FINAL REPORT

TOWN OF BAIROIL
WATER SUPPLY PROJECT
LEVEL II

Submitted to the:
Wyoming Water Development Commission

Submitted by:
Lidstone and Associates, Inc.

May 19, 2000
FINAL REPORT
BAIROIL WATER SUPPLY PROJECT
LEVEL II

Prepared for:
State of Wyoming
Water Development Commission

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LIST OF ACRONYMS AND ABBREVIATIONS

ARV Air release valve
bgs Below the ground surface
BLM United States Department of the Interior, Bureau of Land Management
CO₂ Carbon Dioxide
Cu Copper
EA Each
EPA United States Environmental Protection Agency
ft Feet
gpd Gallons per day
gpm Gallons per minute
gpd/ft Gallons per day per foot
HP Horse Power
LA Lidstone and Associates, Inc.
L.F. Linear Foot
L.S. Lump Sum
MCL Maximum Contaminant Limit
mg/L Milligrams per liter
min Minutes
msl Mean sea level
ND No data
NPDES National Pollutant Discharge Elimination System
O&M Operating and Maintenance
Pb Lead
pCi/L Picocurries per liter
psi Pounds per square inch
PVC Polyvinyl Chloride
Ra 226 Radium 226 isotope
Ra 228 Radium 228 isotope
RUS Rural Utilities Service
SDWA Safe Drinking Water Act
SHPO Wyoming State Historic Preservation Office
SLIB Wyoming State Loan and Investment Board
SRF Wyoming State Revolving Fund
SWTR Surface Water Treatment Rule
USACE United States Army Corps of Engineers
USDI United States Department of the Interior
USFWS United States Fish and Wildlife Service
USGS United States Geological Survey
WDEQ/LQD Wyoming Department of Environmental Quality - Land Quality Division
WDEQ/WQD Wyoming Department of Environmental Quality - Water Quality Division
WSEO Wyoming State Engineer’s Office
WWDC Wyoming Water Development Commission
1.0 INTRODUCTION

1.1 Authorization and Purpose

The Town of Bairoil (Town) is located 40 miles north of Rawlins on Highway 73 in Sweetwater County, Wyoming (Figure 1.1). In the Fall of 1998, the Town of Bairoil submitted an application to the Wyoming Water Development Commission (WWDC) to fund a Level II study for a conceptual design of a long-term, reliable water supply source for Bairoil. On June 1, 1999, Lidstone and Associates, Inc., (LA) entered into a contract with the WWDC to provide professional services to the Level II Bairoil Water Supply Project (the Project). The purpose of the Project is to evaluate the existing system, including the Abel Springs production source and make recommendations for the development of an additional long-term, reliable water supply source.

The Town has concerns about both the quality and the quantity of water provided by Abel Springs. The main supply from Abel Springs does not provide sufficient water to supply the Town during the peak demand periods. During these periods, the Abel Springs water is supplemented by water from deep Battle Springs wells in the Battle Springs wellfield, owned and operated by Merit Energy, Inc. (previously by BP-Amoco). The Merit Energy wells and transmission line into Town are expensive to operate because of the pumping depths and long transmission distance. This is further compounded by operational issues associated with the transmission line. The Town does not currently pay for water from these wells, and is concerned that they may not be able to use water from this source indefinitely. Therefore, the Town would like to be independent of the Battle Springs wellfield.

With respect to quality, the Town’s water supply currently meets the primary drinking water standards. However, the EPA classifies (generally) an infiltration gallery as an unfiltered surface water source subject to the requirements of the Surface Water Treatment Rule (SWTR: 40 CFR Part 141, Subpart H). There has been no action taken against the Town to date. However, this could be an issue in the future due to the lack of adequate treatment as no secondary treatment currently exists. If the EPA reclassifies the Abel Springs source as surface water, or ground water under the influence of surface water, filtration will be required. The Abel Springs water has also shown elevated iron concentrations. In addition, the Town is concerned about livestock grazing and source contamination in the vicinity of the water source.
Figure 1.1. Bairoil Water Supply Project Level II
Location of Project Site
LA gratefully acknowledge assistance by Greg Adams and Power Resources, Inc. (PRI) of Casper, Wyoming, in providing us with uranium exploration data for the area. We would also like to thank Kevin Boyce of the WWDC for his assistance throughout this project and are grateful to Tony Rigano of the Town of Bairoil for making maps and plans or the water system available to us and for personally showing us key aspects of the water system. We would like to express our appreciation to Lynda Anderson of the Town of Bairoil for her assistance with the project. We would further like to thank Lori Brandon, Mayor, and the Town Council of Bairoil.

1.2 Previous Studies

Several previous studies of water system alternatives have been contracted by the Town of Bairoil. These studies include a 1979 study by Corewood, Inc., of Riverton, Wyoming, and a 1982-1983 study and well drilling program by Hydro-Search, Inc., of Denver, Colorado. In addition, system upgrades have been completed by several engineering firms.

The 1979 Corewood study described the geology and hydrology of Abel Springs, the construction of Abel Creek wells #1 and #2, and the Abel Springs collection system. In addition, it described the water rights for the infiltration gallery. Water samples were collected from the Abel Springs infiltration gallery and the Abel Creek wells and were tested for major ions. These analyses showed no water quality problems.

A ground water exploration project was conducted in 1983 for the WWDC by Hydro-Search, Inc. This project assessed the water usage of Bairoil, reviewed the hydrogeology of the area, and selected primary target aquifers and drill sites for test well installation. The project identified the need for an additional water supply which would produce at least 100 gpm. The Fort Union and Battle Springs Formations were both selected as potentially suitable aquifers for ground water development; however, the Battle Springs Formation was preferred because of its potentially higher yields. A site was selected for the construction of a well screened in the Battle Springs Formation, located approximately one and one half miles west of Abel Springs. A test well was installed in November and December 1984. The well was briefly pump tested and water samples were collected. Unfortunately, the concentrations of tested radionuclides in the water exceeded the water quality standards and the well was abandoned.

1.3 Summary of Current Project

The WWDC and the Town of Bairoil sponsored the Level II investigation to locate a suitable alternative water source for the Town. Project funding stipulated that the proposed source should provide the minimum anticipated quantity and quality to meet the Town's needs for the minimum life of the project loan or an estimated 30 years. In conjunction with identifying the location and yield of the proposed water source, LA was directed to prepare conceptual designs and cost estimates for a transmission line to convey water from the source to the existing distribution system.
This Level II investigation identified and investigated the following alternative water supply options:

- Upgrade the existing infiltration gallery.
- Develop a ground water source from the Battle Springs Formation.
- Develop a ground water source from the Fort Union Formation.
- Construct an infiltration gallery in Camp Creek.
- Purchase the deep Battle Springs Formation wells which currently provide a backup water supply.

Based on the evaluation of the data and determination of each source’s potential for success, LA completed a well in the Battle Springs Formation. The Battle Springs Formation is widely mineralized with uranium in the Bairoil vicinity. On previous projects, LA has found that radionuclide concentrations are closely related to the proximity of uranium ore deposits and that radionuclide concentrations in ground water decrease sharply away from ore bodies. Therefore, the exploration program included an evaluation of uranium mining records and exploration data to help define the location of mineralized zones in proximity to the Town of Bairoil. Following the evaluation of historical data, three new boreholes, one well, and three soil pits were logged and tested as part of this project. The water quality from the completed well was tested and the sustainable yield was determined by a series of aquifer tests. Preliminary design work and cost estimates have been prepared to develop a water supply from the Battle Springs Formation and to upgrade the Abel Springs infiltration gallery.
2.0 SUMMARY OF EXISTING SYSTEM

2.1 General

The Bairoil water system is classified as a community water supply (EPA, 1998) and provides water for an average daily resident population of 160 via 65 active service connections. It also supplies water to the Bairoil School and several commercial establishments including Merit Energy’s Wertz Unit CO₂ recycling facility. Historically there have been as many as approximately 80 service connections in the early 1980’s.

The water into each service is unmetered with an initial tap fee of $500 for a residential connection and $750 for a commercial connection. The monthly user fee is a flat rate of $12.50. These rates do not include an allocation for a sinking fund, for major repairs, or for replacement of the system. The annual water system budget for 1997-1998 was $31,444, with 10 percent of this budget being spent annually for water quality testing. The Town has a Wyoming certified operator on site (Tony Rigano).

2.2 Water Supply/Source

The Town presently receives its water supply from two sources:

- Abel Springs: Primary Source
- Battle Springs Wellfield: Supplemental Source

In addition, there are nearly 60,000 linear feet of transmission line; 350,000 gallons of storage in one tank; and 18,000 linear feet of distribution line. A plan of the system is presented on Figure 2.1.

2.2.1 Abel Springs

The Abel Springs, the primary source of water for the Town of Bairoil, was developed in the 1950’s. The springs are located approximately three miles northwest of the Town. It provides an estimated flow of 35 to 100 gallons per minute (gpm) from an infiltration gallery. The flow rate is thought to vary seasonally, although no data are available to support this. The infiltration gallery was constructed in the bottomland of Abel Creek, approximately one half to one mile upstream of the springs. The springs are susceptible to drought and reportedly fails to provide a satisfactory water supply during these dry times.
Figures 2.2 and 6.1 show a plan of the gallery from data collected on site. No as-built plans were found documenting the infiltration gallery configuration or materials. The layout of the Abel Springs collection system was prepared based on field observations only, and may be incomplete. It appears that the water enters the infiltration gallery through perforated lateral collector arms. The arms connect with a main transmission line, and the water from the infiltration gallery is conveyed through the transmission line to four concrete collection boxes of 7,000 gallons each. These collection boxes have a gravel base, allowing additional water to flow from the springs into the boxes. These tanks are kept locked and the area patrolled weekly. The collection boxes have the inlets and outlets at approximately the same elevation with overflow pipes to daylight. The recharge area and spring is overlain by unfenced rangeland. The actual infiltration gallery is partly located on land owned by the Sun Ranch, and partly on BLM land.

There are no records of improvements to the infiltration gallery, however there is a substantial amount of construction debris in the vicinity of the gallery including pipe fragments. From this debris it appears that at least some concrete-asbestos lines have been replaced with C-900 PVC lines; that the lines have a nominal diameter of six inches; and that a portion of the collection system may have been upgraded in 1982 at the same time as the Abel Springs transmission line replacement project. It is assumed that the main Abel Springs transmission line is in good condition, and no additional construction beyond the proposed pipeline would be required. However, there is a possibility that there is some water loss between the infiltration gallery and the Bairoil storage tank.

The water flows a distance of approximately 3.5 miles from the collection boxes at Abel Springs through a 6-inch PVC pipe to a 350,000 gallon steel storage tank located above town (Figure 2.2). The transmission line was upgraded in 1982 and an as-built plan was filed with the WDEQ/WQD. The accuracy of the as-built drawing may be questionable given that the actual location of the line relative to Abel Creek is incorrect on the as-built plans.

### 2.2.2 Battle Springs Wellfield

Currently utilized as the supplemental water source for the Town of Bairoil, the Battle Springs wellfield (Figure 2.1) comprises six deep wells. They are screened in the Battle Springs Aquifer with individual reported yields of 347 to 589 gpm and a combined yield for all wells of approximately 2,650 gpm. The well details are provided in Table 2.1.

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Permit Number</th>
<th>Total Depth (ft)</th>
<th>Yield (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battle Springs Water Supply #1</td>
<td>SW SW Sec. 14 T27N R92W</td>
<td>UW 14775</td>
<td>2080</td>
<td>392</td>
</tr>
<tr>
<td>Battle Springs Water Supply #2</td>
<td>SW SW Sec. 19 T27N R91W</td>
<td>UW 14776</td>
<td>2084</td>
<td>347</td>
</tr>
<tr>
<td>Battle Springs Water Supply #3</td>
<td>NW NW Sec. 24 T27N R92W</td>
<td>UW 14777</td>
<td>2010</td>
<td>388</td>
</tr>
<tr>
<td>Battle Springs Water Supply #4</td>
<td>SW SW Sec. 15 T27N R92W</td>
<td>UW 14793</td>
<td>2043</td>
<td>420</td>
</tr>
<tr>
<td>Battle Springs Water Supply #6</td>
<td>SE SW Sec. 24 T27N R92W</td>
<td>UW 26762</td>
<td>2010</td>
<td>589</td>
</tr>
<tr>
<td>Battle Springs Water Supply #8</td>
<td>NE NW Sec. 31 T27N R91W</td>
<td>UW 26764</td>
<td>2002</td>
<td>514</td>
</tr>
</tbody>
</table>
Figure 2.2 Location of Existing Transmission Line and Infiltration Gallery
The wells provide a backup source and additional fire storage capacity (source redundancy) for the Town. These wells are 1,000 to 1,300 feet deep and are located 13 to 18 miles west of the Town. The primary purpose of these wells is to supply water Merit Energy production facilities through a Merit Energy (formerly BP-Amoco) owned and maintained pipeline. In 1984 the Town constructed a 2,500-foot, 4-inch PVC pipeline to connect the Merit Energy transmission line to the Town’s storage tank.

The water is pumped from one well at a time to a cistern located south east of the wells. The water flows out of the cistern under gravity and through a transmission line to Merit Energy production facilities. Pumped water constantly flows into the cistern, and when the demands are normal the cistern stays full and overflows to a lagoon. However, when the water demands are high, the water level in the cistern may occasionally fall below the level of the outlet. When this happens, air locks occur and the transmission line has to be manually bled at eight to ten air release valves (ARVs). Because this is a time-consuming operation, water is pumped constantly into the cistern, resulting in high pumping costs.

2.3 Disinfection

The Town's potable water is disinfected prior to going into the storage tank. No other treatment is applied to the water. The disinfection consists of chlorine gas injection. The disinfection apparatus is located in its own building adjacent to the storage tank and chlorine is injected into the water line prior to entry into the storage tank. The contact time in the tank is estimated to be seven hours. Chlorine safety guidelines are adhered to by trained personnel. The disinfection residual is monitored on a weekly basis.

2.4 Storage

Storage for the water system is in a 350,000 gallon covered steel tank which was built in 1985. The tank is structurally sound, well maintained and in good condition. The outside of the tank was re-coated in 1996. The ground elevation at the tank is 7,006 feet msl. During the winter months the tank is kept about half full to prevent damage from ice build up. The area where the tank is located is not subject to flooding. The tank area and chlorine facility are fenced, locked and inspected on a daily basis. The tank is inspected annually. The tank has both high and low overflow levels. The high overflow is located 38 feet above the base of the tank and will overflow continuously when the tank is full. The low overflow is located 20 feet from the base of the tank and allows more rapid water circulation, water to remain fresh during the lower flows of winter, and for the control of ice buildup. In addition, a drain is located in the base of the tank to allow the tank to be emptied for maintenance.

Water from the Abel Springs infiltration gallery flows to the southeast through a six-inch PVC pipe and through a four-inch PRV vault before flowing into another six-inch pipe and into the storage tank. Water flows into the Bairoil water system from the Battle Springs transmission line through a four-inch line; passes through three CLA-VAL PRV valves, an altitude valve, and a flow meter; and flows into a six-inch line into the storage tank. The water flows out of the storage tank through a six-inch pipe which connects with a eight-inch pipe which, in turn, connects with the ten-
inch transmission line to carry the water to the Bairoil distribution system. The precise location of each connection between the different line sizes is not known. Figure 2.3 presents the best analysis of the line schematic including valves and controls into the storage tank. A water meter is located in the ten-inch line, approximately 300 feet south west of the tank, prior to entering the transmission/distribution system. The water meter is contained in a meter vault and can be bypassed if necessary.

2.5 Distribution System

Treated water from the storage tank to the distribution system is gravity conveyed by a single, 4,100 foot long, 10-inch PVC pipeline to the entrance of the distribution system. The distribution system is also gravity-based. The distribution system consists of the following lines (Table 2.2):

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Diameter (inches)</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,500</td>
<td>8</td>
<td>PVC</td>
</tr>
<tr>
<td>10,900</td>
<td>6</td>
<td>PVC</td>
</tr>
<tr>
<td>2,100</td>
<td>4</td>
<td>PVC</td>
</tr>
<tr>
<td>1,020</td>
<td>4</td>
<td>Transite</td>
</tr>
<tr>
<td>560</td>
<td>2</td>
<td>PVC</td>
</tr>
</tbody>
</table>

In addition, there are two miles of two-inch line to Merit Energy’s Wertz Unit CO₂ recycling plant and approximately 1,620 feet of ¾-inch PVC pipe to the corrals at the south end of town. The line to the corrals is a service line. The exact locations of these lines are unknown. The line types and their function in the distribution system are detailed below.

- Main lines: 8-inch to 4-inch PVC
- Distribution lines: 4-inch to 2-inch PVC
- Service lines: ¾-inch to ½-inch PVC and copper

The system has 31 fire hydrants servicing the Town. According to the plat map there are numerous shutoff valves that allow the lines to be isolated, but many of these are covered in dirt and are hard to find. There are also six dead ends to the existing system which make it necessary to blow the line out periodically. Pressure in the line, measured at the town hall during a 1993 survey by RCH & Associates, was 72 psi for the low volume storage tank to 80 psi for the full tank.
Several line replacement projects have taken place over the last 20 years. The distribution system map on file with the WDEQ/WQD and on file with the Town is not current nor are line locations, pipe sizes and the location of critical shutoff valves. As part of this project, LA incorporated the operator's detailed notes with their field observations to prepare Figures 2.2, 2.3 and 2.4. However, because of inaccuracies of the original surveyed platting, LA was unable to rectify the line length with the plats.

### 2.6 Water Quality

#### 2.6.1 Source Water Quality

**Abel Springs.** Microparticulate analyses (MPA) have been performed on raw water from Abel Springs in 1992 and 1993. These analyses showed that small populations of algae were present in the water. The water was free of Giardia and/or other surface water organisms.

A water sample was collected from Abel Springs for analysis in 1982. The results of these analyses showed that the water quality met the DEQ Chapter VIII standards for the tested constituents. The tested constituents and results were calcium (18.9 mg/L), iron (0.056 mg/L), magnesium (2.85 mg/L), manganese (<0.01 mg/L), potassium (0.33 mg/L), sodium (4.31 mg/L), alkalinity as CaCO$_3$ (61.9 mg/L), pH (8.05 s.u.), sulfide (3.99 mg/L), chloride (2.35 mg/L), TDS (108 mg/L), and hardness (Ca, Mg as CaCO$_3$ - 58.9 mg/L).

**Storage Tank.** Over many years, several other samples of the system water have been collected from the storage tank prior to entrance into the distribution system. These samples could contain mingled Abel Springs and Battle Springs well water. The sample results of radiological parameters from the storage tank indicate that the water meets the WDEQ-WQD Chapter VIII standards for Class I water. Samples were collected from the storage tank in July 1996 and March 1999 for analyses of the EPA Primary and Secondary Parameters. In the results from these analyses concentrations of all chemical constituents in the water were below their respective MCLs.

**Battle Springs Wellfield.** Water quality data for the wells which supply the Battle Springs pipeline and from various points within the Town's distribution system are available. The primary water quality concern in the Battle Springs Formation is the presence of radionuclides. Table 2.3 outlines the November 1995 sampling results.

<table>
<thead>
<tr>
<th>Name</th>
<th>Gross Alpha (pCi/L)</th>
<th>Ra 226 (pCi/L)</th>
<th>Ra 228 (pCi/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battle Springs Water Supply #1</td>
<td>11.5</td>
<td>5.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Battle Springs Water Supply #2</td>
<td>13.5</td>
<td>4.8</td>
<td>3.1</td>
</tr>
<tr>
<td>Battle Springs Water Supply #3</td>
<td>5.3</td>
<td>6.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Battle Springs Water Supply #4</td>
<td>5.6</td>
<td>1.5</td>
<td>2.6</td>
</tr>
<tr>
<td>Battle Springs Water Supply #8</td>
<td>28.8</td>
<td>0.8</td>
<td>ND</td>
</tr>
</tbody>
</table>
Table 2.3 indicates that during this particular sampling period, only Well No. 4 was able to meet all radionuclide standards as outlined in Chapter VIII of WDEQ/WQD Rules and Regulations. (The Class I standard for Gross Alpha is 15 pCi/L and for Ra$^{226}$ plus Ra$^{228}$ is 5 pCi/L)

2.6.2 Water Quality in the Distribution System

Water quality data from various points within the Town’s distribution system are available. Water samples from several taps in town indicate that elevated levels of copper have been observed, sometimes approaching the WDEQ/WQD Class I (Drinking Water) standard (1.0 mg/L) and the EPA SDWA Standard (1.0 mg/L). Because a high level of fluctuation in copper levels exists, it is believed this condition is more a function of copper piping in the service lines and internal plumbing than the source water quality (see Table 2.4 for a comparison of copper levels and sample locations from the most recent water analyses). Samples were collected for lead and copper analyses from the storage tank in April and July 1999. These showed that lead and copper concentrations were below the quantification limit.

<table>
<thead>
<tr>
<th>Sample Date</th>
<th>Location</th>
<th>Copper (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/09/99</td>
<td>Storage Tank Outfall</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>6/08/99</td>
<td>Storage Tank Outfall</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>4/09/99</td>
<td>108 Elk Court</td>
<td>0.62</td>
</tr>
<tr>
<td>6/08/99</td>
<td>108 Elk Court</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Water quality samples from the Town’s distribution system indicate that there are no other problems with meeting the Chapter VIII, Class I standards or the EPA Primary and Secondary Drinking Water Standards.
3.0 WATER DEMAND

Few detailed records of water consumption exist for the Town of Bairoil. A flow meter was installed in the transmission line exiting the water storage tank in January 1997. Unfortunately, the meter ceased to work after one year and metered records are only available for 1997. A brief review of climatic data from the Bairoil area indicate that 1997 had relatively normal precipitation.

The records indicate that the daily water usage varied from a low average of 30,000 gallons in the fall of 1997 to a maximum daily usage of approximately 150,000 gallons during July 1997. Over the entire year of 1997, water usage averaged 56,260 gallons per day. Assuming that 160 people are provided with water, this translates to an daily usage ranging from 187.5 gallons per day (gpd) to 937.5 gpd per person.

The average daily demand was obtained by calculating the average of the daily usage throughout 1997. The maximum daily demand was determined by examining the graph of the daily demand versus time (Figure 3.1) and reading the highest average daily demand (July 1997). A value for the peak hourly consumption was determined by doubling the maximum daily demand. Based on statewide projection for the area, the present and future demand requirements are identical. The demand estimates are presented in Table 3.1.

| Table 3.1: Water Demand Estimates for the Town of Bairoil (Current and Future) |
|-----------------------------|-----------------|-----------------|
| Demand                      | Gallons         | Gallons per Minute |
| Average Daily               | 56,250          | 39               |
| Maximum Daily               | 150,000         | 105              |
| Peak Hourly                 | 12,500          | 210              |

The maximum daily demand was used to establish the design capacity of the system. Since the existing maximum daily demand for the Town of Bairoil is 150,000 gpd (105 gpm), the supply source should provide water at a rate equal to or greater than 105 gpm.

3.1 Distribution System and Storage Requirements

The distribution system should be capable of conveying the larger of the peak daily plus fire flow demand, or the peak hourly demand. Storage facilities should be adequate to meet anticipated demand in excess of the direct supply capacity. This demand generally includes equalization, emergency, and fire storage. Equalization storage is an amount of storage set aside to supplement the system for short periods of time when demand exceeds production. This amount is typically determined from a mass diagram of hourly consumptive use and may be estimated as some percentage of maximum daily demand. Emergency storage is provided to maintain a constant supply of water during periods when supply to the storage facility is interrupted by power failure or maintenance of the supply components, typically one average day's consumption. Fire storage is the quantity of water reserved to accommodate the large demands of fire fighting.
Figure 3.1: Daily Water Use (1997)
Town of Bairoil, Wyoming

Data smoothed by moving average (7 day period)

Note: Meter failed during May 1997
To evaluate the storage requirements for the Town of Bairoil, design criteria were established. Equalization storage was estimated to be 20 percent of the maximum daily demand. Emergency storage consisted of three average day's consumption. Fire flow requirements were estimated for two scenarios: (1) the fire protection provided with the storage remaining following the allotments for emergency and equalization storage and (2) the fire protection associated with providing the maximum fire protection for a town the size of Bairoil (this requirement is generally 1000 gpm for two hours). With these criteria, the evaluation of the existing storage facility is provided in Table 3.2. The calculations provided in Table 3.2 indicate that the Town has sufficient storage with the existing 350,000 gallon storage tank.

<table>
<thead>
<tr>
<th>Type</th>
<th>Storage (gal)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Emergency Storage</td>
<td>168,750</td>
<td>3 x average daily demand</td>
</tr>
<tr>
<td>2. Equalization Storage</td>
<td>30,000</td>
<td>0.2 x maximum daily demand</td>
</tr>
<tr>
<td>3. Fire Flow (existing tank)</td>
<td>151,200</td>
<td>1,260 gpm for 2 hours</td>
</tr>
<tr>
<td>Subtotal (1+2+3)</td>
<td>350,000</td>
<td>Existing storage tank volume</td>
</tr>
<tr>
<td>4. Fire Flow (max. protection)</td>
<td>120,000</td>
<td>1,000 gpm for 2 hours</td>
</tr>
<tr>
<td>Subtotal (1+2+4)</td>
<td>318,750</td>
<td>Total storage required for maximum fire protection</td>
</tr>
</tbody>
</table>
4.0 POTENTIAL WATER SUPPLY ALTERNATIVES

Four alternatives were identified and evaluated in the development of a long-term, reliable supply for the Town of Bairoil. All four alternatives are ground water sources – two alternatives would use the Quaternary alluvial or colluvial aquifer and two alternatives would utilize a deep Tertiary ground water source. The alternatives are described below and the location of each alternative’s construction activity is shown on Figure 4.1. The sub-sections which follow provide a more detailed description of the proposed alternatives.

1. Complete a new well in the Battle Springs Formation or the Fort Union Formation and run a connecting pipeline to the existing Abel Springs pipeline or directly into the Town.

2. Redevelop the existing Abel Springs infiltration gallery.

3. Develop a new infiltration gallery in the adjacent Little Camp Creek Drainage.

4. Purchase a portion of the Battle Springs wellfield and pipeline from Merit Energy.

4.1 Alternative No. 1 – New Well and Transmission Line

The Battle Springs Aquifer is known to have elevated radium concentrations in some areas surrounding Green Mountain, north of Bairoil. Other areas exist where water quality meets the criteria outlined for Class I (drinking) water, under the WDEQ/WQD Rules and Regulations. This is evident from the water quality of the Battle Springs wellfield currently supplementing the Bairoil water supply. Historical geophysical data from a uranium exploration program in Sections 19 and 20 of T27N, R90W were used to define an area where sands are well-developed and radionuclide concentrations are low. Exploration boreholes for a suitable site for the water well were located based partly on these geophysical data. The Fort Union Formation may also provide a suitable ground water supply. No Fort Union wells are developed in this area. An exploration borehole was completed to investigate this alternative.

With this Alternative, the existing Abel Springs infiltration gallery would remain in place. A ground water well supplemented by the Abel Springs supply would serve as the primary supply to the Town of Bairoil. Each source would provide a certain degree of redundancy.
4.2 Alternative No. 2 – Abel Springs Redevelopment and Expansion

This alternative would entail the improvement of the existing infiltration gallery, focusing on the expansion of the infiltration gallery collection system and on reducing water losses between the infiltration gallery and the Bairoil storage tank. Currently, the amount of available information concerning the design of the gallery is incomplete. Field reconnaissance by LA has partially delineated the location of some pipelines above the collection boxes which are fed by the infiltration gallery. Figure 2.2 shows the location of the existing main lines to the gallery as well as the location of the collection boxes. There is no written documentation of any repairs or upgrades which may or may not have occurred.

4.3 Alternative No. 3 – Construct an Additional Infiltration Gallery in Little Camp Creek

This alternative entailed development of a second infiltration gallery in Little Camp Creek and a pipeline to tie it into the Abel Springs line. A reconnaissance of the Little Camp Creek drainage was performed to determine if suitable source conditions exist. The reconnaissance indicated that the Little Camp Creek drainage probably is unsuitable for an infiltration gallery. This was based on the width of the drainage valley and vegetation growth along the floor of the valley. If suitable conditions has existed, soil pits would have been excavated to determine water levels, saturated thickness, and material gradation of the alluvial aquifer. A pipeline and booster station would have been required to lift water over the divide between the Little Camp and Abel Springs drainages and to tie in with the existing Abel Springs pipeline.

4.4 Alternative No. 4 – Purchase Deep Battle Springs Wellfield and Transmission Line

Presently, the Town augments the main supply from Abel Springs with water from the Battle Springs wellfield during periods of peak demand. Water is manually diverted into the Bairoil storage tank when the Abel Springs can not keep up with demand. Last year this situation occurred for only two months.

These wells and pipeline are now owned and operated by Merit Energy, Inc. The existing pipeline is over 30 years old. The Town has not compensated Merit Energy, or the previous owners, for any of the water received to date. This alternative would call for improvements in the water line to eliminate the air locking and adjustment/replacement of the gate valve so that the supply can be shut off during periods of low demand. A totalizing meter would be installed, so that an accurate measurement of diverted water from this source could be made. A contract may need to be negotiated with Merit Energy, Inc., for the purchase of the pipeline when it is no longer needed by their operations. Abel Springs would still serve as the primary supply for Bairoil and the pipeline would only be used during periods of peak demand and would also act as the redundant supply.
4.5 Preferred Alternative

Alternative No. 1 is the preferred alternative. Alternative No. 2 is also considered a viable secondary alternative worth pursuing. Below is a summary of reasons for this conclusion.

Alternative No. 1 is the preferred alternative because:

- The Battle Springs Formation is an established ground water source which generally provides a relatively safe, low maintenance water supply of consistent quality.

- A potential source of good quality ground water in the Battle Springs Formation could be located relatively close to Abel Springs. Therefore, the construction cost to provide a transmission line from the well to a connection with the Abel Springs transmission line would be relatively low.

- A ground water source is likely to meet future regulatory requirements, whereas surface water may be subject to additional treatment requirements in the near future.

Alternative No. 2 is ranked below and second to Alternative No. 1 yet it may be worth pursuing simultaneously because:

- Abel Springs is the present water supply for the Town and is known to provide good quality drinking water. The source of the water is alluvial/colluvial material and the water contains no radium.

- Construction costs to expand the infiltration gallery will be relatively low.

- The increase in water production will probably not exceed 15 to 20 percent. Therefore, a supplemental supply will still be required during peak usage periods.

- Currently, Abel Springs is considered a ground water source not under the direct influence of surface water. However, the EPA survey which made that determination was performed at the time of the year when the potential for surface water influence on the Abel Springs Aquifer was minimal. Therefore, it may be reasonable to conclude that the Abel Springs water source has not been completely and accurately characterized for at least part of the year. This conclusion is based on the fact that runoff during April, May and June may directly influence the Abel Springs source water quality. It is entirely possible that the Abel Springs source could be reclassified as a ground water source under the direct influence of surface water in the near future, thus requiring additional treatment (e.g., filtration). However, the required treatment technology is simple and the treatment could be provided at a relatively low cost.
Alternative No. 3 was ranked below Alternative Nos. 1 and 2 and is not considered viable because:

- A potential supply source has not been found within Little Camp Creek.
- Little Camp Creek does not have a wide valley and wetland vegetation is not well established, indicating that the potential for a suitable infiltration gallery site is small.
- The cost for transmission (line and pump) as well as the potential to incur wetland mitigation cost appear to be much higher than those associated with either Alternative Nos. 1 or 2.

Alternative No. 4 was ranked below Alternative Nos. 1 and 2 and is not considered viable because:

- Only one well, Well No. 4, meets drinking water quality standards in terms of radionuclides according to the standards outlined in WDEQ/WQD Rules and Regulations, Chapter VIII.
- There are problems with the pipeline which can cause air locks that must be rectified to make the system work relatively efficiently. No work has been completed to determine the degree of modifications required to accomplish this.
- Pumping costs and the maintenance of an 18-mile pipeline to serve only as a supplemental water supply could be cost prohibitive to the Town. The remaining four wells for which data are available do not meet drinking water standards; therefore, the pipeline cannot serve as a redundant source.
- The system is greater than 20 years old and has exceeded its own design life. Ultimately the Town would need to replace 18 miles of pipeline.

Alternative No. 1 is the preferred alternative, therefore a field program was undertaken to find, test and develop a new ground water supply. Alternative No. 2 is considered a viable improvement of a supplemental source. Further investigation, design and construction under Level III is recommended. Further details are provided in Section 5.
5.0 GROUND WATER EXPLORATION AND DEVELOPMENT

5.1 General

A ground water exploration and development program was undertaken to find a ground water supply. The geology of the area was reviewed to find areas which had the potential to provide an abundant source of good quality ground water. The following information sources were used to review the geology.

- USGS Geologic Quadrangle Maps of the area
- USGS Ground Water Reconnaissance Maps and Reports
- WSEO Well Logs
- Previous Consultants’ Reports
- Geophysical logs and maps provided by Power Resources, Inc. (confidential information)
- Air photographs taken in the late 1970s and early 1980s.

The geology near Bairoil has been investigated in detail due to the economic occurrence of uranium, oil and gas. Bairoil is located in the Great Divide Basin on the northward plunging Lost Soldier Anticline. The formations west of Town dip west and southwest towards the main synclinal axis of the Great Divide Basin.

In the Bairoil area, the geologic strata range in age from Cretaceous to Tertiary. Also present are Pleistocene pediment gravels, Holocene alluvium along the drainage valleys, and areas with Holocene colluvium and landslide deposits. A generalized summary of the geologic succession near Bairoil is provided in Table 5.1.

The following five aquifers were identified as potentially suitable for water supply.

- Quaternary Alluvium
- Battle Springs Formation
- Fort Union Formation
- Fox Hills Formation
- Lance Formation

Although the five aquifers were identified as potentially suitable for water supply, water quality considerations limited the determination of a target aquifer. The alluvium may be susceptible to surface water influence and source contamination, hence treatment costs may be prohibitive. However, the current Abel Springs system is alluvial and does not require extensive treatment. The Cretaceous aquifers (Fox Hills Formation and Lance Formation) tend to have naturally high concentrations of total dissolved solids which limit the potability of those aquifers. The sand units within the Fort Union Aquifer are typically too thin for good yielding wells. Therefore, the principal aquifer of interest for the project was the Battle Springs Aquifer. Secondary investigations were completed in the Fort Union and the alluvium.
Table 5.1: Geologic Succession in the Bairoil Area

<table>
<thead>
<tr>
<th>System</th>
<th>Series</th>
<th>Subdivision</th>
<th>Lithology</th>
<th>Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternary</td>
<td>Holocene</td>
<td>Surficial Deposits</td>
<td>Mainly alluvium and colluvium.</td>
<td>Alluvium lines the drainage valleys and covers low-lying land. Colluvium present on higher land surrounding the Whiskey Ridge and Stratton Rim. Generally thin.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Holocene / Pleistocene</td>
<td>Gravels</td>
<td>Terrace Gravels (boulders, gravel, sand and silt) and Boulder Gravels (boulders, gravel and some sand).</td>
<td>Terrace Gravels present on creek terraces near Bairoil. Boulder Gravels forms colluvium and lag deposits throughout area. Generally thin.</td>
</tr>
<tr>
<td>Tertiary</td>
<td>Eocene</td>
<td>Battle Springs Fm.</td>
<td>silt and clay with interbedded sand Conglomerate in the upper part. Some portions are highly mineralized with uranium.</td>
<td>The highlands of Whiskey Peak, Whiskey Ridge, Stratton Rim, and Green Mountain are mainly composed of the Battle Springs Formation. The beds dip away from the Town of Bairoil. Up to 2,300 ft. thick.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower Unit Battle Springs Fm. / Fort Union Fm.</td>
<td>Interbedded siltstone, sandstone and mudstone.</td>
<td>Crops out stratigraphically below the Battle Springs Formation in isolated outcrops around the highlands. Mainly covered with surficial deposits. Thickness = 800 to 1,150 ft.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lance Fm.</td>
<td>Interbedded siltstone, sandstone and mudstone. Carbonaceous, some coal near base.</td>
<td>Crops out north and west of Bairoil below the Fort Union Fm. Thickness = 1,300 to 3,900 ft.</td>
</tr>
<tr>
<td>Cretaceous</td>
<td>Upper Cretaceous</td>
<td>Fox Hills Fm.</td>
<td>Mainly fine sandstone with some interbedded shale.</td>
<td>Crops out north and west of Bairoil below the Lance Formation. Thickness = 200 to 800 ft.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lewis Shale</td>
<td>Interbedded shale and sandstone.</td>
<td>Flat-lying areas north of Bairoil. Thins out to west. Thickness = 0 to 700 ft.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mesaverde Fm.</td>
<td>Interbedded siltstone, sandstone and carbonaceous siltstone.</td>
<td>Flat-lying areas north of Bairoil. Thins to west. Thickness = 0 to 400 ft.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cody Shale</td>
<td>Mudstone, shale, minor sandstone.</td>
<td>Basin Floor deposit. The Town of Bairoil is located mainly on the Cody Shale. Thickness = 3,300 ft - 5,400 ft.</td>
</tr>
</tbody>
</table>
The Battle Springs Formation has been identified as a major aquifer within central Wyoming. Local ground water recharge to the Battle Springs Aquifer comes from the surrounding highlands in the area. Green Mountain, Whiskey Peak, Bull Springs Rim, and Stratton Rim all serve as local recharge areas.

5.2 Exploration Boreholes

5.2.1 Selection of the Borehole Locations

The following factors were considered when locating the boreholes.

*Accessibility.* The site had to be accessible for a drill rig and all the other required vehicles. Areas close to existing, bladed roads were favored over locations not close to a road. Archaeological clearance was required for all exploration boreholes. Hence, site selection was influenced by the need to minimize ground disturbances.

*Low radionuclide concentrations.* The geophysical data were evaluated to assess which areas were away from the uranium ore trends and where the radionuclide concentrations were likely to be low.

*Drill away from historical uranium exploration disturbances.* The LA boreholes were located in areas that had not been subject to extensive uranium exploration for the following two reasons.

- Uranium companies did not focus their exploration on areas with low radionuclide concentrations. Meeting EPA water quality standards was the primary focus of this water development program.

- Many of the historical exploration boreholes may have been improperly abandoned. Drill hole abandonment records are absent. Therefore, avoidance of extensively drilled areas will minimize the potential for cross contamination between aquifers that may exist in heavily drilled areas.

*Locate the well such that transmission costs are minimized.* The LA boreholes were sited at locations where the transmission line could be connected to the existing transmission line from Abel Springs into Bairoil.

In the Bairoil area, the water quality in the Battle Springs Formation is often limited by high concentrations of radionuclides. The Battle Springs Formation is known to be highly mineralized in places and contains uranium roll-front deposits. A large amount of uranium exploration was performed in the area in the 1970s and early 1980s by several companies. Air photographs dated July 5, 1978, reflect land disturbance at the peak of the mineral exploration program. Geophysical data were made available by Power Resources, Inc, of Casper, Wyoming, for Section 19, Township 27 North, Range 90 West. These data were collected by Kerr-McGee during the 1970s. In addition, limited data were available at other locations along and west of the Stratton Rim. These data showed that the Battle Springs Formation generally contains higher concentrations of
radionuclides on top of and to the west of Stratton Rim. Unfortunately, the sands are less developed to the east and southeast of the Stratton Rim. Therefore, the distance from the extensively explored areas was balanced against the suspected decreasing conductivity and decreasing thickness of the Battle Springs Formation.

5.2.2 Exploration Borehole Construction

Exploration boreholes were sited and drilled at three locations (Figure 5.1). These are:

- Borehole No. 1: SE NE Section 19, T27N R90W
- Borehole No. 2: NW SW Section 20, T27N R90W
- Borehole No. 4: SE SE Section 20, T27N R90W

The drilling contractor was R & R Drilling, Mills, Wyoming. The boreholes were drilled between August 2 and August 12, 1999. The drill cuttings from each of the boreholes were examined, logged and collected at 10-foot intervals by a professional geologist. Each borehole was geophysically logged by StrataData of Mills, Wyoming, after the borehole had been completed and conditioned. The logs included natural gamma, spontaneous potential, 16-inch normal resistivity and point resistivity. After the boreholes were logged, they were abandoned by backfilling with cement. The WSEO Permits are provided in Appendix I.
Figure 5.1
Bairoil Water Supply Project Level II
Location of the Exploratory Boreholes
Borehole No. 1 was drilled between August 2 and August 5, 1999. The borehole was drilled using a 5½-inch wing bit. The total depth of the borehole was 700 feet. The borehole was advanced through a sequence of sand and gravel, siltstone and clay. The sand and gravel were arkosic and the grains were composed of granitic fragments. The siltstone was a green/grey color and was sometimes dark gray and carbonaceous. It is apparent that there is a discrepancy between the geophysical log and the geologic log, in that the geologic log shows much better developed sands than the geophysical log which may have resulted from a large amount of caved sand from the upper part of the borehole. Therefore, the geophysical log is considered to provide a more accurate log of the sand stratigraphy. The geophysical log shows that sands are not well developed throughout the section below 300 feet. In addition, there are relatively high gamma readings at approximately 250 feet. Therefore, this borehole location was not considered to reflect a suitable location for a test well.

Borehole No. 2 was advanced between August 5 and August 10, 1999. The well was drilled using a 5½-inch wing bit from 0 to 480 feet and a 5½-inch Kenclaw bit from 480 to 640 feet. The total depth of the borehole was 640 feet. The borehole was advanced through a sequence of sand, gravel, siltstone and clay. The uppermost 350 feet was generally silt with minor sand. The silt was commonly carbonaceous and contained minor amounts of coal. The sand was generally a coarse grained, angular, arkosic, and composed of granitic grains. The sand became relatively more abundant below 350 feet. The geophysical log shows a silty sand present between 350 and 370 feet and an alternating sequence of sand and silt between 450 and 580 feet. In addition, the gamma readings were low throughout the entire drilled interval. Therefore, this borehole location was considered favorable for a test well.

Borehole No. 4 was advanced between August 10 and August 12, 1999, using a 5½-inch Kenclaw bit. The total depth of the borehole was 620 feet. This borehole was collared at a lower elevation than the other two boreholes and also was drilled at a lower stratigraphic level. The borehole was drilled near the base of the Fort Union Formation to determine whether good sands are developed in the Fort Union Formation at this location. The borehole was advanced through a fine grained sequence and the drill cuttings were generally comprised of silt and clay. No good sands were observed and the geophysical log confirms that the sedimentary sequence did not contain any sands with good aquifer properties.

In summary, the exploration boreholes showed that only the site of Borehole No. 2 had good potential as a well site. There are several thin sands in the lower part of the borehole, the gamma readings were low, and the lower sands are well protected from the higher gamma surface by a thick section of silt.

5.3 Test Well Installation and Development

Well Installation. A well (Bairoil 2A) was drilled and constructed within 50 feet of Borehole No. 2. The drilling contractor selected for this work was Barnhart Drilling of Riverton, Wyoming. The well was constructed between October 19 and November 5, 1999. Initially, a borehole was advanced with a 12-inch diameter mill bit. After the borehole had been advanced to the target depth (580 feet) a suite of geophysical logs were ran. The geophysical logging was performed by StrataData of Mills, Wyoming. The logs included natural gamma, spontaneous potential, 16-inch normal resistivity and point resistivity.
The well, constructed in the lower part of the Battle Springs Formation, showed lithologies similar to those encountered in the exploration borehole (Bairoil No. 2). The stratigraphic sequence was not identical, indicating that the sands pinch in and out laterally over a very short distance. The exploration borehole indicated that the well could be constructed with multiple screened intervals so that only some of the sand units were screened. This was considered to be a good design because many of the sand units would not yield significant water due to high proportions of silt. The placement of the well screens was determined based on the depths of the thickest and cleanest sand units as indicated by the geophysical logs. Just below the lower section there was a relatively thick sand with slightly elevated gamma readings at the base. Therefore, the lowermost sand was screened out to prevent reduce the potential for radium contamination. The completion details of Bairoil Well No. 2A are provided on Figure 5.2 and in Table 5.2.

<table>
<thead>
<tr>
<th>Table 5.2: Completion Details – Bairoil No. 2A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth (ft)</td>
</tr>
<tr>
<td>0 - 35</td>
</tr>
<tr>
<td>(+)2 - 362</td>
</tr>
<tr>
<td>374 - 433</td>
</tr>
<tr>
<td>465 - 553</td>
</tr>
<tr>
<td>574 - 580</td>
</tr>
<tr>
<td>362 - 374</td>
</tr>
<tr>
<td>433 - 465</td>
</tr>
<tr>
<td>553 - 574</td>
</tr>
<tr>
<td>0 - 271</td>
</tr>
<tr>
<td>271 - 290</td>
</tr>
<tr>
<td>290 - 580</td>
</tr>
</tbody>
</table>

NOTES

Surface Casing: 14-inch diameter, steel, seamless, 3%-inch wall thickness
Casing: 8%-inch diameter steel, schedule 20
Screen: 8%-inch diameter, type 304 stainless steel, v-slot, wire wrapped, 0.020-inch slot size
Cement: Class G mixed with 10% bentonite and 2% calcium chloride.
Seal: 3%-inch diameter bentonite pellets.
Filter Pack: 10-20 grade silica sand
Figure 5.2
Bairoil Water Supply Project Level II
Completion Diagram: Well No. 2A
The screen and casing sections were screw threaded. A sand filter pack was tremied into the borehole to 290 feet. During emplacement, the top of the filter sand in the borehole was regularly tagged to ensure that no bridges were left in the filter pack. The top of the filter pack is considerably higher than the uppermost screen to allow water from an upper sand unit to be drawn into the well. This upper sand unit may contribute some water; however, it did not appear thick or clean enough to screen. A 19-foot thick bentonite seal was emplaced above the screen after which the well was cemented to the surface. The cement was pumped into the borehole on November 5, 1999, using a cement truck. The cement was briefly circulated through the borehole to ensure that no voids were left in the cement. After construction, the cement was allowed to partially cure.

**Well Development.** After the cement was partially cured, the well was developed for 18 hours on November 7 and 8. Development was completed using a drill rig with a large compressor. The well was developed by the following methods: (1) surging with clean water to expel the drilling mud from the bore and injecting the clean water into the formation until free flow was established at the well head; (2) air jetting the screened intervals; and (3) "rawhiding" the well, which entailed air lifting the column of water in the well bore until it nearly reached the top of the well casing, then removing the air source and allowing the water column of water to surge back into the well and formation. These three well development techniques continued in various combinations until water being lifted from the well was clear and free of sand.

### 5.4 Well Yield

A series of pump tests were conducted on the developed well by Ward’s Well Service of Riverton, Wyoming, for the following two reasons.

- To evaluate a maximum sustainable yield.
- To determine the hydraulic properties of the aquifer and any boundary conditions surrounding the well.

A 50-HP pump was set in the well. The pump intake was set at 531 feet bgs. During the test, water was lifted from the well through a three-inch pump column. Once at ground surface the flow was transmitted through a discharge line fitted with a gate valve at the well head and an inline flow meter. The flow meter provided both total gallons pumped and instantaneous flow. The discharge line directed flow to a drainage 100 feet west of the well where water was allowed to flow down a slope into that drainage. All discharges during pump testing adhered to all requirements of the governing NPDES Permit (WYG720013). During the tests, the discharged water was very clear and absorbed into the ground, never flowing more than 1,500 feet on the ground surface.

The water level during the pump tests was measured using a 250-psi In-Situ PXD-261 pressure transducer and recorded on an In-Situ Hermit 3000 data logger. The transducer was taped to the pump column just above the pump bowls and was lowered into the well as the pump was being lowered. The final depth of the transducer was approximately 525 feet bgs. The transducer was secured at the well head.
5.4.1 Step Test

Method. A step test was conducted on November 17, 1999. The step test comprised four steps, each with a higher pumping rate than the previous. During each step a constant discharge rate was maintained. Each step directly followed the previous step so that there was no recovery of the water levels between steps. At the end of the final step, the pump was switched off and the water level was allowed to recover. The water level measurements for each step were measured and recorded on a logarithmic time schedule. This ensured that more measurements were recorded in the early part of each test when the water levels were changing rapidly.

Results. The initial static water level was 154.1 feet bgs. The water level in the well did not reach steady state during any of the pumping intervals. However, a pseudo-steady state was achieved during each of the steps. Figure 5.3 presents the water level versus time during the step test. Table 5.3 presents a summary of the step test results.

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Flow Rate (gpm)</th>
<th>Step Duration (min)</th>
<th>Total Drawdown (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>75</td>
<td>139</td>
<td>201</td>
</tr>
<tr>
<td>1</td>
<td>85</td>
<td>119</td>
<td>263.7</td>
</tr>
<tr>
<td>2</td>
<td>95</td>
<td>60</td>
<td>306.2</td>
</tr>
<tr>
<td>3</td>
<td>105</td>
<td>44</td>
<td>351.2</td>
</tr>
</tbody>
</table>

The drawdown versus flow rate is presented on Figure 5.4. This shows that the specific capacity of the well is relatively constant with an approximate value of 0.23 gpm/ft. It is important to note that due to the relatively short steps, the specific capacity curve does not truly reflect the drawdown that would be expected to occur from longer term pumping.

5.4.2 Constant Discharge Test

Method. A constant discharge test was performed to evaluate the hydraulic properties of the aquifer and possible hydrologic boundaries in the area. The test was run at 75 gpm, estimated to be the maximum safe sustainable yield from the step testing. The test was run from November 13 to November 16, 1999, and had a total duration of 75 hours. The initial static water level was 160.5 feet bgs. The flow rate was kept approximately constant during the entire test. On November 14, the flow meter air locked and ceased to function. Subsequently a graduated five-gallon bucket and stopwatch were used to measure the flow rate. Some fluctuations in pumping rate were observed, and, when necessary, the flow rate was adjusted. A few significant changes in flow rate can be seen on the plots of the drawdown versus time. Initially, the flow rate was too high; thus the rate was adjusted during the first 10 minutes of the test. In addition, the flow rate increased between 1,600 and 3,150 minutes. This increase in flow was not a discrete event and occurred gradually over time, probably because of drift in the valve. To alleviate the possible cause of this increase, the valve was taped so drift would be halted. From 3,150 minutes to the end of the test the flow rate remained at a constant 75 gpm. After the Constant Rate Test, the well recovery was monitored until the recovery was 93 percent complete.
Figure 5.3: Step Test - Water Level versus Time
Bairoil Water Supply Project, Level II
Figure 5.4: Specific Capacity Curve
Bairoil Water Supply Project, Level II

[Graph showing specific capacity curve with discharge (gpm) on the x-axis and drawdown (ft) on the y-axis.]

Key points:
- 75 gpm at drawdown of 200 ft
- 85 gpm at drawdown of 220 ft
- 95 gpm at drawdown of 260 ft
- 105 gpm at drawdown of 300 ft
**Results.** Plots of water level versus time are presented in Figures 5.5 and 5.6. During pumping, the water level in the well declined in a log-linear manner and steady state conditions were not attained. The final drawdown was 263 feet. At the end of the test the rate of drawdown was very low and the water level had reached pseudo-equilibrium. During actual use, the well would not pump continuously over long periods; therefore, the pump test results show that the well should be able to sustain pumping at 75 gpm.

Recovery of the well was monitored for approximately 23 hours. The data show that the well recovered by 93% in the first 23 hours after the pumping ceased.

The drawdown data and recovery data were analyzed using the Hantush Method for leaky aquifers (Hantush, 1960) and the Theis Recovery Method (Theis, 1935) respectively. The Hantush Method was used because the late time data reflect properties of a leaky system, as indicated by the leveling out of the drawdown curve faster than the theoretical drawdown predicted by the Theis method. The graphical solutions are presented in Figures 5.7 and 5.8. The solutions provide transmissivities of 147 gpd/ft and 298 gpd/ft, respectively. The aquifer thickness was assumed to be 235 feet. Therefore, the hydraulic conductivity was calculated to be 0.6 gpd/ft² and 1.3 gpd/ft², respectively. These are consistent with typical hydraulic conductivities of consolidated sandstone.

**5.5 Water Quality**

Water samples were collected from the well for the following suites of analyses.

- Total Radium 226
- WDEQ/LQD Guideline VIII
- EPA SDWA Phase II/V

The analyses were performed by Energy Laboratories of Casper, Wyoming. The laboratory results are included as Appendix II.

The water quality from the well was a serious concern because of the widespread presence of radionuclides in the Battle Springs Formation in the Bairoil area. Therefore, several water samples were collected for radium analyses during pump testing. The results are presented in Table 5.4.

<table>
<thead>
<tr>
<th>Sample Date</th>
<th>Radium 226 (pCi/L)</th>
<th>Radium Precision ±</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-10-99</td>
<td>1.2</td>
<td>0.3</td>
</tr>
<tr>
<td>11-11-99</td>
<td>3.2</td>
<td>0.4</td>
</tr>
<tr>
<td>11-14-99</td>
<td>3.4</td>
<td>0.3</td>
</tr>
<tr>
<td>11-15-99</td>
<td>4.5</td>
<td>0.4</td>
</tr>
<tr>
<td>11-16-99</td>
<td>3.7</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Figure 5.5: Constant Rate Test - Water Level versus Time
Bairoil Water Supply Project, Level II
Figure 5.6: Recovery Test - Water Level versus Time
Bairoil Water Supply Project, Level II
FIGURE 5.7: CONSTANT RATE TEST ANALYSIS

Data Set: L:\WWDC101\PUMPTES0\CONSTANT\BOCSTH.AQT
Date: 05/15/00 Time: 15:26:55

PROJECT INFORMATION

Company: Lidstone & Associates, Inc.
Client: Town of Bairoil
Project: WWDC101
Test Location: Bairoil
Test Well: MW 2A
Obs. Well: MW 2A
Test Date: 11/13/99

AQUIFER DATA

Saturated Thickness: 235. ft
Anisotropy Ratio (Kz/Kr): 1.

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush
T = 147. gal/day/ft
S = 0.03414
β = 0.1
FIGURE 5.8: RECOVERY TEST ANALYSIS

Data Set: L:\WYWDC101\PUMPTEST\STEPTEST\CSTRECV.AQT
Date: 02/28/00   Time: 15:23:42

PROJECT INFORMATION

Company: Lidstone and Associates, Inc.
Client: Town of Bairoil
Project: WYWDC101
Test Location: Bairoil, Wyoming
Test Well: Bairoil 2A
Obs. Well: --
Test Date: 11/16/99 - 11/17/99

AQUIFER DATA


SOLUTION

Aquifer Model: Confined  T = 298.6 gal/day/ft
Solution Method: Theis (Recovery)  S' = 1.945
In addition, uranium was below the reporting limit (0.0003 mg/L) in the one sample that was analyzed for uranium.

The recently revised (October 1999) National Primary Drinking Water Standard for total radium 226 and radium 228 (combined) is 5 pCi/L. The average concentration of radium 226 from the well is 3.2 pCi/L. A sample was analyzed for radium 228 and the results were below detection. LA reviewed historical radium 228 data from the Battle Springs Formation to determine long-term averages. From a review of the radium analyses of the Merit Energy-owned Battle Springs wells, it can be inferred that the average concentration of radium 228 in the Battle Springs Formation would be 1.2 pCi/L. Therefore the combined average concentration of radium 226 and radium 228 will average 4.4 pCi/L. The Town of Bairoil’s proposed new ground water supply well water will meet the National Primary Drinking Water Standard for radium. It is also important to remember that this water will be blended with water from the Abel Springs infiltration gallery. The Abel Springs water has very low concentrations of radium. Therefore, the blended water in the system will contain much lower radium concentrations and will be well below the EPA MCL.

A water sample was collected on November 14, 1999, mid-way through the pump testing, for WDEQ/LQD Guideline VIII analyses. The analyses were performed to characterize the gross chemistry of the ground water. The analyses indicate that the water is a calcium-bicarbonate type water and the water meets the WDEQ/WQD Chapter VIII Class I water quality standards.

Water samples were collected on November 16, 1999, at the end of the pump testing, for EPA SDWA Phase II/V analyses. These analyses indicate that the water meets the National Primary Drinking Water Standards for drinking water.
6.0 CONCEPTUAL DESIGNS AND COST ESTIMATES

6.1 Alternative No. 1 – New Well and Transmission Line

The project team has prepared costs to extend a transmission line from the new source well (Bairoil 2A) to the existing system at Abel Springs. For this alternative, a water transmission line would extend from the well and would be buried approximately 8 feet below ground surface. The line would extend for a distance of approximately 2 miles and would make a connection with the existing line approximately 2,300 feet down from the lower collection box at Abel Springs. The pipeline would have a downhill grade for its entire length, with an average grade from the well head to the connection with the existing line of 5.5 percent. The line would be 6-inch diameter PVC DR14 pipe, and would be rated to 200 psi. The pipeline has been designed with PVC DR14 because of the corrosive nature of the soils and the anticipated line pressures. Pressure relief valves should be installed at several locations along the line to insure that line pressures are in accordance with the manufacturer’s rating and that the ground water source does not backflow into the Springs. Gate valves should be present every 2,000 to 3,000 feet for line testing and replacement; two gate valves should be installed at the connection to Abel Springs line such that either source can be isolated; and the line should be bedded for the entire length.

The new water line will pass entirely through BLM land. The water line from the collection boxes to the 350,000 gallon storage tank was replaced in the mid-1980’s. Therefore, it is assumed that the main Abel Springs transmission line is in good condition and no additional construction beyond the proposed pipeline would be required.

Single phase power would be provided for the well to a submersible pump set at the well. A buried powerline will extend from the well to an existing transformer located 1.25 miles southeast of the new well. This transformer was established for the Union Telephone Company, Inc., in September 1994 and serves the radio transmission tower on top of Whiskey Peak. Figure 6.1 shows a detail of the proposed well location as well as the transmission and power line routes.

The well will be used to supplement the water supply from Abel Springs. Therefore, the required yield will vary throughout the year because of variations in the demand and yield from Abel Springs. The pump testing indicated that the well could sustain a pumping rate of 75 gpm. However, a design pumping rate of 60 gpm should provide enough water to the Bairoil water system; the projected pumping rate for the well is 60 gpm. The total pumping head for the proposed pump unit will be approximately 440 feet. The minimum size motor to meet the above conditions is 15 HP; assuming the pump and motor are each approximately 80 percent efficient. For purposes of this report, the motor was sized at 15 HP utilizing a single phase power source. Well operation and system telemetry would be controlled through a radio unit based on monitoring of water levels in the 350,000 gallon storage tank. Flow and mixing of Abel Springs and the ground water source waters will be controlled by pressure valves and telemetry. An estimate of the probable costs to develop the ground water supply has been presented in Table 6.1. This estimate includes the cost of the well that was installed in this Level II Study.
Table 6.1: Estimate of Probable Costs to Develop a Ground Water Supply-Alternative 1 *

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase Level II (1999) production well</td>
<td>L.S.</td>
<td>1</td>
<td>$110,000.00</td>
<td>110,000</td>
</tr>
<tr>
<td>Construction Mobilization</td>
<td>L.S.</td>
<td>1</td>
<td>$24,000.00</td>
<td>24,000</td>
</tr>
<tr>
<td>6-inch PVC DR14 @ 200psi</td>
<td>L.F.</td>
<td>10,000</td>
<td>$5.00</td>
<td>50,000</td>
</tr>
<tr>
<td>Fittings, 11.25°, 22.5°, 45°, 90°</td>
<td>L.S.</td>
<td>1</td>
<td>$5,000.00</td>
<td>5,000</td>
</tr>
<tr>
<td>6 inch gate valve and valve box</td>
<td>EA</td>
<td>10</td>
<td>$700.00</td>
<td>7,000</td>
</tr>
<tr>
<td>Air relief valve and vault</td>
<td>EA</td>
<td>1</td>
<td>$3,000.00</td>
<td>3,000</td>
</tr>
<tr>
<td>Blow off fitting and drain</td>
<td>EA</td>
<td>1</td>
<td>$3,000.00</td>
<td>3,000</td>
</tr>
<tr>
<td>PRV's + manhole</td>
<td>EA</td>
<td>2</td>
<td>$5,000.00</td>
<td>10,000</td>
</tr>
<tr>
<td>Excavation/backfill</td>
<td>L.F.</td>
<td>10,000</td>
<td>$10.50</td>
<td>105,000</td>
</tr>
<tr>
<td>Bedding</td>
<td>L.F.</td>
<td>10,000</td>
<td>$1.00</td>
<td>10,000</td>
</tr>
<tr>
<td>Submersible Pump, single phase, 15 HP, includes labor</td>
<td>EA</td>
<td>1</td>
<td>$18,000.00</td>
<td>18,000</td>
</tr>
<tr>
<td>Power line to well</td>
<td>EA</td>
<td>1</td>
<td>$40,000.00</td>
<td>40,000</td>
</tr>
<tr>
<td>Telemetry from tank to well</td>
<td>EA</td>
<td>1</td>
<td>$25,000.00</td>
<td>25,000</td>
</tr>
<tr>
<td>Labor (pump setting, plumbing, electrical, fencing, mobilization)</td>
<td>L.S.</td>
<td>1</td>
<td>$20,000.00</td>
<td>20,000</td>
</tr>
</tbody>
</table>

**SUBTOTAL (1)**  $ 430,000.00

**ENGINEERING 10% OF SUBTOTAL (1)**  $ 43,000.00

**SUBTOTAL (2)**  $ 473,000.00

**CONTINGENCY @ 15% OF SUBTOTAL (2)**  $ 70,950.00

**TOTAL CONSTRUCTION COSTS**  $ 543,950.00

**SURVEYING**  $ 15,000.00

**GEOTECHNICAL INVESTIGATIONS**  $ 7,000.00

**PERMITTING COSTS**  $ 20,000.00

**FINAL PLANS/SPECIFICATIONS**  $ 60,000.00

**EASEMENT ACQUISITIONS (LEGAL FEES)**  $ 8,500.00

**SUBTOTAL (3)**  $ 654,450.00

*Please note that while every effort was made to make this cost estimate as accurate as possible. At the time of writing, piping costs are rising monthly because of rising petroleum costs and high demand. Therefore, the costs may be higher at the time of construction.*
6.2 Alternative No. 2 – Abel Springs Redevelopment and Expansion

This section presents an approach to expand the Abel Springs infiltration gallery, reduce water losses between the infiltration gallery and the Bairoil storage tank, and reduce any losses from the collection boxes. Table 6.2 presents the cost estimates for the Abel Springs Redevelopment and Expansion.

In order to evaluate the potential of this alternative, a series of soil pits were excavated to establish the material gradation of the alluvium. Examination of the walls of the open test pits indicated that the shallow material in the Abel Springs area is very fine grained with a low hydraulic conductivity. Thin seams of coarser, more permeable sediment are present. The infiltration gallery could be expanded by adding approximately 500 feet of new or extended collector arms. The current existing trunk lines above the collection boxes would still be used to convey the water to the main transmission line (assuming these pipelines are in good condition and would not have to be replaced). The existing deep Battle Springs wells would commingle and augment the Abel Springs source.

The investigation and design of the infiltration gallery would include: (1) mapping of the existing infiltration gallery; (2) evaluation of the infiltration gallery with the native material as backfill; (3) evaluation of the infiltration gallery with various sand and gravel filter materials as backfill; (4) development of specifications for the screen (slot size and open area); (5) evaluation of conveyance within the transmission line; and (6) assessment of the potential clogging of the infiltration gallery.

In addition, losses from the infiltration gallery would be evaluated and plans would be prepared to repair any areas with significant losses. The following three line sections would be evaluated for water loss by isolating or metering the relevant sections of the system.

- Losses between the collector arms and the collection boxes
- Water flows out of, or into, the floors of the collection boxes
- Losses between the collection boxes and the Bairoil storage tank

The Abel Springs collection boxes are concrete boxes with gravel-lined bases. They were constructed at the location of the actual Abel Springs outflow. However in recent years, the springs may have not been flowing and water may have been flowing out of the collection boxes. If that is the case, LA’s redesign would pipe the collected water through the collection boxes.

As the Bairoil water system has been improved over the years, old structures, some in the vicinity of Abel Springs, have not been fully disconnected or removed. This situation is discussed in Section 6.4, with the related costs shown in Table 6.3, and a map detailing the locations of the old structures on Figure 6.2.
Table 6.2: Abel Springs Redevelopment and Expansion - Alternative 2*

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipeline Construction and Emplacement</td>
<td>L.F.</td>
<td>500</td>
<td>$180.00</td>
<td>$90,000.00</td>
</tr>
<tr>
<td>Granular Filter</td>
<td>L.F.</td>
<td>500</td>
<td>$30.00</td>
<td>$15,000.00</td>
</tr>
<tr>
<td>Excavation</td>
<td>L.S.</td>
<td>1</td>
<td>$15,000.00</td>
<td>$15,000.00</td>
</tr>
</tbody>
</table>

**SUBTOTAL (1)** $120,000.00

ENGINEERING 10% OF SUBTOTAL (1) $12,000.00

**SUBTOTAL (2)** $132,000.00

CONTINGENCY @ 15% OF SUBTOTAL (2) $19,800.00

**TOTAL CONSTRUCTION COSTS*** $151,800.00

SURVEYING $8,200.00

PERMITTING COSTS $15,000.00

FINAL PLANS/SPECIFICATIONS $15,000.00

**SUBTOTAL (3)** $190,000.00

* Please note that while every effort was made to make this cost estimate as accurate as possible. At the time of writing piping costs are rising monthly because of rising petroleum costs and high demand. Therefore, the costs may be higher at the time of construction.
6.3 Distribution System Modifications

Treated water from the storage tank to the distribution system is gravity conveyed by a
ten-inch diameter PVC transmission line. The distribution system is gravity-based over its entire
length. A plan of the existing water distribution system is presented on Figure 2.4. WDEQ/WQD
Rules and Regulations require a minimum operating pressure of 20 psi under all operating conditions
(including fire flow) and 35 psi under normal operating conditions. After modeling the Town’s
distribution system, it became apparent that these requirements were not currently met and that
inadequate pressures are provided under minimal fire flow conditions (500 gpm) throughout most
of the system. This situation is a direct result of the line sizes and demand at the dead-end mains.
To bring the Town’s system into compliance the following modifications are recommended.

- Connect the dead-end main on Badger Circle to the eight-inch system main on
  Antelope Drive, by adding approximately 166 feet of six-inch line.

- Connect the dead-end main at the end of Deer Court to the dead-end main at the end
  of Elk Court (the two cul-de-sacs extending north west from Purple Sage Avenue),
  then extend this main to the six-inch main on Iris Avenue, by adding approximately
  538 feet of six-inch line.

- Connect the six-inch dead-end main at the intersection of Beebe Avenue and Iris
  Avenue to the eight-inch service main on Antelope Drive with approximately 1,180
  feet of six-inch pipe following Iris Avenue.

- Connect the six-inch main from Rodeo Road to the six-inch main at the intersection
  of Rodeo Road and Antelope Drive with approximately 1,216 feet of six-inch line.

- Replace the 4-inch transite line on Primrose with approximately 1,650 feet of 6-inch
  PVC and connect to the 8-inch main on Antelope Drive.

Making the above improvements to the system may help to reduce operations and
maintenance expenses associated with the flushing of mains at dead-ends. Looping the system to
eliminate this requirement may also help to reduce the elevated copper levels which have been
observed in various parts of the system because of improved flow through the entire system.
Figure 6.3 shows a diagram of the existing system and the proposed improvements. Table 6.3
presents the cost estimates for the distribution system improvements and miscellaneous work. The
water distribution modeling was performed by BRS, Inc., whose report is presented in Appendix III.
PROPOSED IMPROVEMENTS TO THE DISTRIBUTION SYSTEM
### Table 6.3: Bairoil Distribution System Improvements and Miscellaneous Work*

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-inch PVC DR14 @ 200psi</td>
<td>L.F.</td>
<td>4750</td>
<td>$ 5.00</td>
<td>$ 23,750.00</td>
</tr>
<tr>
<td>6 inch gate valves</td>
<td>EA</td>
<td>13</td>
<td>$ 700.00</td>
<td>$ 9,100.00</td>
</tr>
<tr>
<td>Hydrants</td>
<td>EA</td>
<td>4</td>
<td>$ 2,500.00</td>
<td>$ 10,000.00</td>
</tr>
<tr>
<td>Fittings</td>
<td>L.S.</td>
<td>1</td>
<td>$ 5,000.00</td>
<td>$ 5,000.00</td>
</tr>
<tr>
<td>Excavation/backfill</td>
<td>L.F.</td>
<td>4750</td>
<td>$ 10.50</td>
<td>$ 49,875.00</td>
</tr>
<tr>
<td>Bedding</td>
<td>L.F.</td>
<td>4750</td>
<td>$ 1.00</td>
<td>$ 4,750.00</td>
</tr>
<tr>
<td>Resurface road</td>
<td>L.S.</td>
<td>1</td>
<td>$ 10,000.00</td>
<td>$ 10,000.00</td>
</tr>
<tr>
<td>Labor (pressure testing, cleanup, mobilization)</td>
<td>L.S.</td>
<td>1</td>
<td>$ 10,000.00</td>
<td>$ 10,000.00</td>
</tr>
<tr>
<td>Leak Detection Survey</td>
<td>L.S.</td>
<td>1</td>
<td>$ 3,000.00</td>
<td>$ 3,000.00</td>
</tr>
<tr>
<td>Surveying/Plans/Easements</td>
<td>EA</td>
<td>1</td>
<td>$ 5,000.00</td>
<td>$ 5,000.00</td>
</tr>
<tr>
<td>Abandon three wells along Abel Creek</td>
<td>L.S.</td>
<td>3</td>
<td>$ 3,666.67</td>
<td>$ 11,000.00</td>
</tr>
<tr>
<td>Abandon old storage tanks</td>
<td>L.S.</td>
<td>3</td>
<td>$ 3,666.67</td>
<td>$ 11,000.00</td>
</tr>
</tbody>
</table>

**SUBTOTAL (1)**: $ 152,475.00

**ENGINEERING 10% OF SUBTOTAL (1)**: $ 15,000.00

**SUBTOTAL (2)**: $ 167,475.00

**CONTINGENCY @ 15% OF SUBTOTAL (2)**: $ 25,000.00

**TOTAL CONSTRUCTION COSTS***: $ 192,475.00

SURVEYING: $ 8,000.00

PERMITTING COSTS: $ 1,525.00

FINAL PLANS/SPECIFICATIONS: $ 35,000.00

**SUBTOTAL (3)**: $ 237,000.00

*Please note that while every effort was made to make this cost estimate as accurate as possible, at the time of writing piping costs are rising monthly because of rising petroleum costs and high demand. Therefore the costs may be higher at the time of construction.
6.4 Removal of Old Water System Structures

Research and field investigation by LA and their subcontractors indicates that there are a number of other problems, potential sources of contamination, and/or precautionary measures associated with the water system which should be addressed. These include the following:

- **Complete abandonment of the three alluvial wells along Abel Creek.**
The wells were taken “off line” because they could not maintain the required yields. Abandon the wells by removing the pumps and plugging the casing to the surface with cement (Figure 6.2).

- **Backfill the old chlorine contact chamber with earth** (Figure 6.2).
Remove all miscellaneous debris.

- **Remove abandoned water storage tanks, old valves and appurtenances.**
Three old water storage tanks are located near the 350,000 gallon storage tank. These should be removed. There are also a series of valves near the 350,000 gallon storage tank, some of which serve the old tanks. It appears that none of these old lines have been properly abandoned and there is a potential for leakage between these lines and the current water system – which could result in water quality problems. These valves to unused lines should be removed and the lines currently required for service re-plumbed accordingly.

6.5 Additional Ground Water Well

In addition to the newly constructed well (Bairoil 2A) in Section 20, LA recommends further ground water exploration in the Abel Springs/Reed Creek area. A second ground water well would provide source redundancy and insure that long-term water supply needs are met by a ground water source only.

6.6 Installation of Water Meters

Although water conservation measures are not funded by the WWDC, it may be prudent to recommend water conservation and the installation of water meters at each transmission line, storage tank and at each service. Water meters will allow the Town to balance water use and water demand throughout the year. In addition, installation of individual water meters at all points in the distribution system and the institution of a rate schedule based on water usage will promote water conservation and reduce operations and maintenance costs. However, we are cognizant of the Town’s reluctance to pursue this option and have not prepared costs for the meters.
7.0 PERMITTING AND ENVIRONMENTAL ISSUES

For this project to proceed with construction, the Town of Bairoil will be required to obtain certain permits, rights of way, and easements. State, county, and federal agencies must be contacted as part of the Level III process. In some instances, the initial contacts have already been made. The following issues for each alternative must be addressed during final design.

7.1 Alternative No. 1 – New Well and Transmission Line

Easements. Easements will be required for the transmission line and the power supply line through the USDI-Bureau of Land Management (BLM). In order to secure an easement, a Cultural Resources Survey will need to be performed along the proposed routes. Clearance for the proposed activities must be obtained from the State Historic Preservation Office (SHPO) as well as the BLM. The US Fish and Wildlife Service (USFWS) may require a survey for Threatened and Endangered Species. Easements may need to be addressed with the Sun Ranch for the distance that the existing road crosses Sun Ranch Property (approximately 4,400 feet). A legal opinion regarding the existing easements in recommended.

USACE §404 Permit. The pipeline will cross at least one drainage which would qualify as a Water of the United States (due to the presence of a defined bed and bank) and will potentially qualify as a Jurisdictional Wetland. These construction activities may require a §404 permit from the USACE and §401 authorization from the State of Wyoming.

WDEQ/WQD Permit to Construct. The transmission line from the well to the existing Abel Springs pipeline will require a “Permit to Construct” from the WDEQ/WQD.

Water Rights Permit. Upon completion and placement of the production pump in the well, the appropriate completion forms must be submitted to the WSEO and the new water right adjudicated by the State Board of Control. A Statement of Beneficial Use should also be filed with the WSEO.

Power Company Coordination. The power company which owns the power line extending from Bairoil to the top of Whiskey Peak must be contacted to arrange a power connection from the line to the well.

7.2 Alternative No. 2 – Abel Springs Redevelopment and Expansion

BLM Easements. The majority of the existing infiltration gallery is located on lands under BLM jurisdiction and a records search indicates that an easement has never been secured. An easement with the BLM would need to be secured and filed with the Fremont County Clerk. A Cultural Resources survey would need to be completed in the area of the proposed activity and clearance from the SHPO obtained. The USFWS would most likely require a survey for Threatened and Endangered species.

USACE §404 Permit. The area of the existing infiltration gallery lies within the bottom of the Abel Springs Creek drainage and this area would potentially be considered a Jurisdictional Wetland. These activities may require a §404 permit from the USACE and 401 authorization from the State of Wyoming. Depending on the projected impact, a wetlands mitigation plan could be required.

WDEQ/WQD Permit to Construct. Modifications to the existing infiltration gallery would require a “Permit to Construct” from the WDEQ/WQD.
Water Rights Permit. An enlarged water right should be registered with the WSEO including a Statement of Beneficial Use. Upon completion of construction, completion forms should be submitted to the WSEO and the right adjudicated before the State Board of Control. A legal opinion regarding the existing Abel Springs water system easement is recommended. Furthermore, a survey documenting the metes and bounds of the existing pipeline will be required.

7.3 Distribution System Improvements

WDEQ/WQD Permit to Construct. The distribution system upgrades will require a “Permit to Construct” from the WDEQ/WQD.
8.0 ECONOMIC ANALYSIS AND ABILITY TO PAY

LA's recommendations to the Town of Bairoil can be considered in three parts: (1) development of a Battle Springs well water supply, the preferred alternative; (2) Abel Springs redevelopment and expansion; and (3) upgrades and modifications to the distribution system. The ground water supply alternative involves the construction of a well in the Battle Springs Formation and a transmission line from the well to the existing Abel Springs pipeline down-gradient of the lowest collection box of the infiltration gallery. It involves all the work necessary to bring the well online and pump water from the well in the water system. A statement of reasons for this selection has been presented in the Chapters 4 and 6.

There are several potential sources for funding this project. These include the following:

- Private financing through the Town of Bairoil
- Wyoming Water Development Commission: 60% grant, 40% loan
- Rural Utilities Service Loan: interest rate of 5%
- Wyoming State Revolving Fund: interest rate of 4%
- Wyoming Mineral Fund Loan
- Wyoming State Lands and Investments Loan: match program

Funding from the Wyoming Water Development Commission can only be secured for the water supply portion of the project. The money available would be in the form of a 60% grant and 40% loan at an interest rate of 7.25 percent.

Funding through the Rural Utilities Services (RUS) is limited because of the per capita income for the Town, which, according to the 1990 Census, was slightly in excess of $40,000. This income level does not allow for a grant from the RUS. To obtain an RUS loan, a bond election must be held at the cost of $2,000 to $5,000 to guarantee the loan. In addition, to be eligible for funding through the RUS, an Environmental Report (ER) must be prepared. An ER was prepared by LA and has been submitted to the WWDC.

Funding from the Wyoming SRF is available at an interest rate of 4%. This funding can be used for both the supply and distribution portions of the project. Money from this program is made available based on a "need basis" which is judged on a point system.

LA has estimated the cost of the water supply (implementation of Alternative No. 1) portion of the proposed project at $654,450. LA has also estimated the cost of the Abel Springs redevelopment and expansion to be $190,000. In addition, LA has included recommendations to bring the water distribution system up to the standards outlined in the WDEQ/WQD Chapter XII Rules and Regulations. These improvements are estimated to cost approximately $237,381.

Tables 8.1 through 8.3 present the financing options for the ground water supply development, the Abel Springs redevelopment and expansion, and distribution system improvements, respectively. The Town of Bairoil has made the determination that they will not apply for RUS or SRF funding. With that in mind, LA has only presented the WWDC funding option in Tables 8.1 and 8.2. For the purposes of this presentation we have incorporated a WWDC loan portion of the grant/loan package. Bairoil has chosen not to request the loan. The work defined in Table 8.3 is not eligible for WWDC funding. LA has presented financing options for funding from the State Loan and Investment Board, SRF, and RUS in this table.
### Table 8.1: Financing of Ground Water Supply Development

<table>
<thead>
<tr>
<th>Item</th>
<th>Financing Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction cost WWDC eligible</td>
<td>$654,450.00</td>
</tr>
<tr>
<td>WWDC 60-percent Grant</td>
<td>$392,670.00</td>
</tr>
<tr>
<td>Loan Amount</td>
<td>$261,780.00</td>
</tr>
<tr>
<td>WWDC Loan @ 7.25% - 30 yr.</td>
<td>($1,775.08)</td>
</tr>
</tbody>
</table>

#### Additional Monthly Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Financing Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorination</td>
<td>$100.00</td>
</tr>
<tr>
<td>Easements</td>
<td>$2.50</td>
</tr>
<tr>
<td>Pumping Cost</td>
<td>$161.10</td>
</tr>
<tr>
<td>Labor</td>
<td>$520.00</td>
</tr>
</tbody>
</table>

#### Long-term Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Financing Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Pump replacements</td>
<td>$22.22</td>
</tr>
</tbody>
</table>

#### Totals

<table>
<thead>
<tr>
<th>Item</th>
<th>Financing Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Monthly Cost</td>
<td>($2,580.90)</td>
</tr>
<tr>
<td>Total Monthly Tap cost @ 65 taps</td>
<td>($39.71)</td>
</tr>
</tbody>
</table>

### Table 8.2: Financing for Abel Springs Redevelopment and Expansion

<table>
<thead>
<tr>
<th>Item</th>
<th>Financing Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Cost</td>
<td>$190,000.00</td>
</tr>
<tr>
<td>WWDC 60-percent Grant</td>
<td>$114,000.00</td>
</tr>
<tr>
<td>Loan Amount</td>
<td>$76,000.00</td>
</tr>
<tr>
<td>WWDC Loan @ 7.25% - 30 yr.</td>
<td>($515.34)</td>
</tr>
</tbody>
</table>

#### Total

<table>
<thead>
<tr>
<th>Item</th>
<th>Financing Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly Tap Cost w/ 65 taps</td>
<td>($7.93)</td>
</tr>
</tbody>
</table>
Table 8.3: Financing Alternatives for Distribution System Improvements

<table>
<thead>
<tr>
<th>Item</th>
<th>Option 1 SLIB</th>
<th>Option 2 SRF</th>
<th>Option 3 RUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Community Cost</td>
<td>$118,690.44</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Loan Amount</td>
<td>$118,690.00</td>
<td>$237,380.00</td>
<td>$237,380.00</td>
</tr>
<tr>
<td>State Loan and Investment Board</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Monthly Payment @ 7.25% for 30 yrs.</td>
<td>($804.81)</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>State Revolving Fund Loan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly Payment @ 4% for 20 yrs.</td>
<td>-----</td>
<td>($1,433.70)</td>
<td>-----</td>
</tr>
<tr>
<td>Rural Utilities Service Loan</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Monthly Payment @ 5.5% for 30 yrs.</td>
<td>-----</td>
<td>-----</td>
<td>($1,341.67)</td>
</tr>
</tbody>
</table>

**Totals**

| Monthly Tap Cost w/ 65 taps                   | ($12.38)          | ($22.06)         | ($20.64)         |

**NOTES**

- Rural Utilities Service (RUS) funding requires a bond election at a cost of $2,000 to $5,000. The above analyses assumes that the Town incurs this cost internally.
- RUS funding is a variable interest rate which changes quarterly.
- The monthly tap cost does not include the initial community cost.
- State Revolving Fund (SRF) money is available through a point system, whereby the community(s) with the most points are the first to be financed.
- Labor cost assumes 4 hours per week at a pay rate of $30 per hour for reading the telemetry unit and chlorination tank operation, etc.
- The analyses assumes there will be 2 pump replacements over the 30 year period at a cost of $4,000 per replacement (includes labor cost).
- State Loan and Investment Board money is based on a 50% loan - 50% community match. Thus, the Town must contribute $114,753.12 towards the improvements to the distribution system.
- Wyoming Water Development Commission (WWDC) Grant money is only available for supply and transmission.
- Pumping Cost estimate was based on a 10HP motor with 440 feet of lift and the overall efficiency of the pump and motor is 67 percent and the price of electricity is $0.06 per KWH.
9.0 RECOMMENDATIONS

This report documents the results of the Level II investigation for the Town of Bairoil Water Supply Project. Based on this investigation LA recommends the following work.

Utilize the new Battle Springs well. This well, Bairoil 2A, was installed during the Level II Investigation and should be tied in to the water system. This is the preferred water supply alternative. This work is eligible for WWDC funding. Costs have been prepared for this alternative and are presented in Table 6.1

Rehabilitate and expand the Abel Springs infiltration gallery. This alternative is also considered a viable means of increasing the quantity of high quality Abel Springs water in the system. The estimated increase in yield is expected to be approximately 20 to 30 percent. This work is eligible for WWDC funding. Costs have been prepared for this alternative and are presented in Table 6.2.

Make modifications to the distribution system. LA recommend several improvements to the distribution system to increase water pressures throughout the system and hence improve fire flow, and to improve the water quality. The improvements will allow the system to meet the pressure requirements as outlined in the WDEQ/WQD Rules and Regulations. In addition, the improvements will eliminate the requirement for the constant flushing under the current configuration. These improvements consist mainly of looping dead-end mains. This work is not eligible for WWDC funding. Costs have been prepared for this alternative and are presented in Table 6.3.

Remove old water system structures. LA recommends that the old storage tanks and water system components be removed. They are still partially connected to the existing system and there is a resultant chance of contamination through those disused components. Costs have been prepared for this work although it is not strictly an improvement to the distribution system. These costs have been presented in Table 6.3. The recommended removals are:

- Abandon the three alluvial wells along Abel Creek.
- Remove the old water storage tanks in Bairoil.
- Clean up old water system components that are no longer in use.

Perform miscellaneous work. LA also recommend that the following miscellaneous work be performed on the system. Costs have not been prepared for all of this work.

- Conduct a leak detection survey of the distribution system.
- Replace the broken transmission line meter.
- Add water meters at the points of service.
- Repair broken seals and welds at the Abel Springs collection boxes.
- Fence off the collection area from livestock.
- Repair the altitude valve on the Battle Springs line.
- Install a backflow preventer at the junction between the ¾-inch service line to the corrals and the distribution line, if one is not already in place. The backflow preventer should be an approved reduced pressure principal backflow prevention device in the system line, as specified by Chapter XII of the DEQ/WQD Rules and Regulations.

Clarify or obtain all easements.
Keep Merit Energy's Battle Springs wellfield on line. The Merit Energy Battle Springs wellfield should continue to be utilized for supplemental water to meet high demand flows, as long as there is no cost to the Town for doing so.

Drill a second Battle Springs well for redundant supply. If the new Battle Springs well is brought online and is augmented by the Abel Springs water, the Town will have an adequate supply for meet the demand. The Town will no longer be dependent on Merit Energy's Battle Springs pipeline. However, there is no redundant supply. Therefore, LA recommend that an additional well be constructed in the Battle Springs Formation as an extension of the Level II investigation. This well should also be located such that it can be connected into the transmission line.

9.1 Operations and Maintenance Consideration

If the above recommendations are implemented and using the chlorination system already in place, the Town should be able to meet anticipated future EPA ground water treatment rules without any change in personnel requirements to operate the system.
10.0 REFERENCES


Appendix I
Wyoming State Engineer's Office
Well Permits
STATE OF WYOMING
OFFICE OF THE STATE ENGINEER
HENSCHLER BLDG., 4-E CHEYENNE, WYOMING 82002

APPLICATION FOR PERMIT TO APPROPRIATE GROUND WATER

APPLICATION FOR WELLS AND SPRINGS
Note: Only springs flowing 25 gallons per minute or less, where the proposed use is domestic and/or stock watering, will be considered as ground water appropriations.

APPLICATION FOR OFFICE USE ONLY

PERMISS NO. U.W. 118628
WATER DIVISION No. 1 DISTRICT Fremont
U.W. DISTRICT

Temporary Filing No. U.W. 28-1-60
NOTE: Do not fold this form. Use typewriter or print neatly with black ink.
ALL ITEMS MUST BE COMPLETED BEFORE APPLICATION IS ACCEPTABLE

NAME AND NUMBER OF WELL or SPRING Bairrol BH-1

1. Name of applicant(s) Wyoming Water Development Commission Phone: (307) 777-7626
2. Address of applicant(s) Herschler Building, 122 W. 25th Street, Cheyenne, WY 82002
(MAILING ADDRESS)
(CITY) (STATE)
(MAILING ADDRESS)
(CITY) (STATE)
_760 Whalers Way, Ste. B-200 Ft. Collins, CO 80525 Phone: (970) 223-4705
(MAILING ADDRESS)
(CITY) (STATE)
(MAILING ADDRESS)
(CITY) (STATE)
4. Use to which the water will be applied:
   [ ] Domestic: Use of water in 3 family dwelling units or less, noncommercial watering of lawns and gardens totaling one acre or less. Number of houses served? __________
   [ ] Stock Watering: Normal livestock use at four tanks or less, within one mile of well or spring. Stockwatering pipelines and commercial feedlots are a miscellaneous use. Number of stock tanks? __________
   [ ] Irrigation: Watering of commercially grown crops (large-scale farming of golf courses, cemeteries, recreation areas, etc., is miscellaneous use).
   [ ] Municipal: Use of water in incorporated Towns and Cities (use of water in unincorporated towns, subdivisions, improvement districts, mobile home parks, etc. are classified as miscellaneous use).
   [ ] Industrial: Long term use of water for the manufacture of a product or production of oils or other minerals (oil field water, operations, power plant water supply, etc.). (Describe in REMARKS)
   [ ] Miscellaneous:

   Any use of water not defined under previous definitions such as stockwater pipelines, subdivisions, main watering, minimal irrigation systems or stock watering, will be considered as ground water appropriations. (Describe miscellaneous use completely)

   [ ] Monitor, Observation or [X] Test Well: (Describe in REMARKS)

5. Location of the well or spring: (NOTE: Quarter-quarter (40 acre subdivision) MUST be shown. EXAMPLE: SE 1/4 NW 1/4 of Sec. 12, Wyoming, Fremont County, SW 1/4 NE 1/4 of Sec. 19, T. 27 N., R. 90 W. of the 6th P.M. (or W.R.M.). Wyoming, if located in a platted subdivision, also provide Lot Block Subdivision (or Addn) of ____________ Resurvey Location: Tract __________, (or Lot) __________

6. Estimated depth of the well or spring is ______ feet.

7. (a) MAXIMUM instantaneous flow of water to be developed and beneficially used: ______ gallons per minute.

   NOTE: If for domestic and/or stock use, this application will be processed for a maximum of 25 gallons per minute. For a spring, after approval of this application, some type of artificial diversion or improvement must be constructed to qualify for a water right.

   (b) MAXIMUM volumetric quantity of water to be developed and beneficially used per calendar year: ______

   Circle appropriate units: (Gallons) (Acre Feet) A four person family utilizes approximately one (1) acre-foot of water per year or 325,000 gallons.

8. Mark the point(s) or area(s) of use in the tabulation box below.

   TABULATION BOX

<table>
<thead>
<tr>
<th>TWP</th>
<th>RNG</th>
<th>SEC</th>
<th>NE 1/4</th>
<th>NW 1/4</th>
<th>SW 1/4</th>
<th>SE 1/4</th>
<th>NE 1/4</th>
<th>NW 1/4</th>
<th>SW 1/4</th>
<th>SE 1/4</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. If for irrigation use:
   a. Describe MAXIMUM acreage to be irrigated in each 40 acre subdivision in the tabulation box above.
   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.

10. If not irrigation use, describe method of irrigation, i.e. center pivot sprinkler, flood, etc.: _____________________________

    118628 SEE REVERSE SIDE
11. The well or spring is to be constructed on lands owned by ... Bureau of Land Management...

(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 the co-applicant.)

12. The water is to be used on lands owned by ... N/A ...

(If the landowner is not the applicant, a copy of the agreement relating to the usage of appropriated water on the land should be submitted to this office. If the landowner is included as co-applicant on the application, this procedure need not be followed.)

NOTE: Water rights attach to the area(s) and/or point(s) of use.

REMARKS: Exploration borehole for water supply purposes. The borehole will not be completed as a water well and will be abandoned in place.

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

(Domestic use is defined as use of water in 3 single family dwellings or less, non-commercial watering of lawns and gardens totaling one acre or less)

$25.00

IRRIGATION, MUNICIPAL, INDUSTRIAL, MISCELLANEOUS

$50.00

MONITOR (For water level measurements or chemical quality sampling) or TEST WELL

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

STATE ENGINEER'S OFFICE

This instrument was received and filed for record on the 4th day of August, 19...

118628

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 sub-surface formations or at the land surface.

Approval of this application may be considered as authorization to proceed with construction of the proposed well or spring. A Statement of Completion will be filed within thirty (30) days of completion of construction.

Completion of construction will be made by December 31, 19...

This application is for test purposes only; no water will be beneficially used. This permit will be automatically cancelled on December 31, 2000 or upon receipt of an acceptable Statement of Completion. PROOF OF APPROPRIATION AND BENEFICIAL USE OF GROUND WATER (FORM U.W. 1) IS WAIVED UNDER THIS PERMIT.

Approval of this application may be considered as authorization to proceed with construction of the proposed well or spring. A Statement of Completion will be filed within thirty (30) days of completion of construction.

Completion of construction will be made by December 31, 19...

This application is for test purposes only; no water will be beneficially used. This permit will be automatically cancelled on December 31, 2000 or upon receipt of an acceptable Statement of Completion. PROOF OF APPROPRIATION AND BENEFICIAL USE OF GROUND WATER (FORM U.W. 1) IS WAIVED UNDER THIS PERMIT.
APPLICATION FOR PERMIT TO APPROPRIATE GROUND WATER

STATE OF WYOMING
OFFICE OF THE STATE ENGINEER
HERSCHLER BLDG., 4-E CHEYENNE, WYOMING 82002

APPLICATION FOR PERMIT TO APPROPRIATE GROUND WATER

Note: Only springs flowing 25 gallons per minute or less, where the proposed use is domestic and/or stock watering, will be considered as ground water appropriations.

NAME AND NUMBER OF WELL OR SPRING  Bairoil BH-2

1. Name of applicant(s)  Wyoming Water Development Commission  Phone: (307)777-7626
2. Address of applicant(s)  Herschler Bldg., 122 W. 25th St., Cheyenne, WY 82002
   (MAILING ADDRESS)  (CITY)  (STATE)  (ZIP)
3. Name & address of agent to receive correspondence and notices  Chris Lidstone-Lidstone & Associates, Inc
   760 Whalers Way, Suite B-200, Fort Collins, CO 80525
   (MAILING ADDRESS)  (CITY)  (STATE)  (ZIP)

4. Use to which the water will be applied:
   ☐ Domestic: Use of water in 3 single family dwellings or less, noncommercial watering of lawns and gardens totaling one acre or less. Number of houses served? _____
   ☐ Stock Watering: Normal livestock use at four tanks or less within one mile of well or spring. Stockwatering pipelines and commercial feedlots are a miscellaneous use. Number of stock tanks? _____
   ☐ Irrigation: Watering of commercially grown crops (large-scale lawn watering of golf courses, cemeteries, recreation areas, etc. is miscellaneous use)
   ☐ Municipal: Use of water in incorporated Towns and Cities (use of water in unincorporated towns, subdivisions, improvement districts, mobile home parks, etc. are classified as miscellaneous use).
   ☐ Industrial: Long term use of water for the manufacture of a product or production of oil, gas, or other minerals (oil field water flood operations, power plant water supply, etc.). (Describe in REMARKS)
   ☐ Miscellaneous: Any use of water not defined under previous definitions such as stockwater pipelines, subdivisions, mine dewatering, mineral oil exploration, drilling, reclamation purposes, potable and sanitary supplies in offices or light manufacturing, animal waste management, etc. Describe miscellaneous use completely:
   ☐ Monitor, Observation or ☐ Test Well: (Describe in REMARKS)

5. Location of the well or spring: (NOTE: Quarter-quarter (40 acre subdivision) MUST be shown. EXAMPLE: SE 1/4 NW 1/4 of Sec. 12, Township 14 North, Range 68 West.)
   Fremont County  NE 1/4  SE 1/4 of Sec. 19, T. 27 N., R. 90 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 . Resurvey Location: Tract , (or Lot) .

6. Estimated depth of the well or spring is 600 feet.

7. (a) MAXIMUM instantaneous flow of water to be developed and beneficially used: 0 gallons per minute.
   NOTE: If for domestic and / or stock use, this application will be processed for a maximum of 25 gallons per minute. For a spring, after approval of this application, some type of artificial diversion or improvement must be constructed to qualify for a water right.
   (b) MAXIMUM volumetric quantity of water to be developed and beneficially used per calendar year: 0
   Circle appropriate units: (Gallons) (Acre Feet) A four person family utilizes approximately one (1) acre-foot of water per year or 325,000 gallons.

8. Mark the point(s) or area(s) of use in the tabulation box below.

TABULATION BOX

9. If for irrigation use:
   a. Describe MAXIMUM acreage to be irrigated in each 40 acre subdivision in the tabulation box above
   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.

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

Permit No. U.W. 118629
Book No. 897 Page No. 80
11. The well or spring is to be constructed on lands owned by Bureau of Land Management
(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 the co-applicant.)

12. The water is to be used on lands owned by N/A
(If the landowner is not the applicant, a copy of the agreement relating to the usage of appropriated water on the land should
be submitted to this office. If the landowner is included as co-applicant on the application, this procedure need not be followed.)
NOTE: Water rights attach to the area(s) and/or point(s) of use.

REMARKS: Exploration Borehole For Water Supply Purposes. The borehole will
not be completed as a water well and will be abandoned in place.

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

August 1, 1995

THE LEGALLY REQUIRED FILING FEE MUST ACCOMPANY THIS APPLICATION

DOMESTIC AND/OR STOCK WATERING USES
(Domestic use is defined as use of water in three family dwellings or less,
noncommercial watering of lawns and gardens totaling one acre or less.)

IRRIGATION, MUNICIPAL, INDUSTRIAL, MISCELLANEOUS

$50.00

MONITOR (For water level measurements or chemical quality sampling) or TEST WELL

NO FEE

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

THE STATE OF WYOMING )
) ss.
STATE ENGINEER'S OFFICE )
This instrument was received and filed for record on the 6th day of August, A.D.
1999 at 9:30 o'clock a.m.

Permit No. U.W. 118629

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 sub-surface formations or at the land surface.

This application is for test purposes only; no water will be beneficially used. This
permit will be automatically cancelled on December 31, 2000 or upon receipt of an acceptable
Statement of Completion. PROOF OF APPROPRIATION AND BENEFICIAL USE OF GROUND WATER
(FORM U.W. 8) IS WAIVED UNDER THIS PERMIT.

Approval of this application may be considered as authorization to proceed with construction of the proposed well or spring. A Statement
of Completion will be filed within thirty (30) days of completion of construction.

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

The required appropriation shall be limited to the quantity to which permission is granted, and to the point of use of ground water
demanded by the application.

Witness my hand this 13TH day of SEPT., A.D. 1999.

[Signature]

State Engineer
APPLICATION FOR PERMIT TO APPROPRIATE GROUND WATER

APPLICATION FOR WELLS AND SPRINGS

Note: Only springs flowing 25 gallons per minute or less, where the proposed use is domestic and/or stock watering, will be considered as ground water appropriations.

FOR OFFICE USE ONLY

PERMIT NO. U.W. 118630
WATER DIVISION No. I DISTRICT
U.W. DISTRICT Fremont Co.

Temporary Filing No. U.W. 28/9-60
NOTE: Do not fold this form. Use typewriter or print neatly with black ink.
ALL ITEMS MUST BE COMPLETED BEFORE APPLICATION IS ACCEPTABLE

NAME AND NUMBER OF WELL or SPRING Bairoil BH-3

1. Name of applicant(s) Wyoming Water Development Commission Phone: (307) 777-7626

2. Address of applicant(s) Herschler Bldg., 122 W. 25th St., Cheyenne, WY 82002
   (MAILING ADDRESS) (CITY) (STATE) (ZIP)

   760 Whalers Way, Ste. B-200, Fort Collins, WY 80525 Phone: (970) 223-4705
   (MAILING ADDRESS) (CITY) (STATE) (ZIP)

4. Use to which the water will be applied:
   □ Domestic: Use of water in 3 single family dwellings or less, noncommercial watering of lawns and gardens
   totaling one acre or less. Number of houses served: 
   □ Stock Watering: Normal livestock use at four tanks or less within one mile of well or spring. Stockwatering pipelines and commercial feedlots are a miscellaneous use. Number of stock tanks: 
   □ Irrigation: Watering of commercially grown crops (large-scale lawn watering of golf courses, cemeteries, recreation areas, etc., is miscellaneous use).
   □ Municipal: Use of water in incorporated Towns and Cities (use of water in unincorporated towns, subdivisions, improvement districts, mobile home parks, etc. are classified as miscellaneous use).
   □ Industrial: Long term use of water for the manufacture of a product or production of oil/gas or other minerals (oil field water flood operations, power plant water supply, etc.). (Describe in REMARKS)
   □ Miscellaneous: Any use of water not defined under previous definitions such as stockwater pipelines, subdivisions, mine dewatering, mineral/oil exploration drilling, reclamation purposes, potable and sanitary supplies in offices or light manufacturing, animal waste management, etc. Describe miscellaneous use completely:
   □ Monitor, Observation or Test Well: (Describe in REMARKS)

5. Location of the well or spring: (NOTE: Quarter-quarter (40 acre subdivision) MUST be shown. EXAMPLE: SE 1/4 NW 1/4 of Sec. 12, Township 14 North, Range 68 West)
   Fremont County SW 1/4 SE 1/4 of Sec. 19, T. 27 N., R. 90 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 . Resurvey Location: Tract , (or Lot )

6. Estimated depth of the well or spring is 600 feet.

7. (a) MAXIMUM instantaneous flow of water to be developed and beneficially used: 0 gallons per minute.
   NOTE: If for domestic and/or stock use, this application will be processed for a maximum of 25 gallons per minute. For a spring, after approval of this application, some type of artificial diversion or improvement must be constructed to qualify for a water right.
   (b) MAXIMUM volumetric quantity of water to be developed and beneficially used per calendar year: 0
   Circle appropriate units: (Gallons) (Acre Feet) A four person family utilizes approximately one (1) acre-foot of water per year or 325,000 gallons.

8. Mark the point(s) or area(s) of use in the tabulation box below.

9. If for irrigation use:
   a. Describe MAXIMUM acreage to be irrigated in each 40 acre subdivision in the tabulation box above.
   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.

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

Permit No. U.W. 118630 SEE REVERSE SIDE Book No. 897 Page No. 81
11. The well or spring is to be constructed on lands owned by Bureau of Land Management.
   (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 the co-applicant.)

12. The water is to be used on lands owned by N/A
   (If the landowner is not the applicant, a copy of the agreement relating to the usage of appropriated water on the land should be submitted to this office. If the landowner is included as co-applicant on the application, this procedure need not be followed.)

NOTE: Water rights attach to the area(s) and/or point(s) of use.

REMARKS: Exploration Borehole For Water Supply Purposes. The borehole will not be completed as a water well and will be abandoned in place.

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

THE LEGALLY REQUIRED FILING FEE MUST ACCOMPANY THIS APPLICATION

DOMESTIC AND/OR STOCK WATERING USES
   (Domestic use is defined as use of water in 3 single family dwellings or less, noncommercial watering of lawns and gardens totaling one acre or less.)
   $25.00

IRRIGATION, MUNICIPAL, INDUSTRIAL, MISCELLANEOUS
   $50.00

MONITOR (For wellbore measurements or chemical quality sampling) or TEST WELL
   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
STATE ENGINEER’S OFFICE
This instrument was received and filed for record on the 4th day of August, 1999, at 9:30 o'clock A.M.

118630

Permit No. U.W.

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 sub-surface formations or at the land surface.

This application is for test purposes only; no water will be beneficially used. This permit will be automatically cancelled on December 31, 2000 or upon receipt of an acceptable Statement of Completion. PROOF OF APPROPRIATION AND BENEFICIAL USE OF GROUND WATER (FORM U.W. 8) IS WAIVED UNDER THIS PERMIT.

Approval of this application may be considered as authorization to proceed with construction of the proposed well or spring. A Statement of Completion will be filed within thirty (30) days of completion of construction.

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

This application is subject to the responsibility to which permits are entitled under Wyoming law and its regulations.

Witness my hand this 13TH day of September, 1999.

[Signature]
APPLICATION FOR PERMIT TO APPROPRIATE GROUND WATER

APPLICATION FOR WELLS AND SPRINGS

Note: Only springs flowing 25 gallons per minute or less, where the proposed use is domestic and/or stock watering, will be considered as ground water appropriations.

NAME AND NUMBER OF WELL or SPRING

Wyoming Water Development Commission

1. Name of applicant(s):

Wyoming Water Development Commission

2. Address of applicant(s):

Herschler Bldg., 122 W. 25th Street, Cheyenne, WY 82002

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

Chris Lids, Ass Ocia te

760 Whalers Way, Suite B- 200, Fort Collins, CO 80525

4. Use to which the water will be applied:

☐ Domestic: Use of water in 3 single family dwellings or less, noncommercial watering of lawns and gardens totalling one acre or less. Number of houses served?

☐ Stock Watering: Normal livestock use at four tanks or less within one mile of well or spring. Stockwatering pipelines and commercial feedlots are a miscellaneous use. Number of stock tanks?

☐ Irrigation: Watering of commercially grown crops (large-scale lawn watering of golf courses, cemeteries, recreation areas, etc., is miscellaneous use).

☐ Municipal: Use of water in incorporated Towns and Cities (use of water in unincorporated towns, subdivisions, improvement districts, mobile home parks, etc. are classified as miscellaneous use).

☐ Industrial: Long term use of water for the manufacture of a product or production of oil, gas or other minerals (oil field water flood operations, power plant water supply, etc.) (Describe in REMARKS)

☐ Miscellaneous: Any use of water not defined under previous definitions such as stockwater pipelines, subdivisions, mine dewatering, mineral oil exploration drilling, reclamation purposes, potable and sanitary supplies in offices or light manufacturing, animal waste management, etc. Describe miscellaneous use completely:

☐ Monitor, Observation or Test Well: (Describe in REMARKS)

5. Location of the well or spring: (NOTE: Quarter-quarter (40 acre subdivision) MUST be shown. EXAMPLE: SE 1/4 NW 1/4 of Sec. 12, Township 14 North, Range 68 West.)

Fremont County, SE 1/4 SE 1/4 of Sec. 20, T. 27 N. R. 90 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 Resurvey Location: Tract , (or Lot)

6. Estimated depth of the well or spring is ______ feet.

7. (a) MAXIMUM instantaneous flow of water to be developed and beneficially used: ______ gallons per minute.

NOTE: If for domestic and / or stock use, this application will be processed for a maximum of 25 gallons per minute. For a spring, approval of this application, some type of artificial diversion or improvement must be constructed to qualify for a water right.

(b) MAXIMUM volumetric quantity of water to be developed and beneficially used per calendar year: ______

Circle appropriate units: (Gallons) (Acre Feet) A four person family utilizes approximately one (1) acre-foot of water per year or 325,000 gallons.

8. Mark the point(s) or area(s) of use in the tabulation box below.

TABULATION BOX

<table>
<thead>
<tr>
<th>TWP</th>
<th>RNG</th>
<th>SEC</th>
<th>NE 1/4</th>
<th>NW 1/4</th>
<th>SW 1/4</th>
<th>SE 1/4</th>
<th>TOTAL</th>
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</tr>
</tbody>
</table>

9. If for irrigation use:

a. Describe MAXIMUM acreage to be irrigated in each 40 acre subdivision in the tabulation box above.

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.

10. If for irrigation use, describe method of irrigation, i.e. center pivot sprinkler, flood, etc.:
11. The well or spring is to be constructed on lands owned by the Bureau of Land Management.
   (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 the co-applicant.)

12. The water is to be used on lands owned by N/A.
   (If the landowner is not the applicant, a copy of the agreement relating to the usage of appropriated water on the land should be submitted to this office. If the landowner is included as co-applicant on the application, this procedure need not be followed.)

NOTE: Water rights attach to the area(s) and/or point(s) of use.

REMARKS: Exploration Borehole For Water Supply Purposes. The borehole will not be completed as a water well and will be abandoned in place.

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 __________, 1999

THE LEGALLY REQUIRED FILING FEE MUST ACCOMPANY THIS APPLICATION

DOMESTIC AND/OR STOCK WATERING USES $25.00
   (Domestic use is defined as use of water in 3 single family dwellings or less.
    noncommercial watering of lawns and gardens totaling one acre or less.)

IRRIGATION, MUNICIPAL, INDUSTRIAL, MISCELLANEOUS $50.00

MONITOR (For water level measurements or chemical quality sampling) or TEST WELL 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 ss.

STATE ENGINEER’S OFFICE

This instrument was received and filed for record on the 4th day of August, A.D. 1999, at 9:30 a.m.

Permit No. U.W. 118631 ____________________________

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 sub-surface formations or at the land surface.

This application is for test purposes only; no water will be beneficially used. This permit will be automatically cancelled on December 31, 2000 or upon receipt of an acceptable
Statement of Completion. PROOF OF APPROPRIATION AND BENEFICIAL USE OF GROUND WATER
(FORM U.W. 8) IS WAIVED UNDER THIS PERMIT.

Approval of this application may be considered as authorization to proceed with construction of the proposed well or spring. A Statement
of Completion will be filed within thirty (30) days of completion of construction. A Statement of Completion will be filed by December 31, 1999.

Completion of construction and abandonment of the beneficial use of water for the purposes specified in Item 4 of this application
will be made by December 31, 1999.

The permitted appropriation shall be limited to the quantity to which the permits were issued or determined, or any modifications thereof,
and subject to any limitations on total water quantity, period of application or period of beneficial use.

Witness my hand this 18th day of September, A.D. 1999.

______________________________
State Engineer
APPLICATION FOR PERMIT TO APPROPRIATE GROUND WATER

APPLICATION FOR PERMITS TO APPROPRIATE GROUND WATER

Note: Only springs flowing 25 gallons per minute or less, where the proposed use is domestic and/or stock watering, will be considered as ground water appropriations.

FOR OFFICE USE ONLY

Temporary Filing No. U.W. 88-11-60

NAME AND NUMBER OF WELL or SPRING: Bairoil BH-5

1. Name of applicant(s): Wyoming Water Development Commission 
   Phone: (307) 777-7626

2. Address of applicant(s): Herschler Bldg., 122 W. 25th St., Cheyenne, WY 82002
   (MAILING ADDRESS) (CITY) (STATE) (ZIP)

3. Name & address of agent to receive correspondence and notices:
   760 Whalers Way, Ste. B-200, Fort Collins, WY 80525
   Phone: (970) 223-4705
   (MAILING ADDRESS) (CITY) (STATE) (ZIP)

4. Use to which the water will be applied:

   - Domestic: Use of water in 3 single family dwellings or less, noncommercial watering of lawns and gardens totaling one acre or less. Number of houses served? 
   - Stock Watering: Normal livestock use at four tanks or less within one mile of well or spring. Stockwatering pipelines and commercial feedlots are a miscellaneous use. Number of stock tanks? 
   - Irrigation: Watering of commercially grown crops (large-scale lawn watering of golf courses, cemeteries, recreation areas, etc., is miscellaneous use).
   - Municipal: Use of water in incorporated Towns and Cities (use of water in unincorporated towns, subdivisions, improvement districts, mobile home parks, etc. are classified as miscellaneous use).
   - Industrial: Long term use of water for the manufacture of a product or production of oil/gas or other minerals (oil field water flood operations, power plant water supply, etc.). (Describe in REMARKS)
   - Miscellaneous: Any use of water not defined under previous definitions such as stockwater pipelines, subdivisions, mine dewatering, mineral/ oil exploration drilling, reclamation purposes, potable and sanitary supplies in offices or light manufacturing, animal waste management, etc. Describe miscellaneous use completely:
   - Monitor, Observation or Test Well: (Describe in REMARKS)

5. Location of the well or spring: (NOTE: Quarter-quarter (40 acre subdivision) MUST be shown. EXAMPLE: SE 1/4 NW 1/4 of Sec. 12, Township 14 North, Range 68 West.)
   Sweet Water County, NW 1/4 SW 1/4 of Sec. 2, T. 26 N., R. 91 W. of the 6th P.M. (or W.R.M.), Wyoming. If located in a platted subdivision, also provide Lot Block No. of the Subdivision (or Add'n) of . Resurvey Location: Tract , (or Lot) .

6. Estimated depth of the well or spring is 600 feet.

7. (a) MAXIMUM instantaneous flow of water to be developed and beneficially used: 
   NOTE: If for domestic and / or stock use, this application will be processed for a maximum of 25 gallons per minute. For a spring, after approval of this application, some type of artificial diversion or improvement must be constructed to qualify for a water right.
   (b) MAXIMUM volumetric quantity of water to be developed and beneficially used per calendar year: 
   Circle appropriate units: (Gallons) (Acre Feet) A four person family utilizes approximately one (1) acre-foot of water per year or 325,000 gallons.

8. Mark the point(s) or area(s) of use in the tabulation box below.

   TABULATION BOX

9. If for irrigation use:
   a. Describe MAXIMUM acreage to be irrigated in each 40 acre subdivision in the tabulation box above.
   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.

10. If for irrigation use, describe method of irrigation, i.e. center pivot sprinkler, flood, etc.:
11. The well or spring is to be constructed on lands owned by

Bureau of Land Management

(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 the co-applicant.)

12. The water is to be used on lands owned by N/A

(If the landowner is not the applicant, a copy of the agreement relating to the usage of appropriated water on the land should be submitted to this office. If the landowner is included as co-applicant on the application, this procedure need not be followed.)

NOTE: Water rights attach to the area(s) and/or point(s) of use.

REMARKS: Exploration Borehole For Water Supply Purposes. Thr borehole will not be completed as a water well and will be abandoned in place.

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

$25.00

(Domestic use is defined as use of water in 3 single family dwellings or less, noncommercial watering of lawns and gardens totaling one acre or less.)

IRRIGATION, MUNICIPAL, INDUSTRIAL, MISCELLANEOUS

$50.00

MONITOR (For water level measurements or chemical quality sampling) or TEST WELL

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

STATE ENGINEER'S OFFICE

This instrument was received and filed for record on the 4th day of August, A.D. 1999, at 9:30 o'clock a.m.

Permit No. U.W. 118632

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 sub-surface formations or at the land surface.

This application is for test purposes only; no water will be beneficially used. This permit will be automatically cancelled on December 31, 2000 or upon receipt of an acceptable Statement of Completion. PROOF OF APPROPRIATION AND BENEFICIAL USE OF GROUND WATER (FORM U.W. 8) IS WAIVED UNDER THIS PERMIT.

Approval of this application may be considered as authorization to proceed with construction of the proposed well or spring. A Statement of Completion will be filed within thirty (30) days of completion of construction.

Completion of construction and completion of the beneficial use of water for the purposes specified in Item 4 of this application will be made by December 31, 1999.

The amount of appropriation shall be limited to the quantity which is entitled and determined by the water level and/or point of application of beneficial use determinations.

Witness my hand this 13th day of Sept., A.D. 1999.

State Engineer
APPLICATION FOR PERMIT TO APPROPRIATE GROUND WATER

APPLICATION FOR WELLS AND SPRINGS
Note: Only springs flowing 25 gallons per minute or less, where the proposed use is domestic and/or stock watering, will be considered as ground water appropriations.

NAME AND NUMBER OF WELL or SPRING: Bairoil BH-6

1. Name of applicant(s): Wyoming Water Development Commission Phone: (307) 777-7626

2. Address of applicant(s): Herschler Bldg., 122 W. 25th St., Cheyenne, WY 82002
   (MAILING ADDRESS) (CITY) (STATE) (ZIP)

3. Name & address of agent to receive correspondence and notices: Chris Lidstone-Lidstone & Associates, Inc
   760 Whalers Way, Ste. B-200, Fort Collins, CO 80525 Phone: (970) 223-4705
   (MAILING ADDRESS) (CITY) (STATE) (ZIP)

4. Use to which the water will be applied:
   [ ] Domestic: Use of water in 3 single family dwellings or less, noncommercial watering of lawns and gardens totalling one acre or less. Number of houses served?
   [ ] Stock Watering: Normal livestock use at four tanks or less within one mile of well or spring. Stockwatering pipelines and commercial feedlots are a miscellaneous use. Number of stock tanks?
   [ ] Irrigation: Watering of commercially grown crops (large-scale lawn watering of golf courses, cemeteries, recreation areas, etc., is miscellaneous use).
   [ ] Municipal: Use of water in incorporated Towns and Cities (use of water in unincorporated towns, subdivisions, improvement districts, mobile home parks, etc. are classified as miscellaneous use).
   [ ] Industrial: Long term use of water for the manufacture of a product or production of oil and/or other minerals (oil field water flood operations, power plant water supply, etc.). (Describe in REMARKS)
   [ ] Miscellaneous: Any use of water not defined under previous definitions such as stockwater pipelines, subdivisions, mine dewatering, mineral / oil exploration drilling, reclamation purposes, potable and sanitary supplies in offices or tight manufacturing, animal waste management, etc. Describe miscellaneous use completely:
   [ ] Monitor, Observation or Test Well: (Describe in REMARKS)

5. Location of the well or spring: (NOTE: Quarter-quarter (40 acre subdivision) MUST be shown. EXAMPLE: SE 1/4 NW 1/4 of Sec. 12, Township 14 North, Range 68 West.)
   Fremont County, SW 1/4 NW 1/4 of Sec. 30, T 27 N., R. 90 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 . Resurvey Location: Tract , (or Lot )

6. Estimated depth of the well or spring is feet.

7. (a) MAXIMUM instantaneous flow of water to be developed and beneficially used: gallons per minute.
   NOTE: If for domestic and / or stock use, this application will be processed for a maximum of 25 gallons per minute. For a spring, after approval of this application, some type of artificial diversion or improvement must be constructed to qualify for a water right.

   (b) MAXIMUM volumetric quantity of water to be developed and beneficially used per calendar year: Gallons (Acre Feet) A four person family utilizes approximately one (1) acre-foot of water per year or 325,000 gallons.

8. Mark the point(s) or area(s) of use in the tabulation box below.

   TABULATION BOX

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<th>NE 1/4</th>
<th>NW 1/4</th>
<th>SW 1/4</th>
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<td>NW%</td>
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<td>SW%</td>
<td>SE%</td>
<td></td>
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</table>

9. If for irrigation use:
   a. Describe MAXIMUM acreage to be irrigated in each 40 acre subdivision in the tabulation box above.
   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.

10. If for irrigation use, describe method of irrigation, i.e. center pivot sprinkler, flood, etc.:
11. The well or spring is to be constructed on lands owned by Bureau of Land Management

(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 the co-applicant.)

12. The water is to be used on lands owned by N/A

(If the landowner is not the applicant, a copy of the agreement relating to the usage of appropriated water on the land should be submitted to this office. If the landowner is included as co-applicant on the application, this procedure need not be followed.)

NOTE: Water rights attach to the

Remarks: Exploration Borehole for Water Supply Purposes. The borehole will not be completed as a water well and will be abandoned in place.

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

$25.00

IRRIGATION, MUNICIPAL, INDUSTRIAL, MISCELLANEOUS

$50.00

MONITOR (For: vol., measure or chemical quality sampling) or TEST WELL

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

 STATE ENGINEER'S OFFICE

This instrument was received and filed for record on the 4th day of August, 1999, at 9:30 a.m.

Signature of State Engineer

Permit No. U.W. 118633

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 control 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 sub-surface formations or at the land surface.

This application is for test purposes only; no water will be beneficially used. This permit will be automatically cancelled on December 31, 2000 or upon receipt of an acceptable Statement of Completion. PROOF OF APPROPRIATION AND BENEFICIAL USE OF GROUND WATER (FORM U.W. 8) IS WAIVED UNDER THIS PERMIT.

 Approval of this application may be considered as authorization to proceed with construction of the proposed well or spring. A Statement of Completion will be filed within thirty (30) days of completion of construction.

Completion of construction will be made by December 31, 1999.

Witness my hand this 13th day of Sept., A.D. 1999.

Signature of State Engineer
December 6, 1999

Ms. Carol Lacy
State of Wyoming
Office of the State Engineer
Herschler Building
122 W. 25th St.
Cheyenne, WY 82002

RE: Statement of Completion and Description of Well – Bairoil

Dear Carol:

Please find enclosed one LW-6 (118629) for the Test Well, Bairoil BH-2. As I told you on the telephone this afternoon, the location on the UW-5 was in error because the well was mislocated in the field. Please re-file according to the location provided on the UW-6.

We apologize for the error and the extra work it will cause.

Sincerely,

LIDSTONE AND ASSOCIATES, INC.

[Signature]

Stephen C. Howard, P.G.
Senior Hydrogeologist

SCH:sea
Enclosures: (1) UW-6: 118629 (Bairoil BH-2)
Send by: mail
K:\OPEN\Wywdc101\bh2 uw6 letter.wpd
STATE OF WYOMING
OFFICE OF THE STATE ENGINEER
HERSCHLER BUILDING
CHEYENNE, WYOMING 82002
(307) 777-5959

STATEMENT OF COMPLETION AND DESCRIPTION OF WELL OR SPRING

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

PERMIT NO. U.W. 118629 NAME OF WELL (SPRING) BAIRIOIL BH-2

1. NAME OF OWNER ____________________________________________________________________________
   WYOMING WATER DEVELOPMENT COMMISSION

2. ADDRESS ____________________________________________________________________________________
   Please check if address has changed from that shown on permit:
   City Cheyenne State WY Zip Code 82002 Phone No. (307) 777-7626

3. USE OF WATER: Domestic [] Stock Watering [] Irrigation [] Municipal [] Industrial [] Miscellaneous []
   Monitor or Test [] Coal Bed Methane [] Explain proposed use (Example: One single family dwelling)

   Subdivision Name ____________________________________________________________________________
   Lot __________ Block __________
   If surveyed, bearing, distance and reference point: _______________________________________________

5. TYPE OF CONSTRUCTION: Drilled [] Mud Rotary [] Dug [] Driven [] Other []
   Describe: ________________________________________________________________________________

6. CONSTRUCTION: Total Depth of Well/Spring 580 ft.
   Depth to Static Water Level 150 ft. (Below land surface)
   a. Diameter of borehole (Bit size) 12 inches.
   b. Casing Schedule New [] Used []
      8 1/2 diameter from 43 ft. to 362 ft. Material Steel Gage 20
      8 1/2 diameter from 374 ft. to 433 ft. Material Steel Gage 20
   c. Was casing cemented: Yes [] No [] Cemented Interval, From 0 feet to 271 feet.
   d. Number of sacks of cement used 100 type of cement Class C with 10% Bentonite
   e. Perforations: Type of perforator used ________________________________
      Size of perforations ______ by ______ inches.
      Number of perforations and depths where perforated:
      __________ perforations from ________ ft. to ________ feet.
      __________ perforations from ________ ft. to ________ feet.
   f. Was well screen installed? Yes [] No []
      Diameter: 8 ______ slot size: ______ set from ______ ft. to ______ ft.
      Diameter: 8 ______ slot size: ______ set from ______ ft. to ______ ft.
      Diameter: 8 ______ slot size: ______ set from ______ ft. to ______ ft.
      Diameter: 8 ______ slot size: ______ set from ______ ft. to ______ ft.
   g. Was well gravel packed? Yes [] No [] Size of gravel 10-20
   h. Was surface casing used: Yes [] No [] Was it cemented in place? Yes [] No []

7. NAME & ADDRESS OF DRILLING COMPANY Barnhart Drilling Company, P.O. Box 1638 Riverton, WY

8. DATE OF COMPLETION OF WELL (including pump installation) OR SPRING (first used) November 5, 1999
11. If spring, how was it constructed? (Some method of artificial diversion, i.e., spring box, cribbing, etc., is necessary to qualify for a water right.)

12. PUMP TEST: Was a pump test made? Yes ☐ No ☐
   If so, by whom  Wards Well Service
   Address 105 E. Washington, Riverton, WY 82501
   Yield: 50 gal/min. with 175 foot drawdown after 6 hours.
   Yield: 75 gal/min. with 260 foot drawdown after 75 hours.

13. LOG OF WELL: Total depth drilled 580 feet.
   Depth of completed well 580 feet. Diameter of well 8 inches.
   Depth to first water bearing formation 360 feet.
   Depth to principal water bearing formation. Top 360 feet to Bottom 580 feet.
   Ground Elevation, if known 7,920

DRILL CUTTINGS DESCRIPTION:

<table>
<thead>
<tr>
<th>From Feet</th>
<th>To Feet</th>
<th>Material Type, Texture Color</th>
<th>Remarks (Cementing, Shutoff)</th>
<th>Indicate Water Bearing Formation &amp; Name</th>
<th>Indicate Perforated Casing Location</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>sand, minor silt &amp; clay</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>55</td>
<td>347</td>
<td>silt, minor thin sand</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>372</td>
<td>407</td>
<td>interbedded sand &amp; silt</td>
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<tr>
<td>407</td>
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<td>sand</td>
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<td>580</td>
<td>silt</td>
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14. QUALITY OF WATER INFORMATION:
   Does a chemical and/or bacteriological water quality analysis accompany this form? Yes ☐ No ☑
   It is recommended that chemical and bacteriological water quality analyses be performed and that the report(s) be filed with the records of this well. (Contact Department of Agriculture, Analytical Lab Services, Laramie, 742-2984.)
   If not, do you consider the water as: Good ☐ Acceptable ☑ Poor ☐ Unusable ☑

REMARKS: ____________________________________________________________

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

December 6, 1995

FOR STATE ENGINEER'S USE ONLY

Date of Receipt _____________________, 1999
Date of Approval ___________________, 1999
Date of Priority AUGUST 4, 1999, 1999

for State Engineer
Appendix II
Water Quality of the New Well
<table>
<thead>
<tr>
<th>Radiometric</th>
<th>Method</th>
<th>Reporting Limit</th>
<th>Units</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radium-226 (quick count)</td>
<td>$^{226}$Ra</td>
<td>903.0</td>
<td>0.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Radium Precision ±</td>
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<td></td>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td>Radium-226 (final count)</td>
<td>$^{226}$Ra</td>
<td>903.0</td>
<td>0.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Radium Precision ±</td>
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<td></td>
<td></td>
<td>0.3</td>
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<td>Radiometric</td>
<td>Method</td>
<td>Reporting Limit</td>
<td>Units</td>
<td>Results</td>
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<tr>
<td>---------------------</td>
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</tr>
<tr>
<td>Radium-226 (quick count)</td>
<td>^{226}_{\text{Ra}}</td>
<td>903.0</td>
<td>0.2</td>
<td>pCi/L</td>
</tr>
<tr>
<td>Radium Precision ±</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Radium-226 (final count)</td>
<td>^{226}_{\text{Ra}}</td>
<td>903.0</td>
<td>0.2</td>
<td>pCi/L</td>
</tr>
<tr>
<td>Radium Precision ±</td>
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<td></td>
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**LABORATORY ANALYSIS REPORT**
**LIDSTONE & ASSOCIATES**

<table>
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<tr>
<th>Sample ID:</th>
<th>Sample Date:</th>
<th>Sample Matrix:</th>
<th>Laboratory ID:</th>
<th>Report Date:</th>
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<tr>
<td></td>
<td>11-15-99 @ 16:30</td>
<td>Water</td>
<td>34449-3</td>
<td>December 12, 1999</td>
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<table>
<thead>
<tr>
<th>Radiometrics</th>
<th>Method</th>
<th>Units</th>
<th>Reporting Limit</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radium 226, Total Quick Count</td>
<td>EPA 903.0</td>
<td>pCi/L</td>
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<td>11.1</td>
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<tr>
<td>Radium Error Estimate ±</td>
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<td></td>
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<tr>
<td>Radium 226, Total Final Count</td>
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<td>pCi/L</td>
<td>0.2</td>
<td>4.5</td>
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<tr>
<td>Radium Error Estimate ±</td>
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<td></td>
<td></td>
<td>0.4</td>
</tr>
<tr>
<td>Radiometric</td>
<td>Method</td>
<td>Reporting Limit</td>
<td>Units</td>
<td>Results</td>
</tr>
<tr>
<td>------------------------------</td>
<td>---------</td>
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</tr>
<tr>
<td>Radium-226 (quick count)</td>
<td>$^{226}\text{Ra}$</td>
<td>903.0</td>
<td>0.2</td>
<td>pCi/L</td>
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<tr>
<td>Radium Precision ±</td>
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<td></td>
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</tr>
<tr>
<td>Radium-226 (final count)</td>
<td>$^{226}\text{Ra}$</td>
<td>903.0</td>
<td>0.2</td>
<td>pCi/L</td>
</tr>
<tr>
<td>Radium Precision ±</td>
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### LABORATORY ANALYSIS REPORT

**LIDSTONE & ASSOCIATES**

**Sample ID:**
**Sample Date:**
**Sample Matrix:**
**Laboratory ID:**
**Report Date:**

#### Major Ions

<table>
<thead>
<tr>
<th>Ion</th>
<th>Method</th>
<th>Units</th>
<th>Reporting Limit</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>EPA 200.7</td>
<td>mg/L</td>
<td>1.0</td>
<td>31.9</td>
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<tr>
<td>Magnesium</td>
<td>EPA 200.7</td>
<td>mg/L</td>
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<td>mg/L</td>
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<td>10.5</td>
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<tr>
<td>Potassium</td>
<td>EPA 200.7</td>
<td>mg/L</td>
<td>1.0</td>
<td>1.7</td>
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<tr>
<td>Carbonate</td>
<td>SM 2212 B</td>
<td>mg/L</td>
<td>1.0</td>
<td>&lt; 1.0</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>SM 2212 B</td>
<td>mg/L</td>
<td>1.0</td>
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<tr>
<td>Sulfate</td>
<td>SM -5000 SO₄</td>
<td>mg/L</td>
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<td>9.1</td>
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<tr>
<td>Ammonium as N</td>
<td>SM 4500-NO₃</td>
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<tr>
<td>Nitrate</td>
<td>SM -500-NO₃</td>
<td>mg/L</td>
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<tr>
<td>Fluoride</td>
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<td>Silica</td>
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#### Non-Metals

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<td>SM 2540 C</td>
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<td>Conductivity</td>
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<tr>
<td>Alkalinity</td>
<td>SM 2212 B</td>
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<td>111</td>
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<tr>
<td>pH</td>
<td>SM -500-4</td>
<td>std. units</td>
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#### Trace Metals

<table>
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<tr>
<th>Ion</th>
<th>Method</th>
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<tbody>
<tr>
<td>Aluminum</td>
<td>EPA 200.4</td>
<td>mg/L</td>
<td>0.10</td>
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<tr>
<td>Arsenic</td>
<td>EPA 200.8</td>
<td>mg/L</td>
<td>0.005</td>
<td>&lt; 0.001</td>
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<tr>
<td>Barium</td>
<td>EPA 200.5</td>
<td>mg/L</td>
<td>0.10</td>
<td>&lt; 0.10</td>
</tr>
<tr>
<td>Boron</td>
<td>EPA 200.8</td>
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<tr>
<td>Cadmium</td>
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<td>mg/L</td>
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<tr>
<td>Chromium</td>
<td>EPA 200.8</td>
<td>mg/L</td>
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<tr>
<td>Copper</td>
<td>EPA 200.8</td>
<td>mg/L</td>
<td>0.1</td>
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<tr>
<td>Iron</td>
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<td>Lead</td>
<td>EPA 200.8</td>
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<td>Manganese</td>
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<td>mg/L</td>
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<tr>
<td>Mercury</td>
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<td>mg/L</td>
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<tr>
<td>Molybdenum</td>
<td>EPA 200.8</td>
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<tr>
<td>Nickel</td>
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<tr>
<td>Selenium</td>
<td>EPA 200.8</td>
<td>mg/L</td>
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<tr>
<td>Vanadium</td>
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<td>Zinc</td>
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#### Radiometrics

<table>
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<th>Results</th>
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<tr>
<td>Uranium</td>
<td>EPA 200.8</td>
<td>mg/L</td>
<td>0.0003</td>
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<tr>
<td>Radium 226, Dissolved Quick Count</td>
<td>EPA -403.3</td>
<td>pCi/L</td>
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<td>8.2</td>
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<tr>
<td>Radium Error Estimate</td>
<td>±</td>
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<tr>
<td>Radium 226, Dissolved Final Count</td>
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<td>pCi/L</td>
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<tr>
<td>Radium Error Estimate</td>
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<tr>
<td>Radium 226, Total Quick Count</td>
<td>EPA -403.3</td>
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<td>9.6</td>
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<td>Radium Error Estimate</td>
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<tr>
<td>Radium 226, Total Final Count</td>
<td>EPA -403.3</td>
<td>pCi/L</td>
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<td>3.4</td>
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<tr>
<td>Radium Error Estimate</td>
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#### Quality Assurance Data

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<td>Calc TDS</td>
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<td>TDS V/C Balance</td>
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<td>0.80 - 1.20</td>
<td>0.97</td>
</tr>
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</table>

---

**SHIPPING:** 2393 SALT CREEK HIGHWAY • CASPER, WY 82009

**MAILING:** P.O. BOX 3258 • CASPER, WY 82602

E-mail: energy@trib.com • FAX: (307) 234-1639

PHONE: (307) 235-0515 • TOLL FREE: (888) 235-0515
# US EPA Primary & Secondary Drinking Water Analysis Report

**Client:** LIDSTONE & ASSOCIATES  
**Attn:** Philip Beetstone  
**PWS #:** Not Provided  
**Report Date:** December 14, 1999  
**Sample ID:** Bairoil Well 1  
**Sample Date/Time:** 11-16-99/11:10  
**Laboratory ID:** 34495-1

### SDWA Phase

<table>
<thead>
<tr>
<th>SDWA Phase</th>
<th>Primary Inorganic Constituents</th>
<th>Method</th>
<th>LAB ID</th>
<th>LAB MRL</th>
<th>EPA MCL</th>
<th>LABORATORY RESULTS</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>Antimony</td>
<td>EPA 200.8</td>
<td>ELI-C</td>
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### Secondary Inorganic Constituents

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### Radiochemical Constituents - µg/L

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### Footnotes and Abbreviation Descriptions

1. **ELI-B** = Energy Laboratories, Inc. - Billings, MT  
2. **ELI-C** = Energy Laboratories, Inc. - Casper, WY  
3. **ELI-RC** = Energy Laboratories, Inc. - Rapid City, SD  

2. **MRL =** Method Reporting Limit  
3. **SMCL =** Secondary Maximum Contaminant Level  

N.A. = Not Applicable  
N.R. = Not Requested  
TTR = Treatment Technique
## SDWA REGULATED CONSTITUENTS

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<td>Lindane</td>
<td>58-89-9</td>
<td>ELI-C</td>
<td>0.01</td>
<td>0.20</td>
<td>505</td>
<td>Not Detected</td>
<td>Not Detected</td>
</tr>
<tr>
<td>II</td>
<td>Methoxychlor</td>
<td>72-43-5</td>
<td>ELI-C</td>
<td>0.05</td>
<td>40.0</td>
<td>505</td>
<td>Not Detected</td>
<td>Not Detected</td>
</tr>
<tr>
<td>II</td>
<td>Oxamyl (vldaze)</td>
<td>23135-22-0</td>
<td>ELI-C</td>
<td>2.0</td>
<td>200</td>
<td>531.1</td>
<td>Not Detected</td>
<td>Not Detected</td>
</tr>
<tr>
<td>II</td>
<td>Pentachlorophenol</td>
<td>87-86-5</td>
<td>ELI-B</td>
<td>0.10</td>
<td>1.0</td>
<td>515.1</td>
<td>Not Detected</td>
<td>Not Detected</td>
</tr>
<tr>
<td>II</td>
<td>Pheochlorophenol</td>
<td>1918-02-11</td>
<td>ELI-B</td>
<td>0.30</td>
<td>500</td>
<td>515.1</td>
<td>Not Detected</td>
<td>Not Detected</td>
</tr>
<tr>
<td>II</td>
<td>Pheochlorophenol</td>
<td>122-34-9</td>
<td>ELI-C</td>
<td>1.0</td>
<td>4.0</td>
<td>505</td>
<td>Not Detected</td>
<td>Not Detected</td>
</tr>
<tr>
<td>II</td>
<td>Pheochlorophenol</td>
<td>8001-35-3</td>
<td>ELI-C</td>
<td>1.0</td>
<td>3.0</td>
<td>505</td>
<td>Not Detected</td>
<td>Not Detected</td>
</tr>
<tr>
<td>II</td>
<td>2,4,5-TP</td>
<td>91-22-4</td>
<td>ELI-B</td>
<td>0.20</td>
<td>50.0</td>
<td>515.1</td>
<td>Not Detected</td>
<td>Not Detected</td>
</tr>
</tbody>
</table>

**MONITORED CONSTITUENTS**

| Aladir     | 309-00-2 | ELI-C | 0.01 | 0.3 | 505 | Not Detected | Not Detected |
| Butachlor  | 23184-60-9 | ELI-B | 0.10 | N/A | 525.2 | Not Detected | Not Detected |
| Carbaryl   | 63-25-2  | ELI-C | 1.0  | N/A | 531.1 | Not Detected | Not Detected |
| Dicamba    | 1918-00-9 | ELI-B | 0.25 | 300 | 515.1 | Not Detected | Not Detected |
| 3-Hydroxycarbofuran | 16635-42-0 | ELI-C | 1.0  | N/A | 531.1 | Not Detected | Not Detected |
| Methomyl   | 16732-77-5 | ELI-C | 1.0  | N/A | 531.1 | Not Detected | Not Detected |
| Metolachlor| 53128-45-2 | ELI-B | 0.10 | N/A | 525.2 | Not Detected | Not Detected |
| Metribuzin | 21087-44-9 | ELI-B | 0.10 | N/A | 525.2 | Not Detected | Not Detected |
| Propachlor | 1918-76-7  | ELI-B | 0.10 | N/A | 525.2 | Not Detected | Not Detected |
Bairoil Well 2A - Water Quality

Diagram showing concentrations of Mg, Ca, Na, HCO3, and Cl in a triangular plot.
Appendix III
Bairoil Distribution System Modeling
(BRS, 1999)
Existing System

The Bairoil distribution system consists of a single 350,000 gallon ground-level storage tank located approximately one mile from town at a reported surface elevation of 7040 feet. The tank elevation is approximately 140 feet above town yielding static pressures within the distribution system of approximately 50 to 60 psi. The distribution system consists of PVC piping ranging in size from two inch to ten inch and a limited portion of four inch transite pipe serving the Amoco facility. As constructed the system has several dead-end mains, i.e., the north end of Beebe Avenue, Rodeo Road and Primrose Avenue. Normally dead-ends are to be avoided in the design of water supply systems. This is due both to system flows and water quality due to stagnation.

System Model - Base Conditions

A Cybernet flow model was developed based on the available information relative to pipe size and type. No data was available relative to pipe condition and/or actual pipe flows and pressures. As a result, rather than calibrating the model, typical roughness values were used. Model junctions used in the model are shown on Figure 1.

Demands were place on the system based on average and peak demands of approximately 300 and 600 g.p.m. respectively. These demands are the hypothetical demands of all taps simultaneously using water, and should not be confused with the water demand estimates presented in chapter III of the report. The location of demands was selected in the field based on the location of active taps. Under average demand modeled pressures ranged from 51 to 73 psi at junctions J20 and J12 respectively. Under peak demand pressures dropped to a range of 44 to 69 psi. Thus, under normal and peak operating conditions the system performed acceptably.

Distribution System Evaluation

To assess the integrity of the distribution system under high demands (minimal fire flow or a line break) a 500 g.p.m. demand was place at various locations throughout the system when the system was operating at peak demand. The following table shows the impact of such an instantaneous demand on the system.
Table 1. Model Results with 500 g.p.m. Demand at a Junction

<table>
<thead>
<tr>
<th>Junction</th>
<th>Location</th>
<th>Pressure (psi)</th>
<th>Junction&lt;20psi</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>J18</td>
<td>West end Rodeo</td>
<td>17-60</td>
<td>17,18,20,24,26</td>
<td>Most of system in low 20's psi</td>
</tr>
<tr>
<td></td>
<td>Road</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J24</td>
<td>North end Beebe</td>
<td>7-60</td>
<td>19 through 26</td>
<td>20's and low 30's psi</td>
</tr>
<tr>
<td></td>
<td>Ave.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J13</td>
<td>Primrose at Amoco</td>
<td>(-42)-52</td>
<td>J13</td>
<td>Negative pressure at J13</td>
</tr>
<tr>
<td>J12</td>
<td>East end Primrose</td>
<td>34-52</td>
<td>None</td>
<td>System acceptable</td>
</tr>
<tr>
<td>J23</td>
<td>Cul-de-sac off</td>
<td>5-60</td>
<td>19,21-26,28</td>
<td>Many junctions in low 20's psi</td>
</tr>
<tr>
<td></td>
<td>Purple Sage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J30</td>
<td>Town Hall</td>
<td>21-60</td>
<td>None</td>
<td>Several junctions in low to mid 20's psi</td>
</tr>
</tbody>
</table>

In summary, the model indicates based on the assumed flow conditions, that inadequate pressure is provided by the system under minimal fire flow conditions at junctions J18, J24, J13 and J23. This situation is a direct result of line size and demand at the dead-end mains. WQD Regulations Chapter XII requires minimum pressure of 20 psi under all conditions of flow, including fire flow where hydrants are provided, and 35 psi under normal operating conditions. Typical water system design would require:

1. Dead-end mains should be minimized by looping.
2. Any main smaller than six inches shall be justified by hydraulic modeling and analysis.
3. Water mains serving fire hydrants shall be a minimum of six inches when served from two directions, or where the maximum length of six inches is 250 feet or less in one direction. Otherwise hydrants should be served by a minimum eight inch line.

Potential System Improvements

Based on the flow model results the following potential system improvements, if implemented, would alleviate the apparent deficiencies in the distribution system.

1. Connect the dead-end main on Beebe to the eight inch system main and connect the ends at the Cul-de-sac off Badger Circle.
2. Connect the main from Rodeo Road to the six inch main at the intersection of Rodeo Road and Paintbrush.
3. Replace the four inch transite line on Primrose with six inch PVC and connect to the eight inch main on Antelope Drive.
If these system improvements were implemented a minimum of 20 psi system pressure would be maintained in accordance with WQD regulations as shown on the following table.

**Figure 2. Model Results with 500 g.p.m. Demand at Junction WITH System Improvements**

<table>
<thead>
<tr>
<th>Junction</th>
<th>Location</th>
<th>Pressure (psi)</th>
<th>Junctions&lt;20psi</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>J18</td>
<td>West end Rodeo Road</td>
<td>24-60</td>
<td>None</td>
<td>System pressure acceptable</td>
</tr>
<tr>
<td>J24</td>
<td>North end Beebe Ave.</td>
<td>22-60</td>
<td>None</td>
<td>System pressure acceptable</td>
</tr>
<tr>
<td>J13</td>
<td>Primrose at Amoco</td>
<td>34-58</td>
<td>None</td>
<td>System pressure acceptable</td>
</tr>
<tr>
<td>J12</td>
<td>East end Primrose</td>
<td>35-55</td>
<td>None</td>
<td>System pressure acceptable</td>
</tr>
<tr>
<td>J23</td>
<td>Cul-de-sac off Purple Sage</td>
<td>23-60</td>
<td>None</td>
<td>System pressure acceptable</td>
</tr>
<tr>
<td>J30</td>
<td>Town Hall</td>
<td>24-60</td>
<td>None</td>
<td>System pressure acceptable</td>
</tr>
</tbody>
</table>

These potential system improvements, as shown on Fig 6.3, would solve the identified possible system deficiencies relative to flow/pressure. Prior to design of such improvements on site flow/pressure testing from hydrants should be completed to calibrate the flow model and determine final line sizes. Further, there is no current development south of Paint Brush Drive between Antelope and Beebe Avenues. If this area was developed a looped main along Rodeo Road to Beebe Avenue and proceeding north to Paint Brush Drive would be recommended.

**Water Quality**

Reportedly a substantial amount of operating and maintenance expense is currently incurred flushing mains at dead-ends and in some cases lead and copper have been elevated in analyses. It is a typical requirement that dead-end mains be flushed regularly at a velocity in excess of 2.5 ft/sec to remove scaling etc. Looping the system would eliminate this requirement and would provide for better distribution of chlorine in the system. The source of the lead copper is most likely individual service lines. Although looping the system may provide for greater dilution of these constituents it will likely not solve the problem. The individual service connections responsible for the source of these constituents would need to be isolated and replaced.