PAVILLION AREA WATER SUPPLY
LEVEL I STUDY

FINAL REPORT

FOR THE
WYOMING WATER DEVELOPMENT COMMISSION

OCTOBER 2011

James Gores & Associates
RIVERTON, WYOMING

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PAVILLION AREA WATER SUPPLY LEVEL I STUDY

Submitted to:

STATE OF WYOMING
WATER DEVELOPMENT COMMISSION
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TABLE OF CONTENTS

CHAPTER I – SERVICE AREA AND WATER DEMANDS

CHAPTER II – STUDY AREA AND WATER DEMANDS

CHAPTER III – AREA WATER RESOURCES INVENTORY

CHAPTER IV – EVALUATION OF THE TOWN OF PAVILLION'S PRESENT WATER SYSTEM AND ITS SUPPLY RESOURCES

CHAPTER V – IDENTIFICATION OF ALTERNATIVE SOLUTIONS

CHAPTER VI – PRELIMINARY COST ESTIMATES

CHAPTER VII – SELECTION OF PREFERRED ALTERNATIVES

CHAPTER I

SERVICE AREA AND WATER DEMANDS

1. History of the Project and Its Need

The Town of Pavillion, Wyoming, is a small, rural, agricultural community in north central Fremont County, Wyoming. The Town was established in the early 1900's. It served as a work camp for the Department of Interior Bureau of Reclamation when the Bureau was constructing the Midvale Irrigation Project between the 1920's and the 1950's. In the first half of the 1900's, this area's land was converted from sagebrush rangeland to irrigated farms. Today, the Midvale Irrigation District headquarters is in the Town of Pavillion. It is also home to Fremont County School District No. 6.

Immediately following World War II, several thousand acres of uncultivated land was offered to returning veterans by allotment drawing on the Midvale project. The economic capabilities of most of the people who were starting a farm from raw ground left little to invest in a house and its water supply. Water could reliably be had from wells in the area. Those wells were commonly constructed in the most economical manner possible, without cementing of the casing, even at the surface. Some of the area produced suitable water for home use. In other areas, particularly north and east of the Town of Pavillion, getting a domestic well with good water was always an uncertain venture. Most wells produced marginal quality water at best. Still, that was better than the alternative of hauling house water, and most residents opted to live with what was available from their wells.

The Town of Pavillion formed in the early 1900's when the area's first agricultural production began as a result of the irrigation project. The Town installed a central water system sometime in the 1940's. The Town's well happened to produced better quality drinking water than many of the wells in the surrounding area. That trend is largely true today. The Town's wells, though, produce water having many of the same chemical signatures of the area's surrounding wells. The lower concentration of the objectionable taste and odor constituents renders the Town's water more desirable than some of the water from the surrounding areas.

Development of natural gas began in the area northeast of Town in the 1960's. The Pavillion Gas Field was further developed in the 1980's by a succession of owners/operators. In recent years, the gas field operator has applied techniques to stimulate production from the field including hydraulic fracturing (fracking). Some nearby residents have voiced concerns that the fracking operations have led to a noticeable decline in the quality of the groundwater produced from their domestic wells. The situation attracted wide-spread media attention.

Because of the water quality concerns, the US Environmental Protection Agency (EPA), through its Resource Conservation and Recovery/Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) section conducted extensive testing of water wells in the Pavillion area in 2009 and again in 2010. Some of the Town of Pavillion's wells were included in the EPA testing. **It is important to note that the EPA did not use their safe drinking water standards as the primary criteria in testing well water in the Pavillion area.** The test results did cover some but not all drinking water parameters.

It is important to understand that the mission of the RCRA/CERCLA section of the EPA is to deal with hazardous waste and its cleanup, not drinking water issues. This EPA focused its Pavillion area testing on its mission of identifying potentially hazardous materials regardless of their possible source. **The RCRA/CERCLA section of EPA did reported test results related to public drinking water standards for those constituents that their testing program covered. These results were compared to Maximum Contaminate Level (MCL) established for public drinking water. However, the drinking water section of the EPA Region 8 office was not involved in the groundwater investigations in the Pavillion area during the 2009-2010 testing.** There are no standards for private drinking water, only for public supplies.

In August 2010, the EPA advised the rural residents living in the area of Pavillion not to drink water from their private domestic wells. In late 2010, the State of Wyoming commissioned this study to identify alternative solutions to the dilemma of locating suitable domestic water for those rural residents in the Pavillion area. The charge of this investigation is not to determine reasons for the area's groundwater quality concerns, but rather, to give the residents of the rural Pavillion area alternatives for a water supply that they might find more palatable.

2. Findings and Conclusions

The testing performed by the EPA in 2009 and 2010 focused only on hazardous materials identification and did not consider drinking water standards. While EPA's testing did measure the concentration of some of the contaminates which the EPA regulates through its drinking water standards, it did not test for all drinking water contaminates. Reviewing the EPA's test results for the concentration of the constituents regulated under drinking water standards finds that the water produced by the rural private wells meets public drinking water standards with the exception of only three wells. The EPA does not regulate private drinking water wells.

The EPA gave the tested wells designation numbers PGDW "XX " in a numerical sequence. The wells mentioned below are identified with that EPA numbering system.

Primary standards, the only ones regulated by EPA, were exceeded in three wells. Well PGDW25 exceeds primary standards for arsenic by a factor of three. Well PGDW38 slightly exceeds selenium standards. Well PGDW22 exceeds nitrate standards. Nitrate is a common chemical found in fertilizer and septic tank effluent. Testing was inconclusive on three other wells, PGDW41, 43, and 44 showed trace hydrocarbon compounds in one test and "non detect" in a second test for the same compound.

Chemicals in EPA's secondary standards are not regulated by the agency. Three different wells exceed secondary standards for one element each: manganese, iron, or aluminum. Nearly all area wells exceed secondary standards for sulfate, a compound very common in Wind River Formation groundwater. While it is not regulated, nearly all Wind River Formation wells exceed sodium guidelines for persons on a low sodium diet.

Contrary to EPA issued advice in August 2010, for rural residents not to drink water from the private domestic wells, EPA's water testing data shows that the water from only the three private wells noted above have constituents known to pose health threats as defined by EPA standards for public drinking water supplies.

The Wind River Formation is the only aquifer in the Pavillion area providing usable drinking water. It was determined, through this and other studies, that the water quality of this aquifer varies widely over very short distances between wells. Likewise, water quality varies widely among wells that are of the same depth. In summary, there is no identifiable trend in groundwater quality that shows an area or a drilling depth that offers assurance of installing a well with good quality water. Appendix I, Groundwater Quality Information, provides supporting data.

No groundwater of better quality is known to be available in the rural area north and east of Pavillion than the water already being produced by the area's private wells. If a more palatable source of water is to be obtained, it must either be imported into the area or the private wells would need to be individually treated to improve palatability.

In summary, it was found that the Wind River Formation in the rural Pavillion area generally produces water meeting public water supply standards. While the water in many cases is palatably objectionable because of its taste and odor characteristics, it still meets EPA's public water supply standards.

3. Recommendations

Based on finding in the course of this study, which are more fully described in the balance of this report, the following recommendations are offered to the rural residents of the Pavillion area:

1. Rural residents are encouraged to explore forming a water district. Forming a district can make the resulting area eligible for public funding of a water improvement project.
2. Come to a local consensus as to which of the alternatives presented in this study is most favored by those who may wish to be served, should an alternative be implemented.
3. Should area residents come to a consensus on both forming a district and on which alternative they wish to pursue, they need to inform the Wyoming Water Development Commission (WWDC) of their decision. The newly-formed district could then apply to the WWDC for a water development project to be included in the agency's 2012 funding request to the Wyoming legislature. To be considered by the 2012 legislature, that request must be submitted to the WWDC by September 15, 2011.

CHAPTER II

STUDY AREA AND WATER DEMANDS

Introduction

The Town of Pavillion is located in the north-central part of Fremont County, Wyoming. The Town has a 2010 reported population of 231 people. The Town hosts the local school district. It gathers students from a very large geographic area, in excess of 1,200 square miles, the same size as the entire state of Rhode Island. The school's student and staff population of 488 is over twice the population of the Town. The surrounding agricultural area is very sparsely populated. It is comprised of large acreage irrigated farms that likely average a section or more per farm.

For purposes of this study, the greater Pavillion area encircles an area centered on the Pavillion gas field and bounded by the Town of Pavillion four (4) miles to the west, Wyoming Highway 134 on the south, Tunnel Hill Road on the east, and Muddy Ridge on the north. Figure II-1 shows that area.

The portion of the study area most challenged in domestic water supply begins 1½ miles east of the Town of Pavillion. It generally lies north of a sandstone butte outcrop locally referred to as Indian Ridge. In shape, this challenged area is roughly an oval approximately three miles east-west by two miles north-south, as shown in Figure II-1. For purposes of this report, this area will be referred to as the **"northern study area", which is the local area located north of Indian Ridge**. The entire water well drilling history of this area has been one of poor quality water. Attempted wells often produce undrinkable water. It has always been difficult to get a "good well" in this area. This topic is discussed in further detail is provided in Chapter III.

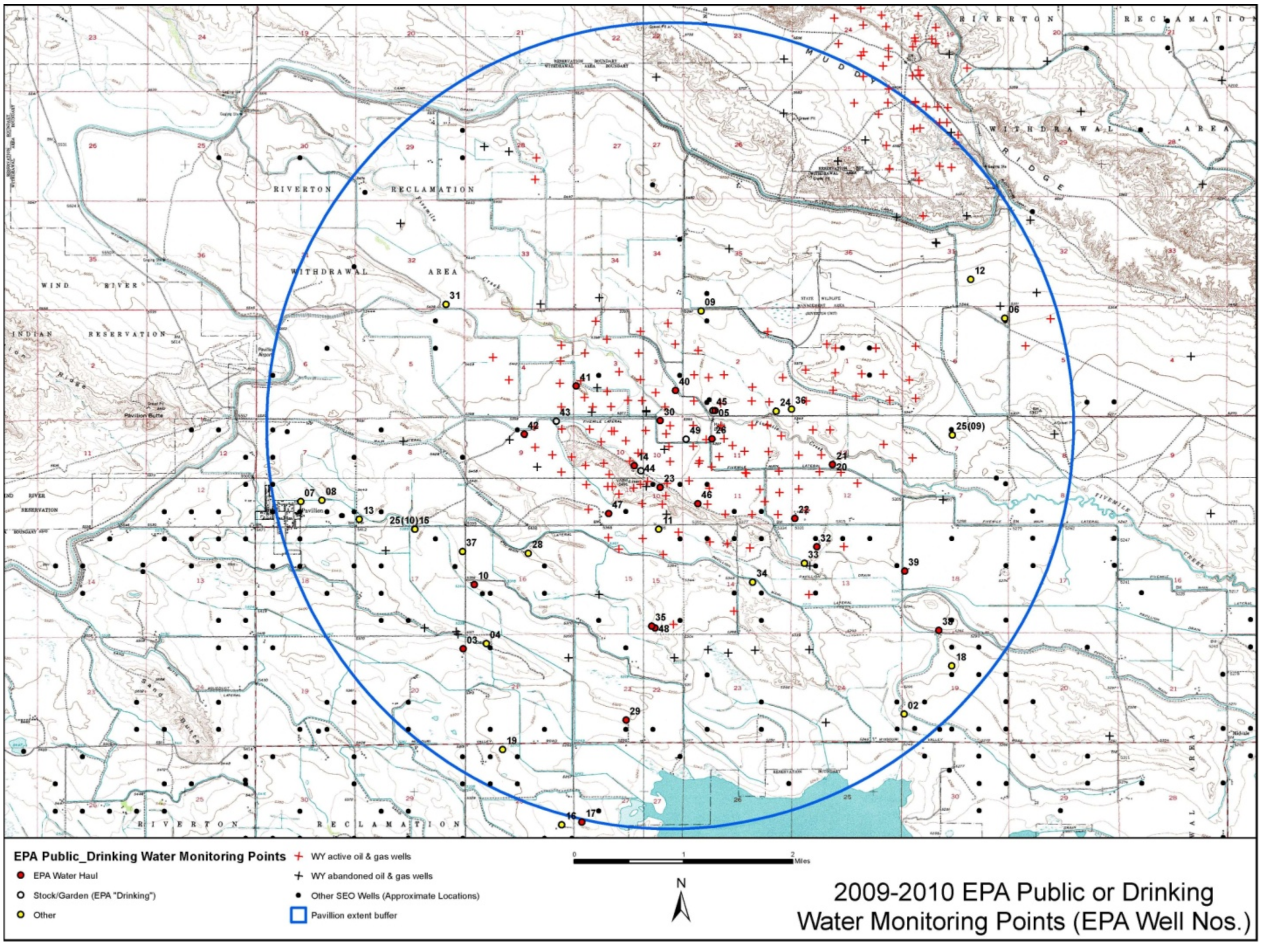


FIGURE II-1: Study Area

The first step in planning an alternate potable water supply for an area is to quantify demand. In order to quantify potable water demand in the study area, three different sectors of demand must be identified. Those are:

1. The Town residents alone,
2. Students and staff who do not live in the Town, and
3. The rural residents living in the potential service area outside of the Town.

In the sections below, these demands are discussed and quantified.

1. Town of Pavillion Service Population and Demand

The Town of Pavillion's U.S. Census recorded 2010 population was 231 people. In 2000, the number was 165. The unexpectedly high 2010 census population has been questioned locally. This 40 percent increase is not evident in the number of homes built in the Town over the past 10 years. It is not expected that the past decade's rate of population increase will continue through the next decade. It is expected that the Town of Pavillion will grow at or near the same rate as the rest of Fremont County in coming decades.

A. Present Demand

The Town of Pavillion is unique in its demand structure because it hosts the Fremont County School District No. 6 student population. Except for three students attending the Crowheart School some 30 miles west of Pavillion, all students in the District attend Wind River Schools in the Town of Pavillion. **Students and staff at the schools total 488** people, as shown in the table below.

TABLE II-1: Wind River School Population

	Staff	Students	**Totals**
Pavillion Residents	40	129	169
Out of Town Residents	47	272	319
Total	**87**	**401**	**488**

The out-of-town students and staff constitute a larger percentage of the water supply demand than is the case in most municipal systems. This school's demand is easily accounted for using typical day-use demands and the school's historical metered water use. School is in session from late August through the end of May, 155 days per year. District 6 operates on a four-day week with Fridays off.

The Town of Pavillion's water production since 2005 has averaged **20,000 gallons per day** (gpd), approximately 7.3 million gallons per year. Out of this amount, the school's metered water use has been approximately 0.9 million gallons per year.

The school consumption translates to 5,806 gpd over the 155 days per year that school is in session. That daily consumption averaged over the school population of 488 people, equates to 12 gallons per capita day (gpcd).

This usage by Town residents translates to an average of **80 gallons per capita per day (gpcd)** based on the 2010 census population. Using the 2000 census population, usage is a more customary value of **110 gpcd**.

B. Forecasting Demand

Pavillion's school population is more than double that of the Town itself, creating a unique water demand demographic. Because of that unique demand configuration, three (3) major population segments were quantified to arrive at a valid demand forecast for the Town. These are:

1. Demand generated by Town residents, including those students and staff that live in Town,
2. The demand generated by the non-town residents who work at or attend school in Pavillion, and finally,
3. The rural Pavillion residents to whom water service may be extended should the Town serve as a supply for a central water system extended to serve the out-of-town area of poor groundwater.

The unique characteristic of the service population demands that the day use by the nonresident staff and children be estimated separate from the Town's residential population. Those who only attend, or work at the school, use drinking, lunchroom, restroom and athletic showering water on a daily basis. Laundry, bathing, and other normal uses are met by their home supply.

The number of day-use customers was determined from school records. These records identified students and staff who reside within Pavillion town-limits and those who do not. That population's demand was determined by dividing the school's metered consumption by the school population, which yielded 12 GPCD. This is very comparable to normal industry values.

Water demand for the Town residents, as shown in Table II-2, was based on an average consumption of 80 GPCD. This was selected over the 110 GPCD value because the Town residents are not allowed to use potable water for lawn and garden irrigation. The Town has a system of irrigation ditches that allows each residence to gravity or pump-irrigate lawns and other landscaping.

C. Defining the Northern Service Area

Delineation of the conceptual Rural Service Area was based on review of local geology and groundwater quality information. Based on the available historical water quality test results, including qualitative information from area users and well-service providers, groundwater quality in the entire Pavillion area has always been difficult. In summary, this area has never produced high-quality groundwater. With only one or two exceptions, in the northern study area shown on Figure II-2 below, the private wells meet EPA primary drinking water standards for public water supplies. However, the water has undesirable taste, aroma, and appearance. Evaluation of the this area's groundwater, both horizontally across its limits, and vertically at the depths that are considered economical for private wells, finds no surface location or drilling depth at which palatable groundwater can be reliably found. It is in this area that an alternate water supply is most needed because there is no available alternative to the present undesirable water produced by the private wells.

D. Demand Forecast

The Town of Pavillion's reported census population has grown by 40 percent over the ten-year period from 2000 to 2010. As noted above, it is not expected that trend will continue into coming decades. Assuming that the population of Pavillion grows at the same rate as forecast for Fremont County in coming decades, the area could experience the service population and resulting water demand shown in the following table.

TABLE II-2 Area Forecast Water Demand

				Average Daily Water Demand Forecast			
Year	Town Population	Out of Town School Population	Out of Town Residence Services	Town Residents	Out of Town School Attendees	Out of Town Residential	Total Daily
2010	231	319	20	18,480	3,828	4,800	27,108
2012	236	326	20	18,907	3,917	4,911	27,735
2014	242	334	21	19,345	4,007	5,025	28,377
2016	247	342	21	19,792	4,100	5,141	29,033
2018	253	350	22	20,250	4,195	5,260	29,705
2020	259	358	22	20,719	4,292	5,381	30,392
2022	265	366	23	21,198	4,391	5,506	31,095
2024	271	374	23	21,688	4,493	5,633	31,814
2026	277	383	24	22,190	4,596	5,764	32,550
2028	284	392	25	22,703	4,703	5,897	33,303
2030	290	401	25	23,228	4,812	6,033	34,073
2032	297	410	26	23,766	4,923	6,173	34,862
2034	304	420	26	24,316	5,037	6,316	35,668
2036	311	429	27	24,878	5,153	6,462	36,493
2038	318	439	28	25,453	5,273	6,611	37,337
2040	326	450	28	26,042	5,394	6,764	38,201

2. Rural Area Population and Demand

The drinking water demand in the rural Pavillion northern study area will depend on a number of factors that, at present, cannot be defined with precision. The area to be served under this project is assumed to be bounded as shown in Figure II-2. That encompasses approximately 20 residences, all lying within the area in which the private well water is unpalatable regardless of meeting EPA primary drinking water standards.

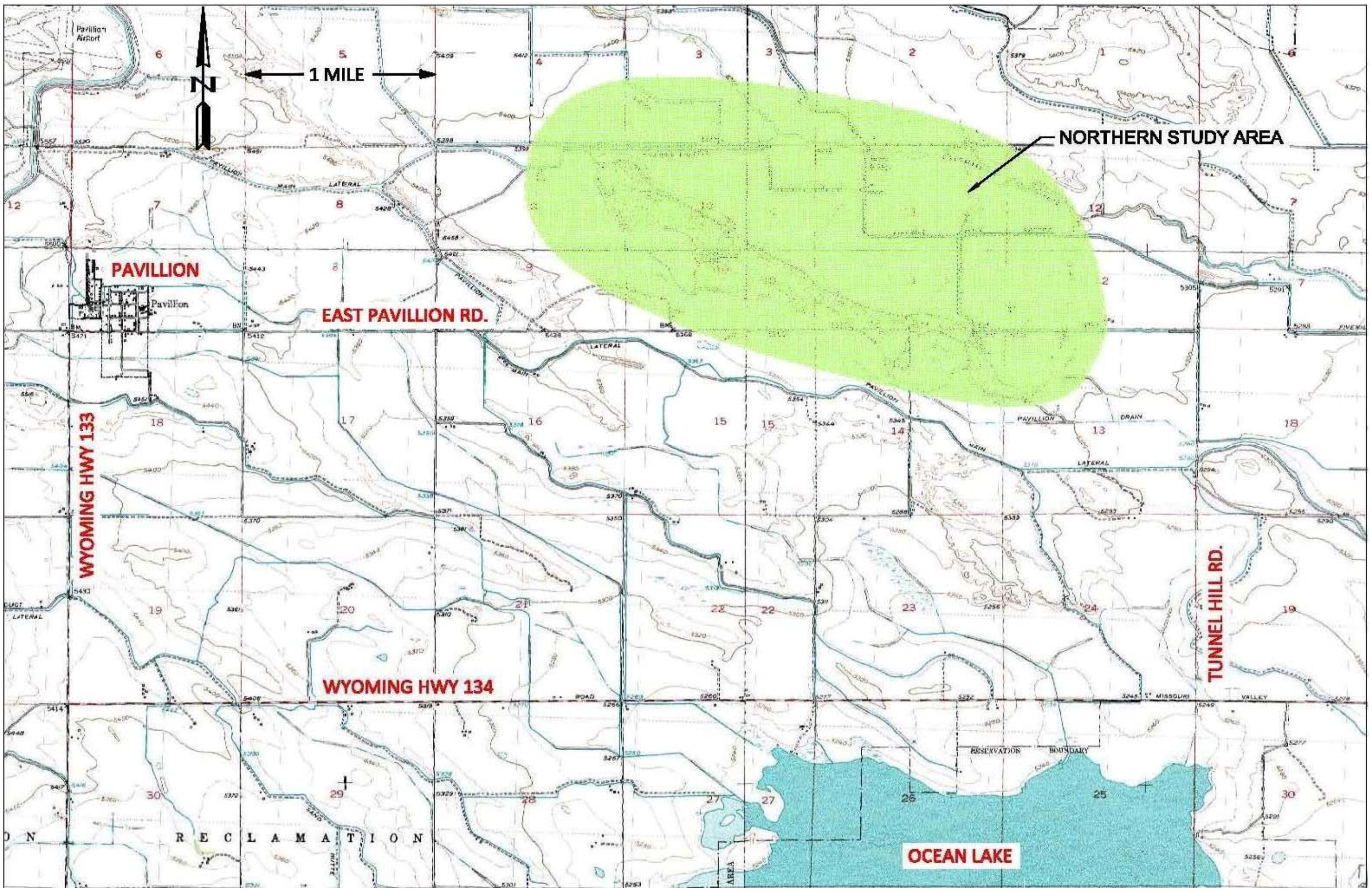


FIGURE II-2: Northern Study Area

A. Present Demand

For purposes of this study, it is being assumed that there are three (3) people per residence in the rural service area. It is further assumed that the present potable water demand of the people living in those 20 residences is **80 gallons per capita per day**. This use rate assumes the house water use consists only of drinking, cooking, bathing, and laundry, and does not include lawn watering, livestock use, or other outdoor uses. Based on these assumptions, the present rural core area demand is approximately 4,800 gallons per day.

B. Future Demand

Future core area demand is entirely dependent on the number of homes served. If a central distribution system is put in place, it will foster increased demand simply because of the availability of potable quality water along the pipeline routes. If the alternative of individual systems becomes the selected means of providing potable water, the northern study area will not be as conducive to residential development. The forecast shown in Table II-2 is based on the assumption that the rural Pavillion area will grow at the same rate as is forecast for the other portions of Fremont County.

3. Demand Forecast Range

In summary, the forecast demand in the year 2040 for the **Town of Pavillion, itself,** is expected to be approximately **32,000 gallons per day**.

The demand for the conceptual **Northern Study Area** is forecast to be about **6,800 gallons per day**.

CHAPTER III

AREA WATER RESOURCES INVENTORY

Introduction

The Tertiary Wind River Formation is the only reliable and economically viable water supply source in the Pavillion area. The existing Town of Pavillion water supply system is presently sourced from five (5) Wind River Aquifer wells. These wells provide a good quality water, and the aquifer has demonstrated that it is capable of providing the quantities needed to meet the projected demands of their system. In contrast to the Town of Pavillion water supply wells, there are numerous private water wells completed in the Wind River Aquifer in the immediate areas surrounding Pavillion that produce water of marginal to very poor aesthetic quality (taste, odor and visual effects). The geologic evaluation is therefore concentrated on the hydrogeologic properties and architecture of the Wind River Formation in order to determine the possibility of drilling a Wind River Aquifer well of high quality that could provide a reliable water supply for the proposed Rural Service Area residents. Materials used in this review included previous water system reports of the area, the United States Geological Survey publications, the Wyoming Water Resource Data System (WRDS), the Wyoming State Engineer's Office (WSEO) and the Wyoming Oil and Gas Commission records. The remainder of this chapter describes the results of our hydrogeologic investigation.

The primary objective of this hydrogeologic review is to try to ascertain what geologic features control the production and quality variations within the Wind River Aquifer in the Pavillion area, and then use this information to identify a potential production well to serve as the water supply source for the core study area.

1. Area Geology and Its Groundwater Water Resources

WIND RIVER AQUIFER

The following description of the Tertiary Wind River Aquifer in the southern Wind River Reservation area was described by Bern Hinckley of Hinckley Consulting and contained in the Northern Arapaho Groundwater Supply Project Report prepared for the Wyoming Water Development Commission (James Gores and Associates, 2009) The Tertiary-age section in the study area is represented by the Wind River, Indian Meadows, and Fort Union Formations. The Wind River Formation is present at the land surface over most of the central portion of the Wind River Basin. The Indian Meadows Formation is distinguished from the overlying Wind River Formation mainly along the northern margins of the Wind River Basin. Elsewhere, including in our study area, the difference between the two is indistinct and a combined "Wind River and Indian Meadows Formations." is mapped beneath the Wind River Formation (e.g. McGreevy, 1969). Beneath these deposits lies the Fort Union Formation, like the other Tertiary deposits, thinnest along the flanks of the mountains and becoming vastly thicker towards the center of the basin. The Wind River Formation begins approximately at the flank of the Wind River

Mountains and increases in thickness to the northeast to reach a maximum thickness of approximately 5,000 ft. in the central part of the basin.

The Wind River Formation is a regional aquifer, although its water-production is quite variable. According to a schematic cross section from McGreevy et. al (1969) (See Figure III-1, Pg. III-2), the most consistently coarse-grained sequence of the formation - the sequence with "the most productive aquifers" – is that nearest the south flank of the Wind River Range. Detailed field work and exploratory drilling reported by Flores et. al (1993) document significant, localized aquifer potential in conglomeratic zones of the Fort Union Formation north of Hudson. Between the Little Wind and Popo Agie Rivers, they identified a northeast flowing channel in which coarse, framework-supported conglomerates accumulated to a thickness of 250 ft. Several of their exploration boreholes produced small flows at the surface (up to 12 gpm), demonstrating at least locally confined-aquifer conditions. The viability of the Fort Union was tested with an exploration well drilled for the Town of Hudson as a Level II Wyoming Water Development Commission project. Although the drill cuttings and geophysical logs appeared promising, the Fort Union Formation was found to be tight with very little production and the water quality was very poor.

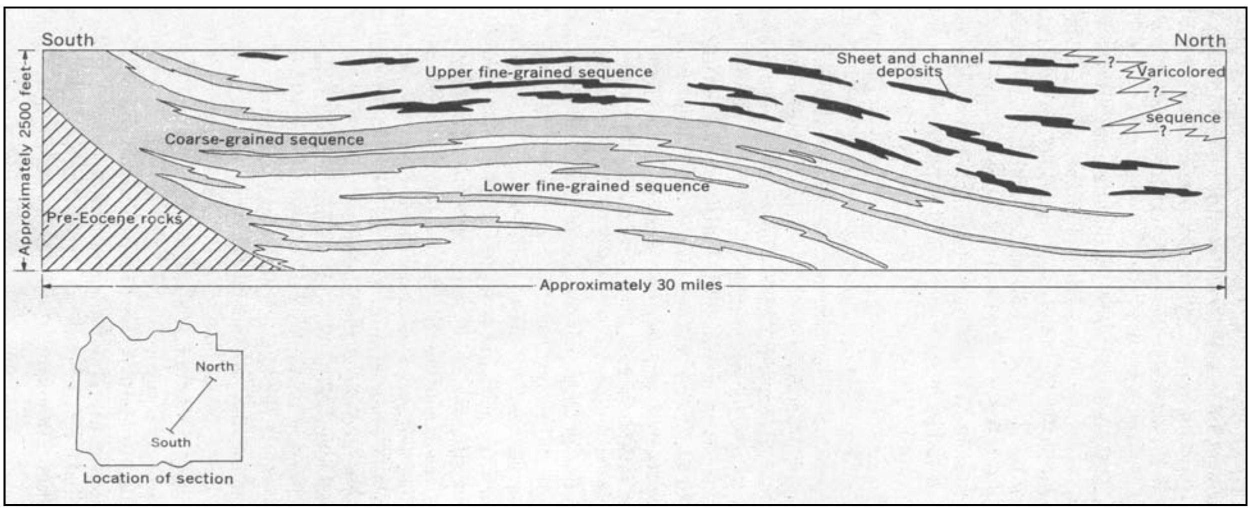


FIGURE III-1: Wind River Formation Schematic Cross-Section

A. Quantity

Daddow (1996) reports specific capacities for Wind River Formation wells across the Wind River Basin ranging from 0.04 - 23 gpm/ft, with a median value of 0.4 gpm/ft. Demonstrating the higher values from this basin-wide range, Wind River Formation wells supplying the City of Riverton have developed substantial supplies from this formation. These wells are from 500 to 1800 feet deep, with pumped yields from 150 to 550 gpm (WSEO permit files). The Riverton wells are completed in McGreevey et al.'s (1969) "coarse-grained sequence." The 1998 Regional Water Master Plan for Riverton (James Gores and Associates, 1998) provides the following summary:

"Pumping test data as reported by Morris et al. (1959), McGreevy et al. (1969), Anderson & Kelly (1986) and Wester-Wetstein (1997) indicate transmissivity (T) values from 2,000 gallons per day per foot (gpd/ft), to 12,000 gpd/ft. Also, from the pumping tests performed in 1951 (Morris, et.al., 1959), a coefficient of storage value for the Wind River aquifer was determined to be 2 x 10-4. The resulting specific capacity (ratio of yield to drawdown) from these same tests ranges from 1.5 gallons per minute per foot of drawdown (gpm/ft) to over 5 gpm/ft. Anderson & Kelly (1976) recommend that values for T and S of 5,000 gpd/ft and 1 x 10-4, respectively, be used for planning purposes and anticipated specific capacities of approximately 2.5 to 3 gpm/ft."

Pump testing on the Town of Pavillion wells, however, provides a somewhat more limited production potential from the Wind River Aquifer. A summary of the aquifer test data for the Town's wells has been summarized in Chapter IV of this report. To summarize, the transmissivity of the aquifer in the Pavillion area ranges from approximately 90 gpd/ft to 1,100 gpd/ft with a production capacity ranging from less than 10 gpm to approximately 115 gpm. The "Capacity" section of Chapter IV provides these details.

B. Quality

Daddow (1996) found the groundwater quality in the Wind River Formation to be quite variable across the Wind River Basin, a function of local recharge, permeability, groundwater flow, and lithology conditions. TDS levels from 211 - 5,110 mg/L were measured. "Near Riverton and Arapahoe," Daddow (1996) reports the Wind River Formation has TDS concentrations "usually less than 500 mg/L" with sodium as the dominant cation. In the Pavillion area, water produced from the Wind River Aquifer is typically high in total dissolved solids with sodium and Sulfates typically found in concentrations far exceeding EPA's Secondary Drinking Water Standards. A Wind River Aquifer exploration well drilled in the Ethete area produced water that exceeded EPA's Primary Drinking Water Standards for the combined Radium 226 and 228 levels. Water quality records for these four constituents (TDS, sodium, Sulfate and radionuclides) were the primary basis on which the well siting review in the Pavillion area was based.

The variability of both the production and the quality of water produced from the Wind River Formation in the rural Pavillion area has plagued the individual landowners in the area in the past.

C. Hydrogeologic Investigation

This studies initial step in evaluating the Wind River Aquifer was to review the existing water quality data from producing wells in the study area. Because of the significant variation in water quality throughout the area, the water quality data from 70 wells were reviewed. These water quality data were compiled from the Wyoming Research Data System (WDRS) records, the State Engineer's Office records, from the Environmental Protection Agency data base, and from water samples collected and analyzed as part of this study. These data where then plotted in an attempt to identify potential trends to the water quality data. The most consistent constituent reported was the concentration of total dissolved solids (TDS). The concentration of the two problematic constituents in the groundwater, sodium and sulfate, are accurately reflected by mapping the TDS concentrations, as these two elements dominate the chemical makeup of the groundwater supply in the area. Therefore, a groundwater with a high TDS concentration will be high in both sodium and sulfate, while low TDS water will have significantly reduced concentrations in these two elements.

Mapping the water quality data, in whole, indicated no identifiable spatial trend. Figure III-2 (Pg. III-4) shows these mapped TDS concentrations for the water supply wells in the area. Table III-1 is a listing of these wells with their associated water quality parameters. As shown in Figure III-2, the TDS concentration for the wells can vary from less than 500 parts per million (ppm, which is equivalent to mg/L) to over 1,000 ppm within a very small area. The quality of water produced from the wells in the immediate area of the Town of Pavillion provide a good example of the degree of variation in the quality of water produced from the Wind River Aquifer.

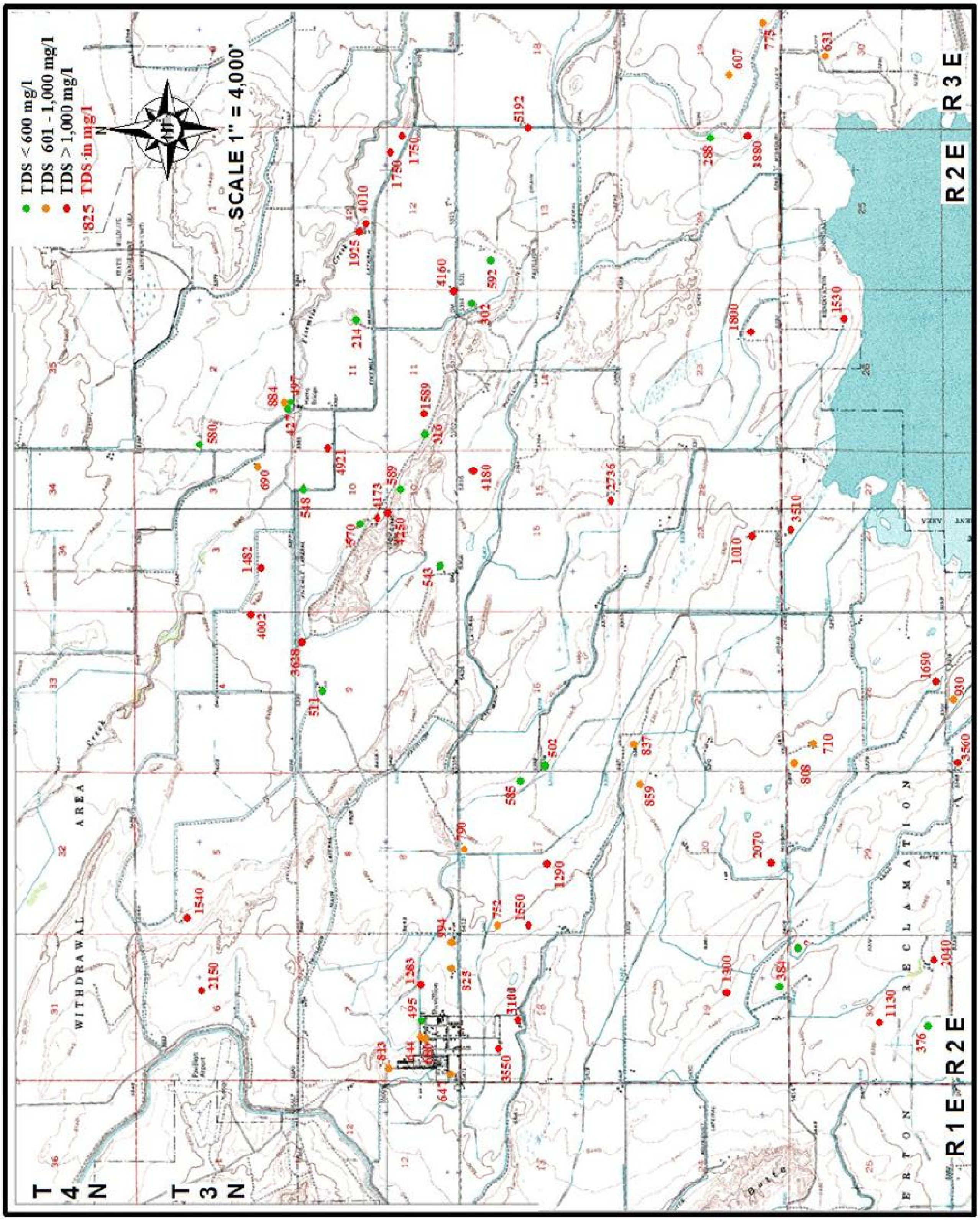


FIGURE III-2: Area Wells - Water Quality

TABLE III-1
Study Area Wells – Water Quality Data

	Permit #	Twnshp		Rng		Sect.	Qtrqtr	Well Depth	Static Depth	Mwbz Top	Mwbz Bottom	Ground Elevation	Chemical Data Source	TDS (mg/l)	Cond (μmho/cm)	Sodium (mg/l)	Sulfate (mg/l)
1		3	N	2	E	2	SE SW						WRDS Has Chemical Analysis	884	1340	210	860
2		3	N	2	E	2	SW NW						WRDS Has Chemical Analysis	580			300
3	P170310W	3	N	2	E	2	SWSW					5356	EPA Well No. PGDW45	427		59	213
4	PGDW05	3	N	2	E	2	SWSW					5355	EPA Well No. PGDW05	497		189	287
5	P66345W	3	N	2	E	3	NWSW	70	7	15	25	5397	EPA Well No. PGDW41	4002		1030	2670
6	P98084W	3	N	2	E	3	SESE					5374	EPA Well No. PGDW40 ???	690		244	426
7	PGMW01	3	N	2	E	3	SESW					5393	EPA Well No. PGMW01	1482		128	1010
8		3	N	2	E	5	SW NW						WRDS Has Chemical Analysis	1540	2180	459	990
9	P14914P	3	N	2	E	6	SWNE	130	50	Unknown	Unknown		WRDS Has Chemical Analysis ????	2150	2810	362	945
10	P98757W	3	N	2	E	7	NWSW	517	22	504	512	5479	Sampled by Wester-Wetstein on 2-18-11	813	1261	255	439
11		3	N	2	E	7	SE SE						WRDS Has Chemical Analysis	994	1400	203	480
12	P58929W	3	N	2	E	7	SESE	57	38	38	57	5420	WRDS Has Chemical Analysis ????	825	1250		
13	P70972W	3	N	2	E	7	SESW	506	165	478	498	5466	EPA Well No. PGPWO1	495		173	300
14	P34345W	3	N	2	E	7	SESW	510	255	480	495	5472	WRDS Has Chemical Analysis	680		190	400
15	P59104W	3	N	2	E	7	SESW	510	300	480	500	5472	WRDS Has Chemical Analysis	644		210	460
16		3	N	2	E	7	SW SW	380					WRDS Has Chemical Analysis	647	974	210	345
17	P76991W	3	N	2	E	7	SWSE	515	269	472	510	5446	EPA Well No. PGPWO2	1283		393	847
18	PGDW43	3	N	2	E	9	NENE					5397	EPA Well No. PGDW43	3628		911	2470
19	P41517W	3	N	2	E	9	NENW	200	50	180	200	5400	EPA Well No. PGDW42	511		181	311
20	PGDW30	3	N	2	E	10	NENE					5371	EPA Well No. PGDW30	548		195	333
21	P24507P	3	N	2	E	10	NWSE	750	80	Unknow n	Unknow n	5404	WRDS Has Chemical Analysis	4250			2900
22	P24508P	3	N	2	E	10	NESE	175	80	Unknown	Unknown	5436	EPA Well No. PGDW23	589		194	368
23	P124049W	3	N	2	E	10	SESW	484	246	410	484	5385	EPA Well No. PGDW47	543		183	330
24		3	N	2	E	10	SW NE						WRDS Has Chemical Analysis	570	913	174	320
25	PGDW44	3	N	2	E	10	SWNE					5399	EPA Well No. PGDW44	4173		994	2880
26	PGDW49	3	N	2	E	11	NWNW					5373	EPA Well No. PGDW49	4921		1210	3160
27	PGMW03	3	N	2	E	11	SENE					5351	EPA Well No. PGMW03	214		27	28
28	P51810W	3	N	2	E	11	SESE					5338	EPA Well No. PGDW22 ???	4160		908	2780
29	PGDW46	3	N	2	E	11	SWSW					5377	EPA Well No. PGDW46	316		91	126
30	PGMW02	3	N	2	E	11	SWSW					5364	EPA Well No. PGMW02	1589		1020	108
31		3	N	2	E	12	NE SE						WRDS Has Chemical Analysis	1750		447	1110
32		3	N	2	E	12	NE SE						WRDS Has Chemical Analysis	1750		447	979
33	P97501W	3	N	2	E	12	SENW					5328	SEO	4010		555	1161
34	PGDW20	3	N	2	E	12	SENW					5328	EPA Well No. PGDW20	1925		550	1270
35	P64110W	3	N	2	E	13	NWNW	675	235	661	669	5331	EPA Well No. PGDW32	592		193	368
36	P42890W	3	N	2	E	13	SENE	57	14	50	57	5300	WRDS Has Chemical Analysis EPA Well No. PGDW39	5192		1110	3640
37		3	N	2	E	14	NE NE						WRDS Has Chemical Analysis	302	457	38	67
38	P30217W	3	N	2	E	15	NENE	350	40	170	350		WRDS Has Chemical Analysis	4180			2700
39	PGDW48	3	N	2	E	15	SWSE					5358	EPA Well No. PGDW48	2736		725	1840
40	P183732W	3	N	2	E	16	NWSW	740	220	720	740	5360	Sampled by Wester-Wetstein on 1-12-11 (EPA Well No. PGDW10)	502	934	195	293
41		3	N	2	E	17	NE SW						WRDS Has Chemical Analysis	1290			827
42	P101483W	3	N	2	E	17	NWNE	80	8	50	70	5393	EPA Well No. PGDW25 ???	790		269	441
43	P182983W	3	N	2	E	17	SENE	760	350	740	760	5376	Sampled by Wester-Wetstein on 1-12-11	585	886		
44		3	N	2	E	17	SW NW						WRDS Has Chemical Analysis	752	1140		
45	P46362W	3	N	2	E	17	SWNW	220	170	170	180	5388	WRDS Has Chemical Analysis	1550		140	1100
46	P62641W	3	N	2	E	18	NENW	705	-1	640	685	5455	WRDS Has Chemical Analysis	3550		970	2200
47		3	N	2	E	18	SE NW						WRDS Has Chemical Analysis	3100			2140
48		3	N	2	E	19	NW SE						WRDS Has Chemical Analysis	1300			642
49	P53567W	3	N	2	E	19	SWSE	140	57	120	140	5420	WRDS Has Chemical Analysis	384		175	84
50	P120203W	3	N	2	E	20	NENE	450	100	410	450	5347	EPA Well No. PGDW03	859		251	570
51	P25636W	3	N	2	E	20	SESW	41	21	41	41	5360	WRDS Has Chemical Analysis	2070			750
52	P168584W	3	N	2	E	21	NWNW	440	134	420	440	5375	EPA Well No. PGDW04	837		265	532
53	P110443W	3	N	2	E	22	SESW	420	214	364	417	5360	Ow ner Furnished - This Study	1010	1539	298	570
54		3	N	2	E	23	SE SE						WRDS Has Chemical Analysis	1800		454	620
55	P28496W	3	N	2	E	24	NESE	65	18	20	36	5293	SEO	288			29
56	P26200W	3	N	2	E	24	SESE	740	30	275	290	5260	WRDS Has Chemical Analysis	3880			2610
57		3	N	2	E	26	SE NE						WRDS Has Chemical Analysis	1530	2160	445	988
58		3	N	2	E	27	NE NW						WRDS Has Chemical Analysis	3510	3790	339	2310
59	P40603W	3	N	2	E	28	NWNW	40	20	20	40	5312	WRDS Has Chemical Analysis	710			210
60	P76475W	3	N	2	E	28	NWNW	320	100	290	320	5320	SEO	808	1320	260	540
61	P14548P	3	N	2	E	28	SWSE	60	20	Unknown	Unknown	5300	WRDS Has Chemical Analysis	1690			1049
62	P30162W	3	N	2	E	30	NENE	200	60	145	200	5400	WRDS Has Chemical Analysis				169
63	P32163W	3	N	2	E	30	NESW	425	350	350	375	5380	WRDS Has Chemical Analysis	1130			690
64	P9441P	3	N	2	E	30	SESE	582	72	Unknown	Unknown	5371	WRDS Has Chemical Analysis ????	2040	2720	579	1290
65	P116598W	3	N	2	E	30	SESW	470	180	423	470	5347	SEO	376		229	119
66		3	N	2	E	33	NE NW						WRDS Has Chemical Analysis	930			296
67	P25011W	3	N	2	E	33	NWNW	300	140	240	290	5340	WRDS Has Chemical Analysis	3560			2400
68	P177246W	3	N	3	E	19	SWSE	1000	162	980	1000	5287	Sampled by Wester-Wetstein on 1-12-11	775	1180	248	457
	P177246W	3	N	3	E	19	SWSE	1000	162	980	1000	5287	Sampled by Wester-Wetstein on 1-12-11	590	1180	126	237
69	P190223W	3	N	3	E	19	SWSW	1055	250	1035	1055	5309	Sampled by Wester-Wetstein on 1-12-11	607	920		
70	P191733W	3	N	3	E	30	SENW	900	200			5272	Sampled by Wester-Wetstein on 1-12-11	631	956		

Depth of completion data is available for slightly over one-half of the wells. This well completion data allowed the well data to be divided up into three different groups. These groups were those wells producing from an elevation of 5,400 feet to 5150 feet (shallow wells less than 220 feet deep), those producing from an elevation of 5,100 feet to 4,750 feet (medium depth wells from 220 feet to 600 feet deep) and those producing from an elevation from 4,750 feet to 4,250 feet (deep wells greater than 600 feet deep). These data were then plotted (See Figures III-3 to III-5, Pgs. III-8-10, and Tables III-2 to III-4, Pg. III-11) and analyzed for potential trends. **From an observation of the plotted data, again, no notable trend was noted.**

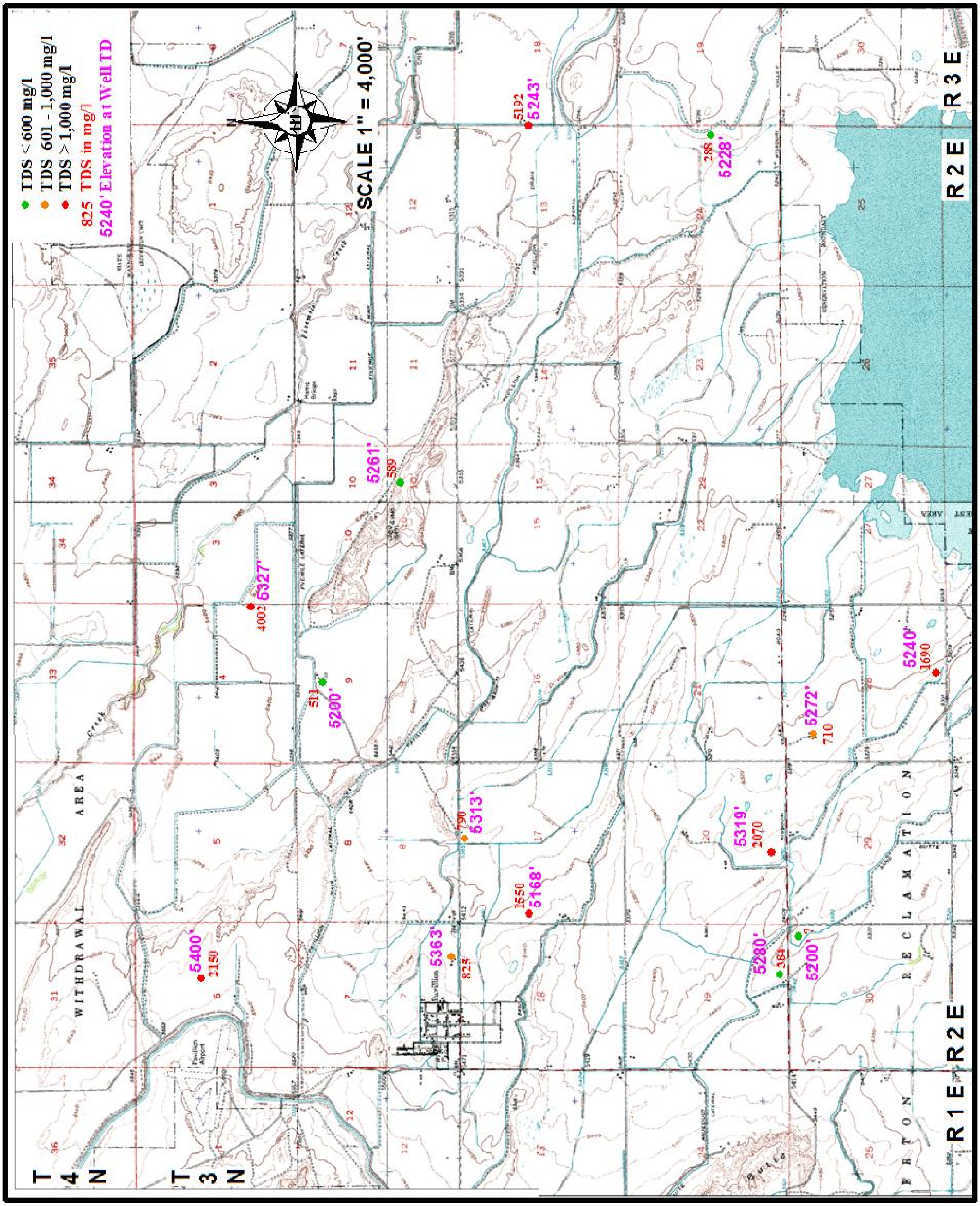


FIGURE III-3: Shallow Wells - Water Quality

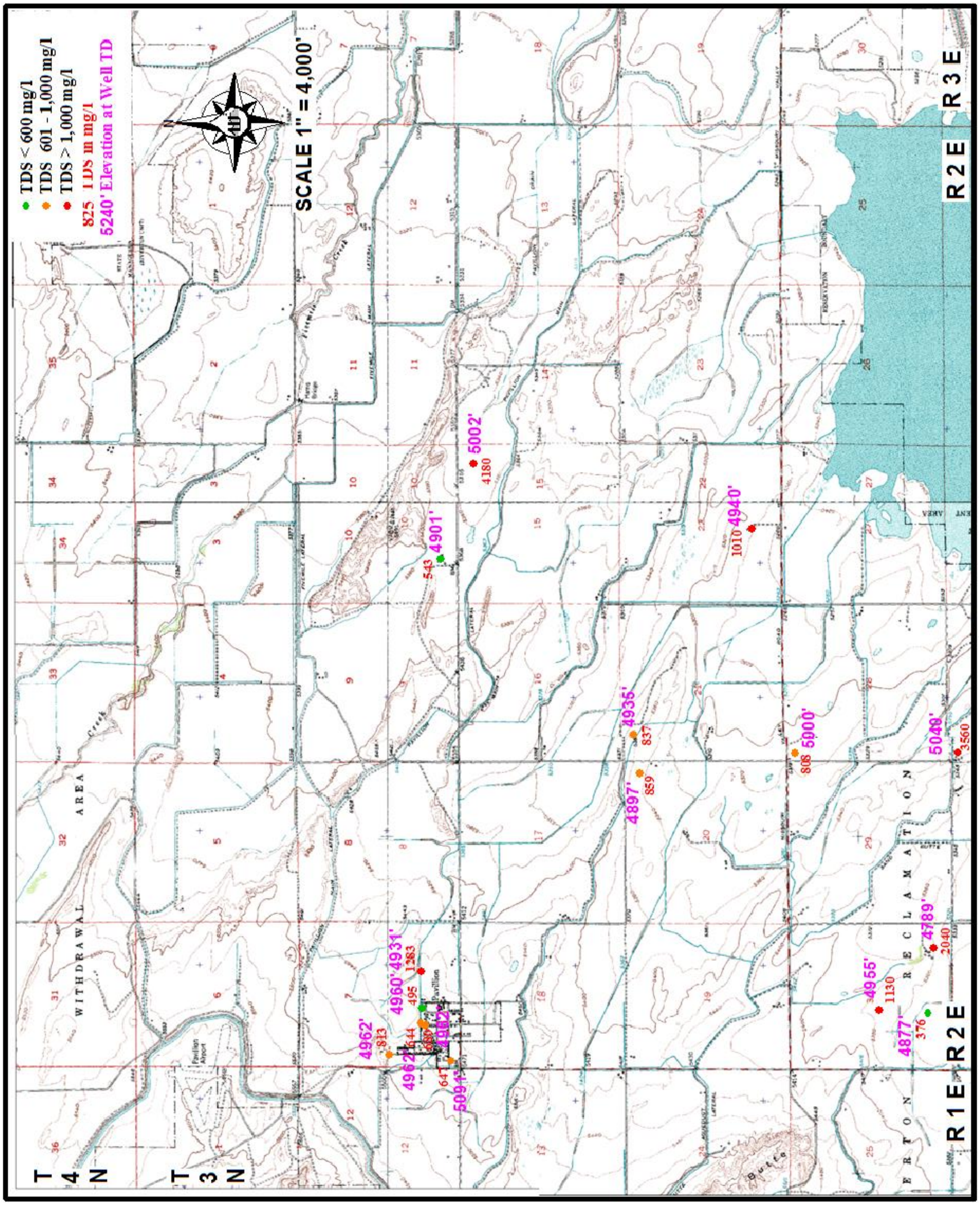


FIGURE III-4: Medium Depth Wells - Water Quality

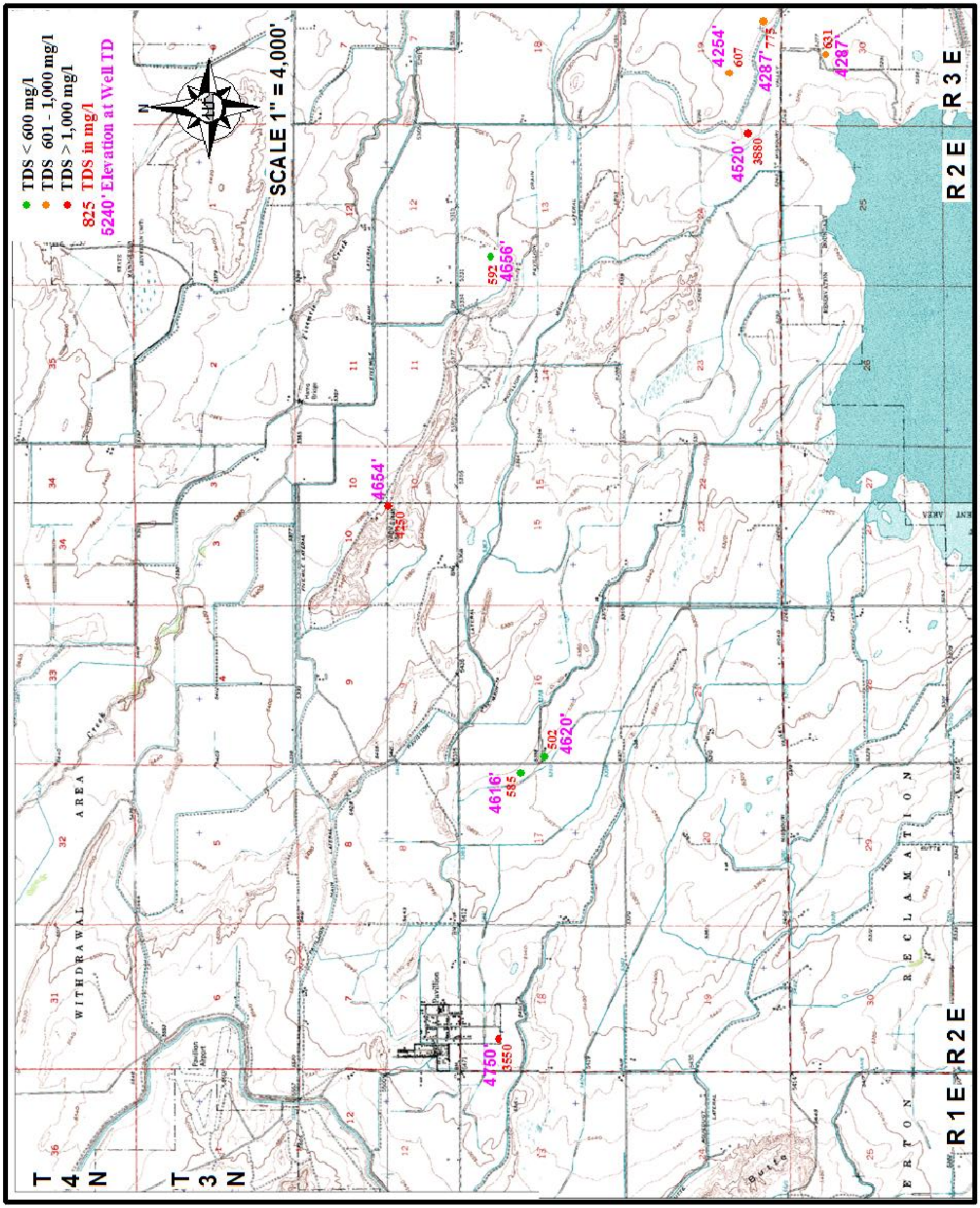


FIGURE III-5: Deep Wells - Water Quality

TABLE III-2
Shallow Wells – Water Quality Data

Permit #	Twnshp		Rng		Sect.	Qtrqtr	Well Depth	Static Depth	Mwbz Top	Mwbz Bottom	Ground Elevation	Chemical Data Source	TDS (mg/l)	Well Depth Elevation
P66345W	3	N	2	E	3	NWSW	70	7	15	25	5397	EPA Well No. PGDW41	4002	5327
P14914P	3	N	2	E	6	SWNE	130	50	Unknown	Unknown	5530	WRDS Has Chemical Analysis ????	2150	5400
P58929W	3	N	2	E	7	SESE	57	38	38	57	5420	WRDS Has Chemical Analysis ????	825	5363
P41517W	3	N	2	E	9	NENW	200	50	180	200	5400	EPA Well No. PGDW42	511	5200
P24508P	3	N	2	E	10	NESE	175	80	Unknown	Unknown	5436	EPA Well No. PGDW23	589	5261
P42890W	3	N	2	E	13	SENE	57	14	50	57	5300	EPA Well No. PGDW39	5192	5243
P101483W	3	N	2	E	17	NWNE	80	8	50	70	5393	EPA Well No. PGDW25 ???	790	5313
P46362W	3	N	2	E	17	SWNW	220	170	170	180	5388	WRDS Has Chemical Analysis	1550	5168
P53567W	3	N	2	E	19	SWSE	140	57	120	140	5420	WRDS Has Chemical Analysis	384	5280
P25636W	3	N	2	E	20	SESW	41	21	41	41	5360	WRDS Has Chemical Analysis	2070	5319
P28496W	3	N	2	E	24	NESE	65	18	20	36	5293	SEO	288	5228
P40603W	3	N	2	E	28	NWNW	40	20	20	40	5312	WRDS Has Chemical Analysis	710	5272
P14548P	3	N	2	E	28	SWSE	60	20	Unknown	Unknown	5300	WRDS Has Chemical Analysis	1690	5240
P30162W	3	N	2	E	30	NENE	200	60	145	200	5400	WRDS Has Chemical Analysis		5200

TABLE III-3
Medium Depth Wells – Water Quality Data
(Depth 220 to 600 Feet)

Permit #	Twnshp		Rng		Sect.	Qtrqtr	Well Depth	Static Depth	Mwbz Top	Mwbz Bottom	Ground Elevation	Chemical Data Source	TDS (mg/l)	Well Depth Elevation
P76991W	3	N	2	E	7	SWSE	515	269	472	510	5446	EPA Well No. PGPWO2	1283	4931
P70972W	3	N	2	E	7	SESW	506	165	478	498	5466	EPA Well No. PGPWO1	495	4960
P98757W	3	N	2	E	7	NWSW	517	22	504	512	5479	Sampled by Wester-Wetstein on 2-18-11	813	4962
P34345W	3	N	2	E	7	SESW	510	255	480	495	5472	WRDS Has Chemical Analysis	680	4962
P59104W	3	N	2	E	7	SESW	510	300	480	500	5472	WRDS Has Chemical Analysis	644	4962
	3	N	2	E	7	SW SW	380				5471	WRDS Has Chemical Analysis	647	5091
P124049W	3	N	2	E	10	SESW	484	246	410	484	5385	EPA Well No. PGDW47	543	4901
P30217W	3	N	2	E	15	NENE	350	40	170	350	5352	WRDS Has Chemical Analysis	4180	5002
P120203W	3	N	2	E	20	NENE	450	100	410	450	5347	EPA Well No. PGDW03	859	4897
P168584W	3	N	2	E	21	NWNW	440	134	420	440	5375	EPA Well No. PGDW04	837	4935
P110443W	3	N	2	E	22	SESW	420	214	364	417	5360	Ow ner Furnished - This Study	1010	4940
P76475W	3	N	2	E	28	NWNW	320	100	290	320	5320	SEO	808	5000
P9441P	3	N	2	E	30	SESE	582	72	Unknown	Unknown	5371	WRDS Has Chemical Analysis ????	2040	4789
P116598W	3	N	2	E	30	SESW	470	180	423	470	5347	SEO	376	4877
P32163W	3	N	2	E	30	NESW	425	350	350	375	5380	WRDS Has Chemical Analysis	1130	4955
P25011W	3	N	2	E	33	NWNW	300	140	240	290	5340	WRDS Has Chemical Analysis	3560	5040

TABLE III-4
Deep Wells – Water Quality Data

Permit #	Twnshp		Rng		Sect.	Qtrqtr	Well Depth	Static Depth	Mwbz Top	Mwbz Bottom	Ground Elevation	Chemical Data Source	TDS (mg/l)	Well Depth Elevation
P24507P	3	N	2	E	10	NWSE	750	80	Unknow n	Unknow n	5404	WRDS Has Chemical Analysis	4250	4654
P64110W	3	N	2	E	13	NWNW	675	235	661	669	5331	EPA Well No. PGDW32	592	4656
P183732W	3	N	2	E	16	NWSW	740	220	720	740	5360	Sampled by Wester-Wetstein on 1-12-11 (EPA Well No. PGDW10)	502	4620
P182983W	3	N	2	E	17	SENE	760	350	740	760	5376	Sampled by Wester-Wetstein on 1-12-11	585	4616
P62641W	3	N	2	E	18	NENW	705	-1	640	685	5455	WRDS Has Chemical Analysis	3550	4750
P177246W	3	N	3	E	19	SWSE	1000	162	980	1000	5287	Sampled by Wester-Wetstein on 1-12-11	775	4287
P177246W	3	N	3	E	19	SWSE	1000	162	980	1000	5287	Sampled by Wester-Wetstein on 1-12-11	590	4287
P190223W	3	N	3	E	19	SWSW	1055	250	1035	1055	5309	Sampled by Wester-Wetstein on 1-12-11	607	4254
P26200W	3	N	2	E	24	SESE	740	30	275	290	5260	WRDS Has Chemical Analysis	3880	4520
P191733W	3	N	3	E	30	SENW	900	200			5272	Sampled by Wester-Wetstein on 1-12-11	631	4372

Failing to identify any noticeable trends from the water quality data plots, the investigation shifted to a review of the high water quality wells to try to ascertain what hydrogeologic parameter was controlling their quality of water as opposed to the predominant poor water quality wells in the area. The initial phase of this investigation was focused on a series of deep wells with which a member of our study team, Doyle Ward of Ward's Well Service, was familiar. Mr. Ward pointed out that there were several deep wells in the Pavillion area that produced good quality water. The locations of these wells are shown on Figure III-6 (Pg. III-13) and the well data listed in Table III-5.

Several of the well owners were contacted during the investigation, and from these discussions it was determined that the well drillers were targeting a specific sand lens that was characterized by a clean white sand. This sand lens has been described in the driller's logs as "course white sand". A review of a mud log report for the Kerr-McGee Corporation No. 1 Tribal Unit Well (49-013-20654) located in the NW¼ NW¼ of Section 23, Township 3 North, Range 2 East (See Figure III-6, Pg. III-13) describes the sand at a depth of approximately 800 feet (similar depth to those wells listed in Table III-5) as being "white to light gray, course grained, sub-angular to sub-round". Geophysical logs and mud logging records for wells on file with the Wyoming Oil and Gas Commission were reviewed in the area of Pavillion and in the area of the wells listed in Table III-5 (Pg. III-12). The locations of the oil and gas wells are shown on Figure III-6 (Pg. III-13). A review of the geophysical logs for these wells revealed a porous sand zone that correlates well with the described section of coarse white sand. The porosity of the sands in this section approach 30% in some of the wells reviewed. Figure III-7 (Pg. III-14) is a section from the dual induction log of the Kerr-McGee Corporation No. 1 Tribal Unit Well (49-013-20654) where the porous sand zone has been highlighted in yellow. Using the data from the deep wells with the high water quality, the oil and gas wells, and the Town of Pavillion wells, a cross section was constructed to see if the porous sand zone present in the deep wells with high water quality could be correlated with any of the producing sands in the Town of Pavillion wells. The location of this cross-section is shown in Figure III-8 (Pg. III-15) and the cross-section shown in Figure III-9 (A-A', Pg. III-16). Initially, it appeared that the porous sand zone could be extrapolated into the Pavillion area and the quality of the water then determined based upon an individual well being completed in this sand lens. However, the static water levels in the Pavillion wells do not correlate well. A review of the cross-section (Figure III-9, Pg. III-16) shows that there are as many as four distinct potentiometric surfaces associated with the Wind River Aquifer in the immediate area around the Town.

TABLE III-5
Deep Wells – High Quality Water

Permit #	Twnshp		Rng		Sect.	Qtrqtr	Applicant	Yld Act	Well Depth	Static Depth	Mwbz Top	Mwbz Bottom	Chemical Data Source	TDS (mg/l)	Na (mg/l)	Sulfate (mg/l)
P183732W	3	N	2	E	16	NWSW	CARL & KATHY CHAPMAN	15	740	220	720	740	Sampled by Wester-Wetstein on 1-12-11 (EPA Well No. PGDW10)	502	195	293
P182983W	3	N	2	E	17	SENE	ROB & ANN MCFALL	14	760	350	740	760	Sampled by Wester-Wetstein on 1-12-11	585		
P150327W	3	N	2	E	30	SESE	DOUG & TRISH ADAMS	20	975	52	950	975	Was not Sampled - Homeowner not present			
P177246W	3	N	3	E	19	SWSE	DANIEL I. & SHEILA R. SUMMERLIN	25	1000	162	980	1000	Sampled by Wester-Wetstein on 1-12-11	775	248	457
P190223W	3	N	3	E	19	SWSW	JOHN STOYSICH	20	1055	250	1035	1055	Sampled by Wester-Wetstein on 1-12-11	607		
P191733W	3	N	3	E	30	SENW	GARY AND BARBARA FOY	12	900	200			Sampled by Wester-Wetstein on 1-12-11	631		

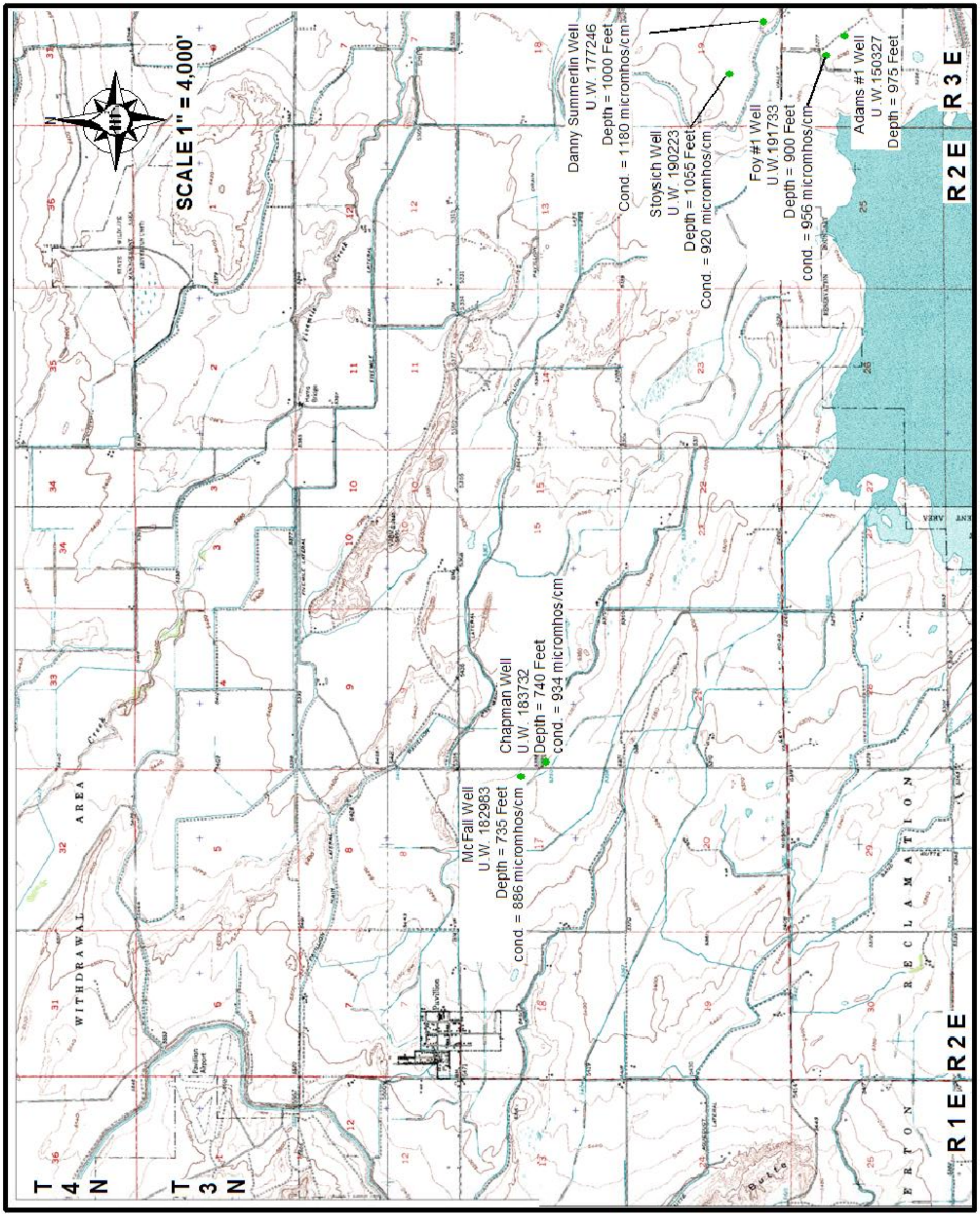


FIGURE III-6: High Quality Water – Deep Well Location Map

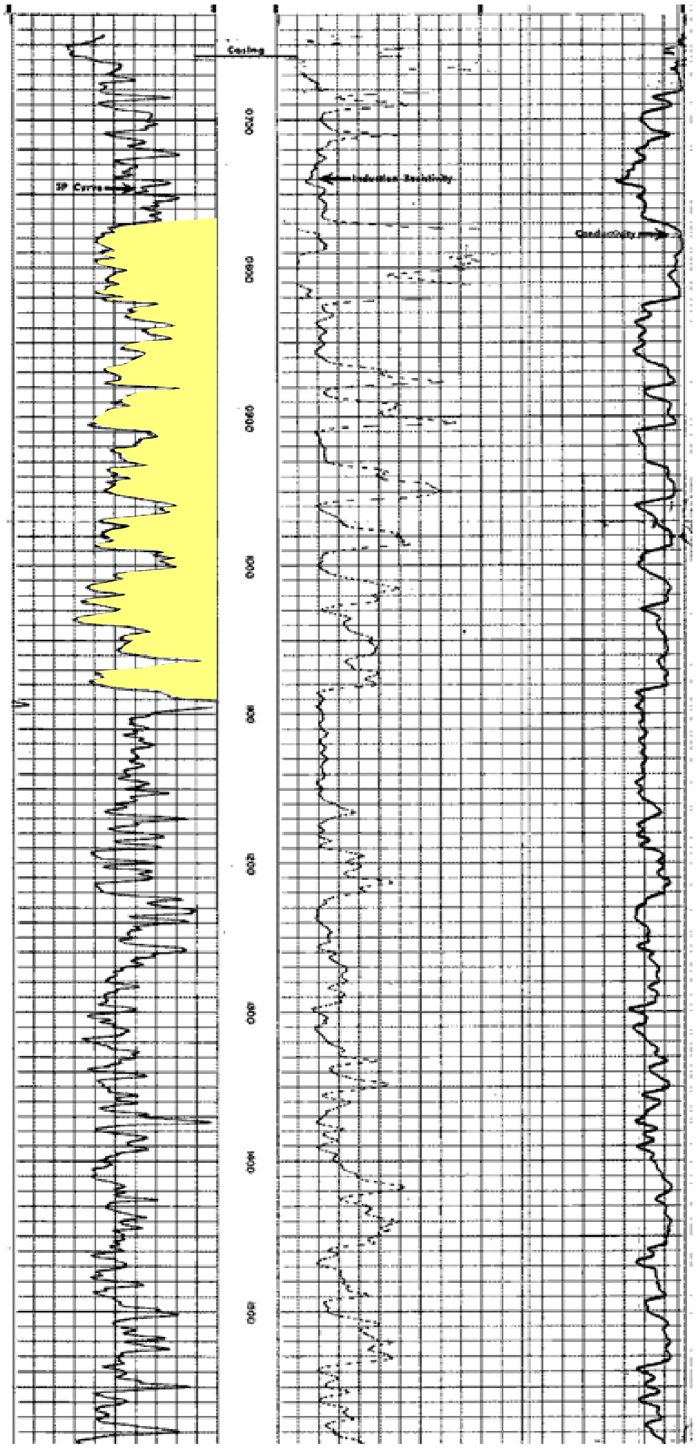


FIGURE III-7:
Geophysical Trace of Coarse Sand Lens

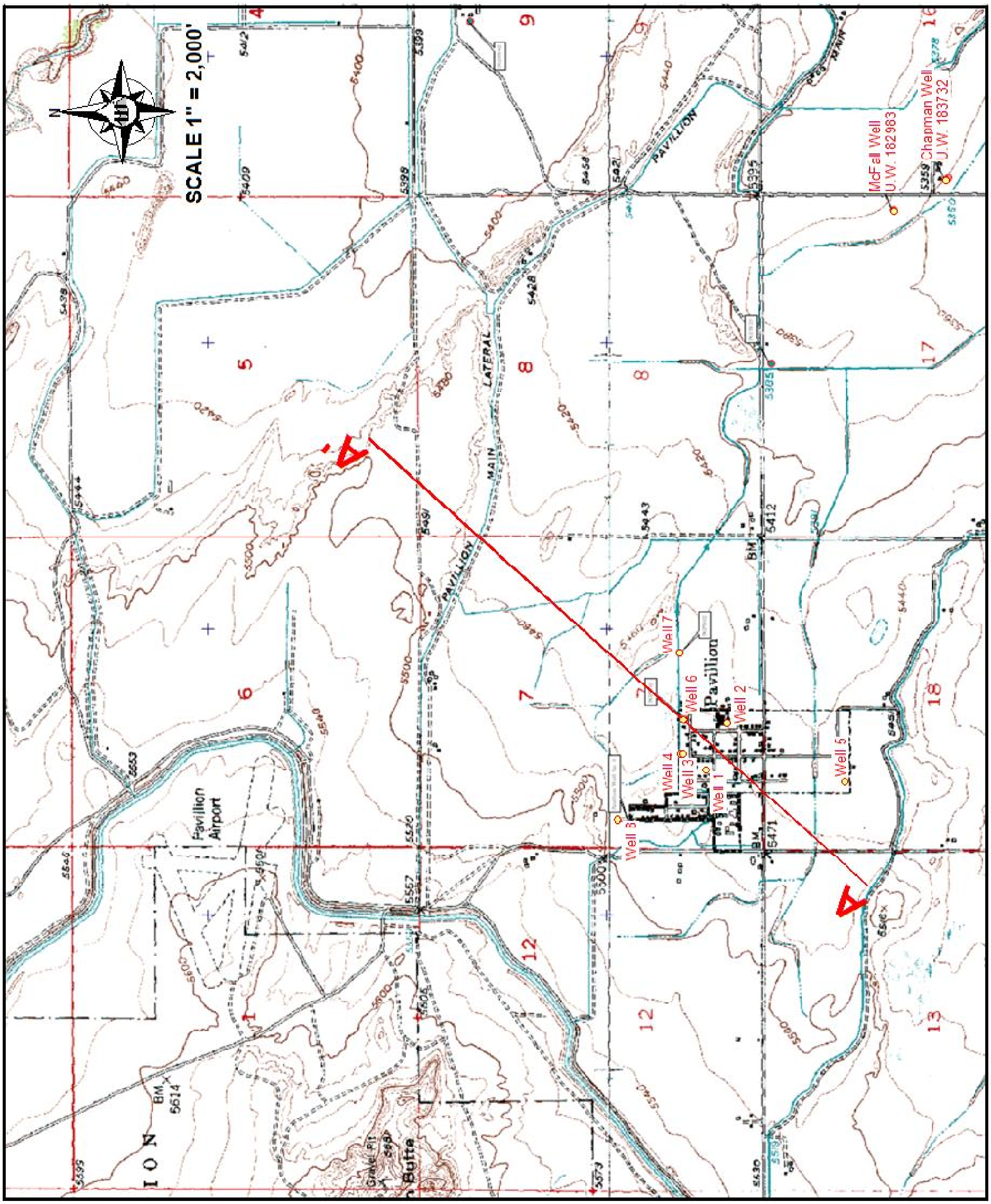


FIGURE III-8: Cross Section Location Map

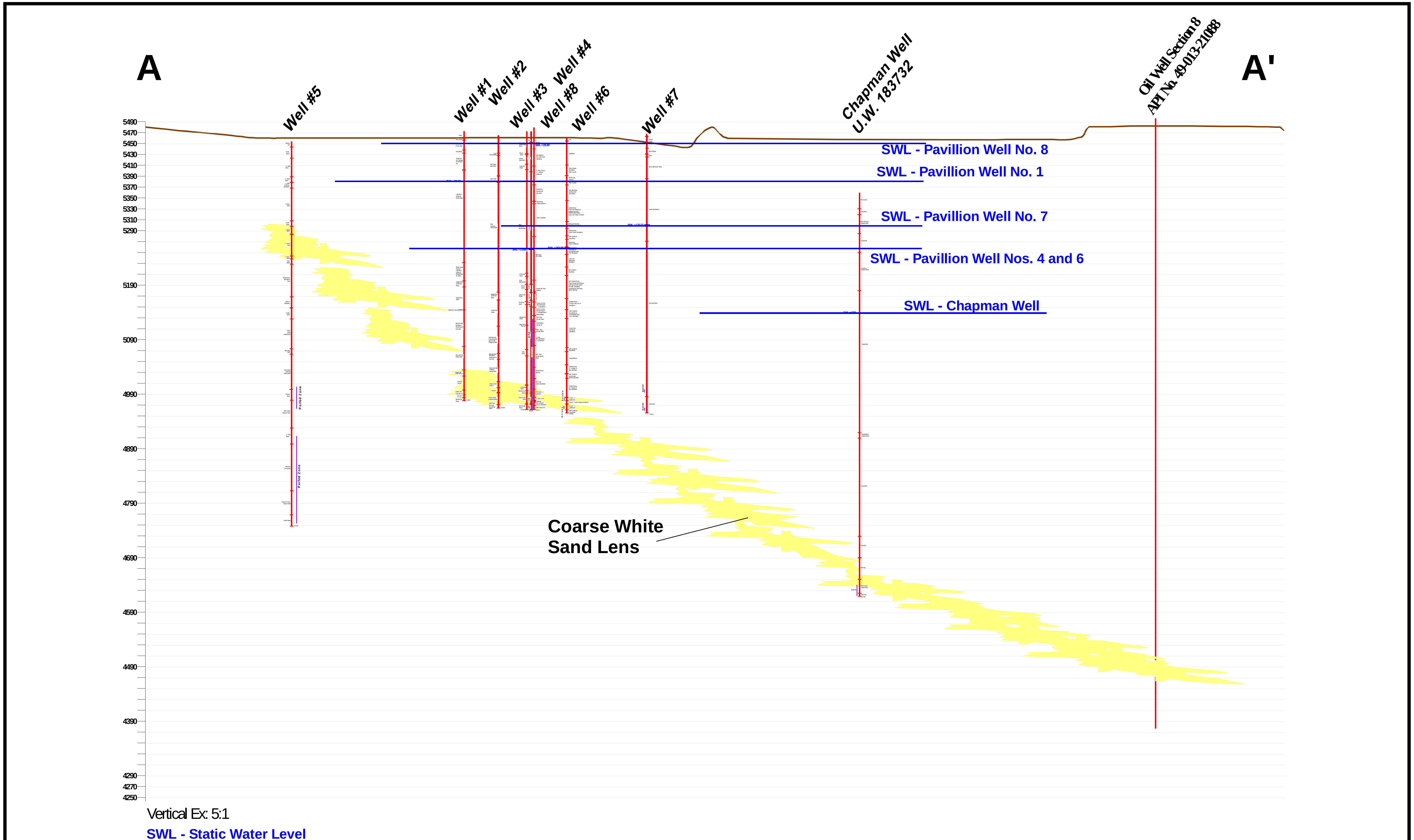


FIGURE III-9: Pavillion Area Cross-Section A-A'

The varying potentiometric surfaces indicate that the thick coarse sand lens present in the different wells shown in Figure III-9 are not all interconnected and are therefore, probably sourced from different recharge areas and travel through varying reaches of the Wind River Formation that are comprised of rocks with dissimilar chemical properties. Because the coarse sand lenses in the Pavillion wells do not appear to be connected, it is reasonable to assume, given the depositional history of the Wind River Formation, that these coarse sands represent different river channel deposits with varying points of origin and travel paths from the source rock area to their point of deposition. The variation in the source rock and the different travel paths could explain the variations in the quality of the water.

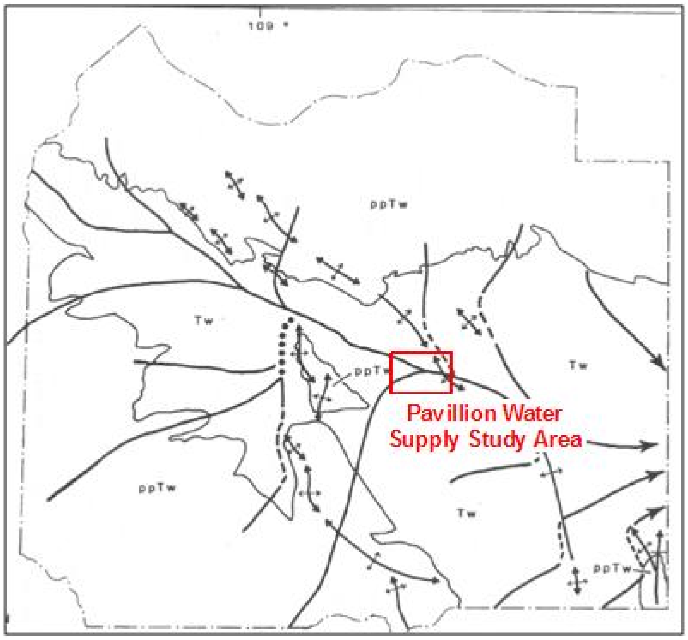


FIGURE III-10: Eocene River Systems

From previous work in the Riverton area, it was known that the ancient Eocene Epoch (Early Tertiary) river systems in the region roughly paralleled today's modern river systems (See Figure III-10). The ancient Eocene period flow paths and the positions of the ancient Eocene river systems were reviewed to determine if the coarse sand deposits in the deep wells and oil and gas wells shown in Figure III-6 correlate to the mapped Eocene river systems. Figure III-11 shows a more detailed view of the approximate location of the Eocene river systems with respect to the Pavillion project study area. The mapped Eocene age paleo-Wind River is located slightly to the north of the wells shown on Figure III-11, but it is on trend with the wells. A cross-section was next constructed along a path in general, which parallels the paleo-Wind River to determine if the coarse sands represented an earlier stage of the paleo-Wind River which was located slightly south of its position shown in Figures III-10 and III-11 (Pgs. III-17-18). The location of this cross-section is shown in Figure III-12 (Pg. III-19) and the cross-section shown in Figure III-13 (Pg. III-20). From this cross-section (B-B'), it appears that there is a reasonable correlation between the coarse white sand lens in the private domestic wells and the oil and gas wells as shown in Figures III-12 and III-13 (Pgs. III-19-20). The gentle dip to the southeast parallels the mapped paleo- Wind River channel as shown in Figure III-10 (Pg. III-17). The static water levels in the domestic wells also appear fairly uniform through these wells with a slight dip to the southeast which generally parallels the dip of the sand bodies in the formation.

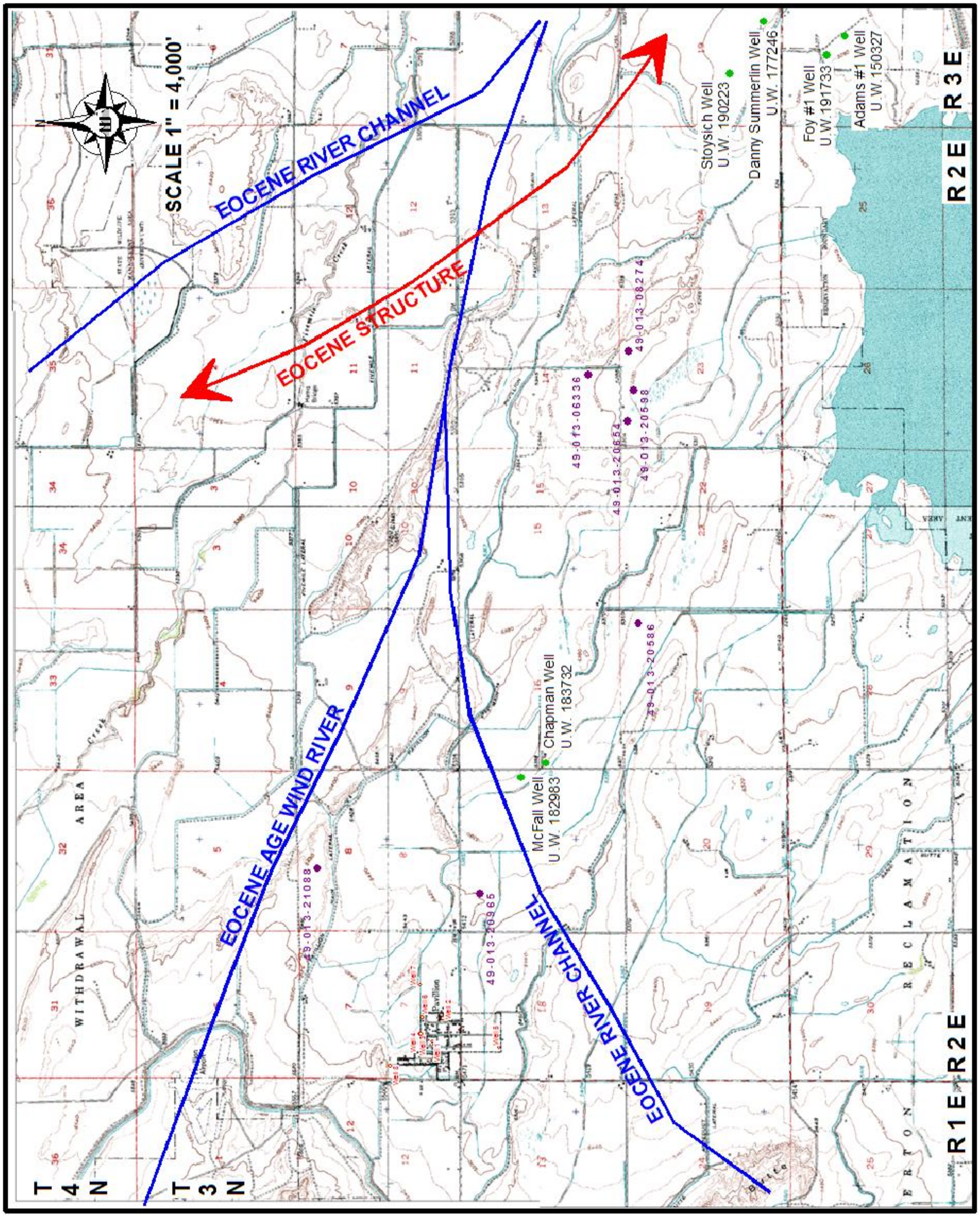


FIGURE III-11: Eocene Age River System and Structures

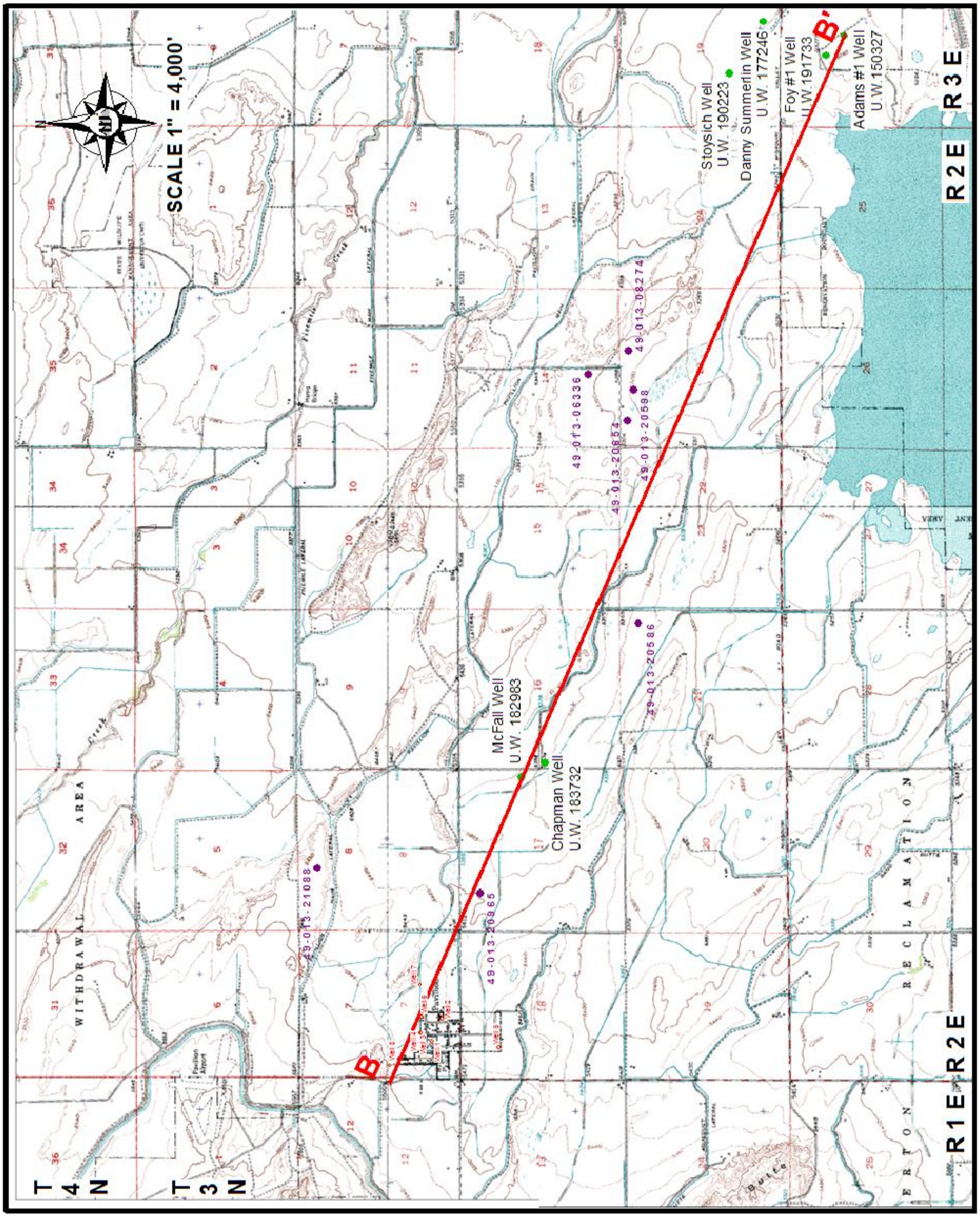
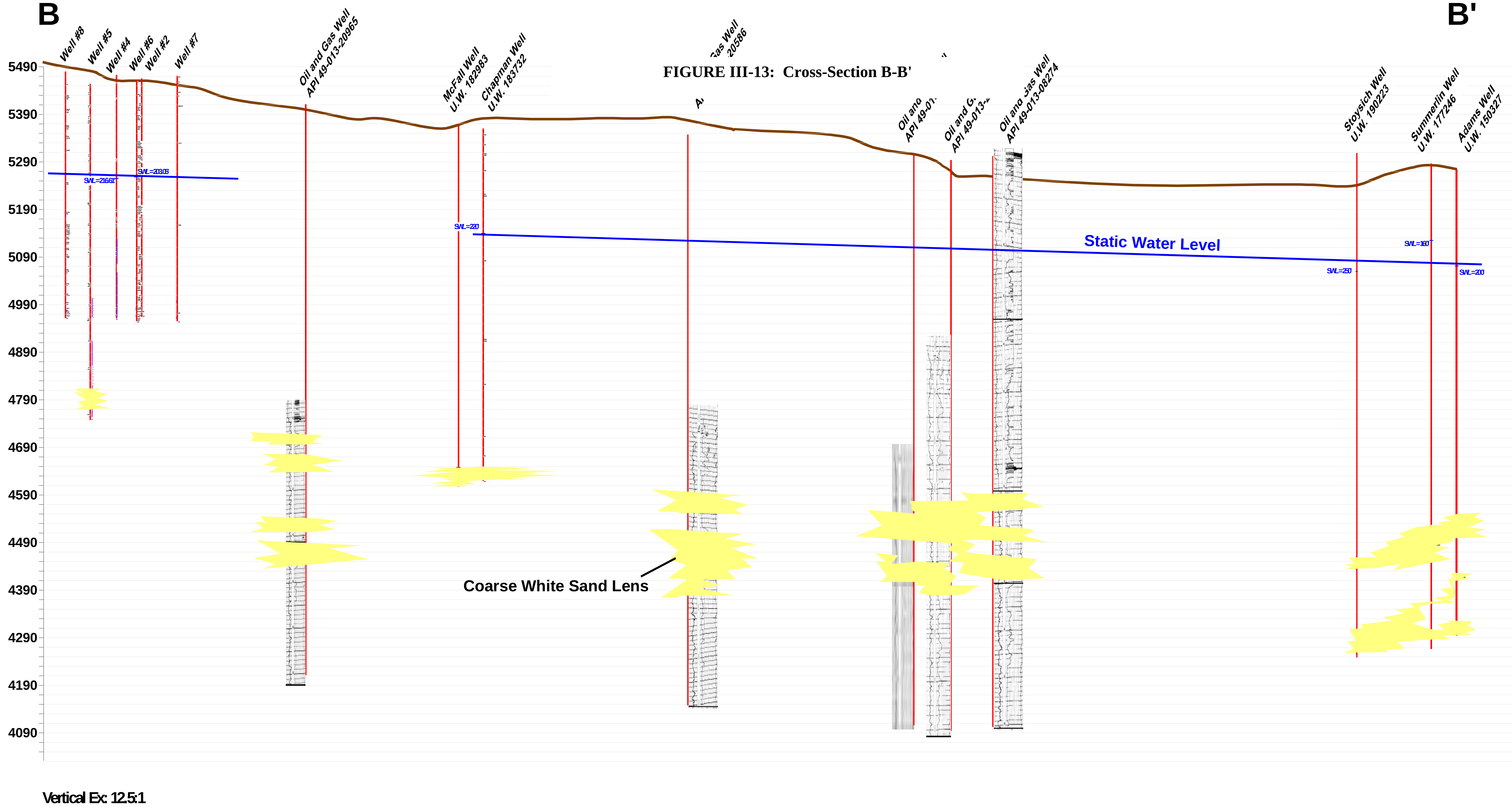


FIGURE III-12: Cross-Section B-B' Location Map

FIGURE III-13: Cross-Section B-B'



However, as shown in Figure III-13 (Pg. III-20), the Town of Pavillion's wells all appear to be completed at depths that are too shallow to have intercepted the coarse white sands highlighted in cross-section B-B'. The producing interval in the Pavillion wells is generally at or near the bottom of the wells, and, as can be seen in Figure III-13 (Pg. III-20), these producing horizons do not appear to be on trend with the deep sand lenses highlighted in the other wells. If the sands in the deeper wells shown in cross-section B-B' are in good communication with each other, this could explain the relatively uniform quality of water in the deeper wells (see Table III-5, Pg III-12) which have a total dissolved solids concentration ranging from 502 mg/L to 775 mg/L as compared to that of the Town of Pavillion wells where the concentration of total dissolved solids ranges from 495 mg/L to over 1,200 mg/L (See Table III-6, Pg. III-21). The total dissolved concentration in Well No. 5, which was abandoned and not put into service, was over 3,500 mg/L.

TABLE III-6
Town of Pavillion Wells Quality Water

Permit #	Twnshp		Rng		Sect.	Qtrqtr	Applicant	Facility Name	Yld Act	Well Depth	Static Depth	Mwbz Top	Mwbz Bottom	Well Log	Chemical Analysis	Chemical Data Source	TDS (mg/l)	Cond (µmho/cm)	Sodium (mg/l)	Sulfate (mg/l)
P98757W	3	N	2	E	7	NWSW	TOWN OF PAVILLION	PAVILLION #8	30	517	22	504	512	Yes	Yes	Sampled by Wester-Wetstein on 2-18-11	813.00	1261.00	255.00	439.00
P70972W	3	N	2	E	7	SESW	TOWN OF PAVILLION	PAVILLION #6	30	506	165	Unknown	Unknown	Yes	Yes	EPA Well No. PGPW01	495.21		173.00	300.00
P34345W	3	N	2	E	7	SESW	TOWN OF PAVILLION	TOP #3	40	510	255	480	495	Yes	No	WRDS Has Chemical Analysis	680.00		190.00	400.00
P59104W	3	N	2	E	7	SESW	TOWN OF PAVILLION	NM #4	45	510	300	480	500	Yes	No	WRDS Has Chemical Analysis	644.00		210.00	460.00
P76991W	3	N	2	E	7	SWSE	TOWN OF PAVILLION	PAVILLION #7	30	515	269	472	510	Yes	No	EPA Well No. PGPW02	1283.41		393.00	847.00
P62641W	3	N	2	E	18	NENW	TOWN OF PAVILLION	S #5	0	705	-1	640	685	Yes	Yes	WRDS Has Chemical Analysis	3550.00		970.00	2200.00

Given the coarse sand matrix of the producing horizons in the deeper wells and the apparent communication between these sands, it appears that a well completed in the deeper coarse sand lens and on trend with the wells shown in cross-section B-B' would yield potentially higher quality of water because the groundwater would travel through these coarse sand lenses quicker and there would be less dissolution of minerals into the water.

The most promising exploration area appears to be with the correlation of high quality water produced from wells that have been completed in the coarse white sand lens at an elevation of approximately 4,400 feet to 4,600 feet, MSL and on a trend with that of cross-section B-B' (See Figure III-12, Pg. III-19). It is believed that there is good communication within the coarse white sand lens and the recharge area, and a well completed in this sand would yield a good quality of water as opposed to the high TDS water that is very prevalent in the Pavillion area. The coarse grained sands should also provide the transmissivity necessary to meet the demands of the proposed Rural Service Area.

D. Rural Service Area Well Sites Selection

In an effort to delineate all of the potential water supply options for the Rural Service Area residents, two potential production well sites were selected (See Figure III-14, Pg. III-23). The first site (Location "A") was selected based on the potential to develop a water source with good to high quality water – total dissolved solids concentration of 750 mg/L or less. The second site (Location "B") was based on a location that would be within boundary of the Rural Service Area, and would therefore minimize the construction cost to tie this well into the proposed Rural Service Area water system. The quality of water within the Rural Service Area is generally characterized as poor with total dissolved solids concentrations of greater than 1,000 mg/L. The water from a well drilled at Location "B" could, therefore, possibly require treatment to lower the concentration of sodium and sulfates in the water to acceptable drinking water standards as defined by EPA's Secondary Drinking Water Standards.

The location of Well "A" was determined based on the following criteria:

1. Locate on trend of wells that produce groundwater of good quality,
2. Minimize distance from well to the area within the Rural Service Area which contains the highest concentration of potential users,
3. Minimize drilling depth to target aquifer sands, and
4. Locate the well on non-irrigated acreage.

As shown in Figure III-16 (Pg. III-23) the proposed Well "A" is on trend with the wells completed in the deeper coarse white sand lens that produce water with total dissolved concentrations of less than 750 mg/L. The depth to the target sands in the area of the McFall and Chapman wells is approximately 750 feet while the depths of completion in the wells located in Sections 19 and 30 of Township 3 North, Range 3 East are at approximately 1,000 feet. The most concentrated area of potential users within the Rural Service Area is in the southeastern quadrant. Although the distance to this concentrated user area could be shortened by locating the well in Sections 22 or 23, the wells with the highest quality of water are the Chapman and McFall wells, and therefore, the proposed Well "A" was located closer to these two wells. Finally, the well was located in a non-irrigated parcel of land. Originally, the proposed well location was located closer to the middle between the McFall and Chapman homes. However, due to archeological and easement issues, it was moved to a non-irrigated section closer to the Chapman residence. (See Figure III-15, Pg. III-22).

FIGURE III-15: Well Location "A"

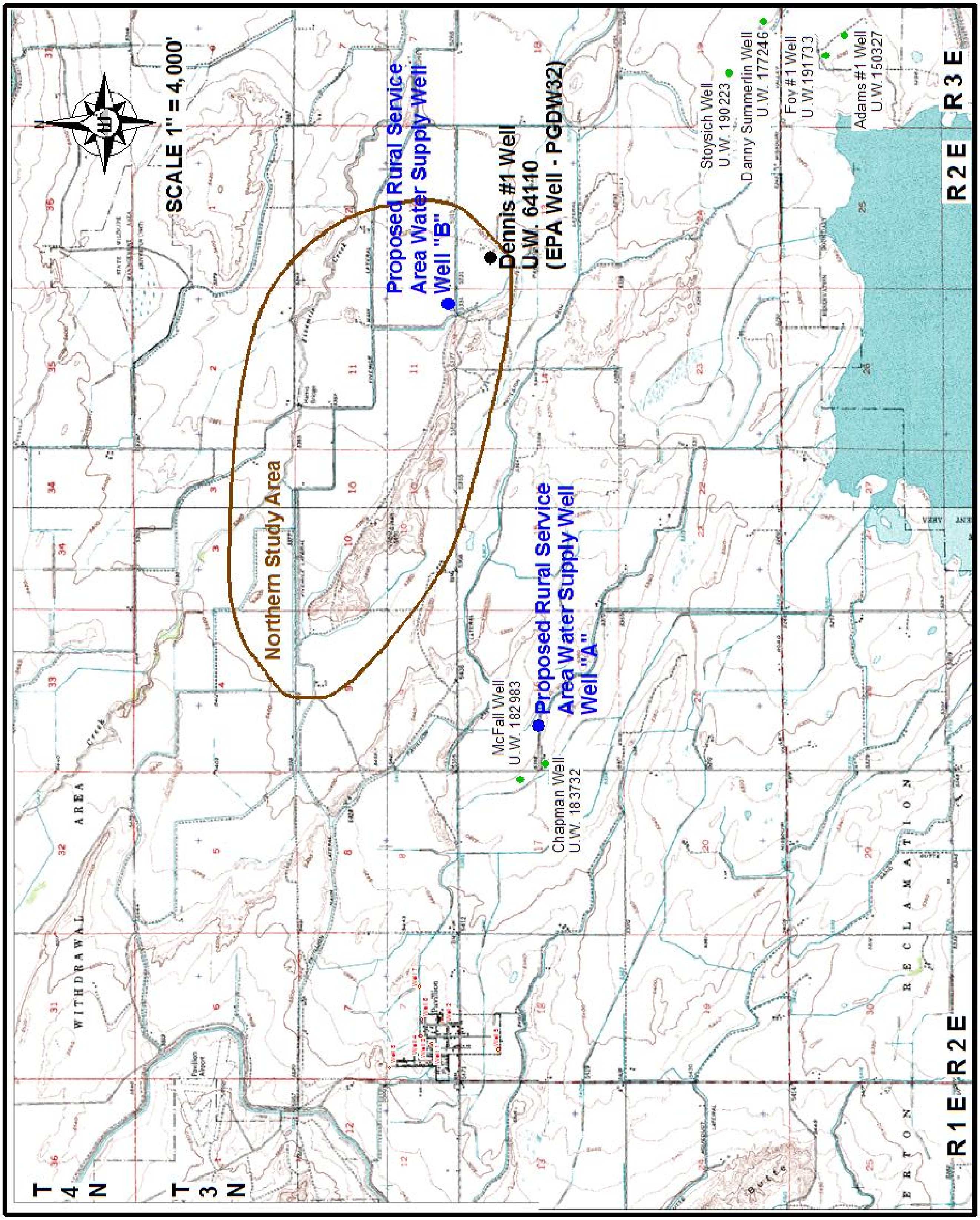


FIGURE III-14: Proposed Rural Service Area Water Supply Wells Location Map

The location for Well "B" was based on two criteria. The first criterion was the distance from the area with the highest concentration of potential users, and the second was the land use of the proposed site. As shown in Figure III-16 (Pg. III-24), the location of Well "B" is in a non-irrigated parcel of land and is essentially surrounded by potential users. One well located just to the southeast from the proposed Well "B" site, the Dennis #1 Well (U.W. 64110) was completed in a white sand lens at a depth of 661 to 669 feet. The quality of water produced from this sand is good with a total dissolved concentration of approximately 600 mg/L. The potential, therefore, exists to complete a well within the Rural Service Area boundaries that will produce water similar in quality to that projected for Well "A". The number of wells completed in this sand is, however, limited to just the Dennis #1 Well in the area of Well "B" and therefore, the probability of developing a well with this quality of water is less dependable at location "B" as opposed to that of well location "A".

FIGURE III-16: Well Location "B"

E. Well Design

As mentioned previously, the target aquifer for both well locations "A" and "B" is the coarse white sands located between the elevation of approximatley 4,400 feet to 4,600 feet MSL. At the proposed location "A" site, it is projected that this sand lens will be intercepted at a depth of approximately 780 to 950 feet below the ground surface. At location "B", it is anticipated that the coarse white sand lens, if present, would be at a depth of approximately 670 to 700 feet below ground level. To be conservative and to allow for some flexibility in the design, the cost estimate to drill and complete these wells was based on a total depth of the well of 1,000 feet.

The well design would consist of 50 feet of surface casing set and cemented in place with an 11-inch borehole then advanced to a depth of 950 feet or to the top of the target sand lens. A 7-inch steel casing would then be set and cemented in place to a depth of 950 feet or just above the target sand lens. After allowing the neat cement grout to set, a 6¼-inch diameter borehole would be advanced to a depth of 1,000 feet. A production string consisting of 5½-inch steel casing and approximately 40 feet of stainless steel screen would then be placed inside the 6¼-inch diameter borehole with the top of this stringer sealed inside the 7-inch casing using a K-Packer. The stainless steel screen would be placed opposite the coarse white sand lens, the depth of which would be selected using geophysical logs. Figure III-17 (Pg. III-26) shows the proposed design for the Rural Service Area water supply well.

The anticipated static water level at both Location "A" and Location "B" would be approximately 250 feet below the ground surface. The well design would, therefore, allow for the maximum amount of drawdown since the pump chamber (7-inch casing) would be set to just above the target aquifer. At a minimum the drawdown available would be 400 feet (top of sand at a depth of 670 feet) and the maximum would be approximately 700 feet if the 7-inch casing is set at a depth of 950 below ground level. Based on the results from the pump tests performed on the Town of Pavillion wells, this amount of drawdown should be adequate for the proposed well to meet the system demands of the Rural Service Area users.

F. Water Quality

It is anticipated that the quality of water from a well completed at Location "A" would be very similar to that of the water produced from the Chapman or McFall wells (See Figure III-14). Both of these wells produce good quality water that will meet most of EPA's drinking water standards with the exception of the Secondary Drinking Water Standards established for total dissolved solids (TDS) and sulfate. It is anticipated that the water will be slightly higher in TDS with an anticipated concentration of approximately 600 mg/L as compared to the standard of 500 mg/L and the concentration of sulfate is anticipated to be near or above 300 mg/L as compared to the Secondary Standard limit of 250 mg/L. The concentration of sodium will also be elevated with an anticipated concentration of over 200 mg/L. Concentrations of TDS, sodium and sulfate at these levels may produce some taste and odor issues and this level of sodium does present a health concern for people with hypertension. The recommended optimum level of sodium in drinking water is 20 mg/L.

The quality of water that will be produced from a well at Location "B" is more difficult to predict due to the lack of data in that area. As mentioned earlier, one well, the Dennis #1 well (See Figure III-14) does produce a quality of water that is very similar to that anticipated from the well at Location "A". However, most of the wells in the defined Rural Service Area produce water of a much poorer quality with TDS concentrations exceeding 1,000 mg/L. Therefore, treatment of the water produced from this well to, at a minimum, lower the concentrations of primarily sodium and sulfate has been factored into the total overall cost for this supply option.

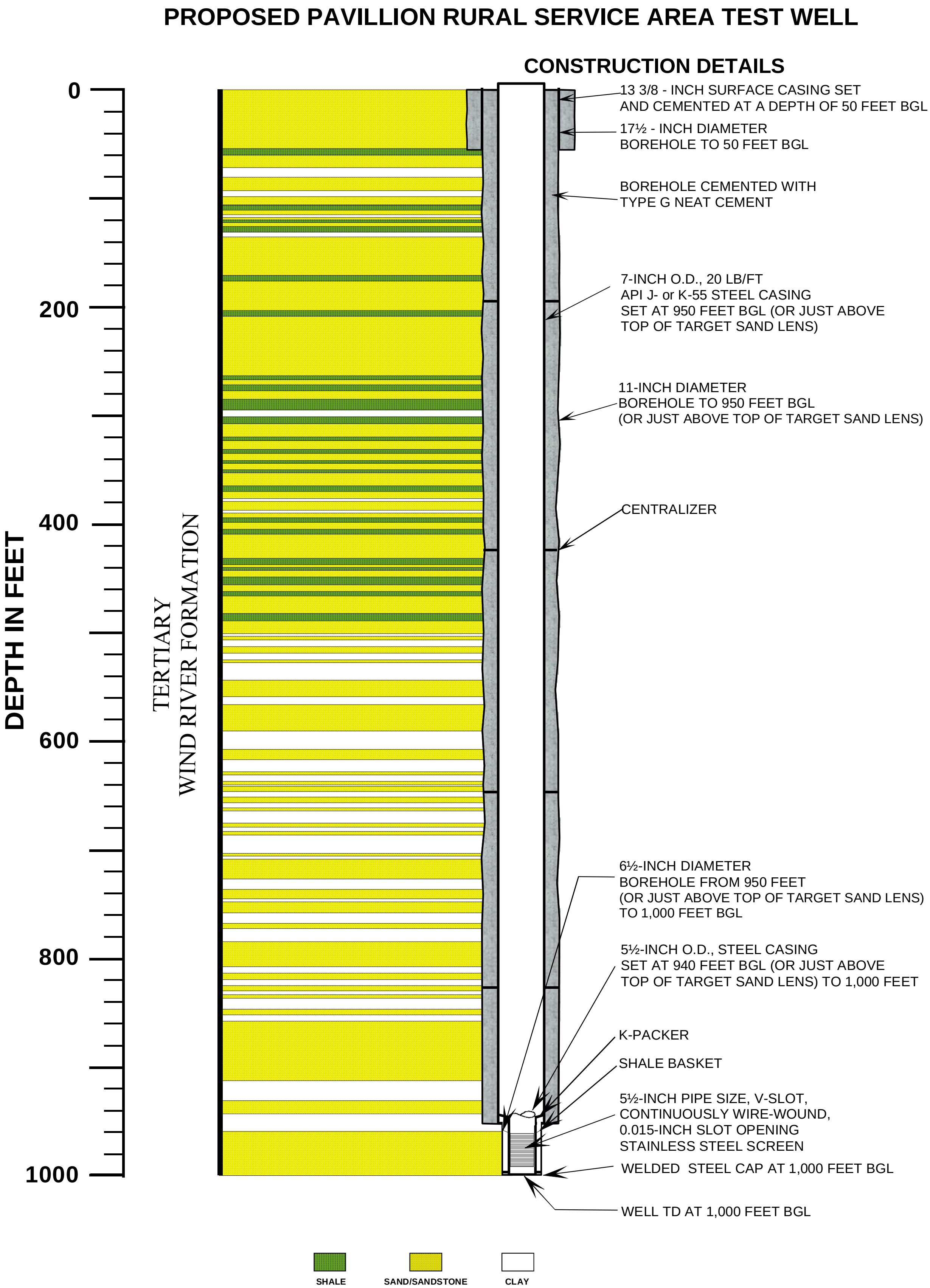


FIGURE III –17: Rural Service Area Proposed Well Diagram

G. Potential Sources of Contamination

Due to the concern of the oil and gas wells in the area and their potential impacts to water wells, a review of the oil and gas wells in the area of the Location "A" was conducted. The concerns of the oil and gas well impacts within the Rural Service Area are well documented and the treatment of the water from a proposed well at this location has been factored into the cost of this option and; therefore, the impacts from the oil and gas wells at Location "B" are not addressed here. The results of oil and gas well activity in the area of Location "A" follows.

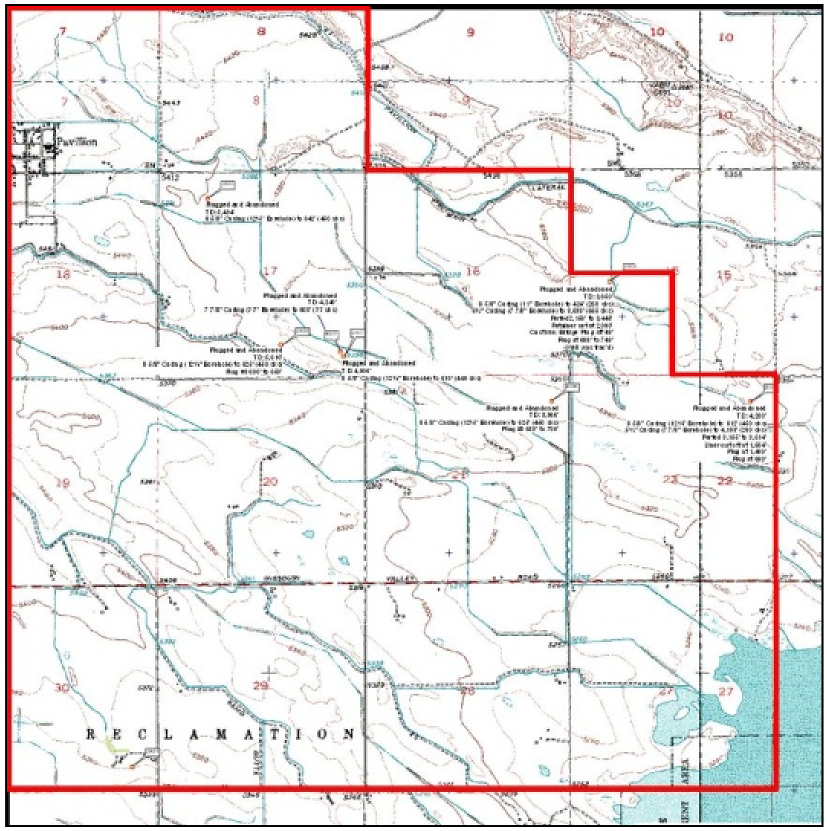


FIGURE III –18: Oil and Gas Well Investigation Area

A search of the Wyoming Oil and Gas Commission On-Line records was made for the following area to the south and east of Pavillion (area outlined in red if Figure III-18, Pg. III-27). The search revealed a total of 8 wells in the area, all of which have been plugged and abandoned. Most of these wells were drilled to depths of greater than 3,600 feet; depth ranged from 3,650 to 8,021 feet with all but two of the wells completed in the Fort Union Formation which underlies the Wind River Formation. One was TD'd near the base of the Wind River Formation (Section 15 Well) and one was TD'd in the Cretaceous Mesaverde Formation. All of these wells have surface casing ranging in diameter from 7⅞-inch to 9⅝-inch cemented in place to depths that average 599 feet (range from 436 feet to 642 feet, most are at the 600 to 625 range). The surface casings have been cemented in place, on average with twice the volume of cement required to fill the void space between the casing and a gage borehole. Most of the boreholes were 12¼-inch in diameter and most of these wells used around 450 sacks of cement when sealing the surface casing. Out of the eight wells reviewed, only two wells were placed into production and then later plugged and abandoned. These wells are located in Sections 15 and 22. A more detailed description of each of these wells is given in Appendix II of this document.

Based on a review of the completion records for these 8 wells, it appears that the potential for contamination to the Wind River Aquifer is minimal to non-existent. Although plugging and abandoning procedures were not available (Oil and Gas Commission website) for all of the wells, it appears the standard method of abandoning the wells is to spot at a minimum two cement plugs in the surface casing; one at the bottom of the casing and one from approximately 100 feet below surface to or to near the surface. Those wells that were completed and put into production were abandoned in a similar fashion, only with the addition of a cement retainer and plug placed above the perforated sections and, typically, another cement or cast iron bridge plug placed between the cement retainer and the base of the surface casing. As mentioned in each of the individual descriptions for the well, it appears that the cement coverage placed to seal the surface casing was more than adequate, as in each well the cement volume pumped in the annular space between the casing and borehole wall was at or above twice the volume required to fill a gage hole. Only two of these wells were completed which indicates the lack of a marketable quantity of gas in this area, and since the production time was very limited it would not allow for much gas to escape through a poorly completed well (if any of these wells were poorly cemented) and up into the overlying formations.

CONCLUSIONS

From the review of the Pavillion wells and the domestic wells in the study area, it appears that a potential water supply source for the Rural Service Area residents could be developed from the Wind River Aquifer that would provide a good quality water comparable or slightly better than that produced from the Town of Pavillion wells. The proposed water supply well would target a coarse white sand lens at a depth ranging from 600 to 1,000 feet. One potential site has been located within the proposed Rural Service Area. The cost for this well includes a water treatment system because it is anticipated treatment would be necessary to address the quality issues that have been well documented.

The second well site would target an area outside of the proposed Rural Service Area in an area with documented good quality water from the Wind River Aquifer. This area is up-gradient from the Rural Service Area and in an area that imposes very minimal potential for contamination to the proposed well. Although this option would require more pipeline to convey the water to the Rural Service Area, this option would require only minimal treatment (disinfection).

2. Area Surface Water Resources

Surface water that is available in the Pavillion area originates from either the Wind River or Five Mile Creek. The Wind River is the source water for both Ocean Lake, two and one-half miles south, and Pilot Butte Reservoir, six miles west of the area needing service. There are adequate surface water resources in the basin to meet the potable water needs of the Town of Pavillion and the rural area having undesirable groundwater and needing and alternate supply.

Five Mile Creek originates at the southern edge of the Owl Creek Range and flows southeast, spilling into the Wind River at the south end of Boysen Reservoir. According to USGS stream flow records compiled between 1949 and 1965, there is adequate perennial flow in this stream to meet the potable water requirements of the Town of Pavillion and the rural area needing an alternate supply. Also, the WWDC Wind River Basin master plan indicates a present surplus of 3,900 acre feet annually being available in Five Mile Creek. The 20 residences targeted as needing an alternate domestic water supply would use only 7.6 acre feet per year.   Five Mile Creek's flow upstream of the irrigated ground is unreliable. Ocean Lake, as well, is sourced from irrigation runoff.

3. Quality of Area Water Resources

There is limited published water quality data known to be available for the most nearby surface water sources of Ocean Lake, Pilot Butte Reservoir, and Five Mile Creek. DEQ's most recent testing of Five Mile Creek was done 10 years ago, in 2001. For Ocean Lake, the latest water quality testing was done in 2003. Neither source was tested using drinking water parameters as a focus.

The Natural Resource Conservation Service (NRCS) performed a watershed inventory of Five Mile Creek along with adjoining drainages in 2003 to 2005. The data they developed correlates with the DEQ data of 2001. The NRCS data is in the report Appendices.

None of the testing of the sources provides bacteriological data. The nearby Muddy Creek data, however, shows high total coliforms counts, in the 6,100 to 8,200 range. Because the drainages traverse similar agricultural landscapes with similar livestock operations, Five Mile Creek would likely have similar total coliforms levels.

The water quality data that is available from Wyoming DEQ and NRCS shows that Ocean Lake and Five Mile Creek waters are treatable to EPA drinking water standards using either conventional or microfiltration technology. Should these water bodies be selected as a source, additional water quality testing will need to be conducted to determine the applicable technologies to apply to any treatment process.

Microfiltration technology is more sensitive to water chemistry than conventional filtration. In particular, iron and manganese concentrations would have to be determined because both are known to foul the filter membranes in concentrations well below one part per million (1ppm).

The DEQ surface water quality information that is known to be available is shown in Tables III - 7 and III-8 (Pgs. III-30-31).

Table III-7

Wyoming Department of Environmental Quality, Water Quality Division
Monitoring and Assessment Report, Ocean Lake – WYGH100800005
Page 17 – Table 1 Physicochemical results and Trophic State Index scores for Ocean Lake. July 2003.
Fremont County

	Ocean Lake Pelagic	Ocean Lake Pelagic	Ocean Lake - Mills Point	Ocean Lake - Drain 6 Littoral
Date	7/15/2003	7/15/2003	7/15/2003	7/15/2003
Sample Depth (m)	1	5.5	1	1
Time	0840	0840	0950	1357
Temperature (Celsius)	21.8	20.9	21.8	21.9
pH	8.5	8.4	8.5	8.5
Conductivity (uS/cm)	1414	1391	1414	1416
Dissolved Oxygen (mg/L)	6.6	5.5	6.6	6.9
TSS (mg/L)	5	18	5	5
Alkalinity (mg/L as CaCO3)	210	230	210	230
Nitrate (mg/L as N)	<0.1	<0.1	<0.1	<0.1
Total Phosphorus (mg/L)	<0.1	<0.1	<0.1	<0.1
Total Ammonia (mg/L)	<0.1	<0.1	<0.1	<0.1
Secchi Disk (ft)	2	NA	1.7	3.1
Chlorophyll a (mg/m^3)	4.1	NA	3.5	2.4
TSI for Secchi Disk	67.4	NA	69.4	60.9
TSI for Chlorophyll a	44.4	NA	42.9	39.2
*TSI for Total Phosphorous	62.3	NA	62.3	62.3
Sheen	None	None	None	None
Color	None	None	Green	Brown/Green
Odor	None	None	None	None
NA = Not applicable				
*Total phosphorous value set at the detection limit of 0.1 mg/L				

Table III-8
Wyoming Department of Environmental Quality
Water Quality Division
Five Mile Data

StationID	ChemSampID	WaterbodyName	CollDate	CollTime	ChemParameter	ChemValue	ChemNumeric	ChemUnits	BelowDet
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	ALK	200	0	mg/l	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	CHLORIDES	20	0	mg/l	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	COLOR	brown	0	None	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	SpecificConductance	1950	0	µmho/cm	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	Flow	15.36	0	cfs	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	HARDNESS	691	0	mg/l	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	NO2NO3N	1.82	0	mg/l	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	ODOR	anaerobic	0	None	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	Oilsheen	none	0	None	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	OXYGEN	8.01	0	mg/l	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	pH	8.29	0	SU	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	SULFATES	885	0	mg/l	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	temp	17.9	0	deg C	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	Tphos	0.1	0	mg/l	1
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	TSS	11	0	mg/l	0
WB158	1527	Fivemile Creek - S7T3R3	27-Aug-01	00-Jan-00	TURBIDITY	5.24	0	NTU	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	ALK	180	0	mg/l	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	CHLORIDES	58	0	mg/l	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	COLOR	slight brown	0	None	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	SpecificConductance	3200	0	µmho/cm	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	Flow	0.71	0	cfs	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	HARDNESS	1582	0	mg/l	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	NO2NO3N	0.1	0	mg/l	1
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	ODOR	anaerobic	0	None	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	Oilsheen	none	0	None	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	OXYGEN	8.29	0	mg/l	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	pH	8.13	0	SU	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	SULFATES	1993	0	mg/l	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	temp	25.1	0	deg C	0
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	Tphos	0.1	0	mg/l	1
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	TSS	2	0	mg/l	1
WB159	1528	Fivemile Creek - Wyoming Canal Crossing	27-Aug-01	00-Jan-00	TURBIDITY	0.83	0	NTU	0

With treatment, either Ocean Lake or Five Mile Creek could serve as a source to provide drinking water to the Town of Pavillion and the surrounding rural area. Current treatment technologies will meet requirements to produce drinking water meeting EPA standards. The primary obstacle to using surface water as a source is the cost of treatment. That issue is addressed in Chapter VI. To a lesser extent, the second obstacle to using surface water is obtaining a water right. That is addressed in the next section.

4. Water Rights Considerations

Any use of surface water for this project will require filing a water right for the proposed system. In that filing, the treatment plant (point of diversion), the piping system, and the individual users (point of use) would have to be identified in a water right filing with the WSEO. Under Wyoming law, any new water right filing would be assigned an adjudication date as of the date of filing. It would be junior to all earlier filings and the last on the river to have rights to the water. In years of low runoff, the water right could be "called out" meaning the system would not be allowed to use the water on which it had filed for a water right.

Under Wyoming law, human consumption is the highest priority use. Because of this, it is highly unlikely that the State Engineer's Office would "call out" a drinking water supply.

If new wells were to be used as a supply for a separate system, water rights would have to be filed on those wells. We assume that a single well, or at the most two, would be sufficient for the system's supply. The adjudicated priority for the well(s) would be as of the date of filing. Unlike surface water, there would be no potential that the State Engineer would order a session of use of the adjudicated well water.

For either a surface water or groundwater source, a water right must be filed with the WSEO. The filing process will take approximately six months to complete for a water right on a well. For a surface water permit, the process will require up to a year to complete and requires significant engineering effort and expense to compile the filing documents for submittal and following the adjudication to completion.

CHAPTER III REFERENCES

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CHAPTER IV

EVALUATION OF THE TOWN OF PAVILLION'S PRESENT WATER SYSTEM AND ITS SUPPLY

Introduction

The Town of Pavillion water system is owned and operated by the Town. The system currently serves the incorporated Town limits, including the Wind River High School, Wind River Elementary School, and Rodeo Grounds. The system has nearly 130 billed accounts spread out over approximately 32 blocks. The existing system is bounded by Euclid Avenue on the north, Washington Avenue on the south, Wyoming Highway 133 on the west, and South Plum on the east, including a loop encircling the Wind River High School. The water system consists of approximately 25,000 feet of transmission and distribution line, eight supply wells, and three storage tanks. These system components are discussed in more detail below. The system map shown in Figure IV-1 on the next page provides a visual reference.

1. Water Supply

A. Facilities

The Town of Pavillion has completed eight municipal water supply wells since 1950. In a 1984 report prepared by M-M (M-M, 1984), the Town had completed five wells. By then, Well No. 1 had caved in twice and had been rehabilitated, Well No. 3 had caved in and has been abandoned, Well No. 5 was abandoned due to unacceptable water quality before it was ever used, and Well No. 2 was failing. Well No. 2 remains intact today, 2011, but due to minimal production, is no longer used. The new wells, recommended by the mid-1980s report, were completed in 1986 and 1987 (Well Nos. 6 and 7). The final well, No. 8, was added in 1995. The five Pavillion wells that are currently active are Nos. 1, 4, 6, 7, and 8.

The next paragraphs provide a well-by-well summary of the Town's wells that are in use. Figure IV-2 shows the location of these wells. The early wells were originally completed open-hole, i.e. no casing, through the water-producing portion of the aquifer. Caving problems led to the rehabilitation of these wells by installing liners through these open-hole sections. The more recent completions – well screens with gravel packs to stabilize the formation – appear to have worked acceptably. No specific deficiencies have been identified with this new well construction. Following, is a summary of each of the Town's wells that are currently in use. A summary of the production capacity of each of well is provided and the end of the next section titled Water Level Data.

Well No. 1, formally titled Town of Pavillion #1 (Permit No. P1111W), was constructed in 1949. It is located in the SE quarter of the SW quarter of Section 7, and was drilled to a depth of 495 feet. The wellhead and meter are located in the well house adjacent to the Stand Pipe Tank.

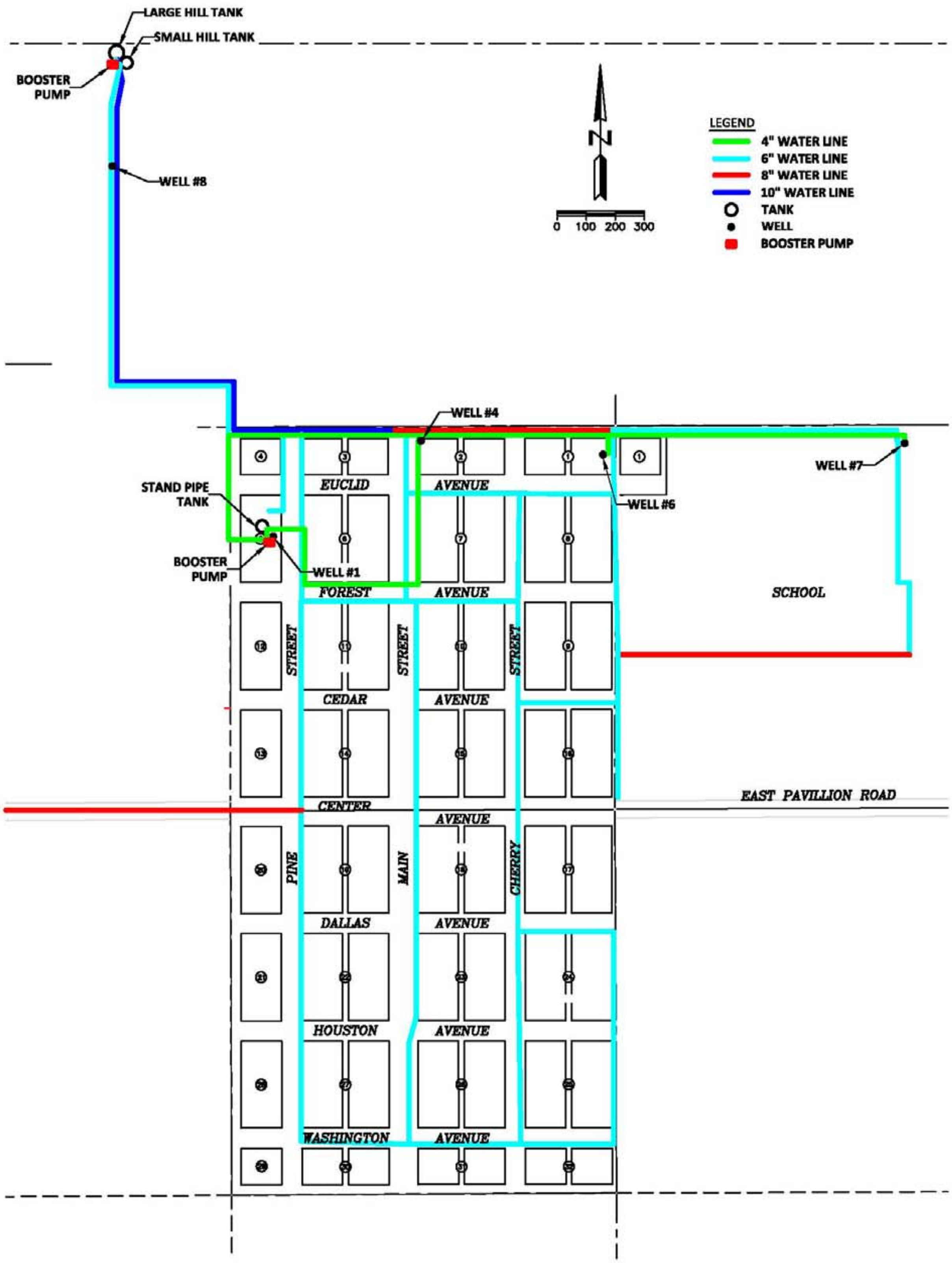

Figure IV-1: Town of Pavillion – System Map

This well is plumbed to the Stand Pipe Tank. It is permitted for a pumping rate of 40 gallons per minute (gpm). The well is situated in a well pit. This type of installation no longer meets Wyoming DEQ standards. This deficiency has been cited by DEQ.

Well No. 4, titled NM #4 (Permit No. P59104W), was drilled in 1982 to a depth of 510 feet. It is located in the SE quarter of the SW quarter of Section 7. The wellhead is located inside of a fenced area containing the pump house, meter, and control panel shown in the figure below. Along with Well No. 1, this well is plumbed to the pump house at Well No. 1 and also feeds the Stand Pipe Tank. The Stand Pipe Tank pump house will be discussed in more depth later in this chapter. This well is screened and gravel packed from a depth of 345 feet to 510 feet.

FIGURE IV-2: Well No. 4 and Pump House

Well No. 6, formally titled Pavillion #6 (Permit No. P70972W), was constructed in 1986. It is located in the SE quarter of the SW quarter of Section 7 and was drilled to a depth of 506 feet. The wellhead is located in a fenced area along with the pump house, meter, chlorinator, and control panel, shown in Figure IV-2. It is screened from a depth of 477 feet to 483 feet and 493 feet to 498 feet. This well was permitted for a flowrate of 25 gpm.

FIGURE IV-3: Well No. 6 and Pump House

Well No. 7, formally titled Pavillion #7 (Permit No. P76991W), was drilled in 1988 to a depth of 515 feet. It is located in the SW quarter of the SE quarter of Section 7. The well head is located in a fenced area along with the pump house, meter, chlorinator, and control panel. A sand screen was installed from 472 feet to 477 feet and 505 feet to 510 feet. It is permitted for a flowrate of 25 gpm.

The final in-service well is No. 8, officially titled Well #8 (Permit No. P98757W). This well was drilled to a depth of 517 feet in 1995. It is located in the NW quarter of the SW quarter of Section 7. The wellhead is located in a fenced area along with the pump house, meter, chlorinator, and control panel. At the time of the site visit in February, 2011, the security fence had been severely damaged due to a fallen tree branch. Screens were installed from 300 feet to 305 feet and 500 feet to 505 feet. The pump house for this well and the damaged security fence can be seen in Figure IV-4 below.

FIGURE IV-4: Well No. 8 Pump House and Damaged Security Fence

Even though the wells have individual chlorinators, the water is currently only dosed at the booster station between the small hill tank and the large hill tank. The wells are currently valved off so that they directly feed the tanks and not the distribution system. If direct feed of the distribution systems is required, then the individual chlorinators can be turned on.

B. Production Operations

The Town of Pavillion municipal wells are operated in two groups: Well Nos. 1 and 4; and Well Nos. 6, 7, and 8. Each group, normally, is turned on and off together in response to water levels in the main storage tank on the north side of the Town. Well Nos. 1 and 4 pump water into a small stand pipe storage tank at Well No. 1. From there a booster pump transfers water on up to the main storage tank. Wells Nos. 6, 7, and 8 pump water directly into the main storage tank.
Review of 2005-2010 monthly production data demonstrates that the peak month is typically June or August, averaging 26,000 gallons per day (gpd). The lowest monthly water production has most commonly occurred in February, but has also occurred in October and April, averaging 17,000 gpd, which equates to a peak to low month ratio of 1.4 to 1.

Although well production meters are read daily (Monday-Friday), the data suggests inconsistent times of day with respect to identifying discrete 24-hour maximum production. A historical maximum day production of approximately 40,000 gpd is suggested by the available data.

Comparison of production data for individual wells for peak months demonstrates that, generally, the well groups come on together, as described above. Variations likely reflect periods when one or another of the wells within each group is temporarily out of service. During peak pumping, the well-by-well allocation of pumping and average hours/day of pumping, based on the discharge rates measured February 18, 2011, have been approximately:

Well No. 1	29 gpm	29% of total	6 hr/day
Well No. 4	17 gpm	18% of total	6.4 hr/day
Well No. 6	29 gpm	15% of total	3 hr/day
Well No. 7	27 gpm	12% of total	2.7 hr/day
Well No. 8	52gpm	26% of total	3 hr/day

There are no water-level measuring devices in any of the Town wells. Mr. Larry Zoller, the Town operator, reports that each well is equipped with a low-level probe which signals the well pump to turn off if the pumping water level in the well approaches the depth of the pump. For example, file records for Well No. 6 list a pump setting of 475 ft. and a "bottom probe" at 474 ft. Mr. Zoller said that the wells are not equipped with a probe set above the low-level sensor to signal recovery of the well and a resumption of pumping.

M-M (1984) found the pumps originally installed in Well Nos. 1 and 4 were over-sized, initially pumping 67 and 49 gpm, respectively, and drawing the pumping water levels down to the pump intakes. Mr. Zoller reports that these original pumps were 10 horsepower, and were subsequently replaced with 5 horsepower pumps to reduce sediment production. At the current, lower pumping rates of 29 gpm and 17 gpm, respectively, he has seen no indication of the low level thresholds having been reached in any of the wells under routine operations. This issue was specifically addressed in association with the February 18, 2011 measurements for this report. Mr. Zoller reported that Well No. 1 ran continuously for 3 days without drawing down to the low-level cutoff. This is consistent with the yields and aquifer properties assessed by the present report, which indicates that none of the wells are stressed sufficiently to be in danger of excessive drawdown.

C. Stratigraphy

All of the Town wells are completed in the Wind River Formation. As discussed above Chapter III this formation includes multiple water-bearing zones, with varying hydraulic and water-quality characteristics.

Figure III-9, in Chapter III, presents a schematic cross-section suggesting one interpretation of subsurface conditions that is consistent with available data. In a formation of this complexity, exact relationships cannot be known with certainty without considerably more-detailed data than are presently available. As indicated on the cross-section, strata dip gently eastward at this location. Thus, the same strata will be encountered somewhat shallower at Well No. 8, the westernmost well, than at Well No. 7, the easternmost well.

The wells are interpreted to be producing from three generalized water-bearing zones, each of which likely consists of multiple, more-or-less, continuous, individual water-bearing strata:

1. An upper zone, around 300 feet deep, with static water levels less than 100 feet, and relatively poor water quality (Total Dissolved Solids (TDS) > 700 mg/L). These strata provide water to Well Nos. 1 and 8.

2. An intermediate zone, relatively productive, around 500 feet deep, with static water levels around 200 feet, and relatively good water quality (TDS < 700 mg/L). These strata provide water to Well Nos. 3, 4, and 6.
3. Deeper zones, of undetermined productivity and static water level, with very poor water quality (TDS > 3000 mg/L). These strata were penetrated by the aborted Well No. 5.

D. Water Level Data

As listed in Table IV-2, the static water levels reported for the various Town of Pavillion wells vary widely, both between wells and between measurements for a single well. M-M (1984) reports "the Town's observations" of fluctuations "up to 150 ft.", the highest levels coinciding with summer irrigation recharge. While an ultimate connection to irrigation system recharge is not unreasonable, the sporadic data available do not suggest any consistent seasonal pattern.

Given the depth of these wells and the inter-bedding of shales and sandstones in the formation, a strongly attenuated response between recharge and water levels is expected, and the range of reported "static" water levels from a single well is surprising. Some of this is due to water levels being measured during periods of recovery from pumping, but the range is still large.

Similar to the reported water levels, the gross chemistry, shown in Table IV-1, identifies substantial differences between wells. For example, the February 2011 conductivity measurements found a twofold difference between Well No. 6 and Well No. 7.

Within the framework of a package of generally more productive strata between 300 and 500 feet, the substantial water level differences between wells support the conclusion that the aquifer is composed of multiple water-bearing zones of limited vertical and horizontal extent, each with its own hydraulic and water quality characteristics.

Based on the driller's logs, M-M (1985) identified the main producing zones in Well Nos. 1 and 4 as 476 - 484 feet and 480 - 500 feet, respectively. Although their 1984 report stated that water level "interference is most evident between wells number four and one", their 1985 testing concluded that the producing intervals in Well Nos. 1 and 4 are "not connected hydraulically", indicating that neither well is "affected by pumping" of the other. This is consistent with the 150 foot difference in static water levels reported on the original Statements of Completion for the wells (150 ft. vs. 300 ft.), and the 124 foot difference measured for the present report in February 2011 (93 ft. vs. 217 ft.). M-M (1985) explained the lack of connection as a reflection of the lateral discontinuity of local sandstone beds. Their 1985 pumping of Well No. 4 resulted in 24 feet of drawdown in Well No. 2, located 568 feet southeast, demonstrating a degree of hydraulic connection in that direction.

The only synoptic measurement of water levels is that of February 2011, made for the present study. At the time, these wells had not been pumped for most of a day. February is not a high-use time of year. When those water levels were measured, water levels were not rising at a rate perceptible over the few minutes of monitoring. On that day, all wells were in routine use and were almost certainly in the process of recovering. Thus, even these water levels are a reflection of the use history, hydraulic response, and background “static” water levels for the various strata producing water to each well.

TABLE IV-1

Pavillion Wells Groundwater Chemistry

Constituent					Well #5 (abandoned)			Well #6		Well #7				
	Well #1	Well #2	Well #3	Well #4	Upper	Lower	SOC	PGDW07	PGPW01	PGDW08	PGPW02	Well #8	EPA Drinking Water Standards	
Sample Date			03/23/77	03/22/82	07/19/83	02/17/83	1985	2009	2010	2009	2010	12/18/95	Primary	Secondary
MAJOR IONS (mg/L)														
Alkalinity, Total as CaCO3								60.6	74.7	82.9	82.8	124		
Calcium								8.85	5.7	36.7	34.4	11.1		
Chloride								15.7	15.3	8.9	8.5	87		250
Fluoride								1.2	1.2	0.5	0.5		4	2
Magnesium									ND		ND	<1.0		
Nitrogen, Nitrate+Nitrite as N			0.3	0	0	0						<0.1	10	
Nitrogen, Nitrate as N								<0.5	<0.3	<0.5	<0.3			
Nitrogen, Nitrite as N								<0.5	<0.3	<0.5	<0.3		1	
Potassium									ND		ND	<1.0		
Silica														
Sodium			190	210	1100	970		213	173	390	393	255		
Sulfate			**400**	**460**	2100	2200		**390**	**300**	**857**	**847**	**439**		**250**
PHYSICAL PROPERTIES														
Conductivity (umhos/cm)												1261		
Hardness as CaCo3 (mg/L)			31	69	540	570								
pH (s.u.)												**8.62**		**6.5 - 8.5**
Total Dissolved Solids (mg/L)			**680**	**644**	3430	3550	576		495		**1283**	**813**		**500**
METALS - TOTAL (mg/L)														
Aluminum									ND		ND			
Antimony									ND		ND		0.006	
Arsenic									0.00031		0.00024		0.01	
Barium									0.0041		0.0076		2	
Beryllium									ND		ND		0.004	
Boron														
Cadmium									ND		ND		0.005	
Chromium									ND		ND		0.1	
Cobalt									ND		ND			
Copper								0.0045	ND	0.0079	ND		1.3	1
Cyanide														
Iron									0.112	0.283	0.255	**0.44**		**0.3**
Lead									ND		ND		0.015	
Manganese								0.0056	0.0071	0.0104	0.0096			0.05
Mercury									ND		ND		0.002	
Nickel									0.00022		0.0004			
Selenium									ND		ND		0.05	
Silver									ND		ND			0.1
Thallium									ND		ND		0.002	
Uranium, Natural													0.03	
Vanadium									ND		ND			
Zinc									ND		ND			5
SEMI-VOLATILES (mg/L)														
Bis(2-ethylhexyl)phthalate									0.002		0.002			
Butylbenzylphthalate									0.00023		0.00023			
Caprolactam									0.00029		0.0038			
TEH, DRO														
TPH as Diesel (DRO)											0.0231			
BACTERIOLOGICAL														
Bacteria, Heterotrophic (MPN/ml)														
Bacteria, Iron Related									Absent		Absent			
Bacteria, Approx. Iron Related Bacteria Population (CFU/ml)									Not Aggressive		Not Aggressive			
Bacteria, Sulfate Reducing									Absent		Absent			
Bacteria, Approx. Sulfate Reducing Bacteria Population (CFU/ml)									0		0			
RADIONUCLIDES (pCi/L)														
Gross Alpha													15	
Radium 228														

E. Aquifer Testing

No well-designed, executed, and documented pump tests of any of the Town of Pavillion wells have been located. Production characteristics reported upon completion are minimal. The tests conducted by consultants in 1984 and 1985 were conducted at changing discharge rates and super-imposed on recovering water levels.

For the present report, cursory measurements were taken at Well Nos. 1, 4, 6, 7, and 8 to provide synoptic water levels, confirm initial pump output, and measure short-term drawdown response. The following analysis is based on all available data, but reflects only reconnaissance-level conclusions aimed at assessing the gross adequacy of the Town system to support limited additional use.

Well No. 1 was tested briefly (42 minutes) by M-M (1984) in 1984. They allowed the well to draw down to the pump setting of 491 feet then measured a "stable" discharge of 24.9 gpm. Subtraction of the pre-test water level (201 ft.) indicates a drawdown of 290 feet. Application of the Theis equation, using the well diameter of 8 inches, a pumping time of 10 hours to overcome the impact of the initially higher pumping rates, and a generic, confined aquifer storage coefficient of 0.001, suggests an aquifer transmissivity on-the-order-of 100 gpd/ft. Water levels in Well No. 1 were observed during the 1985 test pumping of Well No. 4, but, as noted above, no drawdown was observed.

Well No. 2 is currently out of service, but was used as an observation well by M-M (1985) in their testing of Well No. 4. This well was not tested by M-M in 1984 due to very limited production. A rate of 12 gpm quickly drew the pumping water level down to the pump setting, requiring an extended recovery period before re-starting. M-M (1985) states that "the transmissivity calculated for Well No. 4 is about 2.3 times greater than the transmissivity calculated for well No. 2", but gives no values for either well. Applying the stated ratio to their 1985 test data for Well No. 4, shown below, suggests a transmissivity of approximately 90 gpd/ft for Well No. 2.

Test data for Well No. 3 has not been located.

A brief pump test is reported with the Statement of Completion for Well No. 4. A discharge of 50 gpm produced 175 feet of drawdown over an 8-hour pumping period. These values suggest a transmissivity of 550 gpd/ft, but the statement provides no details on changes in discharge rate over the course of pumping or on the progression of drawdown with time.

Well No. 4, tested by M-M in 1985, pumped for 23.17 hours at rates declining from 46.5 to 19.5 gpm. Combined with a total drawdown of 140.94 feet, a well diameter of 8 inches, and an assumed "confined" storage coefficient of 0.001, an effective transmissivity of approximately 200 gpd/ft is suggested. This well was not tested for the present report due to a dangerous short in the electrical system.

Well No. 5 was abandoned shortly after completion due to very high sodium and TDS concentrations. No water-level or test data are available.

Well No. 6 was tested briefly on February 18, 2011 for the present report. From a static water level of 201.8 feet, the well drew down to a pumping water level of 284.57 feet, drawdown of 83 ft., in 41 minutes of pumping at 29 gpm. A semi-log ("Jacob") plot of the time:drawdown data indicates a transmissivity of approximately 430 gpd/ft. The specific capacity for this short test was 0.35 gpm/ft.

M-M (1987) tested Well No. 7 upon its completion in 1987 for 25 hours (1500 minutes) at discharge rates declining from 29.5 to 16.2 gpm. They concluded that the long-term effective aquifer transmissivity is approximately 300 gpd/ft, and concluded a specific capacity of 0.12 gpm/ft was representative, but concluded this test was complicated by the differing hydraulic properties of the different aquifer zones penetrated by the well. M-M (1987) provides no details, but describes their interpretation of a transmissivity of 305 gpd/ft for Well No. 7 as being "in excellent agreement with the values calculated from Well No. 6 and other wells in the lower aquifer during previous tests."

Well No. 7 was briefly tested again on February 18, 2011 for the present report. From a static water level of 170.21 feet, the well drew down to a pumping water level of 348.28 feet (drawdown = 178 ft.) in 90 minutes of pumping at 27 gpm. A semi-log ("Jacob") plot of the time:drawdown data indicate a transmissivity of approximately 220 gpd/ft. The specific capacity for this short test was 0.15 gpm/ft.

Well No. 8 was tested briefly on February 18, 2011 for the present report. From a static water level of 28.94 feet, the well drew down to a pumping water level of 139.3 feet (drawdown = 62.5 ft.) in 42 minutes of pumping, declining from 54 to 51 gpm. A semi-log ("Jacob") plot of the time:drawdown data indicate a near-well transmissivity of approximately 250 gpd/ft, and a long-term effective transmissivity of 1100 gpd/ft. The specific capacity for this short test was 0.46 gpm/ft.

None of these well tests produced data sufficient to estimate aquifer storage characteristics. Given the reported lithologies, the aquifer is obviously confined in the short run, meaning that storage coefficients on the order of 0.0001 to 0.001 likely apply. Over an extended period, adjacent strata probably begin to contribute significant water and the aquifer responds in a less confined manner.

F. Capacity

The instantaneous installed pumping capacity of the currently operating Pavillion wells is approximately 140 gpm. This is the sum of the lower values, after the pump has been running for some time, listed in Table IV-2.

At the transmissivities discussed above, and assuming a generic aquifer storage coefficient of 0.001, the theoretical 7-day pumping rates that could be sustained by the aquifer without drawing pumping water levels down to the highest screens/perforations/slots are as follows:

TABLE IV-2: Well Capacity and Depth

Well Number	Installed Pump Capacity (gpm)	Aquifer Capacity (gpm)	Static Water Level (Ft.)	Total Depth (Ft.)
1	25	17	201	500
4	17	17	300	510
6	27	61	165	506
7	16	9	269	472
8	52	115	22	512
Total	137	219		

Based on the aquifer capacity as determined through the production tests it is evident that the Town of Pavillion's wells have a collective capacity to meet potable water demands for the Town itself plus the projected demand of the approximately 20 rural homes having undesirable drinking water.

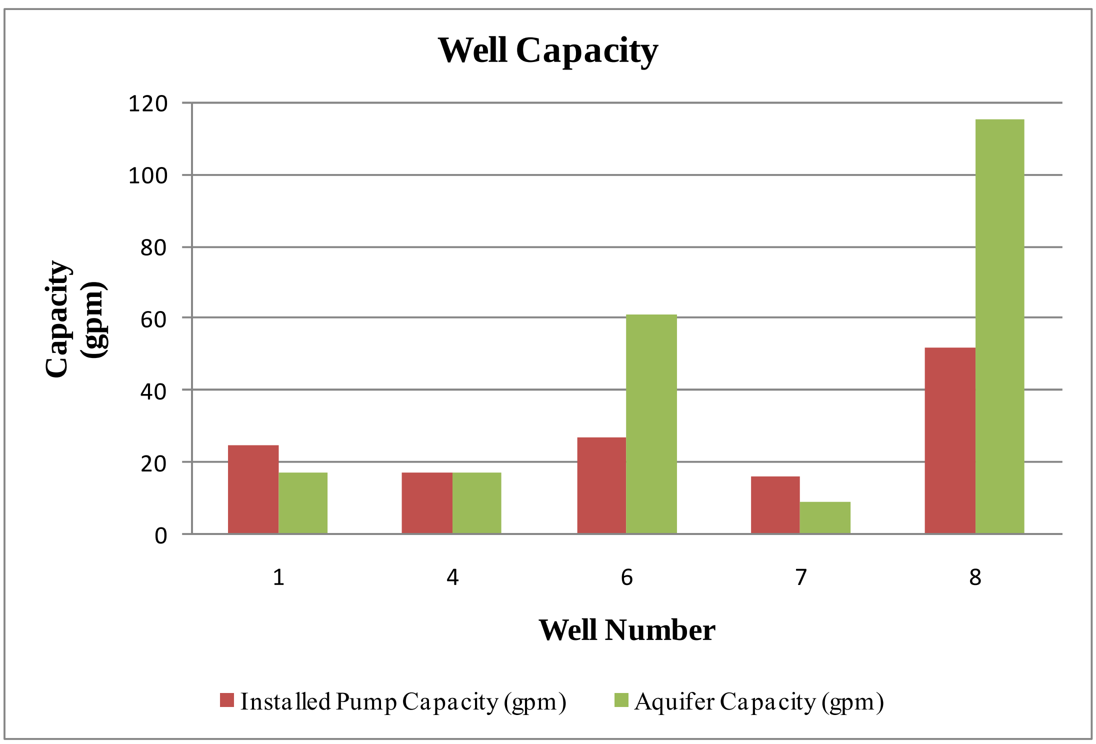

FIGURE IV-5: Well Capacity

In most of these wells (Nos. 1, 4, 7, and 8), the pumps are set below the top of the screened or slotted interval. In Well Nos. 1 and 7, for example, the "aquifer capacity" production rate is less than the installed pump capacity, indicating that the installed pump likely draws water into the open interval of the well during sustained pumping periods. For low-capacity wells like these, the deeper pump settings provide a margin for error in the extrapolation of drawdown from test measurements to situations of sustained pumping, seasonal changes in "static" water level, and inter-well interference.

Review of the hours-of-operation matrix presented above indicates substantial opportunity for increasing the length and frequency of pumping cycles. Even during the peak months used to generate the matrix, wellfield output could be doubled, still leaving a substantial margin for out-of-service periods. A 13.5 gpm increase in daily production could be achieved by bringing Well Nos. 6, 7 and 8 up to the six hours per day use rates presently occurring at Well Nos. 1 and 4 during peak use periods. This adjustment could, in approximately eight hours per day, supply the 6800 gallons per day increase in output from the Town of Pavillion wellfield projected to be necessary to meet the year 2040 demand of a rural water system.

Table IV-1 also suggests room for refining the operation of the Pavillion wellfield to optimize water-quality. For example, preferential pumping of Well No. 6 would minimize the sodium level of the delivered water, although it would still be well above the EPA guidance level for those on restricted-sodium diets. Preferential pumping of Well No. 8 would reduce energy costs by lifting water from the well with the shallowest pumping water level.

G. Water Quality

Table IV-1 presents the available water chemistry for the Town of Pavillion municipal water supply. In Appendix 1 gives test results for a variety of locations across Pavillion's system. Because most samples have been taken under the US EPA compliance program for Public Water Supplies, they are composites of various wells, to reflect the general quality of delivered water. Comparison with the cursory quality data demonstrates the variability likely to result from composite samples taken at different points, when different wells are operating to fill storage tanks.

Because most sampling has been done of the composite system, data for individual Town wells is sparse. Limited analyses were commonly done in association with initial well construction, the recent EPA research provided detailed analyses for Wells No. 6 and No. 7, and select water quality data have been collected for the present report. No discrete water quality data for Wells No. 1 and No. 2 has been located.

The only constituents in Table IV-1 above EPA primary or secondary drinking water standards, shown bolded in the table, for any of the Town of Pavillion wells are sulfate (> 250 mg/L), total dissolved solids (TDS; > 500 mg/L), pH (> 6.5-8.5 s.u.), and iron (> 0.3 mg/L). All four of these constituents are subject only to "secondary" standards. Secondary standards are non-enforceable guidelines regulating contaminants in drinking water that may cause cosmetic effects such as skin or tooth discoloration or aesthetic effects, including color, odor, taste, or fixture staining.

TDS values are greater than the secondary standard in all wells tested, except Well No. 6, which currently measured 495 mg/L, just under the secondary standard of 500 mg/L. The water chemical analysis attached to the Statement of Completion for Well No. 6 shows a TDS value of 576 mg/L in 1986. Sulfate levels greater than the secondary standard of 250 mg/L are present in all wells tested. Well No. 5 was never used due to its unacceptable level of mineralization. The Well No. 7 TDS value of 1,283 mg/L was not measured, but is an approximation based on summing the concentrations of sulfate, fluoride, chloride, calcium, manganese, and sodium.

Well No. 8, at the time of its completion in 1995, had a reported iron level above the secondary standard of 0.3 mg/L, but was substantially below the standard in February 2011. The EPA 2009 and 2010 samples from Well No. 7 were close to the iron standard, but Well No. 6 produced a "non-detect". The blended-water iron concentration for the Pavillion system has not been measured.

Composite samples are taken from various points within the Town of Pavillion water storage and delivery system. Thus, they reflect composites of the five active wells in unknown proportions.

Testing for inorganic compounds/metals such as arsenic, cyanide, fluoride, nitrates, sodium, and sulfate has found mostly "non-detects", and that all constituents sampled, with the exception of sulfate, have been below the primary or secondary drinking water standards. Although not measured, TDS concentrations almost certainly follow suit.

These limited data suggest no large changes in water quality over the last two decades; testing for 11 constituents goes back to 1988.

Available sulfate concentrations reported in the Town wells range from 300 mg/L in Well No. 6 (EPA, 2010), to 857 mg/L in Well No. 7 (EPA, 2009), excluding Well No. 5 sulfate levels. Sulfate was reported to be 453 mg/L at the Town Hall on May 10, 1999 but only 280 mg/L at 216 North Pine Street on January 27, 2011. Whether sulfate levels have actually decreased over the last decade or Well No. 6 was being pumped at a greater rate than the other wells on January 27, 2011 is unclear. Monthly well production data from 2005 to 2008 and 2010 indicate no such time when Well No. 6 was pumped nearly exclusively. In fact, on average, Well No. 6 pumps only about 14 percent of the monthly total pumped. There is no production data from January 2011, but it seems unusual that the sulfate level on Pine Street was lower than any level ever measured in any of the Town wells.

Reported sodium levels have varied from 220 to 300 mg/L over the 1988 to 2011 period for which data are available. The variations suggest no trend, but likely reflect various mixtures of the five active supply wells. Although EPA does not regulate sodium levels in drinking water, these levels are relatively high. EPA has promulgated a Drinking Water Equivalent Level (DWEL) of 20 mg/L, "a non-enforceable guidance level considered protective against non-carcinogenic adverse health effects and is based on an American Heart Association recommendation issued in 1965". "The 20 mg/L value was developed for those individuals restricted to a total sodium intake of 500 mg/day and should not be extrapolated to the entire population (EPA, 2003)".

The Town has also tested the composite system for nitrates, copper, lead, and gross alpha, with the results being mostly "non-detect". The nitrates (nitrate + nitrite) are almost all "non-detects"

(< 0.1 mg/L) with the latest sample on September 10, 2009 being tested at a lower reporting limit, resulting in a concentration of 0.01 mg/L. Reported nitrate concentrations show no determinable change in the last decade. The primary drinking water standard for nitrate is 10 mg/L.

Copper and lead testing, mostly to monitor possible contamination from the distribution system, has occurred at five different locations around the Town. The first reporting period was August 5, 1996 and the last was July 31, 2008. All concentrations were well below the primary standard set by EPA, 1.3 mg/L for copper and 0.015 mg/L for lead, with many "non-detects". These too have shown no discernable change in concentration over the 13-year period reviewed.

Testing for gross alpha has been conducted seven times since 1994, four of which were 1998, with the latest test performed in 2003. Samples were taken from the distribution system. All results show "non-detect" (< 1.0 pCi/l) except that from 2003 at Booster Station No. 2, which resulted in 1.7 pCi/l. The EPA primary standard for gross alpha is 15 pCi/l. In 2003, the Town also tested for Radium 228; the result was a "non-detect" (< 1.0 pCi/l). The primary standard for Ra-228 is 5 pCi/l.

Bacteriological test results show the absence of iron-related and sulfate-reducing bacteria in the Town wells.

Routine sampling for organic compounds regulated by EPA under the Public Water Supply program has found only rare occurrences at or above detection limits. Review of the available Town files finds four analyses over the 1999 to 2010 period, for 62 volatile and 50 semi-volatile organic compounds from samples taken from the water system rather than an individual well. For some of these, EPA has established an allowable maximum contaminant level (MCL); for others, no MCL has been established. For all samples, for all constituents, the concentrations have been less than the detection limit, with the exception of one analysis for chloroform on January 19, 2000, one analysis for chloromethane on May 13, 2005, and one analysis for total trihalomethanes on May 10, 2010. The detailed analyses of samples from Well Nos. 6 and 7 by EPA in 2010 found "non-detect" for chloroform and chloromethane. They did not sample for trihalomethanes, which is typically a drinking-water system disinfection by-product. There is no MCL for chloroform or chloromethane; the MCL for trihalomethanes is 0.080 mg/L. The one detect found 0.0006 mg/L.

In association with their study of potential oil and gas well contamination in the Pavillion area, the 2010 EPA study tested Town Wells No. 6 and No. 7 for many semi-volatile compounds and petroleum hydrocarbons. In both wells, detectable levels of butylbenzylphthalate and caprolactam (semi-volatiles) were measured. There is no established MCL for either of these constituents. EPA (2009) states that caprolactam is "found in the electronics and piping of groundwater wells and [is] likely non-significant."

In the EPA (2010) study, butylbenzylphthalate is listed as having a Reference Dose Screening Concentration (RDSC) of 7.3 mg/L, under the heading of Superfund Chemical Data Matrix. The detected level was well below the concentration limits. The identical concentration of butylbenzylphthalate reported for Well Nos. 6 and 7, despite substantial differences in major chemistry and an apparent difference in strata, discussed above, suggests the possibility of either sampling or laboratory error.

Also, in Well No. 7, a detectable level of total petroleum hydrocarbons (TPH) as diesel (diesel range organics, DRO) was measured. There is no established MCL for this constituent.
The EPA (2010) Table 9 shows no standards for TPH as diesel (DRO). The presence of even low levels of organic compounds potentially associated with oil and gas development has been sufficient for EPA to flag potential concern for private wells. The authors of this report spoke to an EPA official about this concern. The EPA official stated that the EPA has not extended these analyses to the Town of Pavillion wells due to: 1) the established lack of changing water-quality, as indicated by years of monitoring under the Public Water Supply program, and 2) the blending of water from five active wells, i.e. reducing the impact of minor impurities in any one well. However, the Town water quality files provide neither individual well, nor water system composite analyses, for any of the three organic compounds found by EPA in Well No. 6 or No. 7. Similarly, no data have been found to indicate that these compounds have been assessed in any of the other Town wells. Although the consistent "non-detects" for the organic compounds that have been measured for the Town of Pavillion system indicate an absence of contamination, there is simply no track record for the three EPA constituents upon which to base conclusions regarding either trends or blending.

In conclusion, the groundwater available through the Town of Pavillion municipal supply system is fully compliant with EPA standards for a Public Water Supply. This water is less than ideal with respect to total dissolved solids (TDS), sodium, and sulfates, but is consistent with groundwaters sampled over a wide surrounding area, as explained in Chapter III.

The "detects" for semi-volatile compounds by EPA are not judged represent a health concern as there are no EPA established MCL's for these compounds and detected levels are very small, near the limits of detectability.

2. Transmission System

The lines that convey water from the Town wells to the storage tanks form the systems transmisson lines. Computer modeling of the system shows these lines to have adeqate capacity. They all are constructed of modern materials and are in sound condition.

Under the current transmission system, Well Nos. 1 and 4 feed the Stand Pipe Tank directly. Well Nos. 6, 7, and 8 feed the Small Hill Tank. The transmission line for Well No. 4 consists of approximately 1,200 feet of 4-inch PVC that ties into the pump house for the stand pipe tank. Well No. 1 also ties into this pump house. The transmission line between the stand ripe tank and the small hill tank is 4-inch PVC for approximately 500 feet and then enlarges to 6-inch PVC for the remaining 1,500 feet. The transmission line from the large hill tank to the distribution system consists of approximately 1,700 feet of 10-inch PVC and 750 feet of 8-inch PVC.

3. Storage System

Pavillion's water storage system consists of the intercionnected tanks. They are:

- Stand pipe tank, the original tall small diamenter tank in Town,
- Small hill tank situated on the hill north of the Town, and
- The large hill tank also located on the hill north of the Town.

The combined capacity of these tanks slightly exceed the Town's current storage demands when compared to industry criteria.

Water transmission and storage for the Town of Pavillion is unnecessarily complex. Storage consists of three water tanks totalling 295,700 gallons. These tanks are on a maintenance schedule to be inspected and cleaned every three years. A description of each tank is given below.

A. Stand Pipe Tank

The stand pipe tank is a welded steel tank with a calculated storage capacity of 27,000 gallons. This is the original water storage tank for Pavillion and is located in the Town. The foundation elevation is 5464.7 feet. The tank stands 49 feet tall, but the overflow elevation is at 5510.7 feet. This tank is approximately 10 feet in diameter, and was last painted in 1995. The stand pipe tank, pump house for Well No. 1 and No. 4, the blue building, and Well No. 1 housing, the green building, can be seen in Figure IV-6.

FIGURE IV-6: Stand Pipe Tank

B. Small Hill Tank

The small hill tank is a 43,700 gallon bolted steel tank constructed in 1982. The foundation elevation is 5507.3 feet. The tank stands 16 feet high, making the overflow elevation 5523.3 feet. It has a diameter of roughly 22 feet. The last cleaning of this tank was in the summer of 2009. The tank is in sound condition.

C. Large Hill Tank

The large hill tank volume is 225,000 gallons. It is bolted steel, constructed in 1995. It is immediately north of the small hill tank. Its foundation is set at an elevation of 5509.0 feet. It is 56 feet tall and has a diameter of approximately 26 feet. The overflow is at an elevation of 5565.0 feet. This tank was last cleaned in the summer of 2009 and can be seen in Figure IV-7 below.

Figure IV-7: Large Hill Tank

As can be seen, the high water elevation of all three tanks differs greatly. Pavillion's entire distribution system is gravity fed from the large hill tank. When the water level in this tank drops to a set elevation, the booster station between the small and the large tank comes on to replenish the large tank storage. If Well Nos. 6, 7, and 8 cannot keep up with the water drop in the small tank, then the booster station at the stand pipe cones on to move water to small tank. In an emergency fire situation, the booster station between the small and the large tanks has a fire booster pump to move water to the large tank. It does not feed to the distribution system.

For a storage system to be considered adequate, sufficient volume must be available to supply the maximum fire flow rate for a duration determined by the Insurance Services Office (ISO) (fire storage) plus the one average daily's consumption (emergency storage) plus the amount of water needed to supply peak usage for a period of four to six hours (equalization storage). For Pavillion, the fire flow volume, as discussed in more detail below, is 180,000 gallons. This amount should be kept in storage under all operating conditions. Well production data from the past seven years average daily usage to be 20,200 gpd. Equalization storage is considered to be 25 percent of maximum day demand. Analyzing the seven years record, maximum day demand was found to be 41,100 gallons. Using the value of 25% of this 41,100 gallons, equalization storage is calculated to be 10,300 gallons. The summation of the fire flow, average daily demand, and equalization storage values indicates gives a required storage volume for the Town of Pavillion is 210,500 gallons. Pavillion's current storage system is more than adequate to supply this volume. **The large hill tank alone can meet the Town's recommended storage volume.**

4. Distribution System

The majority of the existing distribution system was constructed in the 1980's and consists mostly of 6-inch PVC pipe. The south leg of the loop around the Wind River High School and the dead-end line heading west on Center Avenue from Pine Street are both 8-inch PVC. In total the system has approximately 14,200 feet of 6-inch and 2,000 feet of 8-inch. The continuity in the distribution system's pipe size and material simplifies maintenance.

5. Water Modeling

WaterGEMS V8i was used to model the existing Pavillion water system. The ability of the system to deliver required flows and sufficient operating pressures was analyzed to determine the stability of the system and the possibility of its expansion. Modeling of the transmission and distribution system shows that the system has adequate delivery capacity for projected demands.

Favorable improvements in delivery capacity and circulation could be gained by looping the Center Avenue line that dead ends at the fire station on the west side of Town. Fire flow and delivery redundancy could be enhanced by bringing a line from the large tank to the distribution system near well No. 7 just east of the school complex.

A. Fire Protection

The Wind River High School and Wind River Elementary School are the only structures on the existing water system that would require significant fire flow. However, both structures are sprinklered, so Insurance Services Office (ISO) guidelines for fire flow do not apply. Due to the close proximity of houses around the Town, a fire flow of 1500 gpm is required for general protection. According to ISO, this flow rate needs to be available for a two-hour duration, so a fire storage volume of 180,000 gallons is necessary. As previously mentioned, Pavillion currently has the storage capacity to meet this demand. According to the water model, the vast majority of Pavillion has a sufficient fire flow rate per ISO guidelines. The only section of Town not fully protected is along the 8-inch PVC line that dead ends on the west end of Center Avenue. The model indicates that this stretch is capable of delivering only 1,000 to 1,300 gpm.

A fire booster pump is installed at the small tank. It simply increases the pumping rate between the small and large tanks to meet the higher withdrawal rate from the large tank. It does not pump directly to the system to increase flow.

B. Pressure

It is reported that, before the large hill tank was constructed, Pavillion would experience dangerously low water pressures, below 20 psi. The addition of this tank added approximately 23 psi (static) throughout the system. The water model indicates that pressure on the north end of the system is roughly 41 psi and increases up to 54 psi towards the southerly end. Modeling the fire flow demands showed that adequate flow volume was achieved without having the residual pressure drop below the 20 psi residual pressure required by DEQ.

6. System Service Capacity

Overall, the Pavillion water system is in sound, operating condition. The five in-service wells have the capacity to meet current and future demand with acceptable water quality. The transmission system is functional, but is unnecessarily complex. It is recommended that it be simplified. Existing storage is sufficient to deliver present demand and fire protection, while the distribution piping is composed of adequately sized lines meeting current industry standards. The system as a whole is capable of supplying demand and fire flow rates without lowering system pressures to unsafe levels. Finally, static pressure throughout the system is satisfactory if not ideal.

The Pavillion water system, in its current configuration, is capable of supporting anticipated demand of the existing system for the next thirty years as well as additional users. If the system is expanded to serve residential users outside the Town limits, daily demand for the entire system in the year 2040 is calculated to be approximately 38,200 gallons per day, or 27 gpm. As shown previously, well production is sufficient to meet this flow rate. Required storage for the year 2040 is estimated to be 242,000 gallons, which can be sustained by the existing tanks. Without the addition of a future large facility, recommended fire flow rates are not expected to increase. That allows the current line sizes to remain adequate to meet foreseeable water delivery needs.

From a functional standpoint, the small hill tank and its booster station could be removed from the system as well as the standpipe tank. Removing the small tank from the system could further simplify operations. If this were done, chlorination would have to take place at each individual well of at a central chlorination point on the transmission line to the large tank. Keeping the small tank on the system allows that to occur now. The small tank can serve as system storage when the large tank is taken out of service for repainting and repair in the future. As such the smell tank, while not essential to the system storage

7. Pavillion's System Deficiencies

Pavillion's water system is an outgrowth of a series of piecemeal, low budget, independent projects that separately addressed system problems as the evolved over the past 40 years. The transmission and distribution lines are in sound condition and are adequate to meet future needs. The water production controls and the storage system do not function well as a unit and do not permit optimization of water delivery to the Town.

Pavillion's system, while in sound condition, does have deficiencies that need to be addressed. Those are:

1. Well No. 1, constructed in the 1950's, has a well pit construction, common at the time. To meet current standards this pit needs to be eliminated and the well fitted with a modern pitless adapter.
2. The water production system is inordinately complex and unreliable. Separate control systems manage two separate groups of wells, each of which pump to different tanks. All produced water is ultimately moved to the large tank on the hill north of Town. That tank then supplies the entire Town system. Water from Wells No. 1 and 4 is pumped three times to get it to the large hill tank. Water from wells 6, 7, and 8 is pumped twice to get it to the large tank.
3. The stand pipe tank serves no viable purpose other than to store water that is then pumped to the small hill tank. Using only the single large tank, the system can provide adequate storage to meet forecast demand through the year 2040.
4. The control system for the wells and tanks is outdated. It is split between two locations, one portion at the standpipe and the other at the small hill tank. Adjustments have to be made at the locations and trial tested to verify that together they perform as intended after the adjustment. As configured, these controls do not allow the Town to optimize either production or water quality delivered to the Town.
5. The installed well pumps are not sized to match the production capacity of their respective wells. The Town is losing both production capacity and an ability to thoughtfully blend water from the wells to deliver the best quality water to its residents. This results in suboptimum production of water and likely electrical power inefficiency.

Addressing these deficiencies would do much to bring Pavillion's system up to current standards. The improvements would significantly improve and simplify its operation can be made at nominal cost as compared to the risk of failure of one or more of the components on which the entire system is dependant. It would allow optimization of the wells to deliver both the best quality water and increase the amount of water that is deliverable to the Town. The recommended improvements area is discussed in the following section.

8. Recommended System Improvements

Correcting the deficiencies described above can be achieved with minor changes to the Town's water system. Below is the recommended improvements listed in the order of their priority. The estimated cost of each is given in Chapter VI.

1. Convert the Well No. 1 wellhead to a pitless configuration. This would eliminate a deficiency for which the Town has been repetitively written up in DEQ's inspection reports. Filling the well pit, extending the well casing, and installing a pitless adaptor could also eliminate the wellhouse and chlorination system.
2. In conjunction with eliminating the No. 1 well pit it is recommended that both Wells 1 and 4 be piped directly to the small hill tank. This would eliminate pumping water from these two wells a second time to get it to the small tank and would allow all disinfection to be done at the small tank booster station.
3. Rerouting the discharge for wells No. 1 and 4 will require revamping the tank level controls. It is recommended that the current mechanical electrical system be replaced with a current technology SCADA system with its control center to be located at the Town shop. This would significantly improve the Town's ability to manage the system water quality and quantity production, anticipate well maintenance needs, and record and report water production.
4. Install pumps in wells No. 6 and 8 that match the production capacity of their well. This would increase the Town's water production capacity by approximately 100 gpm.
5. Remove the standpipe tank. Once taken out of service the standpipe tank can be removed. This is low priority task as it affects only the aesthetics of the Town.

Cost estimates for these improvements are presented in Chapter VI.

CHAPTER IV REFERENCES

Brough, James. Wyoming Department of Environmental Quality. "WDEQ's Inspection Report Form, Town of Pavillion (PWS #5600039), Water System Inspection", September 21, 2010.

CHAPTER V

IDENTIFICATION OF ALTERNATIVE SOLUTIONS

Introduction – What is Safe Drinking Water?

The objective of this study is to determine the most feasible way to provide drinking water that is compliant with EPA drinking water standards to the rural Pavillion residents. The quality of drinking water is often a matter of the user's personal opinion. In a formal sense, it is determined by regulation. To regulate the safety of drinking water, the EPA sets primary and secondary standards for water-borne contaminants for public water supplies. There are no EPA standards set for private water supplies. For public water supplies, the limits are primary standards, known as Maximum Contaminant Levels (MCL). They are established for those contaminants that represent known health hazards. Some of the MCL's have been established because of acute short-term effects, such as bacteria levels that cause gastrointestinal problems such as diarrhea or cholera. Other MCL's have been established because there are health concerns if a user is exposed to the contaminant over a long-term or a lifetime. Chemicals such as lead and arsenic fall in this category. Public water systems are not permitted to distribute water that contains any contaminants in excess of the primary standards.

Secondary standards are limits established for contaminants that do not represent health hazards, but do cause nuisance cosmetic and aesthetic problems. Water with constituents in excess of the secondary standards is still considered safe for consumption, but it may have tastes, odors, or other issues that people find objectionable, such as the laxative affect of sulfates.

Under EPA's rules, any water that does not contain contaminants above the primary MCL's is safe for public consumption. Of course, not every possible contaminant has had an MCL established. MCL's have not been established for many of the hydrocarbons detected in the Pavillion area water. However, they are generally recognized as being undesirable at any detectable level in drinking water. Studies have determined that exposure to some hydrocarbons can lead to liver and kidney damage, gastrointestinal problems, or nervous system damage, and that prolonged exposure to some hydrocarbons carries cancer risks. Even though EPA has not established safe limits, several other agencies and states are doing research on the subject. These other entities have come up with some useful guidelines. The EPA report, compiled after their initial investigation in the Pavillion area, used several of these other guidelines in coming up with recommendations about the safety of the water.

The EPA categorizes contaminants into six categories: microorganisms, disinfectants, disinfection byproducts, inorganic chemicals, organic chemicals, and radionuclides. Microorganisms are typically associated with surface water and seldom with groundwater from deep wells, as found around Pavillion. Without the presence of microorganisms, there is also no need for disinfectants, though EPA requires that disinfectant (chlorine) be added as a precautionary measure. Because there are no carbon based contaminates in groundwater, there are no disinfectant by-products as those carbon compounds break down. Finally, there are also no reported problems with radionuclide contaminates in the Pavillion area groundwater. For purposes of this study, EPA's standards are simply a point of reference since they do not apply to private supply wells.

1. Supply Alternatives

As discussed in Chapter III, there is no identified opportunity to develop replacement wells in the conceptual service area of rural Pavillion. Throughout all of its developed history, this area has had difficulty obtaining wells having acceptable drinking water. In the course of this study, there has been no information discovered that identifies any reliably palatable groundwater source within the service area. This situation, then, leaves the area residents with three options:

1) Treating the private well water that is locally available,
2) Importing drinking water from another source, such as:
    a. Piping from Pavillion,
    b. A separate well in a location that produces acceptable groundwater quality,
    c. Installing cisterns and hauling water, or
3) Treating and piping surface water from Ocean Lake or another source.

In the balance of this chapter, those alternatives will be discussed.

2. Individual Solutions

The two individual household solutions that were explored are treating the private wells, and installing cisterns and hauling water. It is assumed that hauled water would come from the Town of Pavillion. Both of these alternatives are discussed in the remainder of this chapter.

Individual Treatment of Water Supplies

One of the alternatives for providing clean and safe drinking water to rural Pavillion area residents is to treat their well water to remove the contaminants. This alternative might be attractive to individual homeowners because it allows them to retain personal control of their own water supply.

An adequate treatment system for the water in the private rural Pavillion wells is not easily defined. It is also quite likely that there is not a "one size fits all" system that can be prescribed for all users in the area. Selection of an effective treatment method should begin with a thorough analysis of the water from each individual well. The analysis must completely identify all contaminants produced by the individual well and the concentration of each. It is recommended that the initial results be verified before going to the expense of purchasing and installing expensive treatment systems.

There is no package treatment system that is effective at removing all contaminants. To do a thorough job of contaminant removal, a combination of different methods will have to be assembled into a single system.

A. Rural Pavillion Area Private Well Water Constituents

The contaminants of concern found in the rural Pavillion area fall into two of EPA's categories, organic and inorganic chemicals. The organic chemicals found in the area include methane. Even though it is an organic chemical, it must be removed by a different technique than most other organics. Therefore, for the purposes of defining treatment methods, the contaminants for area wells can be roughly broken into three groups:

- Methane,
- Other organic compounds, and
- Inorganic minerals.

To effectively treat these three groups of contaminants, a combination of four treatment methods is recommended;

- Aeration,
- Granular activated carbon (GAC) filtration,
- Reverse osmosis (RO), and
- Ion-exchange water softening.

The reverse osmosis treatment would remove the inorganic chemicals by itself, but to prolong the membrane life of these units it is more economical to employ a water softener to remove the excess calcium prior to the reverse osmosis process. Some of the water in the area might also need to be run through an additional process to remove iron and/or manganese. Iron and manganese can quickly foul filters at the concentrations found in some of the area wells. The water softener will remove some of these metals, but if the concentrations are too high, a specific treatment process for their removal is needed.

All of the treatment methods have the added benefit of also removing other contaminants that may be present but that are not necessarily found in the majority of area wells. For example, one of the wells tested exceeded the MCL for arsenic. The above listed treatments will remove the arsenic, although they were not specifically selected for that purpose.

B. Pilot Testing

It is common practice to conduct pilot tests of suggested water treatment regimens. A thorough and complete water analysis can identify general treatment methods that might be successfully employed for many of the water contaminants, particularly for the inorganic chemicals. In rural Pavillion's case, there is not much data on the effectiveness of home treatment for the specific hydrocarbon contaminants in the area's private wells. Much of what information exists applies to industrial applications where the final water quality did not have to meet EPA drinking water standards.

Pilot testing of treatment units is recommended for the rural Pavillion area before settling on a treatment process. While pilot testing is a wise practice, it may not yield results that can be applied to all wells. This is because water quality is not consistent from well to well. Also, there are differences between the various equipment manufacturers' treatment methods for the same contaminant. However, it can give very good indications of the success that might be expected from a treatment process.

For example, one of the residents in the Pavillion area has already installed a whole-house reverse osmosis system. EPA has tested that homeowner's water both before and after going through the reverse osmosis system. Significant improvement in water quality is apparent from those tests. However, the EPA's testing did not include tests for some of the specific hydrocarbons common in the area wells.

In the following sections, treatment processes that are applicable to the Pavillion area homes are discussed. These are the removal of:

1. Methane,
2. Water softening,
3. Organic contaminates, and
4. Inorganic minerals.

Methane Removal

Methane can be common in water wells where geologic conditions trap methane, regardless of whether commercial development is present or not. While the EPA sets no MCL for methane, it can be troublesome and even dangerous. The hazard presented by methane is that it is flammable and potentially explosive when mixed with air in concentrations from 5 to 15 percent by volume. Where methane is present, it is common to be able to light it when water is flowing from a tap. Because of its danger potential, it is the first contaminate that should be removed.

Methane dissolves in water within a narrow temperature range. That temperature happens to be the same temperature range of most groundwater. Heating the water above 58 degrees Fahrenheit will cause the methane to come out of solution from the water.

The EPA has established no MCL for methane. It is regarded as non-toxic, but when dissolved in water it can give the water a milky color and impart an unpleasant smell and taste, sometimes described as "swampy." The U.S. Department of the Interior, Office of Surface Mining, has established guidelines for the need to address methane in drinking water. At concentrations of methane above 28 mg/L, it is recommended that the homeowner take action to reduce the concentration. Water with levels below 10 mg/L is generally considered safe. For wells with concentrations between 10 and 28 mg/L, owners may want to consider reducing the methane level. At the least, it is recommended that the intermediate levels be monitored to detect any increases.

Methane begins to be released from the water as soon as it enters the well. It is recommended that the well caps be ventilated because the gas accumulates in any enclosed space, such as well casings or storage tanks. The action of simply pumping the water through the system will cause some of the methane to be released. If methane levels are significant, its removal should be the first treatment step.

To eliminate methane, some people simply allow the water to stand in an unpressured and vented cistern or tank. This method works primarily by allowing the water to warm and is effective if there is enough time for the water to stand. It requires a large amount of storage volume and is not always reliable unless the water temperature reaches 58° F.

Methane cannot be removed from water by filtration or by adding chemicals. Aeration is regarded as the best means of removal. Aeration can be achieved by either spraying the water through the air as a mist or by bubbling air through the water. Spraying the water inside a tank is the simplest and most common aeration method. Because methane is lighter than air it rises to the top of any container. To prevent a possible explosion, the tank must be ventilated to the outside of the building housing the aeration tank. The well pump can deliver enough pressure to create a spray mist as it fills the first storage tank in the treatment process.

Aeration has the added benefit of also allowing any other gases to escape, such as radon gas or volatile organic compounds (VOC's). To a lesser extent, even some portion of semi-volatile organic compounds (SVOC's) will be removed by aeration as well.

Water containing methane should not be chlorinated before the methane is removed. The methane and the chlorine can react to form trihalomethane, a carcinogenic disinfection byproduct.

Water Softeners

A characteristic of all of the water tested in the Pavillion area is very high calcium content, making it extremely hard water. Calcium levels this high will lead to fouling and premature failure of the RO membrane. Therefore, it is more economical to pre-treat the water to remove the calcium. A very effective means of doing that is with the water softeners commonly available.

These water softeners use an ion-exchange process where they exchange the calcium (hard) ions found in the water for another (soft) ion. The ion exchange itself takes place in a special resin inside the water softener. Based on the amount of resin the softener contains, it can treat only a certain volume of water before the soft ions in the resin are exhausted. The resin must then be "regenerated" by flushing it with a salt solution. It is this regeneration process that uses sodium chloride, common table salt, which many people often associate with water softeners.

If sodium chloride is used as the source of soft ions for the water softener, the ions exchanged for the calcium in the water will be sodium ions. Water in the Pavillion area already contains sodium at varying levels, and the use of sodium chloride will increase the sodium level. Persons on a sodium-restricted diet might want to consider the effects of using common salt. Other salts, such as potassium chloride, are available and work equally well in a water softener by exchanging potassium ions for the calcium in the water.

Depending on the source water's iron and/or manganese levels, an additional treatment process to remove the iron and manganese may need to be part of the system. These metals can quickly foul reverse osmosis membranes if they are not removed beforehand. Conventional water softeners are also effective in removing iron and manganese by ion exchange, up to a point. Concentrations of iron below 5 ppm can be removed by the softener. Levels above that must be removed by other methods prior to the water softener treatment or the metals will clog the ion exchange resin in the water softener too quickly.

Most other methods of iron and manganese removal use oxidation to convert the metals to particles that can then be filtered out of the water. The oxidized forms of iron and manganese are not soluble and can be removed by conventional filtration. This filtration should be done prior to running the water through a water softener because the oxidized metals will quickly foul the softener's ion exchange resin.

Oxidation can be done by various techniques, including aeration, or by introduction of an oxidizing chemical such as sodium hypochlorite or potassium permanganate. Aeration is the simplest method and requires no chemicals. The aeration process will remove methane and at the same time oxidize iron and manganese, provided that the tank in which it occurs is large enough to provide at least 20 minutes of detention time for the water. This allows enough time for the oxygen dissolved in the water by the aeration to contact and oxidize these metals. The water can be filtered before entering the water softener.

Organic Hydrocarbon Removal

Hydrocarbons heavier than methane are usually removed with filtration. These compounds are objectionable because of the smell and taste that they impart to water. In the rural Pavillion area, all of the private wells that were tested showed contamination for these compounds below established MCL limits set by EPA for public water supplies.

The technology most suitable for organic contaminant removal in individual drinking water systems is granular activated carbon filtration. Granular activated carbon (GAC) will filter out most organics, whether they are chronically natural or synthetic. GAC has been designated by the EPA as the best available technology to remove synthetic organic chemicals.

GAC treatment is a simple technique that has relatively low energy requirements. It removes contaminants through adsorption whereby the dissolved contaminants adhere to the surface of the activated carbon. Activated charcoal has an extremely large amount of surface area for its mass. One pound of activated charcoal has a surface area equivalent of up to 100 acres.

A GAC-type filter is commonly found integrated as a pre-treatment method in packaged reverse osmosis systems. A typical system will have a conventional sediment filter ahead of the carbon filter to remove any particles. The GAC filter will then capture organics prior to the RO membranes. The only problem with GAC pre-filters is that they are not usually very big and require constant monitoring and maintenance to ensure the organics are being removed. A GAC filter of approximately one cubic foot of media is recommended in order to give an expected filter life of a year or more.

The GAC filter should be sized large enough to allow the filter to operate for several months to a year before needing replacement. When an activated carbon filter reaches its adsorption capacity breakthrough, it is exhausted. It not only will no longer remove the contaminant, but it can actually release some of the previously captured contaminants back into the water. This can result in higher concentrations of those contaminants than the original source water contained. Filters need more maintenance, cost more with frequent filter media replacement, and have more opportunity for this dumping effect.

Inorganic Mineral Removal

Several of the inorganic minerals found in the Pavillion-area water exceed the EPA secondary standards. Even though most of these minerals are not considered health hazards, there is little question that they have a profound effect on the desirability of the water. They can impart unpleasant odors and tastes to the water, and can also cause significant staining for ordinary domestic uses such as laundry.

Reverse osmosis will remove a very high percentage of inorganic mineral content from water. Unlike conventional filtration where the entire volume of water flows through a filter media, the RO process consists of moving water at high pressure across a membrane of extremely small pore size. The pressure forces some portion of the water through the membrane, but the small pore size prevents larger molecules from moving through. The balance of the water, together with virtually all of the original contaminants, moves on across the membrane, creating a constant stream that flushes the membrane surface and goes out to waste, typically a septic system.

Discharge for the RO waste stream must be taken into consideration. The amount of purified water versus wastewater is the recovery rate. With a lower recovery rate, the well must produce more water, which creates more waste water. Large commercial or municipal RO systems can have recovery rates around 75% with about 25% percent of the water going to waste. Small under-sink systems that operate at fairly low pressures might only recover 15% or 20% of the water. Whole-house systems, such as are being reviewed here, will commonly recover from a third to half of the water. The well must be capable of producing at least three times the amount of water needed by the household. Systems with higher recovery rates waste less water, but that smaller waste stream has to carry the same amount of rejected contaminants. The wastewater quality can become so poor that it is harmful to both vegetation and to septic systems. It is troublesome to dispose of the additional volume of water.

Due to the volume of wastewater, it is usually not recommended to direct the waste stream into the septic system. Increasing the flow through the septic system decreases the effectiveness of the sewage treatment because of the dilution of the wastes, and it significantly shortens the time that the waste spends in the septic tank before discharge. The increased flow can also saturate the septic leach field if it is not designed for the higher flows. Installing a separate drain field or other means of discharge are better alternatives.

With these relatively low water recovery rates, an RO system cannot provide water on demand. Instead, it must be treated at low flows and then stored to be available in quantities as needed. A system that can produce 20 gallons an hour will provide nearly 500 gallons per day (gpm). That is enough water for a 6-person household over the course of a day, but 20 gallons an hour (0.33

gpm) is not adequate flow rate for any normal household function. Consequently, it is necessary to have a holding tank to store the water, together with a pump to pressurize and deliver the water on demand.

A good rule of thumb for sizing the RO system is to have it produce the household's average day water usage in 8 to 12 hours of run time. Smaller systems have to run nearly continuously which can lead to frequent membrane changes. Manufacturers rate their systems at their maximum production capacity running 24 hours a day under ideal conditions. To avoid having the system run continuously, a homeowner would be wise to choose a system rated at three to four times the average daily household water usage. RO systems rated between 1,000 gpd and 2,000 gpd are typical household-sized units.

A basic RO system will consist of the filter membranes and housing, a high pressure pump, pressure gauges, valves, and controls. Many manufacturers market what they term to be a "complete" skid-mounted system with all the components pre-installed on a skid. With the variety of treatment methods proposed here for the total system, the components packaged on the skid must be customized to best meet the homeowner's individual needs and the well's water that is to be treated.

As previously discussed in the section about granular-activated carbon filtering, a sediment pre-filter that will remove the larger contaminant particles is common to most RO units. Because pressure is an important requirement for reverse osmosis, the pore size of this pre-filter should not be so small that the pressure loss is too high. A pore size of about 5 microns is typically adequate.

C. Summary of Treating Private Wells

Whatever treatment system or equipment is chosen, it is recommended that the equipment be NSF certified. NSF International is a non-profit organization that sets performance standards for water treatment devices and chemicals. The NSF certification means the equipment has been tested and evaluated to meet the minimum performance requirements.

Treatment success is highly dependent on system maintenance. Filter replacements, backwashes, etc., must be conducted as recommended by the manufacturer or it is extremely likely that filter lives will be significantly reduced and the treatment results will turn out to be less than satisfactory.

Whole-house systems of the type recommended can occupy a significant amount of space. In particular, the tanks required are bulky. A system could require two or more 500-gallon tanks. Few existing houses will have this amount of available space for installation of the equipment. A small building, heated to stay above freezing in the winter, to house the equipment, will be necessary in most instances.

3. Importing Water from another Source

Importing water from another source can either be delivered through a piped system or hauled and delivered to individual cisterns. In this section those two options will be discussed.

A. Cistern Systems and Hauling Water

The cistern system considered in this study is assumed to be a conventional design. This configuration includes:

- Buried polyethylene storage tanks,
- In-home on-demand pressure pump or conventional pump and pressure tank, and
- Connection plumbing.

A cistern system is significantly easier for a homeowner to operate than is a private well-water treatment system. The drawback is, having to haul in every gallon of drinking water the family uses.

Water hauling was explored using two different approaches: homeowners hauling water themselves, and homeowners banding together to contract water hauling.

The cost of owning and operating a cistern system of this conceptual configuration is detailed in Chapter IV.

B. Piping Water

Delivering water through a piped system will require four major components, 1.) a source, 2.) a transmission line from the source to a storage tank, 3.) the storage tank itself, and 4.) a distribution system to deliver water to the individual users.

In this study the water supply sources that were considered are:

- The Town of Pavillion wells,
- A separate well in a location that produces acceptable groundwater quality, and
- A treated surface water source.

For cost reasons that are shown in Chapter VI, using the Town of Pavillion as a supply source is the preferred source alternative for a piped system. A new well drilled in an area that produces acceptable groundwater is also a viable alternative way to supply a piped system.

As discussed in the next section, surface water could be piped in from either Ocean Lake of Five Mile Creek. For reliability reasons Ocean Lake is favored over Five Mile Creek as a source.

The final method of importing drinking water is to have it truck-hauled to the 20 or so residences in the rural Pavillion area that now have unpalatable water from their private wells. This would require the home be fitted with a cistern and pressure tank for each residence opting to have hauled water. The homes already have pressure tanks installed for their private well systems. In most cases installing a cistern, a pressure pump, and reconnecting the system would be all that is needed.

C. Surface Water

In Section 3 of Chapter III it was pointed out that the surface water sources closest to the rural Pavillion potential service area are Ocean Lake, Pilot Butte Reservoir, and Five Mile Creek. The closest of these, and most reliable, is Ocean Lake, 2½ miles away.

The challenges faced in developing surface water as a source for the area needing service are:

- Obtaining a water right for the water to be used
- Treatment of the water,
- Pumping treated water to a storage tank,
- Piping the water to the users, and
- Obtaining sites for the facilities and right-of-way for the pipelines.

Finally, the system will have to be owned, operated, and maintained by a district or other legal entity. That entity will have to employ a licensed operator who would keep his operators certificate current with DEQ requirements. The license that the operator would have to obtain depends on the complexity of the treatment process coupled with the system's pumping transmission, storage, and distribution system. Based on current DEQ criteria, the system would require either a Class II or a Class III operator.

The complexities of owning, operating, and maintaining a water treatment plant are discussed in Section E.

Obtaining Water Rights

An application to appropriate surface water would have to be filed with the Wyoming State Engineer's Office (WSEO) to obtain a right to the water for the system. This is a complicated and costly filing process. Any water right obtained will be given a current priority right, leaving it "junior" to all other right holders on the Wind River drainage.

Treating the Water

A surface water source has to be treated to meet EPA drinking water standards. Treating surface water requires a complete water treatment plant, similar to the plant built by the Town of Hudson in 2010. This is a costly and complex piece of equipment to own and operate. The owner of the system is required by state regulation to employ a licensed operator and have a backup operator available.

In concept, the plant would draw water from Ocean Lake. The type of plant considered for this alternative is a microfiltration plant which uses membrane filters to capture and remove undesirable material from the water, followed by disinfection, so that the produced water meets drinking water standards. After treatment, pumps would move the water from the plant to the storage tank that would be located approximately 2½ miles away. This is a simplified description of what would be a complex plant and its operation.

Owning, operating and maintaining a water treatment plant is a major undertaking for any water system. The plant must be operated in a way that it consistently produces water meeting EPA standards. The plant, like any other sophisticated piece of equipment, requires constant maintenance. Because surface water can carry pathogens that can cause a disease outbreak, EPA requires monthly reporting of several water quality parameters. Any laps in reporting, or problem with the produced water, results in the EPA issuing violation notices and the potential for fines to the entity owning and operating the plant.

Water Storage

As with all other piped systems being considered, the treated water will be stored in a tank some place near the center of the system. That location also has to be at a location that is approximately 60 feet above the homes being served. This will deliver the minimum operating pressure required by DEQ regulations.

Piping Water to the Users

The final portion is the distribution piping to deliver water to the users. Whether the system would be fed by a water treatment plant, a well, or the Town of Pavillion, the distribution system will be very similar as shown in the exhibits in the Chapter VI.

Obtaining Rights-of-Way and Facilities Sites

A small acreage site of approximately 1½ acres would be needed for the water treatment plant and equipment yard. As with the other piped systems a small site would be needed for the storage tank. Rights of way are required for all transmission and distribution lines.

CHAPTER VI

PRELIMINARY COST ESTIMATES

Introduction

The primary question of any potential user of a planned water system is "**What will it cost me?**" This chapter answers that important question. The costs for the alternative solutions presented in Chapter V are given in this chapter.

The cost of owning, operating, and maintaining a system requires the cost of construction, and, after construction, the cost of operating, maintaining, and, eventually, replacing the system. Those are detailed in this chapter. Also, conceptual sketches of the systems are shown where appropriate.

The alternatives whose costs are presented in this chapter are:

A. A Piped Central System supplied by:
   1. The Town of Pavillion.
   2. A separate well.
   3. Treated service water from Ocean Lake.

B. Individual Resident Solutions of:
   1. Treatment of private well water.
   2. Hauling of drinking water.

1. Piped Central System Supplied by the Town of Pavillion

A piped central system supplied by the Town of Pavillion's wells would originate at the Town limits line near the high school. In concept, at that point a master water meter would measure the amount of water delivered to the rural Pavillion system. The transmission line will extend from Pavillion along East Pavillion Road to a water storage tank on Indian Ridge. From there water is distributed to the users using 4" lines. The system will involve approximately 9.5 miles of piping plus the storage tank. The routing and general configuration of the conceptual system is shown in Figure VI-1.

The WWDC eligible construction costs are estimated to be $1,866,000. WWDC ineligible costs of $173,300 will be required to install service taps and lines to the residences. Total cost will be $2, 039,000.

Operation and maintenance cost are estimated to be $110,200 per year. The water charges, which are included in the O&M, are based on Pavillion's out-of-town water rate of $54.00 per month for 4,000 gallons and $2.00 per thousand gallons thereafter. It is assumed that the average household usage will be 6,000 gallons per month. It also includes operator salary, maintenance vehicle, and 15% reserve for emergencies.

Debt retirement costs are estimated to be $56,400 per year. This is based on 67% grant and financing the remaining 33% of costs plus ineligible items for 20 years at an interest rate of 4%.

Under this financing scenario an average **water bill of $715 per month** per residence would be needed to make the system self-supporting.

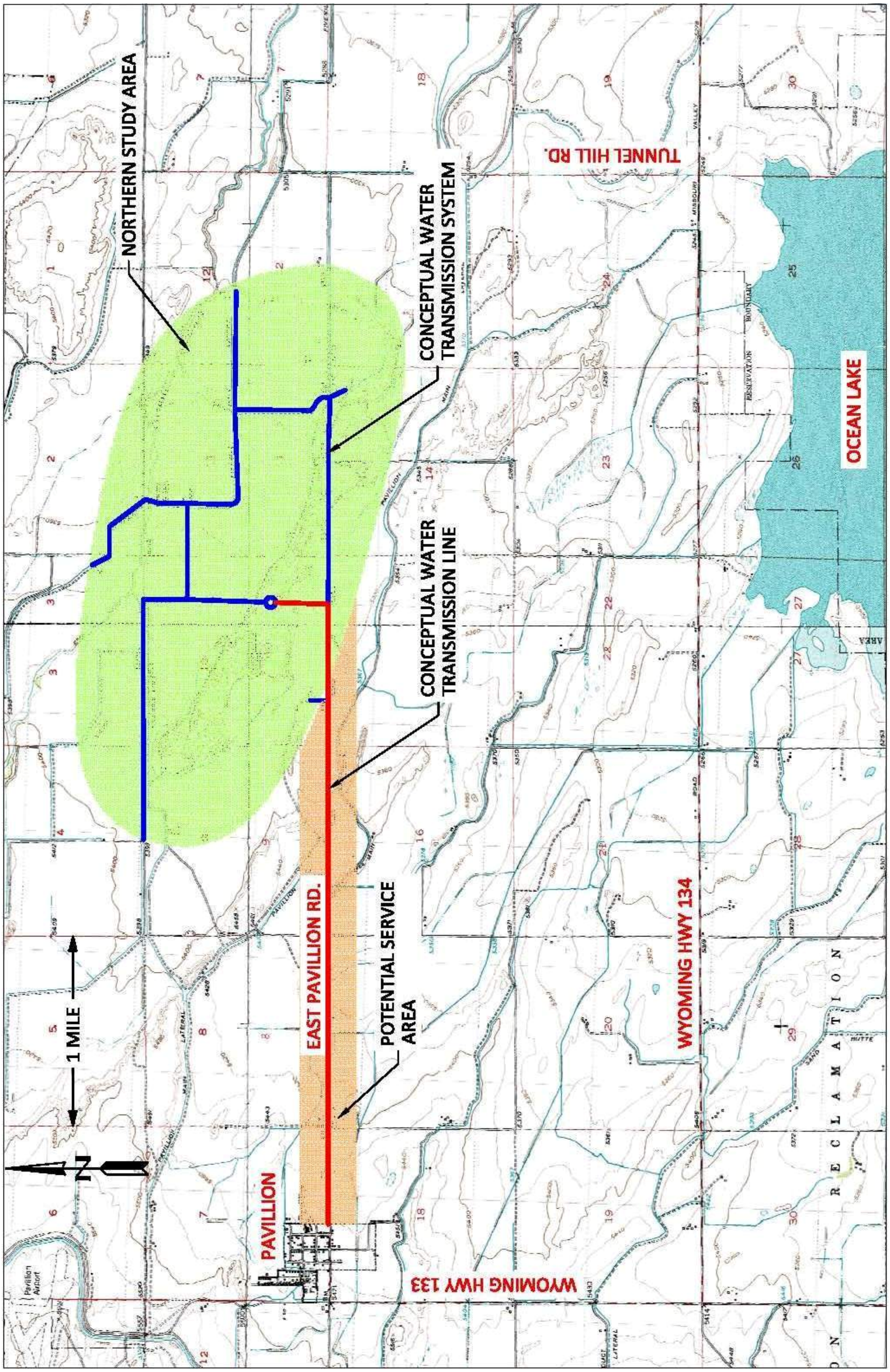

Figure VI-1: Piped Central System Supplied by the Town of Pavillion

TABLE VI-1
PRELIMINARY OPINION OF PROBABLE PROJECT COSTS
Piped Central System Supplied by the Town of Pavillion

Project: **WWDC Rural Pavillion Water Supply** Date: 6/22/2011

Project No: 05-12-00-10 Estimate By JAMES GORES & ASSOCIATES

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization, Bonds, and Insurance	1	LS	$ 113,000	$ 113,000
2	Tap Fee and Master Meter	1	LS	$ 13,000	$ 13,000
3	4" HDPE Waterline and Appurtenances	50000	LF	$ 22	$ 1,100,000
4	10,000 Gallon Storage Tank	1	EA	$ 80,000	$ 80,000
5	Tank Controls, Fencing, Access Road, etc.	1	LS	$ 20,000	$ 20,000
6	Land - Tank Site and Line ROW	1	LS	$ 15,000	$ 15,000
	Subtotal of Construction Costs				$ 1,341,000
7	Contingencies	15%			$ 201,150
	Total Construction Costs				$ 1,542,150
	Non Construction Costs				
8	Engineering Design	10%			$ 154,200
9	Engineering Construction Monitoring	10%			$ 154,200
10	Legal and Administrative				$ 15,000
	Total Non Construction Costs				$ 323,400
	TOTAL ESTIMATED PROJECT COST				$ 1,865,550
	WWDC Ineligible Costs				
11	Service Taps	20	EA	$1,200.00	$ 24,000
12	1" Service Line	4550	LF	$13.00	$ 59,150
13	2" Service line	5300	LF	$17.00	$ 90,100
	Total Ineligible Costs				$ 173,250

TABLE VI-2
PRELIMINARY ESTIMATE OF O&M COSTS
Piped Central System Supplied by the Town of Pavillion

Project: **WWDC Pavillion Area Master Plan** Date: 6/22/2011

Project No: 05-12-00-10 Estimate By: JAMES GORES & ASSOCIATES

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Operator Salary and Benefits	1	YR	$ 77,000	$ 77,000
2	Administration and Billing	1	YR	$ 3,600	$ 3,600
3	Work Truck and Supplies	1	YR	$ 15,200	$ 15,200
4	Annual Water Charges	20	Homes	$ 672	$ 13,440
	Subtotal Annual O&M Costs				$ 95,800
5	Contingencies	15%			$ 14,370
	Estimated Annual Costs				$ 110,170

TABLE VI-3
TABLE OF FINANCING
Piped Central System Supplied by the Town of Pavillion
20 Year Project Financing

			FUNDING		
Item No.	**Description**	**Total Cost**	**67% WWDC Grant**	**33% WWDC Loan**	**Annual Loan Payment**
1	WWDC Eligible Items	$ 1,542,150	$ 1,027,072	$ 515,078	$ (35,426)
2	Engineering, Legal, and Administrative	$ 323,400	$ 215,384	$ 108,016	$ (7,429)
3	**Total WWDC Eligible Costs**	**$ 1,865,550**	$ 1,242,456	$ 623,094	$ (42,856)
4	Service Taps	$ 24,000		$ 24,000	$ (1,651)
5	1" Service Line	$ 59,200		$ 59,200	$ (4,072)
6	2" Service Line	$ 90,100		$ 90,100	$ (6,197)
7	**Subtotal WWDC Ineligible Items**	**$ 173,300**		$ 173,300	$ (11,919)
8	**Total Project**	**$ 2,038,850**	$ 1,242,456	$ 796,394	$ (54,775)

Annual Debt Payment on WWDC Loan *	$ 58,600
Annual System Operation and Maintenance	$ 112,900
Total Annual Cost	$ 171,500
Average Monthly Water Billing **	$ 715

* 20 Yr. Term, 4% APR

** Assumes 20 Services

2. Piped System Supplied by a Separate Well

A piped system supplied by a well, as opposed to the Town of Pavillion's system, would start at a new well drilled for the rural system, as shown in Figure VI-2. As with the piped system describes above a transmission line would extend along East Pavillion Road to the tank planned to be located on Indian Ridge. All other piping would remain the same as in the first alternative.

The construction cost of this system with its well and automation controls is estimate to be $1,800,000 plus $173,000 for installation of service taps and lines for a total cost of $1,973,000. Its annual O &M cost is estimated to be $80,000.

Debt retirement costs are estimated to be $50,400 per year. This is based on 67% grant and financing the remaining 33% of costs plus ineligible items for 20 years at an interest rate of 4%. Operation and maintenance is estimates to be $112,900 per year. This includes the operator's salary and benefits, cost of a maintenance vehicle, power charges for the well, and 15% reserve for emergencies.

Under this financing scenario, an average **water bill of $680 per month** per residence would be required for the system to be self-supporting.

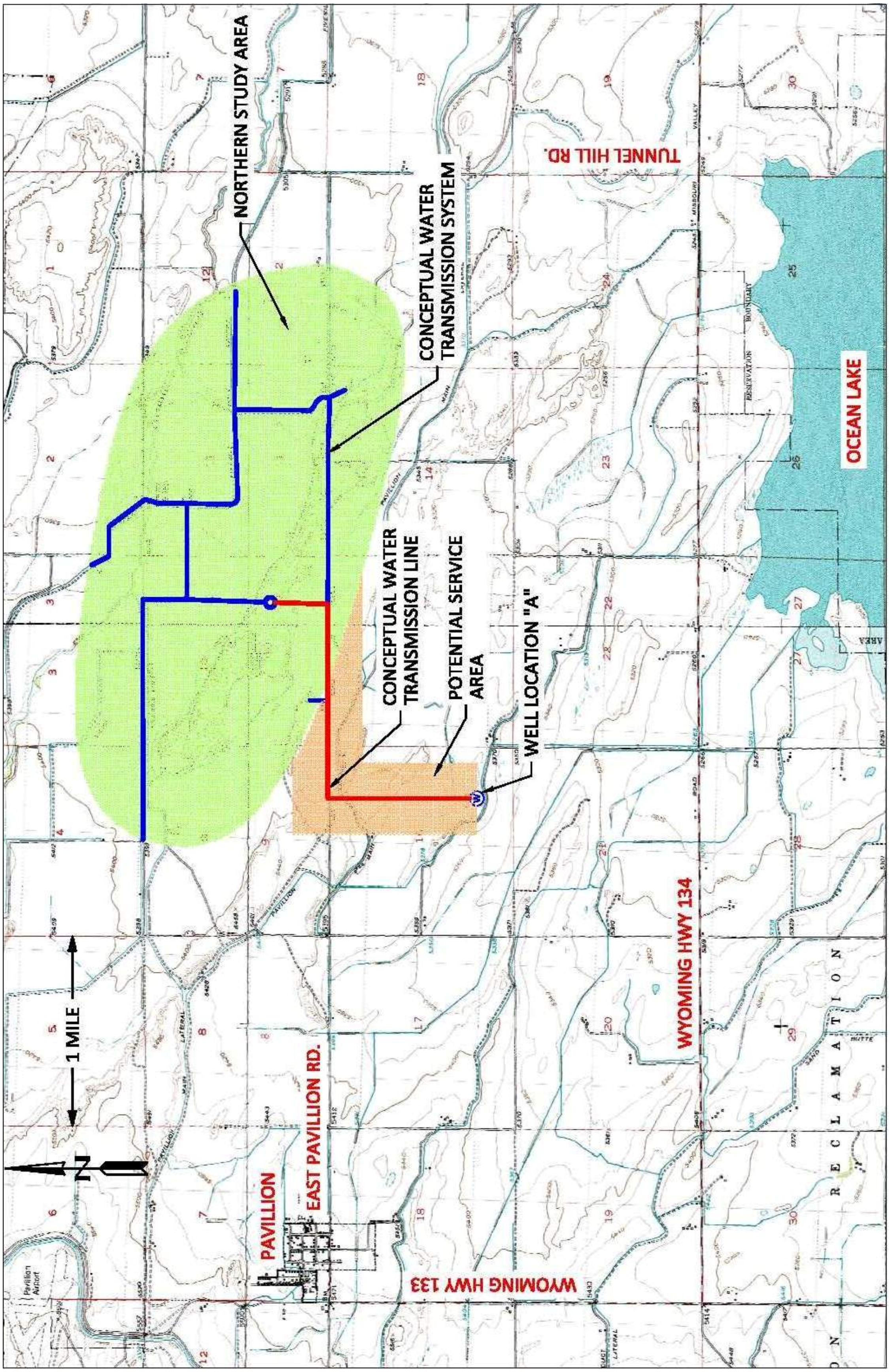

FIGURE VI-2: Piped System Supplied by a Separate Well

TABLE VI-4
PRELIMINARY OPINION OF PROBABLE PROJECT COSTS
Piped System Supplied by a Separate Well

Project: **WWDC Rural Pavillion Water Supply** Date: 6/22/2011

Project No: 05-12-0010 Estimate By: JAMES GORES & ASSOCIATES

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization, Bonds, and Insurance	1	LS	$ 114,000	$ 114,000
2	4" HDPE Waterline and Appurtenances	36500	LF	$ 22	$ 803,000
3	10,000 Gallon Storage Tank	1	EA	$ 80,000	$ 80,000
4	Tank Fencing, Access Road, etc.	1	LS	$ 10,000	$ 10,000
5	1000' Well, Pitless Adapter, and Pump	1	EA	$ 166,500	$ 166,500
6	Well House, Chlorination, and SCADA	1	LS	$ 120,000	$ 120,000
7	Well Site, Tank Site, and Line ROW	1	LS	$ 13,000	$ 13,000
	Subtotal of Construction Costs				$ 1,293,500
8	Contingencies	15%			$ 194,025
	Total Construction Costs				$ 1,487,525
	Non Construction Costs				
9	Engineering Design	10%			$ 148,800
10	Engineering Construction Monitoring	10%			$ 148,800
11	Legal, Administrative and Water Rights				$ 15,000
12	**Total Non Construction Costs**				$ 312,600
	TOTAL ESTIMATED PROJECT COST				$ 1,800,125
	WWDC Ineligible Costs				
11	Service Taps	20	EA	$1,200.00	$ 24,000
12	1" Service Line	4550	LF	$13.00	$ 59,150
13	2" Service Line	5300	LF	$17.00	$ 90,100
	Total Ineligible Costs				$ 173,250

TABLE VI-5
PRELIMINARY ESTIMATE OF O&M COSTS
Piped System Supplied by a Separate Well

Project: **WWDC Pavillion Area Master Plan** Date: 6/22/2011

Project No: 05-12-00-10 Estimate By: JAMES GORES & ASSOCIATES

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Operator Salary	1	YR	$ 77,000	$ 77,000
2	Administration, Testing and Billing	1	YR	$ 6,000	$ 6,000
3	Work Truck and Supplies	1	YR	$ 15,200	$ 15,200
4	Electrical Power for Well	12	Mo.	$ 210	$ 2,520
	Subtotal Annual O&M Costs				$ 98,200
5	Contingencies	15%			$ 14,730
	Estimated Annual Costs				$ 112,930

TABLE VI-6
TABLE OF FINANCING
Piped System Supplied by a Separate Well
20 Year Project Financing

Item No.	Description	Total Cost	FUNDING: 67% WWDC Grant	33% WWDC Loan	Annual Loan Payment
1	WWDC Eligible Items	$ 1,487,525	$ 990,692	$ 496,833	$ (34,172)
2	Engineering, Legal, and Administrative	$ 312,600	$ 208,192	$ 104,408	$ (7,181)
3					
4	**Total WWDC Eligible Costs**	**$ 1,800,125**	$ 1,198,883	$ 601,242	$ (41,353)
5	Service Taps	$ 24,000		$ 24,000	$ (1,651)
6	1" Service Line	$ 59,200		$ 59,200	$ (4,072)
7	2" Service Line	$ 90,100		$ 90,100	$ (6,197)
8	**Subtotal WWDC Ineligible Items**	**$ 173,300**		$ 83,200	$ (5,722)
9	**Total Project**	**$ 1,973,425**	$ 1,198,883	$ 684,442	$ (47,075)

Annual Debt Payment on WWDC Loan *	$ 50,362
Annual System Operation and Maintenance	$ 112,930
Total Annual Cost	$ 163,292
Average Monthly Water Billing **	$ 680

* 20 Yr. Term, 4% APR

** Assumes 20 Services

3. Piped System Supplied by a Water Treatment Plant

Instead of using well water to supply the conceptual system as discussed in the above two options, this alternative would treat water from Ocean Lake and pipe is to a planned tank on Indian Ridge. From that point on, the system piping would remain the same. The conceptual configuration of this alternative is shown in Figure VI-3.

Other possible sources of surface water were also reviewed. They are Five Mile Creek and Pilot Butte Reservoir. The cost of using these alternate sources is the same except for the cost of the water transmission line from the treatment plant to the system. Five Mile Creek is significantly closer than Ocean Lake and would have a lower transmission line cost. The drawback to this alternative, though, is its seasonal reliability. Winter flows may become too low to reliably supply the system. Pilot Butte Reservoir is six (6) miles from the system, increasing the piping cost significantly. The construction, operation, and maintenance (O & M) of the treatment plant is the major cost of this alternative.

The construction cost of this system and its treatment plant is estimate to be $2,927,000 with O&M cost estimated to be $142,000 per year. Because WWDC does not fund treatment, WWDC ineligible costs are $750,000. Those costs may be fundable by the Wyoming State Lands and Investment Board on a 50% grant, 50% loan basis.

Debt retirement costs are estimated to be $152,000 per year. This is based on a 67% grant and financing the remaining 33% of costs plus ineligible items for 20 years at an interest rate of 4%.

Under this financing scenario, an average **water bill of $1,225 per month** per residence would be needed to make the system self-supporting.

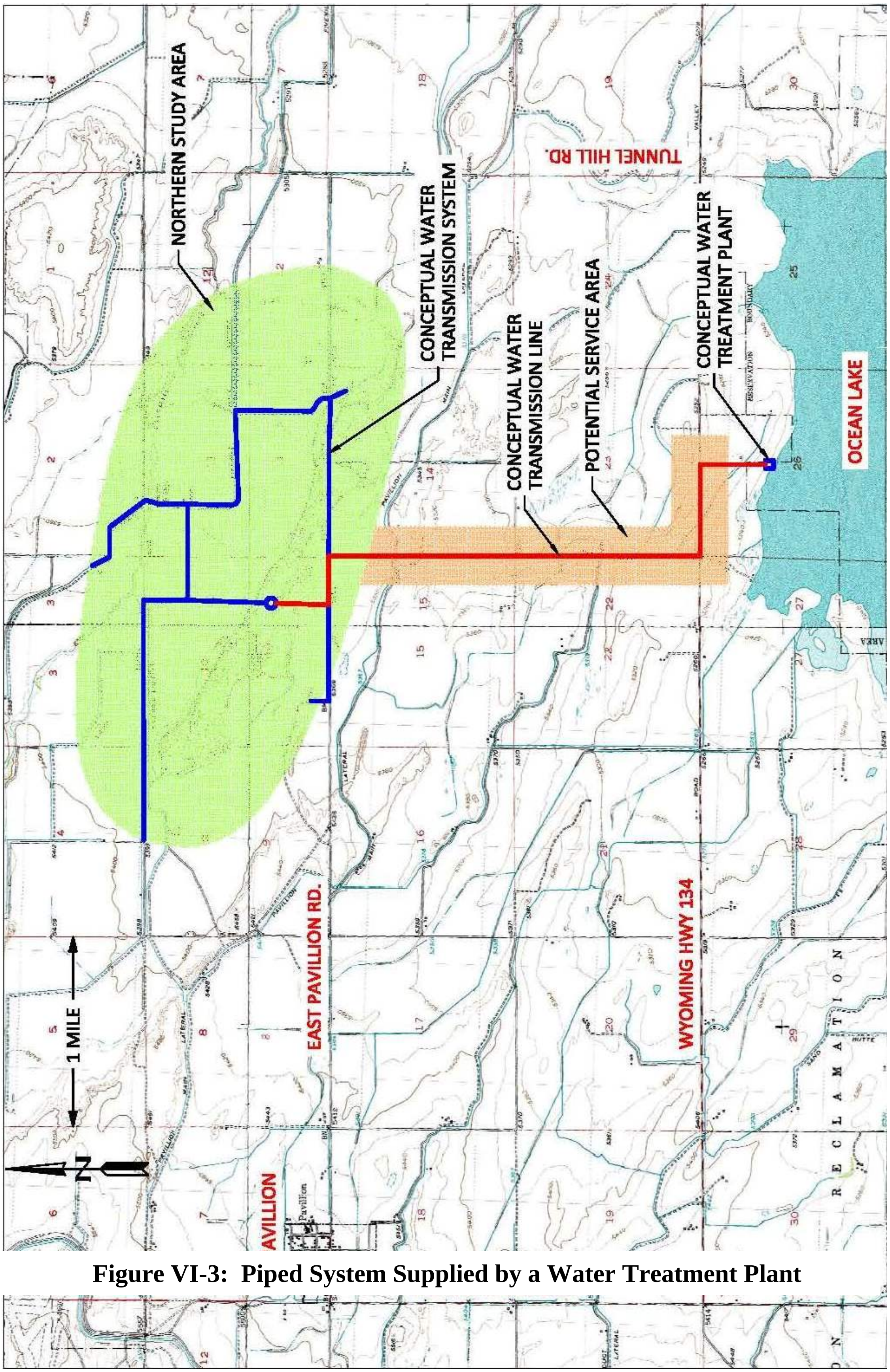

Figure VI-3: Piped System Supplied by a Water Treatment Plant

TABLE VI-7
PRELIMINARY OPINION OF PROBABLE PROJECT COSTS
Piped System Supplied by a Water Treatment Plant

Project: **WWDC Pavillion Area Master Plan** Date: 6/22/2011

Project No: 05-12-00-10 Estimate By: JAMES GORES & ASSOCIATES

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	8,000 gpd Water Treatment Plant				
1	Mobilization, Bonds, and Insurance	1	LS	46,000	$ 46,000
1	Dual Train Treatment Plant - installed	2	Ea	165,000	$ 330,000
2	Wetwell and Pumps	1	LS	60,000	$ 60,000
3	SCADA System	1	LS	50,000	$ 50,000
5	Plant Site (state land)	2	Ac	8,000	$ 12,000
6	Site Improvements and Access Road	1	LS	15,000	$ 15,000
7	Plant Building - 60X50	3,000	SF	35	$ 105,000
8	Water Right Filing	1	LS	5,000	$ 5,000
9	Water Service Lines and Taps	1	LS	173,000	$ 173,000
10	Water Treatment Plant Subtotal				**$ 750,000**
	Transmission and Storage				
10	Mobilization, Bonds, and Insurance	1	LS	101,300	$ 101,300
11	4"Transmission Line	17,500	LF	20	$ 350,000
12	10,000 Gallon Storage Tank	1	EA	$ 80,000	$ 80,000
13	4" Distribution Line	39000	LF	$ 20	$ 780,000
14	Water Line Right-of-Way	56,500	LF	$1.00	$ 56,500
	Subtotal Transmission and Storage				**$ 1,367,800**
	Subtotal of Construction Costs				$ 2,117,800
16	Contingencies	15%			$ 317,670
	Total Construction Costs				**$ 2,435,470**
	Non Construction Costs				
17	Engineering Design	10%			$ 243,500
18	Engineering Construction Monitoring	10%			$ 243,500
19	Legal and Administrative				$ 5,000
	Total Non Construction Costs				$ 492,000
	TOTAL ESTIMATED PROJECT COST				**$ 2,927,470**
	WWDC Ineligible Costs				
11	Service Taps	20	EA	$1,200.00	$ 24,000
12	1" Service Line	4550	LF	$13.00	$ 59,150
13	2" Service line	5300	LF	$17.00	$ 90,100
	Total Ineligible Costs				**$ 173,250**

TABLE VI-8
ESTIMATED O & M COSTS
Piped System Supplied by a Water Treatment Plant

Project: **WWDC Pavillion Area Master Plan** Date: 6/22/2011

Project No: 05-12-00-10 Estimate By: JAMES GORES & ASSOCIATES

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Operator Salary	1	YR	$ 84,000	$ 84,000
2	Administration, Testing, and Billing	1	YR	$ 8,000	$ 8,000
3	Work Truck, Supplies, and Pipe Repairs	1	YR	$ 15,200	$ 15,200
4	Utilities	600	Mo	$ 12	$ 7,200
5	Membrane and Plant Equipment R&R	1	YR	$ 9,000	$ 9,000
	Subtotal of Construction Costs				**$ 123,400**
8	Contingencies	15%			$ 18,510
	Estimated Annual Costs				**$ 141,910**

TABLE VI-9

TABLE OF FINANCING
Piped System Supplied by a Water Treatment Plant
20 Year Project Financing

			FUNDING				
Item No.	**Description**	**Total Cost**	**67% WWDC Grant**	**33% WWDC Loan**	**SLIB Grant**	**SLIB Loan**	**Annual Loan Payment**
1	WWDC Eligible Items	$ 1,887,564	$ 1,257,118	$ 630,446			$ (43,361.40)
2	Legal and Administrative	$ 5,000	$ 3,330	$ 1,670			$ (114.86)
3	**Total WWDC Eligible Costs**	**$1,892,600**	$ 1,260,472	$ 632,128			$ (43,477.09)
4	Water Treatment Plant	$ 796,260		$ 796,260	$ 398,130	$ 398,130	$ (54,765.87)
5	Service lines and Taps	$ 238,740		$ 238,740			$ (16,420.27)
6	**Subtotal WWDC Ineligible Items**	**$1,035,000**		$ 1,035,000			$ (71,186.14)
7	**Total Project**	**$2,927,600**	$ 1,260,472	$ 1,667,128	$ 398,130	$ 398,130	$ (142,046.17)

Total Grant	$ 1,658,602
Total Loan	$ 2,065,258
Annual Debt Payment on WWDC Loan *	$ 151,965
Annual System Operation & Maintenance	$ 141,900
Total Annual Cost	$ 293,865
Average Monthly Water Billing **	$ 1,224

* 20 Yr. Term, 4% APR

** Assumes 20 services

4. Treating Existing Private Wells

An alternative to piping water to the rural residences is for individual homeowners to install a treatment system on their private well as described in Chapter V. This approach offers each homeowner the ability to independently control their water supply and its cost. The recommendations for configuration of the system need to be followed to produce an acceptably palatable water quality from the local private wells.

The initial cost for a typical household treatments system is approximately $15,000.00. With proper periodic maintenance, including periodic filter media and membrane replacement, the equipment is expected to have a service life of 15 years or longer. Averaged over the 15-year life, equipment cost is about $1,000.00 per year. In addition, there is an estimated cost of $90 per month for operation and maintenance as shown in Table VI-10. This alternative is the most challenging to properly operate and maintain on an individual homeowner basis. Keeping filters changed, the water softener charged, the activated carbon media changed and the R.O. unit operating and disposing of its wastewater stream will be homeowner intensive.

The purchase costs of the proposed treatment methods can vary widely depending on water quality analysis results, homeowner's desires, equipment manufacturer, and available options. Not all of the treatment methods discussed may be necessary for some individual wells, and needed sizing of the equipment might also vary. This estimated cost includes a small building (approx. 10'x12') to house the treatment equipment. The costs do not include any expense for installation of a discharge system to handle the waste stream from the RO system if a discharge means is not readily available.

Operating and maintenance cost estimates have also been made to include periodic filter replacement and power costs. The filter and membrane lives will vary according to the water quality. Equipment sizes should be chosen that will be expected to give approximately a year's service for the filter media and two years for the reverse osmosis membranes. Those replacement costs were broken down to a monthly cost equivalent. Monthly expenses, including the amortization of the filter replacement, are estimated to be approximately $80.00 per month.

Assuming a 15-year equipment life, the cost of installing and operating a private treatment system would **total approximately $175 per month.**

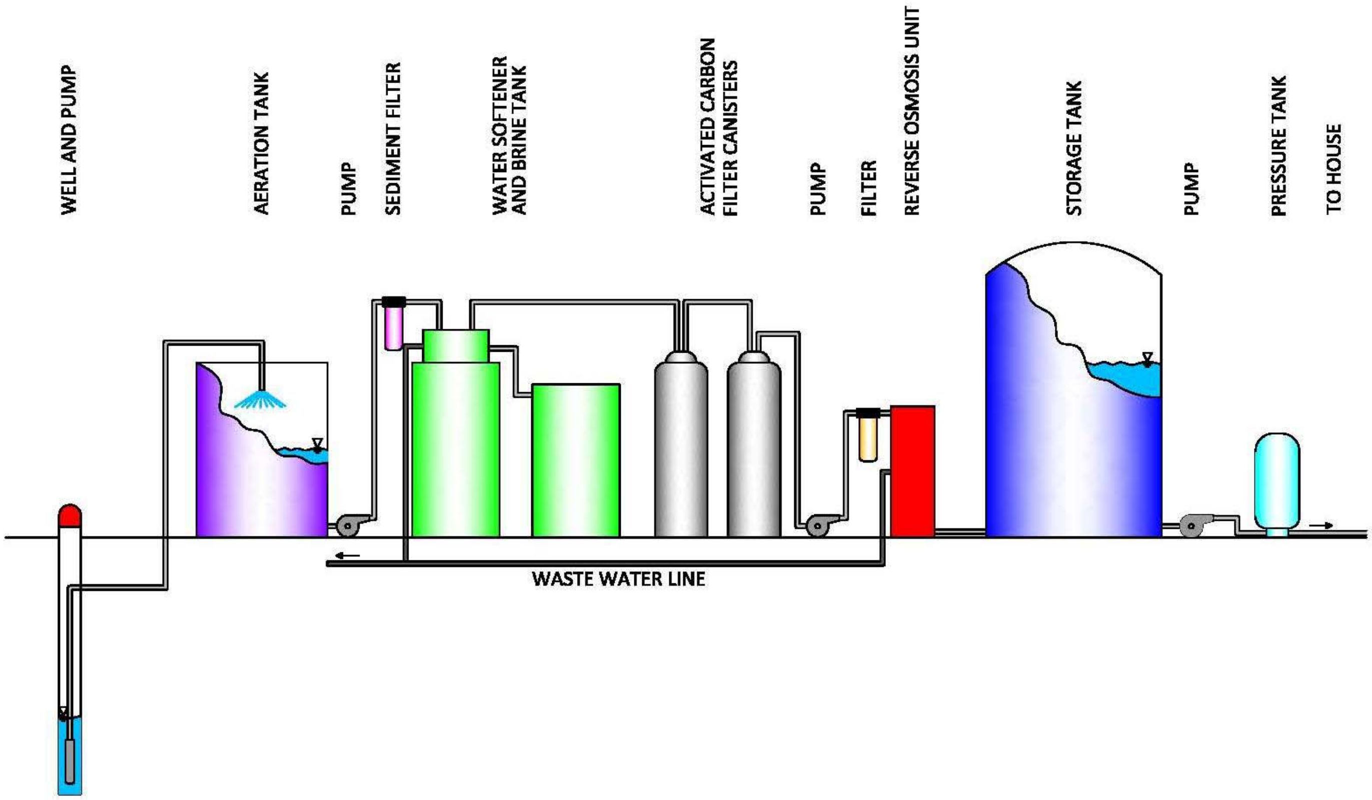

FIGURE VI-4: Typical Individual Treatment Unit

TABLE VI-10

ESTIMATED COSTS OF INDIVIDUAL TREATMENT

Treatment Equipment	**Initial Cost**	**Maintenance**	
		Membranes	Cost/month
Reverse Osmosis unit (2,000 gpd)	$5,000.00	$500/2 yr.	$20.00
Water Softener	$2,000.00		$10.00
Granular Activated Carbon filter bed	$1,000.00	$120/yr.	$10.00
Re-pressure tank, pump, and controls	$1,500.00		
Aeration system	$2,000.00		
Treatment House	$3,500.00		
Electricity and Heat			$50.00
	$15,000.00		$90.00

5. Cistern System and Hauling Water

The final alternative that was explored is converting the homes having unpalatable private well water to cisterns coupled with a water hauling service. This option could be implemented on an individual basis or through the formation of a water district. On an individual basis, each homeowner would install their own system and haul their own water. Under a district approach the WWDC may fund 67% of the cost of cistern system installation. The district would assume a loan for the remaining 33% of the cost. Terms of the loan are currently 20-year term with an annual interest rate of 4%. Without formation of a district the cost of the cistern system would be an individual responsibility. Water hauling could be contracted through the district arranging for an agreed upon water haul delivery schedule using a bulk tanker. Those costs would be paid by the individual district members.

To form a district, those wishing to be in the district would have to follow the legal process for formation of a water district. That would require legal advice, petitioning the County Commissioners, holding the formation election and setting up an administration. Certain annual reports have to be filed for the continuation of the district.

The construction cost of 20 cisterns and the accompanying pump and pressure storage tank is estimate to be $308,000, or approximately $15,400 per household. Operation and maintenance cost will largely depend on the amount of water used. Delivered water is estimated to cost approximately $125 per 3000 gallon load. The installation of the cistern, installation cost, and water haul costs given here are on the higher portion of the expected cost range. Actual costs might be somewhat lower but not significantly. Depending water usage, cost for this alternative are estimated to cost $**250 per month**.

If no State funding is made available through WWDC for a cistern system, and each individual homeowner funds their own cistern system, assuming a 30-year life on the cistern, monthly costs would be approximately $293.

TABLE VI-11
PRELIMINARY OPINION OF PROBABLE PROJECT COSTS
Cistern System

Project: **WWDC Rural Pavillion Water Supply** Date: 6/22/2011

Project No: 05-12-00-10 Estimate By: JAMES GORES & ASSOCIATES

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization, Bonds, and Insurance	1	LS	$ 16,000	$ 16,000
2	1" Poly Waterline and Misc. Plumbing	1000	LF	$ 20	$ 20,000
3	2500 Gallon Cistern	20	EA	$ 6,800	$ 136,000
4	Pump and Pressure Tank	20	LS	$ 1,500	$ 30,000
	Subtotal of Construction Costs				$ 202,000
5	Contingencies	15%			$ 30,300
	Total Construction Costs				$ 232,300
	Non-Construction Costs				
6	Engineering Design	10%			$ 23,200
7	Engineering Construction Monitoring	10%			$ 23,200
8	Legal and Administrative				$ 2,000
9	**Total Non-Construction Costs**				$ 48,400
10	**TOTAL ESTIMATED PROJECT COST**				$ 280,700

TABLE VI-12
TABLE OF FINANCING
Cistern System
20 Year Project Financing

			FUNDING				
Item No.	**Description**	**Total Cost**	**67% WWDC Grant**	**33% WWDC**	**SLIB Grant**	**SLIB Loan**	**Annual Loan Payment**
1	WWDC Eligible Items	$ 308,000	$ 205,128	$ 102,872			$ (7,075)
2	**Total WWDC Eligible Costs**	**$ 308,000**	$ 205,128	$ 102,872			$ (7,075)
3	**Total Project**	**$ 308,000**	$ 205,128	$ 102,872			$ (7,570)

Total Grant	$ 205,128
Total Loan	$ 102,872
Annual Debt Payment on WWDC Loan *	$ 7,570
Annual System Operation & Maintenance	$ 52,000
Total Annual Cost	$ 59,570
Average Monthly Water Billing **	$ 248

* 20 Yr. Term, 4% APR

** Assumes 20 services

6. Improvements to the Town of Pavillion's System

The recommended improvements to the Town of Pavillion's water system in Chapter IV, page 21, are:

1. Eliminating the well pit on Well No. 1
2. Piping Wells No 1 and 4 directly into the small tank
3. Install a SCADA system
4. Install new pumps in wells No. 6 and 8
5. Remove the stand pipe tank

Costs for those improvements are given below in Table IV-13, and possible financing is in Table IV-14.

TABLE VI-13
PRELIMINARY OPINION OF PROBABLE PROJECT COSTS
Town of Pavillion Water System Improvements

Project: **WWDC Rural Pavillion Water Supply** Date: 6/22/2011

Project No: 05-12-00-10 Estimate By JAMES GORES & ASSOCIATES

Item	Description	Quantity	Unit	Unit Cost	Total Cost
Convert Wells No. 1 and 4					
1	Mobilization, Bonds, and Insurance	1	LS	5,000	$ 5,000
2	Pull pump, wellhouse demo, and extend casing	1	LS	10,000	$ 10,000
3	Remove well pit	1	LS	4,000	$ 4,000
4	Install pitless adapter	1	LS	12,000	$ 12,000
5	Connect well to tank transmission line	120	LF	40	$ 4,800
6	New SCADA system	1	LS	20,000	$ 20,000
7	Tie Well No. 4 to tank transmission line	50	LF	50	$ 2,500
8	Booster station demolition	1	LS	3,000	$ 3,000
	Subtotal Well No. 1				**$ 61,300**
Match Well Pumps to Well Capacities					
9	Mobilization, Bonds, and Insurance	1	LS	2,000	$ 2,000
10	Install new pumps in wells 6 and 8	2	Ea	$8,000.00	$ 16,000
	Subtotal Well Pumps No. 6 and 8				**$ 18,000**
Standpipe Tank Removal					
11	Mobilization, Bonds, and Insurance	1	LS	$1,500.00	$ 1,500
12	**Removal and salvage of standpipe tank**	1	LS	$20,000.00	$ 20,000
	Subtotal Standpipe Removal				**$ 21,500**
	Subtotal of Construction Costs				**$ 100,800**
13	Contingencies	15%			$ 15,120
	Total Construction Costs				**$ 115,920**
	Non Construction Costs				
14	Engineering Design	10%			$ 11,600
15	Engineering Construction Monitoring	10%			$ 11,600
	Total Non Construction Costs				$ 23,200
	TOTAL ESTIMATED PROJECT COST				**$ 139,120**

TABLE VI-14
TABLE OF FINANCING
Town of Pavillion Water System Improvements
20 Year Project Financing

Item No.	Description	Total Cost	FUNDING: 67% WWDC Grant	33% WWDC Loan	SLIB Grant	SLIB Loan	Annual Loan Payment
1	WWDC Eligible Items	$ 117,500	$ 78,255	$ 39,245			$ (2,699)
2	Legal and Administrative	$ -					$ -
3	**Total WWDC Eligible Costs**	**$ 117,500**	$ 78,255	$ 39,245			$ (2,699)
4	Removal of Standpipe Tank	$ 21,500		$ 21,500		$21,500	$ (1,479)
							$ -
5	**Subtotal WWDC Ineligible Items**	**$ 21,500**		$ 21,500			$ (1,479)
6	**Total Project**	**$ 139,000**	$ 78,255	$ 60,745		$21,500	$ (6,052)

Total Grant	$ 78,255
Total Loan	$ 82,245
Annual Debt Payment on WWDC Loan *	$ 6,052
Increase in Average Monthly Water Billing **	$ 4

* 20 Yr. Term, 4% APR
** Assumes 130 services

CHAPTER VII

SELECTION OF PREFERRED ALTERNATIVES

Introduction

The three most favorable alternatives, as ranked through a matrix process, are:

1. Individual private cisterns,
2. Individual private well treatment systems, and
3. Water piped from the Town of Pavillion.

The Alternatives Matrix give below shows each alternative's ranking against the criteria.

For clarity, the five alternatives were ranked for each criterion on a score of 1 to 5 with one being best. In the total score, **the lower the numerical score, the better the alternative** was ranked. In assigning the score for each criterion, each alternative was ranked against each other alternative. For example, ranking how each alternative compared under the criteria for system operator, the water treatment plant scored a 5 because of the requirement of employing a state certified Level II operator, while the Town of Pavillion supply option scored a 3, and the well-supplied system was ranked a 4. That is because a Level II operator is required for the plant (quite complex), a Level I operator is required to operate the well along with its distribution system (less complex) and operating a distribution system, even least complex of the piped central systems. Finally, operating an individual cistern is less complex than operating an individual treatment system.

1. Alternatives Matrix

The alternatives matrix is shown on the next page in Table VII-1 along with a financial comparison of the alternatives in Table VII-2.

TABLE VII-1: Alternatives Ranking Matrix

Alternative	Water Quality	Reliability	Construction Cost	O & M Cost	Household Cost/Year	Grant Eligibility	Local Cost	Operator Class	EPA Regulatory Compliance	Water Rights	System Life	Total
Pavillion Source Central System	2	1	4	3	4	1	2	2	3	2	1	**25**
Well Source Central System	3	2	3	4	3	1	1	3	4	4	2	**30**
Water Treatment Plant & Central System	4	4	5	5	5	2	5	5	5	5	4	**49**
Private Treatment for 20 Homes	5	5	1	1	2	5	4	1	2	3	5	**34**
Cisterns for 20 Homes	1	3	2	2	1	1	5	1	1	1	3	**21**

Numerical Ranking: 1 - Best 5 - Worst among alternatives presented

TABLE VII-2: Financial Comparisons

Alternative	Cost to Serve 20 Homes	Monthly Water Bill
Pavillion Source Central System	$1,865,550	$715
Well Source Central System	$1,800,125	$680
Water Treatment Plant & Central System	$2,927,000	$1,225
Private Treatment for 20 Homes	$300,000	$175
Cisterns for 20 Homes	$382,800	$250

Appendix I – Groundwater Quality Information

National Primary Drinking Water Regulations

Microorganisms

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
Cryptosporidium	zero	TT [3]	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste
Giardia lamblia	zero	TT[3]	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste
Heterotrophic plate count	n/a	TT[3]	HPC has no health effects; it is an analytic method used to measure the variety of bacteria that are common in water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.	HPC measures a range of bacteria that are naturally present in the environment
Legionella	zero	TT[3]	Legionnaire's Disease, a type of pneumonia	Found naturally in water; multiplies in heating systems
Total Coliforms (including fecal coliform and E. Coli)	zero	5.0%[4]	Not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present[5]	Coliforms are naturally present in the environment; as well as feces; fecal coliforms and E. coli only come from human and animal fecal waste.
Turbidity	n/a	TT[3]	Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria. These organisms can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.	Soil runoff
Viruses (enteric)	zero	TT[3]	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste

Disinfection Byproducts

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
Bromate	zero	0.010	Increased risk of cancer	Byproduct of drinking water disinfection
Chlorite	0.8	1.0	Anemia; infants & young children: nervous system effects	Byproduct of drinking water disinfection
Haloacetic acids (HAA5)	n/a[6]	0.060[7]	Increased risk of cancer	Byproduct of drinking water disinfection
Total Trihalomethanes (TTHMs)	--> n/a[6]	--> 0.080[7]	Liver, kidney or central nervous system problems; increased risk of cancer	Byproduct of drinking water disinfection

Disinfectants

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
Chloramines (as Cl_2)	MRDLG=4[1]	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort, anemia	Water additive used to control microbes
Chlorine (as Cl_2)	MRDLG=4[1]	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort	Water additive used to control microbes
Chlorine dioxide (as ClO_2)	MRDLG=0.8[1]	MRDL=0.8[1]	Anemia; infants & young children: nervous system effects	Water additive used to control microbes

Inorganic Chemicals

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
Antimony	0.006	0.006	Increase in blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
Arsenic	0[7]	0.010 as of 01/23/06	Skin damage or problems with circulatory systems, and may have increased risk of getting cancer	Erosion of natural deposits; runoff from orchards, runoff from glass & electronicsproduction wastes
Asbestos (fiber >10 micrometers)	7 million fibers per liter	7 MFL	Increased risk of developing benign intestinal polyps	Decay of asbestos cement in water mains; erosion of natural deposits
Barium	2	2	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits
Beryllium	0.004	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries
Cadmium	0.005	0.005	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints
Chromium (total)	0.1	0.1	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits
Copper	1.3	TT[7]; Action Level=1.3	Short term exposure: Gastrointestinal distress Long term exposure: Liver or kidney damage People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level	Corrosion of household plumbing systems; erosion of natural deposits
Cyanide (as free cyanide)	0.2	0.2	Nerve damage or thyroid problems	Discharge from steel/metal factories; discharge from plastic and fertilizer

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
				factories
Fluoride	4.0	4.0	Bone disease (pain and tenderness of the bones); Children may get mottled teeth	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories
Lead	zero	TT[7]; Action Level=0.015	Infants and children: Delays in physical or mental development; children could show slight deficits in attention span and learning abilities Adults: Kidney problems; high blood pressure	Corrosion of household plumbing systems; erosion of natural deposits
Mercury (inorganic)	0.002	0.002	Kidney damage	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands
Nitrate (measured as Nitrogen)	10	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits
Nitrite (measured as Nitrogen)	1	1	Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits
Selenium	0.05	0.05	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	Discharge from petroleum refineries; erosion of natural deposits; discharge from mines

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
Thallium	0.0005	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories

Organic Chemicals

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
Acrylamide	zero	TT[8]	Nervous system or blood problems; increased risk of cancer	Added to water during sewage/wastewater treatment
Alachlor	zero	0.002	Eye, liver, kidney or spleen problems; anemia; increased risk of cancer	Runoff from herbicide used on row crops
Atrazine	0.003	0.003	Cardiovascular system or reproductive problems	Runoff from herbicide used on row crops
Benzene	zero	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Discharge from factories; leaching from gas storage tanks and landfills
Benzo(a)pyrene (PAHs)	zero	0.0002	Reproductive difficulties; increased risk of cancer	Leaching from linings of water storage tanks and distribution lines
Carbofuran	0.04	0.04	Problems with blood, nervous system, or reproductive system	Leaching of soil fumigant used on rice and alfalfa
Carbon tetrachloride	zero	0.005	Liver problems; increased risk of cancer	Discharge from chemical plants and other industrial activities
Chlordane	zero	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide
Chlorobenzene	0.1	0.1	Liver or kidney problems	Discharge from

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
				chemical and agricultural chemical factories
2,4-D	0.07	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops
Dalapon	0.2	0.2	Minor kidney changes	Runoff from herbicide used on rights of way
1,2-Dibromo-3-chloropropane (DBCP)	zero	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards
o-Dichlorobenzene	0.6	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories
p-Dichlorobenzene	0.075	0.075	Anemia; liver, kidney or spleen damage; changes in blood	Discharge from industrial chemical factories
1,2-Dichloroethane	zero	0.005	Increased risk of cancer	Discharge from industrial chemical factories
1,1-Dichloroethylene	0.007	0.007	Liver problems	Discharge from industrial chemical factories
cis-1,2-Dichloroethylene	0.07	0.07	Liver problems	Discharge from industrial chemical factories
trans-1,2-Dichloroethylene	0.1	0.1	Liver problems	Discharge from industrial chemical factories
Dichloromethane	zero	0.005	Liver problems; increased risk of cancer	Discharge from drug and chemical factories
1,2-Dichloropropane	zero	0.005	Increased risk of cancer	Discharge from industrial chemical factories

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
Di(2-ethylhexyl) adipate	0.4	0.4	Weight loss, liver problems, or possible reproductive difficulties.	Discharge from chemical factories
Di(2-ethylhexyl) phthalate	zero	0.006	Reproductive difficulties; liver problems; increased risk of cancer	Discharge from rubber and chemical factories
Dinoseb	0.007	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables
Dioxin (2,3,7,8-TCDD)	zero	0.00000003	Reproductive difficulties; increased risk of cancer	Emissions from waste incineration and other combustion; discharge from chemical factories
Diquat	0.02	0.02	Cataracts	Runoff from herbicide use
Endothall	0.1	0.1	Stomach and intestinal problems	Runoff from herbicide use
Endrin	0.002	0.002	Liver problems	Residue of banned insecticide
Epichlorohydrin	zero	TT[8]	Increased cancer risk, and over a long period of time, stomach problems	Discharge from industrial chemical factories; an impurity of some water treatment chemicals
Ethylbenzene	0.7	0.7	Liver or kidneys problems	Discharge from petroleum refineries
Ethylene dibromide	zero	0.00005	Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer	Discharge from petroleum refineries
Glyphosate	0.7	0.7	Kidney problems; reproductive difficulties	Runoff from herbicide use
Heptachlor	zero	0.0004	Liver damage; increased risk of cancer	Residue of banned termiticide

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
Heptachlor epoxide	zero	0.0002	Liver damage; increased risk of cancer	Breakdown of heptachlor
Hexachlorobenzene	zero	0.001	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Discharge from metal refineries and agricultural chemical factories
Hexachlorocyclopentadiene	0.05	0.05	Kidney or stomach problems	Discharge from chemical factories
Lindane	0.0002	0.0002	Liver or kidney problems	Runoff/leaching from insecticide used on cattle, lumber, gardens
Methoxychlor	0.04	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock
Oxamyl (Vydate)	0.2	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, and tomatoes
Polychlorinated biphenyls (PCBs)	zero	0.0005	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Runoff from landfills; discharge of waste chemicals
Pentachlorophenol	zero	0.001	Liver or kidney problems; increased cancer risk	Discharge from wood preserving factories
Picloram	0.5	0.5	Liver problems	Herbicide runoff
Simazine	0.004	0.004	Problems with blood	Herbicide runoff
Styrene	0.1	0.1	Liver, kidney, or circulatory system problems	Discharge from rubber and plastic factories; leaching from landfills
Tetrachloroethylene	zero	0.005	Liver problems; increased risk of cancer	Discharge from factories and dry cleaners

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
Toluene	1	1	Nervous system, kidney, or liver problems	Discharge from petroleum factories
Toxaphene	zero	0.003	Kidney, liver, or thyroid problems; increased risk of cancer	Runoff/leaching from insecticide used on cotton and cattle
2,4,5-TP (Silvex)	0.05	0.05	Liver problems	Residue of banned herbicide
1,2,4-Trichlorobenzene	0.07	0.07	Changes in adrenal glands	Discharge from textile finishing factories
1,1,1-Trichloroethane	0.20	0.2	Liver, nervous system, or circulatory problems	Discharge from metal degreasing sites and other factories
1,1,2-Trichloroethane	0.003	0.005	Liver, kidney, or immune system problems	Discharge from industrial chemical factories
Trichloroethylene	zero	0.005	Liver problems; increased risk of cancer	Discharge from metal degreasing sites and other factories
Vinyl chloride	zero	0.002	Increased risk of cancer	Leaching from PVC pipes; discharge from plastic factories
Xylenes (total)	10	10	Nervous system damage	Discharge from petroleum factories; discharge from chemical factories

Radionuclides

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
Alpha particles	none[7] ---------- zero	15 picocuries per Liter (pCi/L)	Increased risk of cancer	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation
Alpha particles	none[7] -------	4 millirems	Increased risk of cancer	Decay of natural and man-made

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term)	Sources of Contaminant in Drinking Water
	--- zero	per year		deposits of certain minerals that are radioactive and may emit forms of radiation known as photons and beta radiation
Alpha particles	none[7] ---------- zero	5 pCi/L	Increased risk of cancer	Erosion of natural deposits
Alpha particles	zero	30 ug/L as of 12/08/03	Increased risk of cancer, kidney toxicity	Erosion of natural deposits

Notes

[1] Definitions: Maximum Contaminant Level Goal (MCLG) - The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals. Maximum Contaminant Level (MCL) - The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards. Maximum Residual Disinfectant Level Goal (MRDLG) - The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants. (TT) Treatment Technique - A required process intended to reduce the level of a contaminant in drinking water. Maximum Residual Disinfectant Level (MRDL) - The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

[2] Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter are equivalent to parts per million.

[3] EPA's surface water treatment rules require systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

- Cryptosporidium: Unfiltered systems are required to include Cryptosporidium in their existing watershed control provisions.
- Giardia lamblia: 99.9% removal/inactivation
- Viruses: 99.99% removal/inactivation
- Legionella: No limit, but EPA believes that if Giardia and viruses are removed/inactivated, according to the treatment techniques in the Surface Water Treatment Rule, Legionella will also be controlled.
- Turbidity: For systems that use conventional or direct filtration, at no time can turbidity (cloudiness of water) go higher than 1 nephelolometric turbidity unit NTU), and samples for turbidity must be less than or equal to 0.3 NTU in at least 95 percent of the samples in any month. Systems that use filtration other than the conventional or direct filtration must follow state limits, which must include turbidity at no time exceeding 5 NTU.
- HPC: No more than 500 bacterial colonies per milliliter.
- Long Term 1 Enhanced Surface Water Treatment: Surface water systems or (GWUDI) systems serving fewer than 10,000 people must comply with the applicable Long Term 1 Enhanced Surface Water Treatment Rule provisions

(e.g. turbidity standards, individual filter monitoring, Cryptosporidium removal requirements, updated watershed control requirements for unfiltered systems).

- Long Term 2 Enhanced Surface Water Treatment Rule This rule applies to all surface water systems or ground water systems under the direct influence of surface water. The rule targets additional Cryptosporidium treatment requirements for higher risk systems and includes provisions to reduce risks from uncovered finished water storage facilities and to ensure that the systems maintain microbial protection as they take steps to reduce the formation of disinfection byproducts.
- Filter Backwash Recycling; The Filter Backwash Recycling Rule requires systems that recycle to return specific recycle flows through all processes of the system's existing conventional or direct filtration system or at an alternate location approved by the state.

[4] No more than 5.0% samples total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive per month.) Every sample that has total coliform must be analyzed for either fecal coliforms or E. coli if two consecutive TC-positive samples, and one is also positive for E.coli fecal coliforms, system has an acute MCL violation.

[5] Fecal coliform and E. coli are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Disease-causing microbes (pathogens) in these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms. These pathogens may pose a special health risk for infants, young children, and people with severely compromised immune systems.

[6] Although there is no collective MCLG for this contaminant group, there are individual MCLGs for some of the individual contaminants:

- Trihalomethanes: bromodichloromethane (zero); bromoform (zero); dibromochloromethane (0.06 mg/L): chloroform (0.07mg/L).
- Haloacetic acids: dichloroacetic acid (zero); trichloroacetic acid (0.02 mg/L); monochloroacetic acid (0.07 mg/L). Bromoacetic acid and dibromoacetic acid are regulated with this group but have no MCLGs.

[7] Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.

[8] Each water system must certify, in writing, to the state (using third-party or manufacturer's certification) that when acrylamide and epichlorohydrin are used to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows:

- Acrylamide = 0.05% dosed at 1 mg/L (or equivalent)
- Epichlorohydrin = 0.01% dosed at 20 mg/L (or equivalent)

National Secondary Drinking Water Regulations

National Secondary Drinking Water Regulations (NSDWRs or secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, states may choose to adopt them as enforceable standards.

- National Secondary Drinking Water Regulations – The complete regulations regarding these contaminants available from the Code of Federal Regulations Web Site.
- For more information, read Secondary Drinking Water Regulations: Guidance for Nuisance Chemicals.

List of National Secondary Drinking Water Regulations

Contaminant	Secondary Standard
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	Noncorrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5–8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

SOURCE: http://water.epa.gov/drink/contaminants/index.cfm#List

WYOMING

Wyoming Department of Environmental Quality
Water Quality Division

<u>Guideline for Sampling and Testing Well Water Quality</u>

The Wyoming Department of Environmental Quality (WDEQ) has developed this Guideline to provide basic information to well owners interested in evaluating water well quality for domestic use. Well owners may find the information in this guideline useful in understanding how and when to collect water well samples, what to sample for, and laboratories that perform water quality analyses. The information presented in this guideline is intended to assist well owners in making informed decisions, but well owners are also encouraged to seek professional advice and assistance related to their specific situation or concern.

Potential Sources of Groundwater Contamination

Virtually all types of land use activities have the potential to impact water supplies. Common land use activities that are known to have impacted water supplies include: agricultural, residential, government, commercial, and industrial (including mining and oil and gas development). Water wells can also be impacted by naturally occurring sources of contamination (e.g. arsenic, selenium, fluoride, radium, etc.) at levels that may cause health concerns. Well owners should become familiar with the various types of land use activities within their area in order to understand the types of chemical constituents that are often associated with them and that may impact groundwater. Please refer to the table of potential sources and contaminants available on DEQ's website at http://deq.state.wy.us/wqd/groundwater/index.asp that further describes potential sources of contamination and the types of materials and chemical constituents that are commonly associated with them.

Establishing 'Baseline' Quality of Well Water

DEQ recommends that all domestic wells be initially sampled and analyzed for **Tier 1** (with the exception of disinfection by-products and disinfectants), **Tier 2 and Tier 3** constituents as described below:

Tier 1 (Safe Drinking Water) constituents include those potential drinking water contaminants for which the US EPA has established safe drinking water levels (*National Primary Drinking Water Standards*), and levels that ensure the aesthetic (taste, odor, etc.) quality of drinking water (Secondary Drinking Water Standards). These include certain microorganisms, metals, inorganic minerals and chemical compounds, organic chemicals, and radionuclides known to be potentially harmful or otherwise affect the aesthetic quality of drinking water. A copy is available on DEQ's website at http://deq.state.wy.us/wqd/groundwater/index.asp. A Tier 1 analysis is very expensive and may cost upwards of a few thousand dollars to complete.

Tier 2 and Tier 3 ('Indicators') constituents are a limited set of potential contaminants that can be used to indicate changes in well water quality, and possibly detect the presence of water well contamination. They typically consist of several minerals and metals that occur naturally in ground water, physical parameters (e.g. pH), and one or more chemical constituents usually associated with potential sources of contamination in the area of the well. Different 'indicators' recommended by other agencies and laboratories may be equally suitable for establishing baseline water well quality and monitoring for potential contamination over time. The more comprehensive the list of constituents, the better, when determining whether well water is suitable for domestic use or has been impacted by a potential source of contamination.

Tier 2 constituents include: conductivity, pH, Total Dissolved Solids (TDS), alkalinity, barium, calcium, magnesium, sodium, chloride, sulfate, fluoride, nitrate, lead, arsenic, iron, and total organic carbon. A Tier 2 analysis is relatively inexpensive and will likely cost less than a couple hundred dollars to complete.

Tier 3 constituents are 'indicator' chemical compounds often associated with a potential source of contamination. A Tier 3 analysis can cost between a couple hundred to several thousand dollars to complete, depending upon the type and number of constituents to be analyzed by the laboratory.

Sampling Frequency

Upon completion of **Tier 1, Tier 2 and Tier 3** analyses to establish 'baseline' conditions, it is important to continue to periodically collect samples from the well in order to evaluate whether well water quality has changed over time, or not. Ideally, follow up samples should be analyzed for **Tier 1** constituents on a schedule similar to that required for public water systems, or more frequently if there is a noticeable change in the taste, color, or odor of well water. Generally, for groundwater-supplied public water systems EPA requires sampling and analyses for inorganic and synthetic organic contaminants and radionuclides every three years; volatile organic contaminants every 5 years (or annually if detected in prior samples); and nitrate and nitrite annually. Well owners may consider eliminating the need to analyze for constituents associated with sources of contamination which they believe pose little, if any threat to their water supply.

Unfortunately, the cost for Tier 1 analysis can be very expensive. Alternatively, less expensive sampling and lab analyses can be a useful way to periodically screen for changes in water well quality provided that the well owner understands the limitations of not completing a Tier 1 analyses on schedule. One alternative may be to rotate the sampling schedule by completing a Tier 1 analysis as scheduled in order to evaluate the safety of the well water for drinking water purposes, then complete less expensive Tier 2 and Ties 3 'indicator' sampling during Year 2 and annually or bi-annually thereafter in order to evaluate 'indicators' of potential contamination.

Well owners may wish to consider negotiating water well testing, both pre-and post-drilling, as a condition to their mineral lease, or surface use agreement. Obtaining baseline water well quality and periodic sampling and analysis may be beneficial to both parties.

Sample Collection and Laboratory Analysis

Water well testing should be arranged through a certified water testing laboratory and water well samples should be collected by an unbiased professional. This could be an employee of the water testing laboratory. Doing so can add significantly to the cost of water well testing but may be vital to the admissibility of the sample results if a legal action related to pollution of the water well ensues. It is unlikely that test results from water samples collected by the water well owner will be recognized in legal proceedings, however, well owners are encouraged to consult their own attorneys for professional advice.

It is also important to request laboratory methods that achieve a low detection limit in order to detect the presence of contaminants at low levels. Generally, the lower the detection limit, the more expensive the water quality analysis.

Before selecting a lab it may be prudent to check the laboratory's certifications. Preferred labs are certified by US EPA. Consult the 'Environmental' or 'Water Testing' sections of your local Yellow Pages for a list of laboratories within your area.

The Wyoming Department of Agriculture laboratory in Laramie also provides some analytical services and is EPA certified. For more information, contact the lab at 307-742-2984 or visit them online at: http://wyagric.state.wy.us/images/stories/pdf/forms/aslab/labfees.pdf.

Evaluating Sample Results

Tier 1 sample results should be compared to the safe drinking water levels listed on US EPA's Primary Drinking Water Standards table available on DEQ's website at http://deq.state.wy.us/wqd/groundwater/index.asp. If a sample result for any "primary" constituent exceeds its safe drinking water level (Maximum Contaminant Level (MCL)) listed on the table, the US EPA considers the water not safe for drinking water purposes. In these situations, well owners should discontinue use of the well until an assessment of water treatment alternatives has been completed. The cause may, or may not be associated with man-made contamination. For instance, some areas in Wyoming have naturally occurring constituents in ground water (e.g. arsenic, selenium, fluoride, radium, etc.) that exceed the safe drinking water level. If the cause of contamination is suspected to be a result of some type of human activity, well owners are encouraged to contact DEQ's Spill and Complaint hotline at 307-777-7781 or provide information online at DEQ's website (http://deq.state.wy.us/) by clicking on the link *"Got a Spill?"*.

Tier 1 sample results should also be compared to the aesthetic drinking water levels listed on US EPA's Secondary Drinking Water Standards table available on DEQ's website at http://deq.state.wy.us/wqd/groundwater/index.asp. If a sample result for any "secondary" constituent exceeds its aesthetic drinking water level (Secondary Standard) listed on the table, the water may be safe for drinking water purposes, but may have problems with taste, appearance, or odor. Again, the cause may, or may not be associated with manmade contamination. Well owners should contact their local health department or county conservation district office, or visit DEQ's website at http://deq.state.wy.us/wqd/groundwater/index.asp for further information on water treatment.

Usually one sees only minor fluctuations in **Tier 2** water quality results over time. Tier 2 sample results should also be compared to US EPA's Primary and Secondary Drinking Water Standards table as described above. If Tier 2 sample results illustrate an increasing trend in constituent concentration over time (i.e. over several sampling periods) the well owner is encouraged to consult with the local DEQ Water Quality Division office in Cheyenne, Sheridan, Lander, or Casper.

Tier 3 sample results should be compared to US EPA's latest edition of *"Drinking Water Standards and Health Advisories"* available on DEQ's website at http://deq.state.wy.us/wqd/groundwater/index.asp. If a sample result for any constituent exceeds its safe drinking water level (Maximum Contaminant Level (MCL)) or its drinking water equivalent level (DWEL) listed on the table, the US EPA considers the water to be not safe for drinking water purposes. In these situations, well owners should discontinue use of the well until an assessment of water treatment alternatives has been completed. The cause may, or may not be associated with man-made contamination. If the cause of contamination is suspected to be a result of some type of human activity, well owners are encouraged to contact DEQ's Spill and Complaint hotline at 307-777-7781 or provide information online at DEQ's website (http://deq.state.wy.us/) by clicking on the link *"Got a Spill?"*.

For Further Information:

Wyoming Department of Environmental Quality
Water Quality Division
122 W. 25th St. – 4W
Cheyenne, WY 82002
307-777-7781

Wyoming Department of Environmental Quality
Water Quality Division

WYOMING

Sampling and Testing Water Wells in Areas of Oil and Gas Development

The Wyoming Department of Environmental Quality (WDEQ) has developed this guideline in response to public concern about potential impacts to water wells due to industrial activity, such as oil and gas exploration and development. Water well owners are concerned with maintaining the quality of their water. Periodic sampling and testing of well water is important to initially determine that well water is suitable and safe for drinking water purposes, and to monitor for potential changes in water quality or presence of contaminants over time. Testing can help answer the question of whether a well has been impacted by industrial activity. Water samples may be collected by the well owner or by an independent third party, however, test results from water samples collected by a well owner may not be recognized in legal proceedings.

It is important to collect water well samples prior to drilling or other industrial activity to establish 'baseline' water quality conditions. Mineral and surface owners may be able to negotiate water well testing, both pre-and post-drilling, as part of their mineral lease or surface use agreement.

Water can be tested for hundreds of water quality analytes and parameters. Ideally, well water should be tested as described in WDEQ's ***Guideline for Sampling and Testing Well Water Quality*** (see link below). However, for those who do not wish to go to this extent and expense, the following relatively inexpensive 'indicator' analytes, parameters, and chemical compounds may provide a level of comfort for monitoring potential effects from oil and gas development:

Mineral and metal indicators: conductivity, pH, Total Dissolved Solids (TDS), alkalinity, barium, calcium, magnesium, sodium, chloride, sulfate, fluoride, nitrate, lead, arsenic, iron, and total organic carbon.

Chemical indicators: TPH-DRO and TPH-GRO (Total Petroleum Hydrocarbons – Diesel Range Organics and Gasoline Range Organics); and BTEX (Benzene, toluene, ethylbenzene, and xylenes).

Laboratories can provide information on how to collect a water sample, or provide for sample collection. Laboratories can also help with the selection of additional, or alternative water quality analytes and 'indicators' for other types of potential contaminants.

Laboratory analyses for mineral and metal water quality 'indicators' can be obtained for as little as $150 from the Wyoming Department of Agriculture lab at (307) 742-2984. Lab analyses for chemical indicators is more expensive and may cost a few hundred dollars, or more, but are more likely to detect contamination associated with a variety of different oil and gas related activities.

For more information regarding potential sources of contamination, establishing baseline quality of well water, sampling frequency, evaluation of sample results, and laboratories available to the public please refer to WDEQ's ***Guideline for Sampling and Testing Well Water Quality*** available on WDEQ's website at http://deq.state.wy.us/wqd/groundwater/index.asp.

December 2010

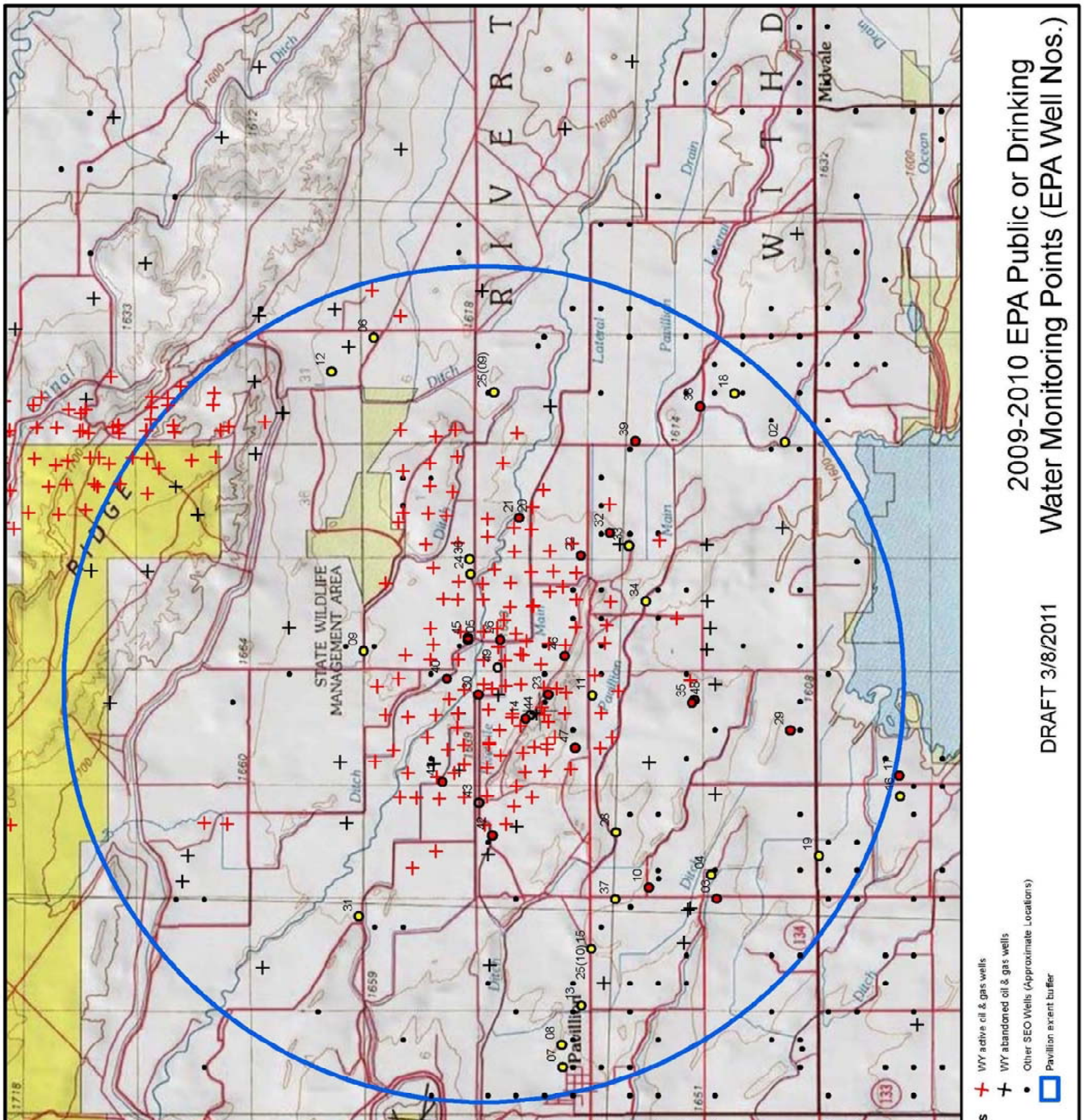
EPA Public_Drinking Water Monitoring Points
EPA Water Haul
Stock/Garden
Other
WY active oil & gas wells
WY abandoned oil & gas wells
Other SEO Wells (Approximate Locations)
Pavillion extent buffer
DRAFT 3/8/2011
2009-2010 EPA Public or Drinking Water Monitoring Points (EPA Well Nos.)
STATE WILDLIFE MANAGEMENT AREA
Pavillion
Midvale
Landing Strips
Pavillion Butte
Sand Butte
RIDGE
RIVERTON
WITH D

Table - Pavillion "Core" Area Groundwater Quality

Constituent	EPA START 3, 2010 Monitoring Points in "Core" Area								
	PGDW5	PGDW20	PGDW22	PGDW23	PGDW30	PGDW32	PGDW40	PGDW41	PGDW46
SEMI-VOLATILES (mg/L) (Table 9)									
2,4,5-Trichlorophenol		0.00019							
Bis(2-ethylhexyl)phthalate		[2]	[2]	[2]	[2]	[2]	[2]	0.011	[2]
Butylbenzylphthalate				0.00018	0.00013	0.00014			
Caprolactam			0.00098	0.00063		0.00054			0.0003
Di-n-butyl phthalate			0.00016	[2]	0.00018	[2]			
Di-n-octyl phthalate	[2]							0.006	
Tris (2-butoxyethyl) phosphate		0.00063							0.00183
TPH, DRO (mg/L) (Table 9)									
TPH as Diesel (DRO)	0.0753	0.0217	0.154		0.035		0.0326	0.479	0.0255
TPH Total Extractable Hydrocarbons								1.3	
PESTICIDES/AROCLOR (mg/L) (Table 9)									
Endosulfan I		0.0000015							
gamma-Clordane							0.0000016		
VOLATILES (mg/L) (Table 10)									
1,3-Dimethyl adamantane	0.00174				0.00181		0.00036		
Adamantane	0.00021					0.0003			
Chloroform								0.00024	
Chloromethane								0.00027	
Ethane		0.0109							
Methane	0.00544	0.172		0.149	0.808	0.0363	0.0989		
Styrene							0.00014		
Toluene								0.00051	
TPH, GRO (mg/L) (Table 10)									
TPH as Gasoline (GRO)	0.0263					0.0226			
TPH Total Purgeable Hydrocarbons	0.049				0.036				
FIXED AND LIGHT GASES IN NATURAL GAS (ppm) (Table 13									
Methane		1300		820	6300		270	12	
Ethane		52		1.7	1.8				
Propanes		5.8							
Butanes		6.9		12	3.1				
Pentanes		1.3		2.3	3.9			3.7	
Hexanes				2.4	0.77			0.75	
Heptanes				0.5	0.79			2.8	
Octanes		1.9		2.4	2.9				
GASOLINE RANGE COMPOUNDS (mg/L) (Table 17)									
Isobutane		0.0026		0.0089					

PGDW14 and PGDW26 are also "core" area monitoring points but there were no data for these wells.

[2]Compund found in method blank; detection is above 10x method blank value.

EPA 2010 Monitoring Points TD and Water Quality

Well ID	Total Depth (ft bgs)	Sodium (mg/L)	Sulfate (mg/L)	Arsenic (mg/L)
PGDW46	48	91.1	126	0.00032
PGDW49	50	1210	3160	0.00071
PGDW39	57	1110	3640	0.00032
PGDW43	100	911	2470	0.0013
PGDW45	100	59.4	213	0.00046
PGDW42	200	181	311	0.001
PGDW05	207	189	287	0.00036
PGDW05D	207	181	287	0.001
PGDW40	220	244	426	0.001
PGDW30	260	195	333	0.001
PGDW41	376	1030	2670	0.00089
PGDW48	380	725	1840	0.00041
PGDW20	460	550	1270	0.0005
PGDW03	500	251	570	0.00042
PGDW04	500	265	532	0.00032
PGDW23	500	194	368	0.001
PGDW47	500	183	330	0.00032
PGPW01	506	173	300	0.00031
PGPW02	515	393	847	0.00024
PGDW32	675	193	368	0.00053
PGDW10	745	195	293	0.001
PGDW44	750	994	2880	0.00048
PGDW25	800	269	441	0.00046
PGDW22		908	2780	0.00047
Total depths were compiled by EPA from SEO records, anecdotal depths from residents and well logs.				

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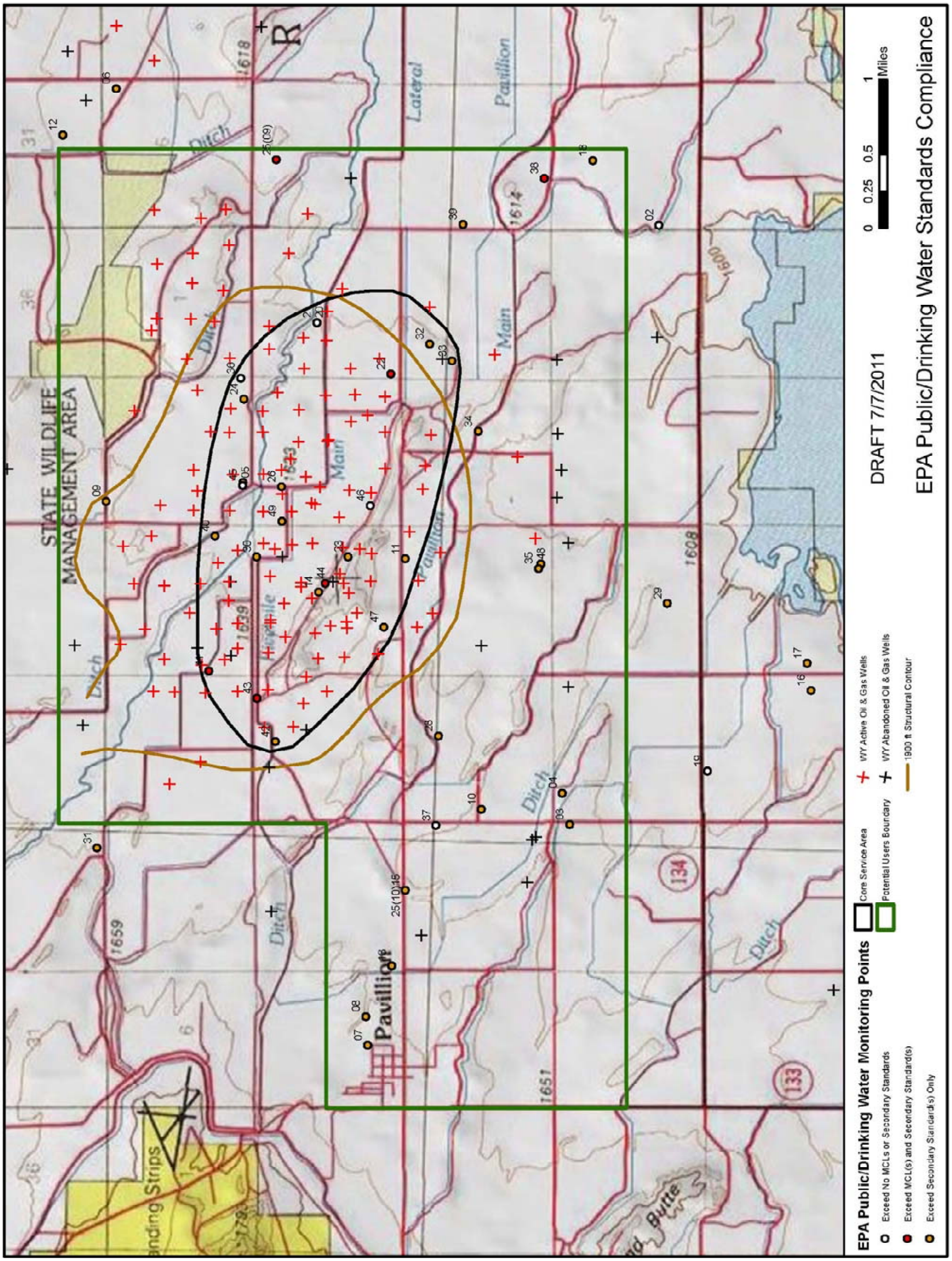
EPA Public/Drinking Water Standards Compliance
DRAFT 7/7/2011
EPA Public/Drinking Water Monitoring Points
Exceed No MCLs or Secondary Standards
Exceed MCL(s) and Secondary Standard(s)
Exceed Secondary Standard(s) Only
Core Service Area
Potential Users Boundary
WY Active Oil & Gas Wells
WY Abandoned Oil & Gas Wells
1900 ft Structural Contour
0 0.25 0.5 1 Miles
STATE WILDLIFE MANAGEMENT AREA
Pavillion
Ditch
Main
Lateral
134
133

Table X - EPA Monitoring Points with MCLs

SampleID	TNS		RNG		SEC	Qtrqtr	NO_3 - N 2/18/11	Gross Alpha (pCi/L) 2/18/11	TDS 2/18/11	TDS SOC	Approx. TDS 2010	EPA (2009, Table 12; 2010, Table 11) Sulfate (SO_4) 2009	Sulfate (SO_4) 2010	Sulfate (SO_4) 2/18/11	Fluoride 2009	Fluoride 2010	Fluoride 2/18/11	Chloride 2009	Chloride 2010	Chloride 2/18/11	Nitrate 2009	Nitrate 2010	Nitrite 2009	Nitrite 2010
PGDW02	3	N	3	E	19	SWSW					299	175			0.7			2.6			<0.5		<0.5	
PGDW03	3	N	2	E	20	NENE					**859**	**549**	**570**		0.9	0.8		25.1	20.7		<0.5	<0.3	<0.5	<0.3
PGDW04	3	N	2	E	21	NWNW					**837**	**551**	**532**		0.9	0.9		21.6	23.3		<0.5	<0.3	<0.5	<0.3
PGDW05	3	N	2	E	2	SESW					497	**295**	**287**		0.9	0.9		17	16.5		<0.5	<0.3	<0.5	<0.3
PGDW06	3	N	3	E	6	NENE					**773**	**485**			1.3			31			<0.5		<0.5	
PGDW09	3	N	2	E	2	NWNW					**542**	**279**			**2.4**			10.5			3.2		<0.5	
PGDW10	3	N	2	E	16	NWSW	<0.1	-3	**589**		**502**	**293**	**293**	**298**	0.9	0.9	1.0	8	7.5	8	<0.5	<0.3	<0.5	<0.3
PGDW11	3	N	2	E	15	NENE					**2582**	**1780**			0.2			15.3			1.3		<0.5	
PGDW12	4	N	3	E	31	SWSE					**793**	**497**			1.5			30.8			<0.5		<0.5	
PGDW13	3	N	2	E	8	SWSW					**607**	**343**			0.7			6.2			1		<0.5	
PGDW14	3	N	2	E	10	SWNE					**2691**	**1820**			0.4			26.1			0.7		<0.5	
PGDW15	3	N	2	E	17	NWNE					**872**	**520**			0.6			9.9			1.8		<0.5	
PGDW16	3	N	2	E	28	NESE					467	**258**			0.8			13.4			<0.5		<0.5	
PGDW17	3	N	2	E	27	NWSW					**934**	**583**			2			49.5			<0.5		<0.5	
PGDW18	3	N	3	E	19	SENW					**2002**	**1380**			1.8			27			0.5		<0.5	
PGDW19	3	N	2	E	28	NENW					427	196			0.9			6.9			2.6		<0.5	
PGDW20	3	N	2	E	12	SENW					**1925**	**1370**	**1270**		0.8	0.8		34.5	32.6		<0.5	<0.3	<0.5	<0.3
PGDW21	3	N	2	E	12	SENW						<1.0			<0.2			0.6			<0.5		<0.5	
PGDW22	3	N	2	E	12	SWSW					**4160**	**2720**	**2780**		<0.2			79.9	74.6		**43.6**	**40.7**	<0.5	<0.3
PGDW23	3	N	2	E	10	NESE					**589**	**365**	**368**		1.2	1.5		19.8	19.7		<0.5	<0.3	<0.5	<0.3
PGDW24	3	N	2	E	2	SESE					**4522**	**3200**			0.6			55.7			<0.5		<0.5	
PGDW25(09)	3	N	3	E	7	NENW						**355**			**4.1**			8.4			<0.5		<0.5	
PGDW25(10)	3	N	2	E	17	NWNE					**790**		**441**						9.5			1.7		<0.3
PGDW26	3	N	2	E	11	NENW					**1839**	**1240**			0.7			14.6			1.5		<0.5	
PGDW28	3	N	2	E	16	SWNE					**595**	**298**			0.5			16.7			3.7		<0.5	
PGDW29	3	N	2	E	22	SESW					**939**	**596**			0.9			24.6			<0.5		<0.5	
PGDW30	3	N	2	E	10	NENE					**548**	**335**	**333**		0.9	0.9		16.3	15.5		<0.5	<0.3	<0.5	<0.3
PGDW31	4	N	2	E	32	SESE					**1510**	**1030**			0.4			13.3			0.5		<0.5	
PGDW32	3	N	2	E	13	NWNW					**592**	**373**	**368**		**2.3**	**2.4**		21.8	21.4		<0.5	<0.3	<0.5	<0.3
PGDW33	3	N	2	E	13	SWNW					**3119**	**2690**			0.2			23			2.1		<0.5	
PGDW34	3	N	2	E	14	NWSE					**1810**	**670**			0.5			28			3.5		<0.5	
PGDW35	3	N	2	E	15	SWSE					**2339**	**1610**			0.3			24.1			0.5		<0.5	
PGDW36	3	N	2	E	2	SESE					330	195			1			3.2			1.2		<0.5	
PGDW37	3	N	2	E	17	NENE					299	89.9			0.9			8.7			1.2		<0.5	
PGDW38	3	N	3	E	18	SESW					**1386**	**908**			1.3			33.7			5.9		<0.5	
PGDW39	3	N	3	E	18	SWNW					**5192**	**3980**	**3640**		0.4	0.3		48	52.9		0.6	<0.3	<0.5	<0.3
PGDW40	3	N	2	E	3	SESE					**690**		**426**						13.1			<0.3		<0.3
PGDW41	3	N	2	E	3	NWSW					**4002**		**2670**			0.5			31.4			<0.3		<0.3
PGDW42	3	N	2	E	9	NWNE					**511**		**311**			1			13.2			<0.3		<0.3
PGDW43	3	N	2	E	9	NENE					**3628**		**2470**			0.4			38.4			<0.3		<0.3
PGDW44	3	N	2	E	10	NWSE					**4173**		**2880**			0.3			39.5			<0.3		<0.3
PGDW45	3	N	2	E	2	SESW					427		213			1.9			14.5			0.3		<0.3
PGDW46	3	N	2	E	11	SWSW					316		126			0.5			8.4			2.3		<0.3
PGDW47	3	N	2	E	10	SESW					**543**		**330**			1.5			21.6			<0.3		<0.3
PGDW48	3	N	2	E	15	SWSE					**2736**		**1840**			0.3			24.1			<0.3		<0.3
PGDW49	3	N	2	E	11	NWNW					**4921**		**3160**			0.4			64.3			7.7		<0.3
PGPW01	3	N	2	E	7	SESW				**576**	495	**390**	**300**		1.2	1.2		15.7	15.3		<0.5	<0.3	<0.5	<0.3
PGPW02	3	N	2	E	7	SWSE					**1283**	**857**	**847**		0.5	0.5		8.9	8.5		<0.5	<0.3	<0.5	<0.3
EPA Drinking Water Standards Primary							10	15								4						10		1
EPA Drinking Water Standards Secondary										500			250			2			250					

Notes:

Bold values indicate primary (MCL) or secondary standard exceeded.

PGDW(09) and PGDW(10) - EPA numbered two different wells "25", one in 2009 and one in 2010; thus the distinction.

SOC - SEO Statement of Completion

The negative value for gross alpha in this analysis indicates that radionuclides in sample are not different from naturally occurring radionuclides and cosmic radiation detected by laboratory instrumentation.

2/18/11 sampling completed by Hinckley and Wetstein for the Chapman Well which is the same well as PGDW10.

We have no EPA location for PGDW01.

PGDW07 and PGDW08 are same as PGPW01 and PGPW02, respectively.

UJ - "The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound may or may not be present in the sample." (EPA table footnote)

2, U - These two EPA Table 9 footnotes indicate the following: 2 - "Compound found in method blank; detection is above 10x method blank value." and U - "Compound found in field blank; for phthalate compounds concentration in the sample is below 10x the concentration in the field blank. Thus, these compounds are NOT used for Risk Assessment per Risk Assessment Guidance for Superfund (Chapter 5 - Data Evaluation)."

G:\0512\J. Draft Report\Appendix - FINAL 8-19-11\Appendix 1 Primary Drinking Water Regulations\08-7-8-11 - EPA Mon Pts Water Quality Table with MCLs.xls

Table X - EPA Monitoring Points with MCLs

EPA (2009, Table 7 & 8; 2010, Table 12)

Aluminum		Antimony		Arsenic			Barium		Beryllium		Cadmium		Chromium		Copper		Cyanide	Iron			
2009	2010	2009	2010	2009	2010	2/18/11	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2009	2010	2/18/11	
				0.0028			0.010UJ		0.001UJ						0.0055						
	<0.2		<0.002		0.00042		0.010UJ	0.0067	0.001UJ	<0.001	0.001UJ	<0.001		<0.002	0.0054	0.0044			<1		
	<0.2		<0.002		0.00032		0.010UJ	0.006	0.001UJ	<0.001		<0.001		<0.002	0.0057	0.0039			<1		
	<0.2		<0.002		0.00036		0.010UJ	0.0111	0.001UJ	<0.001		<0.001		<0.002	0.0056	0.0077			0.0666		
							0.010UJ		0.001UJ						0.0043						
							0.010UJ		0.001UJ						0.0073		0.0031				
	<0.2		<0.002		<0.001	<0.001	0.0109	0.0091	0.001UJ	<0.001		<0.001		<0.002	0.004	0.0027	0.0012		<1	<0.03	
															0.0102						
0.890							0.0158		0.001UJ				0.0018		0.139			**0.695**			
							0.0153		0.001UJ						0.0082		0.0016				
		0.002UJ									0.001UJ				0.0148		0.0012				
0.480		0.002UJ							0.000072						0.0128			0.274			
0.0276		0.002UJ													0.0039		0.0013				
0.0532		0.002UJ													0.0061			0.0204			
									0.002UJ						0.0072						
							0.0167		0.001UJ						0.0089		0.0014				
	<0.2		<0.002		0.0005		0.0097	0.0093	0.002UJ	<0.001		<0.001		<0.002	0.0069	0.0088		0.0342	0.3		
									0.001UJ						0.0264						
	<0.2	0.002UJ	<0.002		0.00047			0.0063	0.001UJ	<0.001	0.00076	<0.001		<0.002	0.0286	0.0163	0.0015		<1		
	<0.2		<0.002		<0.001			0.0089	0.001UJ	<0.001		<0.001		<0.002	0.0037	0.0043			<1		
		0.002UJ							0.001UJ		0.00073				0.0162			**0.995**			
		0.002UJ		**0.031**									0.00058		0.014			0.0517			
	<0.2		<0.002		0.00046			0.014		<0.001		<0.001		<0.002		0.0043			<1		
0.0642		0.004UJ					0.0083				0.00085				0.041						
0.061		0.002UJ					0.0145				0.00026				0.0053						
		0.002UJ					0.0058								0.0263						
0.076	<0.2	0.002UJ	<0.002		<0.001		0.0069	0.0068		<0.001		<0.001		<0.002	0.0039	0.0039		0.117	0.0441		
0.0663		0.004UJ													0.0094						
0.0541	<0.2	0.002UJ	<0.002		0.00053		0.0096	0.0096		<0.001		<0.001		<0.002	0.0152	0.003		**0.412**	0.125		
0.0512		0.002UJ					0.0351				0.000037				0.016						
0.119		0.002UJ					0.0064		0.00047		0.000036				0.0119						
0.0984		0.004UJ					0.0446								0.0092		0.0014	**1.1**			
0.0492		0.002UJ					0.042								0.0135						
0.0334		0.002UJ													0.0078						
0.0671		0.002UJ		0.0021			0.0146						0.00065		0.0114			0.0183			
	<0.2	<0.005	<0.002	<0.005	0.00032		<0.1	0.0069	<0.001	<0.001	0.001	<0.001	<0.010	<0.002		0.0167			**0.33**		
	<0.2		<0.002		<0.001			0.0117		<0.001		<0.001		<0.002		0.0031			**1.26**		
	0.741		<0.002		0.00089			0.0096		<0.001		<0.001		0.0017		0.201			**1.88**		
	<0.2		<0.002		<0.001			0.0079		<0.001		<0.001		<0.002		0.0055			0.0966		
	<0.2		<0.0021		0.0013			0.0054		0.00029		0.00036		0.00045		0.0194			**0.403**		
	<0.2		<0.002		0.00048			0.008		<0.001		<0.001		<0.002		0.04			**2.07**		
	<0.2		<0.002		0.00046			0.037		<0.001		<0.001		<0.002		0.0045UJ			<1		
	<0.2		0.00043		0.00032			0.0751		<0.001		<0.001		<0.002		0.0136			<1		
	<0.2		<0.002		0.00032			0.0076		<0.001		<0.001		<0.002		0.0026UJ			<1		
	<0.2		<0.002		0.00041			0.0084		<0.001		<0.001		<0.002		0.0098			0.0491		
	0.0818		0.00034		0.00071			0.0082		<0.001		<0.001		0.00052		0.0573			**11.4**		
	<0.2		<0.002		0.00031		0.010UJ	0.0041	0.001UJ	<0.001		<0.001		<0.002	0.0045	<0.002			0.112		
	<0.2		<0.002		0.00024		0.010UJ	0.0076	0.001UJ	<0.001		<0.001		<0.002	0.0079	<0.0031		0.283	0.255		
		0.006		0.01			2		0.004		0.005		0.1		1.3		0.2				
0.05-0.2															1.0			0.3			

Notes:

Bold values indicate primary (MCL) or secondary standard exceeded.

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G:\0512\J. Draft Report\Appendix - FINAL 8-19-11\Appendix 1 Primary Drinking Water Regulations\08-7-8-11 - EPA Mon Pts Water Quality Table with MCLs.xls

Table X - EPA Monitoring Points with MCLs

EPA (2009, Table 7 & 8; 2010, Table 12)

Lead		Manganese			Mercury		Selenium			Silver		Sodium			Thallium		Zinc	
2009	2010	2009	2010	2/18/11	2009	2010	2009	2010	2/18/11	2009	2010	2009	2010	2/18/11	2009	2010	2009	2010
0.001UJ		0.0022					0.005UJ			0.001UJ		85.8					0.0115	
0.001UJ	<0.001	0.0034	0.0017			<0.0002	0.005UJ	<0.005		0.001UJ	<0.001	272	251			<0.001	0.0076	0.0025
0.001UJ	<0.001	0.0024	0.0028			<0.0002	0.005UJ	<0.005		0.001UJ	<0.001	270	265			<0.001	0.0118	0.0011
0.0017	0.00042	0.0034	0.0022			<0.0002	0.005UJ	<0.005		0.001UJ	<0.001	192	189			0.00023	0.0101	0.0014
0.001UJ							0.005UJ			0.001UJ		249					0.0036UJ	
0.001UJ							0.0091			0.001UJ		233					0.0051	
0.001UJ	<0.001	0.0042	0.0038	<0.01		<0.0002	0.005UJ	<0.005	<0.001	0.001UJ	<0.001	204	195	202		<0.001	0.0177	0.002
0.002UJ							0.010UJ			0.002UJ		423			0.00012		0.0116	
0.0018		0.0267					0.005UJ			0.001UJ		256					0.0083	
0.001UJ							0.0057			0.001UJ		196					0.0425	
0.0023		0.0015					0.0142			0.001UJ		690			0.000052		0.0363	
0.0017		**0.0686**										269			0.000019		0.0219	
0.00055		0.0029										188					0.0546	
0.0016		0.004										278					0.0744	
0.002UJ		0.0051					0.010UJ			0.002UJ		509					0.004UJ	
0.001UJ							0.003			0.001UJ		194					0.0153	
0.002UJ	<0.001	0.0356	0.0313			<0.0002	0.010UJ	0.00098		0.002UJ	<0.001	520	550			<0.001	0.0061	0.0076
0.0013		0.0067					0.005UJ			0.001UJ		1.12					0.0263	
0.00024	<0.001	0.0039	0.003			<0.0002	0.0062	0.0039		0.001UJ	<0.001	837	908		0.000027	<0.001	0.0194	0.0027
0.001UJ	<0.001	0.0039	0.0028			<0.0002	0.005UJ	<0.005		0.001UJ	<0.001	208	194			<0.001	0.0076	<0.002
0.00029		**0.302**					0.005UJ			0.001UJ		938			0.001UJ		0.769	
0.0014		0.0068					0.0107			0.001UJ		249			0.000019		0.0406	
	<0.001		0.0209			<0.0002		0.0013			<0.001		269			<0.001		0.0151
0.0042		**0.157**										220			0.00012		0.0269	
0.00012		0.00038			0.000091		0.038					239			0.000008		0.025	
0.0013		0.0066										298					0.0253	
0.00014	<0.001	0.0033	0.0022			<0.0002		<0.005			<0.001	210	195			<0.001	0.0355	0.0012
0.002UJ		0.0111										435					0.0329	
0.0016	<0.001	0.0122	0.0032			<0.0002		<0.005			<0.001	199	193			<0.001	0.102	0.0239
0.0022		0.0018					0.0028					178			0.00002		0.0836	
0.00023		0.00089					0.0254			0.001UJ		786			0.000046		0.0284	
0.002UJ		**0.094**			0.000091							587					0.015	
0.00055		0.00062					0.0063					41.7					0.0209	
0.0011		0.00055					0.0083					187					0.0815	
0.00063		0.0022					**0.0673**					373					0.0175	
	<0.001		**0.174**			<0.0002	<0.005	0.0012			<0.001		1110		<0.005	<0.001		0.0268
	0.00091		0.0328			<0.0002		<0.005			<0.001		244			<0.001		0.211
	0.0383		**0.222**			<0.0002		0.0014			<0.001		1030			<0.001		0.0325
	<0.001		0.003			<0.0002		<0.005			<0.001		181			<0.001		0.0012
	0.00081		**0.0844**			<0.0002		0.0039			<0.001		911			0.00076		0.0176
	<0.001		**0.213**			<0.0002		0.0022			<0.001		994			<0.001		0.0063
	0.0021		0.00032			<0.0002		0.0051			<0.001		59.4			<0.001		0.004
	0.0013		0.00031			<0.0002		0.0026			<0.001		91.1			<0.001		0.0327
	<0.001		0.0016			<0.0002		<0.005			<0.001		183			<0.001		0.0022
	<0.001		**0.0857**			<0.0002		0.001			<0.001		725			<0.001		0.0023
	0.0022		**0.158**			<0.0002		0.0023			<0.001		1210			0.00024		0.0187
0.001UJ	<0.001	0.0056	0.0071			<0.0002	0.005UJ	<0.005		0.001UJ	<0.001		173			<0.001	0.0021UJ	<0.002
0.001UJ	<0.001	0.0104	0.0096			<0.0002	0.005UJ	<0.005		0.001UJ	<0.001		393			<0.001	0.0023UJ	<0.002
0.015					0.002		0.05								0.002			
		0.05								0.1							5	

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Table X - EPA Monitoring Points with MCLs

EPA (2009, Table 9; 2010, Table 9)							EPA (2009, Table 13; 2010, Table 10)								
Bis(2-ethylhexyl)phthalate		Fluorene	Naphthalene	gamma-BHC (Lindane)	Heptachlor	Methoxychlor	Benzene	Ethylbenzene	m,p-Xylene	Methane		Methylene chloride	o-Xylene	Styrene	Toluene
2009	2010	2010	2010	2010	2010	2010	2010	2010	2010	2009	2010	2010	2010	2010	2010
	2, U	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
	2, U	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
	U	ND	ND	ND	ND	ND	ND	ND	ND	0.0166	0.0054	ND	ND	ND	ND
	2, U	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
0.002															
0.0025															
0.0012															
0.0016															
										0.0106					
0.0014															
0.0064	2, U	ND	ND	ND	ND	ND	ND	ND	ND	0.137	0.172	ND	ND	ND	ND
0.0016										0.0543					
0.0014	2, U	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
0.0021	2, U	ND	ND	ND	ND	ND	ND	ND	ND	0.146	0.149	ND	ND	ND	ND
0.0098															
	2, U	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
0.0018															
	2, U	ND	ND	ND	ND	ND	ND	ND	ND	0.558	0.808	ND	ND	ND	ND
	2	ND	ND	ND	ND	ND	ND	ND	ND	0.0214	0.0363	ND	ND	ND	ND
0.0031										0.0216					
	2, U	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
	2, U	ND	ND	ND	ND	ND	ND	ND	ND		0.0989	ND	ND	0.00014	ND
	0.011	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	0.00051
	U	ND	ND	ND	ND	ND	ND	ND	ND		0.06	ND	ND	ND	ND
	2, U	ND	**0.00025**	ND	ND	ND	0.00054	ND	ND		ND	ND	ND	ND	ND
	2, U	**0.00018**	ND	ND	0.0000072	ND	ND	ND	ND			ND	ND	ND	ND
	2, U	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	2, U	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
	2, U	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
	2	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
	2, U	ND	ND	ND	ND	ND	ND	ND	ND		ND	0.00033	ND	ND	ND
	2, U	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
	2, U	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND
0.006		0.0001	0.0001	0.0002	0.0004	0.04	0.005	0.7	10			0.005	10	0.1	1

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Table - Pavillion Wells Groundwater Chemistry

Constituent	Well #1	Well #2	Well #3	Well #4	Well #5 Upper	Well #5 Lower	SOC	Well #6 PGDW07	Well #6 PGPW01	Well #7 PGDW08	Well #7 PGPW02	Well #8	Basketeria Store	Town Hall	Booster Station #2	Booster Sta 2 SP02	Booster Sta 2 SP02	216 N. Pine	Entry to Distribution	Entry to Distribution ST01	ST01	Entry to Distribution	Booster Station #2 SP02	Booster Station #2 SP02	SP02	ST01	SP02	SP02	Booster Station #2 ST01
Sample Date			03/23/77	03/22/82	07/19/83	02/17/83	1985	2009	2010	2009	2010	12/18/95	Aug-88	5/10/99	7/21/03	6/23/06	6/16/08	1/27/11	7/19/99	6/29/00	7/26/01	8/22/02	10/12/04	10/3/05	10/5/06	10/3/07	10/6/08	9/10/09	8/24/10
MAJOR IONS (mg/L)																													
Alkalinity, Total as CaCO3								60.6	74.7	82.9	82.8	124																	
Calcium								8.85	5.7	36.7	34.4	11.1																	
Chloride								15.7	15.3	8.9	8.5	87																	
Fluoride								1.2	1.2	0.5	0.5		1.11	1.04	0.8	1.3	1.2												
Magnesium									ND		ND	<1.0																	
Nitrogen, Nitrate+Nitrite as N			0.3	0	0	0						<0.1	0.0	<0.10	0.1	<0.10	<0.10		0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.05	0.01	
Nitrogen, Nitrate as N								<0.5	<0.3	<0.5	<0.3																		<1
Nitrogen, Nitrite as N								<0.5	<0.3	<0.5	<0.3			<0.10	<0.10	<0.10	<0.10		<0.10										
Potassium									ND		ND	<1.0																	
Silica																													
Sodium			190	210	1100	970		213	173	390	393	255	260	244	280	220	240	300											
Sulfate			400	460	2100	2200		390	300	857	847	439		453	486	355	392	280											
PHYSICAL PROPERTIES																													
Conductivity (umhos/cm)												1261																	
Hardness as CaCo3 (mg/L)			31	69	540	570																							
pH (s.u.)												8.62																	
Total Dissolved Solids (mg/L)			680	644	3430	3550	576		495		1283	813																	
METALS - TOTAL (mg/L)																													
Aluminum									ND		ND																		
Antimony									ND		ND			<0.001	<0.001	<0.001	<0.001												
Arsenic									0.00031		0.00024		<0.005	<0.005	<0.005	<0.005	<0.005												
Barium									0.0041		0.0076		<0.10	<0.10	<0.10	<0.10	<0.10												
Beryllium									ND		ND			<0.0005	<0.0005	<0.0005	<0.0005												
Boron																													
Cadmium									ND		ND		<0.005	<0.0005	<0.0005	<0.0005	<0.0005												
Chromium									ND		ND		<0.005	<0.05	<0.05	<0.05	<0.05												
Cobalt									ND		ND																		
Copper								0.0045	ND	0.0079	ND			<0.01	<0.01	<0.01	<0.01												
Cyanide														<0.005	<0.005	<0.005	<0.005												
Iron									0.112	0.283	0.255	0.44																	
Lead									ND		ND		<0.002	0.001	<0.001	<0.001	<0.001												
Manganese								0.0056	0.0071	0.0104	0.0096																		
Mercury									ND		ND		<0.001	<0.0005	<0.0005	<0.0005	<0.0005												
Nickel									0.00022		0.0004			<0.02	<0.02	<0.02	<0.02												
Selenium									ND		ND		<0.005	<0.005	<0.005	<0.005	<0.005												
Silver									ND		ND		<0.005																
Thallium									ND		ND			<0.0004	<0.0004	<0.0004	<0.0004												
Uranium, Natural																													
Vanadium									ND		ND																		
Zinc									ND		ND																		
SEMI-VOLATILES (mg/L)																													
Bis(2-ethylhexyl)phthalate									0.002		0.002																		
Butylbenzylphthalate									0.00023		0.00023																		
Caprolactam									0.00029		0.0038																		
TEH, DRO																													
TPH as Diesel (DRO)											0.0231																		
BACTERIOLOGICAL																													
Bacteria, Heterotrophic (MPN/ml)																													
Bacteria, Iron Related									Absent		Absent																		
Bacteria, Approx. Iron Related Bacteria Population (CFU/ml)									Not Aggressive		Not Aggressive																		
Bacteria, Sulfate Reducing									Absent		Absent																		
Bacteria, Approx. Sulfate Reducing Bacteria Population (CFU/ml)									0		0																		
RADIONUCLIDES (pCi/L)																													
Gross Alpha																													
Radium 228																													

Table - Pavillion Wells Groundwater Chemistry

Constituent	104 W. Euclid	216 N. Pine	114 E. Euclid	203 N. Main	105 S. Main	122 N. Cherry	369 S. Pine	321 N. Main	322 N. Pine	121 S. Cherry	407 N. Olive	204 N. Pine	117 N. Main	106 S. Pine	401 W. Euclid	221 S. Main	122 N. Cherry	204 N. Main	407 N. Olive	216 N. Pine	121 S. Cherry 1	402 E. Washington 2	116 W. Euclid 3	107 S. Pine 4	103 E. Center 5	? 94-15967	Entry to Distribution	Water Radionuclide	Water Radionuclide	Standpipe Water Storage	216 N. Pine	Booster Station #2 SP02	EPA Drinking Water Standards	
Sample Date	8/5/96	8/5/96	8/5/96	8/5/96	8/5/96	6/11/99	6/11/99	6/11/99	6/11/99	6/11/99	7/29/02	7/29/02	7/29/02	7/29/02	7/29/02	7/29/05	7/29/05	7/29/05	7/29/05	7/29/05	7/31/08	7/31/08	7/31/08	7/31/08	7/31/08	5/12/94	2/12/98	5/1/98	8/31/98	11/9/98	5/20/02	11/24/03	Primary	Secondary
MAJOR IONS (mg/L)																																		
Alkalinity, Total as CaCO3																																		
Calcium																																		
Chloride																																		250
Fluoride																																	4	2
Magnesium																																		
Nitrogen, Nitrate+Nitrite as N																																	10	
Nitrogen, Nitrate as N																																		
Nitrogen, Nitrite as N																																	1	
Potassium																																		
Silica																																		
Sodium																																		
Sulfate																																		250
PHYSICAL PROPERTIES																																		
Conductivity (umhos/cm)																																		
Hardness as CaCo3 (mg/L)																																		
pH (s.u.)																																		6.5 - 8.5
Total Dissolved Solids (mg/L)																																		500
METALS - TOTAL (mg/L)																																		
Aluminum																																		
Antimony																																	0.006	
Arsenic																																	0.01	
Barium																																	2	
Beryllium																																	0.004	
Boron																																		
Cadmium																																	0.005	
Chromium																																	0.1	
Cobalt																																		
Copper	<0.01	0.01	<0.01	<0.01	0.04	<0.01	<0.01	0.04	<0.01	0.04	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.04	0.04	<0.01	<0.01	<0.01	<0.01								1.3	1
Cyanide																																		
Iron																																		0.3
Lead	<0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001								0.015	
Manganese																																		0.05
Mercury																																	0.002	
Nickel																																		
Selenium																																	0.05	
Silver																																		0.1
Thallium																																	0.002	
Uranium, Natural																																	0.03	
Vanadium																																		
Zinc																																		5
SEMI-VOLATILES (mg/L)																																		
Bis(2-ethylhexyl)phthalate																																		
Butylbenzylphthalate																																		
Caprolactam																																		
TEH, DRO																																		
TPH as Diesel (DRO)																																		
BACTERIOLOGICAL																																		
Bacteria, Heterotrophic (MPN/ml)																																		
Bacteria, Iron Related																																		
Bacteria, Approx. Iron Related Bacteria Population (CFU/ml)																																		
Bacteria, Sulfate Reducing																																		
Bacteria, Approx. Sulfate Reducing Bacteria Population (CFU/ml)																																		
RADIONUCLIDES (pCi/L)																																		
Gross Alpha																										<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.7	15	
Radium 228																																<1.0		

Appendix II – Oil & Gas Commission Records

(Referred to in Chapter 3, Page 27)

1) Ind 14-20-0258-2963-Tri-22 Well. API #49-013-20581
Location: NE NE Sect. 22, T3N, R2E
Total Depth: 4,200 Feet (Fort Union Formation)
This well was spudded on 12/15/75 and completed (ready for production) on 2/7/76. The well was constructed with 24 lb. 8⅝-inch steel casing to a depth of 612' below the Kelly bushing (KB) and cemented in place inside the 12¼-inch diameter borehole with 450 sacks of cement. For a gage hole, assuming Type G cement with a slurry volume of 1.15 ft^3/sk, this cement job should have only required 220 sacks, therefore, the cement used was over 200%. This well was completed with 15.5 lb, 5½-inch production liner set inside the 7⅞-inch borehole to 4,193 feet and cemented in place with 280 sacks of cement.

The 5½-inch liner was perforated at the following depths:

3155-3163 2 shots per foot
3525-3536 2 shots per foot
3546-3564 2 shots per foot
3573-3579 2 shots per foot
3584-3614 2 shots per foot

This well was completed in the Fort Union as the base of the Wind River Formation was at a depth of 3,518 feet (1817 feet, MSL). In 1980 the well was recompleted by scraping the interior liner and then acidizing with 15% and 7½% HCL to clean the perforations and then placed back on line. This well produced from 1976 to 1985 and was plugged and abandoned in December of 1986 as follows:

1.) Set cement retainer at 3,053' and pump 75 sacks of Type G cement below retainer
2.) Spot 15 sacks of cement on top of the retainer
3.) Cut and retrieve 1,604 feet of the 5½-inch production liner
4.) Spot 35 sack cement plug at surface casing shoe at depth of 660 feet
5.) Spot 25 sack cement plug from 80 feet blg to surface
6.) Weld on plate to surface casing

2) Tribal 1-21 Well. API #49-013-20586
Location: NE NE Sect. 21, T3N, R2E
Total Depth: 3,965 Feet (Fort Union Formation)
This well was spudded on 3/7/76 and was plugged and abandoned on or before 3/24/76. The well was constructed with 24 lb. 8⅝-inch steel casing to a depth of 625' KB and cemented in place inside the 12¼-inch diameter borehole with 450 sacks of cement. For a gage hole, assuming Type G cement with a slurry volume of 1.15 ft^3/sk, this cement job should have only required 224 sacks, therefore, the cement used was over 200%. The Drill Stem Tests (DST) performed following the drilling of the borehole to a depth of 3,966 feet proved unproductive and the well was plugged and abandoned as follows:

1.) Spot 45 sack cement plug at 3965' to 3830'
2.) Spot 45 sacks cement plug at 3650' to 3500'
3.) Spot 45 sack cement plug at 700' to 550'
4.) Spot 10 sack cement plug at surface

The base of the Wind River Formation was at a depth of 3,850 feet.

3) Finlayson 1-17 Well. API #49-013-21086
Location: SW SE Sect. 17, T3N, R2E
Total Depth: 5,610 Feet (Fort Union Formation)
This well was spudded on 8/19/80 and was plugged and abandoned on or before 10/10/80. The well was constructed with 24 lb. 8⅝-inch steel casing to a depth of 625' KB and cemented in place inside the 12¼-inch diameter borehole with 450 sacks of cement. For a gage hole, assuming Type G cement with a slurry volume of 1.15 ft^3/sk, this cement job should have only required 224 sacks, therefore, the cement used was over 200%. The Drill Stem Tests (DST) performed following the drilling of the borehole to a depth of 5,610 feet proved unproductive and the well was plugged and abandoned as follows:

1.) Spot 35 sack cement plug at 4150' to 4050'
2.) Spot 35 sacks cement plug at 2100' to 2000'
3.) Spot 30 sack cement plug at 650' to 600'
4.) Spot 10 sack cement plug at surface

The base of the Wind River Formation was at a depth of 3,680 feet.

4) Runner Herefords 44-17 Well. API #49-013-08017
Location: SE SE Sect. 17, T3N, R2E
Total Depth: 4,240 Feet (Fort Union Formation)
This well was spudded on 5/15/64 and was plugged and abandoned on or before 9/17/64. The well was constructed with 7⅞-inch steel casing to a depth of 603' KB and cemented in place. Records were not available detailing how much cement was used to seal the surface casing or in how this well was abandoned. It is reasonable to believe that the well was abandoned in a similar fashion to the rest of the wells in the area. That being - spotting several cement plugs in the borehole below the surface casing, one plug at the bottom of the surface casing and one plug at the surface.

5) Runner Hereford 1 Well. API #49-013-21157
Location: SE SE Sect. 17, T3N, R2E
Total Depth: 4,006 Feet (Fort Union Formation)
This well was spudded on 9/17/81 and was plugged and abandoned on or before 10/16/81. The well was constructed with 24 lb. 8⅝-inch steel casing to a depth of 610'

KB and cemented in place inside the 12¼-inch diameter borehole with 440 sacks of cement. For a gage hole, assuming Type G cement with a slurry volume of 1.15 ft^3/sk, this cement job should have only required 219 sacks, therefore, the cement used was over 200%. Records were not available detailing how much cement was used to seal the surface casing or in how this well was abandoned. It is reasonable to believe that the well was abandoned in a similar fashion to the rest of the wells in the area. That being - spotting several cement plugs in the borehole below the surface casing, one plug at the bottom of the surface casing and one plug at the surface.

6) Garrett 1 Well. API #49-013-20965
Location: NW NW Sect. 17, T3N, R2E
Total Depth: 5,494 Feet (Fort Union Formation)
This well was spudded on 10/13/79 and was plugged and abandoned on or before 10/8/80. The well was constructed with 24 lb. 8⅝-inch steel casing to a depth of 642' KB and cemented in place inside the 12¼-inch diameter borehole with 450 sacks of Type G cement. For a gage hole, with a slurry volume of 1.15 ft^3/sk, this cement job should have only required 230 sacks, therefore, the cement used was over 195%. The Drill Stem Tests (DST) performed following the drilling of the borehole to a depth of 5,494 feet proved unproductive and the well was plugged and abandoned.

7) Pavillion Fee 13-15 Well. API #49-013-22104
Location: NW NW Sect. 15, T3N, R2E
Total Depth: 3,650 Feet (Wind River Formation)
This well was spudded on 4/10/2001 and completed (ready for production) on 5/26/2001. The well was constructed with 24 lb. 8⅝-inch steel casing to a depth of 436' KB and cemented in place inside the 11-inch diameter borehole with 160 sacks of Type III cement with 3% salt and ¼ lb. of flocele per sack (1.39 ft^3/sk) and tailed with 100 sacks of Type III cement with 3% salt (approx. 1.32 ft^3/sk). For a gage hole, the lead cement job should have filled the annular space, so the tail was all additional to account for borehole deviation and cement loss to the formation. This well was completed with 17 lb, 5½-inch production liner set inside the 7⅞-inch borehole to 3,650 feet and cemented in place with 655 sacks of 50/50 POZ & Type III cement with 2% Gel, 3% Salt, 0.3% Halad 344, ¼ lb/sk of Flocele and 5 lb/sk of Gilsonite (1.48 ft^3/sk). With a gage hole, this cement job should have taken 433 sacks. Driller reported returns of 45 bbls of cement or 252.7 cubic feet which would be approximately 170.7 sacks of cement. Therefore, of the extra 222 sacks of cement, 77% of this volume was pumped to the mud tanks at the surface.

The 5½-inch liner was perforated at the following depths:
2156-2168 3 shots per foot
2476-2480 2 shots per foot
2488-2496 2 shots per foot
2930-2940 4 shots per foot
3438-3448 4 shots per foot

This was completed in the Wind River Formation. The well production was stimulated by frac'ing the well. Perfs were frac'd with 6% potassium chloride, 10% methanol, carbon dioxide and frac sand (12-20). This well had very limited production from 5/26/2001 to December of 2006 and was plugged and abandoned on December 14, 2006 as follows:

1.) Set cement retainer at 2,090 and pump 35 bbls (180 sacks) of Type G cement below retainer
2.) Spot 5 sacks of cement (1 bbl) on top of the retainer
3.) Set cast iron bridge plug at 748 feet
4.) Spot 15 sacks (1.5 bbl) of cement (approx. 60 feet) on top of bridge plug
5.) Spot 10 sack cement plug (2 bbl) from 93 feet blg to 10 feet below surface
6.) Dig out and cut off casing, place dry hole marker

On August 11, 2008 this site was inspected by the Wyoming Oil and Gas Commission and recommended for release. On September 26, 2008 Encana was notified that the Wyoming Oil and Gas Commission had released this well from their Blanket Bond.

8) Clair C Day Well. API #49-013-20491
Location: SE SE Sect. 30, T3N, R2E
Total Depth: 8,021 Feet (Mesaverde Formation)
This well was spudded on 4/20/1974 and was plugged and abandoned on 5/16/1974. The well was constructed with 40 lb. 9⅝-inch steel casing to a depth of 638' KB and cemented in place inside the 12¼-inch diameter borehole with 388 sacks of Type G cement. For a gage hole, with a slurry volume of 1.15 ft^3/sk, this cement job should have only required 174 sacks, therefore, the cement used was over 220%. The Drill Stem Tests (DST) performed in the Lance Formation following the drilling of the borehole to a depth of 8,021 feet proved unproductive and the well was plugged and abandoned. The method of this P&A operation is not known.

Formation tops are as follows:

Fort Union Formation 3,380 feet
Lance Formation 5,095 feet
Mesaverde Formation 7,615 feet

RESPONSES TO SEPTEMBER 2011 PUBLIC COMMENTS

This section will present the public comments received on the Interim Report for the Pavillion Water Supply Level I Study. A public meeting was held September 7, 2011 to present the findings of that report. The minutes of that public meeting are included in this appendix.

Several of the public comments in this section were typed from the hand written forms. This was done to maintain the anonymity of the individuals giving them. This was done in part because it was stated that their identity would remain confidential.

The two public comment forms, which are included at the end of this section in their original form, are from public figures whose identity is well known and whose identity is public knowledge.

In response to the public comments the following statements are offered:

Senator Eli Bebout suggests 1.) continuing to focus on solutions, 2.) continuing to assist and hopefully have a solution, 3.continue to work with all parties and finally 4.) to present documented water quality information for Pavillion area.

RESPONSE: The focus of the study does remain on finding the best feasible solution, nothing else. That requires the efforts of all stakeholders. The appendix of this final report contains a tabular summary of all pertinent drinking water quality data that was made available to the study authors.

Mr. John Fenton, Chairman of the Pavilion Area Concerned Citizens commented that 1.) the cost of a system piped form Pavillion would exceed the financial resources of many, 2.) that the home treatment system would not achieve protection of human health, 3.) that a cistern system, too, would be cost prohibitive and subject to freezing.

RESPONSE:
It is recognized that all of the water supply alternatives are very expensive to install, operate, and maintain. Unfortunately, simple and cost efficient solutions were not able to be found for this water supply dilemma.

Individual No. 1
I think ENCANA should continue to provide drinking water for the people affected by the contaminated water. After speaking with Mr. Ward as far as the well # 6 being the best water in town, I have discovered that this is a private well, not part of the water loop in P'ville. I think the pipeline is not a viable solution moneywise. I think a home cistern system would be the most viable and reasonable under the circumstances. I also believe that there has been an active coverup by the current town council members as well as the mayor of Pavillion and the former town attorney. These people need to "fess up" as the public welfare is at stake. The resale value

of our property is at an all time low and our property taxes and water bills have gone up dramatically.

RESPONSE:
The Wyoming Water Development Commission has no jurisdiction over whether Encana provides bottled drinking water for residents in the rural Pavillion area. All documentation available to the engineers indicates that the Town wells produce water meeting EPA public drinking water standards and that public health is not at risk.

<u>Individual No.2</u>
I was not real surprised at the results of your study. I did feel your estimated monthly costs were a little low especially on the home treatment system. That is about the cost of electricity alone without figuring in the filters, membranes, and general maintenance. As presented, all alternatives are cost prohibitive for the landowner. Of course the most preferable alternative would be a permanent water source eg. The Pavillion pipeline. Probably the most practical and economical would be the cistern system. Don't know if water district would need to be formed and would probably prefer to find funding on an individual basis for this project. At this point I will probably wait and see what the EPA tests show as I am concerned that industry has had a negative impact on my water. If I had not had good water that went bad at the onset of drilling I would not even pursue this.

RESPONSE:
It is recognized that the cost of all alternative systems is costly. The estimated cost of the home treatment system is based on estimates from manufacturers. It could be that those costs are low. There was no local historical operation cost data from which to draw conclusions. These estimates were assembled primarily as a means of the operating cost of one alternative to another.

The purpose of this study was to find alternative solutions to providing quality drinking water to residents of the Pavillion area. However, in regard to changes in water quality in recent years, the single most important data that was not available to this study is any historic water quality test result for private wells in years prior to the development of natural gas resources. That information would have provided a direct comparison to past water quality versus what is being found today. Without that, the engineers could not know whether the private wells' water quality had noticeably changed.

<u>Individual No. 3</u>

I am concerned that forming a water district would be premature at this time with only 3 affected wells being in the study. Further studies should be done before requesting taxpayers to pay for water quality improvement. There should be ways that people with acceptable water could opt out.

RESPONSE:

Further study is neither ruled out nor planned at this time. Individual homeowners will be able to opt out of any proposed solution.

Individual No. 4

1. No one in our area can afford $715 a month or $8580 a year. Loans must be paid back, so getting a loan isn't an option. 2. A home treatment system is cost prohibitive too. These systems don't take out all the impurities either. 3. The home cistern system and hauling water - again - that's cost prohibitive. It is stated in the report that there are no apparent health concerns. I would beg to differ with that. I, myself, have lost my ability to taste and smell. Others suffer headaches, sinus problems, nervous system problems, and these are concentrated right in our area. The EPA testing doesn't test for the chemicals the gas companies keep secret. Gas companies are not following the regulations set for casings, depths, etc. and yet there is political talk of taking EPA out of the regulatory business, cutting back on its authority to enforce what regulations we do have. So it likes to us that we are just out of luck here in the Pavillion drilling field. I wonder how much Encana had to do with your findings. I'm sure that company is very satisfied with your "solutions."

RESPONSE:

It is recognized that all solution alternatives that were able to be found in the course of this study are expensive, and in many cases prohibitively so. The water quality data available from the EPA testing shows that with three exceptions, the area's tested private wells meet public drinking water standards. Documenting health changes in individual persons is beyond the purpose of this study. The water quality data can neither support nor counter these claims.

Individual No. 5

I was not home at that time. My well was not tested. I haul water to drink & pay for it. Can I get water delivered to my houses. I have 4 houses, (addresses deleted to protect privacy) I have called Denver and nobody will call me back. I am lost. All my neighbors get water delivered I was just not home at that time. We need it! I hope you can get that done for me. Because I can't.

RESPONSE:

The Wyoming Water Development Commission is not in charge of designating which homes are designated to receive bottled drinking water.

Individual No. 6

Home treatment system doesn't take all of the containments (sic, contaminants) we have out. This system only enhances them. We have irrigation all around us and that makes a problem to get it drained off. Home cistern maintenance is hard to keep cool in summer and warm in winter. The piped system fed from Pavillion water system is the high cost. We are at least a mile away to make even more added costs and wouldn't address livestock. We need to water too. We need to find a source and get this contaminating to our water aquifer. Thank you for taking the time to do the study on the problems we have at Pavillion and Muddy Ridge gas field and reading our concerns.

RESPONSE:

It is recommended that any private treatment system be matched to the water quality of the individual well. Buried cistern systems should mitigate temperature fluctuations in stored water. It is recognized that all of the supply alternatives are costly. The alternatives that were explored addressed only house water. Lawn irrigation and livestock watering were not envisioned to be supplied by any of the alternative systems.

Individual No. 7

We are one of the 20 wells on the list. We were given Culligan water and we are satisfied with it for now. However, if I have to choose, a home treatment system for a private well would be my choice. I do have questions about the monthly cost. - Have all the wells been tested in Pavillion. Who tests the water? Is the water chemically treatment before it is tested? I know what is used in the wells to treat them, and I also know where the water officer takes his samples to pass his test!

RESPONSE:

The estimates of monthly user costs were derived by adding up the total cost of the alternative system and dividing those cost equally among the 20 estimated subscribers. These are meant to be used for comparison purposes only, not a definition of expected costs. Not all of Pavillion's wells were tested by the EPA. Current water quality data is available, however, on all five Town wells. Testing was done on the water directly from the wells without any chemical additions. Chlorine is added to the Town's water as required by state law. The Town adds nothing else.

RECEIVED
SEP 30 2010
By DKK

September 30, 2011

James Gores and Associates, P.C.
111 N. 3rd Street East
Riverton, WY 82501

Re: Pavillion Area Water Supply – Level I Study Draft Interim Report

Dear Sirs,

On behalf of Pavillion Area Concerned Citizens (PACC) and our members, many of whom live and work in the Pavillion/Muddy Ridge gas field, thank you for accepting our comments.

1. A piped system fed from the Town of Pavillion water system

The pipe fed system as discussed in the interim report will be cost prohibitive and unrealistic. The costs for the system would be approximately one point nine million dollars ($1,900,000.00) to build, one hundred ten thousand dollars ($110,000.00) per year to operate, with an additional monthly bill for each household of over seven hundred dollars ($700.00). Any repairs or related activities would only add to these huge costs. The costs that impacted residents would be asked to pay will exceed the financial resources for many of them. At the September 7, 2011 public meeting, Mike Purcell, Director, Wyoming Water Development Commission (WWDC), explained that, "You never build something like this for just twenty people."

2. Home treatment system for a private well

Home treatment systems are expensive to install, and are extremely time and money intensive to maintain and operate. Again, the impacted residents would be responsible for much of the costs. There is also concern that home treatment systems will not remove all of the regulated and non-regulated toxic and hazardous chemicals and constituents found in impacted wells. Thus, protection of human health will not be achieved.

3. Home cistern system and hauled water.

The cistern system provides a source of water that should be clean and safe, however will pose other challenges. Costs for construction at approximately nineteen thousand dollars ($19,000.00) per system, as well as at least two hundred and fifty dollars ($250.00) per month, are cost prohibitive. The cisterns must also be heated during the winter months to prevent freezing, which will be an additional burden for the users.

The proposed plans will only address household water and will not offer remedy or replacement for livestock, lawn and garden water, which are also impacted.

The formation of a water district, much of the huge financial burden for alternative water systems and the related work to carry out any of the proposed plans will fall squarely on the impacted residents who live in the study area. Residents have not been found to be responsible for the contamination, and we believe neither they nor the citizens of Wyoming should be asked to pay for the remedies and water replacement until the source of contamination is established.

The final findings of the Environmental Protection Agency (EPA) groundwater contamination investigation have not been released. We believe all plans, proposed remedies and financial burdens for replacing our precious water resources should consider EPA's findings.

Respectfully,

John Fenton, Chair
Pavillion Area Concerned Citizens
202 Indian Ridge Road
Pavillion, Wyoming 82523

RECEIVED
SEP 30 2010
By

PAVILLION AREA WATER SUPPLY – LEVEL I STUDY

DRAFT INTERIM REPORT

Public Comment

Date: 9/9/11

Comment:

1) CONTINUE TO FOCUS ON SOLUTIONS NOT THE ISSUE W/ THE EPA, ETC.

2) STATE CONTINUE TO ASSIST & HOPEFULLY HAVE A WORKABLE SOLUTION.

3) WORK CLOSELY (AS YOU HAVE) WITH ALL PARTIES INVOLVED.

4) IN FINAL REPORT WOULD LIKE WELL DOCUMENTED INFORMATION ABOUT WATER QUALITY (LACK OF) IN THE PAVILLION AREA

Rural Resident ☐ **Town of Pavillion Resident** ☐ **Other** ☐ :

If Rural Resident, would you be interested in forming a water district? Yes ☐ **No** ☐

Submitted by: ELI BEBOUT

Address (optional): BOX 112
RIVERTON WY 82501

Phone (optional):

This contact information will be kept confidential.

September 30, 2011 deadline for all comments.

May be mailed to:
James Gores and Associates, P.C.
111 N. 3rd Street East
Riverton, WY 82501

Gores Civil Engineering Consultants