SUPPLEMENT
TO
PHASE I REPORT

OAKLEY
WATER SUPPLY PROJECT
LEVEL II - FEASIBILITY STUDY

FOR

WYOMING WATER DEVELOPMENT COMMISSION

1515 Ninth Street
Rock Springs, Wyoming 82901
Phone (307) 362-7519

SEPTEMBER 1989
September 15, 1989

Wyoming Water Development Commission
Herschler Building
Cheyenne, WY 82002

Attention: Mr. Patrick Erger

Re: Supplement to Phase I Report
Oakley Water Supply Project

Dear Mr. Erger:

We are transmitting herewith five copies of the final revision of the above supplemental report, pursuant to the commitments we made when we submitted the Phase I Report.

This report should be helpful to members of the Oakley Water Users Association and Lincoln County in assessing their need to develop an alternate source of water.

Submission of this report concludes our Phase I work and we look to the Water Development Commission for future direction as to what work should be pursued in Phase II.

Please call me or Bob Johnson of our staff if you have questions or require additional information.

Sincerely,

Wayne L. Johnson, PE and LS
Project Manager

Enc. (5)

cc: 15 copies to Oakley Water Users Association
A. INTRODUCTION

The information and data contained in this report is supplemental to the Phase I Report - Oakley Water Supply Project, Level II Feasibility Study, submitted to the Wyoming Water Development Commission on August 23, 1989. It provides an assessment of the existing domestic wells in the Oakley area which are owned by the people who are considering alternative sources of water. This information will perhaps guide their decision making process in evaluating another water source.

The report is submitted at this late date because additional time was needed to complete:

a. a more detailed geological investigation and interpretation of the water source in the existing wells;

b. integration of subsurface stratigraphy and lithologic data;

c. well construction and completion methods; and

d. water quality data.
Data utilized in compiling the report includes:

1. Water well permits from the Wyoming State Engineer's Office.

2. Well water sample quality data from the Department of Agriculture Laboratory.

3. Information from the City of Kemmerer Planning Office.

4. Geologic data gathered during field trips to the Oakley area.

Compliance with the EPA Safe Drinking Water regulations and the State of Wyoming DEQ standards and guidelines is discussed. Interpretation of the source of the water in each well is made in order to provide the landowners with as much information as possible for their decision-making process leading to Phase II.

Illustrations provided are as follows:

1. A base map of the Oakley area lot owners, water well permit numbers, wells which have been sampled for quality, and the surface geology.
2. Drawings of each landowner water well as constructed and completed, and strata columns where available or projected.

B. GEOLOGY

Although the general geology of the Oakley area has been presented in the Phase I report previously submitted, greater detail is discussed herein because of its application to specific wells and specific sources of groundwater in the Oakley area.

The Oakley/Quarry Subdivision is located in the middle unit of the Frontier Formation, specifically in the lower half. The middle unit ranges from 625 feet to 700 feet in thickness. The Oyster Ridge Sandstone Member, (called the Frontier Sandstone in this report), is 45-50 feet thick in the local area, the remainder is 575-650 feet thick. The lower portion consists of thin (6-20 feet thick) tan sandstone beds and thick (10 feet plus) dark clayey shale sections. These thin sandstones are less resistant to weathering and erosion than the Frontier Sandstone and in the Oakley area contain domestic quantities of water. The dark shales also contain small amounts of water where near enough to the surface to have been subjected to weathering and consequent fracturing.
The twenty water wells completed in the Oakley area produce from one of four sources:

1. Sandstone beds which dip 19 to 21 degrees westward under the subdivision.

2. Weathered and fractured shales found between sandstone beds and on, and in, the drainage of the valley floor, principally in the northern half of the subdivision.

3. The alluvial material which has washed downward from the erosion of the upstream valley and which forms a small alluvial fan.

4. The alluvium which is found in the flood plain of the Hams Fork valley.

These sources contribute to the variety of water quality as determined by testing 13 of the 20 wells in early 1989, through cooperative efforts of the Wyoming Water Development Commission (WWDC), the Wyoming State Laboratory and the Oakley residents. The general quality of the water in the wells is poor although some residents feel that it is "acceptable". Volumes of pumped
water range from 4 to 25 gallons per minute (gpm) but sustained pumping results in noticeable to significant drawdowns in individual wells.

D. WELL CONSTRUCTION

A variety of methods ranging from hand dug and rock-walled wells to those with two casing strings, perforations, gravel packs and cemented casings are found in the subdivision and such construction also contributes to the variety of water test results due to the sampling of selected and/or combined water sources.

E. WATER WELL PERMITS

Water well permits consist of a two-part system required by the State to appropriate groundwater for beneficial use:

1. An application to appropriate groundwater permission to drill and complete a water well; and,

2. A statement of completion and description of the well for beneficial use.
After both are successfully finished, the Wyoming State Engineer's Office will grant the water rights to the applicant as of a priority date and a date of approval. This subsurface water right is permanent so long as beneficial use is made of the water.

All but one landowner in the subdivisions have appropriated the groundwater in their wells and the last one is in the process of appropriation. Several landowners have yet to transfer their name(s) to the permits via the State Engineer's Office after having purchased the homes, lots and wells. These persons have been advised by the consultants and the Lincoln County Planner to process the necessary correspondence and have provided the applications to the landowners via the Kemmerer city planner.

F. WATER QUALITY

The WWDC conducted a water sample analysis program early in 1989, wherein the Oakley/Quarry residents voluntarily sampled their wells and the Wyoming State Laboratory in Laramie analyzed these samples for potability, lawn and garden irrigation, and livestock use.

The following criteria were used in evaluating the water samples:
1. **Human Consumption:**

**Total Dissolved Solids**

EPA .................. 500 ppm max.  
(parts per million)

Wyoming Dept.  
of Agriculture...... 1500 ppm max.

**Sulfates**

EPA.................. 250 ppm max.

Wyoming Dept.  
of Agriculture...... 750 ppm max.

**Nitrates**

EPA.................. 10 ppm max.

Wyoming Dept.  
of Agriculture...... 10 ppm max.

**Bacteriology**

Total Coliform...... 1 per 100 ml. M.F.

**Hardness**

Calcium and Magnesium expressed as Calcium Carbonate

<table>
<thead>
<tr>
<th>ppm</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>Soft</td>
</tr>
<tr>
<td>50-149</td>
<td>Medium Hard</td>
</tr>
<tr>
<td>150-249</td>
<td>Hard</td>
</tr>
<tr>
<td>250-299</td>
<td>Very Hard</td>
</tr>
<tr>
<td>300+</td>
<td>Extremely Hard</td>
</tr>
</tbody>
</table>

**Sodium**

EPA.................. 20 ppm max.
One of three analites (total dissolved solids, sulfates, or nitrates) may exceed the above stated limits as follows:

- **Total Dissolved Solids** ........... 1650 ppm max.
- **Sulfates** .......................... 790 ppm max.
- **Nitrates** .......................... 12 ppm max.

2. **Lawn and Garden Irrigation**

- **Specific Conductance** ............. 1500 mmh max.
  (mmh = micromhos)

3. **Livestock Use**

- **Total Dissolved Solids** .......... 1000 ppm max.
- **Hardness** ........................ 1000 ppm max.
- **Sulfates** ........................ 500 ppm max.
- **Sodium** .......................... 500 ppm max.

Thirteen of twenty wells were sampled and chemically analyzed and three of those were also analyzed by a qualified laboratory for inorganic content. All three wells were below EPA maximum standards for all inorganics. Figure 1 shows those holes which were sampled and analyzed. None of the wells were below the stringent EPA standards for human or livestock consumption or for lawn and garden irrigation.

**CRITICAL PARAMETERS**

The following figures were compiled for the critical parameters for the thirteen wells considering the analytical results from the Wyoming State Laboratory.
HUMAN CONSUMPTION

Total Dissolved Solids: 7 suitable, 6 unsuitable
Hardness: 3 medium hard, 1 very hard,
and 9 extremely hard
Nitrates: 13 suitable
Sulfates: 8 suitable, 5 unsuitable
Total Coliform: 11 samples run, 2 samples not run,
8 safe, 2 unsafe (needs resampling)
and 1 in confluent growth (needs resampling).

SUMMARY FOR HUMAN CONSUMPTION
Chemicals: 7 suitable except for very high hardness;
6 unsuitable;

Bacterially: 8 safe, 3 need resampling.

LAWN AND GARDEN IRRIGATION
Specific Conductance: 2 suitable, 11 unsuitable

LIVESTOCK USE
Total Dissolved Solids: 12 suitable, 1 unsuitable
Sulfates: 8 suitable, 5 unsuitable
INORGANICS

Three of the well water samples from the Oakley Area were analyzed for inorganics by the Wyoming Department of Agriculture and reported by their Official Laboratory Report. In the case of each sample, the results show that the milligram per liter content by element is below the minimum standard set by the E.P.A. Thus the inorganic content found by water analysis is interpreted as safe and is presently of negative concern to well owners.

RADIONUCLIDES

The same three wells were also analyzed for radionuclides by an independent laboratory at the Colorado State University. The minimum E.P.A. standard for drinking water for gross alpha and gross beta is 15 pCi/l. All of the water samples were below that standard and are considered safe for any use.
G. INDIVIDUAL LANDOWNER WELL APPRAISAL

PERMIT NO. 10074 JOHN AND RUTH ROBERTS

The first permit in the area was issued to the landowner for a dug well to the depth of 18 feet in 1936. It was rock-walked and water level was at 10 feet in alluvial gravel; see Figure 2. The ownership has not been transferred to the present landowner.

CARL ANNALA DOMESTIC WELL - NOT PERMITTED

This well is a hand dug well of approximately 12 feet in depth, producing from flood plain alluvium with river drainage as its source; see Figure 3.

PERMIT NO. 32762 - WAYNE DONNAFIELD

The Donnafield family owns two lots and this well is located on the southern of the two lots. It was rotary drilled and cased to 105 feet with no screen installed and no perforations reported. The pump is set 25 feet off bottom at the water level of 80 feet; see Figure 4. The well may have penetrated a foot or two of sandstone
PERMIT NO. - 10074
OWNER - J. ROBERTS

NOT YET PERMITTED
OWNER - CARL A. ANNALA

FIGURE 2.

FIGURE 3.
at the bottom as determined from subcrop extrapolation, but the total water column is being produced partly from the sandstone but principally from the overlying shale section. This 80-foot water level is the second lowest of the area wells, indicating either a slow recharge or a firm casing set on the well bottom or a combination of both. The owner's name of record in Frank M. Cardin and it should be changed with the State Engineer to reflect the present owner.

PERMIT NO. 32920 - WILLIAM WILSON

The well was constructed under the direction of the former owner, Art Bonar, to a depth of 80 feet. Casing was installed to total depth and perforations exist from 40 to 80 feet; see Figure 5. The depth and location of this well in the valley floor indicates that no sandstone was penetrated by the well. The water analysis is interpreted to have come from fractured and water-bearing shale and possibly from overlying alluvium since the static water level is at about 20 feet.

PERMIT NO. 33703 - BUD ATWOOD

This well is the northernmost of two water wells drilled by the former owners, Richard and Dixie Hollar, and the new owner is urged to change the permit to show the new ownership. The well was drilled to 170 feet but cased
PERMIT NO. - 32762
OWNER - WAYNE DONNAFIELD
(FRANK CARDIN)

SOUTH WELL

PERMIT NO. - 32920
OWNER - WILLIAM WILSON

Figure 4.

Figure 5.
only to 50 feet, leaving 120 feet of open hole; see Figure 6. The hole is located 240 feet west of the easternmost sandstone outcrop encountered in the field and the surface location lies in a shale section between the noted sandstone and another sandstone to the west as projected in the subsurface. Since the well has much open hole, it has a water source from both the shale and sandstone beds. No water samples or drill samples are available for further interpretation.

PERMIT NO 34703 - BUD ATWOOD

The second Atwood well is about 160 feet south of the other Atwood well and it too was drilled by the previous owner. It is of similar construction, but at shallower depths, with casing set at 25 feet in a 90 foot well; see Figure 7. This well is a shorter distance from the eastern sandstone outcrop but is projected to have drilled about five feet into the water-bearing sandstone. Water sources are both the sandstone and the overlying shale in 65 feet of open hole. No water analysis has been made on this well so that type of data is unavailable for interpreting sources of the water.

PERMIT NO. 35234 - MARLIN AND ROY LONG

The well was drilled to 82 feet and cased to 40 feet, leaving open hole of 40 feet; see Figure 8. In contrast
PERMIT NO. - 33703
OWNER - BUD ATWOOD
(RICHARD AND DIXIE HOLLAR)

PERMIT NO. - 34703
OWNER - BUD ATWOOD
(RICHARD AND DIXIE HOLLAR)

NOTE - MAIN WATER BEARING, ZONE GIVEN AS 165'-170'

FIGURE 6.

FIGURE 7.
to most other local wells, the casing was cemented in place to prevent up hole contamination. The water quality appears to have been enhanced by this method of the well construction. It appears that sandstone dip projection into the subsurface indicate that the well penetrated several feet into the top of a sandstone aquifer but no records were kept to confirm the interpretation. However, the water analysis indicates that both the sandstone and the overlying shale produce the water, especially with 42 feet of open hole.

PERMIT NO. 37446 - DAN GOLAB

This well was drilled by the previous owners whose name is on the permit. Dan should inform the State Engineer of his purchase of the lot and well so that the well is in his name. The well was drilled to 90 feet and 6" casing was set to total depth. Slotted pipe was installed in the bottom portion of the well and gravel pack, reported as sandpoint, was placed in the annulus, (the space between the casing and drill hole). This well is one of two in the subdivisions to have placed gravel/sand in the annulus behind slotted casing; see Figure 9. The well did not penetrate any water-bearing sandstone and the total water section originates from sources in the shale as indicated from the water sample analysis and the subsurface sandstone projection.
PERMIT NO. - 35234
OWNER - MARLIN AND ROY LONG

COMPLETED 07/23/77

FIGURE 8.

PERMIT NO. - 37446
OWNER - DAN GOLAB
(HARVEY AND ESTER PRICE)

COMPLETED 09/20/76

FIGURE 9.
PERMIT NO. 46369 - GARY AND SUSAN PARK

The well was drilled by cable tools to a depth of only 70 feet and cased to 37 feet; see Figure 10. The State Engineer's Report states that the well penetrated and is completed in a sandstone of about 35 feet in thickness of which the bottom 10 feet is the aquifer. The well is the farthest south of any to be completed in what is apparently a subsurface sandstone lens. This sandstone which may originate from a southerly direction because no other well appears to be completed in an equivalent sandstone zone. The water quality substantiates this conclusion because the well is located at the mid-eastern side of the alluvial fan of about 35' in thickness which contains poorer qualities of water. The projection of sandstone beds from subcrop to the well places the other known sandstone beds at greater depths than the bottom of the hole.

PERMIT NO. 52614 - CHARLES FITZPATRICK

Mr. Fitzpatrick is in the process of changing the name on the permit from the previous owner, Kent Ames. Mr. Fitzpatrick purchased the property and well earlier in 1989. His well is drilled to 120 feet which penetrates 5 feet of the sandstone which outcrops 350 feet from the
PERMIT NO. - 46369
OWNER - GARY AND SUSAN PARK

PERMIT NO. - 52614
OWNER - CHARLES FITZPATRICK
(KENT AMES)

FIGURE 10.

Completed 06/14/79

FIGURE 11.

Completed 07/12/80
well and forms part of the east slope of the drainage just east of his house; see Figure 11. This house and property is the northernmost in the subdivision. The surface is principally weathered shale with very little alluvial cover which has eroded into the lower reaches of the downslope valley. The water quality analysis indicates that most of his well water comes from the sandstone aquifer. The 4" casing string is set at depths of 50-120 feet under the 6" surface casing, which has been set to 50 feet but not cemented.

PERMIT NO. 52778 - VERNAL J. LONG

This well was drilled to 94 feet and the surface casing is set to 52 feet, leaving an open hole of 42 feet; see Figure 12. Although no drill cutting data is available, the projection from the sandstone outcrop on the eastern portion of his property to the well shows that the well penetrated the sandstone at 70 to 94 feet. Because of the comparatively close control on this and the Tom Lozier well, an estimated strata column has been included in Figure 12. The open hole provides for groundwater to be produced from both the shale and the sandstone but the water analysis indicates that a high percentage of the water is coming from the sandstone section because the quality indicators are comparatively low.
PERMIT NO. - 52778
OWNER - VERNAL J. LONG

PERMIT NO. - 64603
OWNER - MICHAEL JETKOWSKI

FIGURE 12.

FIGURE 13.
PERMIT NO. 64603 - MICHAEL JETKOWSKI

The Jetkowski well was drilled to 143 feet and casing was set at 48 feet; see Figure 13. The drill cutting report shows that the well penetrated a series of clays (shales in geological terms) before reaching the water-bearing zones at 121 feet. If projected from the outcrop at the established dip of 21°, the major water-bearing sandstone would fall four to five feet below the total depth of the well. The water level at 130 feet suggests that the source of water is principally from drainage of the open hole between 48 and 121 feet and that most of it comes from what is interpreted as a sandy shale or sandstone at 121-127. This drainage flows downward to the static water level of 130. If the well had been deeper, it would have penetrated the sandstone aquifer found on the eastern side of the valley. It also would have been expected to provide a much higher static water level due to hydrostatic head in the sandstone similar to the Fitzpatrick well where the water level is 60 feet at a higher ground elevation. The water quality interpretation indicates a shale source for the water.

PERMIT NO. 64891 - RUSSELL E. ROBERTS

The well was drilled to the greatest depth of any within the subdivision and casing was set to 30 feet of which the bottom 10 feet is perforated and gravel packed; see
Figure 14. No drill samples were taken or reported but because of the well location at or near the base of the valley alluvial fan, the maximum amount of alluvial deposits were penetrated in the well. This alluvium is underlain by shale. No indication of sandstone as an aquifer is found in the data and the high water quality numbers indicate that the water has come from both the shale and from upslope drainage into the valley alluvium. The water has probably been in place for long numbers of years and has taken minerals into solution as dissolved solids during that time. The gravel placed in the bottom 170 feet of the well has little effect on the water level or quality of used water.

PERMIT NO. 66695 - RAY CURTIS - G.W. MILLER

This well was drilled to 120 feet and perforated casing and gravel pack was installed from 80 to 120 feet to produce water from a 5' sandstone at 80-85 feet and a 10' sandstone penetrated at 100-110 feet; see Figure 15. Both of these sandstones are above the projected depths for the sandstones present in the eastern part of the valley. These 2 sandstones may be related to the sandstone beds in the Jetkowski and Park wells but not reported in other wells along a similar strike line. The water quality interpretation shows that water is being produced by both the two sandstones and by the shale but
PERMIT NO. - 64891
OWNER - R. ROBERTS

PERMIT NO. - 66695
OWNER - RAY AND MARYLIN CURTIS (MILLER)

FIGURE 14.

COMPLETED 10/06/84

FIGURE 15.

COMPLETED 07/01/84
PERMIT NO. 68103 - ROBERT F. TAYLOR

The Taylor well was drilled to 85 feet and a pump set at 75 feet. Although it is assumed that casing was placed in the well, the statement of completion provided to the State Engineer contained no information about the casing; see Figure 16. Little data is available concerning the well construction or strata penetrated and a water quality analysis was not made. However, it is postulated that the well and its water would be similar to the Marlin Long well, 55 feet to the south, since both were drilled to similar depths, the static water levels are the same, and the pumps were set at comparable levels.

PERMIT NO. 76328 - VERNON AND KAY BAGGETT

This well was drilled to 63 feet, surface casing was placed to 45 feet and perforated 4 inch casing was installed from 46 to 60 feet. The hole penetrated surface alluvium and shale with no bedded sandstone encountered; see Figure 17. Analysis of the water indicates a slightly above average suitability for water use from the downhole shale source. Since only 19 feet of shale is the principal producing zone, it is possible that greater concentrations of dissolved solids, while not present, may exist at greater depths.
PERMIT NO. - 68103
OWNER - ROBERT TAYLOR

PERMIT NO. - 76328
OWNER - VERNON AND KAY BAGGETT

FIGURE 16.

FIGURE 17.

NOTE - NO CASING DEPTH OR SIZE GIVEN
PERMIT NO. 79643 - TOM AND MARY LOZIER

The most recent well to be drilled in the Oakley/Quarry Subdivision is the Lozier well, completed in April. A quality test was made in May. The well was drilled to 85 feet, surface casing set at 40 feet, and 4 inch casing placed from 5 to 85 feet, the bottom 25 feet of which is perforated; see Figure 18. Although no drill cutting data is reported, the sandstone which outcrops 110 feet east of the well was projected to be penetrated at a level of 40 feet in the hole and that level was selected at which to set surface casing during well construction. A projected strata column is included in Figure 18. The low water quality numbers indicate that the water is being produced only from the sandstone. Except for hardness, this water sample is of slightly better quality than the other tested well samples.

OTHER WELLS

Four other wells were investigated within certain limits as follows:

PERMIT NO. 34400 - WAYNE DONNAFIELD (JAMES B. WILLIAMS)

The permit for this well is stored on microfiche and contains no completion data. The permit is still listed with James B. Williams as owner of the well and the State
PERMIT NO. - 79443
OWNER - TOM LOZIER

GROUND LEVEL

DEPTH

50

T.D. 85'

100

6" CASING

4" CASING

PROJECTED STRATA

3/4 HP PUMP @ 85'

COMPLETED 04/28/89

FIGURE 18.
Engineer should be notified of the change of ownership. The well is the northernmost on the Donnafield property. A water sample analyzed from the well indicates the well is producing water principally from a shale source.

PERMIT NO. 36868 - TED DRAPER

The permit for this well is also in the form of microfiche only at the State Engineer's Office and the information was not readily available at the time of acquisition of the hard copy of the well permits. In addition, water samples from the Draper well were not taken or analyzed and the lot remains uninhabited and unstructured. The well should be similar to the Fitzpatrick's well if drilled deep enough to produce from the deep-lying sandstone. If shallower and completed in the shale only, the yield and quality should be poor.

PERMIT NO. 60081 - CARL A. ANNALA

This well was drilled by Annala on a hill in the easternmost extent of his property south of Highway 30 and beyond the extent of Figure 1. It was drilled specifically for a source of water to supply a subdivision development of from 50 to 100 lots over the foreseeable future years. The well penetrated an upper sandstone zone 10 feet thick, a shale section of 180 feet to a depth of 190 feet and a 10 foot sandstone aquifer
to 200 feet. Casing was set from 0 to 200, of which the bottom 20 feet was perforated. The water level is at 145 and the well was pumped at 12 gpm for 3 hours, resulting in a 20 foot drawdown. Water quality has not yet been determined. The well, if of acceptable quality, would be expected to supply only a small number of lots over a period of time because of the limited outcrop recharge area east of the well site. The well permit is listed with the State Engineer as cancelled. Further or future use would require reinstatement procedures with the State Engineer.

PERMIT NO. 32553 - RUDY KOCSI, JR.

Southwest of the Oakley subdivision and directly south and across the UP RR tracks from the Annala property, the Koci well was drilled to a depth of 80 feet and casing was set at 60 feet for domestic use. No drill cutting data is available but the water producing zone exists from 50 to 80 feet with a water level of 50 feet and probably is producing from either the alluvium of the Hams Fork flood plain or the underlying shale. No water quality data is available but the water is classified as acceptable by the owner.
H. SUMMARY

The evaluation of individual wells was included as part of the scope of the Oakley Water Supply Project and is presented as data for making future decisions in water supply considerations. The produced water exceeds most of the EPA/DEQ water standards for human consumption, lawn and garden irrigation, and livestock use.

Additionally, a large percentage of the waters exceed the above standards for suitability as set by the Department of Agriculture State Laboratory for the above categories.

Consistent use of these wells over time will diminish both quality and quantity and a new source of water should be considered.