This is a digital document from the collections of the Wyoming Water Resources Data System (WRDS) Library.

For additional information about this document and the document conversion process, please contact WRDS at wrds@uwyo.edu and include the phrase “Digital Documents” in your subject heading.

To view other documents please visit the WRDS Library online at: http://library.wrds.uwyo.edu

Mailing Address:
Water Resources Data System
University of Wyoming, Dept 3943
1000 E University Avenue
Laramie, WY 82071

Physical Address:
Wyoming Hall, Room 249
University of Wyoming
Laramie, WY 82071

Phone: (307) 766-6651
Fax: (307) 766-3785

Funding for WRDS and the creation of this electronic document was provided by the Wyoming Water Development Commission (http://wwdc.state.wy.us)
FORWARD

Comments on the Draft Report issued October 9, 1998 were received from the City of Worland and from the USDA Rural Utility Service (RUS). As appropriate, these comments were incorporated into the Final Report contained herein. A summary of the more significant comments follows:

- **City of Worland**: The majority of Worland’s comments focused on rates which will be charged by Worland to McNutt. Currently Worland has stated their intent to supply McNutt with water, however, the final rate structure has not been negotiated. The matter is complicated by current State statute, Worland City Code, and current practices for outlying districts. The figures utilized in the report reflect the expected rates based on the most similar outlying district, the South Worland Water Users. During Level III and water purchase agreement will be negotiated.

- **RUS**: The most substantive comment received from RUS was that they felt that McNutt should be incorporated with the Washakie Rural District. As subsequently discussed, the WDC concurred with this position.

CURRENT PROJECT STATUS

During the November 17, 1998 WDC meeting the commission emphasized that the regional system should be developed whenever feasible and that small satellite systems, such as McNutt, should be avoided when possible. The WDC recommended that Level III funding be approved for the Washakie Rural District with the addition of McNutt to that system. On November 18, 1998 the McNutt District Board issued a letter to potential users stating that this would be the approach that they must follow and that any initial tap fees would be returned. The McNutt Improvement District may remain in force for the development of other improvements but will petition the Washakie County commissioners to be incorporated within the Washakie Rural District for water service.
PROFESSIONAL CERTIFICATION

I, Douglas L. Beahm, President of BRS Inc., a Wyoming Corporation, hereby certify that the professional services required for the McNutt Water Supply Project, Level II, were developed by me or under my direction and that I am a Professional Engineer licensed in Wyoming as required by the provisions of W.S. 33-29-105 through W.S. 33-29-113. IN WITNESS WHEREOF, I have hereunder set my hand and affixed my seal.

By:

[Signature]

Douglas L. Beahm, P.E. #5499
President, BRS Inc.

I further certify that I am a Professional Geologist licensed as required by the provisions of W.S. 33-41-101 through W.S. 33-41-121, and that all geological work performed in relation to this Project was performed by me or under my direction. IN WITNESS WHEREOF, I have hereunder set my hand and affixed my seal.

By:

[Signature]

Douglas L. Beahm, P.G. #1341
President, BRS Inc.
# TABLE OF CONTENTS

McNutt Water Supply Project - Level II

## EXECUTIVE SUMMARY

Provided under separate cover

## PROFESSIONAL CERTIFICATION

### 1.0 INTRODUCTION

- 1.1 Project Overview and Location .................................................. 1
- 1.2 Goals and Objectives ......................................................................... 1
- 1.3 Related Studies .................................................................................. 4
- 1.4 Public Participation ............................................................................ 4
- 1.5 Acknowledgments .............................................................................. 4

### 2.0 EXISTING CONDITIONS

- 2.1 Project Setting ................................................................................... 5
- 2.2 Current Water Sources and Water Quality ........................................ 5

### 3.0 POTENTIAL WATER SUPPLY ALTERNATIVES

- 3.1 City of Worland .................................................................................. 6
- 3.2 Ground Water Sources ....................................................................... 6
- 3.3 Surface Water Sources ....................................................................... 6

### 4.0 SERVICE AREA/WATER DEMAND

- 4.1 Service Area ..................................................................................... 7
- 4.2 Potential Users .................................................................................. 7
- 4.3 Demand ............................................................................................. 7
- 4.4 Future Growth ................................................................................... 9
- 4.5 Fire Flow ........................................................................................... 9

### 5.0 PRELIMINARY DESIGN

- 5.1 Key Elements of Worland/Boy’s School System .................................. 9
- 5.2 Key Elements of Washakie Rural System ............................................ 9
- 5.3 Design Alternatives .......................................................................... 10
- 5.4 Design Flows/Network Modeling ....................................................... 10
6.0 EASEMENTS, ENVIRONMENTAL ISSUES, AND PERMITS ............ 12

7.0 ESTIMATED COSTS AND FINANCING .................................. 13
  7.1 Construction Costs .................................................. 13
  7.2 Supply/Distribution Components .................................... 13
  7.3 Financing Alternatives ............................................... 13
  7.4 Cost Sensitivity ..................................................... 13

8.0 RECOMMENDED RATE SCHEDULE ...................................... 16
  8.1 District Debt Retirement ............................................ 16
  8.2 Worland Charges .................................................. 16
  8.3 System Operation and Maintenance ............................... 16
  8.4 Water Use Charges .............................................. 17
  8.5 Summary ............................................................. 17

9.0 ADDITIONAL REQUIREMENTS ......................................... 18
  9.1 WDC Requirements .................................................. 18
  9.2 RUS Requirements ................................................ 18
  9.3 Water Purchase Agreement ....................................... 18
  9.4 Level III Design Requirements ................................... 18

10.0 CONCLUSION AND RECOMMENDATIONS ............................ 19

FIGURES

Figure 1.1 - Regional Location Map .................................... 2
Figure 1.2 - Local Location Map ....................................... 3
Figure M-1 - McNutt Estimated Taps ................................. Map Section
Figure M-2 - Conceptual Design ................................ Map Section
Figure M-3 - Cybernet Network Model ............................... Map Section

TABLES

Table 1 - Water Use for Worland and Nearby Cities ............... 8
Table 2 - Cybernet Demand Scenarios ............................... 11
Table 3 - Construction Cost Estimate ............................... 14
Table 4 - Financing Alternatives .................................... 15

APPENDICES

Appendix A - Washakie County Water Supply Alternatives
Appendix B - Typical Construction Details
1.0 INTRODUCTION

The McNutt Water Supply Project is a Level II feasibility study, funded by the Wyoming Water Development Commission (WDC). No previous studies have been completed for this project specifically. However, the Washakie Rural Water Supply Project Level I Study, October 31, 1995, did include this project area. The McNutt Water District is separate from, but surrounded by, the Washakie Rural Water District which is also a Level II study being funded by the WDC. BRS Inc. is the project engineer for both projects.

1.1 Project Overview and Location

The McNutt Subdivision is located in Washakie County, Wyoming, within portions of Section 3, Township 46 North, Range 93 West (refer to Figure 1.1).

The McNutt subdivision is one of the oldest subdivisions in the vicinity, consisting of 45 lots. The McNutt Improvement District was formed in 1997 and encompasses all but five of the lots within the subdivision and limited adjacent acreage. Current water supply is from individual wells or hauled from Worland. There is no current sewer service.

As shown on Figure 1.2, the McNutt District is located along U.S. Highway 20 approximately 4 miles south of Worland, Wyoming. An existing eight inch water service is located within the highway right-of-way between the Wyoming Boy’s School and Worland’s West Tank. A six inch valve was installed along the eight inch service line near the junction of the county road which provides access to McNutt. This will be the likely point of connection to Worland’s system.

1.2 Goals and Objectives

The goal of this project is to determine the feasibility of establishing a public water supply system within the McNutt District. If the project is determined to be feasible by the McNutt District and the potential funding agencies, it may proceed to Level III funding for final design and construction.

Level II project objectives include;

1. Identification of service area and demand;
2. Determination of the preferred source of water supply;
3. Identification of alternatives for water supply;
4. Determination of preliminary costs based on conceptual design data;
5. Completion of an economic analysis of the project including financing;
6. Identification of additional requirements and recommendations which must be met to implement the project.
1.3 Related Studies

Previous studies and reports utilized in this study include:

- Plans and Specifications for the Wyoming Boys School Water Supply.

1.4 Public Participation

A "block party" or neighborhood meeting was held on July 17, 1998. Approximately, 20 persons were in attendance representing 8 families. The status of the project and anticipated activities were discussed along with potential costs and funding. Those residents who attended granted permission for access, site investigation and water sampling completed as part of the site investigation. The major concerns raised were related to costs. The project was welcomed by all but one of those in attendance. The meeting was followed up with individual contacts and a subsequent meeting with the district board to discuss conceptual designs and potential rate structures.

BRS participated with representatives of Worland, Washakie County, RUS and WDC on a Steering Committee for both the McNutt and Washakie Rural Water supply projects. Meetings were held on a monthly basis. Presentations were made to the Worland Utility Commission and Worland City Council. On October 1, 1998 the Worland City council passed a resolution allowing Mayor Herm Emmett to issue a letter of intent to supply the McNutt and Washakie Rural Improvement Districts with water subject to negotiation of water rates.

1.5 Acknowledgments

BRS Inc. would like to acknowledge the efforts, assistance, and data provided for this project by the City of Worland, Mayor Herm Emmett, the Worland City Council and Utilities Commission, Gary Thompson (Superintendent of Public Works), Gary Gerber (Department of Public Works), and Mike Donnell (City Engineer). BRS would also like to thank the McNutt District Board members Carl Yorgason, Eileen Dangle, and Blain Beall for their time and support. In addition, the project received support from the Washakie Rural Steering Committee whose participants included; Worland Mayor Herm Emmett, Larry Bond Worland City Council, Washakie County Commissioners Bill Glanz and Alice Lass, WDC Commissioner George Bower, Washakie Rural Water District Board members Connie Clark, Marlene Loudan, and Mike Hanify, and RUS staff members, John Cochran, Roy Prior, and Karlene Shoden; and our WDC Project Officer Jon Wade.
2.0 EXISTING CONDITIONS

2.1 Project Setting

The McNutt District is located approximately 4 miles south of Worland along U. S. Highway 20. A paved county road proceeds west from Highway 20 some 1,800 feet into the subdivision. Within the subdivision all roads are gravel. The county road crosses the Bluff Canal near the south east edge of the subdivision. The area is generally low relief with slopes of 3% or less. At the western side of McNutt slight ridges form the boundary between farmland and rangeland. Along the northern side of McNutt the area is dissected by Horse Gulch, an ephemeral drainage. USDA mapping shows the soils at the site to be clay loam to sandy loam to a depth of 60 inches with typically less than 5% fragments greater than 3 inches. These soils are mapped as the Lostwells unit and are potential prime farmland soils.

Existing utilities include underground gas and telephone, and overhead power. Existing utilities are generally located within road rights-of-way. In addition to these local service utilities, one major gas supply line must be crossed. Generally all construction will be limited to existing rights-of-way.

2.2 Current Water Sources and Water Quality

Appendix A, Washakie County Water Supply Alternatives, describes potential water supply sources and expected water quality and quantity from various sources. This report includes specific sample data from across the county and one site within the McNutt subdivision. The McNutt sample is number 4 in that report.

Based on questionnaires received during the block party individual well depths vary from 56 to 260 feet. The shallow wells are completed in Quaternary alluvial deposits and would most likely be in communication with surface water. Such wells, used as a drinking water source pose health risks especially given the immediate proximity of individual septic systems. The deeper wells are completed in the Willwood Member of the Fort Union Formation (Tertiary age). Willwood Member wells are the most common completion in the county with depths ranging from 100 to 300 feet. The well yields are relatively low ranging from 1 to 28 gallons per minute. Water quality is generally poor and exceeds EPA secondary standards and health advisories for TDS, sulfate, and sodium. The well sampled in McNutt was selected as to represent the best possible water quality available from shallow to intermediate depth ground water sources. The well was 260 feet deep, completed in November, 1997 with and estimated flow of 12 gallons per minute. The sample exceeded the following standards:

- **TDS**: 1280 ppm - Secondary Standard 500 ppm
- **Sulfate**: 592 ppm - Secondary Standard 250 ppm
- **Sodium**: 431 ppm - Health Advisory 20 ppm
3.0 POTENTIAL WATER SUPPLY ALTERNATIVES

Potential water supply sources include the purchase of water from the City of Worland, ground water sources and surface water sources. Based on water quality, health risk, and cost, the preferred water supply alternative is the purchase of water from Worland. A brief summary of these alternatives follows. A detailed discussion of water supply alternatives is provided in Appendix A.

3.1 City of Worland

The source of water for the City of Worland is the Madison-Bighorn Aquifer from artesian wells located near Hyattville. These wells are located near the source of recharge, a pristine area of the Big Horn Mountains. Water quality is high with TDS levels of approximately 200 ppm and sulfate levels of 13 ppm. This water source meets all EPA primary and secondary standards and health advisories. The only required treatment is chlorination which is accomplished by an established system with qualified Level I operators employed by Worland.

The Worland system can currently provide in excess of 5 million gallons of water per day to the system by gravity flow as compared to a maximum daily summer demand of 4 million gallons. Addition of the McNutt users to this system would increase demand by one percent or less. Thus, Worland can meet both water quantity and quality requirements for McNutt.

3.2 Ground Water Sources

Potential ground water sources include shallow alluvial ground water sources, deep Paleozoic formations (in excess of 10,000 feet), and intermediate depth formations of Tertiary and Cretaceous ages and are discussed in detail in Appendix A. With respect to quality the deep Paleozoic formations represent the best target aquifers. However, the cost of developing these aquifers would be high as would the risks of completing a well of sufficient quantity. It is unlikely that the development of deep aquifer wells could be supported by the limited number of users in McNutt. Shallow alluvial ground water sources would represent the next best alternative with respect to water quality, however, such sources would require water treatment as surface water and would be highly susceptible to contamination from surface sources and shallow septic systems. The operation and maintenance cost for such a system would likely be prohibitive for the limited number of users in McNutt. With respect to intermediate depth ground water sources the Willwood formation represents the best target. Well yields would likely be low and water quality standards for at least TDS, sulfate, and sodium will be exceeded. In essence the well sampled in McNutt (Section 2.2) is as good as can be reasonably be expected in this aquifer. If developed as a community water supply at least two wells would have to be completed along with storage and treatment facilities. Capital and operating costs for such a system would be high for the limited number of users in the District.
3.3 Surface Water Sources

Surface water alternatives are generally limited to options involving the Big Horn River. Treatment would be required to ensure compliance with the Safe Drinking Water Act. This would require a water treatment facility and qualified operators. The water quality of the Big Horn River is acceptable. Parameters such as TDS, sulfate, and sodium approach or slightly exceed secondary standards. Filtration coupled with chlorination could achieve compliance with EPS Surface Water Treatment Rules (SWTR). However, there would always be the risk of contamination of such a system given the substantial drainage area of the Big Horn River (approximately 10,800 square miles) and the variety of human activities in the area. Surface water treatment would not alter TDS, sulfate, odor, or temperature, which may be objectionable to some users. Finally, the cost of such a system would be high for the limited number of users in the McNutt district.

4.0 SERVICE AREA/WATER DEMAND

4.1 Service Area

The service area of the McNutt District includes the platted McNutt subdivision less lots 8, 12, 13, 24, and 25, and includes limited adjacent acreage. The district is located entirely within Section 3, Township 46 North, Range 93 West.

4.2 Potential Users

Potential users are shown on Figure M-1 (Map section). Currently nineteen individual service (3/4 inch) taps have been committed and the potential exists for the addition of nine more taps for a total of twenty eight taps. For planning purposes, it is recommended that twenty taps be considered the minimum number of taps and that twenty five taps be considered the most likely. Although there are forty five lots in the subdivision, the potential for growth appears limited.

4.3 Demand

Table 1 summarizes the current demands from water systems in the region as reported to the WDC. The average monthly demand was 13,582 gallons per tap with a corresponding peak monthly demand of 26,151 gallons per tap. For the purposes of this investigation an average per tap demand of 15,000 gallons per month and peak demand of 30,000 gallons per month was used.

For peak demand network modeling (Section 5.4) a worst case daily demand was employed using 60 gallons per minute, this would simulate the peak daily demand for 100 people. Even at this level of demand the conceptual design system yielded residual pressures in excess of 30 psi at the worst location.
Table 1 - Regional Water Use

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BASIN</td>
<td>1200</td>
<td>660</td>
<td>250</td>
<td>455</td>
<td>1545</td>
</tr>
<tr>
<td>CODY</td>
<td>8200</td>
<td>3805</td>
<td>137</td>
<td>295</td>
<td>461</td>
</tr>
<tr>
<td>LOVELL</td>
<td>2250</td>
<td>975</td>
<td>110</td>
<td>254</td>
<td>462</td>
</tr>
<tr>
<td>LUCERNE</td>
<td>100</td>
<td>100</td>
<td>200</td>
<td>200</td>
<td>350</td>
</tr>
<tr>
<td>NORTH END</td>
<td>500</td>
<td>205</td>
<td>140</td>
<td>341</td>
<td>732</td>
</tr>
<tr>
<td>POWELL</td>
<td>5770</td>
<td>2576</td>
<td>250</td>
<td>560</td>
<td>1008</td>
</tr>
<tr>
<td>SOUTH WORLAND</td>
<td>450</td>
<td>154</td>
<td>139</td>
<td>406</td>
<td>592</td>
</tr>
<tr>
<td>WORLAND</td>
<td>7550</td>
<td>2547</td>
<td>200</td>
<td>593</td>
<td>1378</td>
</tr>
<tr>
<td><strong>WEIGHTED AVERAGE</strong></td>
<td></td>
<td></td>
<td><strong>183.5</strong></td>
<td><strong>433.3</strong></td>
<td><strong>871.6</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOWN OR CITY</th>
<th>TOTAL POP. SERVED</th>
<th>NUMBER OF TAPS</th>
<th>Avg. Monthly use (GPCPM)</th>
<th>Avg. Monthly use (GPTPM)</th>
<th>Peak Monthly use (GPTPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASIN</td>
<td>1200</td>
<td>660</td>
<td>7500</td>
<td>13636</td>
<td>46363</td>
</tr>
<tr>
<td>CODY</td>
<td>8200</td>
<td>3805</td>
<td>4110</td>
<td>8850</td>
<td>13830</td>
</tr>
<tr>
<td>LOVELL</td>
<td>2250</td>
<td>975</td>
<td>3300</td>
<td>7620</td>
<td>13860</td>
</tr>
<tr>
<td>LUCERNE</td>
<td>100</td>
<td>100</td>
<td>6000</td>
<td>6000</td>
<td>10500</td>
</tr>
<tr>
<td>NORTH END</td>
<td>500</td>
<td>205</td>
<td>4200</td>
<td>10230</td>
<td>21951</td>
</tr>
<tr>
<td>POWELL</td>
<td>5770</td>
<td>2576</td>
<td>7500</td>
<td>16800</td>
<td>30239</td>
</tr>
<tr>
<td>SOUTH WORLAND</td>
<td>450</td>
<td>154</td>
<td>4170</td>
<td>12180</td>
<td>17788</td>
</tr>
<tr>
<td>WORLAND</td>
<td>7550</td>
<td>2547</td>
<td>6000</td>
<td>17790</td>
<td>41351</td>
</tr>
<tr>
<td><strong>WEIGHTED AVERAGE</strong></td>
<td></td>
<td></td>
<td><strong>5506</strong></td>
<td><strong>13582</strong></td>
<td><strong>26151</strong></td>
</tr>
</tbody>
</table>

4.4 Future Growth

Future growth within the District is limited to a maximum of 48 taps (platted subdivision plus one tap). Expansion of the District is not likely since the Washakie Rural Water District surrounds the McNutt District. It is likely that the total build out would not exceed 30 taps based on the current configuration of the development and remaining buildable lots.

4.5 Fire Flow

Fire flow could not be sustained without onsite storage and/or a booster pump station. The cost for inclusion of fire flow in the system would be prohibitive for the limited number of users.

5.0 PRELIMINARY DESIGN

The preliminary design relies on Worland for water supply from the 8 inch line along Highway 20 which runs from Worland’s West tank to the Boy’s School tank. The design does not incorporate any storage or booster facility.

5.1 Key Elements of Worland/Boy’s School System Impacting the McNutt System

- Tie in at the existing 6 inch valve from the 8 inch line approximately 8,000 feet from the booster station. Ground elevation 4131 feet, top of valve 4125 feet.
- Maximum pressure at tie in based on Boy’s School tank (300,000 gallons), full at elevation 4282, 65 psi.
- Minimum pressure at tie in with 71 psi at booster pump, 53 psi.
- Worland West Tank 2,500,000 gallons maximum elevation 4221 feet.
- Worland East Tank 2,500,000 gallons maximum elevation 4312 feet.
- Pressure reduction valves (PRV) between Worland’s East and West Tanks equilibrate pressures in the system which operates as a single pressure zone.
- The Boy’s School with its booster pump and tank operates as an independent pressure zone.

5.2 Key Elements of Washakie Rural System Impacting the McNutt System

The southern portion of the Washakie Rural System is currently designed to tie into the Boy’s School system. The south Washakie system is proposed to tie to the Worland system at the intersection of Lane 12 and Road 11. This location is above Worland’s PRVs and would rely on pressure from the East Tank. The main supply from this location would proceed by gravity flow to a tank located on an elevated ridge near Gooseberry Road south of the Boy’s School. The Washakie Rural Tank will be set at an elevation of 4290 feet or higher. Connecting this system to the Boy’s School and McNutt would raise the pressures in both systems and eliminate the need for the booster station. Since the most significant impact of the McNutt system on the Worland system would be a slight additional demand on the booster pump station, connection to the Washakie Rural Tank would eliminate this impact.

-9-
5.3 Conceptual Design Alternatives

The preferred design alternative is shown on Figure M-2 (Map Section). All water lines are located within existing rights-of-way. The main supply line would be 6 inch with a 4 inch distribution loop within the subdivision and limited 2 inch distribution lines to limited residents. An existing 2 inch service line is in place to the most distant user. At the point of connection a master meter, backflow preventer, and meter pit would be installed, as a minimum. In addition an automatic shutoff valve is recommended. Typical design details are provided in Appendix B. Construction specifications will comply with AWWA and WPWSS standard specifications.

Two alternatives were analyzed to determine the change in flow and pressures. These options were to;

1. Replace the 4 inch line with a 6 inch and;
2. In addition, replace the 2 inch lines with 4 inch lines.

The costs of these alternatives increased the estimated project costs by $20,000 (12%) and by $29,000 (18%), respectively. For the maximum daily demand flow condition these options improved residual pressures by approximately 1 psi. Thus, these options were not considered cost effective.

5.4 Design Flows/Network Modeling

System design and network modeling for this project was developed utilizing "Cybernet" hydraulic software developed by Haestad methods and licensed to BRS Inc. This software is an "Autocad" based software which allows the user to evaluate system layout and simulate flow conditions and demand scenarios. The system displays data on flow, pressure, and various other parameters in graphic and text formats.

Figure M-3 (Map Section) shows the Cybernet network model layout and the demand and pressures for the peak daily demand assuming 100 persons (60 gpm). This simulation assumed the pressure available from the 8 inch supply line based on 71 psi at the booster station. At the most distant location and the highest elevation, the residual pressure is approximately 32 psi. This compares to WDEQ/WQD Chapter XII Regulations which require a minimum pressure of 20 psi under all conditions and a normal working pressure of 35 psi.

Table 2 compares the peak demand, average demand, and maximum static pressure in the system. As with the peak demand simulation shown on Figure M-3, the working pressure of the 8 inch main was assumed to be controlled by the booster pump station operating at 71 psi. Under these conditions, average demand pressures within the system range from 33 to 53 psi. If the top elevation of the Boy’s School tank(4282 feet) were to control the system, pressures would increase by approximately 12 psi as reflected by the static pressures.
### Table 2
Cybernet Demand Scenarios

<table>
<thead>
<tr>
<th>Cybernet Node #</th>
<th>Node Location / Description</th>
<th>Peak Demand</th>
<th>Avg. Demand</th>
<th>Static Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>J-13</td>
<td>Worland - 8&quot;</td>
<td>58 psi</td>
<td>58 psi</td>
<td>70 psi</td>
</tr>
<tr>
<td>J-15</td>
<td>6&quot; Main</td>
<td>53 psi</td>
<td>53 psi</td>
<td>65 psi</td>
</tr>
<tr>
<td>J-16</td>
<td>4&quot; Main</td>
<td>43 psi</td>
<td>43 psi</td>
<td>55 psi</td>
</tr>
<tr>
<td>J-17</td>
<td>2&quot; Pipe - Groshart</td>
<td>38 psi</td>
<td>38 psi</td>
<td>51 psi</td>
</tr>
<tr>
<td>J-20</td>
<td>6&quot; Main</td>
<td>48 psi</td>
<td>48 psi</td>
<td>60 psi</td>
</tr>
<tr>
<td>J-30</td>
<td>6&quot; Main</td>
<td>44 psi</td>
<td>45 psi</td>
<td>57 psi</td>
</tr>
<tr>
<td>J-50</td>
<td>6&quot; Main</td>
<td>44 psi</td>
<td>44 psi</td>
<td>56 psi</td>
</tr>
<tr>
<td>J-60</td>
<td>4&quot; Loop</td>
<td>42 psi</td>
<td>42 psi</td>
<td>55 psi</td>
</tr>
<tr>
<td>J-70</td>
<td>6&quot; Main</td>
<td>43 psi</td>
<td>43 psi</td>
<td>55 psi</td>
</tr>
<tr>
<td>J-80</td>
<td>4&quot; Loop</td>
<td>38 psi</td>
<td>38 psi</td>
<td>51 psi</td>
</tr>
<tr>
<td>J-90</td>
<td>2&quot; Pipe - Yorgason</td>
<td>41 psi</td>
<td>42 psi</td>
<td>55 psi</td>
</tr>
<tr>
<td>J-100</td>
<td>2&quot; Pipe - Yorgason</td>
<td>38 psi</td>
<td>39 psi</td>
<td>51 psi</td>
</tr>
<tr>
<td>J-101</td>
<td>Worland - 8&quot;</td>
<td>67 psi</td>
<td>67 psi</td>
<td>79 psi</td>
</tr>
<tr>
<td>J-102</td>
<td>Worland - 8&quot;</td>
<td>62 psi</td>
<td>62 psi</td>
<td>74 psi</td>
</tr>
<tr>
<td>J-105</td>
<td>6&quot; Main</td>
<td>53 psi</td>
<td>53 psi</td>
<td>65 psi</td>
</tr>
<tr>
<td>J-110</td>
<td>2&quot; Pipe - Yorgason</td>
<td>32 psi</td>
<td>33 psi</td>
<td>45 psi</td>
</tr>
</tbody>
</table>

**Assumptions:**

1. Model is based on steady state conditions with one time period.
2. Static pressure determined by Boy’s School Tank, 4282 feet in elevation.
3. Peak and average operating pressures were based on the booster pump operating at 71 psi. If the system operated based on the Boy’s School Tank elevation, operating pressures would increase by approximately 12 psi.
4. Elevations were taken from available data including USGS mapping, as-built data, and limited site survey data.
5. Cybernet Version 3.1 by Haestad Methods was used for modeling.
6.0 EASEMENTS, ENVIRONMENTAL ISSUES, AND PERMITS

Anticipated construction activities for the McNutt project are generally limited to existing easements and rights-of-way. Thus, minimal disturbance will occur in currently undisturbed areas.

Easements/construction permits will be required for work within the right-of-way for U. S. Highway 20 from the Wyoming Department of Transportation; for work in the county right-of-way from Washakie County; and from private owners of the roads within the McNutt subdivision. Additional easement/permits required would include a permit to construct from WDEQ/WQD and Washakie County and permission to cross the Bluff Canal.

RUS funding and/or site environmental assessment lists some 32 items relating to land use and environmental features to be considered in the design and permitting of a project of this nature. Of these items the following features are applicable:

6. Agricultural - Data from the USDA, SCS 1983 shows that the McNutt area has soils potentially capable of sustaining prime farm land, however, no disturbance of native soils is anticipated.

7. Wetlands - related to the Bluff Canal crossing will require notification under nationwide 404 permitting. National wetland inventory maps were consulted and no other wetlands were shown in the vicinity.

8. Historical or Archeological Sites - The State of Wyoming office of historical preservation (SHPO) was contacted. No known historic or archeological sites occur in the project area. Disturbances will be limited to existing disturbed areas minimizing any potential impact to historic or archaeologic sites in the areas should they exist.

9. Critical Habitats - Since the area is disturbed it is not likely that the limited construction activities related to this project would impact critical habitat of threatened and endangered species. There is potential for raptor nesting in the vicinity of Horse Gulch and along the Big Horn River.
7.0 ESTIMATED COSTS AND FINANCING

7.1 Construction Costs

Table 3 provides the estimated construction costs for the preferred alternative. The construction subtotal for all components is estimated at $114,109.00. Unit cost data was derived from recent contractor bids in the vicinity, vendor quotations for materials, and cost data from city of Worland Public Works Department.

7.2 Supply/Distribution Components

Approximately 62% of the system components are related to the water supply system, eligible for WDC funding, and 38% are related to the distribution system, eligible for State Land and Investment Board funding. Table 3 provides costs for individual system components and separates components based on supply or distribution system related funding eligibility. Distribution system items include 4 and 2 inch distribution lines, flushing hydrants, and individual service connections. All costs for engineering, permitting, legal fees, and contingencies were considered proportionate to the system component costs relative to supply and distribution.

The project has been discussed with RUS and would probably be eligible for RUS funding. Given the estimated monthly rates, RUS funding would probably be dominantly loan rather than grant. RUS would fund both supply and distribution components.

7.3 Financing Alternatives

Table 4 provides a comparison of financing alternatives. The lowest cost per month for debt retirement would be to obtain a WDC grant for the supply components, a State Land Investment grant for the distribution components, and then secure a low interest loan for the remaining debt from RUS. RUS will require a bond election at a minimum cost of $5,000.00 and a specific application process. Currently RUS loans are at a rate of 4.75%. A rate of 5% was used in the analysis since the rates change quarterly. The maximum term for a RUS loan to an improvement district such as McNutt is 25 years. The next lowest cost per month would be to avoid the cost of the bond election and secure state loans at the current rate of 7.25% for a 30 year term.

7.4 Cost Sensitivity

Half of the cost of the McNutt system is related to pipeline costs. A change of $1.00 per foot on the installation cost of the pipe would reduce costs by approximately $5,000 or about 4%. This change would reduce monthly costs by approximately $1.45 per user (with RUS financing). The project is also very cost sensitive to the number of users. A change in one user would impact monthly debt retirement costs by approximately $1.00 per month.
MCNUTT RURAL WATER DISTRICT

CONSTRUCTION COST ESTIMATE - ENTIRE SYSTEM
OPTION #1 - BASIC SYSTEM WITH MINIMUM PIPE SIZES
PREPARED BY: BRS INC. 10/07/98

<table>
<thead>
<tr>
<th>ITEM DESCRIPTION</th>
<th>UNIT</th>
<th>QUANTITY</th>
<th>UNIT COST</th>
<th>TOTAL COST</th>
<th>ITEM INCLUSIONS/ GENERAL NOTES</th>
<th>SUPPLY OR DISTRIBUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOBILIZATION</td>
<td>LS</td>
<td>1</td>
<td>$10,000.00</td>
<td>$10,000.00</td>
<td>For Extent of Project</td>
<td>Supply</td>
</tr>
<tr>
<td>6&quot; PVC - 150</td>
<td>LF</td>
<td>2,560</td>
<td>$12.00</td>
<td>$30,720.00</td>
<td>Excavation, Fittings, Backfill</td>
<td>Supply</td>
</tr>
<tr>
<td>4&quot; PVC - 150</td>
<td>LF</td>
<td>2,000</td>
<td>$10.00</td>
<td>$20,000.00</td>
<td>Excavation, Fittings, Backfill</td>
<td>Distribution</td>
</tr>
<tr>
<td>2&quot; PVC - 150 SUPPLY</td>
<td>LF</td>
<td>200</td>
<td>$8.00</td>
<td>$1,600.00</td>
<td>Excavation, Fittings, Backfill</td>
<td>Supply</td>
</tr>
<tr>
<td>2&quot; PVC - 150 DISTRIBUTION</td>
<td>LF</td>
<td>260</td>
<td>$8.00</td>
<td>$2,080.00</td>
<td>Excavation, Fittings, Backfill</td>
<td>Distribution</td>
</tr>
<tr>
<td>6&quot; GATE VALVE</td>
<td>EA</td>
<td>1</td>
<td>$550.00</td>
<td>$550.00</td>
<td>W/ Fittings and Concrete</td>
<td>Supply</td>
</tr>
<tr>
<td>4&quot; GATE VALVE</td>
<td>EA</td>
<td>3</td>
<td>$465.00</td>
<td>$1,395.00</td>
<td>W/ Fittings and Concrete</td>
<td>Supply</td>
</tr>
<tr>
<td>PIPE BEDDING</td>
<td>CY</td>
<td>186</td>
<td>$8.00</td>
<td>$1,488.00</td>
<td>6&quot; deep, 2' width</td>
<td>Supply</td>
</tr>
<tr>
<td>SELECT BACKFILL</td>
<td>CY</td>
<td>372</td>
<td>$8.00</td>
<td>$2,976.00</td>
<td>24&quot; deep, 2' width, not all places</td>
<td>Supply</td>
</tr>
<tr>
<td>UTILITY CROSSING</td>
<td>EA</td>
<td>20</td>
<td>$200.00</td>
<td>$4,000.00</td>
<td>All Types of Utilities/Drainages</td>
<td>Supply</td>
</tr>
<tr>
<td>12&quot; CANAL CASING</td>
<td>EA</td>
<td>1</td>
<td>$4,000.00</td>
<td>$4,000.00</td>
<td>Open Excavation Installation</td>
<td>Supply</td>
</tr>
<tr>
<td>FLUSHING HYDRANT</td>
<td>EA</td>
<td>2</td>
<td>$750.00</td>
<td>$1,500.00</td>
<td>W/ Fittings and Concrete</td>
<td>Distribution</td>
</tr>
<tr>
<td>SERVICE CONNECTIONS</td>
<td>EA</td>
<td>20</td>
<td>$1,000.00</td>
<td>$20,000.00</td>
<td>Meter, Valves, 3/4&quot; Typical</td>
<td>Distribution</td>
</tr>
<tr>
<td>AIR/VAC VALVE ASSEM.</td>
<td>EA</td>
<td>1</td>
<td>$1,200.00</td>
<td>$1,200.00</td>
<td>W/ Fittings and Piping</td>
<td>Supply</td>
</tr>
<tr>
<td>ROAD GRADING</td>
<td>HR</td>
<td>20</td>
<td>$65.00</td>
<td>$1,300.00</td>
<td>Regrade Local Roads</td>
<td>Supply</td>
</tr>
<tr>
<td>DRAIN VALVE ASSEM.</td>
<td>EA</td>
<td>1</td>
<td>$800.00</td>
<td>$800.00</td>
<td>W/ Fittings and Piping</td>
<td>Supply</td>
</tr>
<tr>
<td>CONNECTION STATIONS</td>
<td>EA</td>
<td>1</td>
<td>$14,500.00</td>
<td>$14,500.00</td>
<td>W/ Vault, Valves, Fittings</td>
<td>Supply</td>
</tr>
</tbody>
</table>

SUPPLY SUBTOTAL = $74,529.00  63.00%
DISTRIBUTION SUBTOTAL = $43,580.00  37.00%

CONSTRUCTION COST SUBTOTAL #1 = $118,109.00

ENGINEERING COSTS (10%) = $11,810.90
CONSTRUCTION COST SUBTOTAL #2 = $129,919.90
CONTINGENCY COSTS (15%) = $19,487.99

CONSTRUCTION COST TOTAL = $149,407.89

PREPARATION OF FINAL DESIGNS AND SPECIFICATIONS = $10,000.00
PERMITTING AND MITIGATION = $1,000.00
LEGAL FEES = $3,000.00
ACQUISITION OF ACCESS AND RIGHTS OF WAY = $1,000.00

PROJECT COST TOTAL = $164,407.89  Cost Per Tap = $8,217
**Table 4 - Financing Alternatives**

Assume:

- WDC eligible cost for the project are $102,000.00 with 60% grant.
- State Lands eligible cost for the project are $63,000.00 with 50% grant.
- WDC financing is at 7.25% for 30 years.
- RUS financing is at 5.0% for 25 years (maximum for improvement district).
- Tap fees will be $1500.00 per tap for 20 taps.
- One third of the tap fee will be applied to debt.
- Debt retirement based on 20 taps.

<table>
<thead>
<tr>
<th>Description</th>
<th>WDC Portion</th>
<th>State Lands Portion</th>
<th>Remaining Debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost</td>
<td>$102,000.00</td>
<td>$63,000.00</td>
<td></td>
</tr>
<tr>
<td>Grant</td>
<td>$61,200.00</td>
<td>$31,500.00</td>
<td></td>
</tr>
<tr>
<td>Tap Fees Applied</td>
<td></td>
<td>$10,000.00</td>
<td></td>
</tr>
<tr>
<td>Balance</td>
<td>$40,800.00</td>
<td>$21,500.00</td>
<td>$62,300.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Financing Scenario</th>
<th>Monthly Debt</th>
<th>Monthly Debt per Tap - 20 Taps</th>
<th>Monthly Debt per Tap - 25 Taps</th>
</tr>
</thead>
<tbody>
<tr>
<td>WDC 7.25%, 30 yrs</td>
<td>$422.44</td>
<td>$21.12</td>
<td>$16.90</td>
</tr>
<tr>
<td>RUS 5.0%, 25 yrs</td>
<td>$362.69</td>
<td>$18.50</td>
<td>$14.80</td>
</tr>
</tbody>
</table>
8.0 RECOMMENDED RATE SCHEDULE

The McNutt District rates must consider debt retirement, water purchase charges, operation and maintenance costs (O&M), water use charges, and tap fees. It is critical in the development of a rate schedule that all costs are covered and to the extent possible rates are equitable to all users. In addition, it is desirable that the rate schedule provide an affordable minimum rate with escalation of rates dependent on water use. The following rate schedule is recommended, however, the final decision of rates rests with the District.

8.1 Tap Fees

An initial tap fee of $1,500.00 per active tap is recommended with the option of an inactive tap fee of $300.00 per tap with the balance due upon activation. Once the system is funded and construction contracts let, it is recommended that the tap fee double. From that point forward the tap fee should increase as costs dictate. Of the initial tap fee one third (for 20 taps $10,000.00) is recommended to be applied to the retirement of District debt. The remaining two thirds ($20,000.00) should be held in reserve and for up-front costs such as legal fees and rights-of-way.

8.2 District Debt Retirement

Table 4 provides an estimate of the district debt retirement on a per month basis. Debt retirement should be charged to all taps, active or inactive. If the RUS funding were used, the actual debt retirement fee required per month per tap (20 taps) would be $18.14. It is recommended with this funding scenario that a debt retirement fee of $20.00 per month per tap be collected, at least initially, to build a reserve account.

8.3 Worland Charges

Worland charges will most likely include monthly debt retirement for their water supply system and per 1,000 gallons water use fees. A water purchase agreement with Worland will be required that is compatible with Worland City code and Wyoming State law. The current state law mandates that the charges do not exceed actual costs of water supply to the point of delivery. Current city code and practice is to charge an additional 25% above in-town rates applied to the monthly debt retirement of $6.00 per tap and commercial water use rate of $1.00 per 1,000 gallons. Conservatively Worland charges are estimated at $7.50 per tap and $1.25 per 1,000 gallons.

8.4 System Operation and Maintenance

System operating and maintenance costs may include costs for actual system maintenance and repair, meter reading and billing, insurance, water sampling costs, and incidental expenses. The district would be required to have a qualified operator or a service agreement with a qualified operator. Previous studies have estimated O&M costs at $20.00 per tap per month, Northwest Rural charges a reported $12.50 per tap per month, South Worland charges a $10.00 base fee but increases
water charges from $1.25 to $1.80 per 1,000 gallons. Estimation of actual O&M costs is difficult for a district such as McNutt due to the limited number of users. The following is an estimate of likely costs which may occur during a given year of operation:

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>Cost</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line repair 20 hours @ $50.00 per hour with operator and equipment.</td>
<td>$1,000.00</td>
<td>Initially no costs should be incurred but a reserve account should be established.</td>
</tr>
<tr>
<td>Billing, meter reading etc.</td>
<td>$1,200.00</td>
<td>Assume 10 hours/month at $10.00 per hour.</td>
</tr>
<tr>
<td>Water Sample per EPA requirements.</td>
<td>$400.00</td>
<td>May be waived once history is established. Analytical cost only.</td>
</tr>
<tr>
<td>Insurance and incidental costs</td>
<td>$500.00</td>
<td></td>
</tr>
<tr>
<td>Total Annual Cost</td>
<td>$3,600.00</td>
<td></td>
</tr>
</tbody>
</table>

The monthly cost per tap for 20 taps would be $15.00 per tap.

8.5 Water Use Charges

Water use charges should as a minimum be equivalent to the Worland per 1,000 gallon charges or $1.25 per 1,000. South Worland charges $1.80 per 1,000. It is recommended that a low rate be established for minimum usage and that the rate increase with use. The following schedule is recommended:

- Minimum charge based of 5,000 gallons at $1.50 per 1,000 or $7.50.
- 5,000 to 15,000 gallons at $1.50 per 1,000.
- 15,000 to 30,000 gallons at $3.00 per 1,000.
- District would require multiple tap fee above 30,000 gallons usage.

8.6 Rate Summary

Based on the foregoing assumptions and recommendations (assuming the 25% surcharge from Worland and assuming 20 taps) the following overall rate schedule is recommended.

Minimum rate for 5,000 gallons - $20.00 District debt retirement
$ 7.50 Worland debt retirement
$15.00 O&M
$ 7.50 Water use
$50.00 Total per month per tap
Monthly bill for 15,000 gallons -

$20.00 District debt retirement
$7.50 Worland debt retirement
$15.00 O&M
$.22.50 Water use

$65.00 Total per month per tap

Once the District has established revenues and built up reserve accounts, and/or added users were added to the system, rates could be adjusted accordingly. It is recommended that rates be reviewed at least annually. Note that the 25% surcharge from Worland increases rates by approximately $5.00 per month. Similarly, the addition of 5 taps would reduce rates by approximately $5.00 per month.

9.0 ADDITIONAL REQUIREMENTS

9.1 WDC Requirements

The District must request funding from WDC for the McNutt project as Level III. This request must be made on or before November 1, 1998. WDC will review the project, the Level II report and determine whether to present the project to the legislature for funding in 1999. If the project receives WDC funding, application can be made to the State Land and Investment Board for funding in the spring of 1999.

9.2 RUS Requirements

If the District chooses to pursue RUS funding, an application must be prepared and a bond election held. Most likely the bond election would be held in May 1999. Upon receipt of the application RUS will determine grant/loan mix based on projected user costs.

9.3 Water Purchase Agreement

A water purchase agreement must be established with Worland for the supply of the water. On October 1, 1998 the City of Worland passed a resolution allowing Mayor Herm Emmett to sign a letter of intent to supply water to the McNutt Improvement District.

9.4 Level III Requirements

1. Easements and permits must be obtained.
2. Final tap commitments (with partial payment) and service agreements must be established.
3. Final designs and specifications must be prepared.
4. The point of connection be exposed and pressure tested prior to final design.
5. Critical elevations such a tanks, connection points, and highest taps should be checked.
6. All tap fees should be collected on or before the bidding of the project.
7. Tap fees should be increased once the project is bid.
10.0 CONCLUSIONS AND RECOMMENDATIONS

The McNutt project appears feasible based on monthly costs of comparable systems. The most variable costs will be the O&M costs. These will vary based on a variety of factors including how the District chooses to operate. It is recommended that the District contract O&M services preferably with Worland or another established water district in the vicinity. Consideration may also be given to consolidation of the McNutt District with the Washakie Rural Improvement District.
APPENDIX A

WASHAKIE COUNTY
WATER SUPPLY ALTERNATIVES
(Lidstone & Anderson, Inc.)
TABLE OF CONTENTS

1.0 POTENTIAL WATER SUPPLY SOURCES ........................................ A-1

1.1 Evaluation Criteria .................................................. A-2

2.0 WATER SUPPLY ALTERNATIVES ........................................ A-4

2.1 Surface Water (Bighorn River) Alternatives ......................... A-4
2.2 Shallow Ground Water (Alluvial) Alternatives ....................... A-9
2.3 Intermediate Ground Water (Willwood/Fort Union Formation) .... A-12
2.4 Deep Ground Water (Madison-Bighorn Aquifer) Alternatives ...... A-13
2.5 Purchase treated water (Worland Water System) ...................... A-14
2.6 Summary of Alternative Evaluation ................................... A-14

3.0 REFERENCES .............................................................. A-16

TABLES/FIGURES/ATTACHMENTS

TABLES

Table A-1. Washakie County/McNutt Rural Water Supply Project
Results of Water Quality Monitoring Program. ......................... A-5
Table A-2. Summary of USEPA STORET Water Data Retrieval:
Bighorn River at Worland (USGS Gaging Station 06268600) .......... A-8

FIGURES

Figure A-1. Comparison of Selected Water Quality Parameters
Figure A-2. Reported Yield of Selected Geologic Units. ................. A-10

ATTACHMENTS

Attachment A-1: Bar Charts
1.0 POTENTIAL WATER SUPPLY SOURCES

Several alternative water supply sources were evaluated in support of the Wyoming Water Development Commission’s Washakie County Water Supply Projects. These alternatives include a variety of raw water sources as well as purchase of treated water from the Town of Worland. The potential sources have been identified through the public meeting and scoping process as well as through sound engineering judgement and knowledge of the local hydrologic system. The alternate sources are as follows:

Surface Water (Bighorn River):

Raw water would be obtained from the Bighorn River through direct diversion or an infiltration gallery constructed beneath the channel bed.

Shallow Ground Water (Alluvial Aquifers):

Raw water would be obtained from alluvial well(s) constructed in alluvium adjacent to the Bighorn River.

Intermediate Ground Water (Willwood/Fort Union Formation):

Raw water would be obtained from two or more wells, 150 - 300 feet in depth, completed in the Willwood and/or Fort Union Aquifers.

Deep Ground Water (Madison Aquifer):

Raw water would be obtained from a deep ground water well. If constructed within the boundaries of the this district, well depth could approach 10,000 feet or more and would penetrate the Madison Aquifer.

Purchase Treated Water (Worland Water System):

A transmission line, linked to the Worland water system, would be constructed and treated water would be purchased from the City.
1.1 Evaluation Criteria

The evaluation of these alternatives in this report involves primarily evaluation of water quality and water quantity criteria. Although costs are discussed in qualitative terms, they are evaluated in greater detail within the Level I investigation.

For a source to be viable, it must be shown to be able to provide the quantity of water needed to meet the demand of the service area. It must yield adequate water quality such that drinking water standards can be achieved. Although secondary standards are "aesthetic", they are important reflections of taste (palatability), and certain health standards. The ambient water quality will, to a large extent, drive the level of treatment required before the water can be delivered to the user. Sources poor in quality will obviously require a higher level of treatment in order to meet drinking water standards. For example, high turbidity interferes with disinfection efficiency and often signals the presence of other health hazards. The poorer the water quality and the correspondingly higher level of treatment required, the higher the costs associated with the treatment system as well as the operation and maintenance of that system.

In addition to these physical factors, several institutional and regulatory constraints play important roles in the selection of a water supply for the Water District. An important regulatory constraint involved in the evaluation of alternatives is the level of treatment required in relation to the source. Despite the quality of the water supply, different types of sources require different levels of treatment. Basically, if the source involves surface water or alluvial water that is directly connected to a surface water source, filtration and disinfection is required. On the other hand, a source involving only deep ground water can be utilized with much more lenient regulatory requirements, which may involve only disinfection.

The United States Environmental Protection Agency (USEPA) as part of the 1986 Safe Drinking Water Act (SDWA), promulgated the Surface Water Treatment Rule (SWTR: 40 CFR Part 141, Subpart H, effective December 31, 1990). The SWTR pertains to all public water systems which utilize a surface water source or ground water under the direct influence of surface water. The SWTR defines surface water as all waters which are open to the atmosphere and are subject to surface water runoff. Ground water under the direct influence of surface water is defined as any water beneath the surface of the ground with: (1) significant occurrence of insects or other macro organisms, algae, organic debris or large diameter pathogens such as Giardia lamblia; or (2) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions.

Use of surface or alluvial waters would fall under the requirements of the SWTR. Therefore, water supply alternatives exploiting these sources would need to incorporate an
adequate treatment system. In addition, a licensed operator would be required to operate and maintain the system. Filtration systems may include slow sand filters, commercially available package filter plants and non-conventional filtration including bag or cartridge system.

A final consideration included in the evaluation of alternatives is the assessment of relative risk involved in the quality of each source. A surface water or alluvial source is much more susceptible to contamination and interruption of supply than many ground water sources. The Bighorn River surface water alternative is a major river with a drainage area encompassing approximately 10,800 square miles. A basin of this size contains a large variety of agricultural and urban land uses, including highways, railways, etc. The potential of a spill or accident involving toxic materials will increase with the complexity of the system. Deep ground water, on the other hand, generally provides a source of water which is more protected from activities of man.

With these concepts in mind, the alternatives presented were evaluated and discussed in the following sections. Each alternative may have desirable and undesirable characteristics, the relative weight of each being weighed upon the other. For example, an intermediate ground water source would not need the level of treatment required under the SWTR. However, the quality of these waters is not high and would likely not be palatable without some form of treatment by the end use (i.e., softeners and/or reverse osmosis systems). With these concepts in mind, the various alternatives were evaluated and are discussed in the following paragraphs.
2.0 WATER SUPPLY ALTERNATIVES

Water supply alternatives were evaluated using data obtained from a variety of sources. During the July, 1998 a field investigation was conducted to evaluate water quality in selected wells located throughout the Washakie study area. Water samples were taken from eleven wells and the Big Horn River for laboratory analysis. Field water quality parameters (pH, temperature, and conductivity) were measured and notes taken from interviews with well owners and water users. Measurements were made of the water source following adequate flushing of lines and prior to any treatment. This information was combined with water quality data obtained from the United States Environmental Protection Agency’s STORET database. Additional water quality data were obtained from published reports of the United States Geological Survey and the Wyoming Water Resources Planning Program. These documents also provided valuable information pertaining to regional ground water conditions in terms of water quality and yield of various aquifers.

In the paragraphs that follow, each alternative is discussed individually in terms of water quality, water quantity, feasibility, and treatment requirements. Results of the 1998 field sampling are tabulated and presented as Table A-1. Bar charts showing the results and comparisons of these data are included as Attachment A-1. Sample locations are presented on Plate I of the Level II Investigation. Figure A-1 presents a comparison of selected water quality parameters in each of the alternative sources evaluated. This figure is referred to throughout this report and represents a compilation of data obtained from the STORET database, the USGS publications, and the results of the 1998 field investigation.

2.1 Surface Water (Bighorn River) Alternatives

The surface water alternatives, which are potentially available to the rural water users within Washakie County are limited to options involving the Bighorn River. Water could be diverted directly from the river or an infiltration gallery could be constructed beneath or adjacent to the river. Treatment would be required to ensure compliance with the Safe Drinking Water Act. The water quality of the Bighorn River was characterized using data obtained from the USEPA STORET database. These data were provided to STORET by the USGS which maintains a stream gaging and water quality monitoring station at Worland (USGS gaging station number 06268600). These data were used to evaluate the quality of the Bighorn River as a potential alternative water supply. The period of record for the available data extends from 1964 through
<table>
<thead>
<tr>
<th>Field Parameters</th>
<th>Units</th>
<th>Standard</th>
<th>Results</th>
<th>Results</th>
<th>Results</th>
<th>Results</th>
<th>Results</th>
<th>Results</th>
<th>Results</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td>ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>Deg C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Major Ion</th>
<th>Units</th>
<th>Standard</th>
<th>Results</th>
<th>Results</th>
<th>Results</th>
<th>Results</th>
<th>Results</th>
<th>Results</th>
<th>Results</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>mg/l</td>
<td></td>
<td>110.0</td>
<td>110.0</td>
<td>159.0</td>
<td>159.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/l</td>
<td></td>
<td>41.8</td>
<td>41.9</td>
<td>3.4</td>
<td>6.0</td>
<td>116.0</td>
<td>54.0</td>
<td>24.6</td>
<td>16.6</td>
</tr>
<tr>
<td>Sodium</td>
<td>mg/l</td>
<td></td>
<td>143.0</td>
<td>143.0</td>
<td>555.0</td>
<td>555.0</td>
<td>219.0</td>
<td>94.0</td>
<td>30.0</td>
<td>21.0</td>
</tr>
<tr>
<td>Potassium</td>
<td>mg/l</td>
<td></td>
<td>7.4</td>
<td>7.5</td>
<td>3.0</td>
<td>3.0</td>
<td>13.0</td>
<td>4.8</td>
<td>6.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Sulphate</td>
<td>mg/l</td>
<td></td>
<td>300.0</td>
<td>300.0</td>
<td>592.0</td>
<td>592.0</td>
<td>1900.0</td>
<td>540.0</td>
<td>220.0</td>
<td>137.0</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/l</td>
<td></td>
<td>26.5</td>
<td>33.3</td>
<td>75.4</td>
<td>75.4</td>
<td>111.0</td>
<td>35.8</td>
<td>10.0</td>
<td>9.9</td>
</tr>
<tr>
<td>Antimony as N</td>
<td>mg/l</td>
<td></td>
<td>0.05</td>
<td>0.08</td>
<td>0.69</td>
<td>0.68</td>
<td>2.86</td>
<td>0.08</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/l</td>
<td></td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Fluorine</td>
<td>mg/l</td>
<td></td>
<td>0.04</td>
<td>0.07</td>
<td>1.10</td>
<td>1.01</td>
<td>0.43</td>
<td>1.00</td>
<td>0.63</td>
<td>0.29</td>
</tr>
</tbody>
</table>

### Non-Metals

<table>
<thead>
<tr>
<th>Total Dissolved Solids at 180°C</th>
<th>mg/l</th>
<th>200 Secondary</th>
<th>500 Secondary</th>
<th>1380 Secondary</th>
<th>1380 Secondary</th>
<th>3000 Secondary</th>
<th>1510 Secondary</th>
<th>1510 Secondary</th>
<th>3000 Secondary</th>
<th>1510 Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS</td>
<td>mg/l</td>
<td>102.0</td>
<td>196.0</td>
<td>1380.0</td>
<td>2960.0</td>
<td>1510.0</td>
<td>3000.0</td>
<td>1510.0</td>
<td>3000.0</td>
<td>1510.0</td>
</tr>
<tr>
<td>Ca</td>
<td>mg/l</td>
<td>204.0</td>
<td>248.0</td>
<td>3490.0</td>
<td>3490.0</td>
<td>1210.0</td>
<td>1830.0</td>
<td>1210.0</td>
<td>1830.0</td>
<td>1210.0</td>
</tr>
<tr>
<td>Mg</td>
<td>mg/l</td>
<td>7.33</td>
<td>7.54</td>
<td>8.17</td>
<td>8.13</td>
<td>7.53</td>
<td>7.49</td>
<td>7.46</td>
<td>8.40</td>
<td>7.72</td>
</tr>
<tr>
<td>Na</td>
<td>mg/l</td>
<td>6.92</td>
<td>7.17</td>
<td>7.90</td>
<td>7.90</td>
<td>7.33</td>
<td>7.20</td>
<td>7.38</td>
<td>8.14</td>
<td>7.92</td>
</tr>
<tr>
<td>Residual Sodium Carbonate</td>
<td>mg/l</td>
<td>8.2</td>
<td>8.7</td>
<td>10.1</td>
<td>10.1</td>
<td>8.2</td>
<td>8.7</td>
<td>9.1</td>
<td>9.4</td>
<td>9.1</td>
</tr>
<tr>
<td>Sodium Absorption Ratio</td>
<td>SAR</td>
<td>2.9</td>
<td>5.0</td>
<td>26</td>
<td>25</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Hardness (by calculation)</td>
<td>mg/l</td>
<td>449.3</td>
<td>450.0</td>
<td>155</td>
<td>155</td>
<td>1129</td>
<td>429</td>
<td>326</td>
<td>326</td>
<td>191</td>
</tr>
</tbody>
</table>

### Trace Metals

<table>
<thead>
<tr>
<th>Aluminum</th>
<th>mg/l</th>
<th>0.10</th>
<th>0.10</th>
<th>0.10</th>
<th>0.10</th>
<th>0.10</th>
<th>0.10</th>
<th>0.10</th>
<th>0.10</th>
<th>0.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>mg/l</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Barium</td>
<td>mg/l</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Beryllium</td>
<td>mg/l</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Barium</td>
<td>mg/l</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Chromium</td>
<td>mg/l</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg/l</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

### Radionuclides

<table>
<thead>
<tr>
<th>Carbon14</th>
<th>mCi/l</th>
<th>0.0003</th>
<th>0.0003</th>
<th>0.0003</th>
<th>0.0003</th>
<th>0.0003</th>
<th>0.0003</th>
<th>0.0003</th>
<th>0.0003</th>
<th>0.0003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radium 226</td>
<td>pCi/l</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Radium228 from 226</td>
<td>pCi/l</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Radium226 from 228</td>
<td>pCi/l</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Notes:**
- Primary USEPA Primary Drinking Water Standard
- Secondary USEPA Secondary Drinking Water Standard
- Health No standard, health advisory
Figure A-1. Comparison of selected water quality parameters in various water supply alternatives, Washakie County, Wyoming.

**Total Dissolved Solids**

Sulfate Concentration

Sodium Concentration

Explanation:

These figures display data which characterize each of several water supply alternative sources. The horizontal bars represent level of appropriate drinking water standards.

**Surface Water Sources:**

- BRW (EPA) Bighorn River @ Worland data obtained from USEPA
- BRW (LAB) Bighorn River @ Worland data 1998 Field Investigation
- Qa (Pub) Alluvial Aquifer using data published by USGS
- Qa (LAB) Alluvial Aquifer using 1998 Field Investigation

**Ground Water Sources:**

- Twl (lab) Willwood Formation using 1998 Field Investigation
- Twl (pub) Willwood Formation using data published by USGS
- Tfu (lab) Fort Union Formation using 1998 Field Investigation
- Tfu (pub) Fort Union Formation using data published by USGS
- Mm (pub) Madison Formation using data published by USGS
1986 and generally includes only inorganic parameters. Table A-2 tabulates summary data for the STORET data retrieval.

The data were compared with USEPA drinking water standards in order to determine the acceptability of the source. These standards include both primary and secondary standards. *Primary* standards are prescribed based upon human health considerations and must be met by public water systems. Waters containing concentrations of contaminants in exceedence of *secondary* standards may be objectionable to an appreciable number of people in terms of taste and overall quality. However, they are generally not hazardous to health. The available data for the Bighorn River did not include many analyses of constituents which fall under primary standards. Instead, it included inorganic parameters which fall under secondary standards.

In general, the water quality of the Bighorn River is moderate. Most of the measured inorganic water quality parameters are present in acceptable levels in relation to water quality standards for drinking water (EPA, 1995). However, secondary drinking water standards are approached or exceeded by several constituents. Mean total dissolved solids (TDS) level of 598 mg/L exceeds the secondary drinking water standard of 500 mg/L. Total dissolved solids levels are a function of numerous factors including natural factors such as the geologic, soils and vegetative character of the watershed. Land use practices also influence TDS concentrations. Unique to the Bighorn River are the impacts to water quality associated with the geothermal activity in the region. It has been estimated that the geothermal activity at Hot Spring State Park contributes up to 20% of the dissolved solids load of the river (Hinckley, et al., 1982).

The water can be classified as a sodium/calcium-sulfate type based upon the dominant cations and anion. In order of relative magnitude, the principal cation concentrations are sodium (90.5 mg/L), calcium (70.8 mg/L) and magnesium (17.6 mg/L). The total hardness of the water is 116 mg/L as CaCO3 giving the river a "hard" classification (EPA, 1976). Mean sulfate and bicarbonate concentrations are 279 mg/L and 177 mg/L respectively. The EPA secondary drinking water standard of 250 mg/L for sulfate was frequently exceeded. There is no standard established for sodium concentrations. However, the EPA recommends that drinking water sources contain 20 mg/L sodium, or less, based upon long term health effects (EPA, 1995).

In summary, the Bighorn River presents an acceptable source of water for Washakie County in terms of inorganic chemical quality. The chemical nature of the river is consistent with what would be expected of a major river having a drainage area the size of the Bighorn's (approximately 10,800 square miles). The unique geothermal activity upstream of the study area impacts the chemical nature of the river. Concentrations of sodium, sulfate, TDS and hardness are high but these constituents do not pose threats to human health. They do, however, impart a taste and may cause the water to be less palatable.
# Table A-2. Summary of USEPA STORET water data retrieval:

**Bighorn River at Worland (USGS Gaging Station 06268600)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Mean</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Conductivity</td>
<td>umhos/cm</td>
<td>831</td>
<td>1130</td>
<td>446</td>
<td>--</td>
</tr>
<tr>
<td>pH</td>
<td>s.u.</td>
<td>8.1</td>
<td>8.7</td>
<td>7.5</td>
<td>6.5 - 8.5 Primary</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>mg/l</td>
<td>115.8</td>
<td>420</td>
<td>51</td>
<td>--</td>
</tr>
<tr>
<td>Total Dissolved solids</td>
<td>mg/l</td>
<td>598</td>
<td>1000</td>
<td>300</td>
<td>500 Secondary</td>
</tr>
<tr>
<td>Total Alkalinity</td>
<td>mg/l</td>
<td>162.8</td>
<td>300</td>
<td>99</td>
<td>--</td>
</tr>
<tr>
<td>Boron - Dissolved</td>
<td>ug/l</td>
<td>88.3</td>
<td>130</td>
<td>30</td>
<td>750 Primary</td>
</tr>
<tr>
<td>Calcium - Dissolved</td>
<td>mg/l</td>
<td>70.8</td>
<td>110</td>
<td>37</td>
<td>--</td>
</tr>
<tr>
<td>Chloride - Total</td>
<td>mg/l</td>
<td>17.6</td>
<td>57</td>
<td>2.5</td>
<td>250 Secondary</td>
</tr>
<tr>
<td>Flouride - Dissolved</td>
<td>mg/l</td>
<td>0.56</td>
<td>1.5</td>
<td>0.1</td>
<td>2 Secondary</td>
</tr>
<tr>
<td>Iron - Total</td>
<td>mg/l</td>
<td>96.1</td>
<td>820</td>
<td>10</td>
<td>300 Secondary</td>
</tr>
<tr>
<td>Magnesium - Dissolved</td>
<td>mg/l</td>
<td>24.5</td>
<td>47</td>
<td>9.2</td>
<td>--</td>
</tr>
<tr>
<td>Nitrate - Dissolved as N</td>
<td>mg/l</td>
<td>0.4</td>
<td>2.5</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>Potassium - Dissolved</td>
<td>mg/l</td>
<td>3.9</td>
<td>10</td>
<td>0.2</td>
<td>--</td>
</tr>
<tr>
<td>Sodium - Dissolved</td>
<td>mg/l</td>
<td>90.5</td>
<td>170</td>
<td>40</td>
<td>20 Health</td>
</tr>
<tr>
<td>Sulfate - Total</td>
<td>mg/l</td>
<td>279</td>
<td>470</td>
<td>120</td>
<td>250 Secondary</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>mg/l</td>
<td>0.1</td>
<td>1.5</td>
<td>0</td>
<td>--</td>
</tr>
</tbody>
</table>


**Note:**

- Primary = USEPA primary drinking water standards
- Secondary = USEPA secondary drinking water standards
- Health = No standard, health advisory level
Use of the Bighorn River would require filtration under the SWTR. Chlorination would be required to eliminate coliform bacteria. Pre-filtration and filtration would also eliminate turbidity problems. However, high hardness levels would persist and would likely be treated by individual users through the use of water softeners. Construction of an infiltration gallery below the river would be preferable to direct diversion due to the pre-filtration that would be obtained from river alluvium overlying the gallery.

While the river may represent an acceptable water source, there are additional limitations which merit consideration. Water rights would be required in order to ensure the long term availability of water. Any newly filed water rights would be subject to "call" by prior appropriators. Capital costs associated with a treatment facility and its operation and maintenance, including a licensed operator must be considered. In addition, costs of permitting and regulation now and in the future must be considered.

Finally, while the data indicate that the quality of the Bighorn River may meet drinking water standards the majority of the time, the large "uncontrolled" upstream drainage area has the potential for periodic contamination. In the event of a spill or accident, the water supply source could be easily contaminated and sophisticated monitoring may be required. For example, State Highway 20 follows the Bighorn River from Boysen Reservoir to Worland. Likewise, the Chicago Burlington and Quincy Railroad follows the river along the same reach. In the event of an accident involving either of these transportation routes, use of the river as a drinking water source could be interrupted. For example, the STORET data base of water quality data at Thermopolis (located upstream of the study area) identified elevated phenol measurements in the mid 1960's. The primary drinking water standard for phenol is 1 microgram per liter. The source of the historic phenol measurements is not known nor is it speculated. This observation is used merely as an example of the susceptibility of the river to contamination and the risks involved with its use.

2.2 Shallow Ground Water (Alluvial) Alternatives

Alluvial ground water represents an additional water supply alternative for the County. The alluvium of the Bighorn River consists of unconsolidated clay, silt, and gravel of Quaternary Age. Water level of the Alluvial Aquifer is governed by the stage of the Bighorn River and irrigation return flow from fields irrigated within the floodplain (Susong, et al., 1993). Quantity of alluvial water is not a limiting factor. Yields greater than 200 gpm are possible, but typical well yield is less than 50 gpm (Figure A-2).
Figure A-2. Reported Yield of Potential Target Aquifers

- Alluvium: 50 gpm
- Willwood: 28 gpm
- Fort Union: 20 gpm
- Lance/Mesa Verde: 75 gpm
- Morrison: 10 gpm
- Tensleep: 250 gpm
- Madison: 8,000 gpm
- Bighorn: 2,000 gpm
Either a single well or a well field could be designed and constructed which would deliver an adequate supply within the service area. Many residents within the study area use shallow alluvial wells as sources of domestic water. Examination of the inventory of wells permitted by the Wyoming State Engineer’s office showed hundreds of wells less than 80 feet in depth. Quality of the Alluvial Aquifer ranges from adequate to poor. Individuals who utilize wells, including alluvial wells, often employ a reverse osmosis treatment system to ensure potability.

The quality of the alluvial water would be expected to be similar in nature to that of the Bighorn River. The alluvial water can be described as the subsurface flow of the river through sands and gravels historically deposited by the meandering river. The alluvium provides a high caliber filtration medium for the water. However dissolution of solids within that medium will result in an increase in total dissolved solids, sulfates, and sodium. This conclusion is supported by data obtained during the 1998 field investigation. Well Number 4, an alluvial well, located in the McNutt Subdivision, contained TDS, sulfate, and sodium concentrations which exceed secondary standards and health advisory limits.

An additional concern regarding the use of alluvial wells as the source of domestic water supply is the potential for the aquifer to be contaminated by surface activities. An investigation conducted in the 1980’s by the USGS evaluated the occurrence of agricultural herbicides in ground water samples taken from the underlying Willwood Formation. Several of the samples contained detectable levels of commonly used herbicides: Picloram, 2,4-D, or Dicamba. This lead the investigation to conclude that the Willwood is recharged, and thereby contaminated by the overlying alluvium. (Susong, et al., 1993). One can conclude that the shallow aquifer in Washakie County, including the Alluvial and Willwood Aquifers is susceptible to contamination.

In summary, selection of this alternative would involve working with a water source similar in quality to the surface water source (Bighorn River). General chemical character is good although sodium, sulfate and TDS are present in concentrations higher than those of the river and have commonly been observed to exceed standards. These constituents do not pose detrimental health affects. However, they can impart a taste rendering the water undesirable. Residents who were interviewed testified that irrigation of lawns and landscaping with the alluvial well water has killed vegetation. A significant water quality concern would be the potential for contamination from surface pollutant sources.

Use of the Alluvial Aquifer source would require treatment under the SWTR since chemical and physical characteristics can demonstrate a direct connection to the surface water system. Therefore, consideration of a treatment system must be included in the evaluation of this alternative. Treatment must ensure giardia cyst removal and elimination of coliform bacteria. A watershed control plan would be recommended to prevent the introduction of pesticides and herbicides into the community water supply. The basic chemical nature of the alluvial source and
its potential for contamination would persist. The treated water would remain high in sodium and sulfate resulting in limited irrigation usage and potential health effects. Although reverse osmosis treatment is possible, such a system would not be cost effective at the scale of a community water supply.

2.3 Intermediate Ground Water (Willwood/Fort Union Formation)

Wells completed in the Willwood and/or Fort Union Formations comprise a large percentage of the total wells within the Washakie study area. These wells are typically completed at depths ranging from 100 to 300 feet. These aquifers represent dependable but relatively low yielding water supply sources for the singly household. Yield of wells completed in these formations typically range from 1 to 28 gpm (Figure A-2). A well field, or fields, could be designed and constructed which would deliver an adequate supply within the service area. Individual well fields could be constructed in the northern and the southern portions of the study area.

While wells could be designed and constructed to deliver the quantity of water required to meet most expected demands within the County, the quality of water from these aquifers is generally poor. Samples were taken from six Willwood and two Fort Union wells during the 1998 field investigation (Table A-1). Results of this investigation, as well as published data, show that water quality standards are typically exceeded for several water quality constituents (Figure A-1). The results indicate that chemical character of these aquifers varies from fair to poor. Isolated observations of certain constituents in the Willwood samples exceeded USEPA primary drinking water standards. For example, Sample No. 2 showed both selenium (0.091 mg/L) and nitrate (16.9 mg/L) in excess of the corresponding standards (0.010 mg/L for selenium and 10 mg/L for nitrate). Sample Nos. 12 and 13 both contained iron concentrations in excess of the primary standard of 0.30 mg/L. The Fort Union Aquifer samples showed similar conditions. The iron concentration in Sample No. 6 was 1.01 mg/L.

Mean values for total dissolved solids (TDS), sulfate and sodium concentrations exceeded both secondary standards and health advisories for the Willwood and Fort Union Aquifers. Average Willwood TDS (1513 mg/L), sulfate (775 mg/L) and sodium (429 mg/L) were all above secondary standards. Average Fort Union concentrations were roughly twice those of the Willwood. Average Fort Union TDS was 3195 mg/L, sulfate was 1650 mg/L, and sodium was 807 mg/L. These values, and relationships are consistent with the published data (Figure A-1).

In summary, the Willwood and Fort Union Aquifers represent potential sources for individual residences and are encountered at reasonable depths. However, low water yield would
require multiple wells or well fields. Quality of water in these aquifers is poor and may fail to meet USEPA primary and secondary drinking water standards.

2.4 Deep Ground Water (Madison-Bighorn Aquifer) Alternatives

Deep ground water is severely limited for use as a domestic source due to the great depths at which target aquifers are found within the study area. Although target aquifers including the Lance, Morrison and Tensleep have been identified in Figure A-2, the Madison Aquifer provides the best alternative for high quality, high yielding water. Within the study area, wells would need to be drilled on the order of 11,500 feet deep to tap the water supply aquifer. The Madison Aquifer is the water source for the town of Worland; however, the town’s wells are located approximately 12 miles east of town where the formation is significantly closer to the surface. The Madison Limestone and Bighorn Dolomite are massive, thick-bedded carbonate formations and are dependent upon fractures to create sufficient permeability. Therefore, success of a well completed in these formations is dependent upon whether or not a zone of enhanced permeability is penetrated. Within the Washakie study area, even if a deep well were drilled, encountering such conditions would be unlikely due to lower extent of formation deformation. If a well were completed in the vicinity of the Worland town wells, a cost prohibitive 12-mile transmission line would need to be completed.

The quantity of water available from deep aquifers can be plentiful when areas with secondary permeability are encountered. Yield from the City of Worland’s No. 3 and Husky wells have been estimated to be 14,000 gpm and 5,200 gpm, respectively, under artesian conditions (Figure A-2). Regional investigations report the Madison-Bighorn wells to be more typically 15 - 2,500 gpm depending upon the local secondary permeability (Susong, et al., 1993; Lowry, et. al., 1976).

Water quality of the Madison-Bighorn Aquifer is generally good to excellent. As depicted in Figure A-1, water quality thresholds were not exceeded for the selected parameters. Water from this aquifer is typically low in dissolved solids. Calcium and magnesium concentrations cause the water to be classified as “hard”, however, sodium concentrations are generally very low (generally 1 to 3 mg/L). Sulfate concentrations are typically less than 20 mg/L. Due to the great depth of the aquifer, it can be considered to be relatively immune to contamination from surface sources. Therefore, it would be highly unlikely to detect herbicides or pesticides within the aquifer unless contamination were to be associated with a penetrating well. Therefore, the Madison-Bighorn Aquifer is highly desirable in terms of taste and overall water quality.
In summary, the Madison-Bighorn Aquifer represents an alternative water source which is extremely high in quality. The SWTR would not apply to this aquifer because there is no connection between it and surface water sources. This would result in significantly lower treatment costs than those associated with alluvial or surface water alternatives. However, these benefits are offset by the great drilling depths, and corresponding costs, associated with a new Madison-Bighorn well. To approach this aquifer at a more reasonable depth, the existing City of Worland system would need to be recreated, including a transmission line approximately 12 to 14 miles in length.

2.5 Purchase treated water (Worland Water System)

Connection to the Worland water supply system represents the most attractive alternative in terms of both water quality and water quantity. The quality of water delivered by the existing system is representative of the Madison-Bighorn Aquifer near its recharge zone and is very high in quality. Water quality data measured by the USGS at the wells and provided by the City of Worland, show the water to be very low in dissolved solids (TDS levels equal to 201 mg/L and 195 mg/L for the two wells), and sulfate (13 mg/L in both wells).

A treatment system with Level I operators exists and could continue to provide protection to an expanded area of service. The only treatment required by the City of Worland is chlorination which is required by federal law due to the city’s population.

2.6 Summary of Alternative Evaluation

In summary, all of the proposed alternative sources could provide sufficient water quantity to the rural users of Washakie County. Multiple wells or the construction of a well field may be necessary. The estimated future peak demand could be supplied through the selection of either a surface water, Alluvial Aquifer, intermediate or deep ground water source as the preferred alternative. These conclusions are made assuming water rights could be obtained. The primary limiting factor to the selection of any of these alternatives is the quality of the raw water source.

Total dissolved solids (TDS), sodium and sulfate appear to be the generally limiting water quality constituents for the surface, alluvial, and intermediate ground water sources. Figure A-1 graphically presents comparisons of TDS, sulfate and sodium concentrations for the various alternative water sources. Surface and alluvial sources are highly susceptible to contamination from surface farming practices and man’s activities. Data indicate that the shallow aquifers may
be contaminated by surface application of farm chemicals. These sources would require a sophisticated water treatment system or an adequate "back up" supply. The degree of sophistication will be dependent on the "natural pre-filtration" at the source and the nature of potential contaminants. One can anticipate that alluvial water and then an infiltration gallery will provide some "natural pre-filtration". Frequent monitoring of turbidity and coliform bacteria may be required. Both alternatives will require treatment as required under the SWTR. Additional advantages and disadvantages of each alternative include the relative capital costs, O&M costs and the regulatory requirements of each. Therefore, use of these sources (i.e., surface, alluvial, or intermediate ground water) is not recommended from water quality and treatment requirement standpoints.

The deep ground water source is significantly higher in quality than the other alternatives and is isolated from contamination by its extreme depth. However, the depth to this source would also prove to be cost prohibitive. The most feasible method of attaining water from this source would be to connect to the City of Worland's municipal system, which currently taps this deep ground water source.
3.0 REFERENCES


United States Environmental Protection Agency (EPA), 1995. Data retrieval from the STORET water quality database.


Wyoming State Engineers Office (WSEO), 1995.
Washakie Co. 1998 Field Investigation
Total Dissolved Solids

Legend:
Qa = Quaternary Alluvium
Twl = Tertiary Willwood Formation
Tfu = Tertiary Fort Union Formation
BRW = Bighorn River @ Worland
? = Formation Unknown

Secondary Standard = 500 mg/l
Washakie Co. 1998 Field Investigation

Sulfate

Legend:
- Qa = Quaternary Alluvium
- Twl = Tertiary Willwood Formation
- Tfu = Tertiary Fort Union Formation
- BRW = Bighorn River @ Worland
- ? = Formation Unknown

![Bar Chart for Sulfate Levels in Different Wells](chart.png)

- **Secondary Standard**: 250 mg/L
Washakie Co. 1998 Field Investigation
Selenium

Legend:
Qa = Quaternary Alluvium
Tw1 = Tertiary Willwood Formation
Tfu = Tertiary Fort Union Formation
BRW = Bighorn River @ Worland
? = Formation Unknown

Primary Standard = 0.010 mg/L
Washakie Co. 1998 Field Investigation

Sodium

Legend:
Qa = Quaternary Alluvium
Tw1 = Tertiary Willwood Formation
Tfu = Tertiary Fort Union Formation
BRW = Bighorn River @ Worland
? = Formation Unknown

Health Advisory = 20 mg/l
Washakie Co. 1998 Field Investigation
Nitrate

Legend:
Qa = Quaternary Alluvium
TwI = Tertiary Willwood Formation
Tfu = Tertiary Fort Union Formation
BRW = Bighorn River @ Worland
? = Formation Unknown

Primary Standard = 10 mg/l
Washakie Co. 1998 Field Investigation
Iron

Legend:
Qa = Quaternary Alluvium
Twl = Tertiary Willwood Formation
Tfu = Tertiary Fort Union Formation
BRW = Bighorn River @ Worland
? = Formation Unknown

Iron (mg/L)

Secondary Standard
=0.30 mg/l

Well ID
APPENDIX B

TYPICAL CONSTRUCTION DETAILS
TYPICAL WATER SERVICE LINE

NOT TO SCALE

CORPORATION SADDLE OR TAPPING IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATION

NOT TO SCALE

DETAIL OF PROPERLY INSTALLED CORPORATION STOP, SHOWING GROUSENECK IN SERVICE AREA

TYPICAL WATER SERVICE LINE

WATER DEVELOPMENT COMMISSION
MCNUTT WATER SUPPLY PROJECT
WASHAKIE COUNTY, WYOMING

REVISION DATE: 9/28/98
LAST PLOT DATE: 11/9/98
GAD FILENAME: DETAIL1.DWG
HIGHWAY & RAILROAD BORE DETAIL

SEALING—INSTALL RUBBER O-RINGS OR GASKETS AROUND EACH PIPE (CASING CARRIER) TO PROVIDE CONTINUOUS WATERTIGHT SEAL, TO PREVENT EXPANSION & CONTRACTION.

NOTE:
SLED LENGTHS TO BE 75% OF PIPE LENGTHS.

RUBBER BOOT ATTACH WITH 1" STEEL BANDS

1" STEEL BAND

SCHEDULE 40 STEEL CASING DIAMETER VARIES POLY OR BITUMINOUS COATED

OVERALL BELL OR JOINT DIMENSION

STEEL CASING PIPE (CARRIER PIPE)

WATER LINE SIZE VARIES

INSULATE VOIDS

1" STEEL BANDS (3 PER SLED)

TREATED REDWOOD RUNNER
DIMENSION VARIES W/PIPE SIZE

NOT TO SCALE

PIPE CASING DETAIL

NOT TO SCALE

WATER DEVELOPMENT COMMISSION
MCNUTT WATER SUPPLY PROJECT
WASHAKIE COUNTY, WYOMING
TYPICAL TRENCH DETAIL

TYPICAL SECTION FOR UTILITY TRENCH, BACKFILL & PAVEMENT REPLACEMENT

N.T.S.

VERTICAL TRENCH WALLS WITH SHORING TO CONFORM TO OSHA REGULATIONS TYPE 2 EXC.

CUT AND REMOVE PAVEMENT AS REQUIRED FOR TRENCH EXCAVATION

BASE COURSE

SUBGRADE (PAVED AREAS) GROUND SURFACE (UNPAVED AREAS)

BACKSLOPE AS SPECIFIED TO CONFORM TO OSHA REGULATIONS TYPE 1 EXC.

NATIVE BACKFILL COMPACT TO 90% STANDARD PROCTOR

SELECT BACKFILL COMPACTED TO 90% STANDARD PROCTOR

PIPE BEDDING COMPACTED TO 90% STANDARD PROCTOR

MINIMUM PIPE D.D. PLUS 6" MAXIMUM PIPE D.D. PLUS 24"

NOTE: THIS DETAIL APPLIES TO TRENCHES IN PAVED ROADWAYS. MOST TRENCHES WILL BE OUTSIDE OF PAVED AREAS, WHERE BASE COURSE AND PAVEMENT IS NOT REQUIRED
CANAL OR CREEK CROSSING

NOT TO SCALE

OVERALL BELL OR JOINT DIMENSION
WATER LINE (SIZE VARIES)
1" STEEL BANDS (3 PER SLED)

STEEL OR HDPE CASING PIPE (CARRIER PIPE)
INSULATE VOIDS
TREATED REDWOOD RUNNER DIMENSION VARIES W/PIPE SIZE

PIECE CASING DETAIL

NOT TO SCALE

WATER DEVELOPMENT COMMISSION
MCNUTT WATER SUPPLY PROJECT
WASHAKIE COUNTY, WYOMING
NOTE: MODEL SIMULATES 71 PSI AT THE BOOSTER STATION (HGL = 4254 FT.) THE MAXIMUM PRESSURES WOULD LIKELY BE HIGHER (TOP OF BOY'S SCHOOL TANK HGL = 4202 FT.)

WATER DEVELOPMENT COMMISSION
MCNUTT WATER SUPPLY PROJECT
WASHAKIE COUNTY, WYOMING