1 INTRODUCTION

Test Well #2A (TW#2A) for the Gillette Madison Pipeline Project is located in the SW1/4, NE1/4, SW1/4, SE1/4 of Section 36, T.52N., R.67W. of the 6th Principal Meridian (W.R.M.), Crook County, Wyoming, at 740,040.98 East, 1,437,156.93 North, State Plane (Wyoming East Zone) (Figure 1).

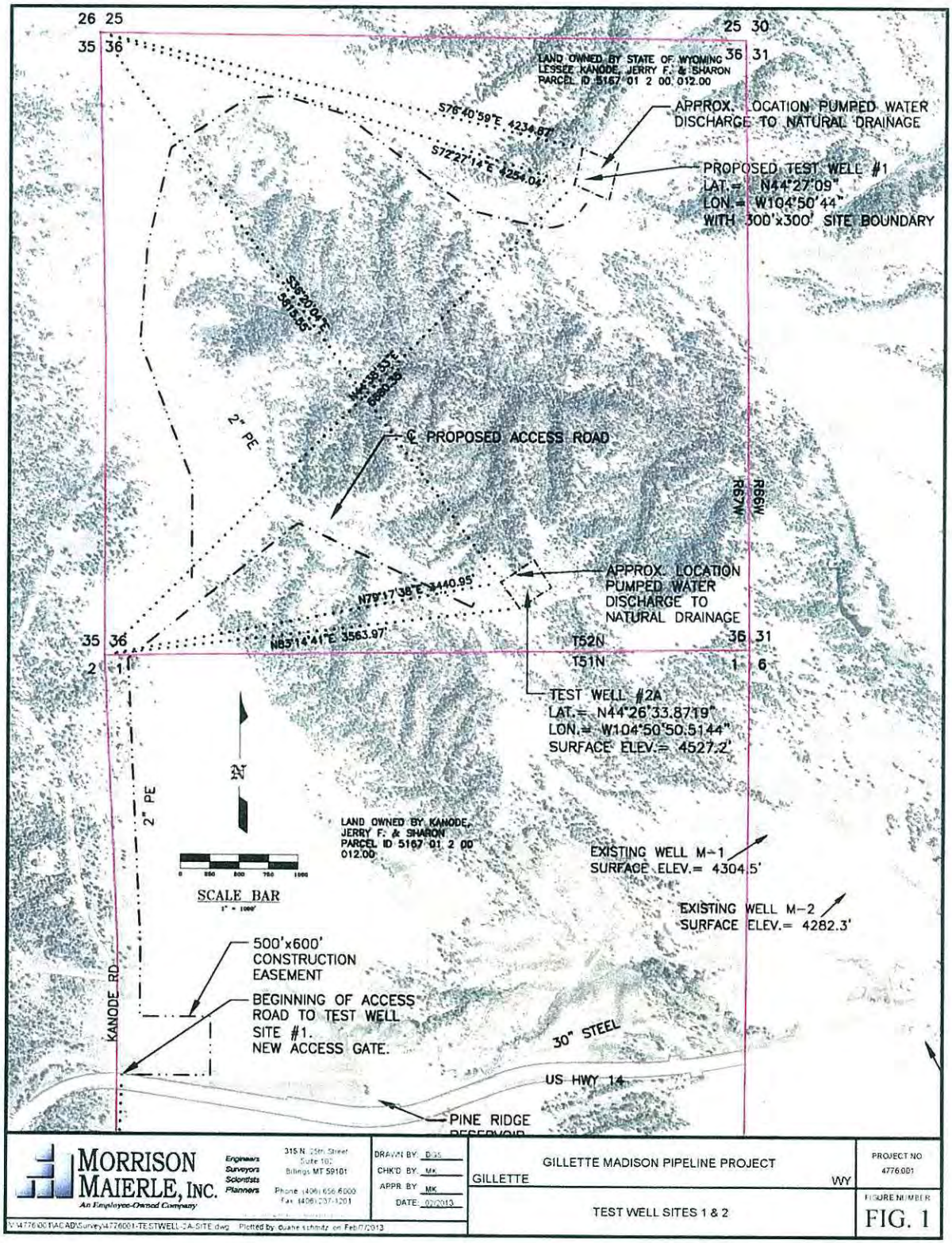
Test Well #2A is part of a groundwater development program implemented by the City of Gillette, Wyoming, as an element of on-going expansion of its sources of water supply in order to meet existing and future demands. Evaluation of potential sources of water in the region around Gillette, including both surface water and groundwater resources, was completed by the City of Gillette in 2007 (Morrison-Maierle, 2007). The 2007 Level II study identified the Madison aquifer in the vicinity of the existing City of Gillette Madison Well Field, north of Key Hole Reservoir and Moorcroft, as the most favorable alternative for future development of additional water supply from the standpoint of long-term resource quantity and reliability.

Test wells at site #2 were drilled to verify the Madison aquifer yield and water quality at one of two sites selected for evaluation by work following the 2007 Level II study. The sites are referred to on Bid Documents and plans as test well sites #1 and #2. Test well drilling commenced first at test well site #2 during construction of access road to test site #1. Therefore, Test Well #2 and Test Well #2A were drilled before Test Well #1. Test Well #2 was abandoned due to lost tools and was replaced by Test Well #2A which is at an offset location from Test Well #2 on the same drilling pad.

1.1 Test Well #2

Rig up at Test Well #2 began 10/25/2011. A 14-3/4 inch diameter pilot hole was drilled to a total depth of 1626 feet by 11:30 a.m. on 11/21/2011 after dealing with repeated total loss of circulation beginning at a depth of 1585 feet on 11/18/2011. The pilot hole was reamed to a diameter of 22 inches, reaching a total depth of 1692 feet (66 feet deeper than the pilot hole) on 12/22/2011, while struggling with repeated loss of circulation, deteriorating borehole stability and drilling with formation water. After the Christmas holiday, starting 12/27/2011, all further efforts were focused on stabilizing the borehole. On 1/19/2012, while drilling out cement and pea gravel backfill at 888 feet, a tool joint was unscrewed at 210 feet, leaving drill pipe, drill collars and tools in the hole. Extensive attempts were made to recover the tools; however, fishing was unsuccessful and the hole was plugged and abandoned ending 2/8/2012. Tools remaining in the hole include a 14-3/4 inch pilot bit, a 22-inch reamer and sub, four 11-inch drill collars and one piece of 6-inch drill pipe with 9-inch tool joints with the top of the tool joint at 520 feet and the bottom of the bit and reamer assembly at 680 feet. The drill collars were shot off just above the reamer, but did not move after being cut by the shot. Disc 1 contains copies of the Daily Drilling Reports on IADC – API official daily drilling report forms and the construction history of Test Well #2 is described in section 3.4 Construction History, of this report. Appendix A is the drill cutting sample log with geologic interpretation for Test Well #2.

Figure 1: Location of Test Wells #1 and #2.



1.2 Test Well #2A

Following plugging and abandonment of Test Well #2 and resolution of contractual issues related to that effort, an offset site, Test Well #2A, was selected on the same drilling pad (Figure 2). The well design for Test Well #2A was modified to provide a deep surface casing to stabilize the borehole above the zone of lost circulation. Rigging up was completed on 6/14/2012 and drilling through the surface conduit on Test Well #2A began on 6/16/2012. A 14-3/4 inch diameter pilot hole was drilled to a total depth of 1529 feet by 7/8/2012, when loss of drilling fluid began and continued at an increasing rate. Geophysical logs were run on 7/9/2012 and reaming of the pilot hole to 32-inch diameter began on 7/10/2012, ending with 32-inch borehole to a depth of 1510 feet on 8/7/2012. The 32-inch borehole was cased with 24-inch casing to a depth of 1484 feet and pressure cemented on 8/10/2012.

The 24-inch surface casing stabilized the test well upper borehole. A 22-inch borehole was drilled from 1484 to 1868 feet and 16-inch casing was set to 1850 feet and cemented on 9/12/2012. A 14-3/4 inch borehole was completed to 2390 feet on 9/21/2012 and 10-3/4 casing was cemented from 1795 to 2385 feet on 9/23/2012 with the top of the Madison identified from 10-foot drill cutting samples at 2370 feet. The Madison aquifer section was drilled with a 9-7/8 button bit and 6,700 cfm of compressed air capability coupled to two 1600-psi boosters. The well was completed on 10/5/2012 at a total depth of 2891 feet. Figure 3 provides a schematic drawing of the well completion. Disc 1 contains the Daily Drilling Reports for Test Well #2A and the drill cutting sample log with geologic interpretation is provided in Appendix B.

On 10/18/2012, Test Well #2A was subjected to an initial stepped rate test, with one step at 510 gpm resulting in 407.9 feet of drawdown after 180 minutes of pumping time. A second step was initiated at 650 gpm, causing 537.6 feet of drawdown 20 minutes into the second step, before the test pump was stopped due to excessive vibration. The stepped rate test indicated hydraulic performance of the well was not acceptable.

Test Well #2A was stimulated with a 30,000-gallon treatment of 15% hydrochloric acid treatment on 11/13/2012. Following the hydraulic fracturing with acid, the well was subjected to a second aquifer test starting 12/3/2012, producing a constant rate of discharge of 1500 gpm for 2-minutes less than 48 hours, when the generator motor failed. After approximately 48 hours at 1500 gpm, drawdown in the well was 436.9 feet, showing substantial improvement in hydraulic performance compared to drawdown to 407.9 feet after pumping 500 gpm for 3 hours prior to the acid fracturing stimulation.

1.3 Permits and Certificate of Survey

Test Well #2 and #2A are located on State Lands. The Wyoming Board of Land Commissioners provided Temporary Use Permit No. 2119 to the City of Gillette for two test wells with drill pads and construction of an access road (Appendix C).

Figure 2: Locations of Test Wells #2 and #2A on drill pad.

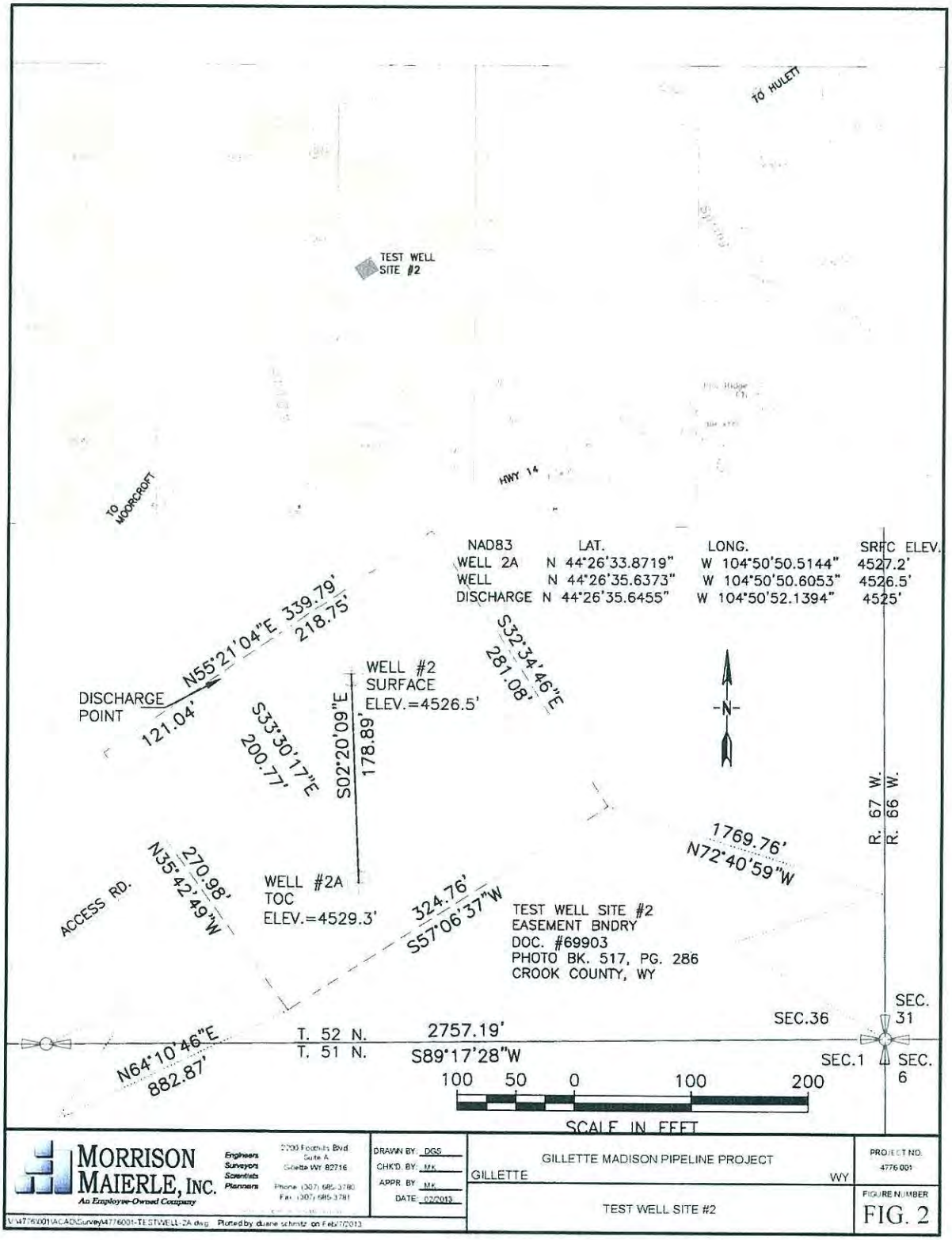
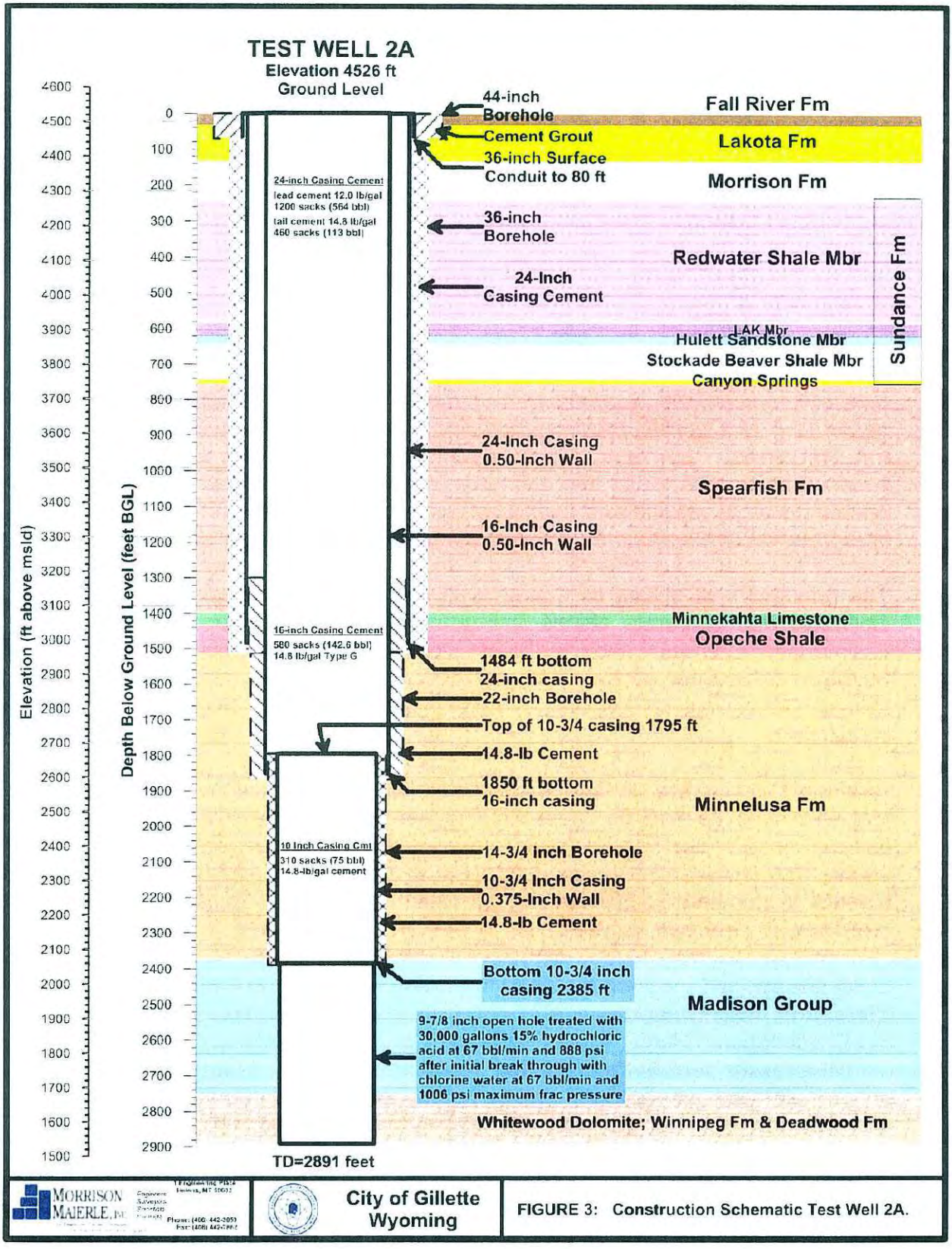


Figure 3: Well completion drawing for Test Well #2A.



The priority date of Permit No. U.W. 195672 is February 16, 2011. The Wyoming Office of the State Engineer (SEO) provided Permit No. U.W. 195672 to the City of Gillette for construction of a well referred to as "MADISON 12" in the NW1/4, NE1/4, Section 36, T.52N., R.67W (Appendix C). The permit was extended in late 2012.

The Wyoming Department of Environmental Quality (DEQ) issued to the City of Gillette, Permit to Construct, Permit No. 11-067, City of Gillette Madison Well 12, Madison Pipeline Project, issued 7/20/2011. The DEQ also provided the Layne Christensen Company authorization under the Wyoming Pollutant Discharge Elimination System (WYPDES) General Permit for Temporary Discharges, WYG72091 (Appendix C).

The Certificate of Survey for completed Test Well #2A (Madison Well M-12) is provided in Appendix D.

1.4 Consultants, Contractors and Support Services

Morrison-Maierle, Inc., working as a subconsultant to the design engineering consultant of Burns & McDonnell, provided geologic consulting services for selection of sites for the test wells. Likewise, Morrison-Maierle, Inc. provided civil engineering design services for access roads and drill pads, contract administration of the drilling contract, on-site geologic logging and hydrogeologic support for well completion, geophysical log interpretation and aquifer tests and construction and site surveying services.

The principal well drilling contractor was the Layne Christensen Company of Denver, Colorado with corporate offices in Fontana, California. Subcontractors to the Layne Christensen Company included Northstar Energy and Construction, LLC (formerly MGM) of Gillette for access road and drilling pad construction and Wyoming Caisson Drilling Companies of Gillette and Rat Hole Drilling of Casper for surface conduit installations.

Brannan Trucking Inc. of Gillette installed water line to provide drilling fluid water at the test well sites as well as water hauling services in the winter when water line was frozen. Jim's Water Service of Gillette provided initial water and mud hauling services; on-site frac tanks and used mud disposal services, all of which were later provided by Kissack Water and Oil Service, Inc. of Rozet. Ridgeway Trucking of Casper provided cross-country trucking services.

Local site support included fuel from the Farmers Coop Association of Gillette; motor oil, filters, and miscellaneous parts from NAPA in Sundance, site sanitation services from Big D Sanitation, Gillette; Ryan Sanitation Co., LLC, Gillette; and fork lift, generator and air compressor rentals from United Rentals in Gillette. Large generators used for primary electrical power to the drilling rig and mud pit pumps, as well as power for yield and drawdown test pumps, were provided by Wagoner Cat of Aurora, Colorado.

Machine shop services for resurfacing drill collars, fabricating replacement parts, and rebuilding various rig equipment were provided by L&H Industrial of Gillette. Claude's Welding Service, Inc. of Gillette provided welding of steel well casing and cementing

shoes, fabrication of casing hangers, and general rig repair and maintenance welding. Walker Inspection of Gillette provided inspection of drill pipe and drill collar tool joints.

Cement delivery and pumping for surface conduit (caisson) cementing was provided by Campbell County Concrete of Gillette. Drilling fluid products and mud engineering were provided by Baroid Industrial Drilling Products of Arvada, Colorado. Basic Energy Services of Gillette provided deep well casing cementing services and was supported by Maverick Stimulation Company, LLC of Fort Logan, Colorado for high-pressure, hydraulic fracturing stimulation of Test Well #2A with acid.

Oilfield support services for fishing tools were provided by Weatherford International, Inc. of Riverton, Wyoming. Downhole geophysical logs were provided by Goodwell Incorporated, Gillette; gyroscopic drift and deviation surveys were provided by Gyrodata Incorporated, of Casper with support from Pioneer Wireline Services based in Casper.

Other Gillette businesses that provided support and materials for the project included Blackhawk Crane, Powder River Supply, Contractors Supply, DXP Safety, Airgas, National Oilwell, Firemaster, Conway Freight, Howard Supply (Casper and Gillette for Rigging Certification), Promax Systems, Home Depot, J&T Oilfield Electric, Crumb Electric Supply, Crescent Electric, Wyoming Caterpillar, Carquest Auto Supplies, O'Reily Auto Supplies and East Side RV Services.

Fencing for the drill sites was installed by the Knode family who graze cattle on the State land where the wells are located and who provided insight to local concerns such as discharge of pumped water, potential for erosion and noise abatement.

Living quarters for the drilling crews and engineering and geologic support staff were obtained from the Best Western Motel, Gillette, the Rangeland Court Motel, Moorcroft, and the Empire Guest House, Pine Haven.

1.5 Start and Completion Dates

A caisson drill commenced installation of surface conduit for Test Well #2 (Madison 12) on 10/18/2011. The well was plugged and abandoned on 2/8/2012 after lost tools could not be recovered.

Drilling of Test Well #2A, an offset well, commenced 6/16/2012 through a surface conduit that was installed on 6/6/2012 and cemented on 6/7/2012. The well was completed at a total depth of 2891 feet on 10/5/2012. After an 11/13/2012 acid fracture treatment, the well was subjected to yield and drawdown tests with the final constant rate test conducted at 1500 gpm for 48 hours starting 12/3/2012.

2 GEOLOGY

The distribution, availability and long-term reliability of groundwater resources for water supply development by the City of Gillette, Wyoming, are dictated by the geology of the area. The differences between porosity and permeability of the various subsurface