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A PLAN TO DRILL AND TEST
A WATER WELL
SOUTH OF THE TOWN OF GLENROCK, WYOMING

Prepared for
TOWN OF GLENROCK
GLENROCK, WYOMING 82637

December 9, 1982

Prepared By
NELSON ENGINEERING
430 South Cache St.
P.O. Box 1599
Jackson, Wyoming 83001

RECEIVED
DEC 13 1982
Wyoming Water Development Commission
A PLAN TO DRILL AND TEST
A WATER WELL
SOUTH OF THE TOWN OF GLENROCK, WYOMING

BACKGROUND:

Water for Glenrock's culinary system is supplied from nine wells. Six of the wells - the Gallery, Lythgo, and four Deer Creek wells are located near the center of Town at Deer and 1st Streets along Deer Creek. The Park well is located in the City Park, also adjacent to Deer Creek. Fox Hills Wells No. 1 and 2 are located in the northeastern part of Town. See Figure 1.

The Town maintains year-round rights for municipal purposes totaling 1623 gpm. I call this the Theoretical Maximum Yield that current water rights can produce. The maximum quantity of water these rights will yield during the peak summer demand, however, is only 990 gpm. This has been called the Physical Maximum Yield because it reflects the maximum the physical plant is capable of. Probable sustained 24-hour yield is estimated at about 700 gpm, or about 1 mgd. This is called Probable Maximum Yield. In addition to municipal water rights, the Town has acquired 1.13 cfs of irrigation water that could be converted to municipal use for a five-month period to yield 448 gpm.

The following table provides a summary of the Town's water rights and likely peak summer yields.

<table>
<thead>
<tr>
<th>Source</th>
<th>Municipal</th>
<th>Permit No.</th>
<th>Flow, in gpm</th>
<th>Period Available</th>
<th>Physical Maximum peak summer day demand (c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deer Creek Well #1</td>
<td>17439</td>
<td>150</td>
<td>1-1/12-31</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Deer Creek Well #2</td>
<td>17440</td>
<td>120</td>
<td>1-1/12-31</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Deer Creek Well #3</td>
<td>17441</td>
<td>70</td>
<td>1-1/12-31</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Deer Creek Well #4</td>
<td>17442</td>
<td>80</td>
<td>1-1/12-31</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Lythgo</td>
<td>none (a)</td>
<td>150</td>
<td>1-1/12-31</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Park</td>
<td>none (a)</td>
<td>240</td>
<td>1-1/12-31</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Gallery</td>
<td>12071</td>
<td>448</td>
<td>1-1/12-31</td>
<td>DRY</td>
<td></td>
</tr>
<tr>
<td>Fox Hills #1</td>
<td>44473</td>
<td>125</td>
<td>1-1/12-31</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Fox Hills #2</td>
<td>44855</td>
<td>240</td>
<td>1-1/12-31</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td></td>
<td>1623</td>
<td></td>
<td>990 (b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>But reduced because of continuous 24-hour pumping . . . . . 700 (d)</td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td></td>
<td>448</td>
<td>5-1/9-30</td>
<td>448</td>
<td></td>
</tr>
</tbody>
</table>
(a) These wells were developed before the State of Wyoming required them to be registered.

(b) The peak summer day system demand for the year 2000 is projected to be 2370 gpm. With a present Physical Maximum Yield from all municipal sources of 990 gpm, the city needs to develop at least an additional 1380 gpm.

(c) Source of information is Glenrock's application for a groundwater supply study, made to Wyoming Water Development Commission, and on-site observations.

(d) Probable sustained 24-hour production—about 1 mgd. Called Probable Maximum Yield.

Glenrock has an estimated 873 residential hookups, (12 of which are outside the corporate limits), and 54 commercial hookups serving a population of about 2900. Average use is about 245 gpcpd for an average daily consumption of 675,000 gallons. Peak day summer demand is 1,265,400 gpd. See Figure 2, "Projected Water Use", and Table 2, "Projected Population and Water Use."

From the material presented, it is obvious that Glenrock must do something now to establish a long-range plan of water source development. Alternatives being considered at this time include:

1. Little Snake River Water - Glenrock is a member of the North Platte Water Development Board via its Joint Powers Agreement. Glenrock's objective is to maintain its position of parity on the Board in order to maintain its option on future water this program will develop.

2. Deer Creek Dam - Glenrock is sponsor of the project and wishes to maintain its position of leadership to provide an option on future water this project may develop.
<table>
<thead>
<tr>
<th>YEAR</th>
<th>POPULATION</th>
<th>PER HOOKUP</th>
<th>RESIDENTIAL HOOKUPS</th>
<th>COMMERCIAL HOOKUPS</th>
<th>AVE. USE gpcd</th>
<th>DAILY CONSUMPTION (1,000gpd)</th>
<th>PEAKING CONSUMPTION (1,000gpd)</th>
<th>AVERAGE YEARLY CONSUMPTION (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>1515</td>
<td>3.60</td>
<td>420</td>
<td>30 ±</td>
<td>250</td>
<td>379</td>
<td>2.0</td>
<td>757</td>
</tr>
<tr>
<td>75</td>
<td>1980</td>
<td>3.50</td>
<td>566</td>
<td>35 ±</td>
<td>247</td>
<td>489</td>
<td>2.0</td>
<td>978</td>
</tr>
<tr>
<td>80</td>
<td>2738</td>
<td>3.37</td>
<td>813</td>
<td>42</td>
<td>245</td>
<td>671</td>
<td>1.8</td>
<td>1265</td>
</tr>
<tr>
<td>85</td>
<td>3494</td>
<td>3.38</td>
<td>1034</td>
<td>57</td>
<td>237</td>
<td>828</td>
<td>2.0</td>
<td>1656</td>
</tr>
<tr>
<td>90</td>
<td>4460</td>
<td>3.39</td>
<td>1320</td>
<td>70</td>
<td>225</td>
<td>1004</td>
<td>2.3</td>
<td>2308</td>
</tr>
<tr>
<td>95</td>
<td>5692</td>
<td>3.40</td>
<td>1675</td>
<td>85</td>
<td>213</td>
<td>1212</td>
<td>2.35</td>
<td>2849</td>
</tr>
<tr>
<td>00</td>
<td>7265</td>
<td>3.40</td>
<td>2000</td>
<td>100</td>
<td>200</td>
<td>1453</td>
<td>2.35</td>
<td>3414</td>
</tr>
<tr>
<td>05</td>
<td>9272</td>
<td>3.45</td>
<td>2700</td>
<td>120</td>
<td>200</td>
<td>1854</td>
<td>2.35</td>
<td>4357</td>
</tr>
</tbody>
</table>

Population projection from Step One Facilities Plan

gpcd - Gallons per Capita per Day

gpd - Gallons per Day

AF - Acre Feet
* TOTAL WATER RIGHTS - THEORETICAL MAXIMUM YIELD - 1623 G.P.M.
** PHYSICAL PLANT CAPABILITY - PHYSICAL MAXIMUM YIELD - 990 G.P.M.
*** 24 HOUR SUSTAINED FLOW - PROBABLE MAXIMUM YIELD - 700 G.P.M.

FIG. 2
3. Deer Creek Allumium – Glenrock's present source and the most immediately developable water supply for the Town.

4. Casper Formation - Subject of this plan and as yet unknown as to the potential or developability.

5. Other Aquifers - As yet untested and unknown as to potential or developability.

From the standpoint of practicality both items 1) ... Little Snake River ..., and 2) ... Deer Creek Dam ... listed above, are classified as long-term water resource possibilities. Neither project presents a real hope of delivering water to Glenrock before 1987-88, and more likely not prior to 1990. Item 3) ... Deer Creek Aquifer ... appears to present the most immediate and developable source of water for the Town. However, potential contamination and flooding of Deer Creek are problems inherent with the system which must be evaluated, along with system costs, prior to major expenditure on facilities.

Item 4) ... Casper Formation ... represents an intermediate range (1985-86) water resource. According to preliminary studies done by Nelson Engineering, it is probably economically feasible (see attached report dated 9/9/82). The first step in determining this resource feasibility is the test well proposed herein. Item 5) ... Other Aquifers ... is an unknown to be investigated on future schedule.
PROCEDURE:

The test well is to be drilled at the mouth of Little Deer Creek Canyon near the southwest corner of Section 3, T 32 N, R 76 W. At the chosen location, Little Deer Creek flows northerly approximately 200' west of the site, and ± 250 feet of Casper formation is exposed. Little Deer Creek is spring fed with a majority (about 80%) of its flow rising in springs between the mouth of the canyon and its first main fork about a mile upstream. Little Deer Creek was estimated to flow 1.0 to 1.5 cfs in November of 1982.

Weather permitting, on December 13 and 14, 1982, Nelson Engineering will establish a flow measuring station near the mouth of Little Deer Creek canyon, slightly upstream of where the test well is to be drilled. Flows in the stream will be monitored during the week to establish a baseline flow prior to well drilling and testing.

Access to the site is over county roads to the junction south of Deer Creek, thence across V.R. Ranch. Both the site and access road are shown on the attached map, Figure 3.

The geology and formations expected to be encountered, and drilling interpretations are included as Figure 4. The descriptions and drilling interpretations are based on site inspection, publications, knowledge of the formations, and map study. They may or may not represent actual conditions as said actual conditions can only be determined by the proposed test drilling.

Figure 5 is a plan of drilling. More specifically, our plan would be to have a threaded "T" welded to the top of the 12" dia. surface casing. It would then be possible to provide a valve on the horizontal arm so that flowing pressures could be diverted away while the vertical pipe was capped, then close the valve to shut the well in. The entire 30' of surface casing will be used and cemented into position regardless of how soon we leave the "valley fill silt" and enter Casper Formation.
## Glenrock Artesian Test Well #1

### Description and Drilling Interpretations

<table>
<thead>
<tr>
<th>Age</th>
<th>Formation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pennsylvanian</td>
<td>Casper</td>
<td>Unconsolidated, valley fill silt, sand &amp; gravel soils with water table below stream level.</td>
</tr>
<tr>
<td>Paleozoic</td>
<td>Mississippian</td>
<td>Sandstone with interbedded layers of limestone and dolomite. Dolomite conglomerate at the base. This formation carried an estimated 450 - 900 GPM under sufficient hydrostatic pressure to rise to the surface. The water is transmitted through the sands with larger volumes occurring in the more cavernous sections. The massive sand sections will drill firm but with good penetration with rock bits. The cavernous or open sections will drill broken with rock bits. The limestone layers are relatively thin, but may require &quot;button bits&quot; for satisfactory penetration. The dolomite layers are also expected to be fairly thin in relation to total formation thickness. These zones will drill hard, and will probably require &quot;button bit&quot; or down-hole air hammer drilling. It is anticipated that sufficient water flow will be encountered without fluid injection with air drilling.</td>
</tr>
<tr>
<td>Cambrian</td>
<td>Flathead</td>
<td>Limestone and dolomite, massive to thin bedded with caverns in upper part and sandy at base. The upper portion will drill fairly hard and broken. The remainder of the section will drill hard. Bit selection will range from rock bit to &quot;button bit&quot; and/or air hammer bit to maintain adequate penetration. Hopefully, sufficient artesian water will be produced through this section to maintain circulation with air; if not, it may be necessary to inject clear water from the adjacent stream to maintain circulation.</td>
</tr>
<tr>
<td>Pre-Cambrian</td>
<td>Granite</td>
<td>Sandstone with interbedded shale and conglomerate at base. The sandstone may be platy and quartzitic and drill difficult because of its &quot;dead&quot; reaction to drilling pressure. Bit selection will range through those used in the Madison. Again, sufficient water should be encountered down hole to remove cuttings.</td>
</tr>
</tbody>
</table>

- Sandstone with interbedded layers of limestone and dolomite. Dolomite conglomerate at the base. This formation carried an estimated 450 - 900 GPM under sufficient hydrostatic pressure to rise to the surface. The water is transmitted through the sands with larger volumes occurring in the more cavernous sections. The massive sand sections will drill firm but with good penetration with rock bits. The cavernous or open sections will drill broken with rock bits. The limestone layers are relatively thin, but may require "button bits" for satisfactory penetration. The dolomite layers are also expected to be fairly thin in relation to total formation thickness. These zones will drill hard, and will probably require "button bit" or down-hole air hammer drilling. It is anticipated that sufficient water flow will be encountered without fluid injection with air drilling.

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- Sandstone with interbedded shale and conglomerate at base. The sandstone may be platy and quartzitic and drill difficult because of its "dead" reaction to drilling pressure. Bit selection will range through those used in the Madison. Again, sufficient water should be encountered down hole to remove cuttings.

---

**Disclaimer:** The above descriptions and drilling interpretations are based on an on-site inspection of bedrock outcrops, combined with other knowledge and publication research. These descriptions and interpretations may or may not represent actual sub-surface site or drilling conditions. The Contractor is urged to visit the site and assure himself of site conditions prior to tendering a drilling project bid.

John McLellan, Geologist 11/24/82
PROPOSED DRILLING PLAN
GLENROCK ARTESIAN TEST WELL #1

STEP 1: DRILL, INSTALL & CEMENT MINIMUM 12" STEEL CASING TO DEPTH OF ± 30'.

STEP 2: DRILL OPEN 6 7/8" - 6" HOLE THROUGH CASPER FORMATION AND UPPER CAVERNOUS SECTION OF THE MADISON FORMATION. PERFORM PUMP TEST FOR PRODUCTION VOLUME. COLLECT 2 SAMPLES OF WATER FOR CHEMICAL ANALYSIS. OBSERVE EFFECT ON STREAM FLOW. REAM HOLE AND INSTALL & CEMENT 10" STEEL CASING TO DEPTH OF ± 330'. OBSERVE EFFECT ON STREAM FLOW.

STEP 3: DRILL OPEN 6" HOLE THROUGH REMAINDER OF THE MADISON LIMESTONE FORMATION. REAM TO 6 7/8". TEST FOR YIELD AND SAMPLE WATER. OBSERVE EFFECT ON STREAM FLOW.

STEP 4: DRILL OPEN 6" HOLE THROUGH FLATHEAD FORMATION AND TO GRANITE. TEST FOR YIELD AND SAMPLE WATER.

STEP 5: COMPLETION - DEPENDING UPON RESULTS: COMPLETE WELL AS A STANDBY WELL, USE AS AN OBSERVATION WELL, USE AS A STOCK WELL, OR COMPLETELY PLUG AND ABANDON.

NOTES: Down-hole drilling is to be accomplished with the use of air drilling and clear water injection should it be necessary. Should complete loss of circulation occur, it will be up to the driller and engineer's representative to determine a method of down-hole progression with the least detrimental effect to the well and groundwater.

DISCLAIMER: Specific down-hole conditions are unknown and cannot be accurately anticipated. This plan is based on assumed conditions inferred from the known lithology of the formation. These inferences may or may not be correct, and the drilling contractor should use his experience and judgement in bidding.
It is anticipated to use compressed air to blow and test the Casper formations during step two. Immediately thereafter, or as convenient during step two, the hole produced thus far will be electrologged. This will necessitate some down-time for the driller but will be coordinated and handled as expeditiously as possible.

After testing and logging the well, it will be reamed to allow installation of a 10" dia. casing to the depth of step two. Steps three and four will proceed as described, and again air pump testing will be conducted. Prior to step five, the bottom portion shall be electrologged and, at the discretion of the WWDC, mechanical pump testing will be performed. Step 5 will proceed as described.

During all of the processes outlined above, the flow of Little Deer Creek will be monitored using an appropriate flow section and a Stevens Type F water level surface recorder.

At each flow testing procedure, water samples will be taken according to accepted procedures and tested for water quality as pertains to drinking water quality parameters. On selected samples, total chemical testing will be conducted. Other testing as required by WWDC will be arranged for as requested by WWDC.

A representative of Nelson Engineering will be on the site at all times during the drilling and testing operations, and will be under the direct supervision of John McElihat, who will also be on-site on a periodic, on-demand basis. John lives in Casper and is therefore readily available. John will supervise the collection of cutting samples, monitor logging practices, and have the authority to establish the quality of geologic evidence returned from the well.

A revised copy of the Specifications and Contract Documents for this test well is attached and made a part hereof.
GENERAL

The Glenrock Town Council has authorized Nelson Engineering to investigate the possibilities of obtaining potable groundwater in sufficient supply to meet the Town's demand. This report will update the council on our findings and make a recommendation for investigative drilling.

AQUIFER

The aquifer that is the most promising is in the Tensleep Madison formation, sometimes referred to as the Casper formation. The formation surfaces in the Deer Creek Range of the Medicine Bow Mountains and dips to the North. The aquifer is recharged by the snow and rain that falls in the mountains and therefore is generally of good quality and low temperature. The Madison aquifer to the North of Glenrock is recharged by the same system, however, the quality of the water deteriorates as one gets further away from the source of recharge.

There are two good potential drilling sites near Glenrock. One is at the mouth of Little Deer Creek and the other is at the mouth of Box Elder Creek. The Little Deer Creek site is on State-owned land leased by the VR Ranch. This site is good because the Tensleep formation folds and possibly faults, thus providing a potential for fractures in the sandstone and limestone, which would allow the groundwater to flow more readily. This site also has a relatively large recharge basin which is the Little Deer Creek drainage basin.

The Box Elder site has potential for a very good well because the Tensleep formation has a more moderate dip. This site is geologically and topographically similar to the area where the Douglas Spring is located. In fact, there are two small springs in this area. The recharge basin is larger than the Little Deer Creek site. Geologically, the Box Elder site appears better than the Little Deer Creek site because of the known entity of the Douglas Spring; however, the possible fractures in the formations at the Little Deer Creek site could produce the same water productivity. The potential well sites at the mouth of Box Elder Creek are located on the Bixby and Hiser property.
EXPLORATORY DRILLING

Prior to drilling a large diameter production well, a small hole should be drilled into the formation to determine if the formation will transmit the quantity of water required. The "slim hole" should be drilled with an air rotary or hammer drill rig. A mud rotary rig could seal off a potential water bearing strata thus indicating a dry hole when actually there is water available. Samples of the cuttings should be collected and the hole logged to identify the type of formation and depth, however, the main objective is to determine if the water is there and to find out the quality and static water level of the aquifer.

Pronghorn Drilling of Glenrock has given us an estimated cost of $4 to $5 per foot for a 6 1/4 inch hole using a hammer drill. The estimated cost for the exploratory drilling is $4,000 to $5,000 per hole.

PIPELINE

The size and location of the pipeline which would transport the water into Town depends on a number of factors. The capacity of the well and the static water pressure will determine the size of the pipeline and whether or not a pump is required. Similarly, the terrain over which the pipeline crosses will influence the size and pumping requirements.

The cost of a pipeline from either site would be about the same. The elevation of the Little Deer Creek site and the terrain the pipeline would have to cross indicates that the water could flow by gravity into Town. The elevation of the Box Elder site and the ridges that have to be crossed would require a pump to get the water to Town. These statements are based on the assumption that the wells are free flowing; i.e., do not require pumping to get the water to the ground surface of the well.

The following cost estimate is based on a pipeline from the Little Deer Creek site into Town, however, the cost of pipeline from the Box Elder site would be very close to the same. Any pumps installed in the pipeline would increase the construction cost and add to the operation and maintenance expense.
COST ESTIMATE

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipeline</td>
<td>43,600 ft.</td>
<td>$348,800</td>
</tr>
<tr>
<td>Installation</td>
<td>43,600 ft.</td>
<td>$348,800</td>
</tr>
<tr>
<td>Blow-off Valves</td>
<td>10 ea.</td>
<td>$10,000</td>
</tr>
<tr>
<td>Vacuum Relief Valves</td>
<td>9 ea.</td>
<td>$10,000</td>
</tr>
<tr>
<td>Isolation Valves</td>
<td>25 ea.</td>
<td>$18,750</td>
</tr>
<tr>
<td>Highway Bore</td>
<td>500 ft.</td>
<td>$70,000</td>
</tr>
<tr>
<td>Production Well</td>
<td>LS</td>
<td>$150,000</td>
</tr>
</tbody>
</table>

SUBTOTAL: $956,350

10% Contingency
Legal, Administration and Engineering: $95,000
Right-of-Way and Land Purchase: $25,000
Construction Inspection: $50,000

TOTAL ESTIMATED COST: $1,222,000

Amortized cost at 11% for 20 years = $153,480

Approximate Number of Equivalent Residential Taps in 1982 = 1,100

Cost per tap per month = $11.63

The cost estimate assumes that the well will produce sufficient water to meet the average day demand in the year 2000 of 1,000 gpm or 1,440,000 gallons per day. These costs should be revised after the exploratory drilling and final drilling are complete.

As a method of comparison to other water sources, the Town of Hanna is currently constructing a 2 MGD water treatment plant at a construction cost of $823,600. Their cost did not include a river intake, nor does the cost include the legal, engineering and inspection cost.

Some possible funding sources for this project are the Wyoming Farm Loan Board, the Wyoming Water Development Commission and the Federal Farmers Home Administration. The application to any of these agencies would require a verification of the aquifer potential and Glenrock's need.

RECOMMENDATION

1. Obtain access from the landowners at each site and permission to drill a test hole.
2. Drill an exploratory test hole at the Little Deer Creek site and the Box Elder site to determine the best potential water source.
3. Prepare an application for grants or loans or both to the applicable agencies for funding.
As an alternative, the Council might consider drilling at only one site, however, this might limit the potential for obtaining a better well at the other site.
CONTRACT DOCUMENTS
AND
SPECIFICATIONS
FOR
TOWN OF GLENROCK
TEST WELL

Job No. 82-149-4
November 1982

Project Manager: Albert L. Nelson, PE & LS
NELSON ENGINEERING
430 S. Cache
Box 1599
Jackson, WY 83001
(307) 733-2087
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</tr>
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</table>
DESCRIPTION

The work to be performed under this contract shall consist of drilling, casing, developing, and testing of a test well as herein required. Hereinafter in these specifications, the DRILLER shall mean whosoever is successful in contracting to do this work, and the names DRILLER and CONTRACTOR shall mean the same person.

LANDSCAPE PRESERVATION

The Contractor shall confine his operations to the staked limits of the work. Any necessary disturbances outside the staked limits shall have prior written approval by the Engineer, and resulting disturbances shall be satisfactorily corrected at the Contractor's expense.

CLEANUP

Prior to closing of the contract, the Contractor will remove all equipment, tools, and excess materials from the area. Any unnecessary damage to the roads and landscape will be repaired at the Contractor's expense.

BARRICADES; DANGER, DETOUR, AND WARNING SIGNS

The Contractor shall provide, erect, and maintain all signs, flares, or lights as are necessary for the safety of the public.

EQUIPMENT STORAGE

The Contractor's equipment will be stored in areas designated by the Engineer. Care will be exercised that wastes from these areas do not contaminate nearby streams.

ACCESS TO WORK

Right-of-way for access to the work from existing roads will be provided by the Owner.

AVAILABILITY OF DATA

The following are submitted to assist the DRILLER in preparation of a BID and in planning the work to be done:

1. Location Map showing proposed access road.
2. Description and Drilling Interpretation.

All maps and drawings are attached as Appendix A of the Specifications.
DRILLER'S QUALIFICATION STATEMENT

Provide names, addresses, and telephone numbers of the last five (5) clients for which the driller has performed a similar service. The driller shall also submit to the Engineer a description of the equipment he proposes to utilize.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Measurement and payment of items described in this General Specifications shall be made under the specific Item Specifications which follow.
MOBILIZATION-DEMOBILIZATION

DESCRIPTION

"Mobilization" covers the costs of preparatory work and operation including but not limited to those necessary for the movement of personnel, equipment, supplies, and incidentals to the project site; for the establishment of all offices, buildings, and other facilities necessary for the work on the project and for all other work and operations which must be performed, or costs incurred prior to beginning work on the various items on the project.

"Demobilization" covers the costs of cleaning the job site and restoring the site to approximately the condition at the beginning. This includes dismantling any equipment and removing it from the site as well as removing any rubbish, litter, or other similar material. The ground surface shall be dressed smooth by raking or sweeping, as appropriate. Replanting with grass is not covered under this item, but is paid for separately if called for in the Bid Schedule.

METHOD OF MEASUREMENT

When the percentage of the original contract amount for each unit shown below is earned, the percentage of the contract lump sum price for "Mobilization-Demobilization" shown below will be paid.

<table>
<thead>
<tr>
<th>Percentage of Original Contract Amount Earned</th>
<th>Percentage of Lump Sum Price for Mobilization-Demobilization Earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>30</td>
<td>75</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

BASIS OF PAYMENT

Payment for "Mobilization-Demobilization" will be based on the percentage of the Lump Sum price bid for this item in accordance with the above schedule.
WELL DRILLING

DESCRIPTION

This item shall consist of drilling the well of the diameter and depth prescribed in the Schedule of Items, or to the depths determined necessary to provide the required tests as determined by the Engineer.

CONSTRUCTION METHODS

Drilling - The Contractor shall drill a well at the location designated and staked by the Engineer. The well shall not be less than the size indicated in the Schedule of Items, and drilled to the depth determined by the Engineer, but not to exceed a maximum depth below ground surface of 650 feet. Wells directed to be drilled below this maximum depth will be ordered in accordance with the "Changes" provisions of the contract.

During the progress of the work, after penetration of each important water-bearing stratum, the Contractor shall be prepared to test the well in accordance with this specification as directed by the Engineer to determine the water yield at that level.

The Contractor shall drill the well straight and plumb, and not deviate from the straight and plumb line by an amount sufficient to prevent lowering free to the bottom of the completed well an 8-foot section of well casing with a 2-inch smaller inside diameter than the size called for in the Schedule of Items, with couplings at both ends and in the center. If the drilling fails to meet this specification, the Contractor agrees to correct the alignment at his own expense, or, failing to correct the alignment, to drill another well at his own expense at a point designated by the Engineer. This test is to be performed in the presence of the Engineer or his authorized representative.

Drilling in Unconsolidated Material - Where drilling proceeds through unconsolidated material, conventional drilling, mud and casing installation procedures may be employed.

Drilling of Casper Formation - The Casper formation shall be drilled and tested as directed by the Engineer. At completion of the testing, casing shall be set to isolate the Casper formation from the remaining Madison and Flathead formations.

Drilling of Madison and Flathead Formations - After testing and casing the Casper formation, the driller shall drill and test the Madison and Flathead formations as directed by the Engineer.

Abandoned Wells - In the event the Engineer determines that a well should be abandoned, any remaining uncompleted Contract shall be cancelled in writing, without prejudice to either the Contractor or the Owner. Payment will be made for all items of work or portions thereof completed prior to notice of such cancellation. Any well which is abandoned in this manner shall be cemented closed to protect the water-bearing formations against possible contamination.
Wells relocated for the convenience of the Contractor after commencement of drilling operations will not be considered as abandoned under this clause. All well holes left by relocation of the well sites shall be cemented closed.

Daily Shift Record - The Contractor shall furnish the forms and keep a daily shift record for each hole drilled, recording the following data on the forms required in the particular state in which work is being performed:

A. Depth, thickness, type, and general character, and drilling characteristics of each material encountered during each drilling shift.

B. Depth, thickness, and bailing test results of each water-bearing zone encountered.

C. Length of casing installed during each drilling shift.

D. Depth of fluid level in the hole below some predetermined point, referenced to ground level, at the beginning and end of each drilling shift, and any appreciable change in fluid level during drilling.

E. Depth range of perforated zones, including width, length, spacing, and locations of perforations.

F. Time interval between readings.

The Daily Shift Record shall be kept carefully and accurately, with entries made in sequence so that each may be correlated with the depth of the hole. The shift record shall be complete at the end of each shift and shall be open to inspection at any time. Four complete written copies of the daily shift record shall be delivered to the Engineer within 15 days after performance of all work on each hole, whether the hole is completed or abandoned.

At any time during the progress of the work, the Engineer, using his own equipment and facilities, may make measurements or observations sufficient for him to keep a record corresponding to that kept by the driller. No shutdown time shall be allowed for such observations.

Log of the Hole - The Contractor shall keep an accurate record of the location of the top and bottom of each stratum penetrated, and shall record the type and general character of each material encountered. The log shall be kept up to date, and shall be open for inspection by the Engineer at any time during the work. Four complete written copies of the log shall be prepared and shall be delivered to the Engineer within 15 days after performance of all work on each hole, whether the hole is completed or abandoned. One copy of the log will be sent by the Contractor to the office of the State Engineer in the State in which the well is drilled.
Mudding Agents - No sand, dirt, rocks, mud, old drillings or bailings, or any other foreign materials from the land surface shall be allowed to fall into any hole being made. It is preferred that no mudding agent be used at all. If absolutely necessary to use drilling sludge, then Contractor shall use commercial bentonite or other appropriate commercial mudding agent. Such mud can be used only to the top of the aquifer, as directed by the Engineer, but in no case below the aquifer. Mudding agents are only to be used at Engineer's direction.

Sampling of Materials Penetrated - The Contractor shall collect, properly label, and deliver to the Engineer a one-quart sample of material taken at every change of material, or after each 10 feet of drilling if no material change occurs. In addition, the materials from each water-bearing stratum shall be sampled and properly labeled. The Contractor shall furnish wax paper or plastic containers for all samples, and shall deliver them to the Engineer for mechanical analysis.

METHOD OF MEASUREMENT

The quantity comprising the well drilling as herein described shall be measured as follows:

Well Drilling - The lineal feet of well of 6" diameter, drilled and accepted shall be the primary bid. For as long as the driller makes five feet per hour or more, plus one hour at a lesser amount, he will be paid at the specified rate per foot. The hourly rate for the drilling rig and all accessory equipment shall be the secondary bid. Whenever the driller makes less than five feet per hour, minus the first such hour of such condition, he will be paid at the specified rate per hour.

Down-hole Air Hammer Drilling - Shall be undertaken only as directed by the Engineer. The price shall be per lineal foot for the 6" diameter well drilled. The price per foot shall include furnishing the bit and all accessories necessary for the drilling as directed.

Casing - Casing shall be measured by the lineal foot of the diameter casing actually installed in the well as designated either "Surface Casing" or "10" casing".

Drilling Bits - The driller shall furnish the surface bit to install surface casing and two (2) rock bits as part of the cost of well drilling as defined above. Additional rock bits will be furnished by the driller at a price per each bit. Button bits, if required, shall be supplied by the driller at a price per each bit.

Developing and Testing - All developing and testing shall be on a per hour rate which shall cover the cost of the drilling rig, compressors, and all accessory items required to test the formations as directed by the Engineer.
BASIS OF PAYMENT

The quantities measured as provided above shall be paid for at the contract unit price for "Well Drilling, Per Foot", "Well Drilling, Per Hour", "Drilling Bits - Rock", "Drilling Bits - Button", "Down-hole Air Hammer Drilling, Per Foot", "Surface Casing, Per Foot", "10" dia. Casing, Per Foot", or "Developing and Testing, Per Hour". These prices, and the payment thereof, shall constitute full compensation for drilling the well; bailing the well as necessary; sampling the materials; providing the logs; and for all labor, materials, hauling, equipment, tools and incidentals necessary to complete the item as prescribed.
### GLENROCK ARTESIAN TEST WELL #1

<table>
<thead>
<tr>
<th>AGE</th>
<th>FORMATION</th>
<th>DESCRIPTION AND DRILLING INTERPRETATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unconsolidated, valley fill silt, sand &amp; gravel soils with water table below stream level.</td>
</tr>
</tbody>
</table>

- **Pennsylvanian**
  - **Casper**
    - 30': Sandstone with interbedded layers of limestone and dolomite. Dolomite conglomerate at the base. This formation carried an estimated 450 - 900 GPM under sufficient hydrostatic pressure to rise to the surface. The water is transmitted through the sands with larger volumes occurring in the more cavernous sections. The massive sand sections will drill firm but with good penetration with rock bits. The cavernous or open sections will drill broken with rock bits. The limestone layers are relatively thin, but may require "button bits" for satisfactory penetration. The dolomite layers are also expected to be fairly thin in relation to total formation thickness. These zones will drill hard, and will probably require "button bit" or down-hole air hammer drilling. It is anticipated that sufficient water flow will be encountered without fluid injection with air drilling.

- **Mississippian**
  - **Madison**
    - 225': Limestone and dolomite, massive to thin bedded with caverns in upper part and sandy at base. The upper portion will drill fairly hard and broken. The remainder of the section will drill hard. Bit selection will range from rock bit to "button bit" and/or air hammer bit to maintain adequate penetration. Hopefully, sufficient artesian water will be produced through this section to maintain circulation with air; if not, it may be necessary to inject clear water from the adjacent stream to maintain circulation.

- **Cambrian**
  - **Flathead**
    - 105': Sandstone with interbedded shale and conglomerate at base. The sandstone may be platy and quartzitic and drill difficult because of its "dead" reaction to drilling pressure. Bit selection will range through those used in the Madison. Again, sufficient water should be encountered down hole to remove cuttings.

- **Pre-Cambrian**
  - **Granite**
    - Bottom of hole.

### DISCLAIMER:
The above descriptions and drilling interpretations are based on an on-site inspection of bedrock outcrops, combined with other knowledge and publication research. These descriptions and interpretations may or may not represent actual sub-surface site or drilling conditions. The Contractor is urged to visit the site and assure himself of site conditions prior to tendering a drilling project bid.

John McLellan, Geologist 11/24/82
PROPOSED DRILLING PLAN
GLENROCK ARTESIAN TEST WELL #1

STEP 1: DRILL, INSTALL & CEMENT MINIMUM 12" STEEL CASING TO DEPTH OF ± 30'.

STEP 2: DRILL OPEN 6 7/8" - 6" HOLE THROUGH CASPER FORMATION AND UPPER CAVERNOUS SECTION OF THE MADISON FORMATION. PERFORM PUMP TEST FOR PRODUCTION VOLUME. COLLECT 2 SAMPLES OF WATER FOR CHEMICAL ANALYSIS. OBSERVE EFFECT ON STREAM FLOW. REAM HOLE AND INSTALL & CEMENT 10" STEEL CASING TO DEPTH OF ± 330'. OBSERVE EFFECT ON STREAM FLOW.

STEP 3: DRILL OPEN 6" HOLE THROUGH REMAINDER OF THE MADISON LIMESTONE FORMATION. REAM TO 6 7/8". TEST FOR YIELD AND SAMPLE WATER. OBSERVE EFFECT ON STREAM FLOW.

STEP 4: DRILL OPEN 6" HOLE THROUGH FLATHEAD FORMATION AND TO GRANITE. TEST FOR YIELD AND SAMPLE WATER.

STEP 5: COMPLETION - DEPENDING UPON RESULTS: COMPLETE WELL AS A STANDBY WELL, USE AS AN OBSERVATION WELL, USE AS A STOCK WELL, OR COMPLETELY PLUG AND ABANDON.

NOTES: Down-hole drilling is to be accomplished with the use of air drilling and clear water injection should it be necessary. Should complete loss of circulation occur, it will be up to the driller and engineer's representative to determine a method of down-hole progression with the least detrimental effect to the well and groundwater.

DISCLAIMER: Specific down-hole conditions are unknown and cannot be accurately anticipated. This plan is based on assumed conditions inferred from the known lithology of the formation. These inferences may or may not be correct, and the drilling contractor should use his experience and judgement in bidding.
BID

PROJECT IDENTIFICATION: Test Well for the Town of Glenrock, Wyoming

Bid Submitted To:

Nelson Engineering
P.O. Box 1599
Jackson, Wyoming 83001

1. The undersigned BIDDER proposes and agrees, if this Bid is accepted, to enter into a Subcontract Agreement with NELSON ENGINEERING, as Prime Contractor to the Town of Glenrock, in the form included in the Contract Documents, and to complete all work as specified or indicated in the Contract Documents.

2. This Bid will remain open for sixty days after the day of Bid opening. BIDDER will sign the Agreement and submit other documents required within five days after the date of Notice of Award.

3. In submitting this Bid, BIDDER represents, as more fully set forth in the Agreement, that:

   (a) BIDDER has examined copies of all the Contract Documents and of the following addenda:

      Date  Number

      ____________________________  ____________________________
      ____________________________  ____________________________
      ____________________________  ____________________________

      (receipt of all of which is hereby acknowledged)

   (b) BIDDER has examined the site and locality where the Work is to be performed, the legal requirements (federal, state and local laws, ordinances, rules and regulations) and the conditions affecting cost, progress or performance of the Work and has made such independent investigations as BIDDER deems necessary;

   (c) This Bid is genuine and not made in the interest of, or on behalf of any undisclosed person, firm or corporation and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation;
BIDDER has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid; BIDDER has not solicited or induced any person, firm or corporation to refrain from BIDDING; and has not sought by collusion to obtain for himself any advantage over any other BIDDER or over ENGINEER; and

4. BIDDER will complete the Work for the following price(s):

<table>
<thead>
<tr>
<th>NO.</th>
<th>ITEM</th>
<th>UNIT</th>
<th>UNIT PRICE</th>
<th>AMOUNT</th>
<th>TOTAL PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mobilization/Demobilization</td>
<td>L.S.</td>
<td>$_________</td>
<td>L.S.</td>
<td>$_________</td>
</tr>
<tr>
<td>2</td>
<td>Well Drilling, per foot</td>
<td>Foot</td>
<td>$_________</td>
<td>690'</td>
<td>$_________</td>
</tr>
<tr>
<td>3</td>
<td>Well Drilling, per hour</td>
<td>Hour</td>
<td>$_________</td>
<td>20 hrs.</td>
<td>$_________</td>
</tr>
<tr>
<td>4</td>
<td>Down-hole Air Hammer Drilling</td>
<td>Foot</td>
<td>$_________</td>
<td>100'</td>
<td>$_________</td>
</tr>
<tr>
<td>5</td>
<td>Surface Casing 12&quot; dia.</td>
<td>Foot</td>
<td>$_________</td>
<td>30'</td>
<td>$_________</td>
</tr>
<tr>
<td>6</td>
<td>10&quot; Casing</td>
<td>Foot</td>
<td>$_________</td>
<td>330'</td>
<td>$_________</td>
</tr>
<tr>
<td>7</td>
<td>Drilling Bits-Rock</td>
<td>Each</td>
<td>$_________</td>
<td>5</td>
<td>$_________</td>
</tr>
<tr>
<td>8</td>
<td>Drilling Bits-Button</td>
<td>Each</td>
<td>$_________</td>
<td>2</td>
<td>$_________</td>
</tr>
<tr>
<td>9</td>
<td>Developing &amp; Testing</td>
<td>Hours</td>
<td>$_________</td>
<td>24 hrs.</td>
<td>$_________</td>
</tr>
</tbody>
</table>

TOTAL OF BID $_________
5. BIDDER agrees that the Work will be completed on or before the date, or within the number of calendar days indicated below:

will be completed by the ________ day of ____________________, 19______.

6. The following documents are attached to and made a condition of this Bid:

(a) A tabulation of Subcontractors and other persons and organizations required to be identified in this Bid.

(b) Required Bidders Qualification Statement with supporting data.

7. Communications concerning this Bid shall be addressed to:

Albert Nelson

Nelson Engineering

P.O. Box 1599, Jackson, Wyoming 83001

The address of BIDDER indicated below; or to the following address:

SUBMITTED on ____________________, 19______

If BIDDER is:

AN INDIVIDUAL

By ___________________________ (Seal)

doing business as ____________________________

Business address: ____________________________

Phone No.: ____________________________
A PARTNERSHIP
By __________________________ (Firm Name) (Seal)

__________________________ (general partner)

Business address: __________________________

Phone No.: __________________________

A CORPORATION
By __________________________ (Corporation name)

__________________________ (state of incorporation)

By __________________________ (name of person authorized to sign)

(Title)

(Corporate Seal)

Attest __________________________ (Secretary)

Business Address: __________________________

Phone No.: __________________________

A JOINT VENTURE
By __________________________ (Name)

__________________________ (Address)

By __________________________ (Name)

__________________________ (Address)

(Each joint venturer must sign. The manner of signing for each individual, partnership and corporation that is a party to the joint venture should be in the manner indicated above).
This Agreement is dated as of the ________________ day of ____________________ in the year ________ by and between __________________________ (hereinafter called Engineer), and __________________________ (hereinafter called Driller).

Engineer and Driller, in consideration of the mutual covenants hereinafter set forth, agree as follows:

Article 1. Work

Driller shall complete all work as specified or indicated in the Contract Documents. The work is generally described as follows:

Drilling a test well for the Town of Glenrock, Wyoming, as a test of Casper/Madison/Flathead formations near the mouth of Little Deer Creek in Converse County, Wyoming.

Article 2. Engineer

The Project has been designed by Nelson Engineering as prime contractor for the Town of Glenrock, Wyoming, who is herein subcontracting with the Driller on behalf of the Town. Nelson Engineering is herein called Engineer, and will assume all duties and responsibilities and will have the rights and authority assigned to Engineer in the Contract Documents in connection with completion of the work in accordance with the Contract Documents.

Article 3. Contract Time

3.1 The work will be completed on or before __________, 19_____, and ready for final payment on or before __________, 19_____, (41 days after completion).

Article 4. Contract Price

4.1 Engineer shall pay Driller for performance of the work in accordance with the Bid in current funds as follows: (here, insert a Bid Schedule and unit prices) ____________________________

(CONTRACTOR's Bid may be attached as an exhibit to avoid lengthy retyping of unit price schedules, formulae for escalation of prices, information as to alternatives, etc.)
Article 5. PAYMENT PROCEDURES

Contractor shall submit monthly Applications for Payment which will be processed by ENGINEER.

5.1 Progress Payments. ENGINEER shall make progress payments on account of the Contract Price on the basis of DRILLER's Applications for Payment on or about the 15th day of each month during the work as provided below. All progress payments will be on the basis of the progress of the Work measured by the schedule of values provided for in paragraph 4.1 above.

5.1.1 Prior to completion, progress payments will be in an amount equal to:

- 90% of the Work completed, and
- 90% of materials and equipment not incorporated in the Work but delivered and suitably stored, less, in each case, the aggregate of payments previously made.

5.2 Final Payment. Upon final completion and acceptance of the Work, ENGINEER shall pay the remainder of the Contract Price.

Article 6. INTEREST

All moneys not paid when due hereunder shall bear interest at the maximum rate allowed by law at the place of the Project.

Article 7. DRILLER'S REPRESENTATIONS

In order to induce ENGINEER to enter into this Agreement, DRILLER makes the following representations:

7.1 DRILLER has familiarized himself with the nature and extent of the Contract Documents, Work, locality, and with all local conditions and federal, state and local laws, ordinances, rules and regulations that in any manner may affect cost, progress or performance of the Work.

7.2 DRILLER has studied carefully all reports of investigations and tests of subsurface and latent physical conditions at the site or otherwise affecting cost, progress, or performance of the Work, which were relied upon by ENGINEER, in the preparation of the Contract.

7.3 DRILLER has given ENGINEER written notice of all conflicts, errors or discrepancies that he has discovered in the Contract Documents, and the written resolution thereof by ENGINEER is acceptable to DRILLER.
Article 8. CONTRACT DOCUMENTS

The Contract Documents, which comprise the entire agreement between ENGINEER and DRILLER, are attached to this Agreement, made a part hereof, and consist of the following:

8.1 This Agreement (pages 1 to _____ inclusive).

8.2 Exhibits to this Agreement (pages_____ to____ inclusive).

8.3 Notice of Award.

8.4 Specifications bearing the title______________ and consisting of______ divisions and _______ pages, as listed in Table of Contents thereof.

8.5 Addenda numbers____ to_____, inclusive.

8.6 DRILLER's Bid (pages____ to_____, inclusive) marked Exhibit_______ (attach Bid Form only in special circumstances).

8.7 Documentation submitted by DRILLER prior to Notice of Award (pages____ to_____, inclusive)

8.8 Any Modification, including Change Orders, duly delivered after execution of Agreement.

There are no Contract Documents other than those listed above in this Article 8. The Contract Documents may only be altered, amended or repealed by a Modification agreed to in writing by both parties to this contract.

Article 9. OTHER PROVISIONS

IN WITNESS WHEREOF, the parties hereto have signed this Agreement in triplicate. One counterpart each has been delivered to GLENROCK, DRILLER, and ENGINEER. All portions of the Contract Documents have been signed or identified by GLENROCK and DRiller, or by ENGINEER on their behalf.

This Agreement will be effective on ______________, 19_____

ENGINEER________________________ DRILLER________________________

By______________________________ By______________________________

(Corporate Seal)

Attest__________________________ Attest__________________________

Address for giving notices________________________

________________________

License No. ________________