation	LS	1	$30,000	$30,000
Culverts and Drainage Structures	LF	240	$400.00	$96,000
Seeding	LS	1	$15,000	$15,000
Bedding Material	CY	1971	$36	$70,956
12-Inch PVC Water Main	LF	5820	$50	$291,000
16-Inch PVC Water Main	LF	3030	$90	$272,700
16-Inch HDPE Directional Bore	LF	300	$260	$78,000
8-Inch Hydrant	EA	7	$7,500	$52,500
Connection to Existing System	EA	2	$6,500	$13,000
Gate Valve	EA	26	$4,500	$117,000
Air Release Manhole	EA	4	$10,000	$40,000
Water Service Connection	EA	2	$3,500	$7,000
Surface Reclamation	LS	1	$25,000	$25,000
			Subtotal	$2,877,956
			10% Contingency	$287,796
			Estimated Construction Cost	$3,165,852
Design Engineering & Legal	LS	1	$253,260	$253,260
Construction Engineering	LS	1	$316,581	$316,581
			Total	**$3,735,693**

Priority #2 - Well Sealing

Description

There are currently six wells that will require a 100 foot radius impervious surface be installed and sealed to the casing. The surfacing section will consist of water proof fabric with twelve inches of compacted base gravel placed on it.

Costs

The estimated cost associated with this improvement as it is described above is $605,816. Following is a breakdown of the estimated costs associated with the project.

Cost Estimate

Item	Unit	Quantity	Unit Cost	Total
Mobilization	LS	1	$56,000.00	$56,000
Clearing and Grubbing	LS	1	$4000.00	$4,000
Excavation	CY	4600	$8.00	$36,800
6" of Compacted Base Course	CY	3500	$30.00	$105,000
2" Asphalt	TON	2300	$100.00	$230,000
			Subtotal	$431,800
			15% Contingency	$64,770
			Estimated Construction Cost	$496,570
Design Engineering	LS	1	$56,672	$39,726
Construction Engineering	LS	1	$70,840	$49,657
Administration & Legal	LS	1	$28,336	$19,863
			Total	**$605,816**

Priority #3 - Eliminate 100,000 Gallon Tank and Attach to High Pressure Zone

Description

The "Eliminate 100,000 Gallon Tank and Attach to High Pressure Zone" alternative includes eliminating the existing 100,000 gallon tank located near the airport and connecting the area served by the existing tank to the high pressure zone via a 12" mainline extending from the Prison Tank to the area. Some of the advantages to this alternative include:

- Eliminating the old tank that is coated in lead based paint
- Reducing the amount of excess system storage capacity to help prevent stagnant water within the system
- Supplying adequate pressures and fire flows to the area that includes the airport and the border patrol station.
- Providing the City the option of a temporary connection of the high pressure zone to the low pressure zone on the north side of the tracks similar to the connection that exists south of the tracks. The proposed valve at the intersection of Teton Ave and Prairie Street could be opened during a fire flow event allowing the connection; otherwise this valve will remain closed and in conjunction with a Pressure Reducing Valve (PRV), provide separation of the proposed pressure zone from the low lying areas of town.
- Providing the flexibility for future connections of other areas of town to the high pressure zone.
- The 2006 PER mentions connecting the high pressure zone to the existing system near the new 12" crossing beneath the railroad tracks. With this alternative this connection would require only a few extra fittings and a PRV. This would also providing looping for the long dead end main that extends west from the City out to Pamida and the adjacent businesses.

A schematic of the "Eliminate 100,000 Gallon Tank and Attach to High Pressure Zone" is included in the 2010 Water System PER prepared by Kadrmas, Lee and Jackson, Inc.

Costs

The estimated cost associated with this improvement as it is described above is $1,956,624. Following is a breakdown of the estimated costs associated with the project.

Cost Estimate

Item	Unit	Quantity	Unit Cost	Cost
Mobilization	LS	1	$75,000.00	$75,000
Remove Existing 100,000 Gallon Tank	LS	1	$100,000.00	$100,000
12" Mainline	LF	13,500	$75.00	$1,012,500
Boring Under RR Tracks & HWY 2	LF	300	$350.00	$105,000
Valves	EA	6	$2,000.00	$12,000
Pressure Reducing Valve & Vault	LS	1	$30,000.00	$30,000
Asphalt Surfacing	TON	250	$100.00	$25,000
Crushed Base Course	CY	850	$30.00	$25,500
Crushed Surface Course	CY	320	$30.00	$9,600
			Subtotal	$1,394,600
			15% Contingency	$209,190
			Estimated Construction Cost	$1,603,790
Design Engineering	LS	1	$128,303.20	$128,303
Construction Engineering	LS	1	$160,379.00	$160,379
Administration & Legal	LS	1	$64,151.60	$64,152
			Total	**$1,956,624**

Priority #4 – 4th Street Loop (Project 1)

Description

This project consists of installing an 8-inch loop along 4th Street North to give the commercial properties in this area adequate pressures and flows. The required fire flows for this commercial area are between 1,500 and 2,000 gpm. Hydrant flow tests indicate that the calculated available flows are approximately 1,090 gpm.

Costs

The estimated cost associated with this improvement as it is described above is $137,144. Following is a breakdown of the estimated costs associated with the project.

Cost Estimate

Item	Unit	Quantity	Unit Cost	Total
Mobilization	LS	1	$56,000	$8000
6-Inch PVC Water Main	LF	675	$50	$33,750
Hydrants	EA	1	$3700	$3700
Gate Valves	EA	6	$1000	$6000
20" Base Course	CY	420	$40	$16,800
Asphalt Pavement	SY	750	$30	$22,500
Connection to Existing System	EA	2	$3500	$7,000
			Subtotal	$97,750
			15% Contingency	$14,663
			Estimated Construction Cost	$112,413
Design Engineering	LS	1	$56,672	$8,993
Construction Engineering	LS	1	$70,840	$11,241
Administration & Legal	LS	1	$28,336	$4,497
			Total	**$137,144**

Priority #5 - South East Loop (New 12" Service Line Southeast)

Description

This project consists of installing a new 12-inch main to provide water to the industrial area and fairgrounds on the southeast side of the city. It includes replacing several undersized mains as well as looping the area. This improvement connects to the existing 14-inch main at the intersection of Glacier Avenue and City Shop Road at the north and to an existing 8-inch main on Santa Fe Trail south of town. The required fire flows for this industrial area are between 3000 and 3500 gpm. Hydrant flow tests indicate that the calculated available flows are approximately 625 gpm.

Cost

The estimated cost associated with this improvement as it is described above is $832,271. Following is a breakdown of the estimated costs associated with the project.

Cost Estimate

Item	Unit	Quantity	Unit Cost	Total
Mobilization	LS	1	$28,000	$28,000
12-Inch PVC Water Main	LF	5494	$60	$329,640
Hydrants	EA	8	$3700	$29,600
Gate Valves	EA	10	$1000	$10,000
20" Base Course	CY	1860	$40.00	$74,400
Asphalt Pavement	SY	3344	$30.00	$100,320
Connection to Existing System	EA	6	$3500	$21,000
			Subtotal	$593,208
			15% Contingency	$88,981
			Estimated Construction Cost	$682,189
Design Engineering	LS	1	$54,575	$54,575
Construction Engineering	LS	1	$68,219	$68,219
Administration & Legal	LS	1	$27,288	$27,288
			Total	**$832,271**

Priority #6 - Teton Avenue Upgrade & Local Loops

Description

This project consists of the upgrading an existing 6-inch main to a new 12-inch transmission main along Teton Avenue ending north of the platted City limits, installing an 8-inch loop along Stillwater Avenue that will connect to an existing 10-inch main at the intersection of Prairie Street and Yellowstone Avenue and an existing 6-inch main at the intersection of Stillwater Avenue and Prairie Street North, and installing a new 8-inch loop along Park Avenue between Gallatin Street and Spirit Drive.

These proposed improvements will provide greater flows and pressures during maximum day and fire flow demands. The improvements will also strengthen the distribution system by providing water from more than one direction in the event of a main break.

Cost

The estimated cost associated with this improvement as it is described above is $1,204,299. Following is a breakdown of the estimated costs associated with the project.

Cost Estimate

Item	Unit	Quantity	Unit Cost	Total
Mobilization	LS	1	$40,875	$40,875
12-Inch PVC Water Main	LF	5153	$60	$309,180
8-Inch PVC Water Main	LF	1300	$55	$71,500
Hydrants	EA	2	$3700	$7,400
Gate Valves	EA	13	$1000	$13,000
20" Base Course	CY	3983	$40.00	$159,320
Asphalt Pavement	SY	7170	$30.00	$215,100
Connection to Existing System	EA	12	$3500	$42,000
			Subtotal	$858,375
			15% Contingency	$128,756
			Estimated Construction Cost	$987,131
Design Engineering	LS	1	$78,970	$78,970
Construction Engineering	LS	1	$98,713	$98,713
Administration & Legal	LS	1	$34,485	$39,485
			Total	**$1,204,299**

Priority #7 - Expand Existing Well Field

Description

Once the new UV system expansion is completed, and the new clearwell and booster pump station are completed between the existing well field and the UV disinfection building, the system from the booster pumps through the UV system will have the capacity to pump and treat 3500 gpm. However, the existing well field has a capacity of approximately 2500 gpm, with all wells operating. The design capacity, with one well out of service, is about 2150 gpm. In order to increase the well field capacity, it is likely that new wells will need to be drilled across the river, northeast of the existing well field. In order to increase the design capacity to 3500 gpm, four new wells are anticipated, each with a capacity of about 350 gpm. This will allow one well to be out of service and still provide a total flow of 3500 gpm. Some additional piping will also be necessary to connect the new wells to the existing piping system. No buildings for the wells are included in the cost estimate.

Costs

The estimated cost associated with this improvement as it is described above is $319,703. Following is a breakdown of the estimated costs associated with the project. These costs do not include any costs associated with the potential need for additional water rights for the new wells.

Cost Estimate

Item	Unit	Quantity	Unit Cost	Total
Mobilization	LS	1	$10,851	$10,851
New Well, 50 Feet Deep	EA	4	$255.00	$1,020
Pumps and Installation	LF	4	$10,000.00	$40,000
Controls and Electrical	LS	4	$15,000.00	$60,000
New 12" Water Line	LF	1200	$55.00	$66,000
New 12" Valves	EA	8	$2,500.00	$20,000
Plumbing and Connections	LS	1	$30,000.00	$30,000
			Subtotal	$227,871
			15% Contingency	$34,181
			Estimated Construction Cost	$262,052

Design Engineering	LS	1	$20,964.13	$20,964
Construction Engineering	LS	1	$26,205.17	$26,205
Administration & Legal	LS	1	$10,482.07	$10,482
			Total	**$319,703**

Priority #8 - 5th Street South/O'Haire Blvd Improvements

Description

This is a replacement project to provide adequate fire flows to the hydrants labeled H-33 and H-36 on the schematics provided in the 2010 Water System PER prepared by Kadrmas, Lee and Jackson, Inc. The two hydrants are located in a fairly dense residential area of town and currently do not provide enough fire flow to the area. To provide the fire flows to H-33, 1,380 feet of 6" asbestos concrete pipe would be replaced with 8" PVC pipe along 5th Street South from 7th Avenue South to Beech Avenue. To provide the fire flows to H-36, 270 feet of 4" asbestos concrete pipe would be replaced with 8" PVC along the north/south running section of O'Haire Boulevard. Not only would the fire flow issues in the area be addressed but the concerns with the aging undersized mains would also be addressed. The proposed improvements are summarized in the "Distribution Alternatives 1" schematic included in the 2010 Water System PER prepared by Kadrmas, Lee and Jackson, Inc.

Costs

The estimated cost associated with this improvement as it is described above is $164,747. Following is a breakdown of the estimated costs associated with the project.

Cost Estimate

Item	Unit	Quantity	Unit Cost	Total
Mobilization	LS	1	$10,675	$10,675
Traffic Control	LS	1	$3,000	$3,000
8" Mainline	LF	1650	$35.00	$57,750
Asphalt Surfacing	TON	250	$100.00	$25,000
Crushed Base Course	CY	500	$30.00	$15,000
Valves	EA	3	$2,000.00	$6,000
			Subtotal	$117,425
			15% Contingency	$17,614
			Estimated Construction Cost	$135,039
Design Engineering	LS	1	$10,803.10	$10,803
Construction Engineering	LS	1	$13,503.88	$13,504
Administration & Legal	LS	1	$5,401.55	$5,402
			Total	**$164,747**

Priority #9 - South Industrial Park Road/North Industrial Park Road Improvements

Description

This project includes upsizing the existing water main to provide adequate fire flows to the hydrants labeled H-58 and H-62 thru H-66 on the schematics provided in the 2010 Water System PER prepared by Kadrmas, Lee and Jackson, Inc.. The hydrants are located along South Industrial Park and North Industrial Park Road and one at the fairgrounds all in a low density commercial area. The project would include replacing 2,140 feet of existing 6" asbestos cement pipe located in South Industrial Park Road and North Industrial Park Road with 8" PVC and connecting to the

4" main at the Industrial Park. The project would also include replacing 1,100 feet of very old 4" Cast Iron pipe feeding the fairgrounds with 8" PVC. Not only will adequate fire flows be provided to the area but a long section of dead end main will be eliminated from the system, increasing water quality. The proposed improvements are summarized in the "Distribution Alternatives 2" schematic included in the 2010 Water System PER prepared by Kadrmas, Lee and Jackson, Inc.

Costs

The estimated cost associated with this improvement as it is described above is $327,180. Following is a breakdown of the estimated costs associated with the project.

Cost Estimate

Item	Unit	Quantity	Unit Cost	Total
Mobilization	LS	1	$21,200	$21,200
8" Mainline	LF	4000	$35.00	$140,000
Asphalt Surfacing	TON	350	$100.00	$35,000
Crushed Base Course	CY	700	$30.00	$21,000
Valves	EA	8	$2,000.00	$16,000
			Subtotal	$233,200
			15% Contingency	$34,980
			Estimated Construction Cost	$268,180
Design Engineering	LS	1	$21,454.40	$21,454
Construction Engineering	LS	1	$26,818.00	$26,818
Administration & Legal	LS	1	$10,727.20	$10,727
			Total	**$327,180**

DESIGN CRITERIA

Water Use/ Demand Data

The following projected water usage/demands will be used as the basis for design:

Average Day Demand	575 gpm (827,985 gpd)
Peak Day Demand	1,668 gpm (2,401,590 gpd)
Peak Hour Demand	3,336 gpm
Fire Flows	3,000 gpm for 3 hours

Storage

With the removal of the 100,000 gallon tank the system will still meet the storage capacity requirements of the Uniform Fire Code during a fire flow event and DEQ-1, 7.0.1.b. The storage facilities of the city are in excess of what is required for storage capacity even without the 100,000 gallon tank. With the removal of the 100,000 gallon tank, a new pressure main would be installed to connect the high pressure zone with the area served by the 100,000 gallon tank. With the installation of the new pressure main, the pressures in the vicinity of the 100,000 gallon tank will exceed 100 psi therefore a pressure reducing valve will be required as stated in DEQ-1, 7.3.1: When static pressures exceed 100 psi, pressure reducing devices should be provided on mains in the distribution system.

Distributions System

The distribution system improvements will be designed in accordance with Section 8 of DEQ-1. Some of the more important requirements of this section that will be implemented into the design are:

Pressure
The system must be designed to maintain a minimum normal working pressure of 35 psi. Minimum pressure under all conditions of flow (e.g. fire flows, hydrant testing, and water main flushing) must be 20 psi. Maximum normal working pressure should be approximately 60 to 80 psi.

Diameter
The minimum size of water main for providing fire protection and servicing fire hydrants must be six-inch diameter.

Dead Ends

a. Dead end mains must be minimized by making appropriate tie-ins…
b. Where dead-end mains occur, they must be provided with a fire hydrant if flow and pressures are sufficient, or with an approved flushing hydrant or blow-off for flushing purposes…

Valves
…Valves should be located at not more than 500 foot intervals in commercial districts and at not more than one block or 800 foot intervals in other districts. Where systems serve widely scattered customers and where future development is not expected, the valve spacing should not exceed one mile.

Hydrants, Location and spacing
Hydrants should be provided at each street intersection and at intermediate points between intersections and must be provided as recommended by the fire protection agency in which the water system is being developed…

The Uniform Plumbing Code and the Uniform Fire Code must be adhered to as well as the state's design requirements for distribution system improvements.

Safety Improvements
With the installation of the proposed improvements many safety concerns will be addressed.

The safety improvements associated with removing the tank and connecting to the high pressure zone include the following:

- Shelby has excess storage capacity. Too much storage capacity within a system will cause stagnant water. Eliminating this tank is one of the only solutions to reduce the amount of excess storage capacity within the system.

- The existing tank is coated in lead based paint. Public exposure to the lead based paint that the tank is coated with would be eliminated by removing the existing tank.

- By connecting the area supplied by the existing tank to the high pressure zone adequate pressures and fire flows would be provided to the area. The area served by this tank is partially made up of the airport and the border patrol station.

The safety improvements associated with the distribution system improvements include providing adequate pressures and fire flow to the different areas summarized on the schematics provided in Appendix A for each of the distribution system improvements.

Right of Way Requirements

The City owns or has easements on all lands that currently have water mains; therefore additional land acquisition will not be required for water main replacement projects. In some of the areas where new water main is to be installed, the City does not own and will require additional land acquisition. The City maintains a good rapport with its citizens and has not had problems in the past acquiring easements to better the systems. Land requirements are not anticipated to be a problem.

Environmental Considerations

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 majority of the proposed project is within the urbanized area of Shelby. 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.