Final Report
For
Lysite Water Supply Level II Study

Prepared for:
WWDC
FINAL REPORT

For

LYSITE WATER SUPPLY LEVEL II STUDY

Prepared for:

LYSITE WATER AND SEWER DISTRICT
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Lysite, WY 82642

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February 2008
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1 INTRODUCTION

This report documents the Level II Study completed for the Wyoming Water Development Commission on behalf of the Lysite Water and Sewer District (District), located in Lysite, Wyoming. Lysite is an unincorporated community located in Fremont County east of Shoshoni, where shown on Figure 1-1.

This work was completed according to Consultant Contract No. 05SC0292699 between Stetson Engineering, Inc. and the Wyoming Water Development Commission. Stetson Engineering completed project work from offices located in Riverton and Gillette, Wyoming, and with assistance in geohydrology from Western Groundwater Services, LLC.

1.1 Background Information

A Level I Study for the District was completed by Stetson Engineering and published in a final report during February 2006. The Level I Study Report presents a water supply analysis and evaluation of source of supply options from groundwater. Several alternatives are contemplated by the Level I Study.

The most critical aspect of a new water system for the District was locating a viable aquifer with good capacity and quality. Source capacity requirements for the present population were estimated at 17 gpm, and with future growth were estimated at 43 gpm. A detailed hydrogeological reconnaissance was completed within and adjacent to the District service area. Based on this work it was found in principal that viable aquifer conditions exist south and east from Lysite. North of Lysite it may be possible to develop a useful aquifer, but it is less likely. Source development within the District was considered marginal, but could not be ruled out altogether, and was the least cost source of supply option.

The Level I Study also identified a phased approach for groundwater development. Initial explorations were to be located within the District service area in order to develop a water system for the least cost to members. If a local source could not be developed, a deep aquifer test well would be installed a short distance south of the District service area, providing a more costly water supply, but possibly affordable by the District members. The Level I Study also identified that a likely source of groundwater could be developed approximately 2.75 miles south of the District service area, however, the cost to rate payers was considered excessive. Details of these costs are summarized in Table 1-1.
Figure 1-1
Lysite Location Map
TABLE 1-1  
PROJECT BUDGET ESTIMATE FOR  
DEEP WELL SOUTH OF DISTRICT

<table>
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<th>Component</th>
<th>Cost (2007 $)</th>
<th>WWDC 67% Grant</th>
<th>SRF Loan 2.5% rate</th>
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<td>Well Completion</td>
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<td>Power Service (3-Phase)</td>
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<td>$54,940</td>
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<td>$13,400</td>
<td>$6,600</td>
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<tr>
<td>Point of Use RO Treatment (27 units)</td>
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</tr>
<tr>
<td>TOTAL PROJECT COSTS</td>
<td>$1,373,255</td>
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<td>PERCENTAGE</td>
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<td>55%</td>
<td>45%</td>
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</table>

1.2 Level II Study Summary

A pump test and three drilling explorations were installed for the Level II Study. Lithology and wireline logs were also acquired and interpreted for a gas well installed to the east of the District. None of these data revealed a viable aquifer for water supply development to serve the District. Locations of these explorations are shown on Figure 1-2.

Subsequent to these findings, the District Board was contacted in regard to developing a water supply well south of the District were it is likely a viable aquifer exists. The Board considered that the high cost of a well at this remote location could not be afforded by the rate payers. Subsequent to this finding by the Board, the present Level II Study was terminated. However, should the Board desire to proceed with water supply development to the south (or elsewhere), they can apply for a second Level II Study to secure funds for test well development, and then proceed to Level III for construction.
Figure 1-2
Drilling & Testing Locations

Western Groundwater Services
1.3 Level II Study Recommendations

- The data collected for the Level I and II Studies support that the best chances for good aquifer conditions will be south and east from the District. It appears that subsurface sandstone strata coalesce in this direction forming more substantial aquifer formations, whereas in the Lysite and northerly areas, sandstones are formed by smaller channels separated by mudrocks. Future drilling exploration by the District should favor well sites to the south.

- The present project evaluated aquifer potential based on the indirect measures of borehole lithology and geophysical logs (except for the School Well pumping test). Boreholes were terminated prior to well completion because water production potential was believed to be limited based on these indicators. Future explorations may consider taking greater risk by completing wells to verify site conditions even when they appear marginal. Under marginal conditions, large screen intervals could be installed spanning several sandstones over a few hundred feet, or alternatively, the borehole could be cased, cemented, perforated and hydraulically fractured within discrete sandstone intervals. Upfront consideration should be given to well ownership in the event an expensive completion is built and only partially meets the District water demand, but is not considered a ‘dry hole’. Screening of sandstones over several hundred feet of the borehole should be done only with prior approval from the State Engineer’s Office.

- The key to developing groundwater south of the District where a viable aquifer appears to be present is funding. Financial planning in the Level I Study shows that in all likelihood the District will require a donation from private funds in order to build this water system. The District Board and members interested in developing a water system for the community should actively seek grant funds through private donations, federal appropriations, and/or local sources, such as Fremont County. The oil and gas industry companies working in the area may be interested to assist the District, as they gain directly from good local facilities. Virtually all of these companies have strong interests to assist the communities near to where they are developing resources.

Table 1-1 summarizes the total cost of a water system with a water supply well at the southerly site (2.75 miles from the District). Based on 67% grant funds from the WWDC and a 2.75% low interest loan from the State Revolving Fund (SRF), the monthly bill to rate payers is estimated at $140. It is possible this amount could be reduced $10 to $15 by considering other funding options and scrutinizing the estimated project costs. These small adjustments, however, will not be sufficient to gain member support for the water system.
A monthly rate per account of about $50 is a more reasonable target and has gained member support in other parts of the State. To achieve this rate, the SRF loan would need to be reduced to approximately $165,000, and $450,000 of additional grant funds would be required. These additional grant funds could be sought from other state government or private entities. By 2012 assuming inflation of 3%, the additional grant funds would need to be $565,000.

1.4 Acknowledgements

The District Board members and the community of Lysite were very helpful to the Level I and 2 Studies. Board members were more than willing to provide information and help out with access to private wells and properties. Bill Ramage (Chair), Bob Whitt, Steve Schrock, Steve “Hyde” Shoupe, and Ray Moss all participated in this effort. Others in the community allowed access to their wells for evaluation.

The Wyoming Water Development Commission funded the Level I and 2 Studies in sufficient amounts to put forth a strong effort to locate a water supply and plan a water system for the Lysite community. Kevin Boyce, PG, was the WWDC project manager.
2 HYDRAULIC TESTING

The Lysite School Well, located adjacent to the School Test Boring shown on Figure 1-2, is locally known as a well that produces good quality water. Several local citizens fill water tanks from the School Well. The well log indicates a sandstone aquifer from 250 to 270 feet below ground surface. At the time of construction, the driller reported pump testing the well at 10 gpm with no drawdown over a three hour period. Given these encouraging results, the existing well was pump tested as part of the Level II Study to collect data for a yield analysis of the aquifer. A technical report of the pumping test is included in Appendix A. A summary of the results follows and Figure 2-1 illustrates several of the data plots from the pumping test.

The well pumping test was run at a constant rate for a period of 4-hours\(^1\). The discharge rate for the test was 8.5 gpm, and resulted in full drawdown to the well pump by the end of the test. Drawdown phase data were used to estimate an aquifer transmissivity of 4 ft\(^2\)/d. Recovery phase data (rising water level) yielded a transmissivity of 13 ft\(^2\)/d. Given the available drawdown at the site, the aquifer was found to be insufficient for a municipal well.

A plot from the Level I Study illustrating well drawdown versus discharge rate for varying values of transmissivity is shown on Figure 2-2. This plot shows that at low transmissivity of 12 ft\(^2\)/d, drawdown of at least 120 feet is required to produce at 5 gpm, whereas 17 to 43 gpm is required. Approximately four to 10 wells would be required to meet the estimated source capacity requirements.

Three other private wells in the area were monitored during pumping and recovery phases of the test. Of these, the Knigge well was used to estimate aquifer properties using data from one of the normal pump cycles. A relatively long recovery period was analyzed to estimate an aquifer transmissivity of 4 to 12 ft\(^2\)/d. Possibly the School and Knigge Wells are within the same aquifer zone. The results of the analysis indicated the aquifer open to the Knigge well also could not support a municipal well.

The School Well pumping test was likely testing a shallower aquifer than was reported on the well log. The test pump could only be set to 160 feet due to obstruction in the borehole. Apparently an older pump had fallen into the well. Cascading water could also be heard entering the well during the recovery phase of the test, indicating water entry at depths shallower than the test pump setting.

\(^1\) An NPDES permit was not obtained for discharge of this pumping test, as the discharge water could never reach a surface water. Discharge flowed in local ditches where it infiltrated the subsurface.
Figure 2-1
Shallow Aquifer Well Testing Plots
3 TEST BORINGS

The Level II Study included the installation of three test borings\(^2\). Two of these targeted groundwater development from shallow aquifers, less than 300 feet in depth, within the District service area. The third targeted a deeper aquifer to the south of the District service area. Test boring locations are shown on Figure 1-2.

Geological logging of the boreholes was provided on-site by a Professional Geologist. Samples were collected and bagged by the drilling contractor over 10-foot intervals. Samples were rinsed, dried, and examined under a stereomicroscope at up to 40X power. Lithology, color, cementation, and porosity were observed and logged for the samples. A sample archive was made for each boring and has been provided to the Wyoming Water Development Commission.

3.1 Shallow Aquifer Test Borings

Test borings located within the District service area were intended to evaluate shallow aquifer conditions, less than 300 feet. These borings were installed because existing private wells could not rule out the potential for a viable shallow aquifer, although the likelihood of developing a municipal well appeared marginal. Municipal wells located within the District service area result in the least cost for water system construction.

Test borings were located at the Lysite Community Center (formerly Lysite School), and west of the Lysite Store. Permits from the State Engineer’s Office were obtained for the drilling of both of these explorations. The Community Center test borehole was drilled under Permit No. U.W. 178273. The Store test borehole was drilled under Permit No. U.W. 177547. A surface casing consisting of 18 feet of 6-5/8 inch OD casing was cemented into a 10-inch diameter borehole at both locations. Air-rotary open-hole drilling at 6-inch diameter was completed below the casing. Figure 3-1 provides summary borehole logs. Detailed logs are included in Appendix B, and additional geological information is provided on Photo Plate 1.

The School Test boring penetrated to 305 feet. It encountered two loose sandstones that would be considered water bearing. The first occurred from 130 to 170 feet. The second occurred from 300 to 303 feet, and is too thin to utilize as a primary aquifer. The borehole could be air-lift pumped at 7 to 8 gpm, indicating water production was limited. The sandstone aquifer from 130 to 170 feet was probably the same zone providing water into the existing School Well, determined to have a transmissivity of 4 to 13 ft\(^2/d\). Of the test borings completed for the Level II Study, this was the only good quality sandstone encountered, but drawdown is limited at the site for development of a municipal well. There was no sandstone aquifer encountered between 250 and 270 feet, as had been reported on the existing School Well log. It was concluded the site would not support a municipal well, and the borehole was grouted.

\(^2\) Copies of the Form U.W. 5 and Form U.W. 6 for each exploration are provided in Appendix E.
School Test Borehole  
NENNW 18 38N 90W

Quaternary Alluvium
0'-27', Loose deposits of sand and gravel (Quaternary Alluvium)

Tertiary Wind River Formation
27'-130', Deposits of shallow channels and alluvial plane. Interbedded sandstone, siltstone, and claystone. Some coal. Sandstone typically cemented and of low permeability.

130'-170', Deposit of deeper channel. Loose sandstone, porous and permeable. Occasional siltstone stringer. Arkosic and micaceous. Water bearing

170'-305', Deposits of shallow channels and alluvial plane. Interbedded sandstone, siltstone, and claystone. Low porosity and permeability. Loose sandstone occurred from 300'-303'.

Air-lift pumping 7-8 gpm from 305 ft

Bottom of Borehole, 305 ft, 2/27/07  
Well abandoned April 2007.

Store Test Borehole  
NENNE 13 38N 90W

Tertiary Wind River Formation
0'-70', Deposit of deeper channel. Sandstone partially cemented with iron hydroxide and kaolin. Micaceous. Moderate porosity and permeability.


110'-150', Deposit of deeper channel. Sandstone, but with siltstone and claystone at top of interval. Kaolin and pyrite cement. Arkosic, micaceous. Moderate to poor porosity/permeability.

150'-200', Overbank deposits. Claystone with occasional siltstone and sandstone stringers. Light gray, hard, calcareous, and siliceous.


230'-300', Deposits of channels and alluvial plane. Interbedded sandstone, siltstone and claystone. Sandstones are partially cemented by kaolin and calcite. Moderate to poor porosity/permeability. Airlift pumping 6-7 gpm from 300 feet. Strong hydrogen sulfide odor.

Bottom of Borehole, 300 ft, 3/7/07  
Well abandoned April 2007.

Figure 3-1  
Shallow Aquifer Borehole Summary Logs
A test boring west of the Lysite Store was drilled to a total depth of 300 feet. This well did not encounter any loose sandstone of high porosity. The borehole water production potential was considered much less than at the School location. A highly carbonaceous bed with coal partings occurring from 80 to 90 feet appears to contribute water into the borehole with a strong hydrogen sulfide odor. The test boring was air-lift pumped at 6 to 7 gpm from total depth. It was concluded the site would not be suitable for a municipal well, and the borehole was grouted.

3.2 Deep Aquifer Test Boring

South of the District service area a test boring was installed on BLM land. This exploration was intended to be a test well, however, there was no aquifer formation encountered in the borehole. The borehole was subsequently grouted.

Prior to drilling of the test borehole, Permit No. U.W. 176615 was obtained from the State Engineer’s Office. The deep test boring was drilled by direct rotary using a water-based mud. A surface seal consisting of 9-5/8 inch diameter steel casing cemented into a 12-1/4 inch diameter borehole was installed to 82 feet. Open-hole drilling at 8-3/4 inch diameter was completed below the casing. Figure 3-2 provides a summary log for the borehole. A detailed log, with wireline data to 820 feet, is provided in Appendix C. Additional geological information is provided on Photo Plate 2.

3.2.1 Lithology

The deep test boring encountered intermittent sandstones to a depth of 800 feet, with most sandstone occurrences shallower than 560 feet. These sandstones were partially cemented, with no occurrences of good loose sands. Most sandstones were assigned a porosity value of 3 to 6%, with only a few estimated at greater than 20% porosity. Cementation was largely kaolinite, probably derived from feldspar weathering, which was a common mineral in the sandstones along with mica. A few sandstones were cemented with calcite. Below 800 feet, borehole lithology was dominated by clay minerals. There was a thick section of brown carbonaceous shale from 800 to 1240 feet. Claystone and shale became gray and greenish gray, and non-carbonaceous below 1240 feet.

The borehole was terminated at 1440 feet due to very slow penetration rates. The planned total depth was 1200 feet based on logging data for an abandoned oil and gas well designated as the Lysite 12-18 (location shown on Figure 1-2). This total depth had been extended to 1500 feet during drilling.

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3 An NPDES permit was also obtained from Wyoming DEQ for pumping test discharge (#WYG720115). This permit was never used and was subsequently terminated.
BLM Test Borehole  
NWSNE 13 J8N 91W

0' – 50', Quaternary Alluvium. Sand and gravel, some silt and clay. (Driller reported contact at 30')

50' – 260', Tertiary Wind River Fm. Mostly sandstone from deeper channels. Includes beds of siltstone and claystone. Sandstone is mostly fine-grained and partially cemented with kaolin. Some calcite cement. Some silty/argillaceous sand. Porosity mostly 0 – 12%, occasionally 12% – 20%, rarely >20%. Coal bed at 80' – 90'.


560' – 650', Carbonaceous shale with sparse interbeds of sandstone, and with thin coal horizons.

650' – 800', Interbedded sandstone and claystone from shallow channels and alluvial plane. Sandstone is cemented with calcite or argillaceous. Low porosity. Coal bed from 660' – 670'.

800' – 1240', Carbonaceous shales and claystones. Occasional sandstone bed. Limestone bed at 1140' – 1150'.

1240' – 1340', Claystone

1340' – 1440', Claystone and siltstone.

Bottom of Borehole, 1440',  
3/27/07 1700 hrs

Surface casing at 9–5/8" OD was set to 82 ft.

Well Abandoned April 2007.

Figure 3-2
Deep Aquifer Borehole Summary Log
3.2.2 Wireline

The borehole was logged by Schlumberger, however, the tools could reach only to 830 feet below ground surface due to borehole obstruction. The logging data included: caliper, SP, gamma, spectral gamma (U, Th, K), neutron porosity, bulk density/porosity, photoelectric effect, and array resistivity. These logs are plotted alongside the lithology data in Appendix C.

Wireline data are used to correct borehole samples for depth, to locate casing and screens for well completion, to plan cementing work, and to assess water bearing potential of the formation. A spectral gamma log was run to separate out the effects of potassium feldspar on the gamma radiation readings.

The wireline data were reviewed to assess the potential of water bearing strata. The wireline signature of water bearing sandstone includes low gamma ray values, a deflection of the SP curve, reduced borehole diameter (i.e., filter cake formation), consistent and high porosity data (sandstone matrix), a low photoelectric effect value, and high resistivity. Arkosic sandstones (i.e., with abundant feldspar minerals) will also have a low thorium – potassium ratio, ranging from 0.5 to 0.8. Uranium salts could be present, elevating both uranium concentration and gamma ray values.

Zones from 651 to 657 feet, 686 to 698 feet and from 716 to 725 feet illustrate several of the log indicators for water bearing sandstone. All have a depressed gamma ray and deflected SP. Caliper dimension is also reduced from the 8-3/4 inch borehole. Porosity data for these intervals indicates about 30%, which suggests clean sandstone. Resistivity at 90-inches indicates water conductivities from 650 to 1,550 µS/cm, which suggests acceptable quality (higher values are estimated by different methods).

The thorium – potassium ratio for these zones ranges from 3.7 to 4.4 indicating mixed clay mineralogy. This result could possibly be obtained for arkosic sandstone with some kaolin cement. Photoelectric effect (PE) values are slightly high for sandstone (clean sandstone has a PE of 1.8), suggesting clay is present, but could be influenced by feldspar. Clay minerals, if present, will normally elevate the neutron porosity value.

The lithology data did not reveal good aquifer conditions at these intervals, indicating argillaceous sandstone with kaolin and calcite cements. When the borehole samples were logged, these intervals were not identified as potential water bearing zones. As shown on the borehole log (Appendix C), only the sandstone from 651 to 657 feet is described as clean, but is partially cemented. Claystone with siltstone and sandstone stringers are also described in proximity to these intervals. Clay effects on neutron porosity and PE values are likely. At the time of drilling it was considered that Level II Study budget could be better used to explore for groundwater at a more southerly site. It was considered unlikely that the zones identified would collectively provide water production at the rate required for the District (17 – 43 gpm).
Lysite School Test
150’ - 160’
Clean, loose sandstone characteristic of water bearing formation. Greater than 25% porosity. Individual grains consist of mostly quartz, with minor feldspar and mica.

Lysite School Test
280’ - 290’
Argillaceous, cemented sandstone. Low porosity, non-water bearing unless fractured. Chips consisting of cemented grains are shown.

Lysite Store Test
80’ - 90’
Highly carbonaceous bed, includes coal partings. Apparent source rock for hydrogen sulfide odor in discharge water. Chips of carbonaceous claystone/shale are shown.
BLM Test
700’ - 710’
Cemented sandstone chip (circled) has little porosity. Grains are mostly quartz; cement is kaolin. Other material in photo ranges from loose sand grains to chips of claystone.

BLM Test
910’ - 920’
Carbonaceous shale chips characteristic of interval from 800 to 1240 feet are shown.

BLM Test
1340’ -1350’
Grayish green claystone/shale chips are shown. Other chips include cemented very-fine grained sandstone. Typical sample of lower claystones occurring from 1240’ to 1440’.
4 GAS VENTURES WELL

Gas Ventures is a petroleum company located in Thermopolis that drilled a gas well near to the District service area during July 2007, designated as the Knapp #1-18 where shown on Figure 1-2. The District Board informed Stetson Engineering of the gas well and contact was subsequently made to purchase wireline and lithology data as part of the Level II Study. Wireline data were obtained for the interval from surface to a depth of 3,000 feet. Lithology data did not begin until a depth of 1,000 feet. Wireline data are provided in Appendix D. A summary lithology log for the well is shown on Figure 4-1.

The Knapp #1-18 (API #49-013023096) well was drilled by direct rotary using oil-based mud, with barite added to the mud for weight control. Lithology data was based on samples of drilling cuttings collected at 10 to 30 foot intervals. Baker Atlas conducted geophysical logging in the well, recording data at 0.5 ft intervals. Both lithology and wireline data are based on a datum at the rig Kelly table, 14 feet above ground surface.

4.1 Lithology

A summary log of the borehole lithology is provided on Figure 4-1. Borehole geology from 1,000 to 3,000 feet is dominated by gray shale. There were 25 sandstones logged in this interval, ranging in thickness from 5 to 25 feet. Porosity estimates did not exceed 15%, and some cementation was noted. A lack of significant intervals dominated by sandstone suggests that a viable aquifer is not present. The ability for a thin sandstone isolated above and below by thick sections of shale to receive adequate recharge for long-term sustained production is considered unlikely, particularly given the lenticular nature of the sandstone bodies observed in the Wind River formation.

4.2 Wireline

The cased interval of the well, from surface to 936 feet kb, was logged only by the gamma ray and neutron porosity tools. These data do not reveal any continuous sandstone sections, although a few sandstones appear present, based primarily on low gamma ray readings. Corresponding neutron porosity data are mostly erratic, suggesting influence by borehole effects or clay mineralogy that elevates the porosity readings. The data over the cased interval of the well do not reveal a significant sandstone target for test well drilling.
Gas Ventures - Knapp #1-18

1000-1005, Sandstone, slight cementation, 10-15% porosity
1035-1040, Sandstone, no description
1060-1065, Sandstone, no description

1245-1250, Sandstone, slight cementation, 10-15% porosity
1295-1300, Sandstone, no description

1365-1375, Sandstone, slight cementation, 10-15% porosity
1405-1410, Sandstone, no description

1490-1500, Sandstone, slight cementation, 10-15% porosity

1770-1780, Sandstone, slight cementation, 10-15% porosity
1805-1810, Sandstone, no description

1895-1915, Sandstone, slight cementation, 10-15% porosity
1960-1980, Sandstone, slight cementation, 10-15% porosity

2035-2040, Sandstone, slight cementation, 10-15% porosity
2090-2095, Sandstone, no description
2170-2175, Sandstone, no description
2250-2255, Sandstone, no description
2300-2320, Sandstone, slight cementation, 10-15% porosity
2430-2445, Sandstone, slightly cemented, 10-15% porosity
2490-2505, Sandstone, no description
2640-2665, Sandstone, slight cementation, 10-15% porosity
2700-2705, Sandstone, no description
2870-2880, Sandstone, slightly cemented, 10-15% porosity
2905-2910, Sandstone, no description
2945-2950, Sandstone, no description
2975-2980, Sandstone, no description

Figure 4-1
Gas Ventures Borehole Log 1,000 - 3,000 Ft

log scale 0.90
Below casing, wireline data illustrate a pattern of interbedded sandstone and shale, with some sections of thick shale. Sandstone occurs in intervals of a few feet up to possibly 20 feet (by visual estimate). These patterns are best observed by the gamma ray and resistivity logs. The gamma ray has low values, and the resistivity has high values in the interpreted water bearing sandstone intervals. The best of these intervals also provide a low PE value (near 2.0), and converging neutron and density porosity-values with an average porosity of 25 to 35%. If the neutron values are high, nearing to 50% or higher, the bed likely has significant clay, and water content of the clay is elevating the neutron porosity value. This tendency can be seen in many of the shale beds. If the porosity values converge to a low porosity, less than 20%, the bed is likely cemented sandstone of low permeability. The interval from 1333 to 1355 is the best example of what is probably a good water bearing sandstone section.

PE values, which are a lithology indicator, are observed to have an average value of about 3, which is common in shale formations. Lower values of 1.8 occur in clean sandstone. The use of barite, with a PE of 267 (barnes per electron), as a mud additive has the effect of raising the PE values (feldspar also raises PE). PE spikes to high values shown on the log could be a result of mud entering formation fractures, or possibly incipient fractures formed by mud weight, or barite buildup on the borehole wall for some other reason. These appear to occur within shale intervals, and are not considered significant for water supply development.

### TABLE 4-1
**INTERPRETED BOREHOLE LITHOLOGY**

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<th>Lithology</th>
<th>Top (ft)</th>
<th>Bottom (ft)</th>
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<td>Mixed sandstone and shale</td>
<td>936 (casing)</td>
<td>1190</td>
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<td>Shale</td>
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<td>1333</td>
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<tr>
<td>Sandstone</td>
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<td>1355</td>
</tr>
<tr>
<td>Shale</td>
<td>1355</td>
<td>1404</td>
</tr>
<tr>
<td>Mixed shale and sandstone</td>
<td>1404</td>
<td>2060</td>
</tr>
<tr>
<td>Mostly shale with some sandstone</td>
<td>2060</td>
<td>3000</td>
</tr>
</tbody>
</table>

Wireline data were analyzed in greater detail for interpreted sandstone intervals between 936 and 2,000 feet. The results of these analyses are presented in Table 4-2. These intervals were identified by scanning the tabular data and locating intervals of low gamma ray values. Zones with values below 80 API units were interpreted as sandstone. For these beds, shale volume, average porosity, and water conductivity were estimated. Shale volume was determined based on the average gamma ray (GR) value for the entire bed using the linear method. Average porosity was taken as the simple average of neutron and density porosity-values for the bed midpoint. Water total dissolved solids (TDS) was calculated based on the deep reading of resistivity (120-inch), also taken at the bed midpoint, using the Archie formula and assuming that TDS (mg/L) is equal to 65% of water conductivity (µS/cm). In applying the Archie formula, the 120-inch resistivity was assumed to represent true formation resistivity.
### TABLE 4-2
**WIRELINE DATA FOR SANDSTONE INTERVALS**

<table>
<thead>
<tr>
<th>Depth Interval (ft kb)</th>
<th>GR avg API</th>
<th>Shale Volume</th>
<th>PE Porosity</th>
<th>Fm. Res. Ohm-m</th>
<th>TDS mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>938</td>
<td>941</td>
<td>3</td>
<td>64</td>
<td>9%</td>
<td>2.7</td>
</tr>
<tr>
<td>962</td>
<td>964</td>
<td>2</td>
<td>77</td>
<td>13%</td>
<td>3.4</td>
</tr>
<tr>
<td>991</td>
<td>995</td>
<td>4</td>
<td>79</td>
<td>14%</td>
<td>2.4</td>
</tr>
<tr>
<td>1032</td>
<td>1037</td>
<td>5</td>
<td>71</td>
<td>11%</td>
<td>2.9</td>
</tr>
<tr>
<td>1046</td>
<td>1050</td>
<td>4</td>
<td>78</td>
<td>14%</td>
<td>2.5</td>
</tr>
<tr>
<td>1060</td>
<td>1062</td>
<td>2</td>
<td>71</td>
<td>11%</td>
<td>2.9</td>
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<tr>
<td>1095</td>
<td>1096</td>
<td>1</td>
<td>73</td>
<td>12%</td>
<td>2.9</td>
</tr>
<tr>
<td>1103</td>
<td>1108</td>
<td>5</td>
<td>73</td>
<td>12%</td>
<td>2.8</td>
</tr>
<tr>
<td>1115</td>
<td>1120</td>
<td>5</td>
<td>74</td>
<td>12%</td>
<td>2.7</td>
</tr>
<tr>
<td>1140</td>
<td>1144</td>
<td>4</td>
<td>72</td>
<td>12%</td>
<td>2.9</td>
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<tr>
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<td>1186</td>
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<td>66</td>
<td>10%</td>
<td>2.5</td>
</tr>
<tr>
<td>1334</td>
<td>1348</td>
<td>14</td>
<td>75</td>
<td>12%</td>
<td>3.0</td>
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<tr>
<td>1405</td>
<td>1408</td>
<td>3</td>
<td>82</td>
<td>15%</td>
<td>2.9</td>
</tr>
<tr>
<td>1429</td>
<td>1437</td>
<td>8</td>
<td>76</td>
<td>13%</td>
<td>3.6</td>
</tr>
<tr>
<td>1451</td>
<td>1454</td>
<td>3</td>
<td>76</td>
<td>13%</td>
<td>3.4</td>
</tr>
<tr>
<td>1611</td>
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<td>13%</td>
<td>3.6</td>
</tr>
<tr>
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<td>1648</td>
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</tr>
<tr>
<td>1728</td>
<td>1730</td>
<td>2</td>
<td>73</td>
<td>12%</td>
<td>3.3</td>
</tr>
<tr>
<td>1756</td>
<td>1758</td>
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<td>78</td>
<td>14%</td>
<td>2.9</td>
</tr>
<tr>
<td>1766</td>
<td>1769</td>
<td>3</td>
<td>80</td>
<td>14%</td>
<td>2.8</td>
</tr>
<tr>
<td>1822</td>
<td>1825</td>
<td>3</td>
<td>75</td>
<td>13%</td>
<td>3.1</td>
</tr>
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<td>1828</td>
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<td>1</td>
<td>79</td>
<td>14%</td>
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</tr>
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<td>3.4</td>
</tr>
<tr>
<td>1864</td>
<td>1873</td>
<td>9</td>
<td>75</td>
<td>13%</td>
<td>2.7</td>
</tr>
<tr>
<td>1947</td>
<td>1949</td>
<td>2</td>
<td>76</td>
<td>13%</td>
<td>2.9</td>
</tr>
<tr>
<td>1952</td>
<td>1955</td>
<td>3</td>
<td>73</td>
<td>12%</td>
<td>2.9</td>
</tr>
<tr>
<td>1981</td>
<td>1983</td>
<td>2</td>
<td>65</td>
<td>9%</td>
<td>3.6</td>
</tr>
</tbody>
</table>

A: Calculated based on linear method using minimum and maximum GR values for interval from 900 to 2,900 feet of 45 and 345 API Units.

B: Simple average value of neutron and density porosities.

C: Calculated based on water conductivity as estimated by Archie formula, assuming water saturation equal to 1.0, and setting parameters \( a = 0.62 \), \( m = 2.15 \), and \( n = 1 \). TDS was taken as 65% of the calculated water conductivity.
Sandstone intervals were mostly thin, with a total thickness range from 1 to 14 feet. This thickness range is generally consistent with the lithology log. Lack of significant sandstone intervals, 10 to 20 feet in thickness or greater, is an important factor to consider in regard to water production. It is unlikely the sandstone beds have enough transmissivity for a municipal well to produce 17 to 43 gpm.

Shale volume of sandstone intervals was estimated in the range from 9 to 15%. The linear method used is conservative, and actual values could be lower (e.g., 2 to 5%). The shale volumes indicate occurrences of argillaceous material, either from kaolin cement, micas, or clays. PE values are higher than is normal for sandstone, which also may indicate occurrences of clay minerals. PE values could be influence by barite mud in the borehole filter cake. Without this explanation, PE values indicate possible occurrences of clays in the sandstone. Both the gamma ray and PE values indicate the sandstone intervals may not be clean.

Average porosities range from 9 to 33%. Higher porosity values may represent good porous sandstone, or could be influenced by clay minerals, which elevate the neutron porosity.

Calculations of the water total dissolved solids indicate that most of the interpreted sandstone intervals have high dissolved ion concentrations. Three of the intervals (bold type) have values that are acceptable, or equal to good quality water in the Lysite area. There are accuracy limitations to this method, but overall, the results indicate that water bearing sandstones would not produce water quality acceptable to the District. The most significant sandstone, occurring from 1334 to 1348 feet is estimated to have a TDS of 2,768 mg/L. This TDS level would be unacceptable for a municipal water supply well.

Considering wireline and lithology data for the Knapp #1-18 well, test well drilling in proximity to the well is not recommended, as the data do not support viable sandstone aquifers are present. Collectively, the data support that it is doubtful a good well could be installed at the site. The data support that it may be possible to construct a well with some yield, but yield would be limited by lack of formation and/or low porosity/permeability. The data also support that water quality would likely be unacceptable for direct use without treatment for high dissolved ion concentrations.
APPENDIX A

SCHOOL WELL PUMPING TEST REPORT
LYSITE SCHOOL (COMMUNITY CENTER) WELL
PUMP TESTING RESULTS AND RECOMMENDATION FOR SHALLOW WELL DEVELOPMENT

1 INTRODUCTION

Pursuant to the Level 1 Study Report, the existing water supply well that serves the Lysite Community Center, formerly the Lysite School, and herein referred to as the School Well, was pump tested. The purpose of testing was to assess if the School Well penetrated an aquifer that could be developed for a municipal well, with a target capacity of at least 26 gpm. The School Well log indicates a sandstone aquifer from 250 to 270 feet below ground surface, and that when constructed, the well tested at 10 gpm with 0 feet of drawdown after three hours of pumping.

1.1 Conclusions and Recommendations

- There was no indication from testing that the School Well is open to a suitable aquifer for the purpose of the District. However, it is not known if the well was actually open to the interval from 250 to 270 feet, as indicated on the well log. Data collected in the Knigge Trailer well during the School Well pumping test, 560 feet southeast from the School Well, also indicated unsuitable aquifer conditions.

- Test borings should be drilled at the School and near to Lysite Store in order to assess geological formations occurring between land surface and a depth of 300 feet. These borings will be surface cased at shallow depth (minimum 18 ft), and then drilled open hole at approximately 6-1/4 inch diameter to total depth. Detailed geological logging will be performed on the drill cuttings, and the boreholes may be geophysically logged. Air-lift pumping during drilling will also be used to assess yield potential. Based on these data, a decision will be made as to whether or not a well should be completed and tested. If the shallow borings indicate unsuitable aquifer conditions, a deep aquifer test well will be drilled about ¼ miles south of the Lysite Store on BLM or private lands.

Some of the fees allocated for hydraulic fracturing of the deep well could be used to allow for borehole drilling and well completion in the shallow aquifer (the original plan allowed for one test well to be constructed in the shallow aquifer). Consequently, hydraulic fracturing of the deep well may not be included in the work.

2 TESTING

2.1 Preparation

Ward’s Well Service, Inc. of Riverton installed a test pump in the School Well, and also installed instrument access tubes in monitoring wells. The test pump capacity was approximately 30 gpm. The well locations are shown on Figure 1. Table 1 provides data on well construction.

---

TABLE 1
WELL CONSTRUCTION DATA

<table>
<thead>
<tr>
<th>Name</th>
<th>Installed</th>
<th>Depth (ft bgs)</th>
<th>Diameter (in)</th>
<th>Pump Setting (ft)</th>
<th>Static (ft bgs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>1975</td>
<td>270</td>
<td>6</td>
<td>160/86&lt;sup&gt;A&lt;/sup&gt;</td>
<td>30</td>
</tr>
<tr>
<td>All Service</td>
<td>2001</td>
<td>240</td>
<td>6</td>
<td>230</td>
<td>35</td>
</tr>
<tr>
<td>Knigge Trailer</td>
<td>--</td>
<td>250&lt;sup&gt;?&lt;/sup&gt;</td>
<td>6</td>
<td>180</td>
<td>30</td>
</tr>
<tr>
<td>Ramage House</td>
<td>1981</td>
<td>385</td>
<td>5</td>
<td>166</td>
<td>55</td>
</tr>
</tbody>
</table>

<sup>A</sup> Test pump setting / permanent pump setting.

2.2 Pumping Test

Pressure transducers measuring the water level in the well were installed in each monitoring well, including the School Well. Water level measurements were recorded at 1-minute intervals. The School Well was also equipped with a clamp-on ultrasonic flow meter, measuring the rate of discharge and total volume produced from the well. These data were recorded in the flow meter memory at 5-minute intervals. Water pH, conductivity, and temperature was measured in the School Well discharge using a portable instrument.

It was originally planned that step-rate and constant-rate pumping tests would be completed. However, due to the low rate of production in the School Well, testing was reduced to a single constant rate with a 4-hour pumping phase, followed by about 20-hours of recovery monitoring. The constant rate test was run at 8.5 gpm, and resulted in full drawdown to the pump setting within the 4-hour pumping phase.

2.3 Analysis

Analysis of the test data was completed to assess the aquifer hydraulic capacity at the well site, and to evaluate the potential for interference effects on neighboring wells. This information would in turn be used to determine if a municipal well could be installed at the School site.

2.3.1 School Well

The analysis of data collected in the School Well is presented on Figures 2, 3, 4 and 5. The pattern of the data, which is complex, indicates a few zones or layers are present. Aquifer transmissivity when drawdown was below 100 feet, was estimated at about 4 ft<sup>2</sup>/d. At the end of recovery, when drawdown was less than 20 feet, transmissivity was estimated at 13 ft<sup>2</sup>/d. These results indicate that a municipal well could not be successfully installed into the same formations. There is not enough available drawdown for an aquifer of this low transmissivity to be produced at a rate suitable for the District’s needs. Figure 6 illustrates required drawdown for various well yields, and three values of transmissivity.

Clogging in the well has possibly cut-off water production from the deeper aquifer zone, identified from 250 to 270 feet on the well log. An old well pump and column pipe has been lost in the well, blocking the well below 160 feet. Blue-gray clay produced during testing suggests that possibly the bottom of the borehole is filled with clay, which would also cut-off flow from the deeper interval. Cascading water could be heard in the well during recovery, indicating that the well is not producing from a single deeper zone, as it would appear on the well log.

Water quality data for the School Well discharge exhibited some slight variations in conductivity and temperature during testing. These data are presented in Table 2. The water is alkaline (pH > 7.0) and has
significant dissolved ion concentrations (Conductivity > 1,000), but is among the higher quality waters in the area, as determined during the Level 1 Study. A moderately detailed water analysis for the School Well discharge is provided in the Level 1 Study report. A sample was not collected for the pumping test because of the unfavorable well capacity.

### TABLE 2
FIELD WATER QUALITY PARAMETERS

<table>
<thead>
<tr>
<th>Time since pumping began (min)</th>
<th>pH (standard units)</th>
<th>Conductivity (µS/cm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>8.36</td>
<td>1,750</td>
<td>13.2</td>
</tr>
<tr>
<td>30</td>
<td>8.44</td>
<td>1,708</td>
<td>13.3</td>
</tr>
<tr>
<td>60</td>
<td>8.52</td>
<td>1,683</td>
<td>13.7</td>
</tr>
<tr>
<td>120</td>
<td>8.55</td>
<td>1,698</td>
<td>14.6</td>
</tr>
<tr>
<td>180</td>
<td>8.60</td>
<td>1,642</td>
<td>16.1</td>
</tr>
<tr>
<td>240</td>
<td>8.59</td>
<td>1,683</td>
<td>14.8</td>
</tr>
</tbody>
</table>

2.3.2 Monitoring Wells

Monitoring well data collected at the All Service shop, Knigge trailer, and the Ramage home are presented on Figure 7. The data are shown as depth to water below ground surface, but also reflect differences in elevation of groundwater, as the elevations from one site to another are similar (probably ±10 ft at most).

Data for the Knigge and All Service wells are similar. The Ramage well may have a true static similar to Knigge and All Service, but is a lower producer and does not achieve static between pump cycles. There was no response to pumping in the School Well at any of these three sites.

Because the Knigge well was operated during the monitoring period, some of these data could be used to estimate aquifer transmissivity at the well site. One selection of data was made for a recovery analysis, as shown on Figure 7. The hydrograph for these data and analysis plot are shown on Figures 8 and 9. Although the actual pumping rate was not known, for typical domestic uses, a rate of 3 gpm is probably typical, with 10 gpm representing an extreme maximum. Using these values for the pumping rate prior to recovery, transmissivity was calculated to range from 3.7 to 12.2 ft²/d. These values also indicate that the aquifer at the location of the Knigge well is unsuitable for a municipal.

### 3 CONCLUSIONS & RECOMMENDATIONS

Analysis of pumping test data for the School and Knigge wells indicates that neither location would support a municipal well for the District. As originally planned in the Level 1 Study, this finding would be followed by test well drilling near to Lysite Store.

However, because the School Well could have been clogged, preventing inflow from the original aquifer located between 250 and 270 feet below ground, the shallow aquifer drilling plan will be modified to install test borings near to the Store, and also at the School. These borings will be 6-1/4 inch diameter open holes with shallow surface casing set to 18 feet. Both boreholes will be carefully logged based on cuttings, and if necessary, geophysical logging will be included in the work. Pending the outcome of these boreholes, a decision will be made regarding a well completion at one or both sites. If the shallow
aquifer does not appear suitable, a deep aquifer test well will be drilled about ¼ miles south of Lysite Store on BLM or private lands.

The Phase II budget for the Level 2 Study includes specific budget items for drilling work. The installation of boreholes at the Store and School is additional to the original budget allocation. If a shallow aquifer test well were also installed, additional budget could be required (only if both shallow and deep test wells were completed). The borehole drilling is estimated at $40,000 inclusive of engineering fees. It is recommended that, if necessary, these fees be allocated from the budget for hydraulic fracturing of the deep aquifer test well ($90,000). The deep well, therefore, may not be hydraulically fractured if fees are reallocated to shallow borings and the hydraulic fracture stimulation cannot be completed in the remaining budget of $50,000 (i.e., $90,000 - $40,000 = $50,000).
Figure 1
Well Location Map
Data collected from School Well.

Figure 2
Constant Rate Test Hydrograph
Transmissivity
3.3 - 3.6 ft²/d

well storage effects

1:1 Slope

Data collected from School Well.

Figure 3
Constant Rate Test Log-Log Plot
Data collected from School Well.
Data collected from School Well.
Figure 6
Estimated Yield of Wind River Formation Wells
Data collected from private wells.

Figure 7
Monitoring Well Hydrographs
Knigge Trailer Well Recovery Analysis Hydrograph

Data collected in Knigge Trailer Well.

Figure 8

Western Groundwater Services
Data collected from Knigge Trailer Well.

Transmissivity
3.7 - 12.2 ft$^2$/d
APPENDIX

HYDRAULIC ANALYSIS WORKSHEETS
Pumping Test: CR092906
Analysis Method: Cooper-Jacob Time-Drawdown

Analysis Results:
Transmissivity: 4.00E+0 [ft²/d]

Test parameters:
Pumping Well: School Well
Aquifer Thickness: Confined Aquifer
Casing radius: 0 [ft]
Screen length: 0 [ft]
Boring radius: 0 [ft]
Discharge Rate: 8.46 [U.S. gal/min]

Comments: Data inflections result in uncertain estimate of transmissivity; although, data strongly indicate a low value.
School Well pumping test analysis report

**Pumping Test:** CR092906

**Analysis Method:** Theis Recovery

**Analysis Results:**
- Transmissivity: 1.36E+1 [ft²/d]

**Test parameters:**
- Pumping Well: School Well
- Casing radius: 0 [ft]
- Screen length: 0 [ft]
- Boring radius: 0 [ft]
- Discharge Rate: 8.46 [U.S. gal/min]
- Pumping Time: 243 [min]

**Aquifer Thickness:** Confined Aquifer

**Comments:** Late time recovery data follow a well-defined constant slope. But estimated transmissivity probably reflects full transmissivity of saturated interval contributing to well.

**Evaluated by:** M. Cunnane
**Evaluation Date:** 10/2/2006
Knigge Recovery Analysis [Theis Recovery]

Data follow a well-defined constant slope; Uncertainty in transmissivity estimate exists due to unknown flow rate.

Pumping Test: Knigge Recovery Analysis
Analysis Method: Theis Recovery

Analysis Results:
- Transmissivity: $6.12 \times 10^0$ [ft²/d]

Test parameters:
- Pumping Well: Knigge Trailer
- Aquifer Thickness: Confined Aquifer
- Casing radius: 0 [ft]
- Screen length: 0 [ft]
- Boring radius: 0 [ft]
- Discharge Rate: 5 [U.S. gal/min]
- Pumping Time: 32 [min]

Comments: Data follow a well-defined constant slope; Uncertainty in transmissivity estimate exists due to unknown flow rate.
APPENDIX B

SHALLOW AQUIFER TEST BORING LOGS
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
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<td>@</td>
<td>Abundant</td>
</tr>
<tr>
<td>abt</td>
<td>Abundant</td>
</tr>
<tr>
<td>abv</td>
<td>Above</td>
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<tr>
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<td>Acidic</td>
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<td>After</td>
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<td>Black</td>
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<td>Carbonate</td>
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<tr>
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<td>Cobble</td>
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<td>ceph</td>
<td>Cephalopod</td>
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<td>Cryodolite</td>
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<tr>
<td>cryo</td>
<td>Cryodolite</td>
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| crytx         | Cross 

**Common Abbreviations**
### Engineering Abbreviations

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<thead>
<tr>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>AOF</td>
<td>absolute open flow</td>
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<tr>
<td>BHFP</td>
<td>bottom hole flow pressure</td>
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<td>bottom hole pressure</td>
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<td>bottom hole shut in pressure</td>
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<td>BHT</td>
<td>bottom hole temperature</td>
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<td>BO</td>
<td>barrels of oil</td>
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<tr>
<td>BOPD</td>
<td>barrels of oil per day</td>
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<tr>
<td>BOPH</td>
<td>barrels of oil per hour</td>
</tr>
<tr>
<td>Brik</td>
<td>brackish</td>
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<tr>
<td>BW</td>
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<td>BWPD</td>
<td>barrels of water per day</td>
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<tr>
<td>BWPH</td>
<td>barrels of water per hour</td>
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<td>CIRC</td>
<td>circulate (ed) (t)ion</td>
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<td>cation</td>
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<tr>
<td>COMP</td>
<td>completed (t)ion</td>
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<td>cored</td>
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<td>casing</td>
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<td>development</td>
</tr>
<tr>
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<td>decreasing</td>
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<td>derrick floor</td>
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<td>fair air blow</td>
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<td>FI</td>
<td>flowed (ing)</td>
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<td>flowing pressure</td>
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<td>Ga</td>
<td>gauged</td>
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<td>gas and oil cut mud</td>
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<td>GCM</td>
<td>gas cut mud</td>
</tr>
<tr>
<td>GCW</td>
<td>gas cut water</td>
</tr>
<tr>
<td>GAP</td>
<td>good air blow</td>
</tr>
<tr>
<td>GIP</td>
<td>good initial puff</td>
</tr>
<tr>
<td>GOR</td>
<td>gas-to-oil ratio</td>
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<td>GR</td>
<td>ground</td>
</tr>
<tr>
<td>GTS</td>
<td>gas to surface</td>
</tr>
<tr>
<td>Gty</td>
<td>gravity</td>
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<td>HO</td>
<td>heavy oil</td>
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<td>IAB</td>
<td>initial air blow</td>
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<td>initial production</td>
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<td>kelly bushing</td>
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<td>LOC</td>
<td>location</td>
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<tr>
<td>LSD</td>
<td>legal subdivision</td>
</tr>
<tr>
<td>MCFG</td>
<td>million cubic feet of gas</td>
</tr>
<tr>
<td>MMCFG</td>
<td>million cubic feet of gas</td>
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<tr>
<td>MCO</td>
<td>mud cut oil</td>
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<tr>
<td>MCW</td>
<td>mud cut water</td>
</tr>
<tr>
<td>O &amp; G</td>
<td>oil and gas</td>
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<tr>
<td>O &amp; SW</td>
<td>oil and salt water</td>
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<tr>
<td>OC</td>
<td>oil cut</td>
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<tr>
<td>OCM</td>
<td>oil cut mud</td>
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<td>OFM</td>
<td>oil flecked mud</td>
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<tr>
<td>Op</td>
<td>open</td>
</tr>
<tr>
<td>OTD</td>
<td>old total depth</td>
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<tr>
<td>OTS</td>
<td>oil to surface</td>
</tr>
<tr>
<td>OWDD</td>
<td>old well drilled deeper</td>
</tr>
<tr>
<td>OWPPB</td>
<td>old well plugged back</td>
</tr>
<tr>
<td>OWWO</td>
<td>old well worked over</td>
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<tr>
<td>PB</td>
<td>plugged back</td>
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<td>perforated</td>
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<td>PD</td>
<td>per day</td>
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<tr>
<td>PH</td>
<td>per hour</td>
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<tr>
<td>PKR</td>
<td>packer</td>
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<tr>
<td>PSI</td>
<td>pounds per square inch</td>
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<td>REC</td>
<td>recovered</td>
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<td>rotary table</td>
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<tr>
<td>SAB</td>
<td>strong air blow</td>
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<tr>
<td>SGCM</td>
<td>slight gas cut mud</td>
</tr>
<tr>
<td>SGCW</td>
<td>slight gas cut water</td>
</tr>
<tr>
<td>SI</td>
<td>shut in</td>
</tr>
<tr>
<td>SIP</td>
<td>shut in pressure</td>
</tr>
<tr>
<td>SO</td>
<td>show oil</td>
</tr>
<tr>
<td>SO &amp; G</td>
<td>show oil and gas</td>
</tr>
<tr>
<td>SO &amp; W</td>
<td>show oil and water</td>
</tr>
<tr>
<td>SOC M</td>
<td>slight oil cut mud</td>
</tr>
<tr>
<td>SOC W</td>
<td>slight oil cut water</td>
</tr>
<tr>
<td>SIEZ</td>
<td>squeezed</td>
</tr>
<tr>
<td>SSO</td>
<td>slight show of oil</td>
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<tr>
<td>SW</td>
<td>salt water</td>
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<tr>
<td>SWBD</td>
<td>swabbed</td>
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<tr>
<td>T.D.</td>
<td>total depth</td>
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<td>TSTM</td>
<td>too small to measure</td>
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<td>TSTG</td>
<td>testing</td>
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<td>V.G.</td>
<td>valve open</td>
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<td>wildcat</td>
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<td>weak air blow</td>
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<td>WCM</td>
<td>water cut mud</td>
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<td>WIP</td>
<td>weak initial puff</td>
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<td>WTR</td>
<td>water</td>
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<td>WTR CUSH</td>
<td>water cushion</td>
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### Mechanical Log Abbreviations

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<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tr>
<td>BHCS</td>
<td>bore hole compensated sonic</td>
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<tr>
<td>C Al</td>
<td>caliper</td>
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<tr>
<td>CN</td>
<td>compensated neutron</td>
</tr>
<tr>
<td>DI</td>
<td>dual induction log</td>
</tr>
<tr>
<td>DIL</td>
<td>dual induction laterolog</td>
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<td>DLL</td>
<td>dual laterolog</td>
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<td>DL</td>
<td>density log</td>
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<td>FDL</td>
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<td>GL</td>
<td>guard log</td>
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<td>GR</td>
<td>gamma ray</td>
</tr>
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<td>LL</td>
<td>laterolog</td>
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<td>LL 8</td>
<td>laterolog-8</td>
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<td>microlog, minilog</td>
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<td>MLL</td>
<td>microlaterolog</td>
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<td>N</td>
<td>Neutron</td>
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<tr>
<td>S</td>
<td>sonic, acoustilog</td>
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<tr>
<td>SNP</td>
<td>spontaneous potential</td>
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<td>SP</td>
<td>sidereal neutron porosity log</td>
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<td>PL</td>
<td>proximity log</td>
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### OTHER SYMBOLS

**CONTACTS**
- □ Conformable
- △ Unconformable
- □ Gradational

**POROSITY**
- S Earthy
- F Fenestral
- F Fracture
- □ Intergranular

**SORTING**
- □ Earthy
- F Fenestral
- F Fracture
- □ Intergranular

**FRAMEWORK**
- □ Moldic
- □ Organic
- □ Pinpoint <0.0625mm
- □ Vuggy >0.0625mm

**FRAMEWORK (FW)**
- □ 0 to 5%
- □ 10%
- □ 20%
- □ 30%
- □ 40%
- □ 50%
- □ 60%
- □ 70%
- □ 80%

**ROUNDING**
- □ 90%
- □ 100%
- □ Rounded
- □ Subrounded
- □ Subangular
- □ Angular

### NOTES

**FORMATION SYMBOLS:**
- Qa - Quaternary Alluvium; Twlc - Wind River, Lost Cabin Member; Twl - Wind River, Lysite Member (Tertiary)

**SAMPLES:**
Locations of samples described for the log are indicated by the pointer in the depth column. Lithologies are interpolated between samples.

**COMPONENTS:**
- Rock Builders: F = Fossils <20%; 1 symbol = 20 - 50%; 2 symbols = 50 - 70%; 3 symbols = 70 - 100%.
- Accessories and Minor Beds: 1 symbol = 10 - 20%; 2 symbols = 30 - 40%; 3 symbols = 50%.
- (Selected minerals (*) may be indicated by 1 symbol if significant - may be less than 5%)

**SORTING:**
- Well = 1 or 2 sizegrades; Medium = 3 or 4 sizegrades; Poor = 5 or more sizegrades

**FRAMEWORK (FW):**
- Proportion of sand-sized grains. FW=1 indicates 10% sand-sized grains and 90% mud; FW=C indicates 100% sand-sized grains and 0% mud; FW>=7 is a grain-to-grain contact sample with total interstitial space of about 33%, available for mud, cement and porosity.

**DIAGENESIS:**
- M = Metasomatism; D = Dolomitization; R = Recrystallization; F = Fracturing; L = Leaching; P = Pressure deformation; Secondary cementation (A - Anhydrite, S - Silica, K - Kaolin, C - Calcite and others). Numeric value indicates percentage (1 = 10%...C=100%), 't' indicates trace quantity less than 10%.
Samples below 40' run over a 10 ft continuous interval; sample marker is shown at midpoint.

- Sand, gravelly, brown
- Sand, gravelly, tr clay (gray), brown
- Alluvium - Wind River contact @ ~27 ft bgs
- Clyst, tan; includes sand, gravel embedded or from above
- Silst, gy, arg, tr calc; Silst, tan, arg, tr calc
- Clyst, gy, plyt, slyt, mica, calc
- Sltst, gy, arg, kao cmt, mica, arg
- Dam at 54 ft (check w/drlr)
- Clyst, gy, plyt, slyt, tr calc
- Ss, it gy, m, kao cmt, mica
- Hard, Rough Drilling 97'
- Clyst, lt gn gy, plty, tr calc
- Ss, lt gy, lse, fld, mica, tr glau?
- Rough drilling 137'
- 3 gpm water production @ 150'
- Rough drilling 155'
- Air-lifting 5 gpm @ 160'
- Ss, it gy, lse, slyt, tr mic; Sltst, lt grn gy, plty, tr calc
- Ss, it gy, lse, tr sil cmt, fld, mica; Ss, calc + sil cmt, strg [most of sample is loose grains showing minor qtz overgrowth; some more cemented chips are present; most of this sand section above is of similar nature]
- Ss, it gy, lse, slyt, tr mic; Sltst, lt grn gy, arg, slyt, tr calc
- Ss, it gy, slyt, tr mic; Sltst, lt grn gy, arg, slyt, tr calc
- Ss, it gy, arg, kao cmt, v mica
- Clyst It ov blkv

Diagnoses:

- K 1-2
- C
- K
- C
- K 3
- S 3
- C 2
- S 1
- S 1
- S 2+
### Lysite School Test Borehole Log

#### Track 1

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<th>Depth (FT BGS)</th>
<th>ROP (in)</th>
<th>Porosity Type</th>
<th>Porosity (%)</th>
<th>Lithology</th>
<th>Grain Size (mm)</th>
<th>Recording</th>
<th>Sorting</th>
<th>Framework</th>
<th>Geological Descriptions</th>
<th>Diagenesis</th>
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<td>Top of Hole, 305 ft, 2/27/07 1630 hr</td>
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<td>200</td>
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<td>Ss, lt gy, blyk; Sltst/ vf Ss strg</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Sltst, arg, kao</td>
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<td></td>
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<td>Clast, lt gy, plty, si</td>
<td>Ss, lt gy, f, calc cmt, tr arg/kao, fld, mica</td>
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<td>Clast, lt gy, sil; Ss strg</td>
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<td>Ss, lt gy, calch cmt, arg</td>
<td>C 2+</td>
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<td>Ss, lt gy, calc cmt</td>
<td>Clast, lt grn gy</td>
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<td>C 2+</td>
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<td>Clast, lt grn gy, hd -&gt; sil; Ss strg</td>
<td>Clast, lt grn gy</td>
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<td></td>
<td>Ss, lt gy, calc+kao cmt, arg</td>
<td>C 2</td>
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<td></td>
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<td></td>
<td>Ss, lt gy, ise, m, fld, op, tr kao cmt</td>
<td>K 1</td>
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<td></td>
<td></td>
<td>Air-lift puming 7-8 gpm from 305 ft</td>
<td>Ss, lt gy, f, calc cmt; Clast strg</td>
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<td></td>
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<td></td>
<td>C 3</td>
<td></td>
</tr>
</tbody>
</table>

#### Diagenesis

- **C 2**: Indicates moderate cementation and a more stable sedimentary environment.
- **C 3**: Indicates stronger cementation and a more stable sedimentary environment.
- **K 1**: Indicates a more unstable sedimentary environment with possible karstification.

### Notes
- **Rounding**: Indicates the degree of rounding of the grains.
- **Sorting**: Indicates the degree of sorting of the grains.

**Framework**: Includes a description of the framework of the sedimentary rock, such as sandstone, shale, or conglomerate.

**Diagenesis**: Provides information on the diagenetic processes that have occurred in the sedimentary rock, such as compaction, cementation, or alteration.
Lysite Store Test Boring
Lysite Water and Sewer District
Lysite, Wyoming

Scale 1:240 (5"=100') Imperial

Well Name: Lysite Store Test Boring
Location: Lysite WY
Licence Number: U.W. 177547
Region: Fremont Co.
Spud Date: 3/2/07
Drilling Completed: 3/7/07

Surface Coordinates: NAD 1983: 43 16' 6.26" N (NENENE 13 38N 91W)
107 41' 32.18" W

Bottom Hole Coordinates:
Ground Elevation (ft): 5,266 FT MSL
K.B. Elevation (ft): 5,269 FT MSL
Logged Interval (ft): 0 FT To: 300 FT Total Depth (ft): 300 FT BGS
Formation: Wind River, Tertiary
Type of Drilling Fluid: Air Rotary, Open-hole

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ROCK TYPES
- Anhydrite
- Bentonite
- Breccia
- Chert
- Claystone
- Coal
- Conglomerate
- Dolomite
- Gypsum
- Igneous
- Limestone
- Metamorphic
- Salt
- Shale
- Siltstone
- Sandstone
- Till

COMPONENTS
ROCK BUILDERS
- Algae
- Amphipora
- Belemnite
- Bioclastic
- Brachiopod
- Bryoza
- Cephalopod
- Coral
- Crinoid
- Echinoid
- Foraminifera
- Fossils <20%
- Gastropod
- Intraclasts
- Oolites
- Ostracod
- Pelecypod
- Pellets
- Pisolite >2mm
- Scaphapod
- Stromatopora

ACCESSORIES
- Anhydritic
- Argillaceous
- Bentonite*
- Bituminous
- Calcareous
- Carbonaceous
- Chert (dark)
- Chert (light)
- Coal, thin beds
- Dolomitic
- Feldspar
- Fish remains*
- Iron pellets
- Ferruginous
- Glaucorite*
- Gypsum
- Heavy minerals*
- Kaolin*
- Mineral crystals*
- Nodules
- Pebbles >2mm
- Phosphate pellets
- Plant remains*
- Plant spores*
- Pyrite*
- Salt casts/infill
- Sand grains >1-2mm

MINOR BEDS
- Anhydrite
- Shale
- Bentonite
- Coal
- Dolomite
- Gypsum
- Limestone
- Siltstone
- Sandstone

Western Groundwater Services
## OTHER SYMBOLS

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## NOTES

**FORMATION SYMBOLS:**
- Qa - Quaternary Alluvium; Twlc - Wind River, Lost Cabin Member; Twl - Wind River, Lysite Member (Tertiary)

**SAMPLES:**
- Locations of samples described for the log are indicated by the pointer in the depth column. Lithologies are interpolated between samples.

**COMPONENTS:**
- Rock Builders: F = Fossils <20%; 1 symbol = 20 - 50%; 2 symbols = 50 - 70%; 3 symbols = 70 - 100%.
- Accessories and Minor Beds: 1 symbol = 10 - 20%; 2 symbols = 30 - 40%; 3 symbols = 50%.
- (Selected minerals (*) may be indicated by 1 symbol if significant - may be less than 5%)”

**SORTING:**
- Well = 1 or 2 sizegrades; Medium = 3 or 4 sizegrades; Poor = 5 or more sizegrades

**FRAMEWORK (FW):**
- Proportion of sand-sized grains. FW=1 indicates 10% sand-sized grains and 90% mud; FW=C indicates 100% sand-sized grains and 0% mud; FW>=7 is a grain-to-grain contact sample with total interstitial space of about 33%, available for mud, cement and porosity.

**DIAGENESIS:**
- M = Metasomatism; D = Dolomitization; R = Recrystallization; F = Fracturing; L = Leaching; P = Pressure deformation; Secondary cementation (A - Anhydrite, S - Silica, K - Kaolin, C - Calcite and others). Numeric value indicates percentage (1 = 10%...C=100%), ‘t’ indicates trace quantity less than 10%.
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<th>Depth (ft BGS)</th>
<th>Porosity (%)</th>
<th>Lithology</th>
<th>Grain Size (mm)</th>
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**Lysite Store Test Borehole Log**

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<td>TD 300 ft, 3/7/07 1130 hrs</td>
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APPENDIX C

DEEP AQUIFER TEST BORING LOG
# Lysite BLM Test Boring

**Lysite Water and Sewer District**  
**Lysite, Wyoming**

**Scale 1:240 (5"=100') Imperial**

**Well Name:** Lysite BLM Test No. 1  
**Location:** Lysite WY  
**Licence Number:** UW 176615  
**Spud Date:** 3/14/07  
**Drilling Completed:** 3/27/07

**Surface Coordinates:**  
NAD 1983: 43 15' 53.2" N (NWSENE 13 38N 91W)  
107 41' 41.9" W

**Bottom Hole Coordinates:**  
Ground Elevation (ft): 5,246 FT MSL  
K.B. Elevation (ft): 5,249 FT MSL  
Logged Interval (ft): 0 FT  
To: 1440 FT  
Total Depth (ft): 1440 FT BGS  
Formation: Wind River Formation, Tertiary  
Type of Drilling Fluid: Fresh water mud

Printed by STRIP.LOG from WellSight Systems 1-800-447-1534 www.WellSight.com

---

**ROCK TYPES**

- Anhydrite
- Bentonite
- Breccia
- Chert
- Claystone
- Coal
- Conglomerate
- Dolomite
- Gypsum
- Igneous
- Limestone
- Metamorphic
- Salt
- Shale
- Siltstone
- Sandstone
- Till

**COMPONENTS**

**ROCK BUILDERS**

- Algae
- Amphipora
- Belemnite
- Bioclastic
- Brachiopod
- Bryozoa
- Cephalopod
- Coral
- Crinoid
- Echinoid
- Foraminifera
- Fossils <20%
- Gastropod
- Intraclasts
- Oolites
- Ostracod

**ACCESSORIES**

- Anhydritic
- Argillaceous
- Bentonite*
- Bituminous
- Calcareous
- Carbonaceous
- Chert (dark)
- Chert (light)
- Coal, thin beds
- Dolomitic

**MINOR BEDS**

- Anhydrite
- Bentonite
- Coal
- Dolomite
- Gypsum
- Limestone
- Siltstone
- Sandstone
- Sandy
- Silty
- Siliceous
- Tuffaceous
- Heavy minerals*
- Kaolin*
- Mineral crystals*
- Nodules
- Pebbles >2mm
- Phosphate pellets
- Plant remains*
- Plant spores*
- Pyrite*
- Salt casts/infill
- Sand grains >1-2mm

---

Western Groundwater Services
OTHER SYMBOLS

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<tr>
<th>POROSITY</th>
<th>SORTING</th>
<th>FRAMEWORK</th>
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<tr>
<td>Earthy</td>
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<td>0 to 5%</td>
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<tr>
<td>Fenestral</td>
<td>Moderate</td>
<td>10%</td>
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<tr>
<td>Fracture</td>
<td>Poor</td>
<td>20%</td>
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<td>Intergranular</td>
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<td>Organic</td>
<td>Unconformable</td>
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<td>Pinpoint &lt;0.0625mm</td>
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<td>Vuggy &gt;0.0625mm</td>
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ROUNDING

- Rounded
- Subrounded
- Subangular
- Angular

SORTING

- Well = 1 or 2 sizegrades
- Medium = 3 or 4 sizegrades
- Poor = 5 or more sizegrades

FRAMEWORK (FW)

- FW=1 indicates 10% sand-sized grains and 90% mud
- FW=C indicates 100% sand-sized grains and 0% mud
- FW>=7 is a grain-to-grain contact sample with total interstitial space of about 33%, available for mud, cement and porosity

DIAGENESIS

- M = Metasomatism
- D = Dolomitization
- R = Recrystallization
- F = Fracturing
- L = Leaching
- P = Pressure deformation
- Secondary cementation (A - Anhydrite, S - Silica, K - Kaolin, C - Calcite and others)

NOTES

FORMATION SYMBOLS:

- Qa - Quaternary Alluvium
- Twlc - Wind River Formation, Lost Cabin Member
- Twl - Wind River Formation, Lysite Member

SAMPLES:

- Locations of samples described for the log are indicated by the pointer in the depth column (pointer is centered on 10-ft sample interval as marked during drilling). Lithologies are interpolated between samples.

COMPONENTS:

- Rock Builders: F = Fossils <20%; 1 symbol = 20 - 50%; 2 symbols = 50 - 70%; 3 symbols = 70 - 100%
- Accessories and Minor Beds: 1 symbol = 10 - 20%; 2 symbols = 30 - 40%; 3 symbols = 50%

(Sel ected minerals (*) may be indicated by 1 symbol if significant - may be less than 5%)

SORTING:

- FRAMEWORK (FW):
  - Proportion of sand-sized grains. FW=1 indicates 10% sand-sized grains and 90% mud; FW=C indicates 100% sand-sized grains and 0% mud; FW>=7 is a grain-to-grain contact sample with total interstitial space of about 33%, available for mud, cement and porosity.

DIAGENESIS:

- M = Metasomatism
- D = Dolomitization
- R = Recrystallization
- F = Fracturing
- L = Leaching
- P = Pressure deformation
- Secondary cementation (A - Anhydrite, S - Silica, K - Kaolin, C - Calcite and others)

Numeric value indicates percentage (1 = 10%...C=100%)
# Lysite BLM Test Borehole Log - Spectral Gamma

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<th>Spectral GR</th>
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Lysite BLM Test Borehole Log - Spectral Gamma

Argillaceous material in these samples could be kaolinite.
## Carbonaceous claystones could be designated carbonaceous shale

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**Western Groundwater Services**
### Lysite BLM Test Borehole Log - Resistivity

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<td>Ss, lt gy, f, kao + calc cmt, mica, slty; Clyst, lt gy, calc, arg</td>
</tr>
<tr>
<td>300</td>
<td>40</td>
<td>Ss, lt gy, f, kao + calc cmt, mica, slty; Clyst, lt gy, calc, arg</td>
</tr>
<tr>
<td>350</td>
<td>40</td>
<td>Ss, lt gy, f, kao + calc cmt, mica, slty; Clyst, lt gy, calc, arg</td>
</tr>
<tr>
<td>400</td>
<td>40</td>
<td>Ss, lt gy, f, kao cmt, mica, slty; Clyst, lt gy, calc, arg</td>
</tr>
</tbody>
</table>

**Materials Present:**
- Ss: Sandstone
- lt gy: Lithographic Clay
- f: Fossiliferous
- kao: Kaolinite
- calc: Calcite
- mica: Mica
- slty: Clay
- Clyst: Clysmatic
- Sltst: Siltstone

**Notes:**
- TD 220 FT, 3/19/07, 1730 hrs
- Cylindrical, lt gy, v f, kao + calc cmt, mica, slty; Clyst, lt gy, calc cmt, arg; Sltst, lt gy, calc, arg
Silt, lt gy, calc, sdy, mic

Clyst, lt gy, calc; Sltst strg

Ss, lt gy, calc cmt, slty; Clyst strg

Clyst, lt gy; Coal strg

Ss, lt gy, calc cmt, slty, mica; Sltst strg

TD 475 FT, 3/20/07, 1650 hrs

Ss, lt gy, calc cmt, slty, mica, fld

Sltst, lt gy, calc; Sltst strg

Sltst, lt gy, calc; Sltst strg

Argillaceous material in these samples could be kaolinite

Ss, lt gy, m, calc cmt, arg

Sltst, lt gy, calc; Ss strg

Sltst, lt gy, calc+kao cmt, mica, fld

Clyst, lt gy, calc+kao cmt, mica, fld; Clyst, brn, carb, strg

Clyst, brn, calc; Coal strg; Ss strg

Clyst, brn, calc; Coal strg; Ss strg

Clyst, brn, tr calc; Coal strg; Ss strg

Clyst, brn, carb; Clyst, gy, calc; Ss strg

Clyst, brn, carb; Ss, lt gy

Ss, lt gy, f, calc cmt, arg/kao

C 1

C 2
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
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<tbody>
<tr>
<td>500</td>
<td>Clyst, brn, carb; Clyst, gr, calc strg; Ss strg</td>
</tr>
<tr>
<td>600</td>
<td>Clyst, brn, carb; Clyst, gr, calc strg; Ss strg</td>
</tr>
<tr>
<td>700</td>
<td>Clyst, brn, carb; Clyst, gr, calc strg; Ss strg</td>
</tr>
<tr>
<td>800</td>
<td>Clyst, brn, carb; Clyst, gr, calc strg; Ss strg</td>
</tr>
</tbody>
</table>

**Legend:**
- **Clyst:** Claystone
- **brn:** Brown sandstone
- **carb:** Carbonate
- **gr:** Gravel
- **cal:** Calcite
- **gy:** Gypsum
- **f:** Feldspar
- **kao:** Kaolinite
- **slty:** Salt
- **mica:** Mica
- **fr:** Fracture
- **fl:** Flakes
- **v:** Vitrinite

**Key:**
- **K 1:** Zone K1
- **C 2:** Zone C2
- **K 1+:** Zone K1+

*Note: The diagram includes resistivity logs and interpretations of the borehole log.*
<table>
<thead>
<tr>
<th>Formation Tops</th>
<th>Basic Logs</th>
<th>Depth (FT BGS)</th>
<th>Porosity (%)</th>
<th>Lithology</th>
<th>Rounding</th>
<th>Sorting</th>
<th>Framework</th>
<th>Geological Descriptions</th>
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<td>Caliper (in)</td>
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<td>Sand and organics</td>
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<td>Gamma (API)</td>
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<td>SP (mV)</td>
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<td>Tens (lbs)</td>
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<td>Coal, blk, vtr, bky; Clyst, brn, can</td>
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<td>ROP (min/ft)</td>
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<td>Slitst, lt gy, arg, tr calc</td>
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<td>Clyst, lt gy, calc, slyy</td>
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<td></td>
<td>Slitst, lt gy, kao, sdy, mica</td>
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<td>5</td>
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<td>Ss, lt gy, v f, kao cmt, mica</td>
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<td>Occurrence of kaolinite in samples could be argillaceous material or mixture of both</td>
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<td>K 1</td>
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</tbody>
</table>

**Diagnosis**

- Sand and organics
- Sand, coarse, loose
- Gravel, sandy, with clays
- Coal, blk, vtr, bky; Clyst, brn, can
- Slitst, lt gy, arg, tr calc
- Clyst, lt gy, calc, slyy
- Slitst, lt gy, kao, sdy, mica
- Ss, lt gy, v f, kao cmt, mica
- Occurrence of kaolinite in samples could be argillaceous material or mixture of both
- Ss, lt gy, v f, kao cmt, mica
- Slitst, lt gy, kao cmt, slyy, mica, Clyst strg/bd
- Ss, lt gy, v f, kao cmt, mica
- Slitst, lt gy, kao cmt, slyy, arg, calc cmt; Clyst strg
- Ss, lt gy, v f, kao cmt, slyy, arg, calc cmt; Clyst strg
- Ss, lt gy, v f, arg, calc cmt
Lysite BLM Test Borehole Log - Nuclear

Western Groundwater Services
Lysite BLM Test Borehole Log - Nuclear

Western Groundwater Services
APPENDIX D

GAS VENTURES KNAPP #1-18 LOG
GAS VENTURES -- KNAPP #1-18

Scale 1:480 (2.5"=100') Imperial

Well Name: Gas Ventures - Knapp #1-18
Location: SW/NE SEC. 18; T38N, R90W FREEMONT CO. WY
Licence Number: API 49-013023096
Spud Date: 6/30/07
Drilling Completed: 7/30/07
Region: MADDEN

Surface Coordinates:

Bottom Hole Coordinates:
Ground Elevation (ft): 5,320 FT MSL
K.B. Elevation (ft): 5,334 FT MSL
Logged Interval (ft): 1000 FT To: TD Total Depth (ft): 9050 FT BGS
Formation: Wind River - Upper Fort Union
Type of Drilling Fluid: INVERT/ OIL BASE

Printed by STRIP.LOG from WellSight Systems 1-800-447-1534 www.WellSight.com

GEOLOGIST
Name: Kevin J. Goldrick
Company: Intermountain Wellsite Geologists
Address: PO Box 4007
Casper, WY  82604
(307) 234-8695

Comments

WIRELINE SERVICE COMPANY:
Baker Atlas
Casper, WY

ROCK TYPES

<table>
<thead>
<tr>
<th>Anhydrite</th>
<th>Bentonite</th>
<th>Breccia</th>
<th>Chert</th>
<th>Claystone</th>
<th>Coal</th>
<th>Conglomerate</th>
<th>Dolomite</th>
<th>Gypsum</th>
<th>Igneous</th>
<th>Limestone</th>
<th>Metamorphic</th>
<th>Salt</th>
<th>Shale</th>
<th>Siltstone</th>
<th>Sandstone</th>
<th>Till</th>
</tr>
</thead>
</table>
APPENDIX E

PERMITS AND FORMS FOR DRILLED EXPLORATIONS
STATE OF WYOMING
OFFICE OF THE STATE ENGINEER
HERSCHEL BLDG., 4-E
CHEYENNE, WYOMING 82002
(307) 777-6163

APPLICATION FOR PERMIT TO APPROPRIATE GROUND WATER
APPLICATION FOR WELLS AND SPRINGS

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

PERMIT NO. U.W. 178273
WATER DIVISION NO. 3
U.W. DISTRICT, Fremont County

NAME AND NUMBER OF WELL OR SPRING
Test Boring (School) 178273

1. Name of applicant(s) ____________________________ Phone (307) 377-7626
Wyoming Water Development Corp. 15 WISD

2. Address of applicant(s)
6920 Yellowtail Rd Cheyenne, WY 82002

3. Name & address of agent to receive correspondence and notices
Stetson Engineering, Inc.

4. Use to which the water will be applied:

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

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

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

   Municipal: Use of water in incorporated Towns and Cities. Note 1: use of water in unincorporated towns, subdivisions, improvement districts, mobile home parks, etc., is classified as miscellaneous use. Note 2: a permit may be required by the Wyoming Department of Environmental Quality (WDEQ) if the well will be classified as a public water supply under the WDEQ’s rules and regulations.

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

   Miscellaneous: Any use of water not defined under previous definitions such as stock water pipelines, subdivisions, mine dewatering, mineral/oil exploration drilling, potable supplies in office, etc. (Describe in REMARKS)

5. Location of the well or spring: (NOTE: Quarter-quarter (60 acre subdivision) MUST be shown. EXAMPLE: SE 1/4 NW 1/4 of Sec. 12, Township 14 North, Range 68 West.)

6. Estimated depth of the well or spring is _______ feet. Estimated production interval is _______ ft. to _______ ft.

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

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

8. Mark the point(s) or area(s) of use in the tabulation box below. Note: Upper row refers to the quarter of the section. Next row refers to quarter of the quarter section.

<table>
<thead>
<tr>
<th>TWP</th>
<th>RNG</th>
<th>SEC</th>
<th>NW</th>
<th>SW</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
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</tbody>
</table>

178273  SEE REVERSE SIDE 1294 25
a. Describe maximum acreage to be irrigated in each 40 acre subdivision in the tabulation box above.
b. Land is irrigated from existing water right(s) with water from this well to be additional supply. Describe existing water right(s) under REMARKS.

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

11. The well or spring is to be constructed on lands owned by School Dist. 24, Shoshoni, WY 82640 (The granting of a permit does not constitute the granting of right-of-way. If any easement or right-of-way is necessary in connection with this application, it should be understood that the responsibility is that of the applicant. A copy of the agreement should accompany this application, if the land is privately owned and the owner is not the co-applicant.)

12. The water is to be used on lands owned by NA

(Remote availability of water is not a sufficient basis for granting the requested permission or issuing the permit.
If the landowner is not the applicant, a copy of the agreement relating to the usage of appropriated water on the land should be submitted to this office. If the landowner is also the applicant on the application, this procedure need not be followed.)

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

REMARKS: Test boring will be used to evaluate aquifer occurrence for future water supply well.

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

Signature of Applicant or Authorized Agent

Date

11/1/06

2006

DOMESTIC AND/OR STOCK WATERING USES

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

$25.00

IRRIGATION, MUNICIPAL, INDUSTRIAL, MISCELLANEOUS, COAL BED METHANE

$50.00

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

No Fee

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

THIS SECTION IS NOT TO BE FILLED IN BY APPLICANT

THE STATE OF WYOMING

) ss.

STATE ENGINEER’S OFFICE

This instrument was received and filed for record on the 6th day of November, 2006, at 10:41 o’clock A.M.

Permit No. U.W. 178273

for State Engineer

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

This application is approved subject to the condition that the proposed use shall not interfere with any existing rights to ground water from the same source of supply and is subject to regulation and correlation with surface water rights, if the ground and surface waters are interconnected. The use of water hereunder is subject to the further provisions of Chapter 169, Session Laws of Wyoming, 1967, and any subsequent amendments thereto.

Granting of a permit does not guarantee the right to have the water level or artesian pressure in the well maintained at any specific level.

The well should be constructed to a depth adequate to allow for the maximum development and beneficial use of ground water in the source of supply.

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

Coal Bed Methane wells have Additional Conditions and Limitations on attachment sheet.

This application is for test purposes only; no water will be beneficially used. The approval of this test well permit does NOT OBLIGATE the State Engineer to approve the permanent production well permit. This permit will be automatically cancelled on December 31, 2007, or upon receipt of an acceptable Statement of Completion. PROOF OF APPROPRIATION AND BENEFICIAL USE OF GROUND WATER (FORM U.W. 1) IS WAIVED UNDER THIS PERMIT.

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

Completion of construction and completion of the beneficial use for the purposes specified in Item 4 of this application will be made by December 31, 2007.

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

Witness my hand this 22nd day of November, 2006.

Cheryl Crandall

PATRICK T. TYRRELL, State Engineer

ABANDONMENT CERTIFICATION

Wells drilled by

Abernathy Contracting

36227A

SEP 28, 2007
STATE OF WYOMING

OFFICE OF THE STATE ENGINEER

HERSCHEL BLDG., 4-E
CHEYENNE, WYOMING 82002
(307) 777-6163

STATEMENT OF COMPLETION AND DESCRIPTION OF WELL OR SPRING

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

PERMIT NO. U.W. 178273

NAME OF WELL (SPRING) Test Boring - School

1. NAME OF OWNER Wyoming Water Development Comm., Inc., WY 630

2. ADDRESS 630 W. Center Cheyenne, State WY 82001 Zip Code 82002 Phone No. 307-777-7626

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

   ☐ Monitor or Test ☐ Coal Bed Methane Explain proposed use (Example: One single family dwelling)

4. LOCATION OF WELL (SPRING):
   NW 1/4 NW 1/4 of Section 18 T 38 N R 90 W, of the 6th P.M. (or W.R.M.)
   Subdivision Name Lot Block
   If surveyed, bearing, distance and reference point: Longitude (degrees, minutes, seconds)
   Latitude (degrees, minutes, seconds)
   Datum: 1927 1983 Source: GPS Map Survey

5. TYPE OF CONSTRUCTION: DRILLED x Air Rotary Dug ☐ Driven ☐ Other ☐

   Type of rig and fluid used if any

   Describe:

6. CONSTRUCTION: Total Depth of Well/Spring 305 ft.

   Depth to Static Water Level ft. (Below land surface) Casing Height above ground (ft.)
   a. Diameter of borehole (Bit size) inches
   b. Casing Schedule:
      New Used Joint type: threaded ☐ glued ☐ welded
      Diameter from ft. to ft. Diameter from ft. to ft.
   c. Grouted interval from ft. to ft.

   Amount of grout used:
   d. Type of completion:
      factory screen ☐ open hole ☐ customized perforations

   Perforation: Type of perforator used

   Size of perforations inches by inches.
   Number of perforations and depths where perforated:
   perforations from ft. to ft.
   perforations from ft. to ft.
   Open hole from ft. to ft.

   Well screen details:
   Diameter slot size: set from ft. to ft.
   Diameter slot size: set from ft. to ft.
   Diameter slot size: set from ft. to ft.
   e. Well development method
   f. Was a filter pack installed? Yes ☐ No ☐ Size of sand/gravel
      Filter pack installed from ft. to ft.
   g. Was surface casing used? Yes ☐ No ☐ Was it cemented in place? Yes ☐ No ☐
      Surface casing installed from ft. to ft.

7. NAME AND ADDRESS OF DRILLING COMPANY

8. DATE OF COMPLETION OF WELL (including pump installation) OR SPRING (first used) Abandoned 4/2007

9. PUMP INFORMATION: Manufacturer Type

   Source of power Horsepower Depth of Pump Setting or Intake ft.
   Amount of Water Being Pumped Gallons Per Minute. (For Springs or flowing wells, see item 10.)
   Total Volumetric Amount Used Per Calendar Year.

10. FLOWING WELL OR SPRING (Owner is responsible for control of flowing well).

    If well yields artesian flow or if spring, yield is gal./min. Surface pressure is lb./sq. inch, or feet of water.
    The flow is controlled by: valve ☐ cap ☐ plug ☐
    Does well leak around casing? Yes ☐ No ☐

   Permit No. U.W. 178273

   SEE REVERSE SIDE
11. If spring, how was it constructed? (Some method of artificial diversion, i.e., spring box, cribbing, etc., is necessary to qualify for a water right.)

12. PUMP TEST: Was a pump test made? Yes ☐ No ☒
   Yield: 4 gal/min. with ______ foot drawdown after ______ hours. Air lifting ______ from 305.
          Yield: ______ gal/min. with ______ foot drawdown after ______ hours.

13. LOG OF WELL: Total depth drilled ______ feet.
    Depth of completed well ______ feet. Diameter of well ______ inches.
    Depth to first water bearing formation ______ feet.
    Depth to principal water bearing formation. Top ______ feet to Bottom ______ feet.

   Land surface elevation (ft. above mean sea level) 5302 Datum: ☒1929 ☐1988
   How determined: ☐map ☒datum ☐survey ☐other DEM

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<th>DRILL CUTTINGS DESCRIPTION:</th>
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<td>From</td>
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<tr>
<td>27</td>
</tr>
<tr>
<td>170</td>
</tr>
</tbody>
</table>

14. QUALITY OF WATER INFORMATION:
   Does a chemical and/or bacteriological water quality analysis accompany this form? Yes ☐ No ☒
   It is recommended that chemical and bacteriological water quality analyses be performed and that the report(s) be filed with the records of this well. (Contact Department of Agriculture, Analytical Lab Services, Laramie, 742-2984.)
   If not, do you consider the water as: Good ☒ Acceptable ☐ Poor ☐ Unusable ☐

   REMARKS:
   Borehole was abandoned by cementing to surface 1800 mi/ft.

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

   Mark Lanne ☒
   Signature of Owner or Authorized Agent
   10/15 2007 Date

   FOR STATE ENGINEER'S USE ONLY

   Permit No. U.W. ____________________________
   Date of Receipt OCT 1. 2007 20 Date of Approval ____________________________ 20
   Date of Priority ____________________________ 20 for State Engineer
STATE OF WYOMING
OFFICE OF THE STATE ENGINEER
HERSCHLER BLDG., 4-E
CHEYENNE, WYOMING 82002
(307) 777-6163

APPLICATION FOR PERMIT TO APPROPRIATE GROUND WATER

APPLICATION FOR WELLS AND SPRINGS

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

PERMIT NO. U.W. 177547

FOR OFFICE USE ONLY

WATER DIVISION NO. 3
District: 11
U.W. DISTRCT. Fremont County

NAME AND NUMBER OF WELLS OR SPRING
Test Boring - Store

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

2. Address of applicant(s): 6210 Yellowtail Rd, Cheyenne, WY 82002

3. Name & address of agent to receive correspondence and notices: Helston Engineering, Inc.

   PO Box 467
   Gillette, WY 82717
   Phone: 307-682-8694

4. Use to which the water will be applied:

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

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

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

   Municipal: Use of water in incorporated towns and cities. Note 1: use of water in unincorporated towns, subdivisions, improvement districts, mobile home parks, etc., is classified as miscellaneous use. Note 2: a permit may be required by the Wyoming Department of Environmental Quality (WDEQ) if the well will be classified as a public water supply under the WDEQ's rules and regulations.

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

   Miscellaneous: Any use of water not defined under previous definitions such as stock water pipelines, subdivisions, mine dewatering, mineral/oil exploration drilling, portable supplies in office, etc. Describe in Remarks. Note: a permit may be required by the WDEQ if the well will be classified as a public water supply under the WDEQ's rules and regulations.

   Coalbed Methane Water produced in the production of coal bed methane gas. Note: wells used in the production of coal bed methane will require a permit from the Wyoming Oil and Gas Conservation Commission.

   Monitor, Observation: Note: a WDEQ permit may be required.

5. Location of the well or spring: (NOTE: Quarter-quarter [40 acre subdivision] MUST be shown. EXAMPLE: SE 1/4 NW 1/4 of Sec. 12, Township 14 North, Range 66 West.) Lot 1

   Fremont County (NW 1/4 NE 1/4 SE 1/4 T. 33 N. R. 90 W. of the 6th P.M. (W.R.M.) Wyoming. If located in a platted subdivision, also provide Lot/Tract Block of the Subdivision (or Addn) of Resurvey Location Tract ______, (or Lot) ______.

6. Estimated depth of the well or spring is 300 feet. Estimated production interval is 150 ft. to 300 ft.

7. (a) Maximum instantaneous flow of water to be developed and beneficially used: ______ gpm.

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

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

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

8. Mark the point(s) or area(s) of use in the tabulation box below. Note: Upper row refers to the quarter of the section. Next row refers to quarter of the quarter section.

   TABULATION BOX:

   Permit No. U.W. 177547

   Book No. 1289

   Page No. 49
10. If for irrigation use, describe method of irrigation, i.e. center pivot sprinkler, flood, etc.: NA

11. The well or spring is to be constructed on lands owned by: **Bill Ramage or Steve Schrock**
   (The granting of a permit does not constitute the granting of right-of-way. If any easement or right-of-way is necessary in connection with this application, it should be understood that the responsibility is the applicant’s. A copy of the agreement should accompany this application, if the land is privately owned and the owner is not the co-applicant.)

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

REMARKS: This well will be a test spring drilled to evaluate geology, surface to total depth, it will be grouted to surface after dewatering.

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

Mark L. Cosby, Sr. No. 1019105 2006
Signature of Applicant or Authorized Agent
(406) 585-5747
THE LEGALLY REQUIRED FILING FEE MUST ACCOMPANY THIS APPLICATION

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

IRRIGATION, MUNICIPAL, INDUSTRIAL, MISCELLANEOUS, COAL BED METHANE
   $50.00

MONITOR (For water level measurements or chemical quality sampling) or TEST WELL
   No

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

THE STATE OF WYOMING )
STATE ENGINEER'S OFFICE )
This instrument was received and filed for record on the 12th day of October, A.D. 2006, at 5:30 o'clock A. M.

Permit No. U.W. 177347

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

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

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

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

Coal Bed Methane wells have Additional Conditions and Limitations on attachment sheet.

The approval of this test well permit does NOT OBLIGATE the State Engineer to approve the permanent production well permit. This permit will be automatically cancelled on December 31, 2007 or upon receipt of an acceptable Statement of Completion. PROOF OF APPROPRIATION AND BENEFICIAL USE OF GROUND WATER (FORM U.W. 169) IS WAIVED UNDER THIS PERMIT.

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

Completion of construction and completion of the beneficial use of water for the purposes specified in Item 4 of this application will be made by December 31, 2007.

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

Witness my hand this 23rd day of October, A.D. 2006

Cheryl Crespo

NOTICE OF COMPLIANCE FOR COMPLETION
ANNUAL COMPLETION OF BENEFICIAL USE HEARINGS SEP 28 '07
STATE OF WYOMING
OFFICE OF THE STATE ENGINEER
HERSCHEL BLDG., 4-E
CHEYENNE, WYOMING 82002
(307) 777-6193

STATEMENT OF COMPLETION AND DESCRIPTION OF WELL OR SPRING

PERMIT NO. U.W. 177547
NAME OF WELL (SPRING)  Test boring - Store

1. NAME OF OWNER  Wyoming Water Development Com. / Lynne W. 3D

2. ADDRESS  6920 Yellowtail Trail
City  Cheyenne  State  WY  Zip Code  82002  Phone No. (307) 777-7624

3. USE OF WATER  Monitor or Test  Coal Bed Methane  Explain proposed use (Example: One single family dwelling)

4. LOCATION OF WELL (SPRING): NE 1/4 SE 1/4 of Section 15 T. 30 R. N., W. of the 6th P.M. (or W.R.M.)
Subdivision Name:  
Lot:  
Block:  
If surveyed, bearing, distance and reference point:
Longitude (degrees, minutes, seconds)  
Datum:  
1927  
1983  
Source:  GPS  
Map  
Survey
Latitude (degrees, minutes, seconds)  

5. TYPE OF CONSTRUCTION: DRILLED  
Air Rotary  
Dug  
Driven  
Other  

Describe:  

6. CONSTRUCTION: Total Depth of Well/Spring  
Depth to Static Water Level  
Casing Height above ground (ft.)  
a. Diameter of borehole (bit size)  
b. Casing Schedule:  New  Used  
Joint type:  threaded  glued  welded  
c. Grouted interval, from  
Amount of grout used:  
d. Type of completion:  factory screen  open hole  customized perforations  
Perforation: Type of perforator used  
Size of perforations  
Number of perforations and depths where perforated:  
perforations from  
perforations from  
Open hole from  
Well screen details:
Diameter  
Slot size  
set from  
set from  
e. Well development method:  
How long did development last?  
f. Was a filter pack installed?  Yes  No  
Size of sand/gravel  
Filter pack installed from  
g. Was surface casing used?  Yes  No  
Was it cemented in place?  Yes  No  
Surface casing installed from  

7. NAME AND ADDRESS OF DRILLING COMPANY  
P.C. Drilling  
Lancaster, WY  

8. DATE OF COMPLETION OF WELL (including pump installation) OR SPRING (first used)  
Abandoned 4/1/2007  

9. PUMP INFORMATION: Manufacturer  
Type  
Source of power  
Horsepower  
Depth of Pump Setting or intake  
Amount of Water Being Pumped  
Gallons Per Minute. (For Springs or flowing wells, see item 10.)  
Total Volumetric Amount Used Per Calendar Year.

10. FLOWING WELL OR SPRING (Owner is responsible for control of flowing well),  
If well yields artesian flow or if spring, yield is  
gal/min. Surface pressure is  lb/sq.inch, or  feet of water.  
The flow is controlled by:  
valve  
cap  
plug  

Does well leak around casing?  Yes  No  

Permit No. U.W.  177547

SEE REVERSE SIDE
11. If spring, how was it constructed? (Some method of artificial diversion, i.e., spring box, cribbing, etc., is necessary to qualify for a water right.)

12. PUMP TEST: Was a pump test made? Yes [ ] No [X]  
   If so, by whom:  
   Yield: 60 gal/min. with ______ foot drawdown after ______ hours.  
   Pump lifting during drilling from 300 feet.  
   Yield: ______ gal/min. with ______ foot drawdown after ______ hours.

13. LOG OF WELL: Total depth drilled ______ feet.  
   Depth of completed well ______ feet. Diameter of well ______ inches.  
   Depth to first water bearing formation ______ feet.  
   Depth to principal water bearing formation. Top ______ feet to Bottom ______ feet.

   Land surface elevation (ft. above mean sea level) ______ feet.  
   How determined: [ ] msb [ ] altimeter [ ] survey [ ] Other [X] DEM

   Datum: [ ] 1929 [ ] 1988

   DRILL CUTTINGS DESCRIPTION:

<table>
<thead>
<tr>
<th>From Feet</th>
<th>To Feet</th>
<th>Material Type, Texture Color</th>
<th>Remarks (Cementing, Shut-off)</th>
<th>Indicate Water Bearing Formation &amp; Name</th>
<th>Indicate Perforated Cassing Location</th>
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<td>360</td>
<td>Sandstone/Siltstone/Chert</td>
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<td></td>
</tr>
</tbody>
</table>

14. QUALITY OF WATER INFORMATION:  
   Does a chemical and/or bacteriological water quality analysis accompany this form? Yes [ ] No [X]  
   It is recommended that chemical and bacteriological water quality analyses be performed and that the report(s) be filed with the records of this well. (Contact Department of Agriculture, Analytical Lab Services, Laramie, 742-2994.)
   If not, do you consider the water as: Good [ ] Acceptable [ ] Poor [X] Unusable [ ]
   REMARKS: Borehole was abandoned by cementing to surface.

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

   [Signature]  
   Signature of Owner or Authorized Agent

   10/15/20  
   Date

   FOR STATE ENGINEER'S USE ONLY

   Permit No. U.W.  
   Date of Receipt: OCT 19, 2007  
   Date of Approval:  
   Date of Priority:  
   for State Engineer
APPLICATION FOR PERMIT TO APPROPRIATE GROUND WATER

APPLICATION FOR WELLS AND SPRINGS

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

FOR OFFICE USE ONLY

PERMIT NO. U.W. 176615
WATER DIVISION NO. 3 DISTRICT I
U.W. DISTRICT (Prentice County)

NAME AND NUMBER OF WELL or SPRING

Test Well 3 (Burr)

1. Name of applicant(s)
   Wyoming Water Development
   Down         Phone 307-777-4657
   PO. Box 1810
   Cheyenne, WY 82003
   (CITY) (ZIP)

2. Address of applicant(s)

Mailing Address
   Gilets Hts
   WY 82014
   Phone 307-682-8936
   (CITY) (STATE) (ZIP)

3. Name & address of agent to receive correspondence and notices
   Steffan Engineering, Inc.
   Wyoming Water Development
   Down         Phone 307-777-4657
   PO. Box 1810
   Cheyenne, WY 82003
   (CITY) (STATE) (ZIP)

4. Use to which the water will be applied:

- Domestic:
- Stock Watering:
- Irrigation:
- Municipal:
- Industrial:
- Miscellaneous:

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

6. Estimated depth of the well or spring is 1500 feet.

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

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

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

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

9. If for irrigation use:

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

   b. Land will be irrigated from this well only.

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

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

   Permit No. U.W. 176615
11. The well or spring is to be constructed on lands owned by [Name]. The granting of a permit does not constitute the granting of right-of-way. If any easement or right-of-way is necessary in connection with this application, it should be understood that the responsibility is the applicant's. A copy of the agreement should accompany this application, if the land is privately owned and the owner is not the co-applicant.

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

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

Remarks: Test well will be used to find municipal supply for [Location].

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

[Signature]
7/31/2006

Date

The legally required filing fee must accompany this application

Domestic and/or stock watering uses

Domestic use as defined as use of water in 3 single family dwellings or less. Non-commercial watering of lawns and gardens totaling one acre or less.

Irrigation, Municipal, industrial, miscellaneous, Coal Bed Methane

Monitor (For water level measurements or chemical quality sampling) or Test well

If well will serve multiple uses, submit only one (the higher) filing fee.

This section is not to be filled in by applicant

The State of Wyoming

Secretary

This instrument was received and filed for record on the 2nd day of August, A.D. 2006. at 9:10 A.M.

[Signature]

For State Engineer

Permit No. U.W. 176615

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

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

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

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

Coal Bed Methane wells have additional conditions and limitations on attachment sheet.

The application is for test purposes only; no water will be beneficially used. The approval of this test well permit does not obligate the State Engineer to approve the permanent production well permit. This permit will be automatically cancelled on December 31, 2007 or upon receipt of an acceptable Statement of Completion. Proof of Appropriation and Beneficial Use of Ground Water (Form U.W. 8) is waived under this permit.

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

Completion of construction and completion of the beneficial use of water for the purposes specified in Item 4 of this application will be made by December 31, 2006.

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

Witness my hand this 7/31/2006 day of August, A.D. 2006.

[Signature]

Patrick J. Tyrrell, State Engineer

Notice of Completion of the beneficial use of water in the中华人民共和国 dated SEP 23, '07.
STATE OF WYOMING
OFFICE OF THE STATE ENGINEER
HERSCHEL BLDG., 4-E
CHEYENNE, WYOMING 82002
(307) 777-8163

STATEMENT OF COMPLETION AND DESCRIPTION OF WELL OR SPRING

PERMIT NO. U.W. 176615 NAME OF WELL (SPRING), Test Well 3 (BLM)

1. NAME OF OWNER: Wyoming Water Development Agency, Rapid W.M.

2. ADDRESS: 4320 Wyoming Blvd., Cheyenne, WY

3. USE OF WATER: X Monitor or Test

4. LOCATION OF WELL (SPRING):

   Subdivision Name: SE 1/4 NE 1/4 of Section 13, T. 38 N.R. 91 W., of the 8th P.M. (or W.R.M.)

   Datum: 1927

   Source: GPS

   Lat. ________ N. Long. ________ W.

5. TYPE OF CONSTRUCTION: Drilled

   Type of rig, and rig size if any:

6. CONSTRUCTION: Total Depth of Well: 1440 ft.

   Depth to Static Water Level: ________ ft. (Below land surface)

   Casing Height above ground (ft.): ________ ft.

   Diameter of borehole (inches): ________

   Casing Schedule: New

   Diameter from ________ ft. to ________ ft.

   Material: ________ Gage: ________

   Material: ________ Gage: ________

   Casing Schedule: Used

   Diameter from ________ ft. to ________ ft.

   Material: ________ Gage: ________

   Material: ________ Gage: ________

   Cased interval, from ________ ft. to ________ ft.

   Amount of grout used: ________

   Type: ________

   Example: bentonite pellets

   Perforation: Type of perforator used

   Size of perforations: ________ inches by ________ inches.

   Number of perforations and depths where perforated:

   open hole

   How long did development last?

   Well development:

   Diameter slot size: ________ ft. to ________ ft.

   Diameter slot size: ________ ft. to ________ ft.

   Filter pack installed? Yes No

   Size of sand/gravel: ________

   Filter pack installed from ________ ft. to ________ ft.

   Was a filter pack installed? Yes No

   Surface casing installed from ________ ft. to ________ ft.

   Was surface casing used? Yes No

   Was it cemented in place? Yes No

7. NAME AND ADDRESS OF DRILLING COMPANY: D.C. Drilling, Lusk, WY

8. DATE OF COMPLETION OF WELL (including pump or other installation) OR SPRING (first used): Abandoned, April 2007

9. PUMP INFORMATION: Manufacturer: ________

   Horsepower: ________

   Depth of Pump Setting or intake: ________ ft.

   Amount of Water Being Pumped: ________ GPM

   Total Volumetric Amount Used Per Calendar Year: ________

10. FLOWING WELL OR SPRING (Owner is responsible for control of flowing well):

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

    The flow is controlled by: valve cap plug

    Does well leak around casing? Yes No

Permit No. U.W. 176615

SEE REVERSE SIDE
11. If spring, how was it constructed? (Some method of artificial diversion, i.e., spring box, cribbing, etc., is necessary to qualify for a water right.)

12. PUMP TEST: Was a pump test made? Yes ☐ No ☒
   If so, by whom
   Yield: _______ gal./min. with _______ foot drawdown after _______ hours.
   Yield: _______ gal./min. with _______ foot drawdown after _______ hours.

13. LOG OF WELL: Total depth drilled _______ feet.
   Depth of completed well _______ feet. Diameter of well _______ inches.
   Depth to first water-bearing formation _______ feet.
   Depth to principal water-bearing formation. Top _______ feet to Bottom _______ feet.
   Land surface elevation (ft. above mean sea level) _______
   Datum: ☐ 1929 ☐ 1988
   How determined: ☐ map ☐ altimeter ☐ survey ☐ other

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<tr>
<th>From Feet</th>
<th>To Feet</th>
<th>Material Type, Texture Color</th>
<th>Remarks (Cementing, Shut-off)</th>
<th>Indicate Water Bearing Formation &amp; Name</th>
<th>Indicate Perforated Casing Location</th>
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</tr>
</tbody>
</table>

14. QUALITY OF WATER INFORMATION:
   Does a chemical and/or bacteriological water quality analysis accompany this form? Yes ☐ No ☒
   It is recommended that chemical and bacteriological water quality analyses be performed and that the report(s) be filed with the records of this well. (Contact Department of Agriculture, Analytical Lab Services, Laramie, 742-2984.)
   If not, do you consider the water as: ☐ Good ☐ Acceptable ☐ Poor ☐ Unusable

   REMARKS: Borehole was abandoned by cementing to surface.

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

[Signature]  
[Date: 10/10/2007]  
[Year: 2007]

FOR STATE ENGINEER'S USE ONLY

Permit No. U.W.  
Date of Receipt OCT 1 9 2007  
Date of Prior to  
Date of Approval  
for State Engineer