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LANCE CREEK
WATER SUPPLY STUDY, LEVEL I

JUNE 21, 2011

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I, Christopher G. Moody, a Wyoming registered Professional Geologist, certify that this report was prepared by me or under my direct supervision. (The original signature and stamp are available at the Water Development Office.)
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1.0 INTRODUCTION

1.1 Objectives

This 2009-2011 Lance Creek Water Supply Level I Study was initiated in response to a source water quality violation. At this time, water supply arsenic exceeds the Environmental Protection Agency maximum contaminant limit (MCL) of 0.010 milligrams per liter (mg/L). In addition, the public water supply system of the Lance Creek Water and Sewer District has other problems including:

- MCL exceedance of radium and gross alpha
- Distribution system disinfection deficiencies
- Storage tank condition
- Well age, completion, and remote operation
- Bulk sales station deficiencies

The primary objective of this Level I study is to identify a plan to mitigate the arsenic source water quality violation. The secondary objective is to identify system wide improvements and a financing plan that will support a sustainable public water supply system.

The following activities were performed to meet the study objectives, and the report is structured around these activities:

- Define the present and future District service area boundary, and estimate the current water demands and projected demands (Chapter 2.0);
- Inventory the location, materials, and condition of the water system infrastructure, and describe deficiencies (Chapter 3.0);
- Present conceptual level solutions that correct system deficiencies including treatment for arsenic (Chapter 4.0);
- With the assistance of the District and WWDC, prioritize system improvements and develop Improvement Project Alternatives (Chapter 5.0);
- Perform an economic evaluation that considers potential grant/loan scenarios for the Improvement Project Alternatives (Chapter 5.0); and
• Provide recommendations for the operation and maintenance of the system.

1.2 Background

Figure 1-1 shows the location and basic water system components of the Lance Creek Water and Sewer District (District), including the wellfield, main transmission line, and water storage tank. There are currently 52 taps in the system and a bulk water load-out tap mostly for oilfield use. Several of these taps are private taps that are master metered.

Most of the water system facilities were installed in the early 1940's by oil companies which used the system for process water and for serving the needs of a local population of about 2,000. In 1985, the water system was sold to the Kant Oil Company. From 1985 to 1994, the utility was privately owned and water was used for domestic and stock use. In 1994, the Lance Creek Water and Sewer District was formed making the utility public. In 1996, WWC prepared a water system Master Plan which described deficiencies in the existing system and offered recommendations for improvements (WWC, 1996). From 1998 to 1999, nearly all of the transmission, distribution and service lines were replaced with modern plastic piping materials and appurtenances meeting the State of Wyoming minimum standards. Since the water storage tank was last cleaned in 1999, no durable repairs have been made to the structure.

The draft Level I report was issued on January 11, 2011. After that date, the District released new water use data and water rate structure information. The final report incorporated this new information and draft report comments of the District, EPA and the WDO project manager.
2.0 SERVICE AREA AND DEMAND PROJECTION

2.1 Service Area

The District service area is shown on Figure 1-1 and Plate 1. The District serves 33 residents, 9 businesses and numerous livestock through 52 water taps and sells water through a Bulk Water Load-Out station. Several of the water distribution lines shown on Figure 1-1 and Plate 1 are privately owned and the District is not responsible for operation and maintenance of these lines. The District master meters water delivered to the private distribution lines.

The KKRT (Kremers, Kremers, Reese and Thurston) line, a privately owned and operated line serving 3 patrons and 6 taps, was added to the District’s service area in 2001. While there are no planned additional services, the District may see an occasional tap request in the planning horizon. Undoubtedly, the distribution system has capacity to serve a few more domestic and stock water taps; however, the proposed addition of each new tap and its effect on the system should be evaluated separately.

2.2 Existing Water Demand

The District provided tabulated meter records from 2007-2010 and unaccounted use records from 2008-2009 (Appendix A). Average day demand, maximum day demand and peak demand were calculated using these records. The existing water demands are shown in Table 2-1.

2.3 Projected Water Demand

While the Lance Creek area has a stable ranching population, the water system also has the changing population demands of an oil producing community. During high oil production in the early 1940's there were over 2,000 people living in the area. Currently 44 people live in the service area. Discussions with the District indicate that there is no feeling in the community for sustained economic growth, although there is hope that growth will occur when oil and gas industry economics improve.

For planning purposes this study assumes a 25% increase in water demand, distributed uniformly throughout the existing service area. The projected water demands are shown in Table 2-1.
Table 2-1 Calculated Water Demand

<table>
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<th>Demands</th>
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<th>Projected</th>
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<td>Maximum Day Demand, gpm</td>
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<tr>
<td>Peak Demand, gpm</td>
<td>155</td>
<td>194</td>
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</table>

Notes:
1. Gallons per minute = gpm
2. Average Day Demand based on 2007-2010 total average annual use of 5,137,475 gallons
3. Maximum Day Demand was based on July 2007 data of 1,607,800 gallons
4. Peak Demand was based on water supply unit fixture calculation presented in the project notebook
5. Projected water use is 25% more than existing water use
3.0 EXISTING FACILITIES

This chapter documents the conditions and deficiencies of the existing system. The Lance Creek water supply system includes two water supply wells, about 11 miles of water transmission and distribution lines and a 217,000-gallon capacity water storage tank. The following sections reference Figure 1-1, Plate 1 and the Inventory Table in Appendix D, which describes the existing conditions and problems with the components.

3.1 Water Supply and Wells

The District obtains water from two wells, the State No. 1 and No. 2 wells (State wellfield), which are located about 6 miles south of Lance Creek as presented in Figure 1-1 and Plate 1. A third well, State No. 3, is located south of the two production wells, but the ownership was transferred in 1998 to a private landowner for stock water use. These three wells are located in Section 1 of Township 34 North, Range 65 West, Niobrara County, which is owned by the State of Wyoming.

Water rights information, both current and historical, for the State No. 1, No. 2 and No. 3 wells is included in Table 3-1. Additional water rights information is located in Appendix B. WWC contacted the State Engineer’s Office (SEO) and determined the following:

- The water rights for State No. 1, State No. 2 and State No. 3 were all initially filed by oil companies with a priority date of October 21, 1959 as domestic/industrial use wells.
- A water right for State No. 3 was filed by Harold Miller with a priority date of May 22, 1998 as a stock use well. The filing has been completed and is adjudicated. The filing was a re-filing on the 1959 right which was canceled and the District no longer has a water right to this well.
- The District filed for water rights on State No. 1 and State No. 2 with a priority date of November 7, 1988 as miscellaneous use wells. These filings are currently incomplete and unadjudicated. To complete and adjudicate the rights the District needs to provide the SEO with a Certificate of Ownership and a Beneficial Use Map. The 1988 priority date filings were re-filings of the 1959 water rights which have
been canceled.

- The current area of beneficial use in the permits for the State No. 1 and State No. 2 wells does not reflect the entire service area for the District.
- Under the current miscellaneous use permits, the District is not allowed to sell water to be used for purposes such as oil field use or any other use not within the beneficial use area.

The water rights for the District have three deficiencies as follows:

1. They are incomplete and unadjudicated.
2. The beneficial use area is not current.
3. The District is not permitted to sell water for uses not in the water right.

To correct the first two deficiencies, the District needs to have a beneficial use map prepared by a licensed engineer or surveyor. This map needs to include all of the services that are supplied by the system. The map then needs to be submitted to the SEO. To correct the third water right deficiency, the District will need to file for an enlargement of their current water rights. This would allow the District to sell water for uses not in the permits. However, an enlargement would be temporary and would need to be renewed at the end of the term, probably in the range of 5 years.

Water from the State No. 1 and State No. 2 is comingled to supply water to the District. Historically, State No. 1 has been the primary production well and State No. 2 has been used as a supplementary or backup supply. The wells are manually turned on and off in response to visual observations of the tank water level indicator.

An in-depth description of the regional geology and hydrogeology of the State wellfield was previously developed and presented in the Lance Creek Water Supply Master Plan Level I (WWC, 1996). Under this current study, the original description and interpretation of the water supply situation has been updated. The update work was performed by Wyoming Groundwater, LLC and the work is reported in the form of a technical memorandum, which is presented as Appendix C. The information in the following report section has been excerpted from Appendix C.
3.1.1 Wells and Wellhead Facilities

The condition of State No. 1 and No. 2 well and wellhead facilities were evaluated by physical inspection, a down hole camera survey, geophysical logs, and pump tests. Appendix C presents a complete description of these efforts. A summary of their condition is provided below:

State No. 1 Well
- Drilled in the early 1940s.
- Not completed to current drinking water well standards.
- Casing is in relatively good condition.
- Torch cut slots in casing are moderately encrusted.
- Produces about 80 gpm with 25 feet of drawdown.
- Submersible pump, set 212 feet, model and make unknown.

State No. 2 Well
- Drilled in the early 1940s.
- Not completed to current drinking water well standards.
- The condition of the casing is unknown due to heavy encrustation.
- Produces about 50 gpm with 38 feet of drawdown.
- Submersible pump, set 231 feet, Grundfos model unknown, 2009 installation.

Well buildings and fences are present at the State No. 1 and No. 2 wells. The buildings consist of a steel frame, a galvanized sheet metal skin, and a concrete foundation. The buildings are currently in minor disrepair with damaged roof sheeting and some broken window screens. The pumping rates reported above provide compliance with WDEQ standards regarding minimum required production.

Although the wells and wellhead facilities have some problems, the physical condition and capacity of the wells has not been a problem for the District. The authors of this current study recommend that other water system issues be provided more attention under this study.
3.1.2 Water Quality

Table 3-2 presents the results of water quality testing. The State No. 1 well water has arsenic levels above the Maximum Contaminant Limit (MCL), but all other constituents are within EPA limits. The State No. 2 well water has arsenic concentrations below the MCL, but gross alpha and radium-226 are above their respective MCLs.

3.2 Transmission, Distribution and Storage

WWC inspected the TDS (transmission, distribution and storage) system in August of 2009. Appendix D presents a technical memorandum detailing that site visit, including observations and photographs. The following sub sections summarize information from Appendix D.

3.2.1 Physical Condition

The transmission main alignment is shown in Figure 1-1 and Plate 1. From the State wellfield to the old chlorination unit (station -93+65 to 0+00), the transmission line is 4-inch diameter asbestos cement pipe. The age of this segment of pipe is unknown, but the District reports few maintenance concerns with this segment of pipe. The remaining transmission line (station 0+00 to 408+68), is 4-inch diameter PVC pipe, which was installed in 1998-1999. The 4-inch PVC pipe is likely in excellent condition. The transmission line includes the following appurtenances:

- **Combination Air Valves (5)** – The 1-inch combination air valves are located from station 4+50 to 40+50. These valves automatically allow air in and out of the transmission line when conditions require. All five of the combination air valves appear to be in good condition.
- **Manual Air Releases (18)** – The manual air releases consist of a curb stop and a box hydrant to allow air to be manually released at high points along the alignment. Most of the hydrants are in good condition; however there are a few hydrants that have broken covers.
- **Isolation Valves (3)** – Two isolation valves are located on either side of where the tank
line connects to the transmission line. These valves allow the tank line to be completely isolated from the rest of the system for maintenance. The other isolation valve is located near Cherry Creek at station 137+45. This valve allows the upper portion of the transmission line near the wells to be taken off line while the rest of the system is still being served by the tank. All of the isolation valves are in good condition. Review

- **Pressure Sustaining Valve (1)** – A pressure sustaining valve is located at station 89+60. This valve maintains pressure to the upper portion of the transmission line near the wells that is above the elevation of the tank. The valve also reduces the pressure on the downstream side to a workable pressure. The pressure sustaining valve is in good condition; however, when the system was inspected in August of 2009, the valve was being bypassed.

- **Pressure Reducing Valve (1)** – The pressure reducing valve is located at station 336+00 west of the Putnam Camp Area. The valve maintains the pressure in the line at 80 psi or less. This valve was in good condition in August of 2009, although the valve was being bypassed.

- **Services (11)** – Three of these services are stock taps that are currently not metered. Those three and one other stock tap are located in the upper portion of the transmission line and only receive water when the pumps are on. The remaining 8 taps are located along the rest of the transmission line that is served by the tank.

The distribution system consists of branching small diameter pipe. Most of these pipes are either PVC or polyethylene pipe, new in 1999. In addition, meter pits were installed in 1999. Throughout this report, portions of the distribution system are referenced, as they are on Figure 1-1 and Plate 1, with the following names: the Gateway Area, the Putnam Camp Area, the West Lance Creek Area, the South Line, the Tank Line and the Bulk Water Load-Out Line and Transmission Line. The following appurtenances are a part of the distribution system:

- **Manual Air Releases (4)** – Three of these manual air releases are located on the South Line and one is in the Putnam Camp Area. They are located on high points in the line and allow air to be manually released. One of the releases on the South Line has a
broken cover. The rest of the hydrants are in good condition.

- **Isolation Valves (6)** – Two of the isolation valves are located in the Gateway Area, one is in the Putnam Camp Area, two are in the West Lance Creek Area and one is on the South Line. Each of these valves is located so that a portion of the system can be isolated. All valves are in good condition.

- **Pressure Reducing Valve (1)** – The pressure reducing valve is located before the Gateway Area. The valve maintains the pressure in the line at 80 psi or less. This valve had been submerged with water at some point, was buried in mud and the valve was being bypassed in August of 2009.

- **Blow-Off Hydrants (6)** – There are two blow-off hydrants in the Gateway Area, one in the Putnam Camp Area, two in the West Lance Creek Area and one on the South line. All blow-off hydrants are located at the end of lines to facilitate draining when necessary. Most of the hydrants were in good condition, except one of the hydrants in West Lance Creek that was dug up at the time of the inspection.

- **Services (32)** – These taps are located in the Gateway Area, Putnam Camp Area, West Lance Creek and on the South Line. All of these taps are metered services.

The District sells water to two privately owned and operated water lines. The following is a description of each line:

- The KKRT line is a 2-inch PVC line that branches off of the Transmission line to the east. The line is approximately 5 ¾ miles long with three taps and three private stock taps. The line has a booster pump of unknown size. The line and booster pump are in good condition.

- The other line is a 2-inch line that branches off of the South Line and goes to the west. This line is approximately one mile long with two taps and one private stock tap. The condition of the line is unknown.

The District has one steel storage tank with a capacity of about 217,000 gallons. The tank was an original part of the oil field water supply system and is nearly 70 years old. It is located on BLM land south of the Putnam Camp Area in the SE ¼ of Section 4 of T35N, R65W. The 1996 Master Plan (WWC, 1996) performed an inspection which resulted in the
recommendation that “the storage tank should be a high priority for replacement or repair.” Since that study, the tank has not been replaced. Current board members report that some internal coating repairs have been made but that the repairs are not thought to be adequate.

3.2.2 Hydraulic Capacity

The hydraulic adequacy of the existing and future water system infrastructure was evaluated through the development and use of a pressure pipe network model. The water system infrastructure includes the supply, transmission, storage, and distribution components. EPANET (Version 2.0) software was used. A detailed presentation of the model structure and analysis is included in a Project Notebook technical memorandum. A summary discussion of the modeling results follows.

Figure 3-1 is a schematic that illustrates the general hydraulic relationship between the various components of the District’s water infrastructure system. The schematic shows that water is distributed to users in two pressure zones. The first zone is only served when the wells are on. The second pressure zone is served by the water storage tank, and has service pressures ranging from 15 psi to about 87 psi. The service that has a pressure of 15 psi is a private stock tap on a private line. Within the system owned by the District, the pressures range from 47 psi to about 87 psi. The following sections summarize the hydraulic model scenarios that were evaluated.

3.2.2.1 Peak Water Demand Service

WDEQ regulations, and common engineering criteria, require that water be delivered to users with a minimum residual “curb” pressure of 35 psi during normal peak demand conditions. The existing water distribution system model was loaded with current and future estimated peak hour water demands. Only the zone that is served by the tank was evaluated. The KKRT line was not evaluated due to lack of information on the booster pump. Figure 3-2 presents the results of modeling the existing water distribution system loaded with current peak hour water demands. The figure presents points of residual system pressure at services and other important locations. As shown, there are two areas where residual pressure is less than the 35 psi minimum.
required by WDEQ. One area is near the tank where no taps are located. The other area is on a private line in the West Lance Creek Area. This pipeline is not large enough and or serves an area that is higher than the water tank can effectively serve. This deficiency should be corrected, although options for correcting the problem are limited. WWC investigated the use of a larger diameter pipeline and determined that it would have to be of an impractical and costly size. A booster pump would be the only option for serving this location.

Figure 3-3 presents the modeling results of the existing water distribution system loaded with future estimated peak hour water demands. The figure presents points of residual system pressure at services and other important locations. As shown, there are two areas where residual pressure is less than the 35 psi minimum required by WDEQ. One area is near the tank although there are no taps there. The other area is on a private line in the West Lance Creek Area. This pipeline is not large enough and or serves an area that is higher than the water tank can effectively serve. This deficiency should be corrected as noted in the paragraph above.

As a note to the reader, in this model scenario the projected peak hour water demands (see Table 2-1) were applied to existing model nodes. This assumption means that the District’s water demand growth would be confined to the existing system (i.e. in-filled within the boundaries of the existing transmission and distribution system). In the future, the District should evaluate individual proposals for geographic expansion of the system on a case-by-case basis.

3.2.2.2 Fire Demand Service

Fire flow was not modeled for the system due to the lack of fire hydrants and the District has no required fire flow.

3.2.2.3 Water Storage

The evaluation of the capacity of water storage for Lance Creek considered three pieces of information:
- **WDEQ criteria for water storage:** Assuming a two well system, Lance Creek water storage capacity more than doubles the minimum amounts required by Chapter XII of the WDEQ Water Quality Rules and Regulations.

- **Hydraulic modeling:** The modeling work performed for peak day (discussed previously) shows that water storage is large enough to buffer peak demands. This buffering capacity is fairly large even without input from water supplies at the State wellfield. In other words, system storage will accommodate emergency conditions when water supply wells are not operating.

- **Comparison to other communities:** The water supply storage tank has a volume of 217,000 gallons. Table 3-3 presents water storage and population data for several other Wyoming communities of approximately the same size (WWDC, 2009). For a community of Lance Creek’s size, on a per capita basis, the volume of stored treated water is very large in relation to most other communities.

Based on the above evidence, the District has adequate water storage volume. However, WWC is of the opinion that there is actually more system storage than there should be. Appendix E has been included as background information regarding the age of water in storage.

### 3.3 Water Treatment Facilities

The District treats water with chlorine as a means to provide a disinfectant residual in the distribution system. There are no other water treatment processes.

The present system of chlorination is based on operator experience and hit-or-miss guesswork related to the system water use vs. disinfection needs. The operator loads liquid chlorine (Clorox bleach) into a small (8 gallon) reservoir at the State No. 1 well house and activates a timer-controlled injection pump, corresponding to the amount of time he plans to operate the pump. The application rate is manually adjustable, but the operator indicated that he tries to inject about 2 to 3 gallons of the chlorine in a 24-hour pumping period. Based on an assumed pumping rate of 30 gpm (not verified) and 3 gallons of 6% chlorine solution, the dosing rate is about 4.62 milligrams per liter (mg/L). This dose rate is just short of the 5 mg/L that DEQ requires a system to be able to provide, although it appears that the system has the capacity to
load at this rate.

In the fall of 2009, several of the District's routine coliform tests exceeded EPA compliance limits. Ultimately EPA issued an administrative order (dated December 8, 2009) requiring that steps be taken to prevent recurrence of the violations. However, even if the application of chlorine at the wellhead were optimal, under some water demand scenarios, the residence times of water in the system would exceed recommended values, particularly when there is a large amount of water stored and low use by water users. A preliminary design was devised by the District and WWC. The solution provides for automated chlorine injection at one or perhaps two locations. Emergency funding for these injection stations was obtained under a Mineral Royalty Grants program to address the disinfection problem. This project, referred to as the Emergency Chlorinator Project, was planned for completion during the final study period of this report.

During the beginning stages of implementation of the above-planned Emergency Chlorinator Project, further inquiries from the Department of Environmental Quality (DEQ) determined that the current system of chlorination had not been implemented to its full potential and requested further testing of the system before approving additional chlorinators on the system. The DEQ felt that increasing the dosage of chlorine at the well-head, along with assurance that the chlorine was actually being injected as required might solve the disinfection problem. Further testing by the district under the supervision of the DEQ found that it was possible to get acceptable residuals by boosting the chlorination rates at the well heads. The low previous levels of chlorination were at least partially a result of equipment failures and operator choices in combination with at least some perception that some users did not want to “taste” the chlorine in their water supply.

Some of the funding for a backup chlorination injection pump and new chlorine tank for the well head system at State No. 1, as well as additional heating or insulation for the well house has been approved from the emergency funding previously allocated for the District. Currently, only the well-head improvements are contemplated to address the EPA administrative order, although automation of the chlorination system might help avoid future problems.
3.4 System Operation and Maintenance

There are a few operational issues that challenge the District, each of which is presented in the following paragraphs.

The first challenge relevant to operation and maintenance in a general way is the fact that the District has very limited financial capacity. The small number of users simply cannot generate revenue sufficient to address expensive problems. In the recent past, bulk water sales provided a revenue stream. However, more recently, bulk sales have declined with the depressed economy, leaving reserves in the District depleted. To counter the loss of that revenue stream somewhat, the District recently (October 2010) increased water rates. Table 3-4 presents the water rates and the District tabulated operation and maintenance expenses and revenues over the period from 2007-2009.

The second operational challenge is well operation. The State No. 1 well is manually turned on in order to fill the storage tank. When the tank is full the well is then manually turned off. The distribution system is supplied by water from the storage tank for 3 to 5 days, at which time the well is manually turned on again. There is an indicator of tank volume that can be seen from the Gateway Area. The roads to access the wells are pasture roads that can be hard to access in poor weather. At the outset of this current study, the District asked that an automated tank fill system be conceptually designed and that a budget be prepared for the design. Automated control of tank filling would go a long way towards improving water supply reliability and reduce the time the operator would have to spend traveling to and from the wells.

As mentioned previously, the District sells water to customers via a bulk load out tap. The bulk load out tap is located just west of the Putnam Camp Area, and is situated on BLM lands. The load out was installed in 1999, and includes a water meter and stand pipe with air gap, to address cross connection control requirements. The system is not automated in any way. Users must write down or otherwise keep track of the water loads purchased. At the outset of this current study, the District asked that automated systems be evaluated. Again, automation may reduce operational costs and increase the collection of bulk sales revenue.
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<th>Total depth (Ft)</th>
<th>Static Water Level (Ft)</th>
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<td>State #1</td>
<td>0005</td>
<td>Mis</td>
<td>034N</td>
<td>065W</td>
<td>01</td>
<td></td>
<td></td>
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<td>SW1/4 NW1/4</td>
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<td>132</td>
<td>-104.616</td>
<td>42.953</td>
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<td>065W</td>
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<td></td>
<td>150</td>
<td>NW1/4 NW1/4</td>
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<tr>
<td>State No. 3</td>
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<td>05/22/1998</td>
<td>Complete</td>
<td>Harold Miller (Lessee)</td>
<td>State Well #3</td>
<td>Stk</td>
<td>034N</td>
<td>065W</td>
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<td></td>
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<td>NW1/4 SW1/4</td>
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<td>-104.615</td>
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<td></td>
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<td>42.953</td>
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<td>P102849.0W</td>
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<td>Enl State Land Well #2</td>
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<tr>
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<td>Cancelled</td>
<td>Conoco, Inc.</td>
<td>State Land Well #3</td>
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<td>065W</td>
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<td>175</td>
<td>-104.611</td>
<td>42.949</td>
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Note:
Old Water Rights (For Reference Only)
### Table 3-2 Well Water Quality

<table>
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<tr>
<th>Parameter</th>
<th>State No. 1</th>
<th>State No. 1</th>
<th>State No. 2</th>
<th>State No. 2</th>
<th>Drinking Water MCL</th>
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</thead>
<tbody>
<tr>
<td>Arsenic, mg/L</td>
<td>0.022</td>
<td>0.025</td>
<td>0.003</td>
<td>0.002</td>
<td>0.01</td>
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<tr>
<td>Gross Alpha, pCi/L</td>
<td>0.6</td>
<td>1.1</td>
<td>21.9</td>
<td>14.6</td>
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<tr>
<td>Adjusted Gross Alpha, pCi/L</td>
<td>0.4</td>
<td>1.1</td>
<td>17.8</td>
<td>13.5</td>
<td>15</td>
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<tr>
<td>Uranium, mg/L</td>
<td>0.0003</td>
<td>&lt;0.0003</td>
<td>0.0061</td>
<td>0.0016</td>
<td>0.03</td>
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<tr>
<td>Uranium, pCi/L</td>
<td>0.2</td>
<td>&lt;0.20</td>
<td>4.13</td>
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<td>Radium 226, pCi/L</td>
<td>0.3</td>
<td>1.3</td>
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<td>Radium 228, pCi/L</td>
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<td>0.22</td>
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<td>Radium 226 + 228</td>
<td>1.3</td>
<td>1.5</td>
<td>8.6</td>
<td>8.8</td>
<td>5</td>
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</table>

Adjusted Gross Alpha = Gross Alpha - Uranium, units in pCi/L
Adjusted Gross Alpha used for regulatory compliance of drinking water standards
A bold number indicates exceeds MCL.
MCL exceedance is addressed in the report.
<table>
<thead>
<tr>
<th>Name of Entity</th>
<th>Storage (gallons)</th>
<th>Population</th>
<th>Per Capita Storage (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evergreen Mobile Home Park LLC</td>
<td>2,000</td>
<td>50</td>
<td>40</td>
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<tr>
<td>Raintree Estates Improvement and Service Dist</td>
<td>5,000</td>
<td>75</td>
<td>67</td>
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<tr>
<td>Southside Well I&amp;S District</td>
<td>5,000</td>
<td>65</td>
<td>77</td>
</tr>
<tr>
<td>Big Valley &amp; Crossed Arrows Improvement District</td>
<td>5,000</td>
<td>35</td>
<td>143</td>
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<tr>
<td>Red Lane Domestic Water Inc</td>
<td>17,000</td>
<td>60</td>
<td>283</td>
</tr>
<tr>
<td>Avalon Mobile Manor</td>
<td>14,000</td>
<td>43</td>
<td>326</td>
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<tr>
<td>Belle Fourche Pipeline</td>
<td>16,000</td>
<td>40</td>
<td>400</td>
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<tr>
<td>Hyattville Service and Improvement District</td>
<td>25,000</td>
<td>50</td>
<td>500</td>
</tr>
<tr>
<td>Manville</td>
<td>50,000</td>
<td>95</td>
<td>526</td>
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<tr>
<td>Centennial WSD</td>
<td>66,000</td>
<td>100</td>
<td>660</td>
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<tr>
<td>Wessex Improvement and Service District</td>
<td>16,000</td>
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<td>800</td>
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<tr>
<td>Eight Mile I&amp;S District</td>
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<td>87</td>
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<td>South Riverside Acres Water &amp; Improvement District</td>
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<td>35</td>
<td>1,000</td>
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<tr>
<td>Kirby</td>
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<tr>
<td>Hartville</td>
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<td>Grandview Improvement Association</td>
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<td>Dixon</td>
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<td>Lance Creek Water and Sewer District</td>
<td>217,000</td>
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<td>5,425</td>
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Table 3-4 Lance Creek Water District 3 Year Income and Expense Report (Years 2007 through 2009)

<table>
<thead>
<tr>
<th>Income</th>
<th>3 year total</th>
<th>annual receipt payment</th>
<th>monthly receipt payment</th>
<th>one time receipt payment</th>
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<tr>
<td>Bulk Water</td>
<td>$40,029.00</td>
<td>$13,343.00</td>
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<td>Metered Water</td>
<td>$41,583.41</td>
<td>$1,155.09</td>
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<td>Pipe</td>
<td>$595.85</td>
<td></td>
<td></td>
<td>$595.85</td>
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<tr>
<td>Interest Earned</td>
<td>$1,304.33</td>
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<td>$36.23</td>
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<td>3 Year Total Income</td>
<td>$83,512.59</td>
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</table>

<table>
<thead>
<tr>
<th>Expense</th>
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<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Advertising</td>
<td>$78.32</td>
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<td>$78.32</td>
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<td>Association Dues</td>
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<td>$75.00</td>
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<tr>
<td>Back Up Operator</td>
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<td>$50.00</td>
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<td>Bond Insurance</td>
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<td>Convention and Meeting Expense</td>
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<td>Electricity</td>
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<td>Grant and Contract Expense</td>
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<td>$1,000.00</td>
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<td>Loan Payment Interest</td>
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<td>Loan Payment Principle</td>
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<td>Maintenance and Repairs</td>
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<td>Meter Reading Salary</td>
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<td>Office Supplies</td>
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<tr>
<td>Operator Salary</td>
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<td>Parts</td>
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<td>Postage</td>
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<td>Right of Way Lease</td>
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<td>333.05</td>
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<tr>
<td>Special Use Lease</td>
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<td>Supplies and Materials</td>
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<tr>
<td>Water Testing</td>
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<tr>
<td>3 Year Total Expense</td>
<td>$72,435.20</td>
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</table>

3 Year Average Annual Income $27,837.53
3 Year Average Annual Expense $24,145.07
3 Year Annual Net Profit (Loss) $3,692.46
3 Year Average Monthly Income $2,319.79
3 Year Average Monthly Expense $2,012.09

36 Months Monthly Net Profit (Loss) $307.71

Water Rates
Effective October 1, 2010

Tap Fee - $48.00 per month and will include 2000 gallons
$1.30 per 1000 for usage between 2001-10,000 gallons
$.75 per 1000 for usage over 10,000 gallons
FIGURE 3-1

HYDRAULIC GRADE LINE SCHEMATIC

NOT MODELLED: HGL ~4695 WHEN PUMP RUNNING

HYDRAULIC GRADE LINE = EL 4443

TANK

BULK WATER LOAD-OUT
EL 4325

TAPS

EL Varies 4313 - 4257

LOWER ZONE

STOCK TAPS
EL 4574 - 4370

PRESSURE SUSTAINING VALVE

STATE NO. 2
EL 4640

STATE NO. 1
EL 4640

TAPS

EL Varies 4375 - 4275

K:\WWDC\2009-129 Lance Creek\CADD\SCHEMATIC.dwg, 3-1, 12/30/2010 2:29:33 PM
FIGURE 3-2
PEAK HOUR DEMAND PRESSURE CURRENT
LANE CREEK WATER SUPPLY SYSTEM
WYOMING WATER DEVELOPMENT COMMISSION

LEGEND
- WATER MAIN
- PRIVATE WATER LINE
- PRESSURE NODE (OVER 35)
- PRESSURE NODE (UNDER 35)

END 4" PVC TRANSMISSION LINE, STA. 408+25
WEST LANCE CREEK AREA

PUTNAM CAMP AREA
GATEWAY AREA

SOUTH LINE 217,000 GALLON TANK
BULK WATER LOAD-OUT TANK LINE
TANK LINE CONNECTION, STA. 286+39

MASTER VALVE FOR KKRT
SEE KKRT AREA DETAIL

DESIGNED BY: [Signature]
DRAWN BY: [Signature]
CHECKED BY: [Signature]
DATE: 05/10/11

K:\WWDC\2009-129 Lance Creek\CADD\Lance Creek Water System_083010.dwg, FIG 3-2 (3), 6/21/2011 10:39:36 AM
FIGURE 3-3
PEAK HOUR DEMAND PRESSURE
FUTURE
LANE CREEK WATER SUPPLY, LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION

LEGEND

- WATER MAIN
- PRIVATE WATER LINE
- PRESSURE NODE (OVER 35)
- PRESSURE NODE (UNDER 35)

SCALE
0 2000'
4.0 IMPROVEMENT ALTERNATIVES

This Chapter documents improvement alternatives for the deficiencies presented in Chapter 3.

4.1 Water Supply Wells

4.1.1 Wells and Wellhead Facilities

The State No. 1 and State No. 2 wellhead facilities are not completed to current WDEQ standards. The wells were recommended for rehabilitation or replacement in the 1996 Lance Creek Water Supply Master Plan Level I (WWC, 1996). However, the physical condition of the well casings is relatively good and the pumping equipment is of adequate size. As identified in Chapter 3 the well buildings at State No. 1 and No. 2 need minor repairs and this should be done soon. New wells should eventually be drilled, completed with pitless units and brought into a single well control, metering and treatment building. A cost estimate to complete wellhead work is included in Appendix F.

4.1.2 Water Quality

Water from State No. 1 well exceeds the EPA limit for arsenic and water from State No. 2 exceeds the limits for gross alpha and radium-226. The two basic alternatives for obtaining source water compliance within EPA limits are non-treatment and treatment options. The treatment options are discussed under a later section titled Water Treatment Facilities.

In depth discussion of five non-treatment options are presented on pages 11-13 of Appendix C, and include the following:

- Existing State No.1 Well – Low Flow Pumping
- Existing State No. 1 Well: Plug Fusion Shale Interval
- Existing State No. 2 Well: Plug Lakota Below and in High Gamma Zone
- Drill New Well to Replace State No. 1
• Drill New Well to Replace State No. 2

These non-treatment options are not proven approaches to correcting the problem and carry some risk of not being successful. However, these non-treatment options are generally less costly than the treatment options and far less complicated than treatment from a long-term operating and maintenance perspective.

WWC recommends that the District pursue Level II funding to perform the following evaluations in a sequential manner:

**Step 1:** Perform low-flow water sampling and testing to determine if arsenic concentrations can be reduced under low flow operation.

**Step 2:** Plug the Fuson Shale interval in State No. 1 to determine if it is the source of arsenic and that it can be excluded from the pumped well water.

**Step 3:** Revisit the design of new offset wells at State No. 1 and State No. 2 using water quality and pump test data obtained after plugging the Fuson Shale in State No. 1. If Step 2 is successful, then perhaps drill new offset wells that exclude the region resulting in poor water quality.

These steps were evaluated and the WDO decided to perform a Level II study, starting July 2011, that focuses on step 3. A test well will be drilled near State No. 1 with the goal of obtaining water quality that complies with primary drinking water standards and that positively affects water quality when blended with water from the other supply well. The purpose will be to provide water that is in compliance for arsenic, gross alpha and radium-226. In addition the well must provide adequate yield to meet system demands.

4.2 Transmission, Distribution and Storage

4.2.1 Transmission System

The transmission main between the wells and the old chlorination unit should eventually be replaced. The pipe is 4-inch diameter asbestos cement (AC) and has reportedly been repaired
several times in the past. The remainder of the transmission main to the tank and West Lance Creek is new and in good condition. The following minor improvements are needed to the appurtenances along the transmission main:

- **Manual Air Releases** (18) – Most of the hydrants are in good condition; however there are a few valves that have broken hydrants covers that should be replaced.
- **Pressure Sustaining Valve** (PS-1) – The Pressure Sustaining Valve is in good condition, but as was noted in Section 3.2 the valve was being by-passed. The flow should be routed through the Pressure Sustaining Valve if the system operation is automated by SCADA or Hydraulic Valves. As described in Section 4.4.2, a pressure tank and pressure switches would be required at the wells.
- **Pressure Reducing Valve** (PR-1) – This valve was in good condition, although the valve was being bypassed. This valve should be opened and flow routed through the valve in order to function as designed.
- Three of the services are currently not metered. A meter should be installed on each of these service taps.

4.2.2 Water Distribution

The distribution system is about 10 years old and in good condition with the exception of the Bulk Water Load-Out Line. While the Bulk Water Load-Out line does not currently have any known deficiencies, the line is made of old steel that will eventually need to be replaced, especially if water is sold for domestic purposes. The following improvements are required for appurtenances located throughout the distribution system:

- **Manual Air Release** (M-4) – The release has a broken cover and should be repaired.
- **Pressure Reducing Valve** (PR-2) – The pressure reducing valve currently is buried in mud and is being by-passed. The vault should be cleaned out and the valve should be opened and water routed through it in order to function as designed.
- **Blow-Off Hydrants** (6) – Most of the hydrants are in good condition, except one of the hydrants in West Lance Creek that was dug up at the time of the inspection. The
piping to the hydrant in West Lance Creek should be buried.

As identified in Chapter 3, the distribution lines provide water to minimum residual operation pressure during peak water demand, with one exception, the private line in West Lance Creek. Hydraulic modeling work performed as part of this study indicates that this line will need a booster pump system to keep pressures adequate to that portion of the system. The cost estimate for small system repairs, which includes transmission and distribution line repairs, is shown in Appendix F.

4.2.3 Water Storage

The water storage tank should be replaced due to poor physical condition. A secondary reason for replacement is that the tank is too large for the demands. While there are options to removing and replacing the existing tank, like refurbishing or lining, WWC is of the firm opinion that tank replacement on a modern foundation is the only practical solution, particularly when financial assistance is likely to be used for the project. The size of a replacement tank should be based on common engineering criteria. The following are some general guidelines that are applicable in Lance Creek:

- Provide emergency storage equal to 1 or 2 days of average daily demand minimum.
- Rely on system pumping to meet average daily demands up to peak day demands and provide enough storage to supply necessary additional flows during peak demand portions of the day.
- Set the storage available to supply peak demand equal to 20 to 25% of the total peak day demand volume.

There are two WDEQ regulations applicable to required storage volume.

- Chapter XII, Section 9, (b), (I): Number and Capacity. The total developed groundwater source shall provide a combined capacity that shall equal or exceed the design maximum daily demand. A minimum of 2 wells, or 1 well and finished water storage equal to twice the maximum daily demand shall be provided. Where two
wells are provided, the sources shall be capable of equaling or exceeding the design average daily demand with the largest producing unit out of service.

- **Chapter XII, Section 13, (a), (I), (A).** Water systems serving less than 50,000 gallons on the average daily demand shall provide clear well and system storage equal to the average daily demand.

Using the above criteria and regulations of the state, a reasonable design storage volume for the tank would be about 1.5 times the design Projected Maximum Day Demand. This calculates to $1.5 \times 47 \text{ gpm} \times 24 \text{ hr} \times 60 \text{ min/hour} = 101,520 \text{ gallons}$, or approximately 100,000 gallons.

A tank that is 42 foot tall and 20 foot in diameter (94,000 gallons) would nearly meet the storage estimated above and would be tall enough to provide sufficient pressure throughout the system (Figure 4-1). Figure 4-2 shows a schematic of the new tank. A cost estimate for replacing the existing tank with a new 42 foot tall X 20 foot diameter tank is in Appendix F.

### 4.3 Water Treatment Facilities

#### 4.3.1 Arsenic, Radium and Gross Alpha

Water from State No. 1 well exceeds the EPA limit for arsenic and water from State No. 2 exceeds the limits for gross alpha and radium-226. The options for non-treatment are presented earlier in this chapter, and treatment options are discussed below.

The EPA has determined treatment technologies that are effective for these three contaminants along with other pertinent information about each technology. The EPA has designated which technologies are the Best Available Technologies (BAT) and Small System Compliance Technologies (SSCT) which take cost into consideration. The EPA does not require the use of BATs or SSCTs. Table 4-1 and Table 4-2 summarize the treatment technologies for arsenic and radium & gross alpha respectively.

For a system the size of Lance Creek’s, certain technologies fit this type of system better
than others. For treatment of arsenic, the following technologies are most suitable:

- Activated Alumina (AA)
- Activated Alumina Point of Use (AA) (POU)
- Iron Based Sorbents (IBS)
- Iron Based Sorbents Point of Use (IBS) (POU)
- Point of Use Reverse Osmosis (POU RO)
- Fe/Mn Oxidation/Filtration with Iron Coagulant Addition

For treatment of radium, the following technologies are most suitable:

- Point of Use Ion Exchange (POU IX)
- Point of Use Reverse Osmosis (POU RO)
- Greensand Filtration

For treatment of gross alpha, the following technology is most suitable:

- Point of Use Reverse Osmosis (POU RO)

Specifically for the Lance Creek water chemistry, the treatment approach can be addressed two ways. First, these technologies can be applied in the form of a centralized arsenic treatment plant with mixing of water (blending) from State No. 1 and State No. 2 to reduce radium and gross alpha below MCLs. The second approach is to treat for all contaminants through point of use/point of entry treatment (POU/POE) units.

Treatment option No. 1 includes an iron based sorbent centralized treatment system, and could be used to treat water from State No. 1 well. Figure 4-3 shows a centralized treatment system. Under most conditions State No. 1 is the only well that is used. However, when State No. 2 is needed to supplement flow, mixing would need to occur that would bring the containment levels of radium and gross alpha down to below the MCL. This treatment system would require the replacement of media about every 15 years and a certain amount of oversight.
from the operator. This would require probably a Class II Operator Certification. The cost estimate of a centralized treatment facility is presented in Appendix F.

Treatment option No. 2 includes point of use/point of entry treatment, using reverse osmosis (RO) units installed at all taps other than the stock taps. Point of Use units would be used at residential taps (see Figure 4-4) and Point of Entry would be installed at the business/school/church taps (see Figure 4-5). Maintenance and testing of the POU/POE systems would require operator access inside houses. The RO units require periodic filter changes. The conceptual design cost of POU/POE treatment is presented in Appendix F.

4.3.2 Chlorination

Concurrently with this study, a chlorination system was designed and implemented under an emergency funding grant from the Office of State Lands and Investments. The chlorination system is briefly described in Chapter 3. The objective of the emergency chlorinator project was to address EPA notices of violation regarding the coliform rule.

A secondary objective of the project was to streamline and automate as much of the chlorination process as practical, given the limited budget and timeframe for implementation. By removing operator intervention from the daily operation of the chlorination process, the risk of operator error is reduced. Selected design documents related to the emergency chlorination project are attached as Appendix G.

The existing system of chlorine application at the wells needs to be further upgraded or replaced. WWC recommends that an automated system, similar to the systems proposed for the emergency chlorination project be installed at the wells. A cost estimate for the chlorination system is presented in Appendix F. Further study, requested and supervised by the DEQ has indicated that the District can generally achieve its disinfection obligation by chlorinating at the well head. However, an EPANET model of the system under current use conditions shows that residence times exceed six days, the time that it takes chlorine residual to decay from 5 mg/L to 0.5 mg/L. The model is explained in a memo in Appendix E.
4.4 System Operation

4.4.1 SCADA System

One of the priorities for the District is to automate the well pumping operation. This will reduce frequent access to the well sites, which is especially difficult during bad weather.

The operator has reported that cell phone coverage at the wells does not exist, so a cell phone based system would probably not function. Based on our description of the site conditions and location, Timber Line Electric and Control Corp (TLECC - Morrison, CO), recommends a radio based telemetry system for this application. At a minimum, the system should activate the pumps based on set water levels in the storage tank. If some monitoring and reporting can be incorporated into the system, that would be nice; however, the first priority would be a reliable system of activating and deactivating the pumps.

Although the details of the SCADA system have not been worked out, TLECC has installed similar control systems for Superior, Pine Bluffs, and High Savery Dam among others in the region. TLECC indicated that a Motorola radio-based control system would work well in this location. Power at the tank site, could be a battery bank and solar power panels. This is opposed to buried or overhead electrical service, which would be very expensive due to distance. The cost estimate for a SCADA radio system is presented in Appendix F.

Since the current chlorination system at the well houses is manually activated when the pumps are turned on or off, this auxiliary system should also be changed to an automated system if the pumps are no longer being activated manually. A system similar to the emergency chlorination system described previously should be installed at each of the well houses. Estimated cost for these systems is included in Appendix F. Figure 4-7 shows a schematic of SCADA operations.

4.4.2 Bulk Water Load-Out

The Bulk Water Load-Out is currently based on the “honor system.” Water that is taken
is somehow reported to the District. This means that the amount of loaded water likely exceeds water for which the District is paid. In addition to this unknown lost revenue, the facility has minor operational problems. A new automated Bulk Water Load-Out station would allow the District to receive payment for all water that is sold and would correct the minor issues. A cost estimate for an automated Bulk Water Load-Out station is included in Appendix F. This type of station is present in the community of Chugwater. Figure 4-8 shows this type of system.

4.4.3 Hydraulic Valves

A second option for automating well operation is to use hydraulic valves. This option was explored with the consultation of John Tedder of Rocky Mountain Valve and Control, LLC. The following upgrades to the system would be required for this concept to work as shown in Figure 4-9:

- Altitude Valve – An altitude valve, possibly with a vault, would need to be installed near the tank. The valve would open and close at determined water levels in the tank.
- Gate Valves – A gate valve on either side of the altitude valve.
- Relief Valve – Adjust the relief valve in the tank control vault.
- Pressure Sustaining Valve – Adjust the settings at the PSV at 89+60.
- Pressure Switch – A pressure switch at both the State No. 1 and State No. 2 wells would be used to turn the pumps on and off.
- Pressure Tank – A pressure tank at the well

Additional information regarding the hydraulic valve concept is included in the Project Notebook as a memo called Water System Automation Using Hydraulic Valves, dated 2/16/11. The cost estimate for Water System Automation Using Hydraulic Valves is included in Appendix F.
<table>
<thead>
<tr>
<th>Factors</th>
<th>BAT &amp;/or SSCT</th>
<th>System Size</th>
<th>SSCT for POU</th>
<th>POU System Size</th>
<th>Total Water Loss</th>
<th>Pre-Oxidation Required</th>
<th>Optimal Water Quality Conditions</th>
<th>Operator Skill Required</th>
<th>Waste Generated</th>
<th>Other Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ion Exchange (IX)</td>
<td>BAT &amp; SSCT</td>
<td>25-10,000</td>
<td>No</td>
<td>-</td>
<td>95%</td>
<td>1-2%</td>
<td>Yes</td>
<td>High</td>
<td>Spent Resin, Spent Brine, Backwash Water</td>
<td>Possible pre &amp; post pH adjustment. Pre-filtration required. Potentially hazardous brine waste. Nitrate peaking. Carbonate peaking affects pH.</td>
</tr>
<tr>
<td>Activated Alumina (AA)</td>
<td>BAT &amp; SSCT</td>
<td>25-10,000</td>
<td>Yes 25-10,000</td>
<td>95%</td>
<td>1-2%</td>
<td>Yes</td>
<td>pH 5.5 - 6 &lt; 250 mg/L Cl- &lt; 0.5 mg/L Fe+3 &lt; 0.05 mg/L Mn+2 &lt; 4 mg/L TOC &lt; 0.3 NTU Turbidity</td>
<td>Low</td>
<td>Spent Media, Backwash Water</td>
<td>Possible pre &amp; post pH adjustment. Pre-filtration may be required. Modified AA available.</td>
</tr>
<tr>
<td>Iron Based Sorbents (IBS)</td>
<td>NEITHER</td>
<td>25-10,000</td>
<td>No 25-10,000</td>
<td>up to 98%</td>
<td>1-2%</td>
<td>Yes</td>
<td>pH 6 - 8.5 &lt; 1 mg/L PO4-3 &lt; 0.3 NTU Turbidity</td>
<td>Low</td>
<td>Spent Media, Backwash Water</td>
<td>Media may be very expensive. Pre-filtration may be required.</td>
</tr>
<tr>
<td>Reverse Osmosis (RO)</td>
<td>BAT &amp; SSCT</td>
<td>501-10,000</td>
<td>Yes 25-10,000</td>
<td>&gt; 95%</td>
<td>15-75%</td>
<td>Likely</td>
<td>No Particulates</td>
<td>Medium</td>
<td>Reject Water</td>
<td>High water loss (15-75% of feed water)</td>
</tr>
<tr>
<td>Enhanced Lime Softening (LS)</td>
<td>BAT</td>
<td>25-10,000</td>
<td>No</td>
<td>-</td>
<td>90%</td>
<td>0%</td>
<td>Yes</td>
<td>High</td>
<td>Backwash Water, Sludge (high volume)</td>
<td>Treated water requires pH adjustment.</td>
</tr>
<tr>
<td>Enhanced Coagulation Filtration (CF)</td>
<td>BAT</td>
<td>25-10,000</td>
<td>No</td>
<td>-</td>
<td>95% (w/FeCl3) &lt; 90% (w/Alum)</td>
<td>0%</td>
<td>Yes</td>
<td>High</td>
<td>Backwash Water, Sludge</td>
<td>Possible pre &amp; post pH adjustment.</td>
</tr>
<tr>
<td>Coagulation-Assisted Micro-Filtration (CMF)</td>
<td>SSCT</td>
<td>500-10,000</td>
<td>No</td>
<td>-</td>
<td>90%</td>
<td>5%</td>
<td>Yes</td>
<td>High</td>
<td>Backwash Water, Sludge</td>
<td>Possible pre &amp; post pH adjustment.</td>
</tr>
<tr>
<td>Coagulation-Assisted Direct Filtration (CADF)</td>
<td>BAT &amp; SSCT</td>
<td>500-10,000</td>
<td>No</td>
<td>-</td>
<td>90%</td>
<td>1-2%</td>
<td>Yes</td>
<td>High</td>
<td>Backwash Water, Sludge</td>
<td>Possible pre &amp; post pH adjustment.</td>
</tr>
<tr>
<td>Oxidation Filtration (OXFILT)</td>
<td>BAT &amp; SSCT</td>
<td>25-10,000</td>
<td>No</td>
<td>-</td>
<td>50-90%</td>
<td>1-2%</td>
<td>Yes</td>
<td>Medium</td>
<td>Backwash Water, Sludge</td>
<td>None.</td>
</tr>
</tbody>
</table>

**Table 4-1 Summary of Arsenic Treatment Technologies**
<table>
<thead>
<tr>
<th>Treatment</th>
<th>BAT and/or SSCT?</th>
<th>Customers Served</th>
<th>Ra 226/228</th>
<th>Gross Alpha</th>
<th>Treats for</th>
<th>Source Water</th>
<th>Operator Skill</th>
<th>Solid Residuals</th>
<th>Intermediate Process Options</th>
<th>Liquid Residuals</th>
<th>Intermediate Process Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ion Exchange (IX)</td>
<td>BAT &amp; SSCT</td>
<td>25-10,000</td>
<td>Yes</td>
<td>No</td>
<td>Ground</td>
<td>Intermediate</td>
<td>Spent Resins</td>
<td>Regeneration prior to disposal</td>
<td>Backwash water, brine, and rinse water</td>
<td>Flow equalization, chemical precipitation/pH adjustment, thickening, dewatering, recycle</td>
<td></td>
</tr>
<tr>
<td>POU IX</td>
<td>SSCT</td>
<td>25-10,000</td>
<td>Yes</td>
<td>No</td>
<td>Ground</td>
<td>Basic</td>
<td>Spent Membranes</td>
<td>Dewatering, regeneration prior to disposal</td>
<td>Concentrated waste stream</td>
<td>Chemical precipitation/pH adjustment, thickening, dewatering, recycle</td>
<td></td>
</tr>
<tr>
<td>Reverse Osmosis (RO)</td>
<td>BAT &amp; SSCT</td>
<td>25-10,000</td>
<td>Yes</td>
<td>Yes</td>
<td>Surface</td>
<td>Advanced</td>
<td>Spent Membranes</td>
<td>Dewatering, regeneration prior to disposal</td>
<td>Concentrated waste stream</td>
<td>Chemical precipitation/pH adjustment, thickening, dewatering, recycle</td>
<td></td>
</tr>
<tr>
<td>POU RO</td>
<td>SSCT</td>
<td>25-10,000</td>
<td>Yes</td>
<td>Yes</td>
<td>Basic</td>
<td>Basic</td>
<td>Spent Membranes</td>
<td>Dewatering, regeneration prior to disposal</td>
<td>Concentrated waste stream</td>
<td>Chemical precipitation/pH adjustment, thickening, dewatering, recycle</td>
<td></td>
</tr>
<tr>
<td>Lime Softening</td>
<td>BAT &amp; SSCT</td>
<td>25-10,000</td>
<td>Yes</td>
<td>No</td>
<td>All</td>
<td>Advanced</td>
<td>Spent Membranes</td>
<td>Spent filter media: Regeneration prior to disposal</td>
<td>Spent filter backwash water</td>
<td>Flow equalization, chemical precipitation/pH adjustment, thickening, dewatering, recycle</td>
<td></td>
</tr>
<tr>
<td>Greensand Filtration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Basic</td>
<td>Spent filter media, sludge</td>
<td>Spent filter backwash water</td>
<td>Flow equalization, chemical precipitation/pH adjustment, thickening, dewatering, recycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-precipitation with Barium Sulfate</td>
<td>SSCT</td>
<td>25-10,000</td>
<td>Yes</td>
<td>No</td>
<td>Ground</td>
<td>Intermediate</td>
<td>Spent filter media, sludge</td>
<td>Spent filter backwash water</td>
<td>Flow equalization, chemical precipitation/pH adjustment, thickening, dewatering, recycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-formed Hydrous Manganese Oxide Filtration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Intermediate</td>
<td>Spent filter media, sludge</td>
<td>Spent filter backwash water</td>
<td>Flow equalization, chemical precipitation/pH adjustment, thickening, dewatering, recycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrodeionysis/ Electrodeionysis Reversal</td>
<td>SSCT</td>
<td>25-10,000</td>
<td>Yes</td>
<td>No</td>
<td>Ground</td>
<td>Intermediate</td>
<td>Spent Membranes</td>
<td>Regeneration prior to disposal</td>
<td>Concentrated waste stream</td>
<td>Chemical precipitation/pH adjustment, thickening, dewatering, recycle</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Basic to Intermediate</td>
<td>Spent Membranes</td>
<td>Regeneration prior to disposal</td>
<td>Concentrated waste stream</td>
<td>Chemical precipitation/pH adjustment, thickening, dewatering, recycle</td>
<td></td>
</tr>
</tbody>
</table>

Table 4-2 Summary of Radionuclide Treatment Technologies
FIGURE 4-1
PEAK HOUR DEMAND PRESSURE FUTURE
NEW TANK
LANE CREEK WATER SUPPLY, LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION

WATER MAIN
PRIVATE WATER LINE
PRESSURE NODE (OVER 35)
PRESSURE NODE (UNDER 35)
FIGURE 4-2

NEW TANK

LANCE CREEK WATER SUPPLY, LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION

DESIGNED BY: TJW
DRAWN BY: SDG
CHECKED BY: MTS
DATE: 01/11

WATER TANK WITH STEEL FLOOR FOUNDATION
14’ THRU 31’ DIA.

REV DESCRIPTION
1 RELEASED FOR M/I MARKETING SALES & PRE-SUBMITTAL USAGE 6-6-90, RRK
2 REVISED GENERAL NOTES AND LABELS, REVISED ANCHOR CHAIR POSITIONS: 1-2-91, RRK
3 REVISED NOTE 2
EN 99772, 06/11/98, MCA/
4 CHANGED GLASS FLOOR TO STEEL FLOOR, EN 99770, 09/01/98
5 REVISED COMPANY NAME
EN 01/00, 5/24/01, DNA

ENGINEERED STORAGE PRODUCTS COMPANY

DOUBS, LINDSEY & COMPANY

CONFIDENTIAL

THE COMMISSION OF THE TERRITORIAL LENDIENCY OF THE STATE OF WYOMING
RECEIVES BY THE EXPRES WRITTEN CONSENT OF THE COMPANY.
ALL RIGHTS RESERVED

ELEVATION

ROOF MANWAY
MANWAY PLATFORM
ROOF PANELS
ROOF KNUCKLE
USED ON 25’ & 31’ DIAMETER TANKS

PLAN

LADDER & SAFETY CAGE KIT
STEP-OFF PLATFORM
REQUIREMENT IS BASED
ON TANK HEIGHT

WEB TRUSS STIFFENER
QUANTITY AND LOCATION
PER DESIGN REQUIREMENTS

BOTTOM LADDER RUNG TO FLOOR
BOTTOM OF SAFETY CAGE TO FLOOR
GRADE LEVEL
ANCHOR CHAIR & BOLT

FLOOR LEVEL

TOP OF SHELL SHEET
TRADENAME SHEET
SHELL SHEET ( ) PER RING

TOP OF SHELL SHEET

20’-
NOM. DIA.

NOM. ROOF HEIGHT
42’-
NOM. TANK HEIGHT

GENERAL NOTES:
1. FOR TANK DIMENSIONAL VALUES SEE “WATER & TREATMENT TANK GENERAL DIMENSIONS” DRAWING NO. 261375.
2. FOR FOUNDATION CONFIGURATIONS AND CORRESPONDING CONSTRUCTION MATERIAL REQUIREMENTS REFER TO THE PROJECT SUBMITTAL DOCUMENTATION.
FIGURE 4-3

CENTRALIZED ARSENIC TREATMENT

LANCE CREEK WATER SUPPLY, LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION

DESIGNED BY:
TJW

DRAWN BY:
SDG

CHECKED BY:
MTS

DATE
12/10
FIGURE 4-4

POINT OF USE
RO ARSENIC TREATMENT
LANCE CREEK WATER SUPPLY, LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION
FIGURE 4-5

POINT OF ENTRY
RO ARSENIC TREATMENT
LANCE CREEK WATER SUPPLY, LEVEL I
WYOMING WATER DEVELOPMENT COMMISSION

POINT OF ENTRY RO – LANCE CREEK CHURCH
1. ELECTRICAL CONNECTIONS TO BE DESIGNED BY ELECTRICAL ENGINEER - PENDING:
   - MINIMAL HEAT TO PREVENT FREEZING
   - LIGHT ACTIVITY ON WINTER SPREADING
   - PROTECTED RECEIPTAL TO ALLOW MAINTENANCE EQUIPMENT

2. ADDITIONAL PLUMBING DESIGNS PENDING:
   - STANDARD NOZZLE TO ALLOW DISSOLUTION OF CHLORINATION IN TANK AND DRAINAGE OF ISOLATED CHLORINATION SECTION

3. MASS AND EXTENSION OF CONCRETE BASE MUST BE SUFFICIENT TO PREVENT FLOTTATION OF VALVE DURING FULL SUBMERSION EVENTS. TOP OF VALVE TO BE WATER TIGHT. SUBMIT FLOTTATION CALCULATION FOR ENGINEER'S APPROVAL.

4. ALL PIPE FITTINGS NOT SHOWN. CONTRACTOR TO SUBMIT FOR ENGINEER'S APPROVAL. DETAIL DRUING SHOULDER FLANGE ADAPTS, JOINT RESTRICTIONS, AND OTHER ITEMS REQUIRED TO MAKE INSTALLATION FUNCTION AS INSTRUCTED.

5. CONTRACTOR TO COORDINATE ISOLATION AND DRAINING OF WATER MAIN WITH OWNER. MAXIMUM DRAIN TIME 6 HOURS.

FIGURE 4-6

CHLORINATOR

LANCE CREEK WATER SUPPLY, LEVEL I

WYOMING WATER DEVELOPMENT COMMISSION

DESIGNED BY: TJW
DRAWN BY: SDG
CHECKED BY: MTS
DATE: 12/10
OFFICE:
- Record activity and monitor status
- Take action or respond to warning events

STATE NO. 1 AND STATE NO. 2 WELLS
- Pump control

SIGNAL

TANK

HIGH (TURN OFF PUMP)

LOW (ACTIVATE PUMP)
FIGURE 4-8

AUTOMATED BULK WATER LOAD-OUT STATION

LANE CREEK WATER SUPPLY, LEVEL I

WYOMING WATER DEVELOPMENT COMMISSION

NEAR ALBUQUERQUE, NEW MEXICO
Add Pressure Switch and Pressure Tank at Wells.

Adjust Pressure Sustaining Valve

Add an Altitude Valve with a Gate Valve on either side and adjust the Relief Valve.

FIGURE 4-9

HYDRAULIC VALVE SCHEMATIC

LANCE CREEK WATER SUPPLY, LEVEL I

WYOMING WATER DEVELOPMENT COMMISSION
5.0 MASTER PLAN

5.1 Introduction

Water supply system problems were identified in Chapter 3.0. Conceptual design solutions to those problems were discussed and justified in Chapter 4.0. The objective of Chapter 5.0, and the focus of the study, is to formulate a Master Plan that presents the projects and priorities that the District will support and that will be most beneficial. This Master Plan should maximize benefits to the water supply system, while remaining affordable to the users. This Master Plan considers District priorities, project funding assistance, initial capital cost and continuing operation and maintenance expenses.

5.2 Priorities

The District has four categories of problems and WWC has ordered them in a priority ranking of importance, with source water quality being the most important.

1. Source Water Quality
2. Distribution Water Quality
3. System Operation
4. Miscellaneous

These four categories include eight specific problems. The problems, recommended solutions and total project cost estimates are presented in Table 5-1, which is effectively the Master Plan.

1. The first priority of the District is to solve the Source Water Quality problems of arsenic, radium and gross alpha. The District has submitted a Level II funding application to the WWDC to perform well evaluations as described in Chapter 4. The funding request was approved at the WWDC November 4 and 5, 2010 meeting.
2. The second priority of the District is the Distribution Water Quality. The poor water quality of the system has to do with both the large size of the system and the poor
condition of the water tank. The problem of distribution system water quality may be partially mitigated by the installation of chlorinators as described in Chapter 3. However, to fully address this issue the water storage tank should be replaced by a new smaller one.

3. The third priority for the District is System Operation. The wells currently require manual operation, which is a burden on the operator especially in the winter. In addition, bulk sales load-out is based on the honor system for payment which results in a loss in revenue for the District. The SCADA system, Bulk Water Load-Out and Hydraulic Valves described in Chapter 4 address these operational issues.

4. The fourth priority is termed Miscellaneous, which includes projects that will improve the District’s system but are small or perhaps not critical to system operations. These projects include well facility work, replacing the AC line and small system repairs.

5.3 Funding Assistance

Several state and federal funding agencies and programs are available to assist communities with water system improvements projects. As a general rule, it takes 1 to 2 years to secure funding from these sources.

5.3.1 Wyoming Water Development Commission (WWDC)

The WWDC provides funding for the construction of various water supply projects, including water source development, water transmission, and water storage. Projects may be new or rehabilitation of existing facilities. Items related to water distribution and water treatment are normally not eligible for financing from WWDC. At the present time, eligible projects receive a 67% grant and 33% loan arrangement. The loan portion of the financing, if needed, does not have to originate from the WWDC, and often times does not because more competitive loan rates can be found with other programs. The current loan rate from the WWDC is 4.0% for a 30 year (negotiable) term.
5.3.2 USDA Rural Development – Rural Utilities Service (RUS)

The Rural Utility Service (RUS) administers a federal grant and loan program that assists communities with water and wastewater infrastructure. The RUS program often participates with state agencies on the funding of water and wastewater infrastructure. For loans, the terms are flexible and based in part of the communities ability to pay. Grants are available, but there is a lot of competition for grant money.

The eligibility of a community to receive RUS grant funding depends on two criteria. The first criterion is that the annual indebtedness on the project must exceed 1% percent of the median household income. However, this is typically not the controlling criterion. The second criterion is that the grant funding cannot result in a monthly user fee that is less than the average for the area and type of community. RUS funded projects have specific requirements that should be considered by the District:

- maintenance requirements;
- environmental considerations due to NEPA compliance and possible environmental (wildlife and cultural impact) assessments;
- enhanced engineering oversight and review;
- post-construction monitoring;
- annual water system financial auditing;
- loan origination fee;
- loan repayment begins 1 year after the loan is closed; and
- loan portion is spent prior to the grant portion.

Overall, the RUS program will result in additional administrative costs and may add an additional 1 year to the project schedule.

5.3.3 Wyoming State Land and Investment Board (WSLIB)

WSLIB grants and loans may be available for project components not eligible for funding through the WWDC program, including water distribution system improvements and water
treatment projects. The WSLIB program also funds source development, transmission, and storage projects. At the present time, the most favorable scenario is for, at most, a 75% project grant from the combined resources of the WWDC (67%) and WSLIB (8%). At the present time there is considerable competition for the grant money, so obtaining this most desired arrangement may take time, assuming that the District’s needs rank high relative to other communities.

5.3.4 State Revolving Fund (SRF)

The Wyoming Department of Environmental Quality (WDEQ) administers the EPA-financed revolving loan fund program in Wyoming. SRF fund provide loans (no grants) for all types of water development. Currently the SRF provides 2.5% loan financing with a 20-year term. Given the low interest rate, an SRF loan for the non-grant portion of a project is attractive. However, given the 20-year term for the SRF loan, the monthly payment will be higher than the monthly payment for a longer term 30-year loan from the WWDC.

In many respects, SRF loan funding has the additional administrative cost and potential project delays described for the grant/loan funding from RUS. For example, eligibility for SRF funds will require compliance with NEPA guidelines (i.e., environmental assessment) and an annual financial audit of the water system. Typically, SRF loan funding is attractive for large construction projects.

5.4 Operation and Maintenance

The Master Plan considers the operating and maintenance costs needed to support the District. Table 3-4 presents actual income and expenses data for three years of operation. The tabulated expenses include electrical expenses, debt service, water testing and other costs. Table 3-4 also presents data on revenues that have been generated by the sale of water, to both metered services and the Bulk Load Out station. For the data presented, the 3-year average annual income of the District was on the order of $27,800, until recently (2009), when the annual income was only about $17,200. This decline was due in large part by a dramatic reduction in bulk water sales. To compensate for the reduced bulk sales income, the District recently
(October 2010) instituted a new water rate structure, presented on Table 3-4. The District is hopeful that the new rate structure will go a long ways towards making up for the lost bulk sales revenue.

For planning purposes, the financial evaluation of improvement options considers operating and maintenance expenses. Table 5-2 presents assumed incremental operating and maintenance expenses associated with each of the alternatives improvement projects. Incremental operating expenses are those additional ones needed, above and beyond the current operating costs.

5.5 Financing

Table 5-3 presents financial assumptions and calculations associated with the Master Plan requirements identified earlier in this chapter. The financing calculations are based on grants, loans and financing terms from the various agencies normally providing project assistance in Wyoming. The reader should be aware that the financing terms are assumed, and not firm offers from the agencies. Until more information is provided to these funding agencies, the terms of grants and loans are simply for planning purposes.
<table>
<thead>
<tr>
<th>Priority</th>
<th>Problem</th>
<th>Solution</th>
<th>Capital Cost</th>
<th>Monthly Tap Fee Increase*</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Source Water Quality</td>
<td>Arsenic, Radium and Gross Alpha above the MCL</td>
<td>Well Modification#</td>
<td>$260,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arsenic POU/POE</td>
<td>$130,000</td>
<td>$50</td>
</tr>
<tr>
<td>2</td>
<td>Distribution Water Quality</td>
<td>Size of System</td>
<td>Chlorinators</td>
<td>$30,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Condition of Water Tank</td>
<td>New Water Tank</td>
<td>$380,000</td>
</tr>
<tr>
<td>3</td>
<td>System Operation</td>
<td>Manual Well Operation</td>
<td>Install SCADA</td>
<td>$80,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Truck Tap not Automatic</td>
<td>Bulk Water Load-Out</td>
<td>$100,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manual Well Operation</td>
<td>Hydraulic Valves</td>
<td>$60,000</td>
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<tr>
<td>4</td>
<td>Miscellaneous</td>
<td>Wells not Completed to Water Supply Standards</td>
<td>Wellhead Work</td>
<td>$530,000</td>
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<tr>
<td></td>
<td></td>
<td>Old AC Line from Wellfield to Old Chlorinator Building</td>
<td>Replace AC Line</td>
<td>$380,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minor Deficiencies Discovered during Inspection</td>
<td>Small System Repairs</td>
<td>$15,000</td>
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</tbody>
</table>

* Assuming 75/25 percent grant/loan mix from a variety of funding sources.

#Well Modification is being addressed by a Level II study.
Table 5-2  Operating and Maintenance Costs

<table>
<thead>
<tr>
<th>O&amp;M Item</th>
<th>Priority 1 Source Water Quality</th>
<th>Priority 2 Distribution Water Quality</th>
<th>Priority 3 System Operation</th>
<th>Priority 4 Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Well Modification*</td>
<td>Arsenic POU/POE</td>
<td>Chlorinators</td>
<td>New Water Tank</td>
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<tr>
<td>Salaries and wages</td>
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<td>Parts and repairs</td>
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<td>10,000</td>
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</tr>
<tr>
<td>Pumping - electrical only</td>
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<tr>
<td>Electrical - service charge</td>
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<tr>
<td>Insurance</td>
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<td>0</td>
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<tr>
<td>Chemicals, testing</td>
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<td>4,500</td>
<td>3,000</td>
<td>0</td>
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<tr>
<td>Office supplies, printing, misc</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>TOTAL</td>
<td>$0</td>
<td>$14,500</td>
<td>$3,720</td>
<td>$0</td>
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</tbody>
</table>

This table presents estimates of the additional operating and maintenance expenses associated with each improvement project. The value does not include the operation and maintenance cost already incurred by the District.

*Well Modification is being addressed by a Level II study.
## Table 5-3 Project Financing

<table>
<thead>
<tr>
<th>Well Modification*</th>
<th>Arsenic POU/POE</th>
<th>Chlorinators</th>
<th>New Water Tank</th>
<th>Install SCADA</th>
<th>Bulk Water Load-Out</th>
<th>Hydraulic Valves</th>
<th>Wellhead Work</th>
<th>Replace AC Line</th>
<th>Small System Repairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority 1 Source Water Quality</td>
<td>Priority 2 Distribution Water Quality</td>
<td>Priority 3 System Operation</td>
<td>Priority 4 Miscellaneous</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### GRANTS AND LOANS

**Project Cost Estimate**

- **WWDC**: 67%
- **WWDC and WSLIB Max**: 75%
- **RUS**: 20%
- **WSLIB - Emergency**: 100%

**Loans**

- **WWDC**: $0, $0, $0, $0, $0, $0, $0, $0, $0, $0
- **WWDC and WSLIB Max**: $195,000, $97,500, $0, $285,000, $60,000, $75,000, $45,000, $397,500, $285,000, $0
- **RUS**: $0, $0, $0, $76,000, $16,000, $20,000, $12,000, $106,000, $76,000, $0
- **WSLIB - Emergency**: $0, $0, $30,000, $0, $0, $0, $0, $0, $0, $0

**Loan Total = Project cost**

- **WWDC**: $65,000, $32,500, $0, $19,000, $4,000, $5,000, $3,000, $26,500, $19,000, $0

### ANNUAL USER COSTS

**Annual Loan Cost**

- **WWDC**: $3,759, $1,879, $0, $1,099, $231, $289, $173, $1,532, $1,099, $0

**Additional Annual O&M Expenses**

- **Reserve**: $0, $14,500, $3,720, $0, $500, $0, $200, $0, $0, $0

**Reserve**

- **25%**: $940, $470, $0, $275, $58, $72, $43, $383, $275, $0

**TOTAL ANNUAL COSTS (A +B +C)**

- **4,699, $16,849, $3,720, $1,373, $789, $361, $417, $1,916, $1,373, $0

### WATER RATES

**Number of Taps**

- **28**

**Incremental Increase in Monthly Tap Fee**

- **$13.98, $50.15, $11.07, $4.09, $2.35, $1.08, $1.24, $5.70, $4.09, $0.00

*Well Modification is being addressed by a Level II study.*
6.0 RECOMMENDATIONS

The following are recommendations from the Water Supply Master Plan for the Lance Creek Water and Sewer District. The District should proceed to solve their problems with the following actions:

1. **Priority 1-Source Water.** The District should continue with the Level II Study funded by the WWDC. The study will drill new offset wells in a manner that excludes arsenic from the source water and this program should be completed. Should that program prove unsuccessful (i.e. arsenic cannot be eliminated) then the District may have to adopt water treatment.

2. **Priority 2 – Distribution System Water Quality.** Seek grants and loans to finance the final design and construction of a new water storage tank. The tank would be at the site of the present tank. The new tank would be on the order of 94,000 gallons, or about half the size of the existing tank.

3. **Priority 3 - System Operations.** At a minimum, the District should seek funding for final design and construction of SCADA or Hydraulic Valve improvements, with the primary goal of providing remote well field control. The cost to install this would be somewhat offset by reduced time and expenses for well operation. The District should also consider seeking funding for a new automated bulk water load-out. The cost installation would be somewhat offset by collection of all water that is sold.

4. **Priority 4 – Miscellaneous.** The improvement projects listed in this section are of the lowest priority and should be addressed after the first 3 priorities.
PLATES
<table>
<thead>
<tr>
<th>ITEM</th>
<th>LATITUDE</th>
<th>LONGITUDE</th>
<th>ELEVATION</th>
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<td></td>
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<td>104.704</td>
</tr>
</tbody>
</table>

NOTE: LOCATION OBTAINED USING HANDHELD GPS.
## Raw Water Use Data Furnished By District

<table>
<thead>
<tr>
<th></th>
<th>Metered Use</th>
<th>Unaccounted Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 2007 2008 2009 2010 Average</td>
<td>Year 2008 2009</td>
</tr>
<tr>
<td>January</td>
<td>272,800 239,300 265,600 462,100 309,950</td>
<td>970,000</td>
</tr>
<tr>
<td>February</td>
<td>194,100 222,800 214,700 232,500 216,025</td>
<td>974,700</td>
</tr>
<tr>
<td>March</td>
<td>303,300 224,200 173,300 238,200 234,750</td>
<td>276,300</td>
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<tr>
<td>April</td>
<td>284,400 308,400 218,200 250,400 265,350</td>
<td>191,200</td>
</tr>
<tr>
<td>May</td>
<td>436,400 303,300 346,200 141,500 306,850</td>
<td>1,324,800</td>
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<tr>
<td>June</td>
<td>801,700 609,200 783,300 321,500 628,925</td>
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<tr>
<td>July</td>
<td>1,607,800 1,124,700 523,000 619,900 968,850</td>
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<td>August</td>
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<tr>
<td>September</td>
<td>580,500 500,000 646,900 543,800 567,800</td>
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<tr>
<td>October</td>
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<td>November</td>
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<tr>
<td>Total</td>
<td>6,348,200 5,685,600 4,163,300 4,352,800 5,137,475</td>
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</tr>
</tbody>
</table>

### Notes
1. Unaccounted use is bulk sales, 4 unmetered stock taps and leakage which is believed to be small. Per the District, bulk sales are hard to predict and recently much lower than the data above.

2. Metered water taps include the following:

<table>
<thead>
<tr>
<th>Tap Use</th>
<th># of Taps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>12</td>
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<tr>
<td>Residential/Stock</td>
<td>8</td>
</tr>
<tr>
<td>Stock</td>
<td>2</td>
</tr>
<tr>
<td>Stock Private</td>
<td>4</td>
</tr>
<tr>
<td>Stock Seasonal</td>
<td>5</td>
</tr>
<tr>
<td>Business/School/Church</td>
<td>8</td>
</tr>
<tr>
<td>Business Seasonal</td>
<td>1</td>
</tr>
<tr>
<td>Not Used</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
</tr>
</tbody>
</table>
STATE OF WYOMING
OFFICE OF THE STATE ENGINEER
HERSCHLER BUILDING
CHEYENNE, WYOMING 82002

APPLICATION FOR PERMIT TO APPROPRIATE GROUND WATER

PERMIT NO. U.W. 1

WATER DIVISION 1

NAME AND NUMBER OF WELL

Street # 0005

1. Name of applicant(s) Walter F. Kent
   Address Box 26, Lance Creek, Wyo 82222

2. Address of applicant(s) Box 26, Lance Creek, Wyo 82222

3. Name & address of agent to receive correspondence and notices

4. Use to which the water will be applied: Domestic [ ] Stock Watering [ ] Irigation [ ] Municipal [ ] Water supply for
   Lance Creek Utilities Water & Sewer Dist.

5. Location of the well: (NOTE: Quarter-quarter (40-acre subdivision) MUST be shown. EXAMPLE: SE\NW\W of Sec. 12, Township 14 North, Range 68 West.)
   Nebraska County, 51 N., 55 W. of the 6th P.M. (or W.R.M.), Wyoming. If located in a plotted subdivision, also provide Lot 
   Number of the Subdivision (or Add'n) of

6. Mark the well location on the section grid to the right. LOCATION SHOWN IN ITEMS 5 MUST AGREE WITH GRID. If the proposed well is for irrigation use, sketch and label all irrigation ditches and canals, stream, reservoirs and other wells. Indicate the point of use or lands to be irrigated from other sources.

7. Estimated depth of the well is 291 feet.

8. MAXIMUM quantity of water to be developed and beneficially used: 100 gallons per minute. NOTE: If for domestic or stock use, this application will be processed for a maximum of 25 gallons per minute. SPRINGS: Only springs flowing 25 gallons per minute or less, where the proposed use is domestic or stockwatering, will be considered as ground water appropriations. After approval of this application, some type of artificial diversion must be constructed to qualify for a water right.

9. If use is not irrigation, mark the point(s) or area(s) of use in the tabulation below.

10. If for irrigation use:
   a. Describe MAXIMUM acreage to be irrigated in each 40 acre subdivision in the tabulation below.
   b. [ ] Land will be irrigated from this well only.
   c. [ ] Land is irrigated from existing water right(s) with water from this well to be additional supply. Describe existing water right(s) under REMARKS.

11. If for irrigation use, describe method of irrigation, i.e. center pivot sprinkler, flood, etc.

Permit No. U.W. 111113
12. The well is to be constructed on lands owned by State of Wyoming
(The granting of a permit does not constitute the granting of right of way. If any easement or right of way is necessary in connection with this application, it should be understood that the responsibility is the applicant's. A copy of the agreement should accompany this application, if the land is privately owned and the owner is not a co-applicant.)

13. The water is to be used on lands owned by State of Wyoming People's or Local Utilities
(If landowner is not the applicant, a copy of the agreement referring to usage of appropriated water on the land should be submitted to this office. If the landowner is included as a co-applicant on the application, this procedure need not be followed.)

REMARKS: This is a reprinting of Permit No. U.W. 753

Under penalties of perjury, I declare that I have examined this application and to the best of my knowledge and belief it is true, correct and complete.

Signature of Applicant or Authorized Agent

October 29th, 1988

THE LEGALLY REQUIRED FILING FEE MUST ACCOMPANY THIS APPLICATION

DOMESTIC AND/OR STOCK WATERING USES
(Domestic use is defined as a single-family dwelling and the watering of lawns and gardens not exceeding one (1) acre)

IRRIGATION, MUNICIPAL, INDUSTRIAL, MISCELLANEOUS

MONITOR (For water level measurements or chemical quality sampling)

IF WELL WILL SERVE MULTIPLE USES, SUBMIT ONLY ONE (THE HIGHER) FILING FEE.

THIS SECTION IS NOT TO BE FILLED IN BY APPLICANT

THE STATE OF WYOMING )

) ss.

STATE ENGINEER'S OFFICE )

This instrument was received and filed for record on the 7th day of November, 1988, at 9:00 o'clock A.M.

Permit No. U.W. 1111113

This is to certify that I have examined the foregoing application and do hereby grant the same subject to the following limitations and conditions:

This application is approved subject to the condition that the proposed use shall not interfere with any existing rights to ground water from the same source of supply and is subject to regulation and correlation with surface water rights, if the ground and surface waters are interconnected. The use of water hereunder is subject to the further provisions of Chapter 169, Session Laws of Wyoming, 1957, and any subsequent amendments thereto.

Granting of a permit does not guarantee the right to have the water level or artesian pressure in the well maintained at any specific level. The well should be constructed to a depth adequate to allow for the maximum development and beneficial use of ground water in the source of supply.

If the well is a flowing artesian well, it shall be so constructed and equipped that the flow may be shut off when not in use, without loss of water into surface formations or the surface.

FOR ADDITIONAL CONDITIONS AND LIMITATIONS SEE ATTACHED STATUS SHEET.

Approval of this application may be considered as authorization to proceed with construction of the proposed well.

Construction of well will begin within one (1) year from date of approval. A Statement of Completion will be filed within thirty (30) days of completion of construction, including pump installation.

Completion of the beneficial use of water for the purposes specified in item 1 of this application will be made by December 31, 1999.

The amount of appropriation shall be limited to the quantity to which permittee is entitled as determined at time of proof of application of water to beneficial use.

Witness my hand this 31st day of November, 1988.

GORDON W. FASSEL
State Engineer
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PERMIT NO. U.W. 111113
T.F. No. 20-7-145

PERMIT STATUS

Priority Date November 7, 1988 Approval Date Aug 05 1998

ADDITIONAL CONDITIONS AND LIMITATIONS:

1. A meter acceptable to the State Engineer is required to accurately measure the total quantity of water produced from this well.

2. An annual report shall be submitted to the State Engineer no later than February 15 of each year stating the total amount of water produced from this well each month during the previous January 1 to December 31, twelve (12) month period.

3. The report shall identify the well by name, location, permit number and shall identify the type of meter used for the measurement.

4. The report shall contain at least two (2) semi-annual measurements of the pumping water level in the well as measured after a minimum twenty-four (24) consecutive hours of pumping. The dates the measurements were obtained and the period of time the well was pumped prior to obtaining the measurements must be specified.

5. The report shall contain at least two (2) semi-annual measurements of the static water level in the well as measured twenty-four (24) consecutive hours after pumping has ceased. The dates the measurements were obtained and the period of time the well was 'shut-in' prior to obtaining the measurements must be specified.

6. The State Engineer may, upon written request, waive all or any portion of these conditions and limitations.

GORDON W. FASSETT, State Engineer

Date of Approval

Aug 05 1998
PERMIT NO. U.W. 111113
T.F. No. U.W. 20-7-145

PERMIT STATUS

Priority Date November 7, 1988 Approval Date AUG 0 5 1998

July 28, 1998 -- All right, title and interest in and to this application is assigned from Walter F. Kant, Lance Creek Utilities to LANCE CREEK WATER AND SEWER DISTRICT, Box 26, Lance Creek, WY 82222 per Assignment received July 28, 1998. Assignment is filed in Miscellaneous Notices under Permit No. U.W. 111113.

November 7, 1998 - Statement of Completion in January 1946 received.

SEP 30'99 NOTICE OF EXPIRATION OF TIME FOR COMPLETION OF BENEFICIAL USE MAILED

December 30, 1999 - Proof of Beneficial use on January 1, 1997 received.
STATE OF WYOMING
OFFICE OF THE STATE ENGINEER

IF WELL IS TO BE ABANDONED, SEE STATEMENT OF COMPLETION AND DESCRIPTION OF WELL
ITEM 15, PAGE 4

PERMIT NO. U.W. 11113

1. NAME OF OWNER: Walter F. Kant

2. ADDRESS: Box 26, Lance Creek, Wyoming

3. USE OF WATER: Domestic Stock Watering Irrigation

4. LOCATION OF WELL: SW 1/4 NW 1/4 of Section 1, T. 34 N., R. 65 W., of the 6th P.M. (or W.R.M.), Wyoming, being specifically 330 ft from west line, and 410 ft from south line, Section 1

5. TYPE OF CONSTRUCTION: Drilled □ Rotary □ Dug □ Driven □ Jetted □ Other

6. CONSTRUCTION: Total Depth of Well 291 ft. Depth to Static Water Level 86/3 ft.
   a. Casing Schedule: New □ Used □
      8 5/8 diameter from GL ft. to 285 ft. Material □ Gage □
      diameter from ft. to ft. Material □ Gage □
      diameter from ft. to ft. Material □ Gage □
   b. Perforations: Type of perforator used
      Size of perforations inches by inches.
      Number of perforations and depths where perforated:
      perforations from ft. to feet.
      perforations from ft. to feet.
   c. Was well screen installed? Yes □ No □ not known
      Diameter: slot size: set from feet to feet.
      Diameter: slot size: set from feet to feet.
   d. Was well gravel packed? Yes □ No □ Size of gravel Not known
   e. Was surface casing used? Yes □ No □ Was it cemented in place? Yes □ No □ not known

7. NAME & ADDRESS OF DRILLER: Whitey Hayes, Sheridan, Wyoming (deceased)

8. DATE OF COMPLETION OF WELL: January 17, 1906

9. PUMP INFORMATION: Manufacturer: Layne Western Type Layne Deep Well Turbine pump with 5 ½ tubing 6 stage
   Source of power: Electricity Horsepower: 7½ Depth of Pump Setting 265
   Amount of Water Being Pumped 100 Gallons Per Minute. (For springs or flowing wells, see item 11.)
10. PUMP TEST: Was a pump test made? Yes ☐ No ☐ No doubt
   If so, by whom _______ Well completed in the early 1940s _______ No records available to us _______
   Yield: ___________ gal./min. with __________ foot drawdown after _______ hours.
   Yield: ___________ gal./min. with __________ foot drawdown after _______ hours.

11. FLOWING WELL (Owner is responsible for control of flowing well).
   If well yields artesian flow, yield is ___________ gal./min. Surface pressure is ___________ lb./sq. inch, or _______ feet of water.
   The flow is controlled by: valve ☐ cap ☐ plug ☐
   Does well leak around casing? Yes ☐ No ☐

12. LOG OF WELL: Total depth drilled _______ 291 _______ feet.
   Depth of completed well _______ 291 _______ feet. Diameter of well _______ 8-5/8 _______ inches.
   Depth to first water bearing formation _______ _______ feet.
   Depth to principal water bearing formation. Top _______ feet to Bottom _______ feet.
   Ground Elevation, if known _______ _______

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<tr>
<th>From Feet</th>
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<th>Material Type, Texture, Color</th>
<th>REMARKS: (Cementing, Shutoff, Packing, etc.)</th>
<th>Indicate Water Bearing Formation</th>
<th>Indicate Perforated Casing Location</th>
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QUALITY OF WATER INFORMATION:
Was a chemical analysis made? Yes ☐ No ☐
If so, please include a copy of the analysis with this form.
If not, do you consider the water as: Good ☐ Acceptable ☐ Poor ☐ Unusable ☐
13. TABULATION
   a. If for irrigation, the land proposed to be irrigated should be described in the following tabulation. Describe in the "Remarks" section, under Item 14, the means of conveying the water to the lands and the method of irrigation.

   (Give irrigable acreage in each legal subdivision. If proposed use is for additional supply for lands with a right from another source, indicate in the tabulation the priority or permit number, the source of supply and the name of the ditch or other well.)

   b. If not used for irrigation, show the area and point(s) of use and location of well in the tabulation below. Also describe the method of conveyance in the "Remarks" section under Item 14.

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TOTAL NUMBER OF ACRES TO BE IRRIGATED

Original Supply _________ acres
Additional Supply _________ acres

14. PLAT
   a. If the well is to be used for irrigation, industrial, miscellaneous or municipal use, show the location of the well on the plat below. For such uses, a plat certified by a licensed engineer or land surveyor is required to be submitted at the time the Proof of Appropriation and Beneficial Use of Ground Water is submitted.

   b. For other uses, accurately show the well location, point of use or uses and describe method of conveyance of water to points of use on plat and in "Remarks" section below. Make certain location on plat agrees with written description.

c. A separate map may be submitted if the information required cannot be shown on this plat.

REM \[ \text{REMARKS:} \]

Scale: 2" = 1 Mile

R. 65 W.  R. 65 W.
15. IF WELL IS TO BE ABANDONED, complete Items 1 through 8, Item 12 (Log of Well) and state reason for abandonment and details of the plugging below.

It is the responsibility of the owner to properly plug or fill in the well in order to prevent contamination of ground water and to cover or cap the well at ground level.

Under penalties of perjury, I declare that I have examined this form and to the best of my knowledge and belief it is true, correct and complete.

Signature of Owner or Authorized Agent

Date

Date of Receipt

Date of Priority

Date of Approval

for State Engineer
STATE OF WYOMING
OFFICE OF THE STATE ENGINEER

PROOF OF APPROPRIATION AND BENEFICIAL USE OF GROUND WATER

The owner is responsible for submitting Parts I and II of this form. Part III will be prepared by a State Engineer Representative at time of inspection.

PART I
WATER DIVISION 2
U.W. DISTRICT
STATEMENT OF CLAIM
PERMIT NO. U.W. 111113
WELL REGISTRATION
NAME OF WELL: State Well #1 0005

1. Name of Claimant(s): Lance Creek Water & Sewer District
2. Address: Box 26, Lance Creek, WY
   Zip Code: 82222
3. For What Purposes is Water Used? Use: Municipal
   Date First Used: 11/1/97
   Use: __________ Date First Used: __________
   Use: __________ Date First Used: __________

If use is for irrigation, give date irrigation was completed on all lands under this Permit:

PART II

For Irrigation, Industrial, Municipal and Miscellaneous Wells

A plat which has been certified by a licensed professional engineer or land surveyor shall be submitted to accompany this form. The plat shall be in accordance with Sec. 33-29-111 Wyoming Statutes 1977 or see Chapter V and VI, Manual of Regulations and Instructions issued by the State Engineer’s Office. (Minimum scale shall be 1” = 1 mile.) The map shall be prepared with waterproof black ink on tracing lines or an acceptable equivalent, and shall show on a suitable scale the legal subdivisions, the accurate location of the well or wells, storage facilities, if any, main canals, streams, highways and other important cultural features. Land ownership will be shown, if there is more than one owner under the permit.

IRRIGATION WELLS

Acreage irrigated under terms of this permit will be clearly shown with a distinctive pattern and a distinction clearly made between lands having an original supply and those provided a supplemental supply. Where use is for supplemental supply for lands with a right from another source, indicate the priority or permit number of the source, the source of supply and the name of the ditch, pipe line or other well. Conveyance system will be shown and described. Indicate method of irrigation being used.

INDUSTRIAL WELLS

In addition to the information outlined above, industrial users will locate and describe conveyance facilities to the point(s) of use, giving as accurately as possible the location of points of use. Permits for other sources of water must be identified.

MUNICIPAL WELLS

The plat will show the area of use and show and describe the means of conveyance of the water from the well to the connection with the distribution system for a municipal water system.

MISCELLANEOUS WELLS

(1) The linen plat for wells where the use is described as miscellaneous and where the yield flow of the well exceeds twenty-five (25) gallons per minute must show the area of use and describe and show the means of conveyance from the well to the distribution system and/or points of use.

(2) The plat for wells where the use is described as miscellaneous and where the yield or flow is twenty-five (25) gallons per minute or less may be a 7½ minute United States Geological Survey Quadrangle map in lieu of a linen tracing provided the U.S. Geological Survey Quadrangle map is in compliance with the following conditions:

(a) The entire United States Geological Survey quadrangle map must be submitted to the State Engineer’s Office.

(b) The scale on said quadrangle map must be one to twenty-four thousand.

(c) An identified section corner or quarter corner must be shown on said quadrangle map along with Section, Township and Range.

(d) The section in which the well is located and the section(s) where the area(s) or point(s) of use are located must be subdivided into forty (40) acre tracts and the well location and area(s) or point(s) of use clearly labeled and described.

(e) Said quadrangle map showing the well location and area(s) or point(s) of use must be certified by a professional engineer or land surveyor licensed to practice within the State of Wyoming.

SEE REVERSE SIDE
A "CERTIFICATE OF OWNERSHIP" FROM THE COUNTY CLERK’S OFFICE SHOWING OWNERSHIP OR CONTROL OF LAND(S) INVOLVED MUST ACCOMPANY THIS FORM.

Under penalty of perjury, I declare that I have examined this form and to the best of my knowledge and belief it is true, correct and complete.

[Signature]

Date: Dec 30, 1999

Date of Receipt: 1999
APPLICATION FOR PERMIT TO APPROPRIATE GROUND WATER

FOR OFFICE USE ONLY

NOTE: Do not fold this form. Use typewriter or print neatly with black ink. ALL ITEMS MUST BE COMPLETED BEFORE APPLICATION IS ACCEPTABLE.

Permit No. U.W. 111114

Temporary Filing No. U.W. 240R02

Name and Number of Well
State Well #2 0006

1. Name of applicant(s) 
Walter F. Kant, Lance Creek Utilities

2. Address of applicant(s)
Box 26, Lance Creek, Wyo. 82002

3. Name & address of agent to receive correspondence and notices
Walter F. Kant, Box 26, Lance Creek, Wyo. 82022

4. Use to which the water will be applied: Domestic [ ] Stock Watering [ ] Industrial [ ] Miscellaneous [X] (Describe completely and accurately) Water supply for Lance Creek Utilities

5. Location of the well: (NOTE: Quarter-quarter (40-acre subdivision) MUST be shown. EXAMPLE: NE1/4NW1/4 of Sec. 12, Township 14 North, Range 60 West.) Niobrara County, Nd 1/4 Nd 1/4 of Sec. 3 T. 34 N. R. 65 W. of the 6th P.M. (or W.R.M.), Wyoming. If located in a platted subdivision, also provide Lot , Block of the Subdivision (or Add'n) of

6. Mark the well location on the section grid to the right. LOCATION SHOWN IN ITEMS MUST AGREE WITH GRID. If the proposed well is for irrigation use, sketch and label all irrigation ditches and canals, stream, reservoirs and other wells. Indicate the point of use or lands to be irrigated from other sources.

7. Estimated depth of the well is 37.5 feet.

8. MAXIMUM quantity of water to be developed and beneficially used: 150 gallons per minute. NOTE: If for domestic or stock use, this application will be processed for a maximum of 25 gallons per minute. SPRINGS: Only springs flowing 25 gallons per minute or less, where the proposed use is domestic or stock watering, will be considered as ground water appropriations. After approval of this application, some type of artificial diversion must be constructed to qualify for a water right.

9. If use is not irrigation, mark the point(s) or area(s) of use in the tabulation below.

10. If for irrigation use:
a. Describe MAXIMUM acreage to be irrigated in each 40 acre subdivision in the tabulation below.
b. Land will be irrigated from this well only.

c. Land is irrigated from existing water right(s) with water from this well to be additional supply. Describe existing water right(s) under REMARKS.

Township
  Range Sec. NE1/4 NW1/4 SW1/4 SE1/4 NE1/4 NW1/4 SW1/4 SE1/4 NE1/4 NW1/4 SW1/4 SE1/4 NE1/4 NW1/4 SW1/4 SE1/4 TOTALS

   The water from this well is pumped into the Lance Creek Utilities pipeline with water from the State #1 U.W. 111113 to supply 2 horse and 6 stock tanks. The water from these wells will supply irrigation to 20 acres. The water will irrigate a portion of the south and west sides of the property. See attached sheet for locations of points of use.

SEE REVERSE SIDE
12. The well is to be constructed on land owned by
The granting of a permit does not constitute the granting of right of way. If any easement or right of way is necessary in connection with the application, it should be understood that the responsibility is the applicant's. A copy of the agreement should accompany this application, if the land is privately owned and the owner is not a co-applicant.

13. The water is to be used on land owned by
People in Lance Ck. Utilities
If landowner is not the applicant, a copy of the agreement relating to usage of appropriated water on the land should be submitted to this office. If the landowner is included as a co-applicant on the application, this procedure need not be followed.

REMARKS: This is a re-filing of Permit No. 44.773

Under penalties of perjury, I declare that I have examined this application and to the best of my knowledge and belief it is true, correct and complete.

Signature of Applicant or Authorized Agent

Date

THE LEGALLY REQUIRED FILING FEE MUST ACCOMPANY THIS APPLICATION

DOMESTIC AND/OR STOCK WATERING USES
$10.00

(Domestic use is defined as a single-family dwelling and the watering of lawns and gardens not exceeding one (1) acre)

IRRIGATION, MUNICIPAL, INDUSTRIAL, MISCELLANEOUS
$25.00

(MONITOR (For water level measurements or chemical quality sampling) NO FEE

IF WELL WILL SERVE MULTIPLE USES, SUBMIT ONLY ONE (THE HIGHER) FILING FEE.

THIS SECTION IS NOT TO BE FILLED IN BY APPLICANT

THE STATE OF WYOMING

vs.

STATE ENGINEER'S OFFICE

This instrument was received and filed for record on the 7th day of November, A.D. 1999, at 9:00 o'clock AM.

Permit No. U.W. 44.773

for State Engineer

THIS IS TO CERTIFY that I have examined the foregoing application and do hereby grant the same subject to the following limitations and conditions:

This application is approved subject to the condition that the proposed use shall not interfere with any existing rights to ground water from the same source of supply and is subject to regulation and correlation with surface water rights, if the ground and surface waters are interconnected. The use of water hereunder is subject to the further provisions of Chapter 169, Session Laws of Wyoming, 1957, and any subsequent amendments thereto.

Granting of a permit does not guarantee the right to have the water level or artesian pressure in the well maintained at any specific level. The well should be constructed to a depth adequate to allow for the maximum development and beneficial use of ground water in the source of supply.

If the well is a flowing artesian well, it shall be so constructed and equipped that the flow may be shut off when not in use, without loss of water into surface formations or at the surface.

FOR ADDITIONAL CONDITIONS AND LIMITATIONS SEE ATTACHED STATUS SHEET

Approval of this application may be considered as authorization to proceed with construction of the proposed well.

Construction of well will begin within one (1) year from date of approval. A Statement of Completion will be filed within thirty (30) days of completion of construction, including pump installation.

Completion of Beneficial use of water for the purposes specified in Item 4 of this application will be made by December 31, 1999. Application will be made by December 31, 1999.

The amount of appropriation shall be limited to the quantity to which permittee is entitled as determined at time of proof of application of water to beneficial use.

Witness my hand this 7th day of December, A.D. 1999.

GORDON W. FASSETT
State Engineer
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</table>

- **NE 1/4**: Stack tank
- **NW 1/4**: Stack tank
- **SE 1/4**: House + 2 steel tanks
- **SW 1/4**: House
- **Totals**: Stack tank, House, 2 houses

- **NE 1/4**: House
- **NW 1/4**: House, Stack tank
- **SE 1/4**: House
- **SW 1/4**: Office + change room
- **Totals**: Office, 2 houses + office, School, House, Restrooms and service station.
PERMIT NO. U.W. 111114
T.P. No. 20-8-145

PERMIT STATUS

Priority Date November 7, 1988 Approval Date Aug 3 1998

ADDITIONAL CONDITIONS AND LIMITATIONS:

1. A meter acceptable to the State Engineer is required to accurately measure the total quantity of water produced from this well.

2. An annual report shall be submitted to the State Engineer no later than February 15 of each year stating the total amount of water produced from this well each month during the previous January 1 to December 31, twelve (12) month period.

3. The report shall identify the well by name, location, permit number and shall identify the type of meter used for the measurement.

4. The report shall contain at least two (2) semi-annual measurements of the pumping water level in the well as measured after a minimum twenty-four (24) consecutive hours of pumping. The dates the measurements were obtained and the period of time the well was pumped prior to obtaining the measurements must be specified.

5. The report shall contain at least two (2) semi-annual measurements of the static water level in the well as measured twenty-four (24) consecutive hours after pumping has ceased. The dates the measurements were obtained and the period of time the well was "shut-in" prior to obtaining the measurements must be specified.

6. The State Engineer may, upon written request, waive all or any portion of these conditions and limitations.

[Signature] Date of Approval

GORDON W. FASSETT, State Engineer
PERMIT NO. U.W. 111114
F.P. No. U.W. 20-8-146

PERMIT STATUS

Priority Date November 7, 1988
Approval Date AUG 03 1998

July 28, 1998 -- All right, title and interest in and to this
application is assigned from Walter F. Kant, Lance Creek
Utilities to LANCE CREEK WATER AND SEWER DISTRICT, Box 26,
Lance Creek, WY 82222 per Assignment received July 28, 1998.
Assignment is filed in Miscellaneous Notices under Permit
No. U.W. ___________________.

November 7, 1988 - Statement of Completion in March 1946 received.

SEP 30 '99 NOTICE OF EXPIRATION OF TIME FOR COMPLETION OF BENEFICIAL USE MAILED OCT 06 1999

December 30, 1999 - Proof of Beneficial use on January 1, 1997 received.
STATE OF WYOMING  
OFFICE OF THE STATE ENGINEER  

IF WELL IS TO BE ABANDONED, SEE STATEMENT OF COMPLETION AND DESCRIPTION OF WELL 
ITEM 15, PAGE 4

NOTE: Do not fold this form. Use typewriter or print neatly with black ink.

PERMIT NO. U.W. 11  NAME OF WELL 0006 State Well # 2

1. NAME OF OWNER  
Walter E. Hent 1) Lance Creek Water + Sewer Dist  
Lance Creek, WY 82222  

2. ADDRESS  
Box 26 Lance Creek, WY 82222  
Cheyenne, WY 82002  

3. USE OF WATER:  
Domestic  Stock Watering  Irrigation  Municipal  Industrial  Miscellaneous  

4. LOCATION OF WELL:  
North  1/4  North  1/4 of Section 1, T 38N, R 65W, of the 6th P.M. (or W.R.M.),  
Wyoming, being specifically 330 feet from West line, 440 feet from North Line 
(Bearing and Distance)

5. TYPE OF CONSTRUCTION: Drilled  X  Rotary  Dug  Driven  Jetted  
Other  

6. CONSTRUCTION: Total Depth of Well 315  ft. Depth to Static Water Level 235  ft.  
a. Casing Schedule  New  Used  Drilled in early 1940's  
8 5/8 diameter from GL  ft. to 315  ft. Material  Gage  
Material  Gage  
Material  Gage 
b. Perforations: Type of perforator used  Not known  
Size of perforations  inches by  inches.  
Number of perforations and depths where perforated:  
perforations from  ft. to  ft.  
perforations from  ft. to  ft.  
c. Was well screen installed?  Yes  No  
Diameter:  slot size:  set from  feet to  feet.  
Diameter:  slot size:  set from  feet to  feet.  
d. Was well gravel packed?  Yes  No  Size of gravel  
e. Was surface casing used?  Yes  No  Was it cemented in place?  Yes  No  

7. NAME & ADDRESS OF DRILLER  
Whitey Hayes, (deceased)  Sheridan Wyoming  

8. DATE OF COMPLETION OF WELL (including pump installation)  
Early 1940's  March 1946  

9. PUMP INFORMATION: Manufacturer  Layne  Type Deep well turbine pump  
Source of power  Electricity  Horsepower 15 HP  Depth of Pump Setting 270  
Amount of Water Being Pumped 150 Gallons Per Minute. (For springs or flowing wells, see item 11.)

Permit No. U.W. 111114  Book No. 647  Page No. 65
10. PUMP TEST: Was a pump test made? Yes □ No □ We have no records

If so, by whom ____________________________________________ Address _________________________________
Yield: ___________ gal/min. with _________ foot drawdown after ________ hours.
Yield: ___________ gal/min. with _________ foot drawdown after ________ hours.

11. FLOWING WELL: Owner is responsible for control of flowing well.

If well yields artesian flow, yield is _______ gal/min. Surface pressure is _______ lb/sq. inch, or _______ feet of water.

The flow is controlled by: valve □ cap □ plug □

Does well leak around casing? Yes □ No □

12. LOG OF WELL: Total depth drilled ___________ feet.

Depth of completed well ___________ feet. Diameter of well 8-5/8 ______ inches.

Depth to first water bearing formation ___________ feet.

Depth to principal water bearing formation. Top ___________ feet to Bottom ___________ feet.

Ground Elevation, if known ___________
13. TABULATION

a. If for irrigation, the land proposed to be irrigated should be described in the following tabulation. Describe in the "Remarks" section, under Item 14, the means of conveying the water to the lands and the method of irrigation.

(Give irrigable acreage in each legal subdivision. If proposed use is for additional supply for lands with a right from another source, indicate in the tabulation the priority or permit number, the source of supply and the name of the ditch or other well.)

b. If not used for irrigation, show the area and point(s) of use and location of well in the tabulation below. Also describe the method of conveyance in the "Remarks" section under Item 14.

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<th>Range</th>
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TOTAL NUMBER OF ACRES TO BE IRRIGATED:

Original Supply: _________ acres
Additional Supply: _________ acres

14. PLAT

a. If the well is to be used for irrigation, industrial, miscellaneous or municipal use, show the location of the well on the plat below. For such uses, a plat certified by a licensed engineer or land surveyor is required to be submitted at the time of Appropriation and Beneficial Use of Ground Water is submitted.

b. If other uses, accurately show the well location, point of use or uses and describe method of conveyance of water to points of use on plat and in "Remarks" section below. Make certain location on plat agrees with written description.

c. A separate map may be submitted if the information required cannot be shown on this plat.

R. L5 W. R. L5 W. 

Scale: 2" = 1 Mile

REMARKS:

____________________________________________________

____________________________________________________

____________________________________________________

____________________________________________________
15. IF WELL IS TO BE ABANDONED, complete Items 1 through 8, Item 12 (Log of Well) and state reason for abandonment and details of the plugging below.

It is the responsibility of the owner to properly plug or fill in the well in order to prevent contamination of ground water and to cover or cap the well at ground level.

Under penalties of perjury, I declare that I have examined this form and to the best of my knowledge and belief it is true, correct and complete.

[Signature]

Date

Date

Date

Date
STATE OF WYOMING
OFFICE OF THE STATE ENGINEER

PROOF OF APPROPRIATION AND BENEFICIAL USE OF GROUND WATER

The owner is responsible for submitting Parts I and II of this form. Part III will be prepared by a State Engineer Representative at time of inspection.

PART I

WATER DIVISION 2

STATEMENT OF CLAIM

PERMIT NO. U.W. 111114

WELL REGISTRATION

NAME OF WELL State Well #2 0006

1. Name of Claimant(s) Lance Creek Water & Sewer District

2. Address Box 26 Lance Creek, WY Zip Code 82222

3. For What Purpose(s) is Water Used? Use: Municipal

   Date First Used: 11/01/97

   Use: Municipal

   Date First Used: 11/01/97

   Use: Municipal

   Date First Used: 11/01/97

If use is for irrigation, give date irrigation was completed on all lands under this Permit:

PART II

For Irrigation, Industrial, Municipal and Miscellaneous Wells

A plat which has been certified by a licensed professional engineer or land surveyor shall be submitted to accompany this form. The plat shall be in accordance with Sec. 32-29-111 Wyoming Statutes 1977 or see Chapter V and VI, Manual of Regulations and Instructions issued by the State Engineer's Office. (Minimum scale shall be 2" = 1 mile.) The map shall be prepared with waterproof black ink on tracing linen or an acceptable equivalent and shall show on a suitable scale the legal subdivisions, the accurate location of the well or wells, storage facilities, if any, main canals, streams, highways and other important cultural features. Land ownership will be shown, if there is more than one owner under the permit.

IRRIGATION WELLS

Acreage irrigated under terms of this permit will be clearly shown with a distinctive pattern and a distinction clearly made between lands having an original supply, and those provided a supplemental supply. Where use is for supplemental supply for lands with a right from another source, indicate the priority or permit number of the source, the source of supply and the name of the ditch, pipe line or other well. Conveyance system will be shown and described. Indicate method of irrigation being used.

INDUSTRIAL WELLS

In addition to the information outlined above, industrial users will locate and describe conveyance facilities to the point(s) of use, giving as accurately as possible the location of points of use. Permits for other sources of water must be identified.

MUNICIPAL WELLS

The plat will show the area of use and show and describe the means of conveyance of water from the well to the connection with the distribution system for a municipal water system.

MISCELLANEOUS WELLS

(1) The linear plat for wells where the use is described as miscellaneous and where the yield flow of the well exceeds twenty-five (25) gallons per minute must show the area of use and describe and show the means of conveyance from the well to the distribution system and/or points of use.

(2) The plat for wells where the use is described as miscellaneous and where the yield flow is twenty-five (25) gallons per minute or less may be a 7½ minute United States Geological Survey Quadrangle map in lieu of a linear tracing provided the U.S. Geological Survey Quadrangle map is in compliance with the following conditions:

(a) The entire United State Geological Survey quadrangle map must be submitted to the State Engineer's Office.

(b) The scale on said quadrangle map must be one to twenty-four thousand.

(c) An identified section corner or quarter corner must be shown on said quadrangle map along with Section, Township and Range.

(d) The section in which the well is located and the section(s) where the area(s) or point(s) of use are located must be subdivided into forty (40) acre tracts and the well location and area(s) or point(s) of use clearly labeled and described.

(e) Said quadrangle map showing the well location and area(s) or point(s) of use must be certified by a professional engineer or land surveyor licensed to practice within the State of Wyoming.

SEE REVERSE SIDE
A "CERTIFICATE OF OWNERSHIP" FROM THE COUNTY CLERK'S OFFICE SHOWING OWNERSHIP OR CONTROL OF LAND(S) INVOLVED MUST ACCOMPANY THIS FORM.

Under penalties of perjury, I declare that I have examined this form and to the best of my knowledge and belief it is true, correct and complete.

[Signature]

Date: Dec 27, 1999

Date of Receipt: Dec 30, 1999
The following attachments to Wyoming Groundwater’s Technical Report: Lance Creek Water District State Wellfield Condition and Water Quality, Lance Creek Water Supply, Level I, Study; WG JN 09-28 are provided in the project notebook:

- Attachment A – Downhole Camera Survey Logs
- Attachment B – Pump Test Data and Plots
- Attachment C – Geophysical Logs and Geophysical Log Analysis
- Attachment D – Water Quality Laboratory Data and Supplemental Information
- Attachment E – Blending Calculation Scenarios
To: Murray Schroeder, P.E., WWC Engineering  
From: Chris Moody, P.G., Wyoming Groundwater  
Date: June 21, 2010  
Re: Technical Report: Lance Creek Water District State Wellfield Condition and Water Quality, Lance Creek Water Supply, Level I, Study; WG JN 09-28

This technical report presents the results of field work at the State Wellfield that was performed by Wyoming Groundwater as part of the Lance Creek Water Supply, Level I, Study. Options for wellfield modification/improvement are provided to WWC Engineering that attempt to address water quality issues at the wellfield. The preferred option(s) for addressing water quality issues will be identified by WWC Engineering in consideration of the overall water system Master Plan, and may or may not involve modification of wells or wellfield operation as described in this technical report.

At this preliminary stage of Master Plan development, Wyoming Groundwater identified three options that deserve consideration.

1. Low flow sampling at State No. 1  
2. Plug the Fuson Shale interval in State No. 1  
3. If warranted, design and drill new wells at State No. 1 and State No. 2 using data obtained from tests performed after plugging the Fuson Shale in State No. 1.

Introduction

The arsenic concentration from the Lance Creek Water District’s (District) groundwater supply exceeds the maximum contaminant level (MCL) of 0.010 milligrams per liter (mg/L) established by the Environmental Protection Agency (EPA). A primary objective of the Lance Creek Water Supply, Level I, Study is to identify and evaluate the District’s options regarding the modification of the water supply and/or water treatment for arsenic.

The District obtains water from the State No. 1 and State No. 2 wells (State Wellfield) located 5.7 miles south of Lance Creek, in the W ¼ of the NW ¼ of Section 1, T34N, R65W. The State wells were installed in 1946 and have provided a reliable water supply for Lance Creek. Additional detail on water supply development at Lance Creek and the characteristics of the State Wellfield are provided in WWC (1996).

The Level I study approach was to evaluate the condition, geology, and water quality at the State Wellfield before identifying options to address the arsenic problem. Water supply information will provide a foundation for the development of effective
water supply modification/treatment. Wyoming Groundwater performed or directed the performance of the following tasks as described in this technical report:

- Describe the geology in the vicinity of the State Wellfield
- Downhole camera survey of State No. 1 and State No. 2
- Geophysical logging of State No. 1 and State No. 2
- Pump tests at State No. 1 and State No. 2
- Water quality sampling
- Analysis of water quality data from State No. 1, State No. 2, and selected water wells in the vicinity of the State Wellfield

Condition of the State Wellfield

The physical condition of the State No. 1 and State No. 2 wells was evaluated in the fall of 2009 using a downhole camera survey performed by Sargent Drilling of Broken Bow, Nebraska. The pumps were pulled and a downhole camera with downview and sideview capabilities was run to total depth. Attachment A contains a downhole camera survey observation log and summary at each well. Well survey videos are on DVDs that have been provided to WWC Engineering and Brad Kant, Lance Creek system operator.

State No. 1

Steel casing (8.62 inch outer-diameter, 8.0 inch inner-diameter) exists from 2.6 feet below ground surface to the total depth of the well at 249 feet. Vertical torch-cut slots occur from about 124 to 246 feet. The slots are encrusted to some degree with scale, with relatively minor slot encrustation from 144 to 222 feet. There were no observable compromises in the casing. Sideview observations through the torch-cut slots reveal no filter/gravel pack in the annual space between the casing and drilled hole.

Cloudy water was observed from 124 to 142 feet which suggests that this interval of slotted casing may not be adjacent to a productive part of the aquifer (i.e., poor flow into or through the well) or that the slots in this interval are occluded by encrustation. The pump test conducted at State No. 1 indicates that dynamic water level fluctuations from pumping occur over the interval of 118 to 145 feet. The cloudy water may be a result of slot occlusion caused, in part, by the cycling of wet/dry conditions in the casing.

During the downhole camera survey, suspended particles could be seen moving upward and through casing slots. Apparently, groundwater was flowing through the well in response to the hydraulic gradients caused by the pumping of State No. 2 (i.e., State No. 2 was on during the downhole camera survey at State No. 1).

State No. 1 was originally drilled to a depth of 265 feet which indicates that the bottom 16 feet of the well has filled in with sediment and scale. Given 63 years of service, the State No. 1 well casing appears to be in reasonable condition and the torch-cut slots have experienced only moderate encrustation.
In the course of pulling and reinstalling the pump to facilitate the downhole camera and geophysical surveys, the District made the following improvements to State No. 1:

- Replaced the top 4 sections of drop pipe (i.e., 84 feet)
- Installed a drain-back valve in the drop pipe
- Installed 1-inch poly tubing. The bottom of the tubing is set just above the pump and the top is inserted into the access hole of the sanitary seal. The tubing will allow unobstructed measurement of water level in the well.
- Installed new sanitary seal on top of casing
- Top of pump is set 212 feet below top of casing (214 feet below floor)

State No. 2

Steel casing (8.62 inch outer diameter, 8.0 inch inner diameter) exists from 2.4 feet below ground surface to 277 feet where the casing diameter is reduced from 277 to the total depth of the well at 287 feet. Vertical torch-cut slots occur from 89 to 134 feet and from 157 to 286 feet. A section of unslotted casing occurs from 134 to 157 feet. Many of the slots are heavily encrusted and are partially or perhaps fully occluded. Compared to State No. 1, the slots in State No. 2 are noticeably more occluded by encrustation, with heavy encrustation occurring even in the lower part of the well from 197 to 276 feet (i.e., below the interval of 81 to 121 feet where wet/dry conditions are caused by pumping). There is a short split in the casing at about 164 feet. Sideview observations through the torch-cut slots reveal no filter/gravel pack in the annual space between the casing and drilled hole.

State No. 2 was originally drilled to a depth of 287 feet and was reportedly deepened to 384 feet in September 1946. Based on the current total depth of 287 feet it is suspected that the interval from 287 to 384 feet was completed as open hole that has since caved-in and filled with sediment. Given the amount of encrustation on the casing interior it is difficult to assess the condition of the casing and it is likely that the efficiency of the well is reduced by the occlusion of slots.

In the course of pulling and reinstalling the pump to facilitate the downhole camera and geophysical surveys, the District made the following improvements to State No. 2:

- Installed new pump and pump wire
- Top of pump is set 231 feet below top of casing (234 feet below floor)
- Installed a 55 gpm choke in the drop pipe
- Installed 1-inch poly tubing. The bottom of the tubing is set about 3 feet above the top of the pump and the top is inserted into the access hole of the sanitary seal. The tubing will allow unobstructed measurement of water level in the well.
- Installed new sanitary seal on top of casing
The downhole camera surveys reveal that there are no observable structural compromises of the steel casing in the State No. 1 and State No. 2 wells. Encrustation, rather than corrosion, appears to be the dominant process acting upon the interior of the steel casing. In State No. 2, the occlusion of torch-cut slots is severe enough to suspect a reduction in well performance; however, at the low pump rate of about 50 gallons per minutes (gpm), the well continues to perform adequately for District purposes. Regardless of the qualitative visual observations, given the age of both wells and the uncertain structural integrity of the casing, aggressive well rehabilitation efforts have a risk of causing casing damage and collapse.

State No. 3

State No. 3 is located 0.25 mile south of State No. 1 and was drilled and cased in 1946 to a depth of 290 feet. The well was never included in the Lance Creek water supply system. Ownership of State No. 3 has recently been transferred to Mr. Harold Miller who uses the well for stock watering.

Performance of the State Wellfield

The District has no pump test data from either of the State wells, in large part because the wells have been providing a reliable and adequate supply of water to Lance Creek since 1946. As part of the Level I study, a combination step-test and 24-hour constant rate pump test was performed at State No. 1 and State No. 2. The purpose of the pump tests was to define the basic hydraulics of each well; namely, the magnitude of drawdown in each well at different pump rates (i.e., specific capacity of the well) and at the pump rate of maximum operation. Time-drawdown data were not used to define aquifer parameters because the stratigraphy of the producing zones in each well is not known precisely and the encrustation of the torch-cut slots may impede flow into a well (i.e., poor well efficiency).

Pump tests at State No. 1 and State No. 2 were conducted in a similar manner as listed below.

• 3 to 4 steps of 100 minute duration at progressively higher pump rate
• final “step” pump rate was maintained constant for 24 hours
• pump test water was discharged to the ground surface outside the wellhouse
• water level measurements were obtained manually using a sounder
• pump rate was adjusted using a gate valve and was estimated periodically using a bucket of known volume and a stopwatch
• water quality field parameters (pH, conductivity, and temperature) were measured periodically

Attachment B contains pump test field data, observations, and reference point elevations.
**State No. 1**

Figure 1 shows the plot of time-drawdown data from the pump test at State No. 1. At the end of 24 hours of continuous pumping at approximately 80 gpm, the measured water level decline (drawdown) was 25.5 feet. The specific capacity of State No. 1 is approximately 3.1 gpm/foot of drawdown. During normal pump operation at 80 gpm, there is approximately 71 feet of water above the pump. There are no apparent hydraulic problems with State No. 1 such that the well is easily capable of producing 80 gpm under current well design and conditions.

**State No. 2**

Figure 2 shows the plot of time-drawdown data from the pump test at State No. 2. At the end of 24 hours of continuous pumping at approximately 48 gpm, the measured drawdown was 38.5 feet. The specific capacity of State No. 2 is approximately 1.2 gpm/foot of drawdown. During normal pump operation at 48 gpm, there is approximately 113 feet of water above the pump. Despite the apparent heavy encrustation of the torch-cut slots, State No. 2 is easily capable of producing 48 gpm under current well design and conditions.

**State Wellfield Operation**

The State No. 1 and No. 2 wells can easily produce the maximum design pump capacity of approximately 80 and 50 gpm, respectively, with a combined capacity of about 120 gpm. State No. 1 is the more productive well as indicated by a specific capacity value that is approximately 2.5 times greater than the specific capacity of State No. 2. District records indicate that State No. 1 has always been more productive than State No. 2. Historically, the District uses State No. 1 as the primary supply well and uses State No. 2 only during periods of high demand and when State No. 1 is inoperable due to pump failure or lightening strikes. This operational strategy is appropriate given the hydraulics and pump capacity at each well.

**Geology in the Vicinity of the State Wellfield**

Figure 3 shows the surface geology, stratigraphy, and data obtained from local oil and water wells used in this study to identify formations in the subsurface. In the vicinity of the State Wellfield, the Tertiary White River Group (White River) overlies the Lower Cretaceous-age Inyan Kara Group (Inyan Kara). The dominant formation exposed at the surface is the White River, but there is a sizeable exposure of Inyan Kara approximately 0.4 mile north-northeast of State No. 2. General information on the stratigraphy in the Lance Creek area was obtained from Johnson (1962) and Whitcomb (1965).

The White River Group is comprised of the Brule and Chadron formations and consists primarily of pinkish-gray siltstone, minor variegated claystone, and local coarse-grained channel deposits. In the elevated topography south and southeast of the State
Wellfield, the White River is overlain by the fine- to medium-grained cross-bedded sandstones of the Arikaree Formation.

In the Oligocene, the White River was deposited over a paleo-topography dominated by exposures of the Inyan Kara Group. The relief of the paleo-topography and the unconformity between the White River and the Inyan Kara, produce substantial variation in the thickness of the White River over short distances. In the vicinity of the State Wellfield, the thickness of the White River ranges from 0 to 700 feet. The rapid change in thickness over short distances is illustrated between water well WYO 270 NI #1 in Section 35 (over 500 feet thick) and the Inyan Kara outcrop in Section 36 (White River absent). Between State No. 1 and State No. 2, the elevation of the base of the White River is nearly identical at 4643 feet amsl (i.e., flat erosional surface) and the thickness of the White River is 78 to 116 feet.

The Inyan Kara Group is comprised of three distinct formations from top to bottom: Dakota Sandstone (aka Fall River Sandstone), Fuson Shale, and the Lakota Sandstone. The Inyan Kara is equivalent to the more widespread and commonly known Cloverly Formation. The Dakota is comprised of fine-grained sandstones with minor siltstone and shale, and has a thickness ranging from 35 to 75 feet (Johnson, 1962). The Fuson Shale is comprised of claystone and shale, and has a thickness ranging from 25 to 50 feet. The Fuson is often considered to be a member of the Lakota Sandstone. The Lakota is comprised of coarse grained cross-bedded sandstone and conglomerate, and has a thickness of about 170 feet.

Brad Kant, Lance Creek system operator, provided geophysical logs (gamma, spontaneous potential, resistivity, and conductivity) from an oil well, Atlantic – State #1, located 0.7 mile west of State No. 1. The geophysical logs have detailed annotation of formation tops and stratigraphy as interpreted by a local petroleum geologist, J. Stafford. These logs provided valuable information on subsurface formations and guided the interpretation of geophysical logs from other wells. Mr. Stafford used an overall thickness of 260 feet for the Inyan Kara which is used herein as the most authoritative source of group thickness in the vicinity of the State Wellfield.

The Inyan Kara outcrop northeast of State No. 2 consists of well-cemented, slabby, fine-grained green, tan, brown, and yellow sandstone. The sandstones often “sparkle” which is characteristic of the Cloverly Formation/Inyan Kara.

Underlying the Inyan Kara is the Jurassic-age Morrison Formation. Using actual and estimated elevations of the contact between the Inyan Kara and the Morrison Formation at Atlantic – State #1, State No. 2, and the Inyan Kara outcrop (Figure 3), it can be shown that the Lower Cretaceous formations dip to the west-southwest at about 3 degrees.
Hydrogeology at the State Wellfield

The primary objective in describing the hydrogeology at the State No. 1 and State No. 2 wells is to determine the stratigraphic source of groundwater from each well and to use this information to explain water quality. The hydrogeology at each well was defined using information from the downhole camera surveys, pump tests, and geophysical logs. A critical element in determining the stratigraphy at each well was the correlation of a high gamma zone that occurs in State No. 2 and Atlantic – State #1 and the interpretation of the Fuson Shale interval in the geophysical logs of State No. 1 and State No. 2.

Figure 4 is a graphic representation of well completion and hydrogeologic data obtained at State No. 1 and State No. 2. Attachment C contains the geophysical logs (natural gamma and neutron) run in the cased State No. 1 and State No. 2, and a detailed analysis and interpretation of the logs. The following sections summarize pertinent information at each well as it relates to water quality and water production.

State No. 1 Hydrogeology

State No. 1 has a total depth of 249 feet and is open to (i.e., torch-cut slots in steel casing) the Dakota, Fuson, and the upper 19 feet of the Lakota. Based on the neutron log, the Dakota is probably the primary producing interval with a possible contribution from the Fuson. State No. 1 does not fully penetrate the Inyan Kara and does not penetrate the high gamma zone in the middle part of the Lakota. The estimated depth to the contact between the Inyan Kara and the underlying Morrison Formation is approximately 394 feet.

The Inyan Kara Group is fully saturated whereas the overlying White River Group is unsaturated. Water levels in State No. 1 are representative of head in the Inyan Kara Group. Table 1 lists water level data from the State No. 1. Assuming that water level measurements in 1952 and 1959 were under static (i.e., non-pumping) conditions, it appears that the head in the Inyan Kara aquifer has not declined as a result of pumping over the last 57 years. Similar static water level elevations at State No. 1 and State No. 2 measured in the fall of 2009 indicate that the State wells are completed in the same aquifer and are hydraulically connected.

State No. 2 Hydrogeology

State No. 2 has a total depth of 287 feet and is open to the Dakota, Fuson, and 127 feet of the Lakota. Based on the neutron log, productive intervals occur in the Dakota and Lakota, whereas the Fuson may not be productive. The lack of torch-cut slots in the casing across the majority of the Fuson may support the idea of poor production in the Fuson. State No. 2 does not fully penetrate the Inyan Kara but does penetrate a high gamma zone in the middle part of Lakota. The high gamma zone in State No. 2 at 210 to 217 feet is probably the same 8-foot thick high gamma zone observed in the middle part of the Lakota in the Atlantic – State #1 oil well to the west.
The estimated depth to the contact between the Inyan Kara and the underlying Morrison Formation is approximately 334 feet. State No. 2 was reportedly deepened from 287 to 384 feet in September 1946, but there are no drilling logs available that describe the lithology encountered during deepening. The open (?) hole from 287 to 384 feet has caved-in or filled with sediment.

The Inyan Kara Group is fully saturated whereas the overlying White River Group is unsaturated. Water levels in State No. 2 are representative of head in the Inyan Kara Group. Table 1 lists water level data from State No. 2. Assuming that the water level measurement 1959 was during static conditions, it appears that the head in the Inyan Kara aquifer has not declined as a result of pumping over the last 50 years. Similar static water level elevations at State No. 1 and State No. 2 measured in the fall of 2009 indicate that the State wells are completed in the same aquifer and are hydraulically connected.

**Water Quality at the State Wellfield**

Arsenic concentrations from the District water system exceed the 0.010 mg/L drinking water standard established by the EPA. Arsenic concentrations from eleven water samples collected during August 2004 to December 2009 range from 0.014 to 0.037 mg/L with a mean concentration of 0.024 mg/L. These water samples are representative of water from State No. 1. The absence of water quality data from State No. 2 and the incomplete analysis of inorganic water quality parameters at both wells provided the justification to perform a more detailed water quality sampling and analysis program at both wells.

The water quality sampling and analysis program consisted of a review of the District’s existing inorganic water quality data and two rounds of water sampling from State No. 1 and State No. 2. The first round of sampling occurred on August 5, 2009, and involved the collection of water samples from State No. 1, State No. 2, and State No. 3. The second round of sampling involved the collection of water samples from State No. 1 and State No. 2 at the end of the pump tests conducted on November 30 - December 1, 2009, and September 24 - 25, 2009, respectively. Water quality parameters analyzed include primary cations/anions, selected trace metals (arsenic, selenium, fluoride, iron, and uranium), radionuclides, and the field parameters pH, conductivity, temperature, and dissolved oxygen. Samples were analyzed by Energy Laboratories of Casper, Wyoming.

Water quality data are listed in Table 2. Attachment D contains laboratory data sheets and supplementary water quality information.

**State No. 1 Water Quality**

Groundwater from State No. 1 is classified as a sodium-bicarbonate type water with a total dissolved solids concentration of approximately 310 mg/L. The water quality is excellent but has a single flaw – an arsenic concentration of about 0.024 mg/L that exceeds the EPA drinking water standard of 0.010 mg/L. The source of water to State
No. 1 is the Inyan Kara Group aquifer, specifically, the Dakota and Fuson Shale formations (Figure 4).

Arsenic can be derived from the weathering of metallic ores (e.g., erythrite, arsenopyrite) and is common in water from thermal springs (Hem, 1970). The Dakota is composed primarily of sandstone with occasional thin beds of siltstone and shale. The driller’s log states simply “water sand” throughout the Dakota interval. The mineralogy of the Fuson is more diverse, being composed primarily of shale. The driller’s log states “sandy shale and brown sand” throughout the Fuson interval. Arsenic is more likely to be present in the organic rich/fine-grained shales that may have been deposited under reducing conditions than the organic-poor Dakota/Lakota sandstones that may have been deposited under oxidizing conditions. Based on primary mineralogy, a reasonable hypothesis is that the arsenic is more likely derived from the Fuson than the Dakota/Lakota.

**State No. 2 Water Quality**

Groundwater from State No. 2 is classified as a sodium-bicarbonate type water with a total dissolved solids concentration of approximately 336 mg/L. The water quality is excellent and as two distinctive characteristics: a low arsenic concentration of 0.003 mg/L, and gross alpha and radium 226 concentrations that exceed the EPA drinking water standards (Table 2). The source of water to State No. 2 is the Inyan Kara Group aquifer; specifically, the Dakota and Lakota with the Fuson playing a minor role in supplying water to the well (Figure 4).

Although the basic cation/anion water chemistry from State No. 1 and State No. 2 is similar, there is a subtle difference worth noting. As shown in a Piper (trilinear) diagram presented in Attachment D, water from State No. 2 has a noticeably higher relative proportion of calcium and magnesium, and a lower relative proportion of sodium compared to water from State No. 1. This subtle difference may be explained by the observation that State No. 1 obtains water primarily from the Dakota and Fuson, whereas State No. 2 obtains water primarily from the Dakota and Lakota.

Gross alpha and radium 226 are by-products of the decay of uranium 238, uranium 235, and thorium 232. The decay series of these radionuclides also emit gamma radiation with the more common source of natural gamma radiation being an isotope of potassium. Although natural gamma is not a direct indicator of the source of gross alpha and radium 226 (alpha emitter), the high gamma zone identified in the Lakota from State No. 2 is indicative of the presence of radioactive elements and is highly likely to be the source of the high gross alpha and radium 226. This supposition is supported by the low levels of gross alpha, uranium, and radium 226 from State No. 1 which did not penetrate the high gamma zone in the Lakota.

As discussed previously, the source of arsenic in State No. 1 may be the Fuson Shale. At State No. 2, the neutron log indicates low porosity in the Fuson and the casing does not have torch-cut slots adjacent to the Fuson. These observations suggest that the
low arsenic concentration in State No. 2 may be because the Fuson does not contribute a significant quantity of water to the well and that the sandstones of the Dakota and Lakota are not the source of arsenic.

**Preliminary Water Quality Compliance Analysis**

With respect to compliance with primary drinking water standards, the water quality sampling at the State Wellfield revealed the following:

- State No. 1 has arsenic concentrations that exceed the drinking water standard, and gross alpha and radium 226 concentrations that are less than drinking water standards.
- State No. 2 has arsenic concentrations that are less than the drinking water standard, and gross alpha and radium 226 concentrations that are at or exceed drinking water standards.

Instead of one compliance issue - arsenic; the District has three potential compliance issues – arsenic, gross alpha, and radium 226 + 228 depending on which well is being pumped. Given the drinking water standard compliance/noncompliance relationship of these parameters at each well, a logical first step in the analysis is to see if the blending of water from the two wells can achieve compliance with arsenic, gross alpha, and radium 226 + 228 drinking water standards.

Concerns regarding gross alpha can be alleviated by blending because the adjusted gross alpha value at State No. 2 is at or below the MCL and the adjusted gross alpha value at State No. 1 is very low. Consequently, any blending of water from State No. 2 and State No. 1 will achieve compliance and, consequently, gross alpha will not be part of the compliance analysis that follows.

A mass balance approach was used to determine the concentration of arsenic and radium 226 + 228 that would result by blending different proportions of water from State No. 1 and State No. 2. The analysis does not account for chemical reactions that may occur as a result of mixing. Because the chemistry of the two waters is so similar, it is unlikely that significant chemical changes will occur during mixing.

Table 3 lists the resulting concentration of arsenic and radium 226 + 228 when water from State No. 1 and State No. 2 is blended. Input concentrations for arsenic, radium 226, and radium 228 at each well are discussed in Table 3. To comply with arsenic standards, blending of water from State No. 1 and State No. 2 must be in a proportion of 1:2, respectively. For example, State No. 1 pumped at 25 gpm and State No. 2 pumped at 50 gpm will produce a blended arsenic concentration of 0.010 mg/L. To comply with radium 226 + 228 standards, blending of water from State No. 1 and State No. 2 must be in a proportion of 1.07 : 1. As shown in Table 3, when State No. 1 and State No. 2 are pumped at normal operational rates (78 and 50 gpm, respectively), the blended radium 226 + 228 concentration of 4.4 pCi/L is below the drinking water
standard of 5 pCi/L. Attachment E presents additional tables that summarize the result of various blending scenarios at State No. 1 and State No. 2.

Two important observations can be made from the blending analysis. First, there is no combination of blended water from State No. 1 and State No. 2 that achieves compliance with both arsenic and radium $^{226} + ^{228}$ drinking water standards. Second, achieving arsenic compliance by blending significantly reduces the pump rate from State No. 1 and the total pumping capacity of the State Wellfield. Arsenic compliance by blending reduces the total pump rate from the wellfield to about 75 gpm whereas radium $^{226} + ^{228}$ compliance by blending does not reduce the total pump rate (i.e., about 120 gpm) from the wellfield.

Arsenic and radium $^{226} + ^{228}$ concentrations predicted by the blending analyses should be verified by the laboratory analysis of blended samples.

**Options to Achieve Water Quality Compliance**

The following section identifies options that may achieve compliance with drinking water standards. The options involve modifications to the water supply via structural or operational (e.g., blending) modification to the State No. 1 and State No. 2 wells. Water treatment options are not discussed.

**Existing State No. 1 Well: Low Flow Sampling**

- Pump the well at rates of 30 and 60 gpm and collect water samples to determine if the arsenic concentration declines as a result of lower pump rates.
- If concentration declines are observed, perform blending calculations using new input values for arsenic and pump rate for State No. 1.
- Low cost empirical effort to modify arsenic concentration.
- Although the pump is set immediately adjacent to the Fuson Shale, there is no hydraulic justification to pull the pump up 35 feet into the Dakota Sandstone interval.

**Existing State No. 1 Well: Plug Fuson Shale Interval**

- Squeeze thin cement grout into the annular space of the Lakota and Fuson interval (i.e., 195 to 249 feet) to plug the Fuson Shale that may be source of arsenic. Torch-cut slots are not heavily encrusted so cement is likely to flow through the slots and into the annular space. After plugging operations, State No. 1 will be open only to the Dakota.
- Perform post-plugging pump test and water sampling. It is probable that there will be a reduction in the specific capacity of the well as a result of plugging off the Lakota and Fuson.
- Modified State No. 1 will need to provide at least 55 gpm to achieve radium $^{226} + ^{228}$ compliance via blending with State No. 2.
• Modified State No. 1 pumping at 55 gpm will need to provide an arsenic concentration of 0.017 mg/L or less to achieve arsenic compliance via blending with an unmodified State No. 2 pumping at 50 gpm.
• Risk of casing damage and collapse during plugging operations.
• If warranted, use information obtained from plugging, pump testing, and sampling to design and install a new offset well.

Existing State No. 2 Well: Plug Lakota Below and in High Gamma Zone

• Squeeze thin cement grout into the annular space of the Lakota below and in the high gamma zone (i.e., 205 to 287 feet). Potential problem is that torch-cut slots are heavily encrusted and cement may not flow easily through the slots and into the annular space.
• Prior to plugging, consider “brushing” in interval of 205 to 287 feet to knock off encrustation and to open up the slots.
• Perform post-plugging pump test and water sampling. It is probable that there will be a reduction in the specific capacity of the well as a result of plugging a portion of the Lakota.
• Modified State No. 2 pumping at 50 gpm will need to provide a radium 226 + 228 concentration of 5.8 pCi/L or less to achieve radium 226 + 228 compliance via blending with an unmodified State No. 1 pumping at 25 gpm.
• Risk of casing damage and collapse during plugging operations.
• If warranted, use information obtained from plugging, pump testing, and sampling to design and install a new offset well.

Drill New Well to Replace State No. 1

• Install a new well adjacent to State No. 1 completed only in the Dakota. Data compiled during this field study suggest that the Dakota may have low concentrations of arsenic and radium 226 + 228.
• New well will have to produce at least 55 gpm to comply with radium 226 + 228 standards when blended with water from State No. 2 (if new well at State No. 2 is not installed).
• New well must have to have an arsenic concentration of 0.017 mg/L or less to allow arsenic compliance by blending with State No. 2, and an arsenic concentration of less than 0.010 mg/L to be operated alone.
• Open interval will be about 140 to 190 feet. Total depth of well about 195 feet.
• If arsenic concentration is less than 0.010 mg/L, State No. 1 can be operated during normal demands periods and radium compliance can be achieved when State No. 1 and State No. 2 are run together (blended) during periods of high demand.
• New well constructed to modern public water supply standards provide enhanced water system reliability.
Drill New Well to Replace State No. 2

- Install a new well adjacent to State No. 2 that is completed only in the lower part of the Lakota (i.e., below the high gamma zone) or in the entire Lakota with the annular space in the high gamma zone properly sealed off.
- New well will have to produce at least 50 gpm with a reduced radium 226 concentration of 5.8 pCi/L.
- New well likely to comply with both arsenic and radium 226 + 228 standards.
- Open interval will be about 175 to 200 feet and/or 227 to 334 feet. Total depth of well about 334 feet.
- New well constructed to modern public water supply standards provide enhanced water system reliability.

Option Recommendations

Based on the analysis performed, Wyoming Groundwater provides the following option recommendations, in sequence of performance, for WWC Engineering to consider that address non-treatment compliance with arsenic and radium 226 + 228.

1. Low flow sampling at State No. 1 to determine if arsenic concentrations can be reduced sufficiently under low flow operation.

2. Plug the Fuson Shale interval in State No. 1 to determine if the Fuson Shale is the source of arsenic. Reinstall pump and conduct a pump test to determine the specific capacity of the well and allow sampling of the arsenic concentration in the Dakota. The District should be prepared to drill a new offset well at State No. 1 in the event that the well is damaged during plugging or that plugging the Fuson causes an unacceptable reduction in well production.

3. Revisit the design of new offset wells at State No. 1 and State No. 2 using water quality and pump test data obtained after plugging the Fuson Shale in State No. 1.

References Cited


Attachments

A - Downhole Camera Survey Logs
B - Pump Test Data and Plots
C - Geophysical Logs and Geophysical Log Analysis
D - Water Quality Laboratory Data and Supplemental Information
E - Blending Calculation Scenarios
### Table 1: Water Level Data at State No. 1 and State No. 2; Lance Creek Water Supply, Level I, Study

<table>
<thead>
<tr>
<th>Well</th>
<th>Ground Elevation, ft</th>
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Table 2: Water Quality Data from the State Wells, Inyan Kara Aquifer; Lance Creek Water Supply, Level I, Study
Wyoming Groundwater
Updated: March 8, 2010

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Adjusted Gross Alpha = Gross Alpha - Uranium, units in pCi/L
Adjusted Gross Alpha used for regulatory compliance of drinking water standards
Bold values exceed drinking water MCL
*: Sample collected on 9/20/1989
Table 3: Blending Calculations for State No. 1 and State No. 2; Lance Creek Water Supply, Level I, Study

Update: March 7, 2010

Open valve pumping rates:
- State No. 1 = 78 gpm
- State No. 2 = 50 gpm

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<td>gals/min</td>
<td>mg/L As</td>
<td>gals/min</td>
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<td>25</td>
<td>94.62528388</td>
<td>0.003</td>
<td>189.2505678</td>
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<td></td>
<td>0.000333683</td>
<td>0.031574801</td>
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<th>Radium 226 + 228 Blending</th>
<th>Solution State No. 1</th>
<th>Solution State No. 2</th>
<th>Blended Solution</th>
<th>Ra 226 + 228</th>
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<td>gals/min</td>
<td>pCi/L Ra 226</td>
<td>gals/min</td>
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<td>0.000964794</td>
<td>5.09797E-05</td>
<td>0.009647945</td>
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* Radium 228 is 1.0 pCi/L in both the State No. 1 and State No. 2 wells. So, for compliance analysis purposes, 1.0 pCi/L was added to Radium 226 to get combined Radium 226 + 228.

Comments on Arsenic and Radium 226 Input Values

1. Critical parameter is the consistency of the arsenic value from State No. 1. We have 11 samples with arsenic values ranging from 0.014 to 0.037 mg/L. Median value is 0.023 mg/L. Mean value is 0.024 mg/L. Level I sample values range from 0.022 to 0.025 mg/L.
   Use 0.025 mg/L as input value for arsenic at State No. 1.

2. Arsenic values at State No. 2 are range from 0.002 to 0.003 mg/L.
   Use 0.003 mg/L as input value for arsenic at State No. 2.

3. Historical data from State No. 1 indicates very low Gross Alpha and Radium 226 and 228.
   Radium 226 + 228 value of 1.5 mg/L at State No. 1 is probably representative.
   Use 0.5 pCi/L as input value for radium 226 at State No.1.

4. Radium 226 values at State No. 2 range from 7.6 to 7.8 pCi/L.
   Use 7.8 pCi/L as input value for radium 226 at State No. 2.

5. With any blending of water from State No. 1 and State No. 2, the adjusted gross alpha concentration at State No. 2 will be below the MCL of 15 pCi/L. See Table #.
Figure 1: State No. 1 Pump Test
November 30 - December 1, 2009

Pre-test depth to water = 115.50 feet relative to top of casing
= 4640.5 feet amsl
End of test depth to water = 141.01 feet relative to top of casing
= 4615.6 feet amsl
Top of Pump Elevation = 4544 ft amsl

Specific Capacity (24 hr) = 80 gpm / 25.5 feet
= 3.1 gpm / foot of drawdown
Figure 2: State No. 2 Pump Test  
September 24 - 25, 2009

Elapsed Time, min.

Drawdown, ft.

Specific Capacity (24 hr) = 48 gpm / 38.5 feet  
= 1.2 gpm / foot of drawdown

Pre-test depth to water = 78.78 feet relative to top of casing  
= 4639.8 ft amsl

End of test depth to water = 117.3 feet relative to top of casing  
= 4601.3 ft amsl

Top of Pump Elevation = 4488 ft amsl

Open Valve for 30 minutes  
60 to 51 gpm
**Summary of Oil and Water Well Data. Lance Creek Water Supply, Level I Study**

*Update: 3/8/10*

<table>
<thead>
<tr>
<th>Well Name</th>
<th>Location T, R, Sec, Qtr</th>
<th>T, R, Sec, Qtr Elev., ft.</th>
<th>Ground Elev, ft</th>
<th>Resedibility</th>
<th>Top Elev, ft</th>
<th>Bottom Elev, ft</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>F7 Miller Federal (oil well)</td>
<td>34, 44, 6, S64E</td>
<td>4953</td>
<td>1200</td>
<td>Pt Card</td>
<td>3299</td>
<td>3299 to 375</td>
<td>Testing done at 55ft of Inyan Kara reatined by erosion. Resedibility of Inyan Kara = 94 ft thick</td>
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<tr>
<td>Atlantic - State P1</td>
<td>34, 44, 2, N65W</td>
<td>4713</td>
<td>2220</td>
<td>Yes</td>
<td>2822</td>
<td>2822 to 326</td>
<td>Testing done at 60ft of Inyan Kara reatined by erosion. Resedibility of Inyan Kara = 94 ft thick</td>
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<td>State 1</td>
<td>34, 44, 11, S65E</td>
<td>4701</td>
<td>1380</td>
<td>Yes</td>
<td>580</td>
<td>580 to 730</td>
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<td>Lomerson P1-7 (oil well)</td>
<td>34, 44, 7, N65E</td>
<td>4856</td>
<td>2055</td>
<td>Yes</td>
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<td>685 to 910</td>
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<tr>
<td>Inyan Kara Outcrop</td>
<td>35, 44, 36</td>
<td>4880</td>
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<td>0</td>
<td>Ground Surface (4880)</td>
<td>Testing done at 60ft of Inyan Kara reatined by erosion. Resedibility of Inyan Kara = 94 ft thick</td>
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<td>State No. 1</td>
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<td>265</td>
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<td>110</td>
<td>134 to 289</td>
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<td>State No. 2</td>
<td>34, 44, 1, NWNW</td>
<td>4721</td>
<td>237</td>
<td>Yes</td>
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<td>19 to 347</td>
<td>Testing done at 60ft of Inyan Kara reatined by erosion. Resedibility of Inyan Kara = 94 ft thick</td>
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<td>State No. 3</td>
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<td>4770</td>
<td>290</td>
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<td>150</td>
<td>150 to 560</td>
<td>Testing done at 60ft of Inyan Kara reatined by erosion. Resedibility of Inyan Kara = 94 ft thick</td>
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<tr>
<td>Heth #2 (domestic water well)</td>
<td>34, 44, 2, S64E</td>
<td>4723</td>
<td>240</td>
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<td>2091</td>
<td>2091 to 360</td>
<td>Testing done at 60ft of Inyan Kara reatined by erosion. Resedibility of Inyan Kara = 94 ft thick</td>
</tr>
</tbody>
</table>

**Inyan Kara: Dakota 266 to 344 (78 ft thick); Lakota 344 to 526 (182 ft thick) per J. Stafford**

- **Gamma high (> 320 API units): 404 to 412 feet may be potential stratigraphic marker in Inyan Kara**
- **Spontaneous potential kicks to left: 300 to 335 and 409 to 439**
- **Twr is very thick here and erosional surface slopes down to the south.**
- **Estimated bottom elev. of Inyan Kara = 4880 ft amsl - 260 ft = 4620 ft amsl**
- **Fine-to-medium grained buff, tan, yellow-tan, and light green sandstone; hard; silica cement; sparkles**
- **Water level elevation in well = 4640 ft amsl (118 feet depth to water, relative to ground)**

**FIGURE 3: GEOLOGIC MAP IN VICINITY OF STATE WELLFIELD**

**LANCÉ CREEK WATER SUPPLY, LEVEL I STUDY**

**WHITCOMBS (1965)**

**USGS, 1981: DIGITAL 7.5 MINUTE QUADRANGLE OF MAYNELLE NE, WY.**

**USGS, 1981: DIGITAL 7.5 MINUTE QUADRANGLE OF FLAT TOP, WY.**

**LEGEND**

- T34N 43.3 MILES
- R65W R64W

**TERTIARY ARKANSAN FORMATION: LIGHT-TO BROWNISH GRAY SANDSTONE, VERY FINE-GRAINED**

**TERTIARY WHITE RIVER GROUP: PINNISH-GRAY SILTSTONE IN UPPER PART AND VARIEGATED GRAY, RED, AND GREEN CLAYSTONE IN LOWER PART, LOCAL CHANNEL DEPOSITS OF FINE TO COARSE SANDSTONE AND CONGLOMERATE**

**CRETACEOUS THERMOPOLIS (SULL SKREW) SHALE: BLACK SHALE (NOT SHOWN ON MAP)**

**CRETACEOUS INYAN KARA GROUP: LIGHT TO YELLOWISH-GRAY FINE TO MEDIUM-GRAINED SANDSTONE WITH INTERBEDDED GRAY TO BLACK SHALLOWS AND CLAYSTONE AND CLAYSTONE**

**CRETACEOUS MORRISON FORMATION: VARIEGATED SHALE AND SANDSTONE (NOT SHOWN ON MAP)**

**SOURCE:**

**WHITCOMBS (1965)**

**USGS, 1981: DIGITAL 7.5 MINUTE QUADRANGLE OF MAYNELLE NE, WY.**

**USGS, 1981: DIGITAL 7.5 MINUTE QUADRANGLE OF FLAT TOP, WY.**
FIGURE 4:
STRATIGRAPHY AND COMPLETION OF STATE NO. 1 AND STATE NO. 2
LANCE CREEK WATER SUPPLY, LEVEL 1 STUDY

STATE NO. 1
GROUND = 475'  
STATE NO. 2
GROUND = 472'

- WHITE RIVER GROUP
  - STATE NO. 1 (Twr) 0'-116'
  - STATE NO. 2 (Twr) 0'-70'
- THERMOPOLIS SHALE (7.5' (Rc)
  - STATE NO. 1: 4645' 116'
  - STATE NO. 2: 4643' 78'
- TOP OF SLOTS AT 124'
- TORCH-CUT SLOTS 124'-246'
- PUMPING (8GPM)
- DTFW 143' (4615')
- 10' DRILLED HOLE
- STATE NO. 1
  - DAKOTA (68' THICK)
  - SANDY SHALE/BROWN SAND 249'-280'
  - LAKOTA (EST. 164' THICK)
- STATE NO. 2
  - DAKOTA (53' THICK)
  - SANDY SHALE/BROWN SAND 134'-153'
  - LAKOTA (EST. 171' THICK)
- PUMP SET AT 214'
- SLOUGH 249'-285'
- TD = 249'

- WHITE RIVER GROUP
  - STATE NO. 1 (Twr) 0'-116'
  - STATE NO. 2 (Twr) 0'-70'
- THERMOPOLIS SHALE (7.5' (Rc)
  - STATE NO. 1: 4645' 116'
  - STATE NO. 2: 4643' 78'
- TOP OF SLOTS AT 89'
- TORCH-CUT SLOTS 89'-134'
- PUMPING (48GPM)
- DTFW 123' (4601')
- NO SLOTS 134'-153'
- 8 5/8' OD STEEL 0'-287'
- 10' DRILLED HOLE
- STATE NO. 1
  - DAKOTA (334') (EST. 394')
  - MORRISON FM.
- STATE NO. 2
  - DAKOTA (334') (EST. 394')
  - MORRISON FM.
  - SLOUGH/CAVE-IN 287'-384'

NOTE:
ALL DEPTHS RELATIVE TO GROUND.
MEMO

DATE: 8/10/09

TO: Project File, 2009-129

FROM: Tom Watson, WWC Engineering

RE: Lance Creek Water Existing System Condition

INTRODUCTION

WWC inspected the Lance Creek water system from south to north in early August. GPS points and pictures were taken throughout the system at the taps, PRV vaults, blow offs, wells, tank and load out station. The condition of all components was recorded and deficient areas are noted.

SYSTEM INVENTORY AND CONDITION

1. State Wells # 1 and # 2 – The system has two operating wells, State Well # 1 and # 2, located approximately 6 miles south and east of Lance Creek. These wells were drilled in the early 1940s. Both well buildings are in rough shape.

2. Old Chlorination Unit – There is an old chlorination unit located just south of the Shaner wells. The transmission line from the State wells to the chlorination unit is 4” asbestos cement and from the chlorination unit to Lance Creek it is 4” PVC. This unit is currently not in use.

3. Combination Air Valves – within the first 5000 feet of the 4” PVC transmission line there are five combination air valves. These valves allow air into and out of the system when the well is turned off and on, respectively. All of these valves are in good shape.

4. PRV # 3 Pressure Sustaining Valve – There is a pressure sustaining valve located approximately 9000 ft north of the beginning of the 4” PVC. The purpose of this feature is to keep the transmission line full when the wells are off, since the elevation at the wells is higher than the elevation at the tank. This feature was not functioning when the system was inspected, but it was turned on during inspection. This valve looked to be functioning properly and in good shape.

5. KKRT Line Tap – The KKRT line was added to this system in 2000-2001. This line adds five taps to the system and a large amount of small diameter line.
6. PRV #1 Pressure Reducing Valve – Approximately 60 feet north of where the tank line and gateway line meet there is a pressure reducing valve. The valve reduces pressure to less than 80 psi. This vault was partially full of mud and the components of the valve were caked in mud. There was a hole under the vault where water had entered at some point in time. It appeared that the pressure reducing valve was being by-passed.

7. Truck Load-out Station – North of the water storage tank is a metered truck load-out station. This station is used by the district to sell water in large quantities. It is at the end of a separate line that is not connected to the rest of the system. The station has some problems though. Currently the way that water is metered to users is by the honors system. The vault is also in poor condition. It was partially full of water at the system site visit.

8. Reverse Osmosis Unit at Lance Creek Church – There is an RO unit located in the basement of the church. It only treats the water that is supplied to the church. It seemed to be operating well.

9. PRV #2 Pressure Reducing Valve – Approximately 2750 feet west of the truck load-out station there is a pressure reducing valve. The valve reduces pressure to less than 80 psi. The valve assembly seems to be in good condition. However, the pressure reducing valve is currently being by-passed.

10. Water Tank Control Vault – The water tank control vault is located approximately 150 feet east of the tank. It sends water to the truck load-out station and the water system. All components appeared to be in good condition and functioning properly.

11. Water Storage Tank – The 217,000 gallon water storage tank is located south of the Putnam camp area. This tank is in poor condition. There is a leak at the bottom on the NW side, and there is no solid foundation.

12. Manual Air Release – Along the transmission line, located at high points, are twenty-two manual air releases. These serve to allow air to be removed from the system. Most of these air releases were in good shape, except the one located 2780 feet along the “S” main.

13. Blow-off Hydrants – The system has five blow-off hydrants located at the end of portions of the system. Four of the five hydrants are in good condition. The hydrant in West Lance Creek near the gas plant was undergoing maintenance during the system inspection.
LANCE CREEK WATER SYSTEM

SYSTEM PICTURES

SYSTEM SITE VISIT AUGUST 2009
State Well # 1

State Well # 2

Old Chlorination Unit

KKRT line tap new to system
PRV #3 Pressure Sustaining Valve

Pressure gages initially (pressure sustaining valve by-passed)

Pressure sustaining valve functioning
Typical System Features

Typical Manual Air Release

Typical Blow-off Hydrant

Typical Combination Air Valve
PRV #1 Pressure Reducing Valve
PRV #2 Pressure Reducing Valve

RO unit at the church

Blow-off hydrant near gas plant
Truck Load-out Station
Tank Control Vault
Storage Tank
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<tr>
<th>Item Description</th>
<th>Name</th>
<th>Year</th>
<th>Tap Use</th>
<th>Type</th>
<th>STA</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Elevation</th>
<th>Size</th>
<th>Pictures</th>
<th>Apparent Physical Condition</th>
<th>Improvements</th>
<th>Additional Comments</th>
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**Improvements**

- District should check the private booster pump's capacity.
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<th>Longitude</th>
<th>Elevation</th>
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<td>-</td>
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<td>104°46'00&quot;</td>
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<td>It appeared to be in good condition but was not tested.</td>
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<td>Unknown</td>
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<td>Few minor operational issues and water in vault.</td>
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<td>104°46'00&quot;</td>
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<td>104°46'00&quot;</td>
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<td>-</td>
<td>NA</td>
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Inventories Table

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<th>Type</th>
<th>Use</th>
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<th>Latitude</th>
<th>Longitude</th>
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<th>Size</th>
<th>Pictures</th>
<th>Apparent Physical Condition</th>
<th>Improvements</th>
<th>Additional Comments</th>
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APPENDIX E
1.0 Introduction

Distribution system water quality has been an issue for the Lance Creek Water and Sewer District (District) as evidenced by a number of coliform violations within the past few years. The EPA requested a total coliform MCL compliance plan on February 16, 2010 in an email to the District.

2.0 Objective

This memo presents general discussion about water quality in potable water distribution systems and a limited evaluation of the current water quality situation of the District.

3.0 Water Age

There is a growing body of research regarding water age and how it may be used as a proxy for water quality. Literature on water age is shown in a bibliography of references in Attachment A. Although water age is not regulated, older water does not possess the initial quality of when it was produced and can contribute to problems as shown in Attachment B.

Although current literature does not include a firm standard of maximum water age, there are guidelines for desirable water age. Attachment C presents information on acceptable water age in systems. The criteria for age of water in a system are largely dependant on the type of water supply and condition of the distribution system.

Reference “Distribution Water Quality Issues Related to New Development or Low Usage”, presents an in depth discussion on the water age issue, including methods for reducing retention time and presumably maintaining water quality. Attachment D is a table from this document. The body of the report presents discussion about each of the methods in this table and how they are used by selected water utilities. The referenced document also includes the results of a detailed survey of selected water
utilities. This survey indicates that hydrant flushing is the most widely employed method of controlling water age.

4.0 Water Age – Lance Creek

WWC estimated water age using a simple approach, and a more sophisticated modeling approach.

*Simple Approach* The average water age is based only on the average daily demand and the storage capacity of the distribution system.

\[
\text{Water Age} = \frac{(217,000 \text{ Gallon Tank} + 36,046 \text{ Gallon pipe storage})}{21,600 \text{ the average daily demand}}
\]

\[= \text{ about 12 days.}\]

Table 3-3 (in the Level I report) presents information on water storage capacity for small Wyoming towns. The tabulation shows that the District’s water storage capacity is very large in relation to other communities on a per capita basis.

*Modeling Approach* The District’s EPANET distribution system hydraulic model was used to model water age. Extended period evaluations were performed for current demands with and without bulk water sales.

This modeling work provides estimates of the water age of water parcels at different locations in the distribution system. Six scenarios were examined, and the summary of input and output from that work is presented as Attachment E. Some of the scenarios explored options for reducing water age, such as flushing and the reduction of water storage with a smaller tank.

The modeling work shows that water age is not uniform throughout the distribution system. Water between the tank and the wells is considerably younger than water west of the tank and in the tank. The work also shows that water age in all locations probably exceeds times that are generally thought to be acceptable.
Attachment A
Bibliography

EPA (United States Environmental Protection Agency), Finished Water Storage Facilities, AWWA, August 15, 2002

EPA (United States Environmental Protection Agency), Effects of Water Age on Distribution System Water Quality, AWWA, August 15, 2002

EPA (United States Environmental Protection Agency), Total Colform Rule (TCR) and Distribution System Issue Papers Overview, AWWA, December 2006

EPA (United States Environmental Protection Agency), Distribution System Indicators of Drinking Water Quality, AWWA, December 2006

EPA (United States Environmental Protection Agency), The Effectiveness of Disinfectant Residuals in the Distribution System, AWWA


Attachment B
### Table 4

**Summary of water quality problems associated with water age**

<table>
<thead>
<tr>
<th>Chemical issues</th>
<th>Biological issues</th>
<th>Physical issues</th>
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<td><em>Disinfection by-product formation</em></td>
<td><em>Disinfection by-product biodegradation</em></td>
<td>Temperature increases</td>
</tr>
<tr>
<td>Disinfectant decay</td>
<td><em>Nitrification</em></td>
<td>Sediment deposition</td>
</tr>
<tr>
<td><em>Corrosion control effectiveness</em></td>
<td><em>Microbial regrowth / recovery / shielding</em></td>
<td>Color</td>
</tr>
<tr>
<td>Taste and odor</td>
<td>Taste and odor</td>
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</tr>
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</table>

* Denotes water quality problem with direct potential public health impact.
Attachment C
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<td>Georgia Environmental Protection Division</td>
<td>Daily turnover goal equals 50% of storage facility volume; minimum desired turnover equals 30% of storage facility volume</td>
<td>As part of this project, state regulators were interviewed by telephone.</td>
</tr>
<tr>
<td>Virginia Department of Health, Water Supply Engineering Division, Richmond, VA</td>
<td>Complete turnover recommended every 72 hours</td>
<td>As part of this project, state regulators were interviewed by telephone.</td>
</tr>
<tr>
<td>Ohio EPA</td>
<td>Required daily turnover of 20%; recommended daily turnover of 25%</td>
<td>Code of state regulations; turnover should occur in one continuous period rather than periodic water level drops throughout the day.</td>
</tr>
<tr>
<td>Baur and Eisenbart 1988</td>
<td>Maximum 5 to 7 day turnover</td>
<td>German source, guideline for reservoirs with cement-based internal surface.</td>
</tr>
<tr>
<td>Braid 1994</td>
<td>50% reduction of water depth during a 24 hour cycle</td>
<td>Scottish source.</td>
</tr>
<tr>
<td>Houlmann 1992</td>
<td>Maximum 1 to 3 day turnover</td>
<td>Swiss source.</td>
</tr>
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Source: Kirmeyer et al. (1999)
Attachment D
Table 2.2
Methods for controlling retention time

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<th>Method</th>
<th>Details</th>
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<td>Altering the valving of networks</td>
<td>By changing valve arrangements and hydraulic boundaries, travel times can be reduced and water rerouted to increase velocities in low flowing pipes to maximize velocities.</td>
</tr>
<tr>
<td>Installing time varying valves</td>
<td>Time and other control valves can be used to control flows.</td>
</tr>
<tr>
<td>Manual flushing</td>
<td>Periodic flushing to remove sediment and reduce water age in dead ends and low velocity sections of pipe.</td>
</tr>
<tr>
<td>Automated flushing</td>
<td>Automatic programmed flushing to remove sediment and reduce water age in dead ends and low velocity sections of pipe.</td>
</tr>
<tr>
<td>Abandoning mains</td>
<td>Remove surplus capacity from system.</td>
</tr>
<tr>
<td>Downsizing mains</td>
<td>Reduce system capacity to increase velocities and reduce retention times.</td>
</tr>
<tr>
<td>Increasing turnover of storage tanks.</td>
<td>Eliminate or reduce strategic storage and manage diurnal storage to minimize retention time. This is likely to be linked to resource capacity and operational optimization of both resources and pumping facilities.</td>
</tr>
<tr>
<td>Adjusting pump schedules.</td>
<td>Optimize pumping regime to match supply and demand, minimize energy requirements and retention times (linked to optimizing system storage).</td>
</tr>
<tr>
<td>Taking storage out of service / Removing tank cells</td>
<td>Remove surplus capacity from system.</td>
</tr>
<tr>
<td>Reducing the TWL* of storage facilities.</td>
<td>Eliminate or reduce strategic storage and manage diurnal storage to minimize retention time. The TWL may be varied with seasons.</td>
</tr>
<tr>
<td>Altering storage configuration to avoid dead zones</td>
<td>Replace common inlet outlet with separate pipes and/or install baffles to eliminate dead water zones and improve throughput thereby reduce retention time.</td>
</tr>
</tbody>
</table>

Source: Brandt et al 2004

*TWL = Top Water Level

The literature review provided a small number of technical articles describing studies related to improvement and maintenance of water quality in distribution systems (Kirmeyer et al. 2001, Lahlou 2002), but these do not provide specific direction for design and planning new development or low usage water supply. Water main flushing is a popular and common operational method used to improve water quality in low flow areas and is well documented. Pattison (1980), Chadderton et al. (1992, 1993), Cohen (2000), and Hasit et al. (2004) are among sources for additional information on the subject. Additional operational approaches are outlined in Chapter 3 as found from the survey of water utilities and regulatory agencies.
Attachment E
Scenario No. 1

This scenario represents the base scenario for modeling water age. Existing demands are used on the existing system. This approximates what the system has been experiencing in recent years. This scenario doesn’t take into account the use of water from the bulk water load-out.

Description of Key Inputs

- Current Average Day Demand, 11 gpm
- Original Base Model
- 32’ Draw Down on Tank before State No. 1 Well Turns on
- 3 month run

Summary of Results

Modeling results show that estimated maximum water age in the distribution system piping between the wells and the tank (Gateway Area) are 8 to 10 days. Results from the model estimate that for the tank and the rest of the distribution system (Putnam Camp and West Lance Creek) the maximum water age is considerably higher ranging from 77 to 79 days.
Lance Creek Water Supply, Level I  
WWC Job Number 2009-129  

Water Quality Modeling  

**Scenario No. 2**  

This scenario represents the base scenario while taking into account bulk water sales for modeling water age. Existing demands are used on the existing system. This approximates what the system has been experiencing in recent years. This scenario takes into account the use of water from the bulk water load-out during the three relatively low use months.  

**Description of Key Inputs**  

- Current Average Day Demand, 11 gpm  
- Continuous Bulk Water Demand, 5 gpm (7,200 gpd, 216,000 gal/month)  
- Original Base Model  
- 32’ Draw Down on Tank before State No. 1 Well Turns on  
- 3 month run  

**Summary of Results**  

Modeling shows that estimated maximum water age in the distribution system piping is reduced from scenario 1. The age in the Gateway Area is in the range of 6 to 7 days and in the Putnam Camp and West Lance Creek Areas the age is in the range of 20 to 36 days. However, age in the water storage tank is increased from scenario 1 at about 81 days.
Scenario No. 3

A strategy for reducing water age is to reduce storage in the system. This scenario represents the system with a smaller water tank (20’ dia. X 42’ tall). This scenario doesn’t take into account the use of water from the bulk water load-out.

Description of Key Inputs

- Current Average Day Demand, 11 gpm
- Original Base Model
- Tank 20’ X 42’
- 32’ Draw Down on Tank before State No. 1 Well Turns on
- 3 month run

Summary of Results

Modeling shows that estimated maximum water age in the distribution system piping between the wells and the tank (Gateway Area) is reduced from scenario 1. The age is in the range of 7 to 9 days. However, age in the water storage the tank and the rest of the distribution system (Putnam Camp and West Lance Creek) is greater than in scenario 1. The age is in the range 82 to 85 days.
WQ Scenario 3

[Map of water quality scenario with markers and labels indicating age in hours]
Scenario No. 4

A strategy for reducing water age is to reduce storage in the system. This scenario represents the system with a smaller water tank (20’ dia. X 42’ tall). This scenario takes into account the use of water from the bulk water load-out.

Description of Key Inputs

- Current Average Day Demand, 11 gpm
- Continuous Bulk Water Demand, 5 gpm (7,200 gpd, 216,000 gal/month)
- Original Base Model
- Tank 20’ X 42’
- 32’ Draw Down on Tank before State No. 1 Well Turns on
- 3 month run

Summary of Results

Modeling shows that estimated maximum water age in the distribution system piping between the wells and the tank (Gateway Area) is reduced from scenario 2 and is within guidelines for recommended water age. The age is in the range of 3 to 4 days. However, age in the water storage the tank and the rest of the distribution system (Putnam Camp and West Lance Creek) is greater than in scenario 2. The age is for the rest of the distribution system (Putnam Camp and West Lance Creek) is in the range 41 to 52 days, while the age in the tank is approximately 86 days.
WQ Scenario 4

Day 1, 12:00 AM

Age
24 48 72 144
hours

StateWellNo2No1
Scenario No. 5

Using a SCADA system to control well status based on tank draw down is a strategy to automate the system. This scenario doesn’t take into account the use of water from the bulk water load-out and uses a smaller tank.

Description of Key Inputs

- Current Average Day Demand, 11 gpm
- Original Base Model
- Tank 20’ X 42’
- 7’ Draw Down on Tank before State No. 1 Well Turns on
- 17’ Draw Down on Tank before State No. 2 Well Turns on
- 3 month run

Summary of Results

Modeling shows that estimated maximum water age in the distribution system piping between the wells and the tank (Gateway Area) is reduced from scenario 3. The age is in the range of 7 to 8 days. However, age in the water storage the tank and the rest of the distribution system (Putnam Camp and West Lance Creek) is greater than in scenario 3. The age is in the range of 88.5 to nearly 90 days.

The use of SCADA reduces the age of water that is directly affected by the wells but increases the age that is only served by the tank. However, the range of water age for these two groups is less using SCADA.
Scenario No. 6

Using a SCADA system to control well status based on tank draw down is a strategy to automate the system. This scenario takes into account the use of water from the bulk water load-out and uses a smaller tank.

Description of Key Inputs

- Current Average Day Demand, 11 gpm
- Continuous Bulk Water Demand, 5 gpm (7,200 gpd, 216,000 gal/month)
- Original Base Model
- Tank 20’ X 42’
- 7’ Draw Down on Tank before State No. 1 Well Turns on
- 17’ Draw Down on Tank before State No. 2 Well Turns on
- 3 month run

Summary of Results

Modeling shows that estimated maximum water age in the distribution system piping between the wells and the tank (Gateway Area) is reduced from scenario 4 and is within guidelines for recommended water age. The age is in the range of 1.5 to 3 days. However, age in the water storage the tank is greater than in scenario 4 and the rest of the distribution system (Putnam Camp and West Lance Creek) has a greater range of water age. The age is for the rest of the distribution system (Putnam Camp and West Lance Creek) is in the range 36 to 56.5 days, while the age in the tank is approximately 89 days.

The use of SCADA reduces the age of water that is directly affected by the wells but increases the age that is only served by the tank. The range of water age for the portion directly affected by the wells is less using SCADA. However, on the rest of the system the range of water age is larger.
## Wellfield Replacement, Conceptual Design Cost Estimate

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Cost/Unit</th>
<th>Quantity</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mobilization and Bonds (% of Items 2-6)</td>
<td>LS</td>
<td>8%</td>
<td>1</td>
<td>$24,494</td>
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<tr>
<td>2 Wells</td>
<td></td>
<td></td>
<td></td>
<td>$49,250</td>
</tr>
<tr>
<td>3 State No. 1 Offset Well Completed in Dakota Sandstone</td>
<td>LS</td>
<td>$15,000</td>
<td>1</td>
<td>$15,000</td>
</tr>
<tr>
<td>4 State No. 2 Offset Well Completed in Lakota Sandstone (Below Gamma Zone)</td>
<td>LS</td>
<td>$20,000</td>
<td>1</td>
<td>$20,000</td>
</tr>
<tr>
<td>5 2 Pitless, 1 Wellhouse and treatment</td>
<td>LS</td>
<td>$5,000</td>
<td>1</td>
<td>$5,000</td>
</tr>
<tr>
<td>6 Site Work</td>
<td>LS</td>
<td>$20,000</td>
<td>1</td>
<td>$20,000</td>
</tr>
<tr>
<td>7 Prefabricated Fiberglass Structure</td>
<td>LS</td>
<td>$15,000</td>
<td>1</td>
<td>$15,000</td>
</tr>
<tr>
<td>8 Submersible Pump and Pumping Equipment</td>
<td>LS</td>
<td>$25,150</td>
<td>2</td>
<td>$50,300</td>
</tr>
<tr>
<td>9 Pitless Unit</td>
<td>LS</td>
<td>$12,800</td>
<td>1</td>
<td>$12,800</td>
</tr>
<tr>
<td>10 Interior Pipe, Fittings and Valves</td>
<td>LS</td>
<td>$25,000</td>
<td>1</td>
<td>$25,000</td>
</tr>
<tr>
<td>11 Electrical</td>
<td>LS</td>
<td>$40,000</td>
<td>1</td>
<td>$40,000</td>
</tr>
<tr>
<td>12 Chlorine Solution Storage and Injection System</td>
<td>EA</td>
<td>$5,000</td>
<td>1</td>
<td>$5,000</td>
</tr>
<tr>
<td>13 Crushed Base, Grading W</td>
<td>C.Y.</td>
<td>$80</td>
<td>16</td>
<td>$1,280</td>
</tr>
</tbody>
</table>
## Wellfield Replacement, Conceptual Design Cost Estimate

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Cost/Unit</th>
<th>Quantity</th>
<th>Total Cost</th>
</tr>
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<tbody>
<tr>
<td>10</td>
<td>Free Draining Gravel</td>
<td>C.Y.</td>
<td>$80</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>Riprap, Class 3</td>
<td>C.Y.</td>
<td>$100</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Concrete, Class 4000</td>
<td>C.Y.</td>
<td>$150</td>
<td>5.5</td>
</tr>
<tr>
<td>3</td>
<td>Blow-Off Hydrant</td>
<td>EA</td>
<td>$6,000</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Pressure Transducer</td>
<td>EA</td>
<td>$1,000</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Fence Industrial, 72 In</td>
<td>LF</td>
<td>$35</td>
<td>108</td>
</tr>
<tr>
<td>6</td>
<td>Gates Industrial 72 In 7 Ft</td>
<td>EA</td>
<td>$750</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Unlisted Items (% of Items 2-5)</td>
<td>LS</td>
<td>5%</td>
<td>1</td>
</tr>
</tbody>
</table>

A  Construction Cost Subtotal  
B  Construction Engineering Costs (10% of A)  
C  Subtotal (A+B)  
D  Contingency (15% of C)  
E  CONSTRUCTION TOTAL COST (C+D)  
F  Prepare Final Design and Specs (15% of E)  
G  Permitting and Mitigation  
H  Legal Fees  
I  Acquisition of Access and ROW  

**Project Total Cost**  
**Rounded Total Cost**
## Small System Repairs, Conceptual Design Cost Estimate

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Cost/Unit</th>
<th>Quantity</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Small System Repairs</td>
<td>LS</td>
<td>$10,000</td>
<td>1</td>
<td>$10,000</td>
</tr>
<tr>
<td>A Construction Cost Subtotal</td>
<td></td>
<td></td>
<td></td>
<td>$10,000</td>
</tr>
<tr>
<td>B Construction Engineering Costs (10% of A)</td>
<td></td>
<td></td>
<td></td>
<td>$1,000</td>
</tr>
<tr>
<td>C Subtotal (A+B)</td>
<td></td>
<td></td>
<td></td>
<td>$11,000</td>
</tr>
<tr>
<td>D Contingency (15% of C)</td>
<td></td>
<td></td>
<td></td>
<td>$1,650</td>
</tr>
<tr>
<td>E CONSTRUCTION TOTAL COST (C+D)</td>
<td></td>
<td></td>
<td></td>
<td>$12,650</td>
</tr>
<tr>
<td>F Prepare Final Design and Specs (15% of E)</td>
<td></td>
<td></td>
<td></td>
<td>$1,898</td>
</tr>
<tr>
<td>G Permitting and Mitigation</td>
<td></td>
<td></td>
<td></td>
<td>$0</td>
</tr>
<tr>
<td>H Legal Fees</td>
<td></td>
<td></td>
<td></td>
<td>$0</td>
</tr>
<tr>
<td>I Acquisition of Access and ROW</td>
<td></td>
<td></td>
<td></td>
<td>$0</td>
</tr>
</tbody>
</table>

**Project Total Cost**

$14,548

**Rounded Total Cost**

$15,000
## New Water Tank, Conceptual Design Cost Estimate

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Cost/Unit</th>
<th>Quantity</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mobilization and Bonds (% of Items 2-6)</td>
<td>LS</td>
<td>8%</td>
<td>1</td>
<td>$17,640</td>
</tr>
<tr>
<td>2 Water Storage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remove Existing Tank</td>
<td>LS</td>
<td>$25,000</td>
<td>1</td>
<td>$25,000</td>
</tr>
<tr>
<td>Sitework</td>
<td>LS</td>
<td>$10,000</td>
<td>1</td>
<td>$10,000</td>
</tr>
<tr>
<td>Install 94,000 gal (20' x 42') Tank</td>
<td>LS</td>
<td>$175,000</td>
<td>1</td>
<td>$175,000</td>
</tr>
<tr>
<td>3 Unlisted Items (% of Items 2-5)</td>
<td>LS</td>
<td>5%</td>
<td>1</td>
<td>$10,500</td>
</tr>
</tbody>
</table>

A Construction Cost Subtotal $238,140  
B Construction Engineering Costs (10% of A) $23,814  
C Subtotal (A+B) $261,954  
D Contingency (15% of C) $39,293  
E CONSTRUCTION TOTAL COST (C+D) $301,247  

F Prepare Final Design and Specs (15% of E) $45,187  
G Permitting and Mitigation $20,000  
H Legal Fees $10,000  
I Acquisition of Access and ROW $5,000

Project Total Cost $381,434  
Rounded Total Cost $380,000
## Centralized Arsenic Removal, Conceptual Design Cost Estimate

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Cost/Unit</th>
<th>Quantity</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mobilization and Bonds (% of Items 2-6)</td>
<td>LS</td>
<td>8%</td>
<td>1</td>
<td>$5,460</td>
</tr>
<tr>
<td>2 Arsenic Treatment</td>
<td>LS</td>
<td>$25,000</td>
<td>1</td>
<td>$25,000</td>
</tr>
<tr>
<td></td>
<td>LS</td>
<td>$30,000</td>
<td>1</td>
<td>$30,000</td>
</tr>
<tr>
<td></td>
<td>LS</td>
<td>$35,000</td>
<td>1</td>
<td>$35,000</td>
</tr>
<tr>
<td></td>
<td>LS</td>
<td>$65,000</td>
<td>1</td>
<td>$65,000</td>
</tr>
<tr>
<td>3 Unlisted Items (% of Items 2-5)</td>
<td>LS</td>
<td>5%</td>
<td>1</td>
<td>$3,250</td>
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</table>

A Construction Cost Subtotal $163,710
B Construction Engineering Costs (10% of A) $16,371
C Subtotal (A+B) $180,081
D Contingency (15% of C) $27,012
E CONSTRUCTION TOTAL COST (C+D) $207,093

F Prepare Final Design and Specs (15% of E) $31,064
G Permitting and Mitigation $10,000
H Legal Fees $5,000
I Acquisition of Access and ROW $10,000

Project Total Cost $263,157

**Rounded Total Cost** $260,000
## Reverse Osmosis POE/POU Arsenic Removal, Conceptual Design Cost Estimate

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Cost/Unit</th>
<th>Quantity</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LS</td>
<td>8%</td>
<td>1</td>
<td>$6,077</td>
</tr>
<tr>
<td>2</td>
<td>RO POU/POE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Residential RO POU</td>
<td>EA</td>
<td>$1,100</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>Commercial RO POE (church has RO)</td>
<td>EA</td>
<td>$3,000</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Public Education</td>
<td>LS</td>
<td>$750</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Initial Year Monitoring</td>
<td>LS</td>
<td>$12,500</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Pilot Test</td>
<td>LS</td>
<td>$6,000</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Unlisted Items (% of Item 2)</td>
<td>LS</td>
<td>5%</td>
<td>1</td>
</tr>
</tbody>
</table>

A Construction Cost Subtotal $82,045  
B Construction Engineering Costs (10% of A) $8,204  
C Subtotal (A+B) $90,249  
D Contingency (15% of C) $13,537  
E CONSTRUCTION TOTAL COST (C+D) $103,787  
F Prepare Final Design and Specs (15% of E) $15,568  
G Permitting and Mitigation $5,000  
H Legal Fees $5,000  
I Acquisition of Access and ROW $1,000

Project Total Cost $130,355  
Rounded Total Cost $130,000
## Chlorinators, Conceptual Design Cost Estimate

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Cost/Unit</th>
<th>Quantity</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Chlorination equipment package</td>
<td>EA</td>
<td>$4,000</td>
<td>2</td>
<td>$8,000</td>
</tr>
<tr>
<td>2 6' diameter vault (modified manhole)</td>
<td>EA</td>
<td>$6,000</td>
<td>2</td>
<td>$12,000</td>
</tr>
<tr>
<td>3 Electrical hookup, panels, meter, etc.</td>
<td>EA</td>
<td>$2,000</td>
<td>2</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

**A** Construction Cost Subtotal $24,000  
**B** Construction Engineering Costs (0% of A) $0  
**C** Subtotal (A+B) $24,000  
**D** Contingency (0% of C) $0  
**E** CONSTRUCTION TOTAL COST (C+D) $24,000  
**F** Prepare Final Design and Specs (15% of E) $3,600  
**G** Permitting and Mitigation $0  
**H** Legal Fees $0  
**I** Acquisition of Access and ROW $0  

**Project Total Cost** $27,600  
**Rounded Total Cost** $30,000
## Well Control System (SCADA), Conceptual Design Cost Estimate

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Cost/Unit</th>
<th>Quantity</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mobilization and Bonds (% of Items 2-6)</td>
<td>LS</td>
<td>8%</td>
<td>1</td>
<td>$4,200</td>
</tr>
<tr>
<td>2 System-wide SCADA/Telemetry Upgrade</td>
<td>LS</td>
<td>$25,000</td>
<td>2</td>
<td>$50,000</td>
</tr>
<tr>
<td>3 Unlisted Items (% of Items 2-5)</td>
<td>LS</td>
<td>5%</td>
<td>1</td>
<td>$2,500</td>
</tr>
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A Construction Cost Subtotal $56,700  
B Construction Engineering Costs (10% of A) $5,670  
C Subtotal (A+B) $62,370  
D Contingency (15% of C) $9,356  
E CONSTRUCTION TOTAL COST (C+D) $71,726  
F Prepare Final Design and Specs (15% of E) $10,759  
G Permitting and Mitigation $0  
H Legal Fees $0  
I Acquisition of Access and ROW $0  

Project Total Cost $82,484  
Rounded Total Cost $80,000
## Bulk Water Load-out, Conceptual Design Cost Estimate

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Cost/Unit</th>
<th>Quantity</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mobilization and Bonds (% of Items 2-6)</td>
<td>LS</td>
<td>8%</td>
<td>1</td>
<td>$5,040</td>
</tr>
<tr>
<td>2 Truck Loadout</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitework</td>
<td>LS</td>
<td>$5,000</td>
<td>1</td>
<td>$5,000</td>
</tr>
<tr>
<td>Truck Load-Out Station</td>
<td>LS</td>
<td>$45,000</td>
<td>1</td>
<td>$45,000</td>
</tr>
<tr>
<td>Miscellaneous Site Piping</td>
<td>LS</td>
<td>$5,000</td>
<td>1</td>
<td>$5,000</td>
</tr>
<tr>
<td>Installation</td>
<td>LS</td>
<td>$5,000</td>
<td>1</td>
<td>$5,000</td>
</tr>
<tr>
<td>3 Unlisted Items (% of Items 2-5)</td>
<td>LS</td>
<td>5%</td>
<td>1</td>
<td>$3,000</td>
</tr>
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</table>

A Construction Cost Subtotal $68,040
B Construction Engineering Costs (10% of A) $6,804
C Subtotal (A+B) $74,844
D Contingency (15% of C) $11,227
E CONSTRUCTION TOTAL COST (C+D) $86,071
F Prepare Final Design and Specs (15% of E) $12,911
G Permitting and Mitigation $2,000
H Legal Fees $0
I Acquisition of Access and ROW $0

Project Total Cost $100,981

Rounded Total Cost $100,000
## Well Control System (Hydraulic Valves) Conceptual Design Cost Estimate

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Cost/Unit</th>
<th>Quantity</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mobilization and Bonds (% of Items 2-6)</td>
<td>LS</td>
<td>8%</td>
<td>1</td>
<td>$2,890</td>
</tr>
<tr>
<td>2 Hydraulic Valves</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Altitude Valve</td>
<td>Unit</td>
<td>$5,400</td>
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<td>$5,400</td>
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<tr>
<td>Vault</td>
<td>Unit</td>
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<td>6” Gate Valve</td>
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<td>Pressure Switch</td>
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<td>Pressure Tank</td>
<td>Unit</td>
<td>$15,000</td>
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<td>$15,000</td>
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<td>3 Field Service Contract with Valve Supplier</td>
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<td></td>
<td></td>
<td>$5,000</td>
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<tr>
<td>Tune System</td>
<td></td>
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<tr>
<td>4 Unlisted Items (% of Items 2-5)</td>
<td>LS</td>
<td>5%</td>
<td>1</td>
<td>$1,720</td>
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</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
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<tbody>
<tr>
<td>A Construction Cost Subtotal</td>
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<tr>
<td>B Construction Engineering Costs (10% of A)</td>
<td>$3,901</td>
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<tr>
<td>C Subtotal (A+B)</td>
<td>$42,911</td>
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<tr>
<td>D Contingency (15% of C)</td>
<td>$6,437</td>
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<tr>
<td>E CONSTRUCTION TOTAL COST (C+D)</td>
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<tr>
<td>F Prepare Final Design and Specs (15% of E)</td>
<td>$7,402</td>
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<tr>
<td>G Permitting and Mitigation</td>
<td>$0</td>
</tr>
<tr>
<td>H Legal Fees</td>
<td>$0</td>
</tr>
<tr>
<td>I Acquisition of Access and ROW</td>
<td>$0</td>
</tr>
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</table>

Project Total Cost $56,749

Rounded Total Cost $60,000
In compliance with Chapter 12 of the Wyoming Water Quality Rules and Regulations, Section 6, Engineering Design Report.

(a) Scope and Purpose of Project:

Lance Creek Water and Sewer District has received an EPA notice of violation (attached) demanding they prevent further Coliform violations after a series of routine testing of water system samples resulted in excessive Coliform counts. WWC Engineering and the Operator have determined that the violations are likely a result of excessive storage time (large, rather aged tank), and long distribution times (the system is approximately 15 miles long, from well head to furthest tap). Lance Creek Water and Sewer District proposes to install two automated Chlorination injection systems in low-cost vaults to provide supplemental chlorination when users draw water from the storage tank. Although one injection point on the supply line leading from the tank would be preferable from an equipment and operating standpoint, there is no nearby power, and the cost of running the power to this location greatly exceeds the cost of installing two vaults where power is readily available. About half the users are located west of the tank and the other half are back up the main line to the southeast of the tank. The attached design drawings entitled "Lance Creek Emergency Chlorination Project" include the following:

- sheet G-1, which shows a system-wide map derived from the as-constructed drawings for the system and a project location map
- sheet G-2, showing the detailed locations of the proposed chlorination vaults on a quad map
- sheet D-1, showing the vault details and construction notes
- sheet D-2, showing the process diagram and mix design

(b) Description of System: This project does not include any new water distribution system extensions, however a description of the system is included for background.

- Lance Creek Water and Sewer District was established by resolution before the Niobrara County Commissioners on November 12, 1996. Location and layouts are also attached.
- The District reports the following usage:
  
<table>
<thead>
<tr>
<th>Use</th>
<th>Population Served</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Tap</td>
<td>13</td>
</tr>
<tr>
<td>Residential and Stock</td>
<td>10</td>
</tr>
<tr>
<td>combined on tap</td>
<td>19</td>
</tr>
</tbody>
</table>
The water system is approximately 15 miles long from well head to most distant user, with a 210,000 gallon storage tank at about the halfway point. The pipeline is primarily 4" PVC pipe. In addition there is a separate line from the storage tank to a bulk sale tap where commercial tankers fill up for a fee, as reflected on the income reports from the District.

The regular residential taps have meters and the water rates are based on metered usage. There are some taps considered seasonal which have a flat fee when in use. The district does not currently provide sewer service.

A similar chlorination system has proven successful at the Town of Shoshoni, WY.

(c) Treatment facilities:

(i) General Description and location: Install two flow meter-controlled chlorine injection system packages. Install two vaults with electrical service, drainage, and ventilation control. It is intended that the normal operation of these systems be automated, with a reservoir of chlorine needing mixing/replenishment only every 15 to 30 days. A location map is attached.

(A) Property boundaries. The proposed vaults will be installed within the existing easements for the existing water transmission lines, however, detailed surveys are beyond the scope and budget for this project. Agreements from the landowners, including BLM for the one location are currently being obtained since the project will require a power service at each location from a nearby power line, and in the case of BLM they are evaluating access implications. Site 1 is a location in the northeast quarter of Section 10, Range 65W, Township 35N, approximately 650 west of highway 270 just south of Lance Creek, while Site 2 is in the southeast quarter of Section 4, same Range and Township. Site 1 is on BLM property. Site 2 is adjacent to route 271 and is the property already used by the utility for bulk water sales. Bulk water sales would not be run through the proposed chlorination system but are served by a separate supply line from the storage tank.

(B) Flood protection. Detailed survey is beyond the scope and budget for the design of this project, however, the operator has indicated that the location of Site 2 is generally above any recorded flood elevations (approx. el. 4450 (same as main part of town), while Site 1 is possibly within the flood plain at approximately el. 4410. We are incorporating the ability to easily drop a sump pump into the vaults if needed to evacuate flood or groundwater from the facility. We do not believe the equipment would be damaged by flooding except perhaps causing breakers to trip in the electrical system. The system may become inoperable during extreme floods, although the present system for chlorination at the well-heads remains as a supplement, though the well-head application has proven unreliable for long-term use.

(C) Access. BLM agreement for increased access to site 1 is pending but comes from the nearby highway on a dirt or gravel road. Access to site 2 is open as this site serves as the bulk loading for tankers within the system.
(D) The distance to the nearest habitation for site 1 is approximately 520 feet (using aerial photographs). Site 2 is approximately 300 feet from a habitation. The sites are located on and operate on the main water transmission line for the system.

(E) The proposed vaults should be lockable, as well as the electrical service panels supplying the power. No other security should be necessary.

(F) Topographic Features and contours – See site maps utilizing the USGS topographic quad surveys.

(G) Soils maps and investigation. Regarding soils and foundation support, the operator has indicated that other than occasional groundwater at Site 1 he sees no problem with the proposed installation.

(ii) Service area description and land use plan. Not performed. A brief analysis of land use was prepared as part of the SLIB board emergency funding application package and can be duplicated for DEQ if necessary.

(iii) Recycle flows – not applicable.

(iv) Disposal of waste – not applicable.

(v) Sources of water supply. Lance Creek obtains their water from two wells, however, the chemistry and geological information requested is beyond the design scope of this project. A full report can be supplied from a separate study currently being completed for the WWDC, but the analysis is incomplete. The WWDC study should result in a new application for System improvements within the next year, so the report should be forthcoming at a future date.

(vi) Plant design conditions:

(A) Historical and design population. The population data is provided in the description section above, however, the District indicates that the system has been losing population for some years. Current residential population is listed as 40 persons, but there are also services to livestock and to businesses, one or more churches, and a school.

(B) Existing and projected maximum daily demand flows and demand variations. The Chlorination injection system sizing was based on the historical annual water delivery data provided by the District. The annual use for domestic and stock is approximately 5,540,000 gallons, with a variation of from 5 to 24 gallons per minute, low flow to peak flow. The estimated chlorine usage is 200 gallons per year, diluted from the 10% sodium hypochlorite solution per the injection system supplier's recommendations.

(C) Complete description of existing facilities. Based on a conversation with Brad Kant, (the operator), the existing chlorination facility is a direct drip system where Clorox Bleach is added from a reservoir at the well heads. The location is somewhat difficult to reach and requires manual adjustment of the drip rate based
on operator experience and projected system demands. The system is also rather long, with problematic residence times in the storage tank, depending on supply/demand conditions.

(D) Description of process treatment system – not applicable.

(E) Description of on-site restrooms and sanitary sewer facilities – not applicable.

(vii) Summary of automatic operation and control systems, including basic operation, manual override operation, and maintenance requirements. System will control a calibrated injection pump based on flow through the main. No other operating mode is contemplated. Manual drip system at well heads will remain as a backup system.

(viii) Description of the on-site laboratory facilities and a summary of those tests to be conducted on-site. None.

If no on-site laboratory is provided, a description of plant control and water quality testing requirements, and where the testing will be conducted shall be included. The operator will continue to sample for residual chlorine and coliforms as required for his system. Description of crosscontrol measures to be provided at chemical feed tanks, filters, washdown taps, direct connection to sewer or other relevant protection. Fill hose from the service tap should be mounted so as to prevent submersion into the chlorine mix.

(d) Hazard classification.

(i) A determination of the degree of hazard of all water service connections to be connected to the proposed project. Only one tap is contemplated in this project and it should be classified as low hazard. The material that could potentially be back-siphoned into the system is concentrated disinfecting solution (chlorine).

(ii) A determination of the potential cause of backflow for all water service connections. Within the system, there are low hazard residential taps, as well as high hazard stock taps. The Operator indicates that there are backflow preventers where required, but this was not verified by WWC Engineering. There are also several business, school, and church taps. None of these facilities were examined and are beyond the scope and budget for this project.

Disclaimer: The information within this report is generated to address the general requirements of Chapter 12 of the Wyoming Water Quality Rules and Regulations, Section 6, Engineering Design Report, but does have some limitations: 1. Under the conditions of emergency funding provided by the State of Wyoming SLIB board, only 15% of the total improvements cost may be allocated for engineering design services, thus there are very limited design or research funds available given the low cost of the proposed improvements.

Enclosed are three copies of the application, design report, drawings, and bid/contract instructions for your review. The bid/contract documents also refer to the Wyoming Public Works 2001 Specifications, which are not reproduced here, but are used by public entities throughout Wyoming, including the DEQ. Please advise if you need more detail.
This project has been examined in detail by the Lance Creek Water and Sewer District operator and is hereby authorized for submittal to and approval by the Wyoming Department of Environmental Quality.

Brad Kant – Operator  Riki Kremers – District Secretary

This projected has been designed under the supervision of:

Murray Schroeder, P.E.
LANCE CREEK EMERGENCY
CHLORINATION PROJECT
NIOBRAARA COUNTY
CHLORINATION INJECTION VAULT

ADDENDUM NO. 1

NOTES:

1. ELECTRICAL CONNECTIONS TO BE DESIGNED BY ELECTRICAL ENGINEER. - PENDING:
   • MINIMAL HEAT TO PREVENT FREEZING
   • LIGHT, ACTIVATE ON MACH OPENING
   • PROTECTED RECEPITAL TO ALLOW MAINTENANCE EQUIPMENT

2. ADDITIONAL PLUMBING DESIGNS PENDING:
   • STANDARD HOSE TAP TO ALLOW DILUTION OF CHLORINATION IN TANK AND DRAINAGE OF ISOLATED CHLORINATION SECTION

3. MASS AND EXTENSION OF CONCRETE BASE MUST BE SUFFICIENT TO PREVENT FLOATATION OF VAULT DURING FULL SUBMERGENCE EVENTS. (TOP OF VAULT) VAULTS TO BE WATER TIGHT. SUBMIT FLOATATION CALCULATION FOR ENGINEER'S APPROVAL.

4. ALL PIPE FITTINGS NOT SHOWN. CONTRACTOR TO SUBMIT FOR ENGINEER'S APPROVAL A DETAIL DRAWING SHOWING FLANGE ADAPTERS, JOINT RESTRANTS, AND OTHER ITEMS REQUIRED TO MAKE INSTALLATION FUNCTION AS INTENDED.

5. CONTRACTOR TO COORDINATE ISOLATION AND DRAINING OF WATER MAIN WITH OWNER. MAXIMUM DOWNTIME 6 HOURS.
Specializing in Chemical Feed Systems, Tanks, Valves and Actuators for Water and Wastewater

Flow Rate: 27 gpm, Max = 0.044 mg/1
Min Flow: 2.7 gpm, Min = 0.004 mg/1

Flow Rate: 0.044 mg/1 x 8.34 x 27 gpm = 0.7 lb/day Cl₂
Min Flow: 0.004 mg/1 x 8.34 x 27 gpm = 0.1 lb/day Cl₂

Flow Rate: 0.7 lb/day / 8.5 lb/gal = 0.08 gal/day / 1% conc. = 0.5 gal/day of NaCl solution

Purchase 2ea 5-gallon bucket of 30% NaOCl. Dilute with 90 gallons of water. Store in 125-gallon tank to create 1% solution.

- 27 gpm Flow, 10% solution = 12 days storage
- 2.7 gpm Flow, 1% solution = 120 days storage
- 4.7 gpm Flow, 1% solution = 75 days storage
**OFFICE OF STATE LANDS AND INVESTMENTS**  
**INFRASTRUCTURE FINANCING**

**APPLICATION COVER SHEET**

**Applicant:** Lance Creek Water and Sewer District  
**Date:** 03/10/10

**Address:** P.O. Box 133, Lance Creek, WY 82222  
(Applicant’s)

**Contact Person:** Tom Watson (WWC Engineering, Laramie, WY)  
**Phone:** (307) 742-0031  
**(e-mail address): twatson@wwcengineering.com**

**Phone No.:** (307) 334-4088  
(Applicant’s)

**Fax No.:** (307) 334-4088  
(Applicant’s)

**Applicant’s Tax I.D. Number:** 84-1401998  
(required)

**Project Name and Description:**
Emergency chlorination system for the Lance Creek Water and Sewer District  
Lance Creek Water and Sewer District has received an EPA notice of violation (copy attached) demanding they address a series of Coliform violations from routine testing and need to make improvements to avoid future violations. WWC and the operator have determined that the violations are a result of excessive storage time, both in the system (about 15 miles in length) and in a rather old storage tank on the system. We propose to install two automated chlorination systems in vaults to provide supplemental chlorination when users draw water from the storage tank. Proposed locations and configuration are shown in the attached drawings.

**Priority # 1 of 1**

<table>
<thead>
<tr>
<th>Funding Source</th>
<th>Amount Requested</th>
<th>Percentage Requested</th>
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<tbody>
<tr>
<td>Mineral Royalty Grant</td>
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<td>100</td>
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<tr>
<td>Abandoned Mine Land Grant</td>
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<td></td>
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<tr>
<td>Joint Powers Act Loan</td>
<td></td>
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<tr>
<td>Drinking Water SRF Loan</td>
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<tr>
<td>Clean Water SRF Loan</td>
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**Applicant’s Local Match**

**Applicant’s Other Match**

**Total**

$31,320.00  
100%

**List other Match Sources Individually and provide requested amount and status of request for each source:**

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<thead>
<tr>
<th>Funding Source</th>
<th>Amount</th>
<th>Status: Approved or Pending</th>
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</table>
Lance Creek Water and sewer District has received an EPA notice of violation demanding they prevent further Coliform violations after a series of routine testing of water system samples resulted in excessive Coliform counts. WWC Engineering and the Operator have determined that the violations are likely a result of excessive storage time (large, rather aged tank), and long distribution times (the system is approximately 15 miles long, from well head to furthest tap). We propose to install two automated Chlorination injection systems in low-cost vaults to provide supplemental chlorination when users draw water from the storage tank. Although one injection point on the supply line leading from the tank would be preferable from an equipment and operating standpoint, there is no nearby power, and the cost of running the power to this location greatly exceeds the cost of installing two vaults where power is readily available. About half the users are located west of the tank and the other half are back up the main line to the southeast of the tank. Proposed layouts and location are shown on the attached sketches.

The District reports the following usage:

- Residential Tap 13, Population Served 19
- Residential and Stock combined on tap 10, Population Served 21
- Stock Only Tap 11, Livestock Served approx. 3200
- Business /School /Church Tap 10, Population Served 68

The water system is approximately 15 miles long from well head to most distant user, with a 210,000 gallon storage tank at about the halfway point. The pipeline is primarily 4" PVC pipe. In addition there is a separate line from the storage tank to a bulk sale tap where commercial tankers fill up for a fee, as reflected on the income reports from the District.

The regular residential taps have meters and the water rates are based on metered usage (rates attached). There are some taps considered seasonal which have a flat fee when in use. The district does not currently provide sewer service.

The District has indicated that they are very concerned with future income projections because they have lost some population over the last several years and the trend may continue. They have a small reserve fund to cover emergencies and income fluctuations.

The substantial income they receive from bulk water sales is variable and depends primarily on mining activities in the area.

The district is evaluating the economic impacts of the needed chlorination systems and would like to limit their contribution to picking up the operating budget if the outside funding will cover the capital cost of installation.

The district is in the process of adjusting their water rates to maintain a positive cash flow. Current water rates ($32/month) are already above the $25 monthly average for Wyoming districts and municipalities as reported in the Wyoming Water Development Commission 2009 Water System Survey Report.

Current water rate sheets
Schematic plans for project, location and system layout map.
Cost estimate indicating basis of cost estimate.
Financial balance sheet (spreadsheet), EIN, and SLIB-provided General Financial Information form
Copy of resolution of District formation
Copy of resolution allowing WWC Engineering to act on District's behalf
Copy of recent EPA violation correspondence – Note: letter to EPA includes proposed schedule.
Portion of District bylaws governing new hookups.
Cost Estimate

Lance Creek Emergency Supplemental Chlorination System

<table>
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<tr>
<th>Item</th>
<th>Item</th>
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<th>unit cost</th>
<th>number req.</th>
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<td>2</td>
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<td>12000</td>
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<tr>
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<td>4000</td>
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<tr>
<td>4</td>
<td>design</td>
<td>lump</td>
<td></td>
<td></td>
<td>3600</td>
</tr>
</tbody>
</table>

Maintenance cost (annual)

| A    | chlorine | gal | 25 | 3000 |
| B    | electricity (meter+minimal usage) | 60 | 720 |

Cost of installation and 1st year operation: 31320

Based on a current quote for chlorination equipment and operation from Municipal Treatment Equipment, Inc., and from Vaughn concrete for vault, and from Fremont Electric for a meter hook-up with panels.

Miscellaneous project and design costs were derived from the engineer's proprietary database of projects constructed around the state over the last 10 years.